Energy Efficiency Potential Study for the State of Kansas: Final Report

Prepared by Summit Blue Consulting, LLC

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This report was prepared by Summit Blue Consulting, LLC, on behalf of the Kansas Energy Council's 2007 Energy Conservation and Efficiency Committee. The conclusions contained in this report are based on the Summit Blue's analysis and have not been endorsed by the Kansas Energy Council.

KANSAS ENERGY COUNCIL
DSM POTENTIAL STUDY AND PLAN

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SUMMIT BLUE
CONSULTING, LLC

FINAL REPORT

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E EXECUTIVE SUMMARY

This section of the report provides a high-level overview of the project methodology and results.

E.1 Introduction and Overall Methodology

The Kansas Energy Council (KEC) hired Summit Blue Consulting (Summit Blue) and Energy Insights in late September 2007 to conduct an energy efficiency (EE) potential study for the state of Kansas. The overall project deliverables specified in the May 2007 request for proposal are: "…a report that provides technical, economic and market potential for metropolitan/suburban and rural Kansas by end use in the residential market and by industry segment and end use in the C&I markets." This deliverable was updated during the November 15, 2007 project initiation meeting and subsequent discussions to focus the energy efficiency potential results on each of the overall residential and non-residential (also referred to as Commercial & Industrial– C&I) sectors.

Project Scope of Work

The overall scope of work for the EE potential study is summarized below:

- Conduct a project initiation meeting with KEC staff and Energy Efficiency Committee members.
- Conduct a Midwest-focused DSM benchmarking and best practices analysis.
- Develop baseline consumption profiles and initial building simulation model specifications.
- Characterize energy efficiency measures that are appropriate for Kansas.
- Conduct benefit-cost analysis.
- Estimate energy efficiency potentials for the 2008-2028 period for residential and non-residential customers using a spreadsheet model.
- Prepare draft and final project reports and make a presentation to the KEC on the draft project results.

E.2 DSM Benchmarking and Best Practices Assessment

Data and information were collected for 2006 DSM program results for 24 utilities and energy agencies in the Midwest and across North America. This analysis of DSM program results normalized the reported total program results for utility or agency size and sales to major customer class.

- The achievement of significant DSM savings is influenced by several factors including: the regulatory environment under which utilities and agencies operate, how DSM projects are funded, how the issue of lost revenues is addressed, the provision of financial incentives for DSM performance, and other factors.

- British Columbia, Connecticut, California, Iowa, Massachusetts, Minnesota, and Vermont all achieved about 1% or more reductions in annual energy sales due to DSM programs in 2006 (or 2005). The electricity market structure is not a determining variable in DSM performance; most of the high achievers operated under a traditional market structure, but California is partially restructured. Nor does year that programs began appear to be a strong influence on savings achieved. All states achieving high DSM savings set significant mandated goals for utilities' DSM programs. Other success factors include financial incentives for cost-effective DSM (Minnesota, Vermont), adjustments for lost revenues caused by DSM programs (California), and use of the TRC test or societal test for cost-effectiveness rather than the RIM test (British Columbia, California, Iowa, Minnesota, Vermont).

Table E-1 shows the median electric results for DSM spending, savings, and costs overall for all reviewed organizations.

Table E-1: Medians for Overall Electric Results

Spending as % of Revenue	Energy Savings as % of Sales	Demand Savings as % of Peak Demand	Cost of Energy $/kWh	Cost of Savings	
				$/kWh	$/kW
1.8%	0.8%	0.6%	$0.08	$0.18	$836

San Diego Gas and Electric (SDG&E), National Grid (MA), and Interstate P&L (MN) have the highest electric spending rates at 2.8% to 3.6% of baseline revenues. SDG&E, IPL, Pacific Gas and Electric, and Southern California Edison have the highest electric energy savings as a percentage of baseline sales at 1.4% to 2.1% of sales. The scatter plot below portrays the utility electric energy savings and costs of conserved energy graphically.

Figure E-1: Scatter Plot of Electric Energy Savings and First Year Costs ($/kWh)

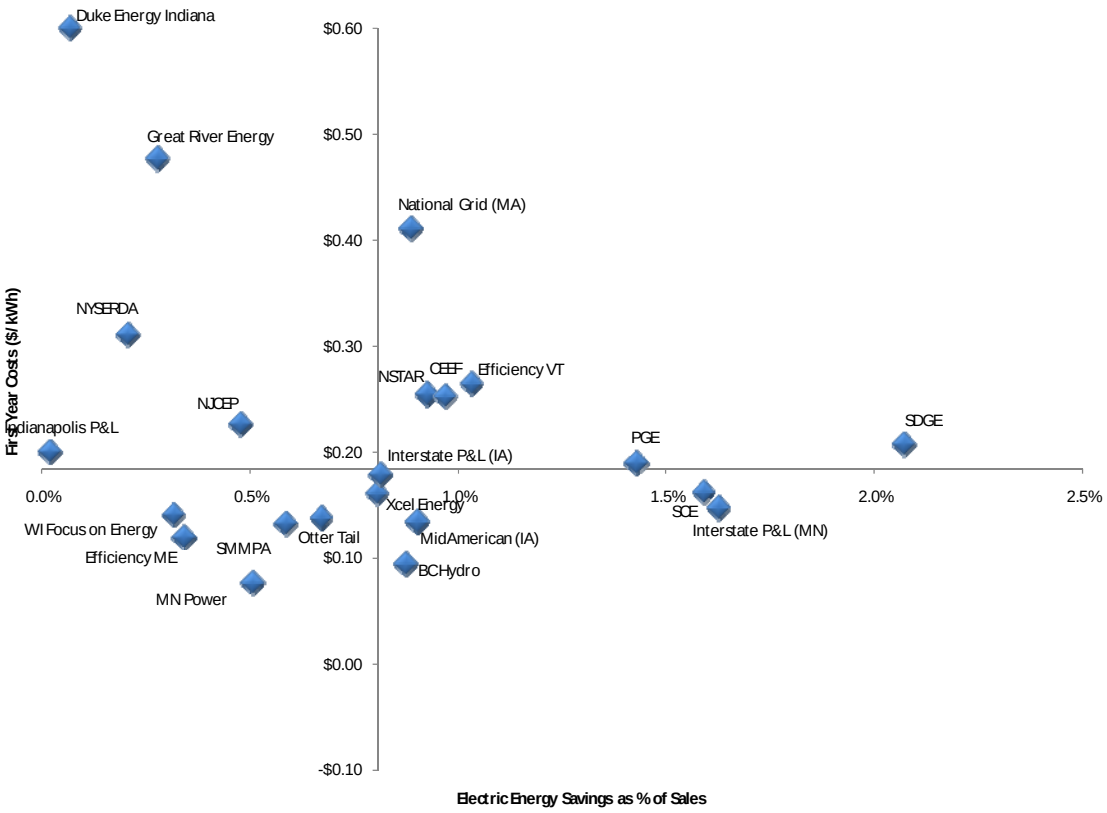


Table E-2 shows the median gas results for DSM spending, savings, and costs overall for all reviewed organizations.

Table E-2: Medians for Overall Gas Results

Spending as % of Revenue	Energy Savings as % of Sales	Cost of Energy $/Mcf	First Year Cost of Savings $/Mcf
2.4%	1.0%	$10.99	$22.17

MidAmerican Energy, IPL MN and IPL Iowa have the highest levels of gas DSM spending at about three percent of baseline sales. Xcel Energy (MN), IPL MN, and Aquila have the highest energy savings of the utilities reviewed at 1.1% to 1.5% of baseline sales.

The scatter plot below illustrates where each organization falls relative to median energy savings and median costs. The utilities listed below achieved above median energy savings as a percentage of sales at costs lower than the median cost:

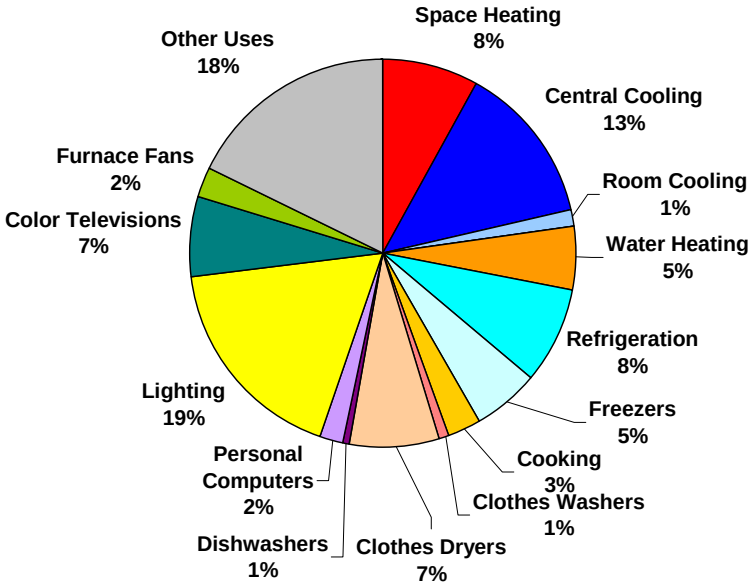
1. Interstate P&L (MN): 1.4%, $20.07/MCF
2. Xcel Energy: 1.5%, $5.78/MCF

Figure E-2: Scatter Plot of Natural Gas Savings and First Year Costs ($/MCF)

E.3 Baseline Energy Consumption Profiles

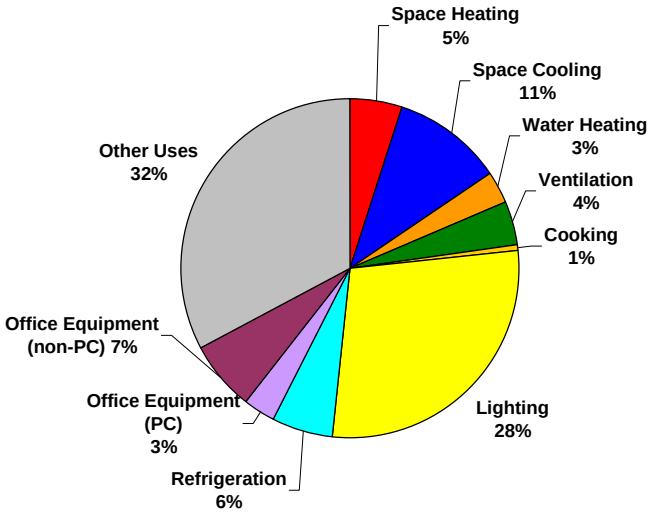
Energy Insights developed baseline market profiles for residential and non-residential customers based on information supplied by Kansas utilities, such as residential appliance saturation surveys, as well as Energy Insights' proprietary Energy Market Profiles information service, and US Energy Information Administration information. Representative pie charts for residential and commercial electricity consumption by end use are shown below. Additional pie charts for natural gas usage and industrial customers are presented in Chapter 4 of this report.

Figure E-3: Residential Electric Consumption Profile



The following pie chart shows the electric consumption profiles for commercial buildings.

Figure E-4: Commercial Electric Consumption Profile



E.4 DSM Measure Characterization and Benefit-Cost Analysis Results

To estimate the savings from installing high-efficiency equipment, we used the eQuest building simulation model. eQuest is a widely used non-residential building simulation model based on the DOE-2 model. The starting point for the analysis was a set of prototypes that are calibrated to the market and technology profiles presented previously. We calibrated the models by adjusting the equipment inventories in the eQuest files to be consistent with the baseline annual energy use by end use and technology profiles. This involved adjustments to five end uses: space heating, space cooling, water heating, interior lighting, and miscellaneous use.

Summit Blue evaluated 48 residential electric EE measures and 18 non-residential electric EE measures, as well as 15 residential gas EE measures and 8 non-residential gas EE measures. Representative and common examples of each technology type, such as compact fluorescent lamps, were analyzed.

Impacts for weather dependent measures such as HVAC were estimated using the eQuest building simulation model. For measures that are weather independent, engineering estimates and reputable published sources such as the California DEER database were used. Average avoided cost estimates were calculated from data provided by KCP&L and Midwest Energy.

The number of residential measures for each end use in this evaluation are as follows:

- 25 lighting energy efficiency measures.
- 10 electric and 8 gas cooling and heating energy efficiency measures, including building envelope measures.
- 7 electric and 2 gas refrigeration and appliance energy efficiency measures.
- 6 electric and 5 gas water heating energy efficiency measures.

The number of non-residential measures for each end use in this evaluation are as follows:

- 8 lighting energy efficiency measures.
- 3 electric and 6 gas cooling/heating/fan motors energy efficiency measures.
- 3 electric and 2 gas water heating energy efficiency measures.
- 4 electric custom and motors energy efficiency measures.

The measures were evaluated for cost effectiveness with respect to each of the four main California stakeholder tests:

1. **Participant Test:** measures are cost effective from this perspective if the reduced electric costs to the participating customer from the measure exceed the after-rebate cost of the measure to the customer.

2. **The Utility Cost Test (UCT):** measures are cost effective from this perspective if the costs avoided by the measures' energy and peak demand savings are greater than the utility DSM program costs to promote the measure, including customer rebates.

3. **Rate Impact (RIM) Test:** measures are cost effective from this perspective if their avoided costs are greater than the sum of the DSM program costs and the "lost revenues" caused by the measure.

4. **The Total Resource Cost (TRC) Test:** measures are cost effective from this perspective if their avoided costs are greater than the sum of the measure costs and the DSM program administrative costs. It should be noted that the magnitude of customer financial incentives offered through DSM programs does not affect the results of the TRC test.

In line with standard industry practice, Summit Blue used the TRC test as the main test to determine which EE measures and programs to include in the EE potential estimates for Kansas, since it is the most widely used test nationally, and is the main test used by the Kansas Corporation Commission. The RIM test is a more restrictive test that is only used as the main DSM "benefit minus cost" test in very few states.[1]

About 85% of non-residential measures analyzed passed the TRC test. About 75% of the residential electric measures passed the TRC test, while 56% of residential gas measures passed the TRC test.

E.5 DSM Potential Results

To perform its assessment of DSM potential, Summit Blue utilized their DSM Resource Assessment Model (DSM-RAM). This is an Excel spreadsheet model based on the integration of DSM measure impacts and costs, utility customer characteristics, utility load forecasts, and utility avoided costs and rate schedules.

DSM-RAM estimates DSM Resource Potential for a number of different perspectives. These include:

- **Technical DSM potential** means the amount of DSM savings that could be achieved, not considering economic and market barriers, to customers installing DSM measures. Technical potential is calculated as the product of the DSM measures' savings per unit, the quantity of applicable equipment in each facility, the number of facilities in a utility's service area, and 100% minus the measure's current market saturation. Technical potential estimates include DSM measures that may not be cost effective, and technical potential does not consider market barriers such as customer's lack of awareness of DSM measures. Therefore, technical DSM potential estimates do not provide a realistic basis for setting DSM program goals.

- **Economic DSM potential** means the amount of technical DSM potential that is "cost-effective," as defined by the results of the Total Resource Cost (TRC) test (or other preferred cost test). The program benefits for the TRC test include the avoided costs of generation, transmission and distribution investments and avoided fuel costs due to the conserved energy caused by the DSM

[1] Florida and Georgia, for example, require DSM programs to pass the RIM test.

programs. The costs for the TRC test are the DSM measure costs plus the DSM program administration costs. The TRC test does not consider economic or market barriers to customers installing DSM measures.

- **Achievable DSM market potential** is an estimate of the amount of DSM potential that could be captured by realistic DSM programs that include cost effective DSM measures over the forecast period covered by this DSM potential analysis. Achievable DSM potential can vary with DSM program parameters, such as the magnitude of rebates or incentives offered to customers for installing DSM measures and thus, many different scenarios can be modeled.

  For this study, five different achievable DSM market potential scenarios were developed. The five scenarios are different multipliers to the assumed base case incentive level. In all scenario cases, the incentive is capped at the incremental cost of the measure.

  - **The Base Case Incentive Scenario:** is either the incentive level currently found in many utilities across the country as identified in the "Best Practices" review, or set at 25% of the incremental capital cost of the measure.

  - **Scenario 1.5 * the Incentive Scenario:** has an incentive level one and one-half times larger than the base case (capped at incremental cost).

  - **Scenario 2.0 * the Incentive Scenario:** has an incentive level twice as large as the base case (capped at incremental cost).

  - **Scenario 2.5 * the Incentive Scenario:** has an incentive level two and one-half times larger than the base case (capped at incremental cost).

  - **Scenario 3.0 * the Incentive Scenario:** has an incentive level three times larger than the base case (capped at incremental cost).

Within the achievable DSM potential assessment, the individual measures are modeled by expected type of DSM program design. Three different program design options are included in DSM-RAM.

- **Replace on Burnout (ROB)** means that a DSM measure is not implemented until the existing technology it is replacing fails. An example would be an energy efficient clothes washer being purchased after the failure of the existing clothes washer.

- **Retrofit (RET)** means that the DSM measure could be implemented immediately. For instance, installing a low flow showerhead is usually implemented before an existing shower head fails. Replacing incandescent lamps may be an ROB but can be treated as a RET because of the relatively short lifetime for incandescent bulbs.

- **New Construction (New)** means measures that are installed at the time of new construction. Baseline technologies may be different in the new construction market and implementation costs are often different because a technology, either the energy efficient or base technology.

Residential Electric DSM Potential Results

Figure E-5 illustrates the DSM potential in the year 2028 for technical and economic potential along with five different DSM achievable market scenarios. For comparison purposes, the residential sector sales forecast for the year 2028 is also provided as the first column in the chart.

Figure E-5: Residential Sector Energy Savings (MWh) for 2028

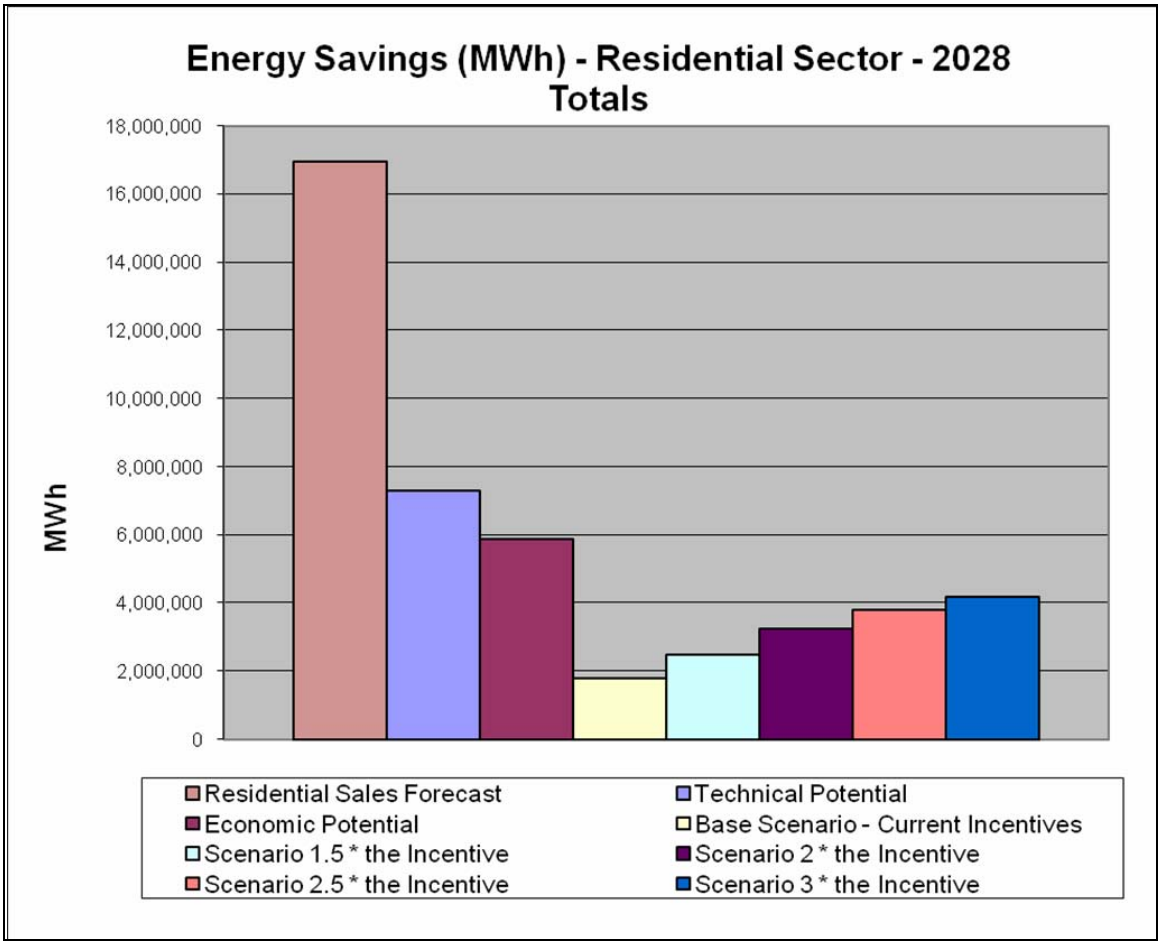


Table E-3 provides the values illustrated in Figure E-4. Technical potential is about 43% of forecasted 2028 residential sales. Economic potential is about 35% and the scenarios range from 11% to 25% of residential sales.

Table E-3: Residential Sector Energy Savings (MWh) for 2028

Energy Savings - Res Sector - 2028 Totals							
Residential Sales Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
16,946,778	7,300,604	5,873,088	1,810,652	2,479,647	3,266,360	3,807,367	4,179,867

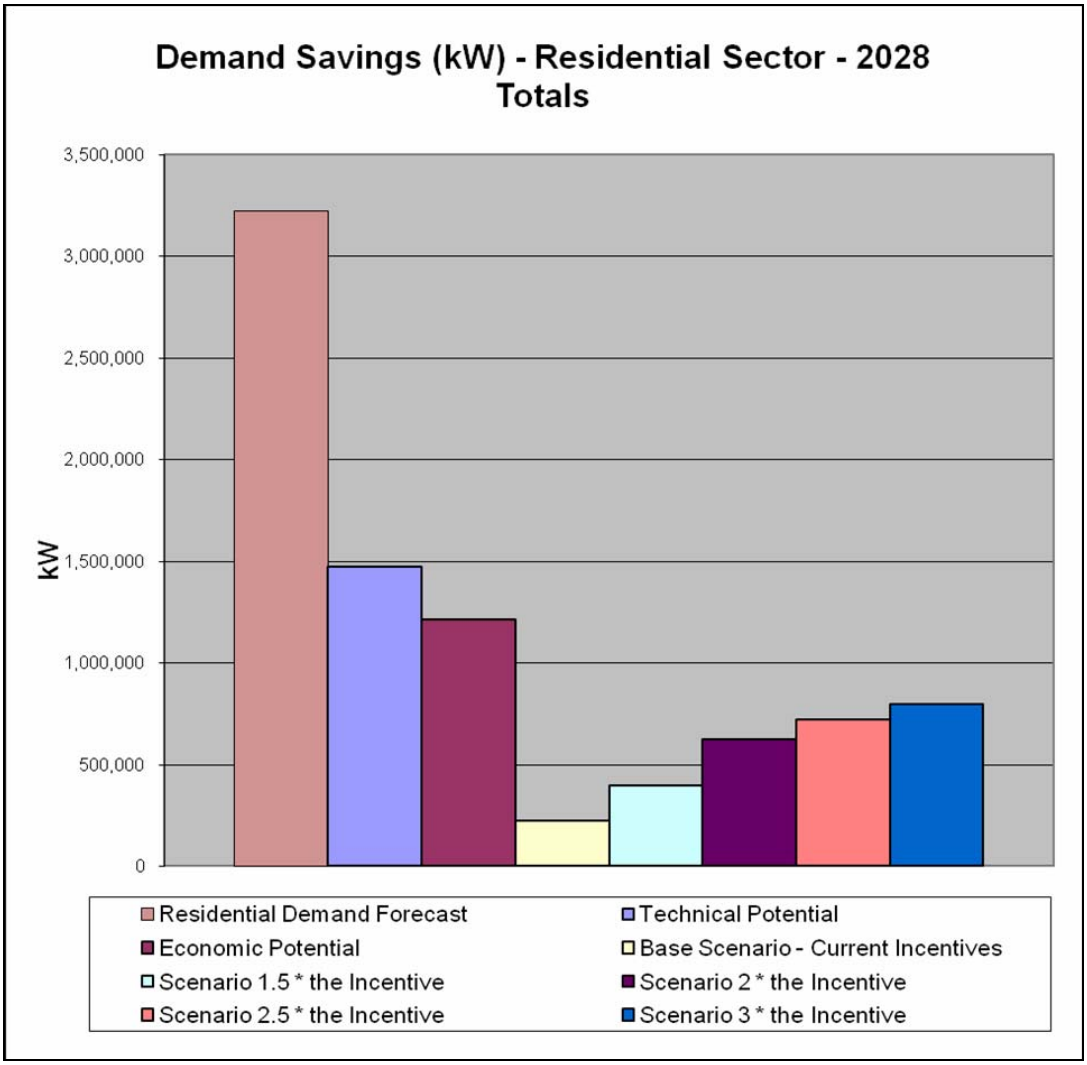
Figure E-6 illustrates the DSM peak demand reduction potential in the year 2028 for technical and economic potential along with five different DSM achievable market scenarios. As with Figure E-4, the residential sector peak demand forecast for the year 2028 is also provided as the first column in the chart. Table E-4 provides the values illustrated in Figure E-6.

Table E-4: Residential Sector Peak Demand Savings (MW) for 2028

Demand Savings - Res Sector - 2028 Totals							
Residential Demand Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
3,226,531	1,471,035	1,209,959	222,735	394,008	620,269	717,185	795,444

The potential estimates for peak demand are similar to those for energy when compared to the peak demand forecast. Technical potential is slightly higher at about 46% of forecasted 2028 residential peak demand. Economic potential is also slightly higher at about 38% and the scenarios range from 11% to 25% of residential peak demand.

Figure E-6: Residential Sector Peak Demand Savings (MW) for 2028



DSM-RAM is calibrated at the measure level to anticipated levels of savings as identified through the "Best Practices" review. The calibration targets for electric residential measures reflect the higher incidence of achieved savings from lighting programs as compared to the other end uses. Lighting measures represent 70% of the initial calibrated energy savings potential as compared to 20% for HVAC measures. The calibration within the base scenario also defines the decision making choice coefficients as determined by the current market place. Figure E-7 reflects this initial calibration of decision making with lighting contributing a 70% share of 2028 base incentive market potential and HVAC 20%. These values translate into peak demand potential savings of about 40% for lighting and 44% for HVAC, as shown in Figure E-8.

Figure E-7: Residential Sector Base Scenario - Current Incentives; Share of Potential Energy Savings (MWh) by End-Use for 2028

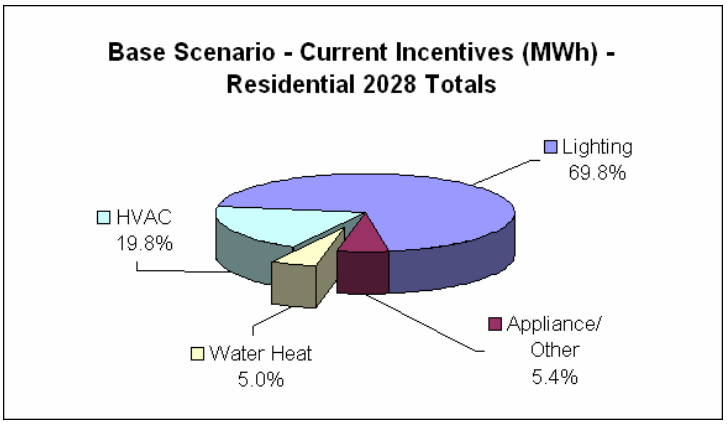
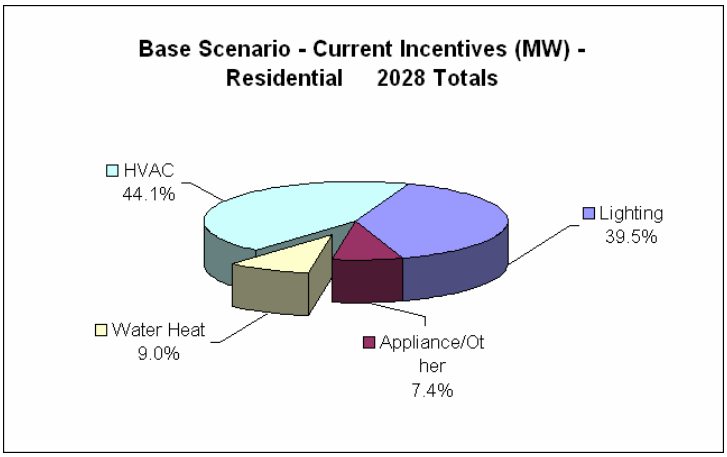


Figure E-8: Residential Sector Base Scenario - Current Incentives; Share of Potential Peak Demand Savings (MW) by End-Use for 2028



Tables E-5 and E-6 provide the values of DSM potential for each scenario, along with technical and economic potential, by end-use.

Table E-5: Electricity Potential Energy Savings (MWh) for 2028 by End-Use – Residential Sector

Energy Savings - Res Sector - Key Year Totals							
Key Year	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
2008	6,861,574	5,495,724	81,749	173,482	184,635	192,661	201,506
2011	6,920,515	5,546,490	329,662	365,327	409,315	445,164	484,648
2016	7,023,953	5,635,493	751,798	895,836	1,087,641	1,258,151	1,425,501
2021	7,134,186	5,730,236	1,185,230	1,502,081	1,924,076	2,259,844	2,570,557
2028	7,300,604	5,873,088	1,810,652	2,479,647	3,266,360	3,807,367	4,179,867

Table E-6: Electricity Potential Peak Demand Savings (KW) for 2028 by End-Use – Residential Sector

Demand Savings - Res Sector - Key Year Totals							
Key Year	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
2008	1,316,084	1,100,095	10,004	24,596	30,039	31,423	33,063
2011	1,337,171	1,115,898	40,375	55,130	73,695	80,045	87,461
2016	1,373,938	1,143,474	92,201	139,676	205,285	236,533	266,806
2021	1,412,824	1,172,668	145,556	236,593	366,983	424,907	480,837
2028	1,471,035	1,209,959	222,735	394,008	620,269	717,185	795,444

Residential Gas DSM Potential Results

Figure E-9 illustrates the residential gas DSM potential in the year 2028 for technical and economic potential along with five different DSM achievable market scenarios. For comparison purposes, the residential sector sales forecast for the year 2028 is also provided as the first column in the chart.

Figure E-9: Residential Sector Gas Savings (MMcf) for 2028

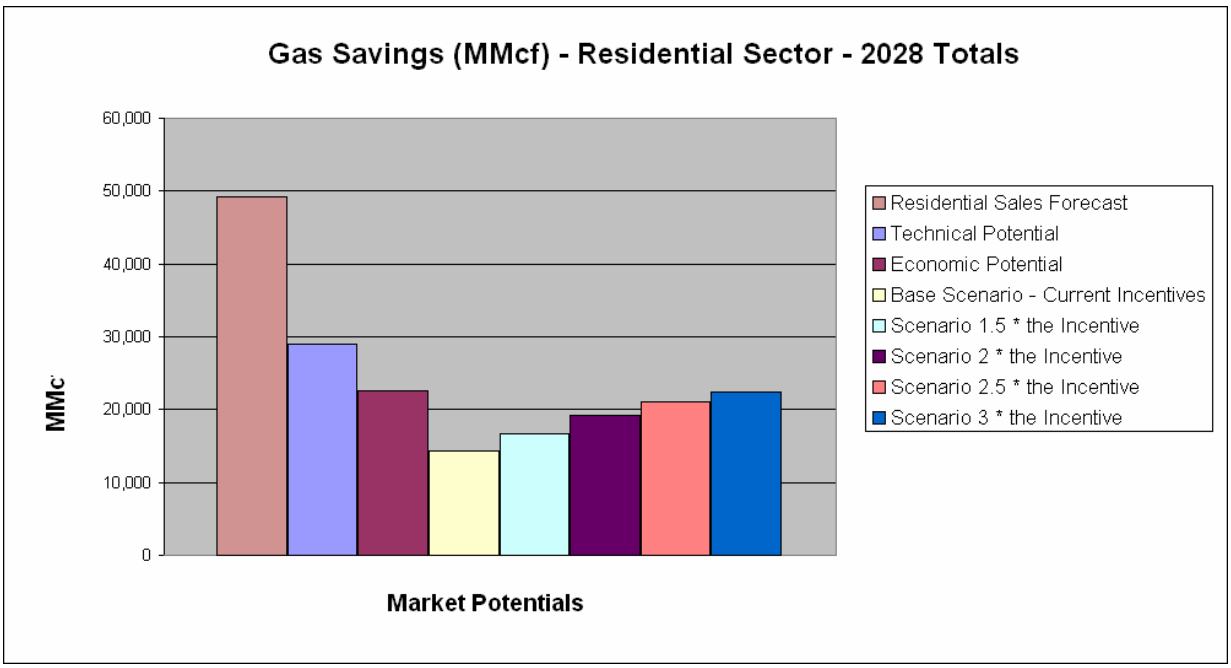


Table E-7 provides the values illustrated in Figure E-9. Technical potential is about 59% of forecasted 2028 residential sales. Economic potential is about 45% and the scenarios range from 30% to 45% of residential sales.

Table E-7: Residential Sector Gas Savings (MMcf) for 2028

Gas Savings (MMcf) - Res Sector - 2028 Totals							
Residential Sales Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
49,231	28,999	22,500	14,353	16,756	19,139	20,984	22,456

The 2008 base case market potential estimates are calibrated to the estimates of savings found in other utility programs as identified through the Best Practices review described earlier. The calibration targets used in developing the different market potential estimates reflect the higher incidence of achieved savings from HVAC programs as compared to the other end uses. HVAC measures represent 95% of the initial calibrated energy savings potential as compared to 5% for Water Heat measures. Figure E-10 shows that by 2028, HVAC measures account for nearly 95% of the gas base scenario DSM potential. Table E-8 provides the values of DSM potential for each scenario, along with technical and economic potential, by end-use.

Figure E-10: Residential Sector Base Scenario - Current Incentives; Share of Potential Gas Savings (MMcf) by End-Use for 2028

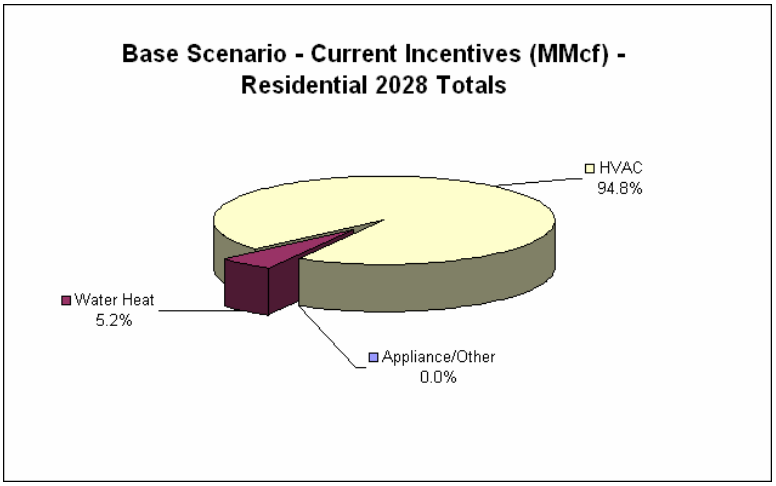


Table E-8: Potential Natural Gas Savings (MCF) for 2028 by End-Use – Residential Sector

Gas Savings (MMcf) - Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Appliance/Other	1,295	0	0	0	0	0	0
Water Heat	2,985	1,405	751	876	959	1,021	1,050
HVAC	24,720	21,095	13,602	15,457	17,404	18,940	20,607

Non-Residential Electric DSM Potential Results

Figure E-11 illustrates the non-residential electric DSM potential in the year 2028 for technical and economic potential along with five different DSM achievable market scenarios. For comparison purposes, the residential sector sales forecast for the year 2028 is also provided as the first column in the chart.

Figure E-11: Non-Residential Sector Energy Savings (MWh) for 2028

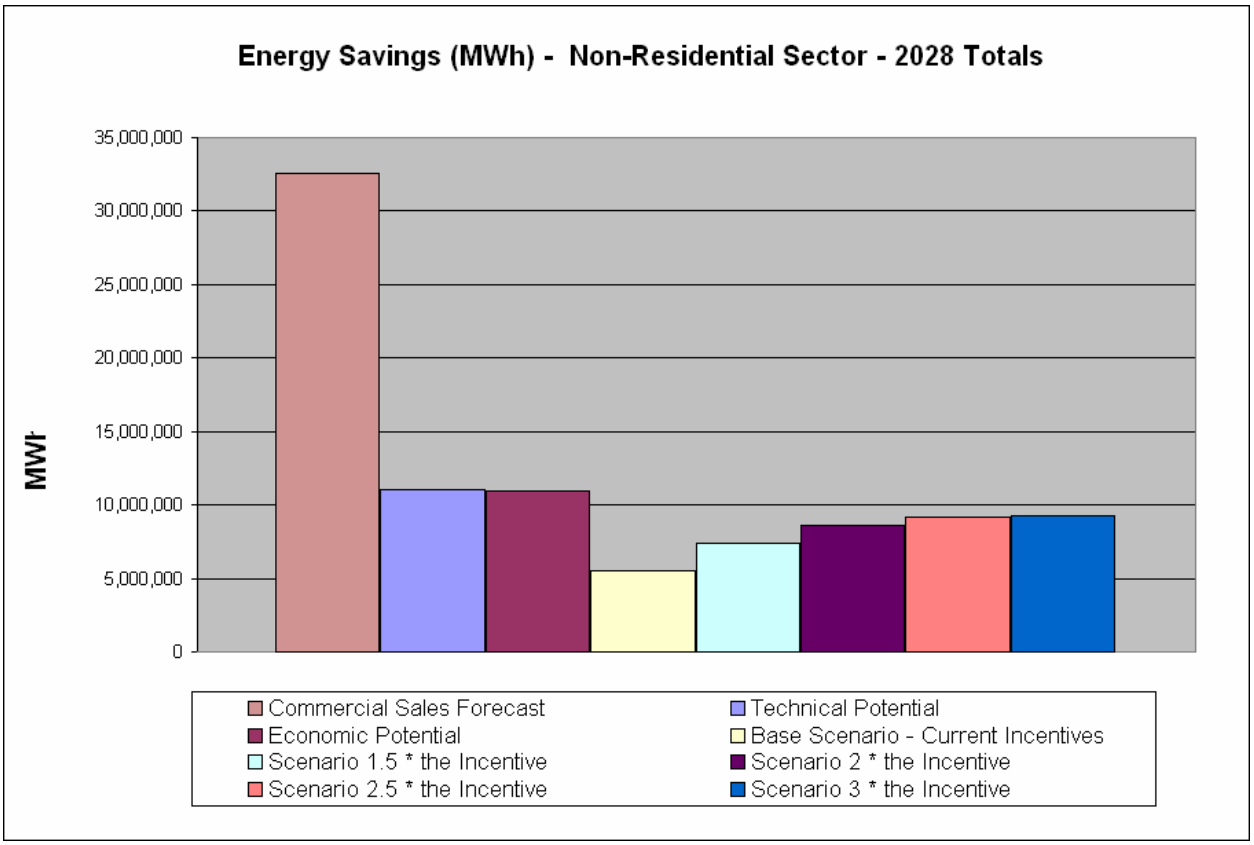


Table E-9 provides the values illustrated in Figure E-11. Both technical and economic potential are about 34% of forecasted 2028 residential sales. The five scenarios range from 17% to 29% of non-residential sales. The base scenario is about 50% of economic potential with the incentive*3 scenario about 84% of economic potential.

Table E-9: Non-Residential Sector Energy Savings (MWh) for 2028

Energy Savings - Non-Res Sector - 2028 Totals							
Commercial Sales Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
32,541,602	11,080,451	10,914,104	5,555,176	7,393,693	8,642,310	9,159,010	9,280,636

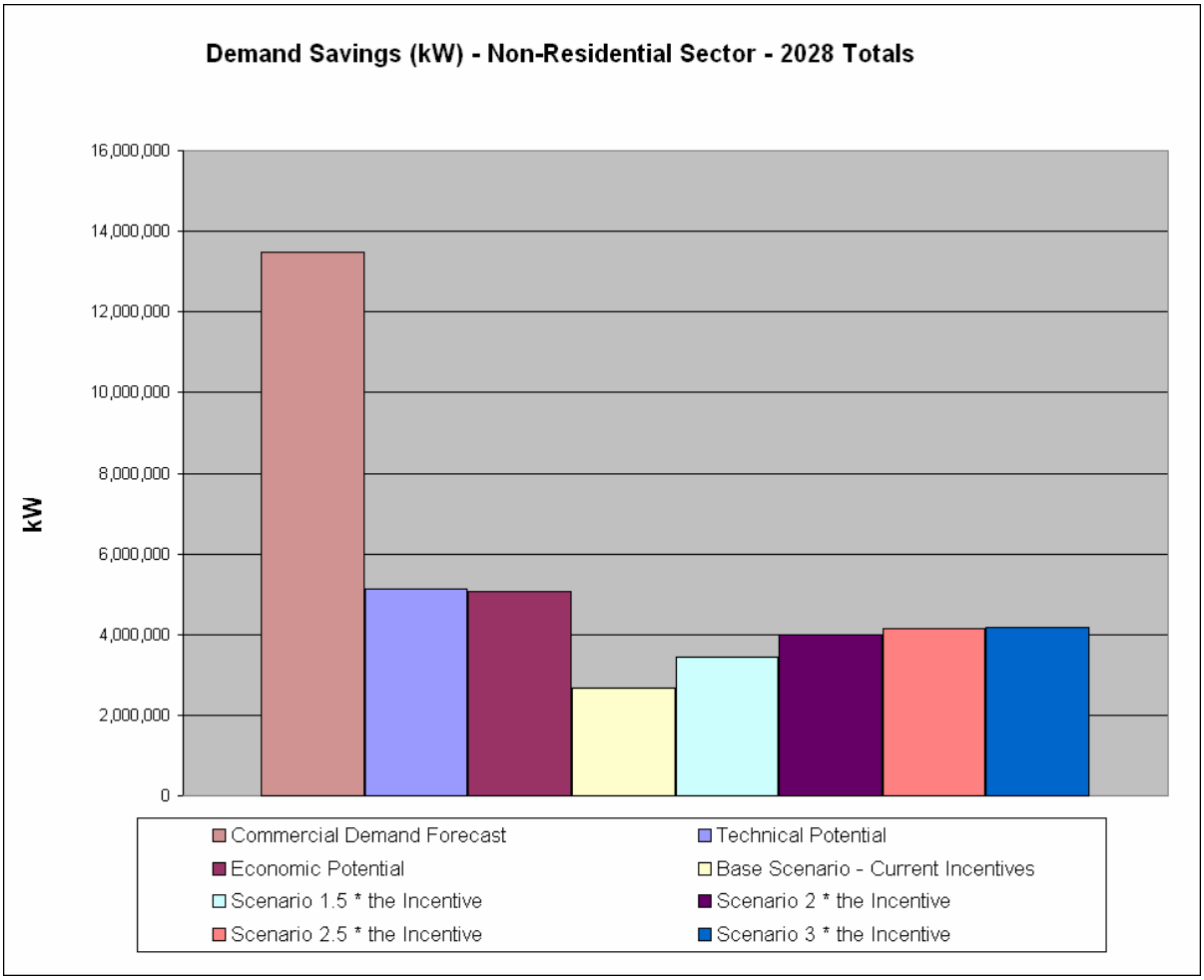
Figure E-12 illustrates the DSM peak demand reduction potential in the year 2028 for technical and economic potential along with five different DSM achievable market scenarios. As with Figure E-10, the non-residential sector peak demand forecast for the year 2028 is also provided as the first column in the chart. Table E-10 provides the values illustrated in Figure E-12.

Table E-10: Non-Residential Sector Peak Demand Savings (MW) for 2028

Demand Savings - Non-Res Sector - 2028 Totals							
Commercial Demand Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
13,492,937	5,129,851	5,080,271	2,659,373	3,453,995	3,991,668	4,132,358	4,175,790

The potential estimates for peak demand savings are a similar but higher than those for energy when compared to the peak demand forecast. Both technical and economic potential are about 38% of forecasted 2028 non-residential peak demand. The scenarios range from 20% to 31% of non-residential peak demand. The base scenario is about 27% of economic potential with the incentive*3 scenario about 82% of economic potential.

Figure E-12: Non-Residential Sector Peak Demand Savings (MW) for 2028



The calibration targets used in developing the different market potential estimates reflect the higher incidence of achieved savings from lighting programs as compared to the other end uses. Lighting measures represent 40% of the initial calibrated energy savings potential as compared to 30% for motors and custom measures and 25% for HVAC measures. The calibration within the base scenario also defines the decision making choice coefficients as determined by the current market place. Figure E-13 reflects this initial calibration of decision making with by the year 2028 giving a lighting contributing a 43% share of 2028 base incentive market potential, motors/custom 32%, and HVAC 25%. These values translate into peak demand potential savings of about 29% for lighting, 19% for motors/custom, and 51% for HVAC, as shown in Figure E-14.

Figure E-13: Non-Residential Sector Base Scenario - Current Incentives; Share of Potential Energy Savings (MWh) by End-Use for 2028

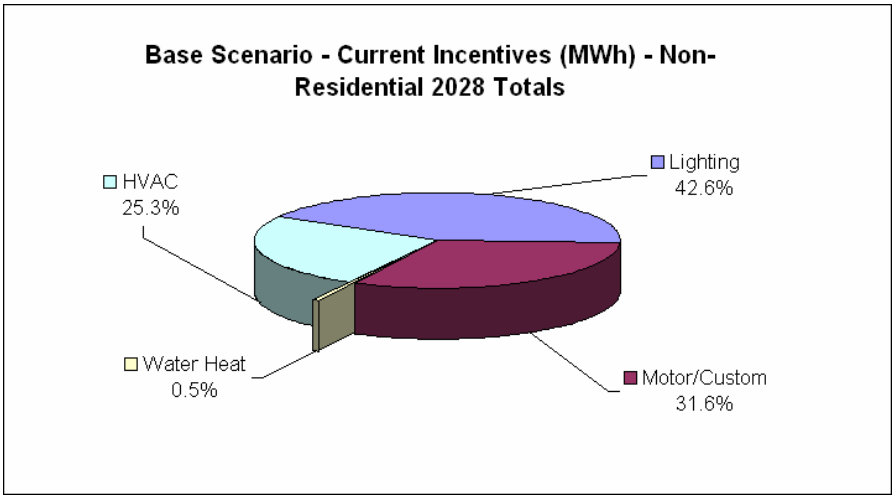
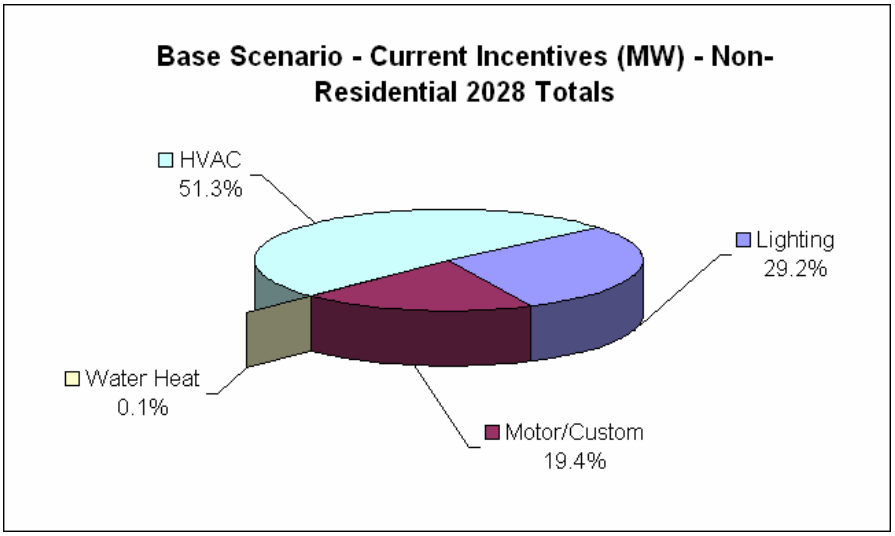


Figure E-14: Non-Residential Sector Base Scenario - Current Incentives; Share of Potential Peak Demand Savings (MW) by End-Use for 2028



The values used in Figures E-13 through E-14 can be found in Table E-11 and Table E-12.

Table E-11: Electricity Potential Energy Savings (MWh) for 2028 by End-Use – Non-Residential Sector

Energy Savings - Non-Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Lighting	4,958,637	4,798,766	2,365,209	3,044,756	3,587,639	3,881,980	4,033,303
Motor/Custom	3,638,811	3,638,811	1,757,645	2,560,709	2,979,299	3,215,357	3,187,382
Water Heat	36,966	30,490	29,519	32,332	32,653	33,417	35,363
HVAC	2,446,036	2,446,036	1,402,804	1,755,896	2,042,718	2,028,257	2,024,588

Table E-12: Electricity Potential Peak Demand Savings (KW) for 2028 by End-Use – Non-Residential Sector

Demand Savings - Non-Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Lighting	1,623,771	1,574,692	776,122	1,007,300	1,200,506	1,276,605	1,325,669
Motor/Custom	1,203,699	1,203,699	515,658	760,087	867,862	944,175	939,390
Water Heat	2,355	1,855	2,017	2,065	2,092	2,114	2,135
HVAC	2,300,025	2,300,025	1,365,575	1,684,542	1,921,209	1,909,464	1,908,596

Non-Residential Gas DSM Potential Results

Figure E-15 illustrates the non-residential gas DSM potential in the year 2028 for technical and economic potential along with five different DSM achievable market scenarios. For comparison purposes, the non-residential sector sales forecast for the year 2028 is also provided as the first column in the chart.

Figure E-15: Non-Residential Sector Gas Savings (MMcf) for 2028

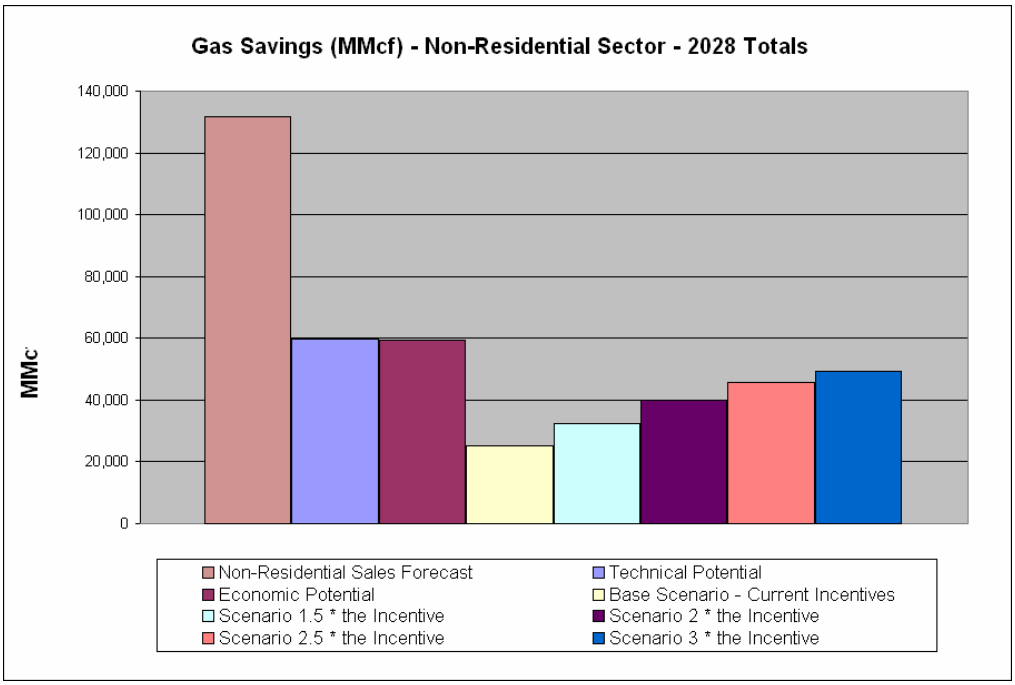


Table E-13 provides the values illustrated in Figure E-15. Both technical and economic potential are about 45% of forecasted 2028 non-residential sales. The five scenarios range from 19% to 37% of non-residential sales.

Table E-13: Non-Residential Sector Gas Savings (MMcf) for 2028

Gas Savings (MMcf) - Non-Res Sector - 2028 Totals							
Non-Residential Sales Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
131,674	59,615	59,391	25,301	32,316	40,017	45,686	49,277

The 2008 base case market potential estimates are calibrated to the estimates of savings found in other utility programs as identified through the Best Practices review described earlier. The calibration targets used in developing the different market potential estimates reflect the higher incidence of achieved savings from HVAC programs as compared to the other end uses. HVAC measures represent 85% of the initial calibrated energy savings potential as compared to 15% for water heat measures.

Figure E-16 shows that by 2028, HVAC measures account for nearly 99% of the gas base scenario DSM potential. Table E-14 provides the values of DSM potential for each scenario, along with technical and economic potential, by end-use.

Figure E-16: Non-Residential Sector Base Scenario - Current Incentives; Share of Potential Gas Savings (MMcf) by End-Use for 2028

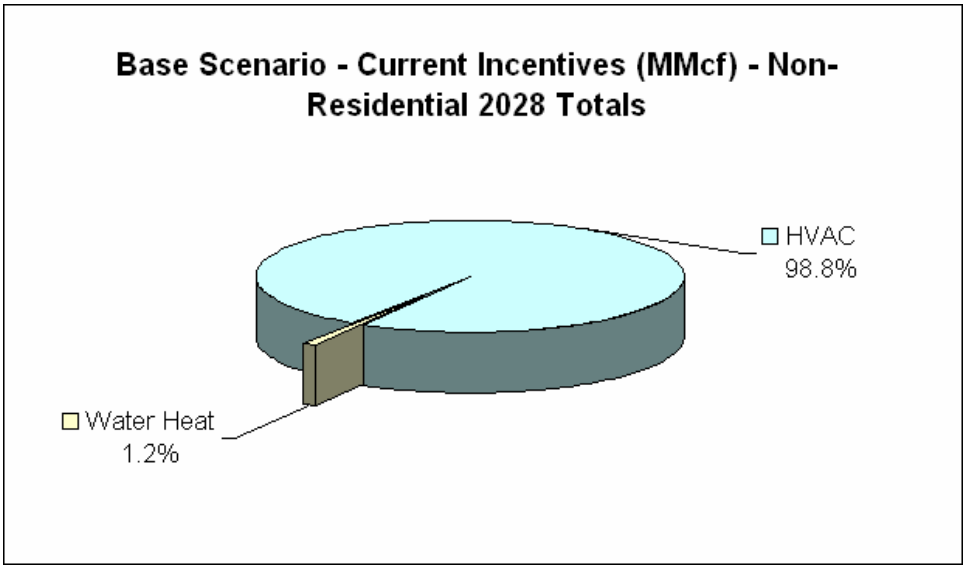


Table E-14: Potential Natural Gas Savings (MCF) for 2028 by End-Use – Non-Residential Sector

Gas Savings (MMcf) - Non-Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Water Heat	221	221	293	284	304	327	286
HVAC	59,394	59,170	25,008	32,032	39,713	45,359	48,991

E.6 Conclusions and Recommendations

The DSM benchmarking analysis results, presented in Chapter 3 of this report, should give the Kansas Energy Council confidence that a variety of utilities in the Midwest and across North America are achieving large- scale results from their DSM programs. Peak demand and energy reductions of 1.0% of utilities' baseline non-residential peak demands and energy sales and 0.8% of residential peak demand and energy sales are being achieved by a variety of Midwestern utilities. While the details of large impact DSM program portfolios often differ significantly between utilities, several common elements have been identified by the analysis conducted:

- Large impacts are being realized from both lighting and multi-product energy efficiency programs for both residential and non-residential sectors.
- Significant impacts are being achieved from residential and non-residential new construction energy efficiency programs.
- Commercial & Industrial (C&I) custom rebate energy efficiency programs have produced significant impacts for some utilities.

The largest sources of uncertainty regarding the estimates that Summit Blue has developed to date for the KEC, stem from using secondary information and the results of telephone surveys to profile Kansas customers. The secondary end use estimates for electric use have higher than actual estimates for the amount of electricity that is used for "miscellaneous" purposes. This is due to the lack of precision in the end use estimates developed by the original sources of the data, such the Department of Energy's Commercial Building Energy Consumption Survey. On site customer surveys generally provide more accurate results than telephone or mail surveys.

Utilities that choose to significantly invest in DSM programs often make significant periodic investments to develop and update such data to aid their DSM program planning. For example, Xcel Energy in Minnesota conducts large-scale market assessments and DSM potential studies that include significant on-site customer data collection every five to ten years. The Iowa utilities conduct DSM potential studies about every five years to support their periodic DSM program filings with their regulators. These utilities collected significant customer data as part of their very recent DSM potential study.

If the KEC and/or Kansas utilities wish to improve their current customer and load data for EE planning purposes, Summit Blue suggests that on-site surveys be conducted as part of future customer survey projects. It is usually most cost effective to conduct the on-site surveys from sub-samples of telephone or mail survey respondents. This approach minimizes the on-site sample sizes required to achieve statistically reliable results.

1 INTRODUCTION

The Kansas Energy Council (KEC) hired Summit Blue Consulting (Summit Blue) and Energy Insights in late September 2007 to develop an energy efficiency potential study for the state of Kansas. The project deliverables were specified in the May 2007 request for proposal as: "…a report that provides technical, economic and market potential for metropolitan/suburban and rural Kansas by end use in the residential market and by industry segment and end use in the C&I markets."

This deliverable was updated during the November 15, 2007, project initiation meeting and subsequent discussions to focus the energy efficiency potential results on each of the overall residential and non-residential sectors. This was done in part due to the lack of consistent statewide data on individual market segments within each sector.

1.1 Background

The Kansas Energy Council is appointed by the Governor of Kansas and its main role is to develop a comprehensive energy plan for the state. The KEC established a committee on energy conservation and efficiency, whose main role is to recommend additional legislative, administrative, or regulatory policies for consideration of the entire KEC.

Several Kansas utilities are currently conducting energy efficiency and/or demand response programs. Several additional Kansas utilities have submitted energy efficiency and demand response programs to the Kansas Corporation Commission for approval.

This study used several types of data and information supplied by Kansas utilities:

- residential appliance saturation data supplied by, Midwest Energy, and Westar Energy;
- non-residential equipment survey results provided by Midwest Energy and Westar Energy; and
- electric avoided-cost information supplied by Kansas City Power and Light and Midwest Energy.

This information was averaged, and the average results were used in the analyses.

1.2 Organization of Report

This report is divided into the following major sections.

1. Executive Summary
2. Introduction
3. Methodology
4. Benchmarking and Best Practice Results
5. Baseline Consumption Profiles and Initial Building Simulation Model Specifications
6. DSM Measure Characterizations
7. Cost Effectiveness Analysis
8. DSM Potential Methodology and Results

2 METHODOLOGY

This section of the report provides a high-level overview of the project methodology. Detailed descriptions regarding the specific analyses performed are included in each section of the report in which the analytical results are presented.

Summit Blue conducted a six-step process to complete the market assessment phase of this assignment:

1. **Conduct project initiation meeting** with KEC staff and Energy Conservation Committee members. This meeting was held on November 15, 2007.

2. **Conduct a Midwest-focused DSM benchmarking and best practices analysis**. The purpose of this analysis is (1) to ensure that the DSM potential estimates that Summit Blue develops for the KEC are reasonable and appropriate and (2) to identify best practices regarding DSM programs. For this analysis, Summit Blue collected information on 2006 (or 2005) DSM program results from 11 other Midwestern utilities and agencies, as well as 11 additional U.S. and Canadian utilities or agencies. The sources used for this analysis include utilities' or agencies' annual DSM regulatory reports as well as FERC Form 861 and Form 826 data.

3. **Develop baseline consumption profiles and initial building simulation model specifications**. Kansas utilities supplied considerable input data for this task: customer counts and billing data by market segment, residential appliance saturation survey results, and non-residential equipment survey results. Other data sources included Energy Insights' proprietary information. Energy Insights used the results of the market profile analysis to calibrate market segment versions of the eQuest building simulation model. eQuest is a widely used non-residential building simulation model based on the DOE-2 model.

4. **Characterize DSM measures that are appropriate for Kansas**. Characterizing measures includes estimating per unit energy and peak demand savings, incremental costs compared to standard efficiency measures, and measure lifetimes. Energy and peak demand savings for climate-dependent measures such as insulation are estimated by the eQuest building simulation model. For energy and peak demand savings for DSM measures that are not weather dependent, such as residential refrigerators, engineering estimates and other published sources such as the California DEER database were used.

5. **Conduct benefit-cost analysis**. KCP&L and Midwest Energy supplied Kansas-specific values such as transmission loss factor, electric prices by sector, and costs of avoided energy, avoided generation, and transmission and distribution. This data, combined with the savings estimated from the DSM measure characterization and program costs estimated from the benchmarking, were used to analyze cost-effectiveness per measure and sector. Four tests were applied to each measure; each test describing cost-effectiveness in a different framework: the participant test, the utility test, the rate payer impact (RIM) test, and the total resource cost (TRC) test. In line with standard industry practice, Summit Blue uses the TRC test as the main benefit-cost analysis test.

6. **Estimate DSM potentials for the 2008-2028 period for residential and non-residential customers.** Using Summit Blue's Excel-based DSM-Resource Assessment Model, we calibrated the DSM potential estimates to the results of the benchmarking analysis discussed above.

3 BENCHMARKING AND BEST PRACTICE RESULTS

This section compares demand-side management (DSM) results of selected utilities and agencies in the Midwest, Northeast, West, and British Columbia, Canada. The analysis compares detailed program results by customer sector of those utilities identified as achieving high levels of DSM savings for below median costs to identify common best practices of top performers.

3.1 Data Collection and Methodology

The following describes the methodology to collect and analyze benchmark programs and compare overall levels of DSM achievements and costs of savings in major customer segments and by program level where appropriate.

Data and information were collected for 2006 (or 2005) DSM program results for 24 utilities and energy agencies (22 for electricity DSM, 6 for natural gas DSM) in eleven states across three regions in the US and for one Canadian utility (see Table 3-1 below). Many of these data were collected for previous projects with additional locations included specifically for this report.

Table 3-1: Benchmarked Utilities and Agencies[2]

Utility/Agency	State	Electricity	Natural Gas
Midwest			
Aquila	IA		X
CenterPoint Energy	MN		X
Duke Energy	IN	X	
Great River Energy	MN	X	
Indianapolis Power & Light	IN	X	
Interstate Power & Light	IA	X	X
Interstate Power & Light	MN	X	X
MidAmerican Energy	IA	X	X
Minnesota Power	MN	X	
Otter Tail Power	MN	X	
Southern MN Municipal Power: The Triad	MN	X	
Wisconsin Focus on Energy	WI	X	
Xcel Energy	MN	X	X

[2] Because 2006 results (both costs and impacts) were not available for BC Hydro, Duke Energy Indiana, Great River Energy, Indianapolis Power & Light, CEEF, NSTAR, New Jersey Clean Energy Program, and the California utilities, their 2005 results are used here. Indianapolis Power & Light DSM results were available only for the residential sector.

Utility/Agency	State	Electricity	Natural Gas
Northeast			
Connecticut Energy Efficiency Fund	CT	X	
Efficiency Maine	ME	X	
Efficiency Vermont	VT	X	
National Grid	MA	X	
New Jersey Clean Energy Program	NJ	X	
New York State Energy Research and Development Authority	NY	X	
NSTAR	MA	X	
West			
Pacific Gas &Electric	CA	X	
San Diego Gas & Electric	CA	X	
Southern California Edison	CA	X	
Canada			
BC Hydro and Power Authority	BC	X	

In North America, DSM is delivered through central agencies or utilities—investor or government owned. In the Midwest, DSM is generally provided through vertically integrated investor owned utilities (IOUs); the exception is Wisconsin Focus on Energy, a central agency providing most DSM programs in the state. The organizations examined in the Northeast region all provide DSM through a central agency, except the IOUs in Massachusetts. The results do not cover all DR provided by the Independent System Operators/Regional Transmission Operators (ISO/RTOs) serving this region—PJM, NYISO and NE-ISO. In Canada, BC Hydro is a vertically integrated Crown corporation. It serves the entire province, has extensive hydro-electric resources, exports significant electricity, and is not deregulated. BC Hydro's DSM programs target only energy conservation, not peak demand reduction, as do all of the energy agencies included in this analysis. In the West, as in the Midwest, most DSM is delivered through investor owned utilities such as the three IOUs included in the analysis.

This analysis of DSM program results normalized the reported total program results for utility or agency size and sales to major customer sector. The benchmarking data for these utilities and agencies were prepared as follows:

- For selected utilities and other organizations offering DSM programs, compiled 2006 reported program results—program descriptions, energy and peak demand savings, and costs.[3] The sources for almost all of the data were utilities' and agencies' annual reports on their 2006 DSM program results. Where 2006 data were not available, 2005 data were used.
- Categorized actual DSM program results by major customer sector—residential and non-residential—and calculated percentages for each sector.

[3] Costs for load management programs exclude rate discount incentives.

- Normalized results by utility or agency overall sales and peak demands to produce estimates of DSM savings as percentages of overall sales and peak demand (where data were available). The main source for the baseline sales and peak demand data was FERC Form 861 and FERC Form 176 from the Energy Information Administration's web site (www.eia.doe.gov).
- Divided spending by the DSM program energy and peak demand savings to determine each utility's cost of conserved energy and peak demand in terms of $/kWh, $/kW, and $/Mcf[4].

Although every effort is made to collect comparable data, given the inherent variation in organizations' evaluation and reporting practices, the results cannot be considered a strictly "apples-to-apples" comparison. For example, utilities may report estimated savings at meter, busbar, or generator; some utilities' methods for estimating savings may be more accurate than others; and only some annual DSM reports included savings that were verified. However, despite these reporting and evaluation variations, the results provide calibration targets for DSM potential estimates and identify key programs and results for top-performing portfolios.

3.2 Regulatory and Market Context for DSM Achievements

This section compares the regulatory and market context of the benchmarked locations and discusses the impact on achievement of DSM.

The achievement of significant DSM savings is influenced by several factors, including the regulatory environment under which utilities and agencies operate, whether DSM funds are provided through system benefit charges (SBC), how the issue of lost revenues is addressed, the provision of financial incentives for DSM performance, etc. Table 3-2 below, provides key characteristics by state such as the electricity market structure, cost-effectiveness tests used, DSM targets, and the year DSM programs began.

British Columbia, Connecticut, California, Iowa, Massachusetts, Minnesota, and Vermont all achieved about 1% or more reductions in annual energy sales due to DSM programs in 2006 (or 2005). The electricity market structure is not a determining variable in DSM performance; most of the high achievers operated under a traditional market structure, but California is partially restructured. Nor does year that programs began appear to be a strong influence on savings achieved. All states achieving high DSM savings set significant mandated goals for utilities' DSM programs. Other success factors include financial incentives for cost-effective DSM (Minnesota, Vermont), adjustments for lost revenues caused by DSM programs (California), and use of less restrictive tests such as the TRC test or societal test for cost-effectiveness rather than the RIM test (British Columbia, California, Iowa, Minnesota, Vermont).

[4] Converted program spending to US dollars where needed using the average currency exchange of US$1=CDN$1.21.

Table 3-2: DSM Environment by State

State/ Province	Year Began	Energy Savings as % of Sales	DSM Environment
British Columbia	2002	0.8%	British Columbia has a traditional electricity market structure. BC Hydro, a vertically integrated utility owned by the province of British Columbia, proposes and implements all DSM that is cheaper than supply options, currently about CDN 4¢/kWh. The utility relies primarily on the TRC test, but regulators have implemented rules related to using the RIM test which may restrict the programs that can be delivered. BC Hydro capitalizes virtually all of its DSM costs but does not get lost revenue adjustment or performance incentives.[5]
California	1974	1.4 to 2.1%	California's electricity market is partially restructured. Authorized DSM budgets are based on funding levels necessary for utilities to meet CPUC savings targets by procuring cost-effective efficiency. Both the TRC and Utility Cost Test are used to screen DSM programs, but the TRC is given double the weight of the UCT. All utilities now have some form of revenue decoupling, removing the disincentive to procure energy efficiency. Some decoupling mechanisms include shared savings with shareholders. The regulator has also indicated that it will develop some sort of incentive for utilities to deliver energy efficiency.[6]
Connecticut	1990s	1.0%	In 1998, state legislation restructured the electricity market and DSM. The two resulting distribution companies (The Connecticut Light and Power Company and The United Illuminating Company) design and implement DSM programs that are funded by the Connecticut Energy Efficiency Fund (CEEF), a statutory charge of $0.003/kWh on retail sales. The Energy Conservation Management Board, with final approval of the Department of Utility Control, sets the DSM budget, performance-based goals and incentives for the DUs. Programs are primarily screened with the utility test; some programs have been additionally screened with the TRC.[7]
Indiana	1990	0.01 to 0.1%	Indiana has a traditional electricity market structure. The State has no formal DSM requirements for utilities. DSM issues have typically played a limited role in the planning and construction of electric generation capacity in the State of Indiana. Indiana utilities are guaranteed cost recovery for DSM programs but not for lost revenue, margin recovery, or DSM financial incentives.

[5] Demand-side Management: Determining Appropriate Spending Levels and Cost-effectiveness Testing Appendix A: Summaries by Jurisdiction, Prepared for the Canadian Association of Members of Public Utility Tribunals (CAMPUT), January 30, 2006.

[6] Ibid.

[7] Ibid.

State/ Province	Year Began	Energy Savings as % of Sales	DSM Environment
Iowa	1990	0.8 to 0.9%	Iowa operates under a traditional electricity market structure. Electric and gas utilities are expected to secure maximum achievable DSM potential, and the Societal Cost test is the primary test and is the benchmark for cost-effectiveness. From 1990-1996, the regulator offered utilities financial incentives to deliver efficiency, as authorized by law, with cost recovery approved via "mini" rate cases that occurred once every few years. In 1996 the law was changed and incentives were abandoned in exchange for concurrent cost recovery. The shift from incentive-based regulation to annual cost recovery is seen as a success by the utilities. Under the original rules, utilities waited for up to six years before recovering their investments in efficiency. This "cost of money" diminished the value of the efficiency incentives.[8]
Maine	2002	0.3%	Maine has a traditional electricity market structure. $1.5 million/year is allocated for SBC funded energy efficiency; the 2006 budget was $9.6 million. Programs are administered by the Maine PUC and delivered through a statewide effort called Efficiency Maine with goals established by statute. It has been noted that "the current rate mechanisms used for Maine investor-owned utilities do not coexist easily with revenue neutral efficiency schemes."[9]
Massachusetts	1990s	0.9%	State legislation restructured the electricity market in 1998 and created a SBC of $0.0033/kWh which was changed to $0.0025/kWh in 2002. The Division of Energy Resources oversees ratepayer-funded DSM programs, run by DUs or municipal aggregators, while the Department of Telecommunications and Energy reviews cost effectiveness with the TRC and approves performance incentives.

[8] Ibid.
[9] Inquiry into New Conservation Programs and Developing a Plan for Using Increases in the Conservation Fund: Docket 2006-446, Maine Public Utilities Commission, March 9, 2007.

State/ Province	Year Began	Energy Savings as % of Sales	DSM Environment
Minnesota	1980	0.3 to 1.6%	Minnesota operates under a traditional electricity market structure. Minimum spending is mandated by law for the utilities: Xcel Energy, which is nuclear based, must spend 2% of electric revenues on DSM; non-nuclear electric utilities must spend 1.5% of revenues; gas utilities must spend 0.5% of revenues on DSM. Spending levels are also determined by IRP process. However, in May 2007 the state passed the New Generation Energy Act which changes goals from spending as percentage of revenues to savings as a percentage of sales, specifically 1.5% of retail sales and a minimum of 1% starting in 2010, effectively doubling savings goals. The regulator considers the societal test to be the most important test of the five California tests but also considers the participant test to be important as well as the utility test. The utilities used to operate under a lost revenue mechanism but experienced long times between rate cases. This became a problem, and in 1999 the regulator developed a new DSM incentive mechanism. The Company earns an incentive for achievement greater than 91% of its minimum spending equivalent energy savings goal, which is equal to the number of kWh expected to save when the utility meets its minimum spending requirement. DSM incentives can equal up to 30% of program costs.[10]
New Jersey	Early 1980's	0.5%	New Jersey has a deregulated electricity market. Cost effective DSM is balanced with impact on rates; $1/MWh is spent for economic demand response. Public benefit funds are available for energy efficiency and renewable energy. Board of Public Utilities now hires third parties—market managers—to design and implement state wide programs. New Jersey has been transitioning into this structure for over two years, which has impacted savings achieved. It is expected the market managers will be provided financial incentives for certain levels of energy savings. [11]
New York	1996	0.2%	New York has a deregulated electricity market. $175 million/year is allocated for SBC-funded energy efficiency administered centrally by the New York State Research and Development Authority (NYSERDA), a public benefit corporation created in 1975 by the New York State Legislature. As SBC Program Administrator, NYSERDA consults with interested parties, prepares an "Operating Plan" to fund individual programs within the funding categories established by the Commission, receives and disburses SBC funds, conducts program evaluations, and prepares program reports. NYSERDA is assisted in the evaluation process by the Independent System Benefits Charge Advisory Group and a number of evaluation contractors. [12]

10 Ibid.

11 Ibid.

[12] Ibid.

State/ Province	Year Began	Energy Savings as % of Sales	DSM Environment
Vermont	2000	1.0%	Vermont has a traditional electricity market structure. DSM was historically funded by a wires charged capped at 3% of revenues; the cap was removed in 2005. Administered centrally as Efficiency Vermont by third party—Vermont Energy Investment Corp. (VEIC). VEIC receives incentives and performance bonuses to achieve savings higher than goals. Efficiency is seen as an option that offers a high level of net benefits to the state, both environmental and economic.[13]
Wisconsin	Mid 1980's	0.3%	Wisconsin has a traditional electricity market structure and pays for DSM through a public benefits fund of up to 3% of annual electric revenues. The Wisconsin Public Service Commission is the overall administrator for the state's public benefits programs, subcontracting with third party "implementation contractors" to implement various parts of the Focus on Energy program portfolio. No financial incentives are available to utilities to provide DSM programs. One notable setback for the Focus on Energy programs in the past was that the Wisconsin legislature diverted 47% of the funds collected from utility ratepayers for the Focus on Energy programs and diverted them to help balance the Wisconsin state budget.[14]

[13] Ibid.

[14] Ibid.

3.3 Best Practice Results

This section compares 2006 electricity and gas DSM program results for residential and non-residential customer sectors combined across the various locations. See Appendix B for complete data and statistics.[15]

3.3.1 Overall Electricity DSM Results

Table 3-3 shows the median result for electricity DSM spending, savings, costs, and energy costs over all customer sectors for the reviewed organizations.

Table 3-3: Medians for Overall Results

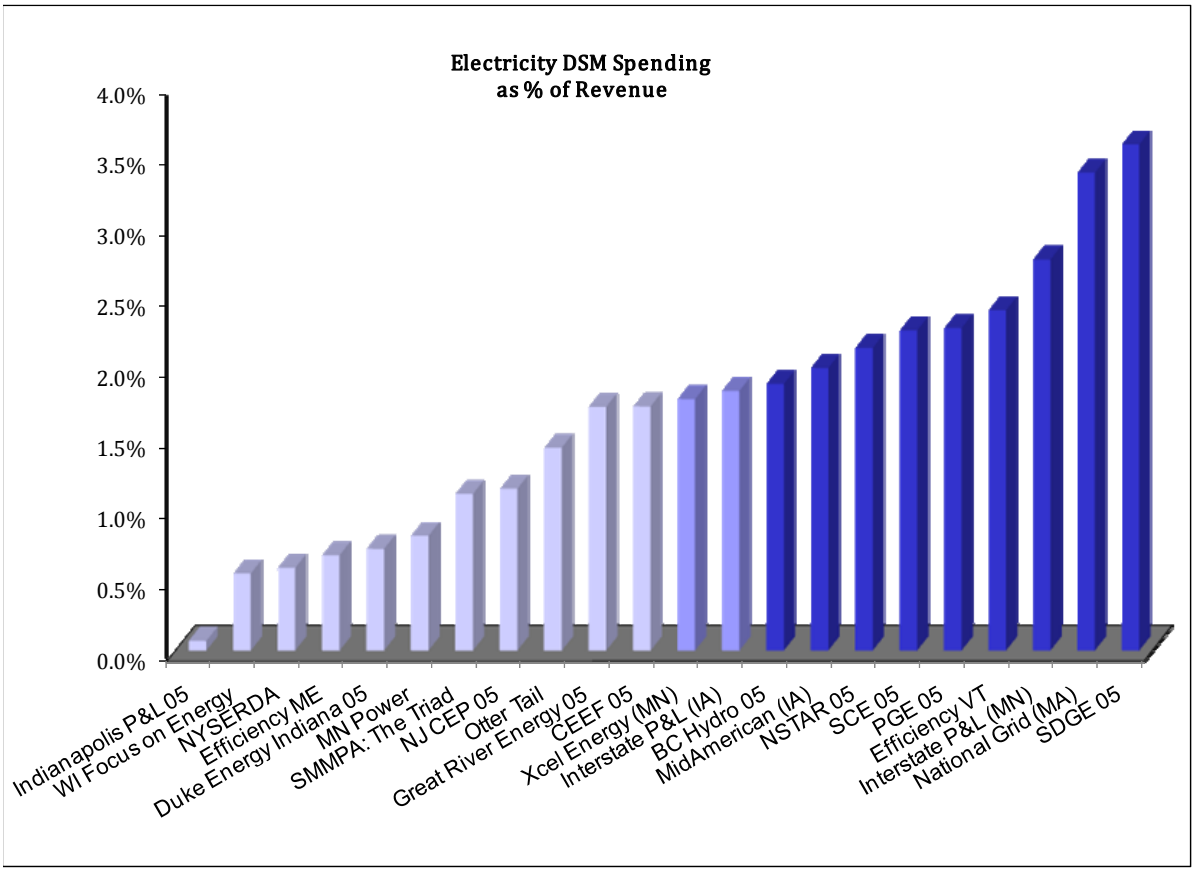
Spending as % of Revenue	Energy Savings as % of Sales	Demand Savings as % of Peak Demand	Cost of Energy $/kWh	Cost of Savings	
				$/kWh	$/kW
1.8%	0.8%	0.6%	$0.08	$0.18	$836

Electricity DSM Spending

The spending on electricity DSM as a percentage of revenue for the organizations reviewed ranges from 0.1% to 3.6% with the median at 1.8%. Figure 3-1 below shows the distribution of spending on electricity DSM as a percentage of annual revenues. Utilities with spending rates in the top quartile are PGE 05, Efficiency VT, Interstate P&L (MN), National Grid (MA), and SDGE 05 which has the highest spending rate, about double the median.

[15] Incremental peak demand savings data were not available for SMMPA, Great River Energy and CEEF.

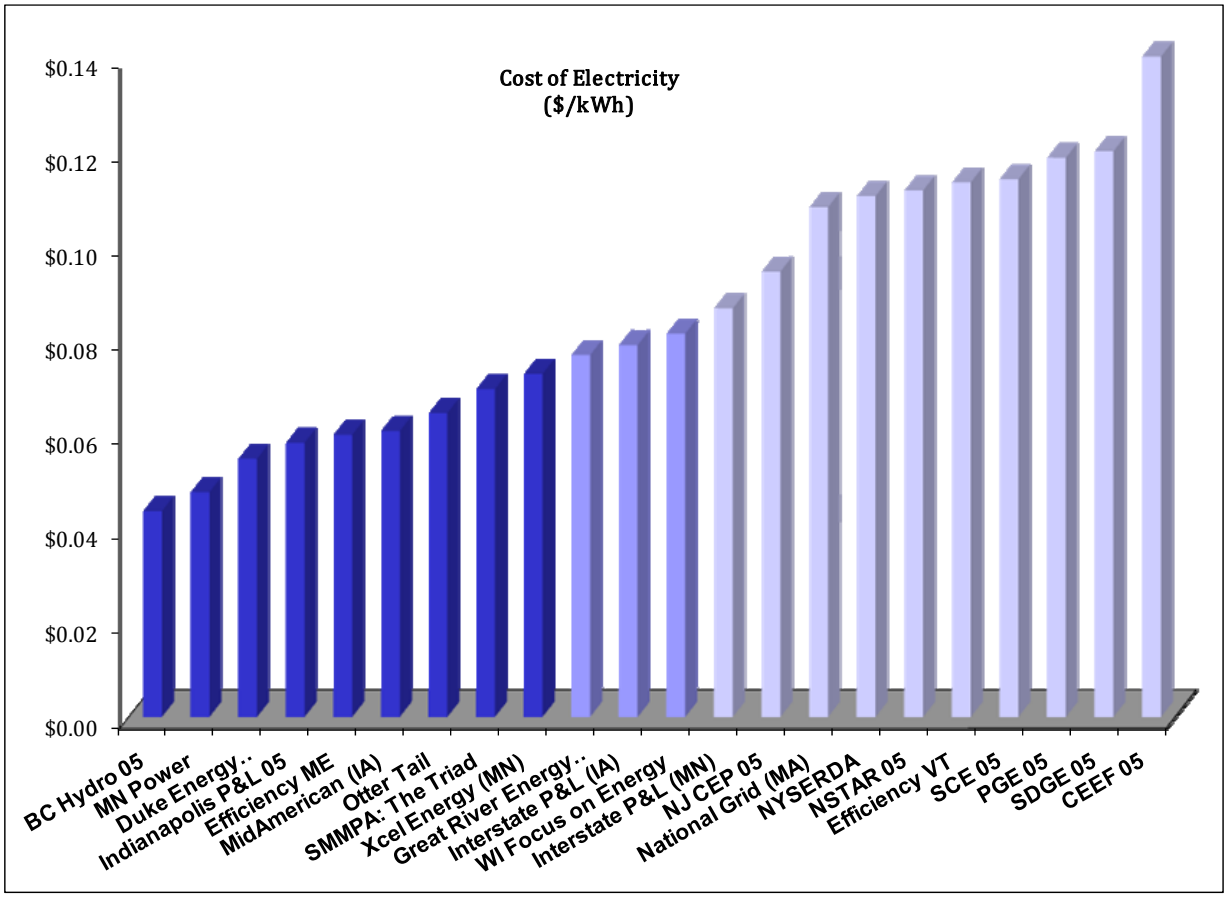
Figure 3-1: Electricity DSM Spending as % of Revenue



Cost of Electricity

The cost of energy for the 22 organizations reviewed ranges from $0.04/kWh to $0.14/kWh (Figure 3-2). Organizations with energy costs in the bottom quartile are Efficiency ME, Indianapolis P&L 05, Duke Energy Indiana 05, MN Power, and BC Hydro 05.

Figure 3-2: Cost of Electricity



Electric Energy and Peak Demand Savings

All of the nine organizations with above median electricity DSM spending rates also achieved above median energy savings as a percentage of sales: SDGE 05 has the highest energy savings as a percentage of sales at about 2.1%, three times the median of 0.8%, while Interstate P&L (MN), SCE 05, and PGE 05 achieved savings rates of about 1.5% of sales; Efficiency VT, NSTAR 05, MidAmerican (IA), National Grid (MA), and BC Hydro 05 achieved savings rates of about 0.9%, (Figure 3-3).

Figure 3-3: Electricity DSM Energy Savings as % of Sales First Year

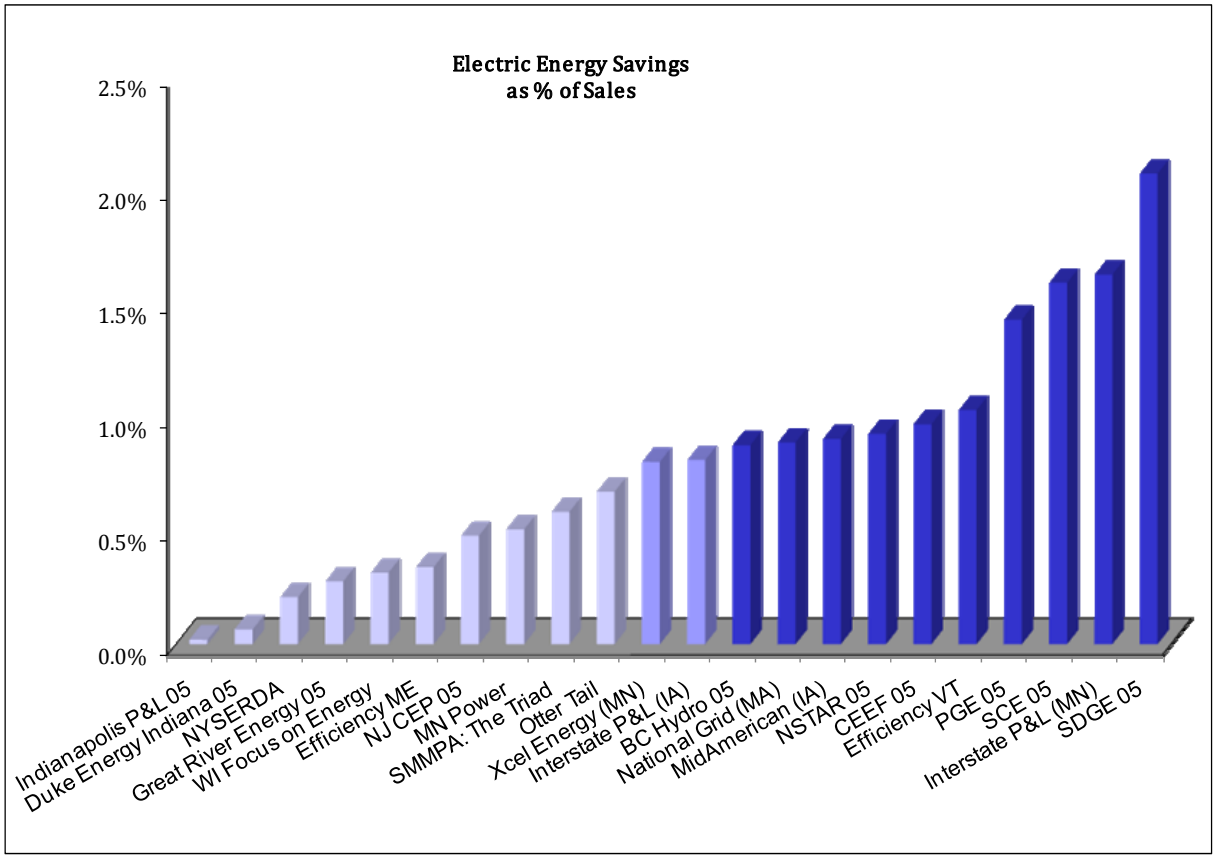
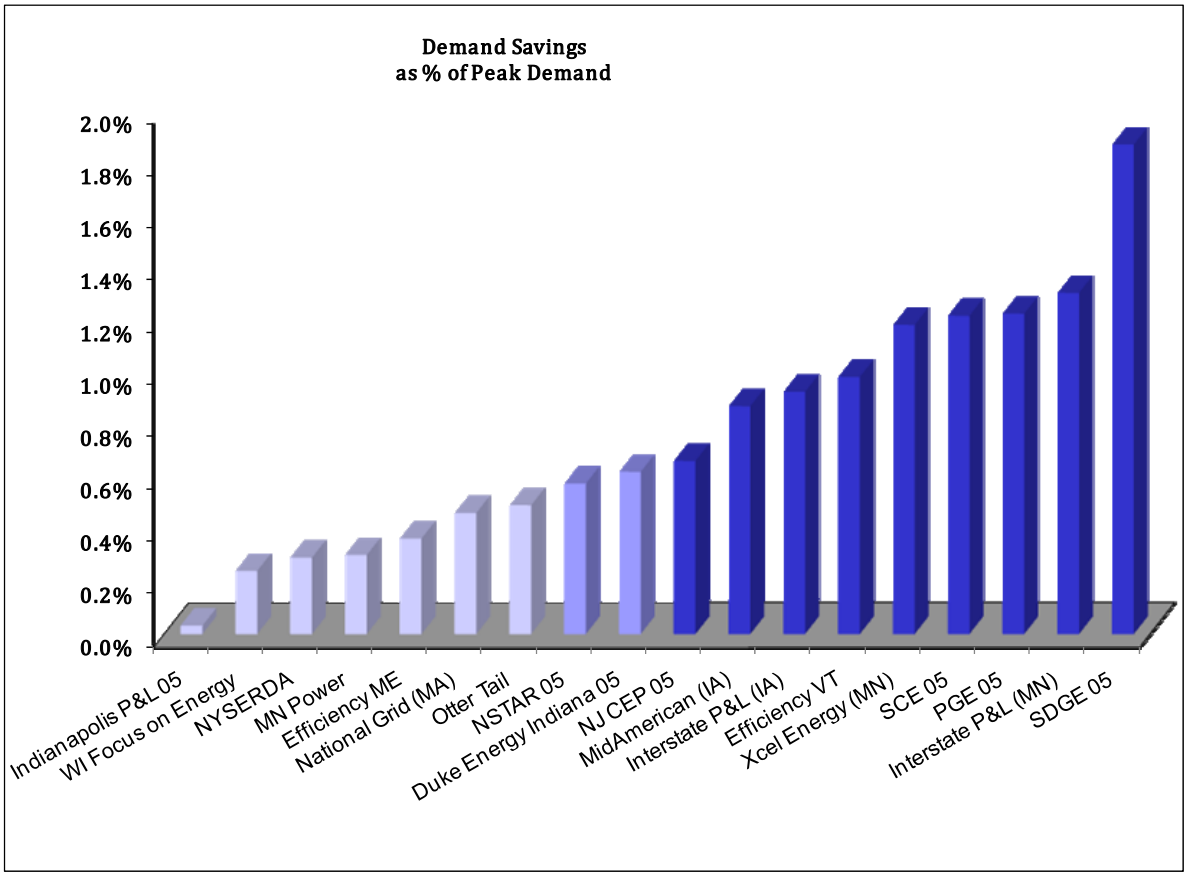


Figure 3-4 shows electricity DSM incremental demand savings as a percentage of annual peak demand. SDGE 05 has the highest demand savings as a percentage of peak demand, at 1.9%, about 3 times the median of 0.6%. Most of the utilities with above median peak demand savings rate have rates of electricity DSM spending at or above the median: Interstate P&L (MN), PGE 05, SCE 05, and Xcel Energy (MN) conserved about 1.2% of peak demand, while Efficiency VT, Interstate P&L (IA), and MidAmerican (IA) conserved about 0.9% of peak demand.

Figure 3-4: Demand Savings as % of Peak Demand



Cost of Savings

As shown in Figure 3-5 below, the cost of first year energy savings ranges from $0.08/kWh to $0.60/kWh, with the median at $0.18/kWh. MN Power achieved the lowest cost of energy savings. BC Hydro, MidAmerican (IA), Interstate P&L (MN), and SCE 05 also achieved their energy savings at costs below the median, near $0.15/kWh, but these four utilities achieved these low cost energy savings with above median electricity DSM spending rates (as a percentage of revenue) and above median energy savings rates (as a percentage of sales).

Figure 3-5: Cost of Electric Energy Savings ($/kWh) First Year

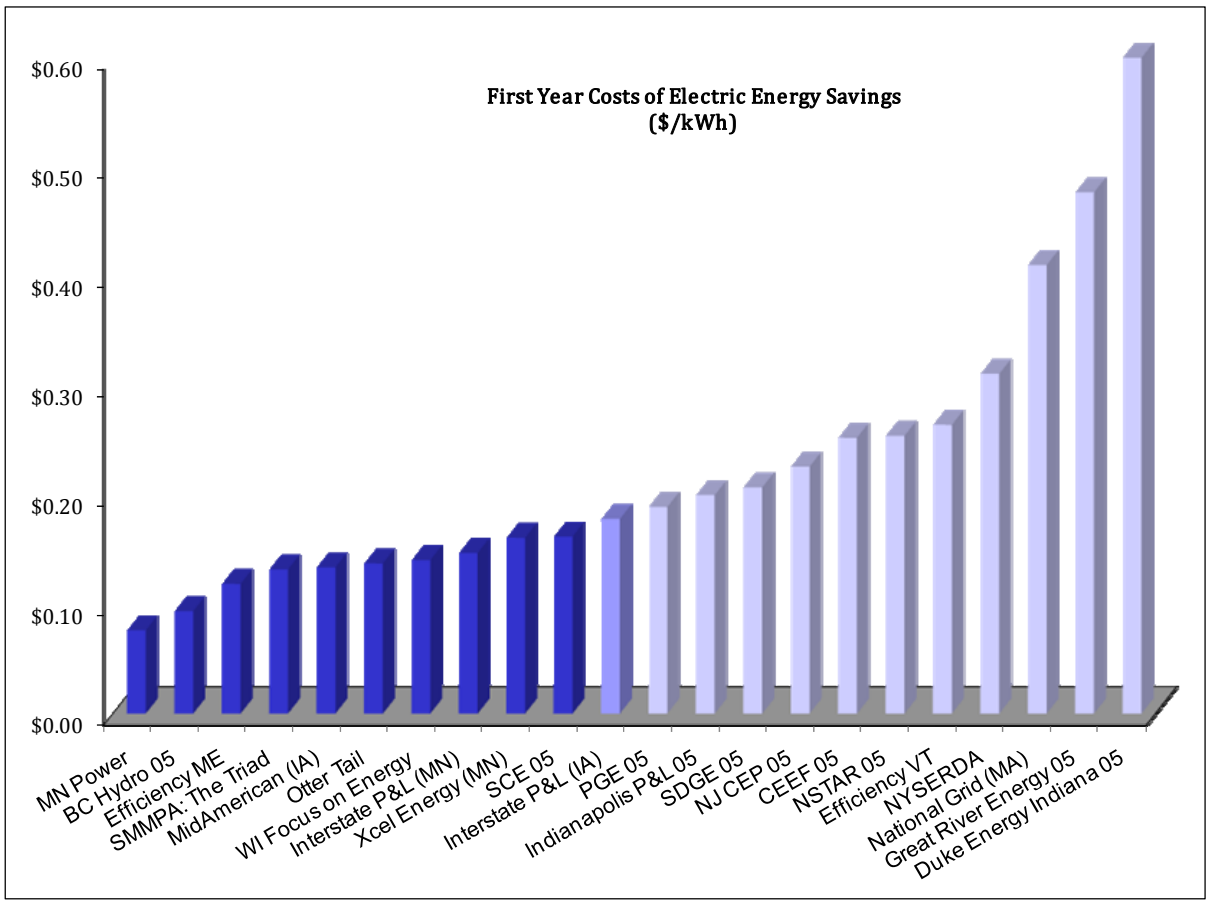
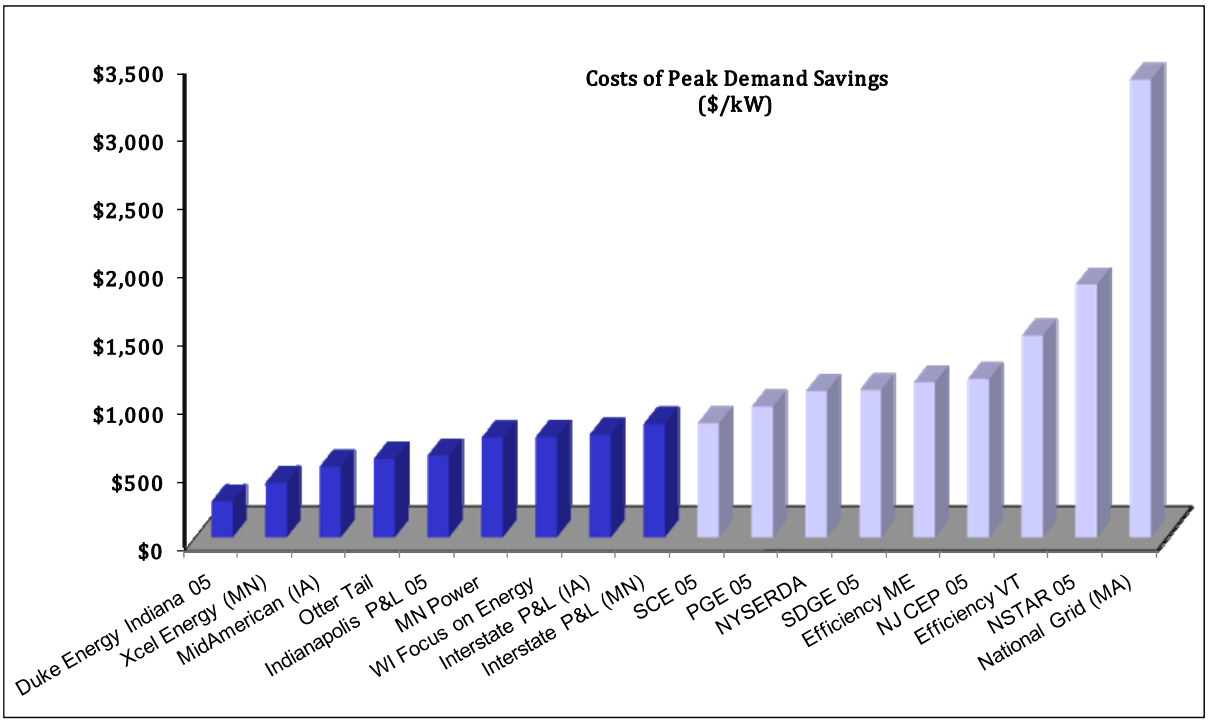


Figure 3-6 shows that Duke Energy Indiana 05, at $265/kW, and Xcel Energy (MN), at $401/kW, have the lowest costs of conserved peak demand, well below the median of $836/kW. Duke Energy Indiana's direct load control program is responsible for the company's low cost of peak demand savings and high cost of energy savings.

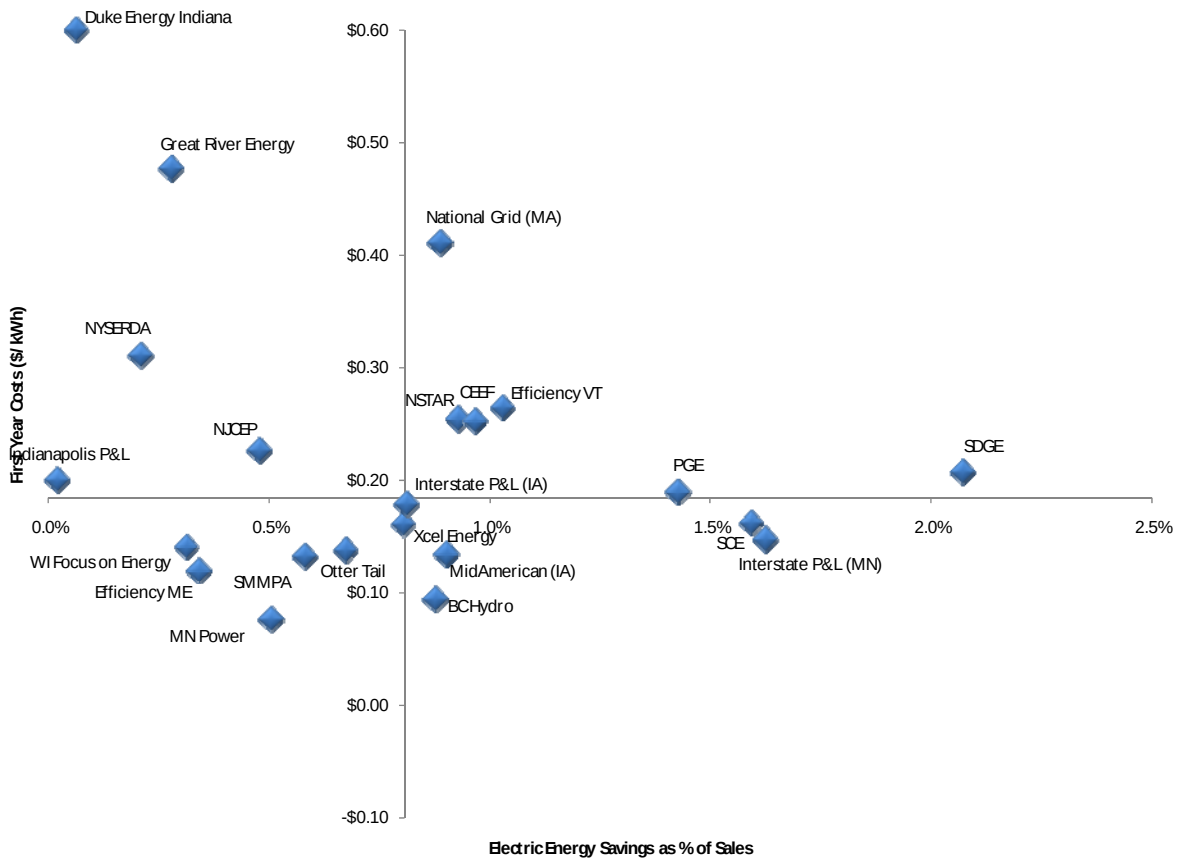
Figure 3-6: Cost of Peak Demand Savings ($/kW)



The scatter plot in Figure 3-7 below illustrates where each organization falls relative to median energy savings and median costs. SDGE 05 achieved the greatest energy savings as percentage of sales, 2.1%, but achieved these savings at a cost, $0.21/kWh, above the median, $0.18/kWh. The utilities listed below achieved median or higher energy savings as a percentage of sales very near or lower than the median cost:

1. Interstate P&L (MN): 1.6%, $0.15/kWh
2. SCE 05: 1.6%, $0.16/kWh
3. PG&E 05: 1.4%, $0.19 /kWh
4. MidAmerican (IA): 0.9%, $0.13/kWh
5. BC Hydro: 0.9%, $0.09/kWh
6. Xcel Energy: 0.8%, $0.16/kWh
7. Interstate P&L (IA): 0.8%, $0.18/kWh

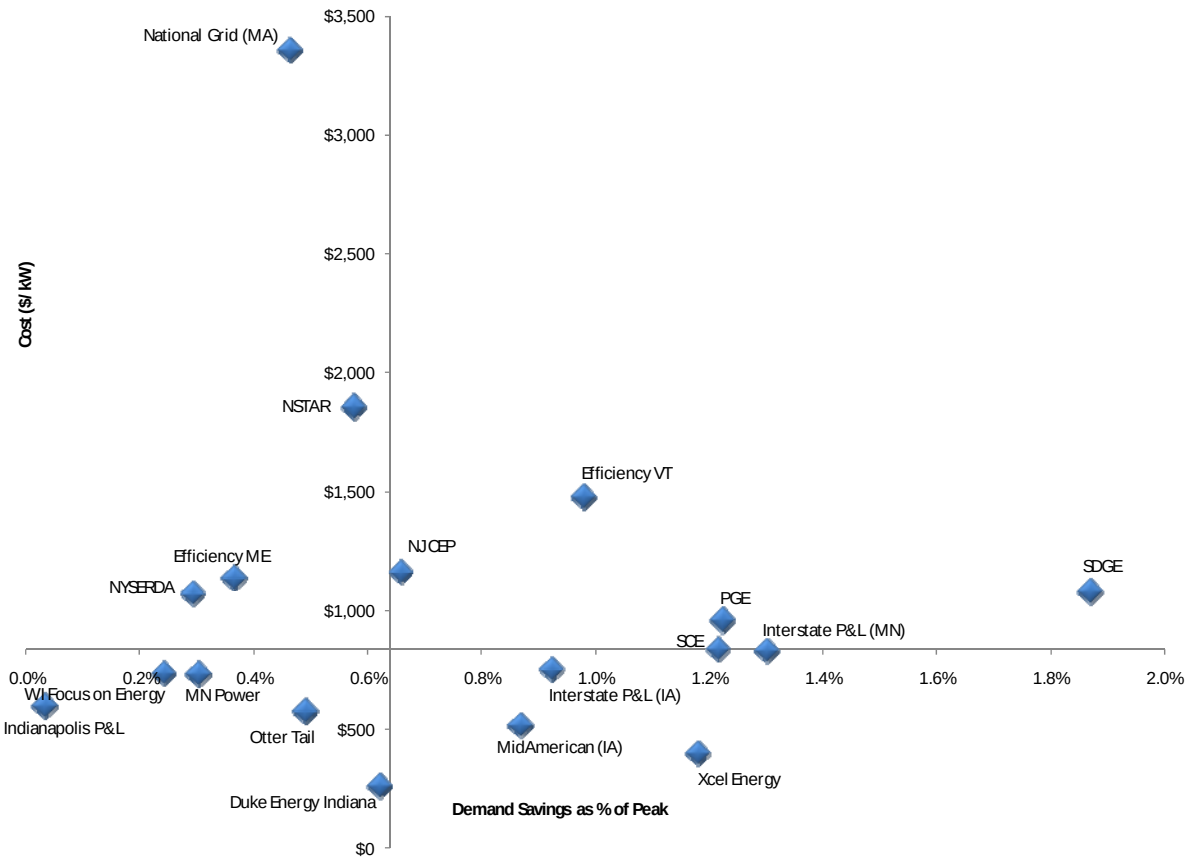
Figure 3-7: Scatter Plot of Electric Energy Savings and First Year Costs ($/kWh)



The scatter plot shown in Figure 3-8 below illustrates organizations' results relative to median peak demand savings and median costs. SDGE 05 achieved the greatest percentage of peak demand savings but at $1,081/kW, costs above the median, $836/kW. The utilities listed below achieved higher than median demand savings as a percentage of peak demand very near or lower than the median cost:

1. Interstate P&L (MN): 1.3%, $833/kW
2. SCE: 1.2%, $839/kW
3. Xcel Energy: 1.2%, $401/kW
4. Interstate P&L (IA): 0.9%, $755/kW
5. MidAmerican (IA): 0.9%, $519/kW

Figure 3-8: Scatter Plot of Peak Demand Savings and First Year Costs ($/kW)



The shape of the energy savings and costs scatter plot illustrates greater variation in costs of energy savings among the organizations that have below median savings as a percentage of sales.

Specifically, these data suggest that an organization with an energy savings rate above the median (0.8% of sales) is more likely to save at or below median costs ($0.18/kWh) than is an organization that has an energy savings rate below the median. The scatter plot of peak demand savings and costs, however, suggests a more complex relationship between peak demand savings and costs of peak demand savings.

3.3.2 Sector Analysis

This section compares 2006 electricity DSM program results for the non-residential (also referred to as Commercial & Industrial–C&I) and residential sectors and reviews program-level detail for those organizations that achieved high savings at low costs.

C&I Sector

Table 3-4 shows the median results for spending, savings, and costs for the C&I sector for all reviewed organizations (where data are available).[16]

Table 3-4: Medians for C&I Results

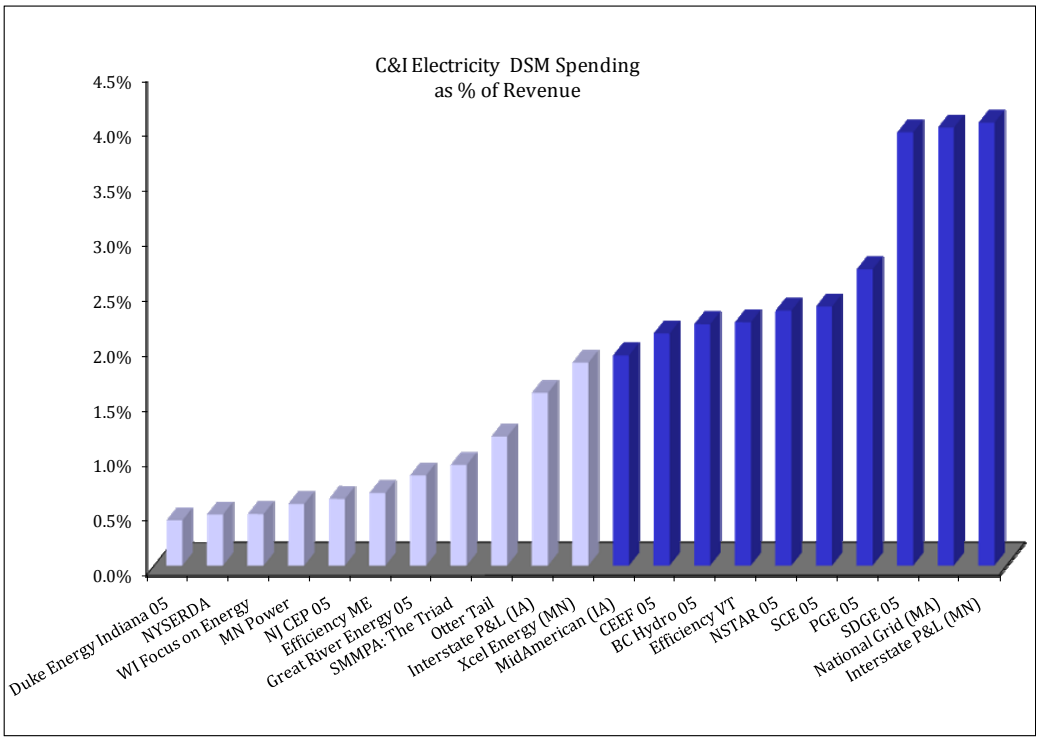
Spending as % of Revenue	Electric Energy Savings as % of Sales	Demand Savings as % of Peak Demand	Cost of Savings	
			$/kWh	$/kW
1.8%	0.7%	0.6%	$0.14	$680

[16] DSM results for the C&I sector for Indianapolis P&L 05 were not available. Duke Energy Indiana C&I data here are based only on small commercial and industrial data.

C&I Electricity DSM Spending

Electricity DSM spending in the non-residential sector, as a percentage of annual revenue of retail energy sales, ranges from 0.4% to 4.0%, with the median at 1.8% (Figure 3-9). Organizations with spending rates in the top quartile are SCE 05, PGE 05, SDGE 05, National Grid (MA), and Interstate P&L (MN) which has the highest spending rate, about twice the median. Every organization with above median spending rate, except BC Hydro and National Grid (MA), also achieved above median energy savings as a percentage of sales (Figure 3-10).

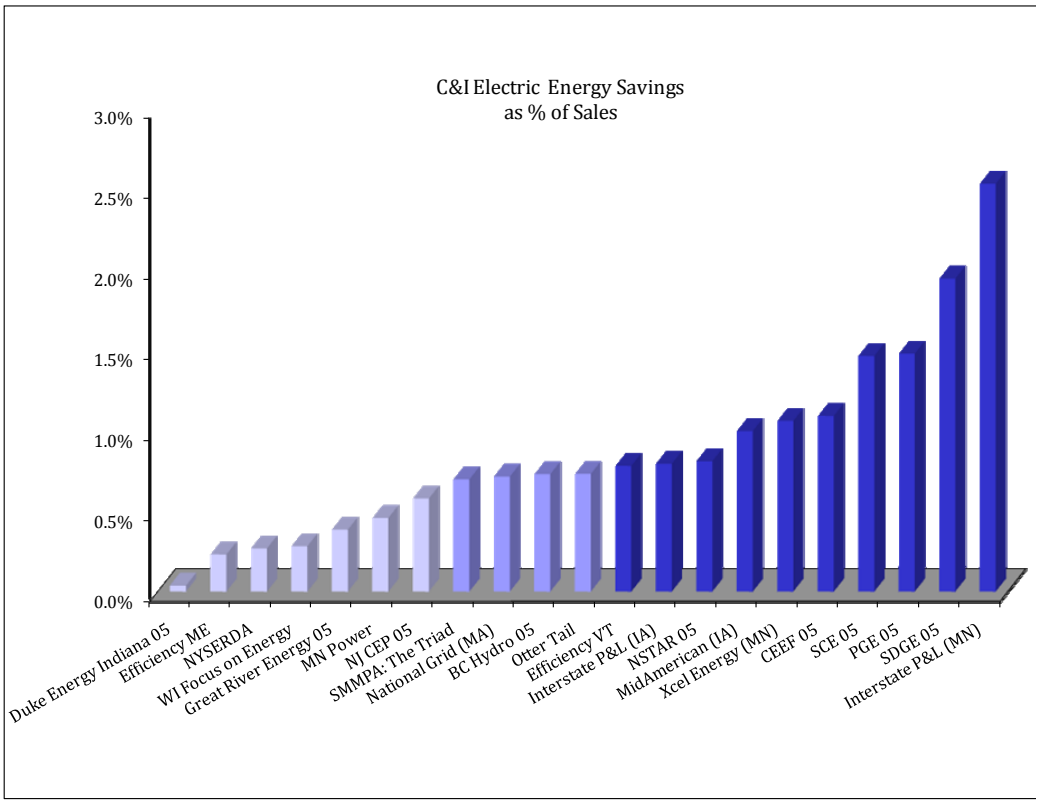
Figure 3-9: C&I Electricity DSM Spending as % of Revenue



C&I Electric Energy Savings

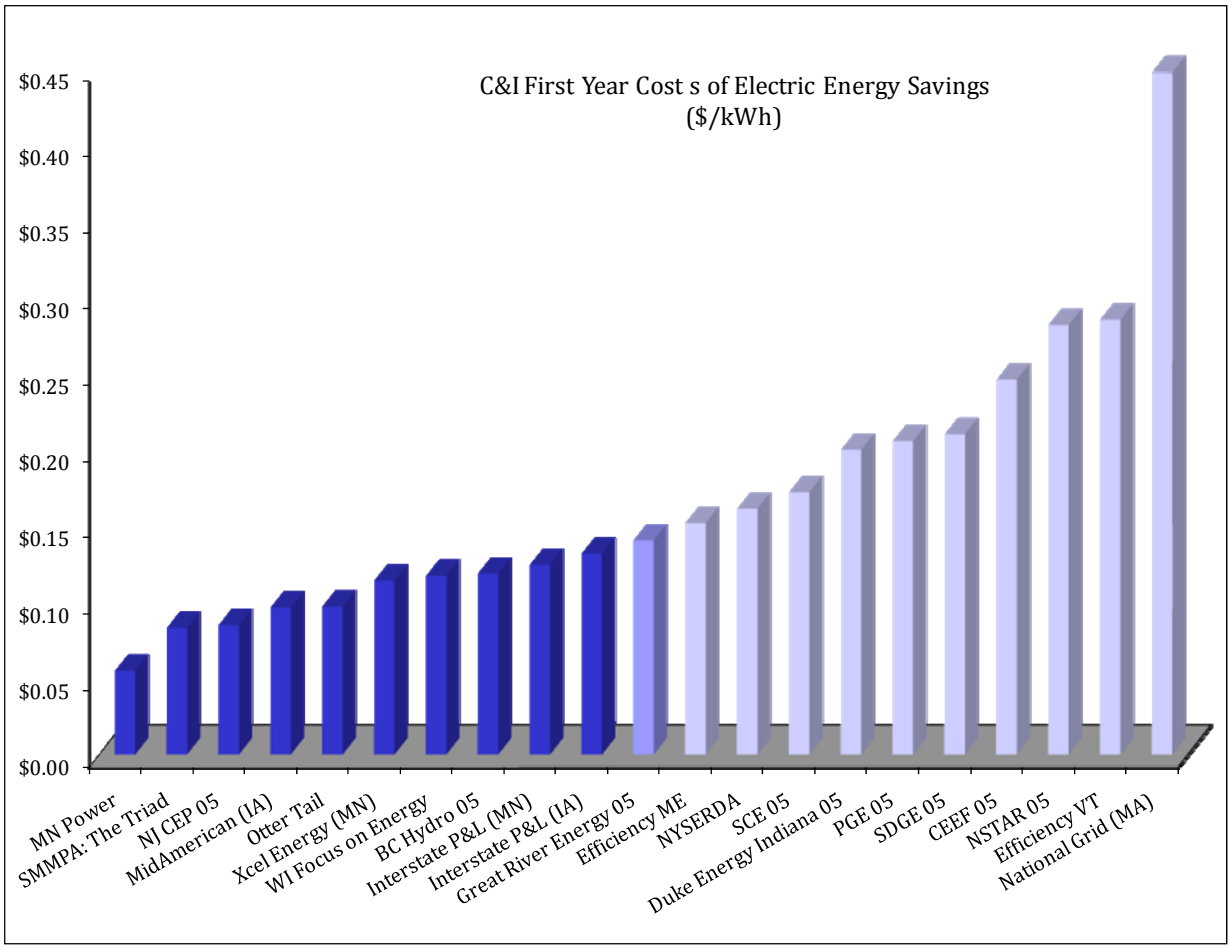
Figure 3-10 and Figure 3-11 show the energy savings as a percentage of sales and the cost of these savings across the various organizations. Energy savings as a percentage of sales ranges from 0.04% to 2.5% with the median at 0.7%. Interstate P&L (MN) has the highest savings rate, over three times the median. SDGE 05, PGE 05, SCE 05, CEEF 05, Xcel Energy (MN), MidAmerican (IA), NSTAR 05, Interstate P&L (IA), and Efficiency VT also achieved above median energy savings ranging from 0.8% - 1.9% of sales.

Figure 3-10: C&I Electric Energy Savings as % of Sales First Year



The costs of first year C&I energy savings range from $0.06/kWh to $0.45/kWh with the median at $0.14/kWh. MN Power achieved the lowest cost of energy savings. Interstate P&L (IA), Interstate P&L (MN), Xcel Energy, and MidAmerican (IA), with near median electricity DSM spending rates and high energy savings rates, achieved their savings at below median costs, about $0.12/kWh.

Figure 3-11: C&I Cost of Electric Energy Savings ($/kWh) First Year



The scatter plot shown in Figure 3-12 below illustrates where each organization falls relative to median energy savings and median costs. Interstate P&L (MN) achieved the greatest rate of C&I energy savings as a percentage of sales at below median costs, $0.12/kWh. The California utilities also achieved high rates of savings, but at costs around $0.20/kWh, well above the median. Xcel Energy, MidAmerican (IA), and Interstate P&L (IA) also achieved above median energy savings rates at below median costs:

1. Interstate P&L (MN): 2.5%, $0.12/kWh
2. Xcel Energy: 1.1%, $0.11/kWh
3. MidAmerican (IA): 1.0%, $0.10/kWh
4. Interstate P&L (IA): 0.8%, $0.13/kWh

Figure 3-12: Scatter Plot of C&I Electric Energy Savings and First Year Costs ($/kWh)

Table 3-5 below shows results for programs delivered by the utilities that achieved above median energy savings rates at below median costs in the C&I sector. Interstate P&L (IA) and Interstate P&L (MN) achieved most of their energy savings with custom type rebate programs. Xcel Energy, which gained most of its savings from several programs, also achieved significant savings with programs for custom rebates, motors, cooling/heating/roofing, but earned most of its savings with programs for new construction and lighting. MidAmerican (IA) achieved most of its savings not only from new construction and lighting but also from motors.[17]

Table 3-5: Electric Energy Savings for C&I Programs as % of Sales

C&I Program/Measures	Interstate P&L (IA)	Interstate P&L (MN)	MidAmerican (IA)	Xcel Energy
Lighting		0.02%	0.50%	0.27%
Cooling/Heating/Roofing		0.02%		0.10%
Refrigeration				0.02%
Motors			(see Lighting[17])	0.10%
Compressed Air				0.12%
Combination	0.05%			
Custom Rebates	0.68%	2.36%	0.12%	0.17%
Energy Audit			0.07%	
New Construction	0.03%		0.27%	0.26%
Agriculture	0.04%	0.13%		0.01%
C&I Interruptible Rates			0.04%	0.01%
C&I Direct Load Control				
Total C&I Savings (GWh)	87.9	13.1	126.2	244.0
Annual C&I Sales (GWh)	11,079.0	516.9	12,664.7	23,028.9
C&I Savings as % of C&I Sales	0.79%	2.53%	1.00%	1.06%

[17] Here MidAmerican (IA)'s lighting savings are from their Non-Residential Equipment Program. While this is a program of incentives for a range of measures, including (in addition to lighting) heating, cooling, and motors, most of this program's 2006 energy savings, 47% of the program total, is from lighting measures while 45% of the program's total energy savings is from VSD/motors. This footnote applies to each of the following five savings tables below.

As seen in Table 3-6 below, costs of energy savings per program varies widely. But costs for Interstate P&L (MN)'s and Interstate P&L (IA)'s custom type rebate programs are just below the median cost. MidAmerican (IA)'s costs per kWh for its high achieving program, the Non-Residential Equipment Program, is just $0.05/kWh, well below the median. Xcel Energy's costs per kWh per program are at or below the median for most programs.

Table 3-6: Costs of C&I Electric Energy Savings by Type of Program[18]

C&I Program/Measures	Interstate P&L (IA)	Interstate P&L (MN)	MidAmerican (IA)	Xcel Energy
Lighting		$0.31	$0.05	$0.16
Cooling/Heating/Roofing		$0.53		$0.14
Refrigeration				$0.07
Motors			(see Lighting - above ftnt [17])	$0.07
Compressed Air				$0.03
Combination	$0.25			
Custom Rebates	$0.10	$0.12	$0.09	$0.06
Energy Audit			$0.21	
New Construction	$0.34		$0.12	$0.10
Agriculture	$0.11	$0.08		$0.14
C&I Interruptible Rates			$0.22	$0.35
C&I Direct Load Control				$2.36
Total C&I Savings (GWh)	87.9	13.1	126.2	244.0
Total Costs ($M)	11.6	1.6	12.2	27.9
Costs of C&I Savings ($/kWh)	$0.13	$0.12	$0.10	$0.11

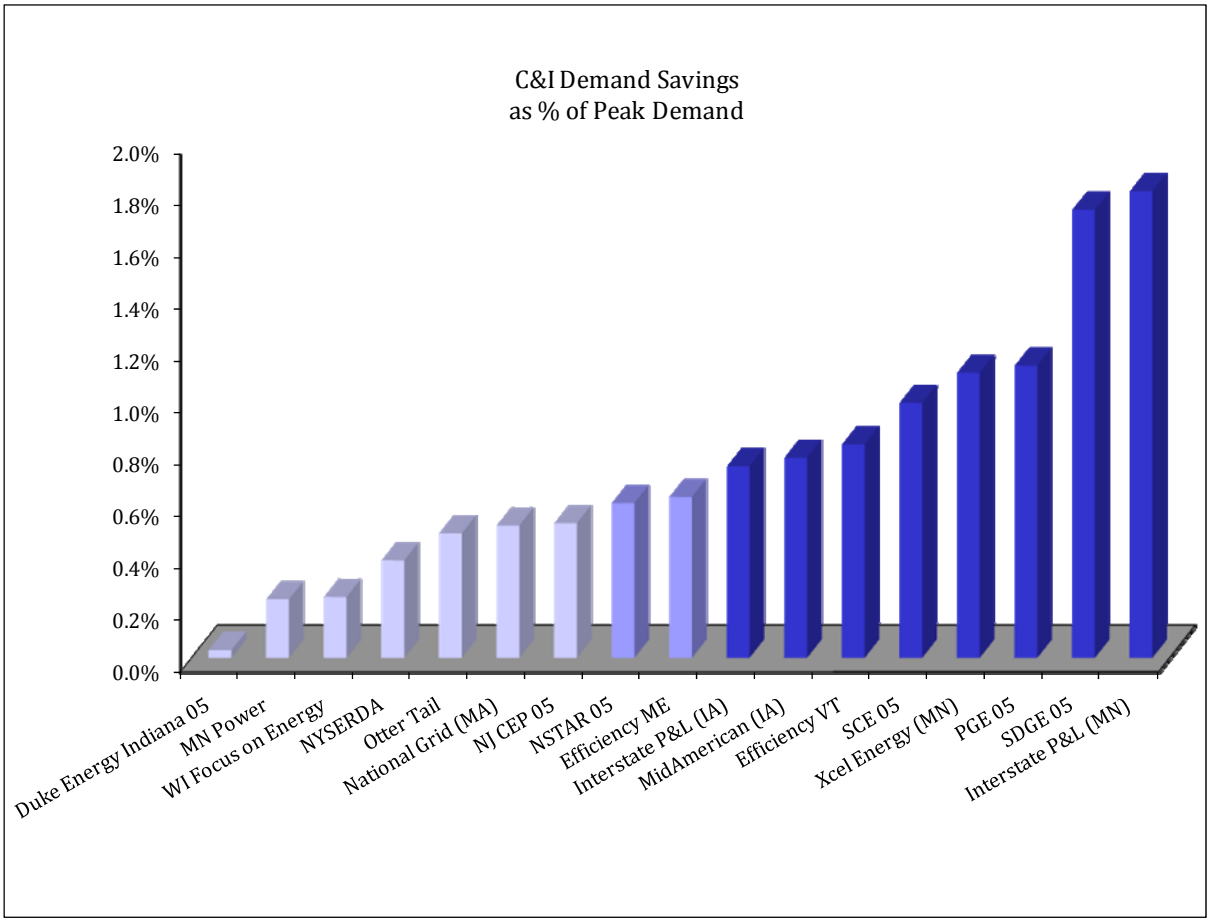
Note: All Cost Savings ($/kWh) are from first year savings results.

[18] Total costs include costs of indirect impact programs, i.e., programs for which energy and peak demand savings are not accountable.

C&I Peak Demand Savings

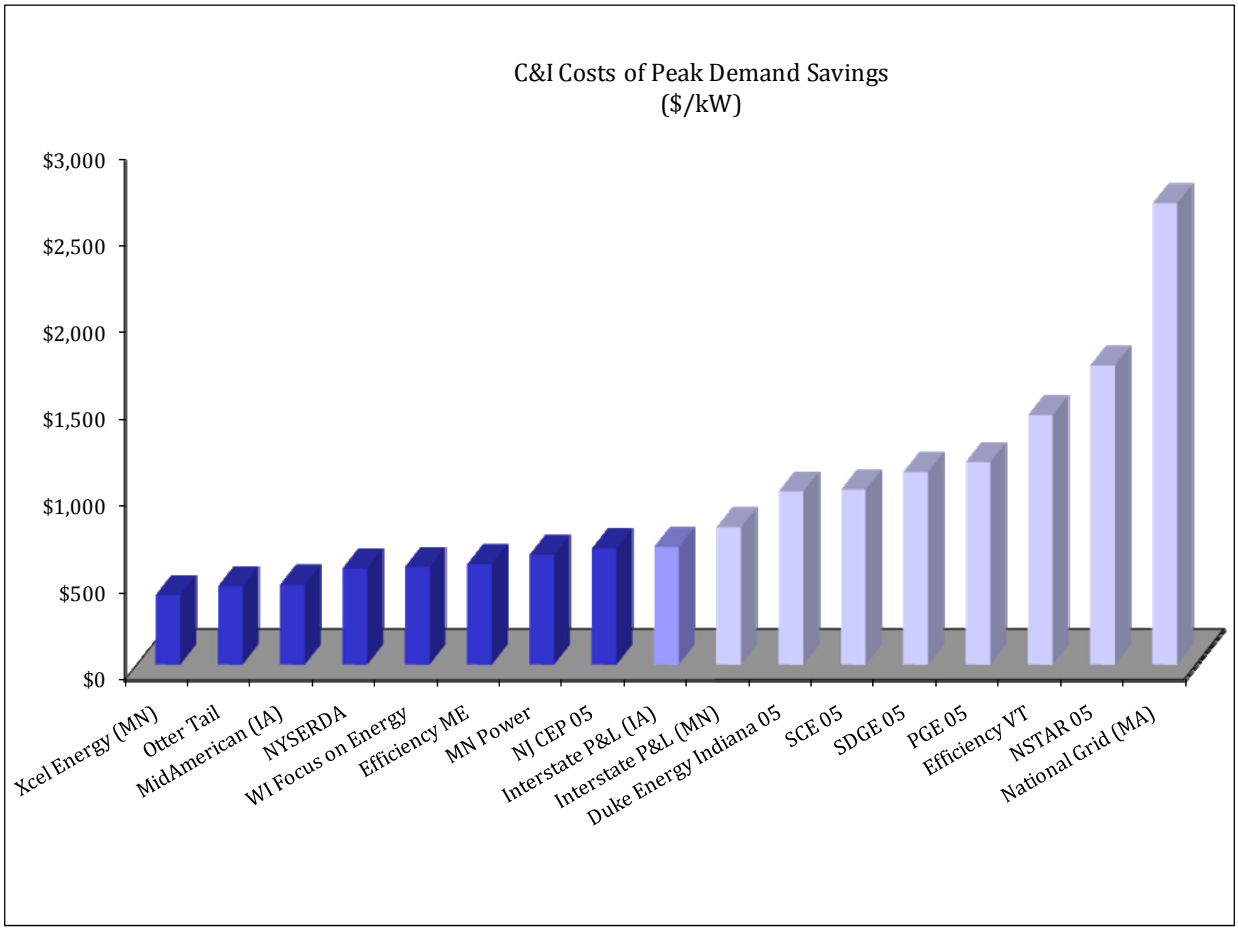
Figure 3-13 and Figure 3-14 below show DSM incremental demand savings as a percentage of annual peak demand and costs of peak demand savings for the C&I customer sector. C&I demand savings as a percentage of C&I peak demand range from 0.03% to 1.8% with the median at 0.6%. Interstate P&L (MN) achieved the highest percentage of conserved peak demand while SDGE 05, PGE 05, Xcel Energy (MN), SCE 05, Efficiency VT, MidAmerican (IA), and Interstate P&L (IA) also achieved above median peak demand savings rates.

Figure 3-13: C&I Demand Savings as % of Peak Demand



Costs of peak demand savings range from $402/kW to $2,662/kW with the median at $680/kW. Xcel Energy achieved their high rate of conserved peak demand with the lowest costs per kW. MidAmerican (IA) also achieved their high rate of peak demand savings at costs per kW well below the median. Lighting, new construction, and load management programs provided significant peak demand savings for these two utilities at below median costs.

Figure 3-14: C&I Cost of Peak Demand Savings ($/kW)



The scatter plot shown in Figure 3-15 below illustrates where each organization falls relative to median peak demand savings and median costs in the C&I sector. SDG&E and Interstate P&L (MN) achieved the greatest peak demand savings rate but achieved those savings at costs above the median. The other California utilities also achieved peak demand savings above the median at above median costs. Xcel Energy and MidAmerican (IA) achieved above median peak demand savings rates at below median costs while Interstate P&L (IA) achieved above median peak demand savings at median costs:

1. Xcel Energy: 1.1%, $402/kW
2. MidAmerican (IA): 0.8%, $463/kW
3. Interstate P&L (IA): 0.7%, $680/kW

Xcel Energy achieved the largest amount of peak demand savings from interruptible rate programs which tend to have low costs of conserved peak demand.

Figure 3-15: Scatter Plot of C&I Peak Demand Savings and First Year Costs ($/kW)

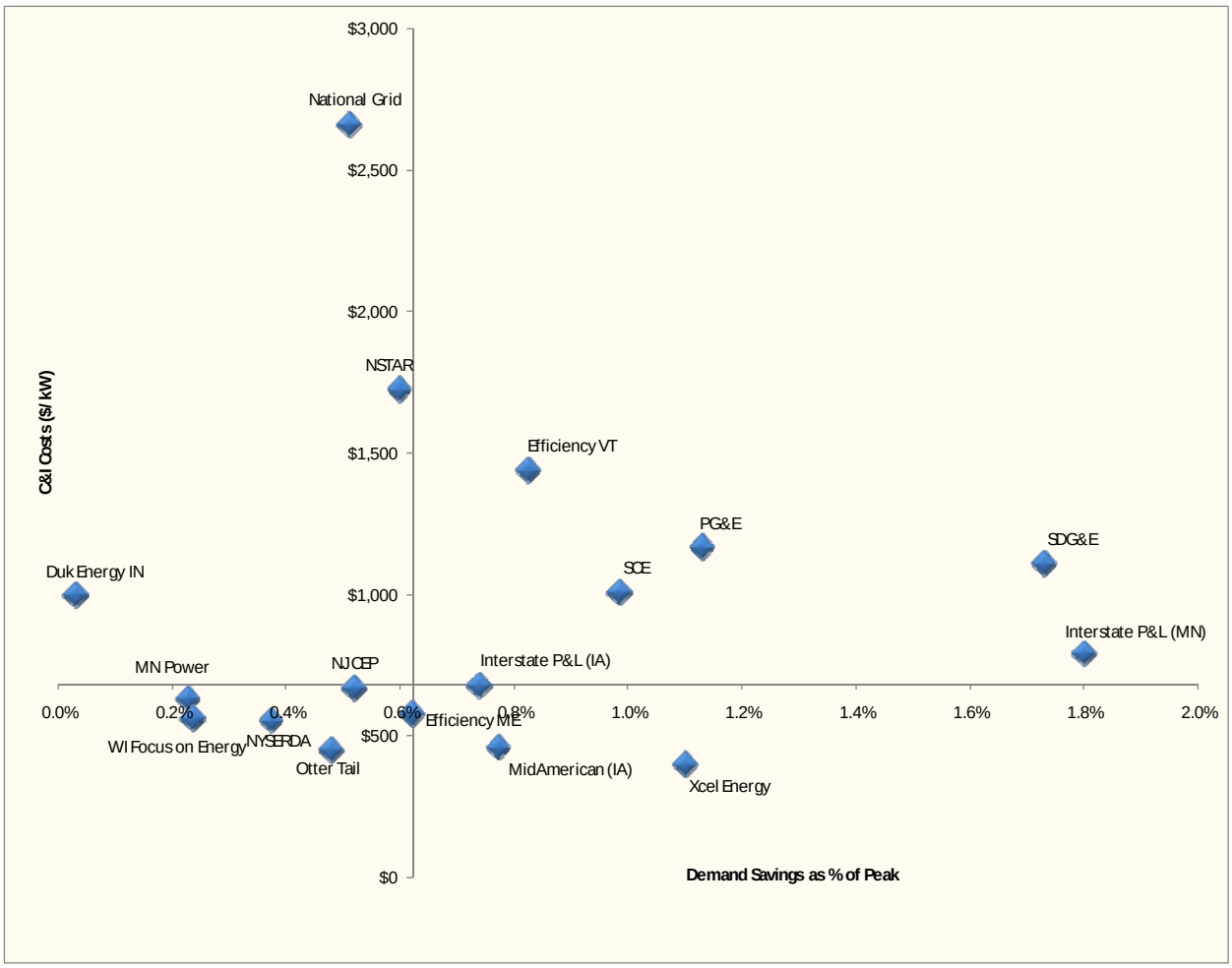


Table 3-7 below compares results by program of organizations that had median or higher peak demand savings rates at below median costs: Interstate P&L (IA), MidAmerican (IA), and Xcel Energy. Interstate P&L (IA) achieved most of their C&I peak demand savings from custom type rebate programs. MidAmerican (IA) achieved peak demand savings mainly from new construction, lighting, and motor programs. While Xcel Energy earned its peak demand savings from several programs, it achieved most of its peak demand savings from load management programs and, like MidAmerican (IA), from lighting and new construction.

Table 3-7: C&I Percent of Peak Demand Savings by Type of Program

C&I Program/Measures	Interstate P&L (IA)	MidAmerican (IA)	Xcel Energy
Lighting		0.36%	0.19%
Cooling/Heating/Roofing			0.09%
Refrigeration			0.01%
Motors		(see Lighting - above ftnt [4])	0.04%
Compressed Air			0.04%
Combination	0.09%		
Custom Rebates	0.59%	0.06%	0.04%
Energy Audit		0.04%	
New Construction	0.03%	0.21%	0.24%
Agriculture	0.04%		0.00%
C&I Interruptible Rates		0.10%	0.29%
C&I Direct Load Control			0.16%
Total C&I Savings (MW)	17.0	26.3	69.2
Peak Demand (MW)	2,293.6	3,398.2	6,278.8
C&I Savings as % of Peak Demand	0.74%	0.77%	1.10%

Table 3-8 below shows the costs of C&I peak demand savings by program for these organizations with high peak demand savings at low costs.

MidAmerican (IA)'s high achieving program, the Non-Residential Equipment Program, achieved most of its peak demand savings at below median cost while Interstate P&L (IA) spent below the median on custom rebates. Although Xcel Energy spent above the median on its high saving lighting program, it achieved overall below median costs per kW with its very low cost-high savings interruptible rates and direct load control program.

Table 3-8: Costs of C&I Peak Demand Savings by Type of Program[19]

C&I Program/Measures	Interstate P&L (IA)	MidAmerican (IA)	Xcel Energy
Lighting		$277	$842
Cooling/Heating/Roofing			$557
Refrigeration			$558
Motors		(see Lighting - above ftnt [17])	$585
Compressed Air			$346
Combination	$705		
Custom Rebates	$573	$682	$907
Energy Audit		$1,200	
New Construction	$1,747	$552	$385
Agriculture	$530		$1,333
C&I Interruptible Rates		$302	$27
C&I Direct Load Control			$193
Total C&I Savings (MW)	17.0	26.3	69.2
Total Costs ($M)	11.6	12.2	27.9
Costs of C&I Savings ($/kW)	$680	$463	$402

Note: All Cost Savings ($/kWh) are from first year savings results.

[19] Total costs include costs of indirect impact programs, i.e., programs for which energy and peak demand savings are not accountable.

C&I Best Practices by Program

This section reviews best practices by program of utilities that achieved significant C&I impacts.

Table 3-9: Distribution of C&I Electricity DSM Spending by Program[20]

C&I Program/Measures	Interstate P&L (IA)	Interstate P&L (MN)	MidAmerican (IA)	Xcel Energy	PGE 05	SDGE 05	SCE 05
Lighting		1.9%	27.5%	35.3%			5.1%
Cooling/Heating/Roofing		2.6%		11.2%	4.1%	2.6%	7.8%
Refrigeration				0.9%			
Motors			(see Lighting - above ftnt [17])	5.9%			
Compressed Air				3.2%			
Combination	12.2%				36.6%	33.5%	30.3%
Custom Rebates	66.9%	88.5%	11.2%	8.5%	20.6%	46.5%	38.7%
Energy Audit			14.8%				
New Construction	9.1%		32.7%	20.9%	20.1%	15.1%	8.8%
Agriculture	4.1%	3.6%		1.4%			
Indirect Impact		3.1%		1.3%	9.9%	1.6%	9.3%
C&I Interruptible Rates	1.8%		8.7%	1.8%			
C&I Direct Load Control				6.8%			
Total C&I Savings (GWh)	87.9	13.1	126.2	244.0	765.4	233.3	838.0
Total Costs ($M)	11.6	1.6	12.2	27.9	157.5	49.1	144.4
Costs of C&I Savings ($/kWh)	$0.13	$0.12	$0.10	$0.11	$0.21	$0.21	$0.17

Note: All Cost Savings ($/kWh) are from first year savings results.

[20] Total costs include costs of indirect impact programs, i.e., programs for which energy and peak demand savings are not accountable.

Table 3-10: Distribution of C&I Electricity DSM Energy Savings by Program

C&I Program/Measures	Interstate P&L (IA)	Interstate P&L (MN)	MidAmerican (IA)	Xcel Energy	PGE 05	SDGE 05	SCE 05
Lighting		0.8%	50.3%	25.2%			8.7%
Cooling/Heating/Roofing		0.6%		9.2%	2.4%	1.6%	9.6%
Refrigeration				1.5%			
Motors			(see Lighting - above ftnt [17])	9.5%			
Compressed Air				11.3%			
Combination	6.5%				56.8%	40.2%	23.6%
Custom Rebates	85.1%	93.1%	12.0%	16.4%	23.4%	47.9%	40.3%
Energy Audit			6.8%				
New Construction	3.5%		27.0%	24.9%	17.4%	10.3%	17.8%
Agriculture	4.9%	5.3%		1.2%			
C&I Interruptible Rates			3.8%	0.6%			
C&I Direct Load Control				0.3%			
Total C&I Savings (GWh)	87.9	13.1	126.2	244.0	765.4	233.3	838.0
Annual C&I Sales (GWh)	11,079.0	516.9	12,664.7	23,028.9	51,840.9	12,013.4	57,313.5
C&I Savings as % of C&I Sales	0.79%	2.53%	1.00%	1.06%	1.48%	1.94%	1.46%

C&I Custom Type Rebate Programs

Custom type rebate programs (custom programs) offer incentives for energy efficiency projects that are not covered by prescriptive rebates or other programs. The program may include:

- a partially or fully subsidized energy audit or study,
- low interest financing for the project, and
- 3rd party consultant or vendor sponsor.

The incentive is usually based on estimated installed savings. Projects may come from a program-sponsored audit/study, a trade ally, or from the customer.

Custom programs are key to a high impact C&I electricity DSM portfolio; every organization reviewed in this study with a C&I energy savings rate above the median has a custom program responsible for at least 12% of the organization's total C&I energy savings.

The custom programs reviewed here are those of the top performers in C&I energy savings and the three California IOUs. Top performers in C&I energy savings are identified as those that achieved above median energy savings at below median costs: Interstate P&L (IA), Interstate P&L (MN), MidAmerican (IA), and Xcel Energy. The three California IOUs, PG&E, SDG&E, and SCE, are included here for the significant impacts they achieved in custom programs.

Interstate P&L (IA) offered two custom programs, the traditional Custom Rebate Program and the Performance Contracting program.

The Custom Rebate program, available to all non-residential customers, offered rebates for energy/ peak demand saving equipment that did not qualify for Interstate P&L (IA)'s Prescriptive Rebates program or their Non-Residential Commercial New Construction program. Projects required review and pre-approval. Interstate P&L (IA) promoted the program principally via account managers whose efforts were supported with seminars, workshops, and direct mailings to customers, vendors, and trade allies.

Through the Performance Contracting program, customers paid for energy efficiency projects with no up-front costs but with guaranteed energy savings. Incentives, in the form of risk premiums, were offered to project developers/contractors to defray risks of marketing, proposal development, customer default, and energy savings and financing underperformance. The risk premium was based on actual savings as verified by an independent 3rd party, kW Engineering. The program was promoted directly to project developers and was administered by Franklin Energy Services, which had been selected from a formal RFP process.

In 2006, Interstate P&L (IA) approved 205 projects for the Custom Rebate program and 29 projects for the Performance Contracting program. Together, the two programs provided 85% of Interstate P&L (IA)'s total C&I energy savings with just 70% of Interstate P&L (IA)'s total C&I spending, the Custom Rebate program providing 75% of the total C&I savings at just 58% of the total C&I spending.

Interstate P&L (MN) principally targeted their custom program, the Commercial, Industrial, and Agricultural Shared Savings Project, to customers with annual electric revenue greater than $50,000. IPL provided a custom package of energy efficiency measures on the basis of IPL's detailed energy audit and offered low-interest financing for the installation of the custom package. IPL promoted Shared Savings via personal contacts, account managers, website, direct mail, bill inserts, newsletters, and newspaper advertising.

IPL technical engineers worked with C&I customers to determine best-suited efficiency technologies and estimate potential savings. For small business customers, IPL contracted an energy engineering firm to deliver the program via subsidized energy audits. If the $75 (normally $400) audit identified potential efficiency improvements, then a Shared Savings project was offered. Submitted projects were required to pass a benefit/cost screening. After a project installation was complete, IPL retained an independent engineering consultant to review the project and estimate energy and peak demand savings, project costs, and any operating cost savings.

In 2006, Shared Savings provided over 90% of Interstate P&L (MN)'s total C&I energy savings with just 19 C&I participants and 6 small business participants. This profile of C&I market and custom program impacts is unique to Interstate P&L (MN) of the organizations reviewed here.

MidAmerican (IA) offered two custom type rebate programs: 1) Non-Residential Custom Systems for new and existing buildings and manufacturing processes and 2) Efficiency Bid for large industrial customers with peak demands of 3MW and greater.

The Non-Residential Custom Systems program offered custom rebates and/or low-interest financing on projects generally identified by customers but also by energy consultants and trade allies. To promote the program to its large customers, MidAmerican relied on its in-house account managers/energy consultants and on a local network of trade allies: engineering firms, mechanical contractors, electrical contractors, and control contractors. MidAmerican met individually with and offered training workshops to their trade allies and had their energy consultants personally deliver program material to large customers.

Efficiency Bid offered incentives through a competitive bidding process in which customers submitted customer-designed energy efficiency projects. MidAmerican (IA) encouraged a systems approach to efficiency and the use of energy use indices to quantify and control energy input per production unit.

MidAmerican (IA) in-house account managers/energy consultants personally promoted the program to eligible customers. Interested customers then worked with a MidAmerican (IA) product manager or a program contractor who would perform facility assessments as needed to identify potential projects. MidAmerican also contracted EnVinta to offer One-2-Five Energy diagnostics to potential program participants.

In 2006 MidAmerican (IA) approved 11 projects for Efficiency Bid and had 112 Non-Residential Custom projects approved and completed. The resulting 2006 total custom programs energy savings constituted 12% of MidAmerican (IA)'s C&I total electricity DSM energy savings, the lowest percentage of the organizations reviewed here and in line with the custom percentage of its total C&I spending, about 13%.

Xcel Energy's Custom Efficiency program offered rebates for pre-approved efficiency projects of $200 per kW saved, up to 50% of incremental costs. Xcel Energy also provided engineering assistance and funding for engineering studies, up to 50% of the study cost, with a maximum of $15,000 per study. Account managers promoted the program and provided assistance in the application process. Applications were required to 1) be submitted before equipment purchase and installation, 2) be reviewed by a professional engineer with an emphasis on deemed savings and interactive energy effects of the system, 3) pass the Societal and Participant Tests, and 4) have a payback between 1 and 15 years. Pre-approved and installed projects that failed the payback period requirement (and, thus, earned no rebate) but would have passed review otherwise may have qualified as "Influenced Savings" which Xcel Energy could claim in its 2006 conservation results (other requirements applied[21]).

In 2006 the Custom Efficiency program achieved about 16% of Xcel Energy's total C&I energy savings at only 9% of Xcel Energy's total C&I electricity DSM costs.

PG&E, SDG&E, and SCE offered the statewide Standard Performance Contract (SPC) program which provided performance-based rebates for custom-designed energy savings retrofits for existing facilities. While available to any non-residential customer in the utility's service area, the program targeted large and medium customers. Customers with peak demand greater than 500 kW were eligible for the same prescriptive measures and incentive rates that were available to small customers as defined in the statewide prescriptive program, Express Efficiency. Small customers could participate in the Standard Performance Contract program with energy efficiency measures that did not qualify for the Express Efficiency program. Incentives for projects outside the prescriptive list were calculated as follows: for lighting and lighting control, $0.05/kWh saved; for air conditioner and refrigerator replacements, $0.14/kWh saved; and for all other, e.g. compressed air, variable frequency drives, and cool roof installations, $0.08/kWh saved. Applicants were eligible for incentives up to 50% of each measure's cost; the maximum incentive per site was $500,000. Applications and projects could be submitted and sponsored by third party consultants, vendors, or contractors on behalf of the customer with their

[21] The following requirements applied to Influenced Savings: pre-approval prior to purchase and installation; passing the Participant and Societal Tests, separate review by the Department of Commerce for projects of 2GWh and greater; savings claims capped at 4% of Xcel Energy's annual CIP achievements; and documentation demonstrating that Xcel Energy's involvement was important in effecting the project.

acknowledgment. SPC promotional material in the form of brochures and an interactive CD-ROM were available to the IOUs for distribution.

SDG&E promoted the program to customers, vendors, contractors and internal groups at energy efficiency events and formal meetings and e/mailed fact sheets to customers and sponsors. SDG&E account managers provided program information quarterly to major customers.

SCE also promoted the program at tradeshow events and direct mailed promotional material to its top 5,000 C&I customers and industry-specific segments. Account managers, assigned to promote the program to SCE's top customers, helped identify retrofit opportunities and assisted in the application process while SCE engineers helped applicants with savings calculations and, as needed, with measurements of existing equipment.

In PG&E's territory, their 2005 SPC budget was fully committed by October 2005.

Market assessment and evaluation of the program for all IOUs included verifying equipment installation and a review of the energy savings estimates for a sample of projects.

SCE offered an additional C&I custom program, the VeSM Advantage Plus Program (VeSM), which focused on process efficiencies for small to large manufactures. SCE contracted the California Manufacturing Technology Center for implementation of VeSM.

Custom programs in 2005 accounted for 23-48% of each California IOU's total C&I energy savings and 20-48% of C&I electricity DSM costs.

For these seven organizations, energy savings achieved by custom programs as a percentage of total C&I energy savings ranged widely from 12% to 93% with the median about 40%. Similarly, costs of custom programs as a percentage of total C&I electricity DSM costs also ranged widely from 9% to 89% with the median also about 40%. For most of these organizations, at least 75% of custom program costs were for incentives.

Clearly, as in Interstate P&L (MN)'s case, large industrial customers present the greatest potential for savings at low program costs. In California, where electricity DSM programs have been running for over twenty years, the IOUs must increase incentives and include smaller C&I customers in their target, resulting in significant impacts but above median costs. In contrast, Xcel Energy, which also has a mature electricity DSM program and market but did not, in 2006, have goals as aggressive as California's, achieved significant energy savings at low costs.

Table 3-11: Spending Distribution and $/kWh per Cost Component for Custom Programs

C&I Custom Rebates Utility/Agency	Program Name	Incentives Costs as % of Total	Incentives $/kWh	Admin & Other Costs as % of Total	Admin & Other $/kWh	Program Total $/kWh
Interstate P&L (IA)	Custom Rebates	80.1%	$0.08	19.9%	$0.02	$0.10
Interstate P&L (IA)	Performance Contracting	61.2%	$0.09	38.8%	$0.06	$0.15
	Total	**76.8%**	**$0.08**	**23.2%**	**$0.02**	**$0.10**
Interstate P&L (MN)	C/I Shared Savings Project	**66.5%**	**$0.08**	**33.5%**	**$0.04**	**$0.12**
MidAmerican (IA)	Efficiency Bid	63.3%	$0.04	36.7%	$0.02	$0.06
MidAmerican (IA)	Nonresidential Custom Program	57.4%	$0.11	42.6%	$0.08	$0.19
	Total	**60.6%**	**$0.05**	**39.4%**	**$0.04**	**$0.09**
PGE 05	EEI-SPC-Standard Performance Contract	**80.9%**	**$0.15**	**19.1%**	**$0.03**	**$0.18**
SDGE 05	EEI-Custom Rebates	94.4%	$0.18	5.6%	$0.01	$0.19
SDGE 05	EEI-SPC-Standard Performance Contract	92.6%	$0.26	7.4%	$0.02	$0.29
	Total	**94.0%**	**$0.19**	**6.0%**	**$0.01**	**$0.20**
SCE 05	EEI-Custom-VeSM Advantange Plus	55.4%	$0.15	44.6%	$0.12	$0.27
SCE 05	EEI-SPC-Standard Performance Contract	87.8%	$0.14	12.2%	$0.02	$0.16
	Total	**87.3%**	**$0.14**	**12.7%**	**$0.02**	**$0.17**
Xcel Energy (MN)	Custom Efficiency-C&I	48.9%	$0.03	51.1%	$0.03	$0.06
Xcel Energy (MN)	Custom Efficiency-Small Business	24.1%	$0.02	75.9%	$0.07	$0.09
	Total	**47.2%**	**$0.03**	**52.8%**	**$0.03**	**$0.06**

Table 3-12: Custom Program Costs and Energy Savings as a % of Total C&I Electricity DSM

C&I Custom Rebates Utility/Agency	Program Name	Program's Costs ($M)	% of Total C&I DSM Spending	Program's Energy Savings	% of Total C&I Energy
Interstate P&L (IA)	Custom Rebates	6.4	58.0%	65.8	74.9%
Interstate P&L (IA)	Performance Contracting	1.4	12.5%	9.0	10.2%
	Total	**7.7**	**70.5%**	**74.8**	**85.1%**
Interstate P&L (MN)	C/I Shared Savings Project	**1.4**	**88.5%**	**12.2**	**93.1%**
MidAmerican (IA)	Efficiency Bid	0.7	6.5%	11.9	9.4%
MidAmerican (IA)	Nonresidential Custom Program	0.6	5.3%	3.3	2.6%
	Total	**1.4**	**11.8%**	**15.2**	**12.0%**
PGE 05	EEI-SPC-Standard Performance Contract	**32.4**	**22.5%**	**179.4**	**23.4%**
SDGE 05	EEI-Custom Rebates	17.8	36.5%	94.2	40.4%
SDGE 05	EEI-SPC-Standard Performance Contract	5.0	10.3%	17.6	7.5%
	Total	**22.8**	**46.8%**	**111.7**	**47.9%**
SCE 05	EEI-Custom-VeSM Advantange Plus	0.7	0.5%	2.8	0.3%
SCE 05	EEI-SPC-Standard Performance Contract	55.2	38.2%	334.8	39.9%
	Total	**55.9**	**38.7%**	**337.6**	**40.3%**
Xcel Energy (MN)	Custom Efficiency-C&I	2.2	8.1%	38.3	15.7%
Xcel Energy (MN)	Custom Efficiency-Small Business	0.2	0.6%	1.7	0.7%
	Total	**2.4**	**8.7%**	**40.0**	**16.4%**

C&I Prescriptive Rebate Programs

Prescriptive rebate programs offer pre-determined rebates for specific types of high-efficiency equipment. Typical prescriptive rebate programs offer rebates for high efficiency lighting, HVAC equipment, motors, and variable speed drives. Rebates are measure-specific and usually increase with equipment efficiency.

Prescriptive rebate programs form the basis of a high impact C&I electricity DSM portfolio; every organization reviewed in this study with a C&I energy savings rate above the median has prescriptive rebate programs that are responsible for at least 25% of the organization's total C&I energy savings (except Interstate P&L (MN), which has unique C&I market and custom program impacts profile, and Interstate P&L (IA)). Costs for prescriptive programs range from 15% to 50% of total C&I electricity DSM costs.

The prescriptive rebate programs reviewed here are those of the three California IOUs and of the top performers in C&I energy savings that achieved significant savings by prescriptive rebate programs: MidAmerican (IA), Xcel Energy, PG&E, SDG&E, and SCE. The three California IOUs are included here for the significant impacts they achieved in prescriptive rebate programs.

MidAmerican (IA)'s Non-Residential Equipment program offered rebates for a wide range of lighting, HVAC, motor, and variable-speed drive measures, focusing on replacement and first-time purchase markets for all measures and primarily the retrofit market for lighting. Participation was driven by dealers in the up-sell of energy efficient equipment to customers. Thus MidAmerican focused on supporting relationships with trade allies by providing new program brochures, contacting and meeting with trade allies directly, and promoting the program at trade shows and conferences. MidAmerican also recognized those trade allies that achieved the highest energy savings through the Non-Residential Equipment program with awards at eight trade ally meetings. MidAmerican continued program development by reviewing and researching equipment, qualifying levels, rebate structures, and rebate levels of other organizations.

Most of 2006 program activity and impacts were from lighting measures which accounted for over 47% of the program's total energy savings and 59% of the program's total incentives. Variable speed drives accounted for 45% of the program's total energy savings at 18% of the program's total incentives.

The Non-Residential Equipment program achieved 50% of MidAmerican's 2006 C&I energy savings at 29% of MidAmerican's C&I electricity DSM costs. As the administrative costs for the Non-Residential Equipment program were so low, about $0.01/kWh, almost all of this program's costs were for incentives. Overall, MidAmerican's costs per kWh for this prescriptive rebate program are the lowest of the organizations reviewed here, about $0.05/kWh.

Xcel Energy offered several channel-specific prescriptive rebate programs: One-Stop Efficiency Shop, Lighting Efficiency, Cooling Efficiency, and Motor Efficiency; eligibility criteria and rebate structure and level were specified for each measure.

The One-Stop Efficiency Shop, Xcel Energy's only prescriptive rebate program that was jointly run with the Center for Energy and Environment, was a lighting efficiency program for small- to mid-sized businesses (with peak demand of 10 to 400kW). The program included a free lighting audit and cost savings plan, referrals to qualified contractors, oversight of the lighting retrofit project, and rebates up to $475/kW saved, maximum of 60% of installed costs. In 2006 the program achieved 12% of Xcel Energy's total C&I energy savings at about 27% of total C&I electricity DSM costs, being Xcel Energy's most expensive prescriptive rebate program.

Xcel Energy's Lighting Efficiency program offered rebates for high-efficiency lighting measures for new construction and greater rebates for retrofits in existing buildings. The program also included a lighting redesign study to determine proper light levels in commonly over-lit spaces. While the program has one of the largest impacts in Xcel Energy's C&I electricity DSM portfolio, continued market saturation and increasing baseline efficiency standards have reduced the impact each year. Some measure rebates were discontinued due to changes in baseline efficiency standards, and new measures were added based on new lighting and lighting control technologies. In 2006 the program achieved 13% of Xcel Energy's total C&I energy savings at about 9% of total C&I electricity DSM costs, being one of Xcel Energy's least expensive prescriptive rebate program.

The Cooling Efficiency program offered rebates for a variety of cooling equipment: PTAC units, water source heat pumps, rooftop units, rooftop economizers, hotel room controllers, split systems, condensing units, air cooled chillers, oversized cooling towers, and centrifugal chillers. Rebates were structured to increasingly reward higher efficiencies: in addition to the base rebate, a specified dollar amount per ton, there was an incremental rebate based on a dollar per ton per 0.1 EER above the base efficiency level. The program also included funding for cooling system replacement Engineering Assistance Studies, up to 50% of study cost with a maximum benefit at $15,000. Xcel Energy promoted the program primarily through trade allies, supporting them with seminars, site visits, and special promotions. Xcel Energy also developed and distributed a cooling guidebook for their business customers. In 2006 the program achieved 4% of Xcel Energy's total C&I energy savings at about 8% of total C&I electricity DSM costs.

Xcel Energy's Motor Efficiency program offered rebates for NEMA Premium efficiency motors and variable frequency drives from 1 hp to 200 hp according to the following structure: for a new application (a new installation or burnout) for a qualifying NEMA Premium motor--$4/hp, to upgrade an existing operating motor to a NEMA Premium motor--$16.50/hp, for a variable frequency drive--$30/hp. As with the Cooling Efficiency program, Xcel Energy relied on key trade allies to promote the program. In 2006 the program achieved about 10% of Xcel Energy's total C&I energy savings at about 6% of total C&I electricity DSM costs.

Combined, Xcel Energy's prescriptive rebate programs achieved about 39% of its total C&I energy savings at about 50% of its total C&I electricity DSM costs, the bulk of those savings earned from lighting and motors for large C&I customers.

PG&E SDG&E and SCE offered a traditional prescriptive rebate program, the statewide Express Efficiency program. The Express Efficiency program offered prescriptive rebates for lighting, refrigeration, air conditioning, food service, and agricultural retrofits to small and medium customers (with peak demand less than 500 kW) and had a special emphasis on hard to reach customers (very small businesses or small businesses in a rural zip code). All three IOUs distributed marketing materials for specific technologies (halogen lighting, strip curtains, compressors, refrigerators, etc.) to specific industries (hotel/motel, grocery, restaurant, retail, office, etc.). PG&E worked with vendors to stock selected products at minimal costs to customers and used energy audits to promote comprehensive retrofits. SDG&E also marketed the program at vendor meetings, workshops, and seminars and ran a CFL exchange promotion.

To focus on hard to reach (HTR) customers, each IOU was challenged to achieve a minimum participation rate of HTR customers. To meet these challenges, the IOUs worked with community organizations and leaders: PG&E field representatives organized and attended community events; SCE account managers worked as members of organizations in communities they served and delivered community-specific promotions and services with language assistance as needed; and SDG&E worked with faith-based organizations and offered simplified program applications in English, Spanish, and Vietnamese. Additionally, SDG&E designed their Small Business Energy Efficiency Program (SBEEP)

to increase HTR participation. Through SBEEP, SDG&E installed specific lighting measures at no cost for eligible customers; participants were targeted through on-site audits.

Market assessment and evaluation of Express Efficiency for all IOUs included review of peak demand and energy savings estimates, review of program design for effectiveness, assessment of HTR customer satisfaction, analysis of incentive levels, and sampled on-site verifications of installed measures.

In 2005 Express Efficiency program achieved about 25% of total C&I energy savings for both SDG&E and SCE at 23% of SCE's total C&I electricity DSM costs but only 12% of SDG&E's total C&I electricity DSM costs. For PG&E, Express Efficiency achieved over 40% of the utility's total C&I energy savings at only 10% of its total C&I electricity DSM costs.

PG&E, SDG&E, and SCE also offered upstream incentives to distributors to stock and sell qualifying high efficiency motors and HVAC products in the statewide Upstream--Motors and HVAC program. Rebates to distributors applied to installations (new construction and retrofit) for qualifying packaged and split system air conditioners, dual pack units, heat pumps, package chillers, and motors. Distributors registered to participate through the statewide website, a part of the program's user-friendly paperless rebate system developed by Energy Solutions. SDG&E and SCE promoted the program with personal meetings and direct mailings with distributors as well as with customers and manufacturers. Some participating distributors passed some or all of the cost savings to their customers--some with more competitive bids--others with their own rebate program; some increased their stocking of qualifying efficient equipment from 15% to over 50% of total stock; one opened a new distribution center to accommodate increased stocking of efficient units; and one HVAC manufacturer improved the efficiency of their 15-200 ton products to meet the program efficiency requirements. Ultimately, the program increased the installation rates of high efficiency HVAC and NEMA Premium motors.

Market assessment and evaluation of the program for all IOUs included verifying equipment installation for a sample, review of energy and peak demand savings estimates, ex-post impact analysis, process evaluation, and analysis of incentive levels.

In 2005 Upstream Motors and HVAC achieved 2-3% of total C&I energy savings at about 3-5% of total C&I electricity DSM costs for each IOU (however SDG&E did not report costs for this program).

For these five organizations, prescriptive rebate programs achieved 30-50% of a utility's total C&I energy savings at 15-50% of the utility's total C&I electricity DSM costs. And the cost of the incentives composed 70-85% of total prescriptive rebate programs costs.

Xcel Energy and the California IOUs have mature electricity DSM programs and, thus, similar challenges: increased market saturation of energy efficient measures, higher efficiency baseline standards that obviate existing incentives, and inherently higher costs for programs designed for hard to reach customers. However, the combined energy savings of the California IOU's prescriptive rebate programs cost less per kWh, $0.10/kWh, than Xcel Energy's prescriptive rebate programs, $0.14/kWh; this may be explained by the cost-savings of the statewide program infrastructure of Express Efficiency and Upstream Motors and HVAC.

Table 3-13: Spending Distribution and $/kWh per Cost Component for Prescriptive Rebate Programs

C&I Lighting Cooling/Heating/Roofing Motors Utility/Agency	Program Name	Incentives Costs as % of Total	Incentives $/kWh	Admin & Other Costs as % of Total	Admin & Other $/kWh	Program Total $/kWh
MidAmerican (IA)	Nonresidential Equipment Program	**85.8%**	**$0.05**	**14.2%**	**$0.01**	**$0.05**
PGE 05	Upstream-Motors and HVAC	81.3%	$0.28	18.7%	$0.06	$0.35
PGE 05	EEI-Prescriptive-Express Efficiency	79.0%	$0.04	21.0%	$0.01	$0.05
	Total	**79.7%**	**$0.05**	**20.3%**	**$0.01**	**$0.06**
SCE 05	EEI-Prescriptive-Small Nonresidential Hard-to-Reach		-	-	-	
SCE 05	EEI-Prescriptive-Express Efficiency	-	-	-	-	
SCE 05	Total C&I EEI-Prescriptive Cost	**83.2%**	**$0.13**	**16.8%**	**$0.03**	**$0.16**
SCE 05	Upstream-Motors and HVAC	-	-	-	-	
SDGE 05	Upstream-Motors and HVAC	79.1%	$0.27	20.9%	$0.07	$0.34
SDGE 05	EEI-Prescriptive Rebates	75.4%	$0.07	24.6%	$0.02	$0.09
	Total	**76.1%**	**$0.08**	**23.9%**	**$0.03**	**$0.11**
Xcel Energy (MN)	Lighting Efficiency-C&I	63.7%	$0.05	36.3%	$0.03	$0.08
Xcel Energy (MN)	Lighting Efficiency-Small Business	65.1%	$0.06	34.9%	$0.03	$0.09
Xcel Energy (MN)	CEE-One-Stop Efficiency Shop	n/a	-	n/a	-	$0.25
Xcel Energy (MN)	Cooling Efficiency-C&I	78.9%	$0.16	21.1%	$0.04	$0.21
Xcel Energy (MN)	Cooling Efficiency-Small Business	73.9%	$0.18	26.1%	$0.06	$0.24
Xcel Energy (MN)	Motor Efficiency-C&I	65.8%	$0.04	34.2%	$0.02	$0.07
Xcel Energy (MN)	Motor Efficiency-Small Business	65.2%	$0.08	34.8%	$0.04	$0.12
	Total	**69.2%**	**$0.07**	**30.8%**	**$0.03**	**$0.14**

Table 3-14: Prescriptive Rebate Program Costs and Energy Savings as a % of Total C&I Electricity DSM

C&I Lighting Cooling/Heating/Roofing Motors Utility/Agency	Program Name	Program's Costs ($M)	% of Total C&I DSM Spending	Program's Energy Savings (GWh)	% of Total C&I Energy Savings
MidAmerican (IA)	Nonresidential Equipment Program	**3.4**	**29.0%**	**63.5**	**50.3%**
PGE 05	Upstream-Motors and HVAC	6.4	4.5%	18.6	2.4%
PGE 05	EEI-Prescriptive-Express Efficiency	15.0	10.4%	319.6	41.8%
	Total	**21.4**	**14.9%**	**338.2**	**44.2%**
SCE 05	EEI-Prescriptive-Small Nonresidential Hard-to-	-	-	53.6	6.4%
SCE 05	EEI-Prescriptive-Express Efficiency	-	-	151.5	18.1%
SCE 05	Total C&I EEI-Prescriptive Cost	32.9	22.8%	205.1	24.5%
SCE 05	Upstream-Motors and HVAC	-	-	27.0	3.2%
	Total	**32.9**	**22.8%**	**232.1**	**27.7%**
SDGE 05	Upstream-Motors and HVAC	1.3	2.6%	3.8	1.6%
SDGE 05	EEI-Prescriptive Rebates	5.9	12.1%	62.0	26.6%
	Total	**7.2**	**14.7%**	**65.8**	**28.2%**
Xcel Energy (MN)	Lighting Efficiency-C&I	1.9	7.2%	25.3	10.4%
Xcel Energy (MN)	Lighting Efficiency-Small Business	0.6	2.2%	6.7	2.7%
Xcel Energy (MN)	CEE-One-Stop Efficiency Shop	7.3	26.9%	29.4	12.0%
Xcel Energy (MN)	Cooling Efficiency-C&I	1.8	6.5%	8.4	3.4%
Xcel Energy (MN)	Cooling Efficiency-Small Business	0.4	1.4%	1.6	0.7%
Xcel Energy (MN)	Motor Efficiency-C&I	1.5	5.5%	22.2	9.1%
Xcel Energy (MN)	Motor Efficiency-Small Business	0.1	0.5%	1.1	0.5%
	Total	**13.6**	**50.3%**	**94.7**	**38.8%**

C&I New Construction Programs

New construction programs offer incentives for energy efficient new construction, renovation, and room addition projects. The program typically includes:

- professional energy efficiency design assistance, and
- incentives for installed measures that increase with savings beyond minimum code.

Eligibility for incentives is usually based on a minimum percentage of energy savings beyond that required by state building energy code.

New construction programs are key to a high impact C&I electricity DSM portfolio; every organization reviewed in this study with a C&I energy savings rate above the median has a new construction program responsible for at least 10% of the organization's total C&I energy savings (except Interstate P&L (MN),

which has unique C&I market and custom program impacts profile, and Interstate P&L (IA)). New construction programs are also key because they ensure that the most cost-effective energy efficiencies in a new building are realized from its first day of operation.

The new construction programs reviewed here are of the three California IOUs and of the top performers in C&I energy savings that achieved significant savings by new construction programs: MidAmerican (IA), Xcel Energy, PG&E, SDG&E, and SCE. The three California IOUs are included here for the significant impacts they achieved in new construction programs.

MidAmerican (IA)'s Commercial New Construction program offered energy efficient design assistance through a third party contractor, The Weidt Group, to design teams and offered construction incentives ranging from $0.05 to $0.14 per kWh to the building owner for achieving a minimum of 5% of energy savings beyond that required by current state building energy code. MidAmerican promoted the program through architectural, engineering, and building contractor firms, trade ally meetings and events, and MidAmerican awarded firms for high efficiency design projects. Account managers personally delivered materials to customers and attended project design assistance meetings. In addition to providing energy design assistance, The Weidt Group also provided project management and project completion verification.

In 2006 the Commercial New Construction program achieved about 27% of MidAmerican's total C&I energy savings at about 35% of total C&I electricity DSM costs, and about 80% of program costs were for incentives.

Xcel Energy's Energy Design Assistance provided professional energy consulting and incentives ranging from $170 to $275 per peak kW saved on installed measures. Design assistance was offered in two tiers by market: Custom Consulting and Plan Review. Custom Consulting targeted buildings early in the design stage and larger than 50,000 square feet and provided the design team with a broad selection of energy efficient design solutions as indicated by hourly, whole-building, energy use simulations on the basis of building-specific data. Building design professionals were compensated for their time spent in meetings and additional design review. Plan Review targeted buildings 15,000 – 50,000 square feet that were in early to mid stages of design, and Plan Review provided streamlined reviews of preliminary designs with recommendations for efficient upgrades within two weeks to better fit the small commercial new construction market's needs. Verification of installation was a requirement for incentives and ensured proper installation and operation.

In 2006, Energy Design Assistance achieved 24% of Xcel Energy's total C&I energy savings at about 22% of total C&I electricity DSM costs, and incentives were only a little over half of total program costs.

PG&E SDG&E and SCE offered the statewide Savings by Design which provided general energy design education, project-specific energy design assistance, and cash incentives for owners and for design teams for achieving savings beyond 10% of current state building energy codes. Similar to Xcel Energy's new construction program, Savings by Design had 1) a custom design approach, the Whole Building Approach, for integrated, custom design analysis for large projects and 2) a stream-lined performance-based approach, the Systems Approach, for other projects. Savings by Design also included a component of education and outreach which delivered seminars and workshops and distributed program brochures and energy design CDs.

2005 impacts and costs for Savings by Design vary more across the three IOUs than other statewide programs: the program achieved about 18% of total C&I energy savings for both PG&E and SCE but at 22% of total C&I electricity DSM costs for PG&E and only 9% for SCE. For SDG&E, Saving by Design achieved 10% of total C&I energy savings at 15% of total C&I electricity DSM costs. Incentives

composed 46% of PG&E's total Savings by Design costs, 58% of SCE's, and 80% of SDG&E's. This variability may be a consequence of the facts that, in new construction programs, typically 1) large savings are achieved by a few projects and 2) large projects take more than a year to complete.

For all five utilities, rising state building energy codes and equipment standards reduced potential savings each year and required new incentive rates and structures and the inclusion of new technologies in the programs.

Table 3-15: Spending Distribution and $/kWh per Cost Component for New Construction Programs

C&I New Construction Utility/Agency	Program Name	Incentives Costs as % of Total	Incentives $/kWh	Admin & Other Costs as % of Total	Admin & Other $/kWh	Program Total $/kWh
MidAmerican (IA)	Commercial New Construction	79.1%	$0.09	20.9%	$0.02	$0.12
PGE 05	Savings by Design	45.7%	$0.11	54.3%	$0.13	$0.24
SDGE 05	Savings by Design	79.7%	$0.25	20.3%	$0.06	$0.31
SCE 05	Savings by Design	57.7%	$0.05	42.3%	$0.04	$0.09
Xcel Energy (MN)	Energy Design Assistance	52.6%	$0.05	47.4%	$0.05	$0.10

Table 3-16: New Construction Program Costs and Energy Savings as a % of Total C&I Electricity DSM

C&I New Construction Utility/Agency	Program Name	Program's Costs ($M)	% of Total C&I DSM Spending	Program's Energy Savings	% of Total C&I Energy
MidAmerican (IA)	Commercial New Construction	4.0	34.4%	34.1	27.0%
PGE 05	Savings by Design	31.7	22.0%	132.9	17.4%
SDGE 05	Savings by Design	7.4	15.2%	24.0	10.3%
SCE 05	Savings by Design	12.7	8.8%	149.0	17.8%
Xcel Energy (MN)	Energy Design Assistance	5.8	21.5%	60.7	24.9%

C&I Demand Response Programs

Demand response (DR) programs offer incentives for reducing peak demand. Demand response programs may include:

- interruptible rates– reduced rates for customers who agree to curtail load on peak demand, and
- direct load control– incentives for customers who allow the utility to directly control equipment (such as central air conditioners) during periods of peak demand.

Eligibility for interruptible rates programs is usually based on a minimum kW load that the customer is able to shed on peak demand.

Demand response programs can provide significant reductions in peak demand at very low costs per kW. Best practice C&I DR programs that demonstrate this are those of MidAmerican (IA), which achieved 13% of its total C&I peak demand savings at about $300/kW, and those of Xcel Energy, which achieved 40% of Xcel Energy' C&I peak demand at about $90/kW[22].

In MidAmerican (IA)'s demand response program, the Curtailment program, participating customers agreed to shed at least 250 kW upon request by 1) shedding load completely, without replacement; 2) shifting load to non-peak periods; or 3) shifting load to on-site generated power. Participants agreed to a maximum of six hours per curtailment and a maximum of 16 curtailments per season, June-September. Participants who had proved their ability to shed load over a year were eligible for 3-year contracts which have higher incentive per kW; additional terms applied. MidAmerican (IA) promotes the Curtailment program through its account managers and website. The Curtailment program also offered access to an internet-based program, Curtailment Manager by Itron, that notified users of curtailment events, provided near-real time performance monitoring, and other energy analysis modules.

In 2006, MidAmerican (IA) had four curtailments, now averaging 3.3 per season, and achieved a realization rate of 87%. The Curtailment program achieved 13% of MidAmerican (IA)'s total C&I peak demand savings at about 9% of the utility's total C&I DSM costs, at only $300/kW.

Xcel Energy offered two demand response programs to its small business, commercial, and industrial customers: Electric Reduction Saving (ERS, also marketed as Peak Controlled Rates and Energy Controlled Rates), an interruptible rates program, and Saver's Switch (SS), a direct load control program. ERS was available to customers who agreed to reduce a minimum of 50 kW on short notice in return for monthly discounts up to 60% of peak demand charges and to pay penalties for non-compliance. Since 1997, ERS has averaged 24-41 controlled hours per year, about 7-8 occurrences per year. Customers who participated in SS allowed Xcel Energy to directly control their rooftop AC units during periods of peak demand by way of 900 MHz paging in exchange for monthly discounts during months with curtailments. For both programs, participants agreed to curtailments and corresponding discounts at any time of year, although they typically occurred during summer months; other terms applied. Customers could participate in one of the two DR programs; small and medium businesses typically chose SS while large businesses typically chose ERS. Xcel Energy promoted its demand response programs directly through account managers.

[22] Data for DR programs of the California IOUs were not available.

In 2006 Electric Reduction Saving and Saver's Switch achieved over 40% of Xcel Energy's total C&I peak demand savings at about $90/kW ($27/kW for ERS and $190/kW for SS), only 9% of Xcel Energy's total C&I DSM costs.

Residential Sector

Table 3-17 shows the median result for spending, savings, and costs for the residential sector for the twenty-two reviewed organizations.

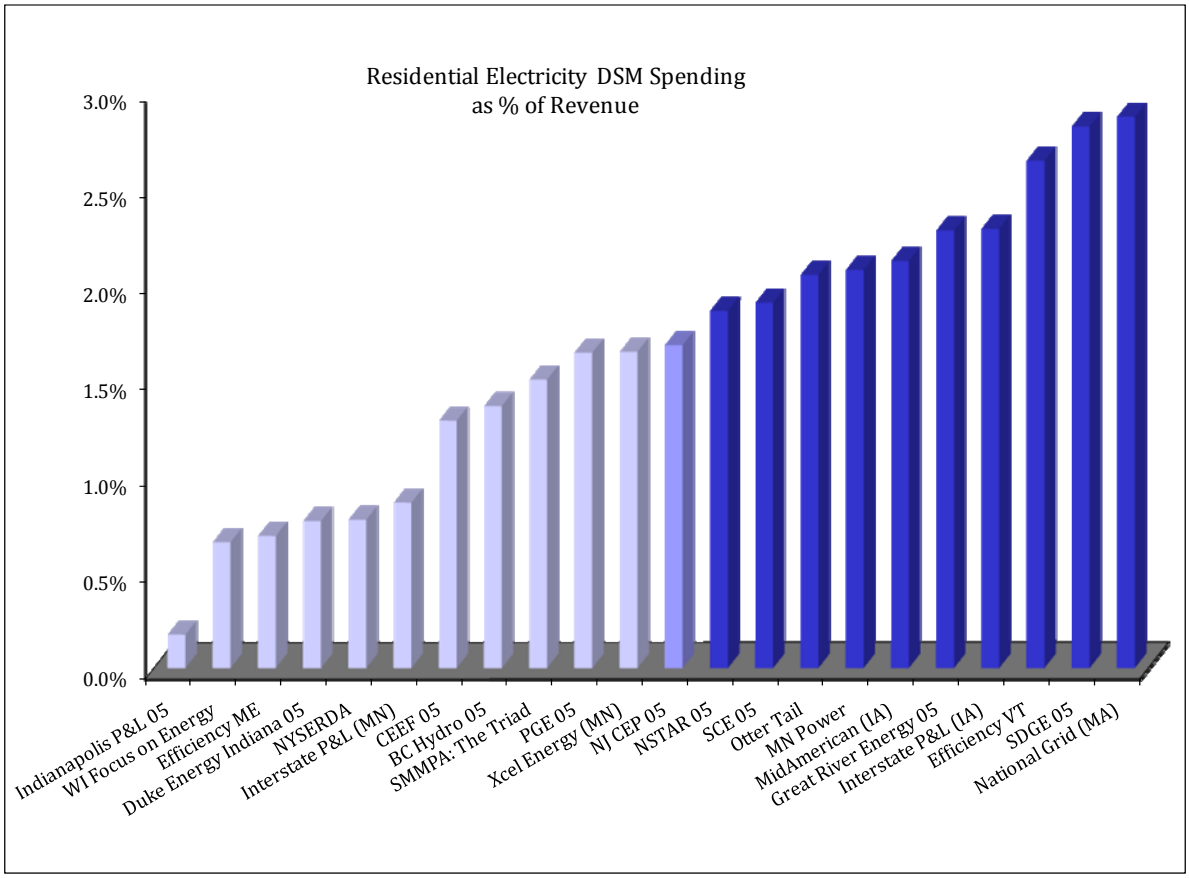
Table 3-17: Medians for Residential Results

Spending as % of Revenue	Electric Energy Savings as % of Sales	Demand Savings as % of Peak Demand	Cost of Savings	
			$/kWh	$/kW
1.7%	0.6%	0.9%	$0.27	$915

Residential Electricity DSM Spending

Electricity DSM spending in the residential sector as a percentage of annual revenue of retail residential energy sales ranges from 0.2% to 2.9%, with the median at 1.7% (Figure 3-16). As in the C&I sector, SDG&E is in the top two for electricity DSM spending as a percentage of sector revenue. Almost every organization with above median spending achieved above median energy savings rates. CEEF 05, BC Hydro, and PG&E had spending rates below median but energy savings rates above median.

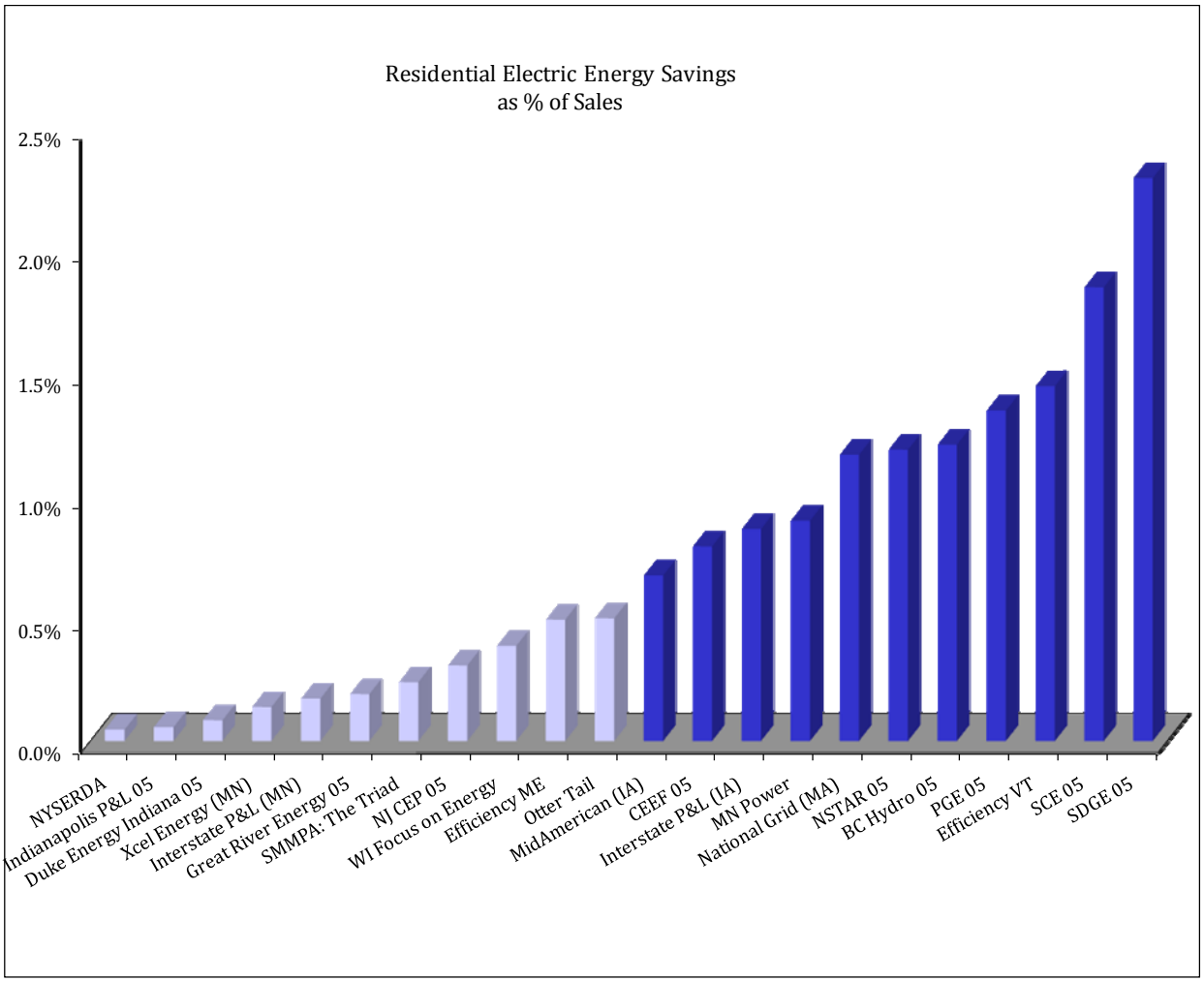
Figure 3-16: Residential Electricity DSM Spending as % of Revenue



Residential Electric Energy Savings

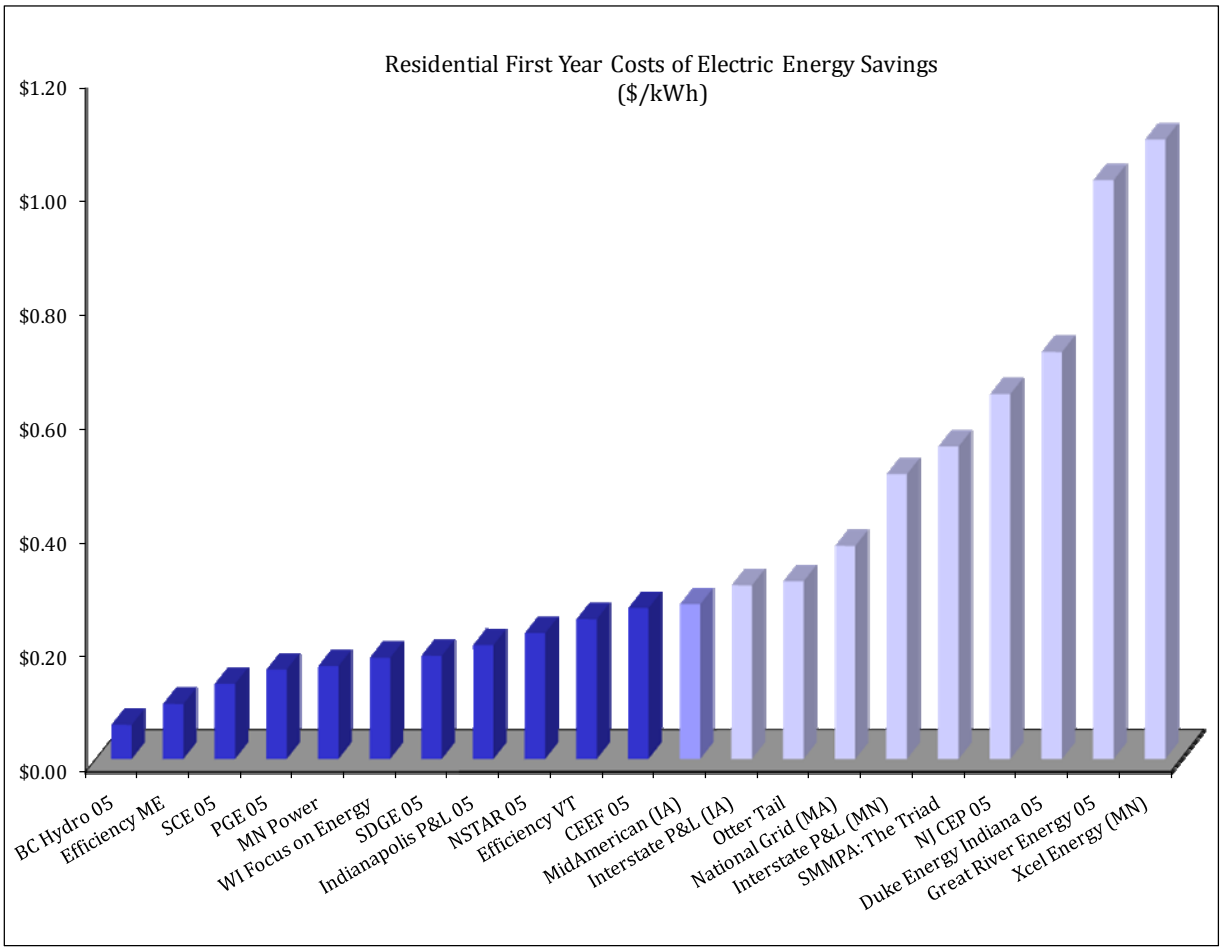
Figure 3-17 and Figure 3-18 show the energy savings as a percentage of sales and the cost of these savings across the various organizations. Energy savings as a percentage of sales ranges from 0.05% to 2.3% with the median at 0.6%. SDGE 05 has the highest savings rate, almost four times the median; SCE 05 also has an energy savings rate near 2.0%. Efficiency VT, PGE 05, BC Hydro 05, NSTAR 05, and National Grid (MA) achieved above median energy savings as a percentage of sales, around 1.3%; MN Power, Interstate P&L (IA), CEEF 05, and MidAmerican (IA) also achieved above median energy savings, about 0.8% of sales.

Figure 3-17: Residential Electric Energy Savings as % of Annual Sales First Year



Cost of energy savings ranges widely from $0.06/kWh to $2.64/kWh[23] with the median at $0.27/kWh. As in the C&I sector, BC Hydro, MN Power, and WI Focus on Energy achieved below median costs of energy savings in the residential sector, BC Hydro achieving the lowest costs/kWh. Efficiency ME, SCE, PG&E, SDG&E, Indianapolis P&L, NSTART, Efficiency VT, and CEEF also achieved residential energy savings below the median cost.

Figure 3-18: Residential Costs of Electric Energy Savings ($/kWh) First Year

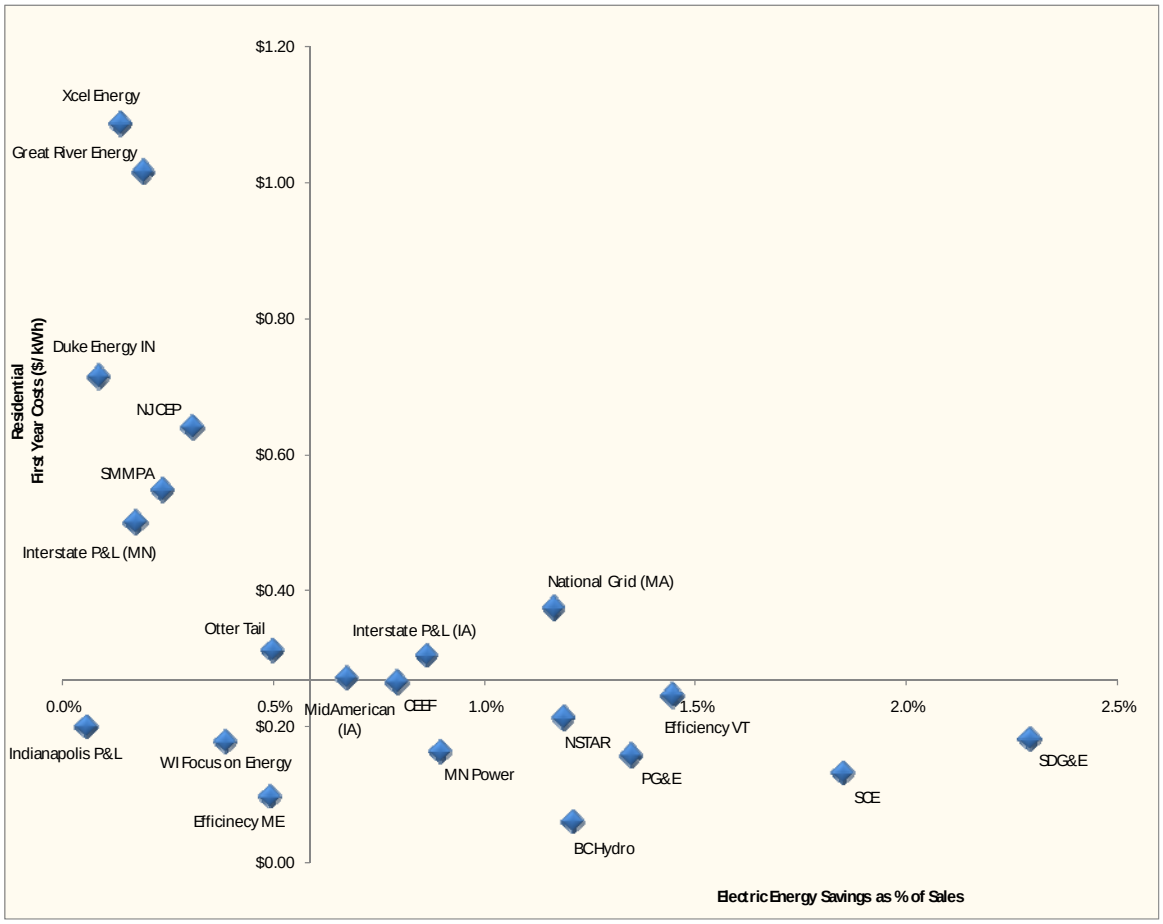


[23] Residential cost of energy savings for NYSERDA, $2.64/kWh, is excluded from the graphs so as not to skew the scale.

The scatter plot shown in Figure 3-19 below illustrates where each organization falls relative to median energy savings and median costs. SDGE 05 achieved the greatest residential energy savings as a percentage of sales, well above the median and at below median costs. Below are SDG&E and the other organizations that achieved energy savings rates above median and at costs/kWh very near or below median:

1. SDG&E: 2.3%, $0.18/kWh
2. SCE: 1.8%, $0.13/kWh
3. Efficiency VT: 1.4%, $0.25/kWh
4. PG&E: 1.3%, $0.16/kWh
5. BC Hydro: 1.2%, $0.06/kWh
6. NSTAR 05: 1.2%, $0.21/kWh
7. MN Power: 0.9%, $0.16/kWh
8. Interstate P&L (IA): 0.9%, $0.30/kWh
9. CEEF 05: 0.8%, $0.26/kWh
10. MidAmerican (IA): 0.7%, $0.27/kWh

Figure 3-19: Scatter Plot of Residential Electric Energy Savings and First Year Costs ($/kWh)



The shape of the energy savings and costs scatter plot illustrates the high variation in costs of energy savings among the organizations that have below median savings as a percentage of sales. Specifically, these data suggest that an organization with an above median residential energy savings rate is more likely to save at or below median costs than is an organization with a below median savings rate.

Table 3-18 and Table 3-19 below show results and costs for programs delivered by the utilities that achieved above median energy savings rates at below median costs in the residential sector.

MN Power, PG&E, SDG&E, and SCE achieved most of their high savings at costs well below the median from their programs which combine multiple measures. MN Power's Triple E Plus program includes product incentives for lighting, cooling/heating/roofing, and building envelope as well as services for new construction; the California IOU's each have several combination programs which include incentives for lighting, programmable thermostats, cooling, and appliances. For these four utilities, most of the energy savings of their combination programs were achieved by lighting measures, and their costs were kept low by leveraging community and national (e.g., Energy Star) resources for delivery. Interstate P&L (IA) also achieved most of its savings from its combination program, Prescriptive Rebates, at costs near median, and most of the savings for that program were from lighting and cooling. New construction and refrigerator/freezer removal programs also earned significant energy savings for Interstate P&L (IA). MidAmerican (IA) achieved most of its savings well below median costs from its energy audit program which includes (in addition to the audit) installation of free water heating and lighting measures and incentives for window improvements and insulation—most of this program's 2006 activity was with lighting. New construction and cooling/heating/roofing programs also earned significant energy savings for MidAmerican (IA), however at costs above median. BC Hydro, Efficiency VT, and NSTAR achieved most of their energy savings from lighting measures below median costs.[24]

Table 3-18: Electric Energy Savings for Residential Programs as % of Energy Sales

Residential Program/Measures	BC Hydro 05	Efficiency VT	Interstate P&L (IA)	MidAmerican (IA)	MN Power	NSTAR 05	PGE 05	SDGE 05	SCE 05
Lighting	0.94%	1.11%				0.94%			
Cooling/Heating/Roofing		0.05%		0.11%		0.01%			0.03%
Building Envelope	0.01%								
Refrigerator/Freezer Removal	0.22%		0.15%					0.10%	
ES Appliances		0.09%				0.06%			
Water Heating		0.01%							
Energy Audit			0.07%	0.30%		0.07%			
Combination			0.51%		0.72%		1.34%	2.10%	1.78%
Low Income			0.05%	0.04%	0.18%	0.11%		0.07%	
New Construction	0.03%	0.11%	0.09%	0.19%		0.01%	0.01%	0.03%	0.04%
Fuel Switch	0.01%	0.08%							
Res Direct Load Control				0.02%					
Total Res Savings (GWh)	191.0	29.7	32.4	34.3	9.1	80.4	400.6	163.0	534.1
Annual Res Sales (GWh)	15,814.0	2,051.1	3,750.5	5,086.4	1,011.7	6,773.8	29,752.3	7,104.6	28,888.9
Res Savings as % of Res Sales	1.21%	1.45%	0.86%	0.67%	0.90%	1.19%	1.35%	2.29%	1.85%

[24] Efficiency VT reports only impacts per end-use and reports costs at the program level.

Table 3-19: Costs of Residential Electric Energy Savings by Type of Program[25]

Residential Program/Measures	BC Hydro 05	Efficiency VT	Interstate P&L (IA)	MidAmerican (IA)	MN Power	NSTAR 05	PGE 05	SDGE 05	SCE 05
Lighting	$0.03					$0.07			
Cooling/Heating/Roofing				$0.41		$2.29			$0.21
Building Envelope	$0.33								
Refrigerator/Freezer Removal	$0.12		$0.13					$0.21	
ES Appliances						$0.47			
Water Heating									
Energy Audit			$0.26	$0.12		$0.73			
Combination		$0.14	$0.27		$0.12		$0.13	$0.12	$0.11
Low Income			$0.20	$0.22	$0.20	$0.62		$1.29	
New Construction	$0.08	$1.23	$0.35	$0.28		$2.78	$1.23	$1.67	$0.79
Fuel Switch	$0.08	$0.18							
Res Direct Load Control				$1.00					
Total Res Savings (GWh)	191.0	29.7	32.4	34.3	9.1	80.4	400.6	163.0	534.1
Total Costs ($M)	11.4	7.3	9.9	9.3	1.5	17.1	63.0	29.5	70.4
Costs of Res Savings ($/kWh)	$0.06	$0.25	$0.30	$0.27	$0.16	$0.21	$0.16	$0.18	$0.13

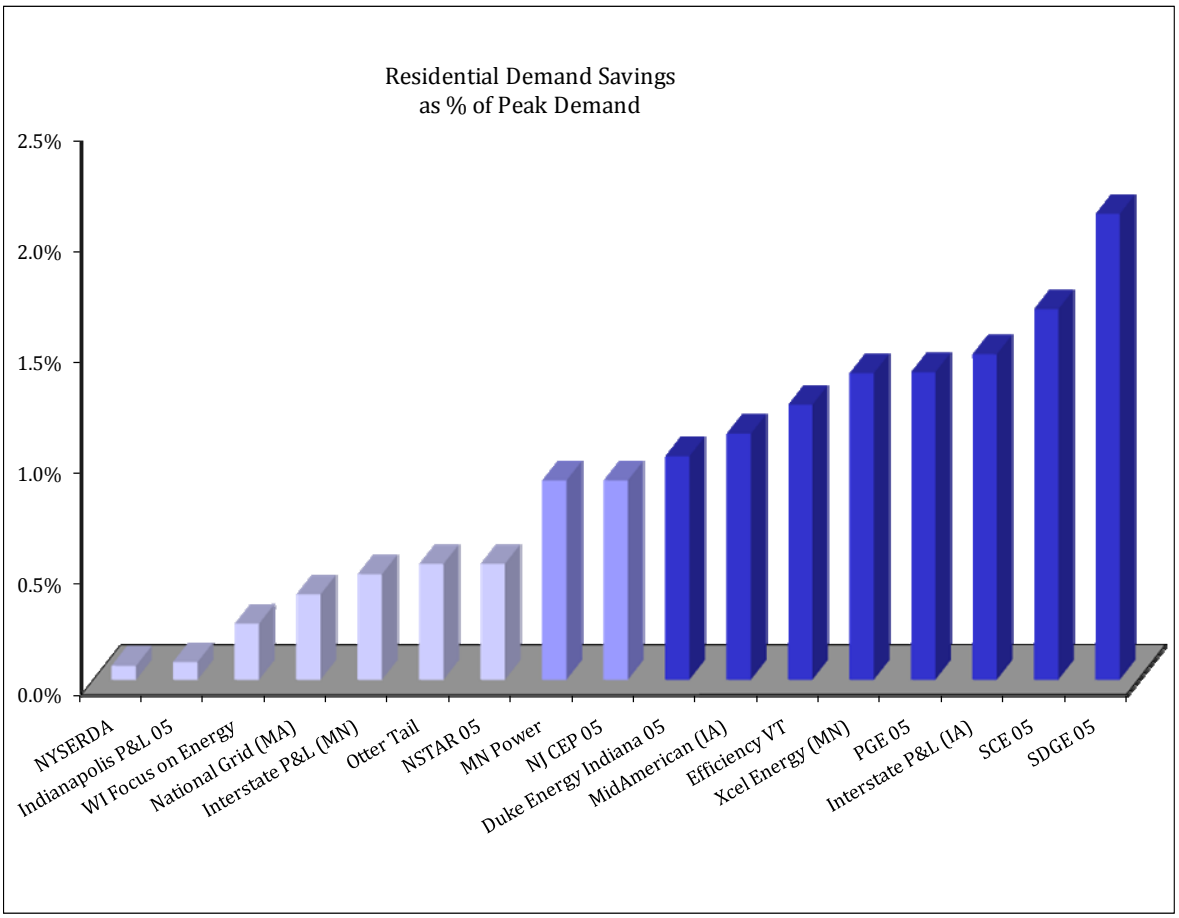
Note: All Cost Savings ($/kWh) are from first year savings results.

[25] Total costs include costs of indirect impact programs, i.e., programs for which energy and peak demand savings are not accountable.

Residential Peak Demand Savings

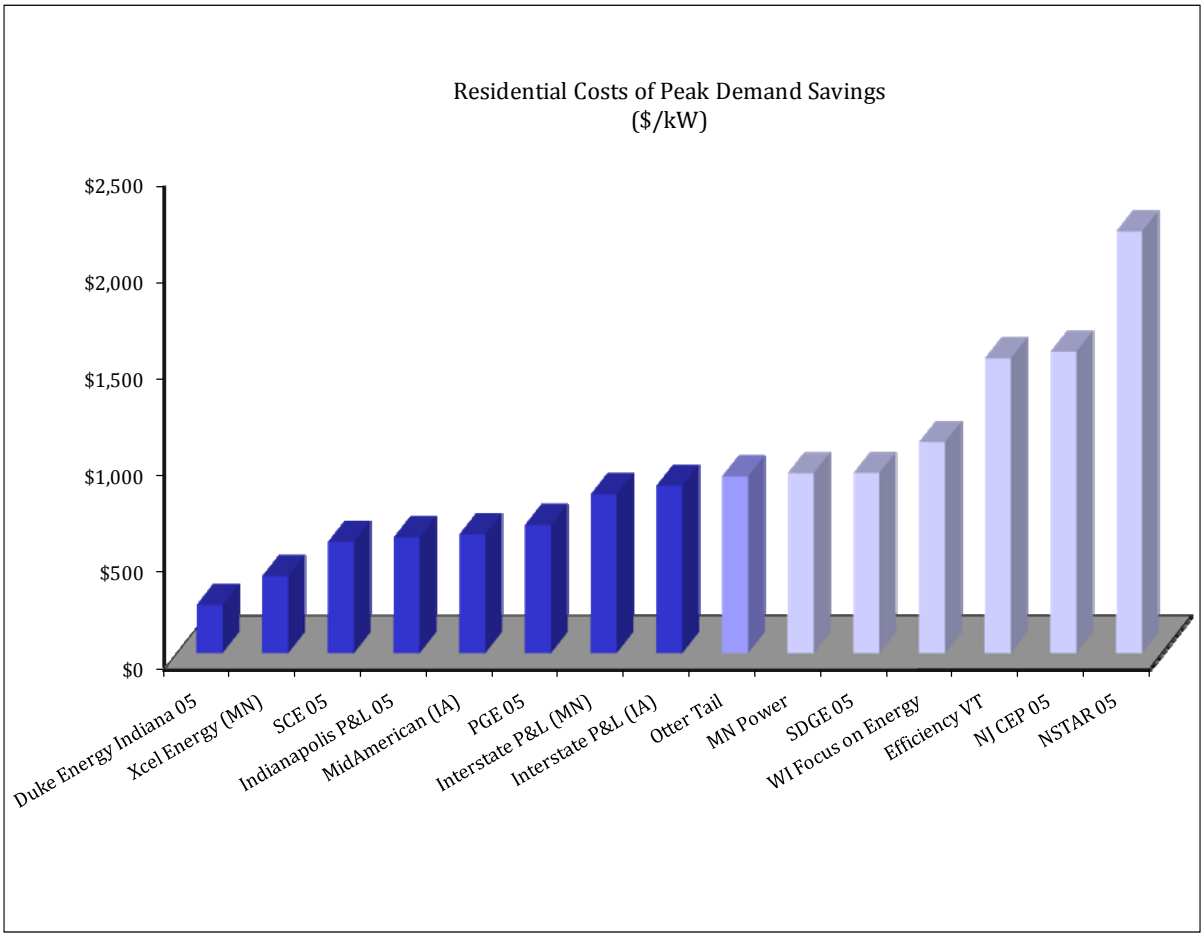
Figure 3-20 below shows electricity DSM incremental demand savings as a percentage of annual peak demand for the residential customer sector. Demand savings as a percentage of peak demand range from 0.1% to 2.1%, with the median at 0.9%. SDGE 05 achieved the highest peak demand savings percentage. SCE 05, Interstate P&L (IA), PGE 05, Xcel Energy (MN), Efficiency VT, MidAmerican (IA), and Duke Energy Indiana 05 also achieved above median rates of peak demand conserved.

Figure 3-20: Residential Demand Savings as % of Peak Demand



Shown below in Figure 3-21, costs of peak demand savings range widely from $250/kW to $9,354/kW[26] with the median at $915/kW. SCE, Interstate P&L (IA), Xcel Energy, PG&E, MidAmerican (IA) and Duke Energy Indiana achieved their high percentage of peak demand savings at costs below the median.

Figure 3-21: Residential Cost of Peak Demand Savings ($/kW)



[26] Residential cost of peak demand savings for NYSERDA, $9,354/kW, is excluded from the graphs so as not to skew the scale.

The scatter plot shown in Figure 3-22 below illustrates where each organization falls relative to median peak demand savings and median costs in the residential sector. As in the C&I sector, Xcel Energy, MidAmerican (IA), and Interstate P&L (IA) achieved a high percentage of peak demand savings at low costs in the residential sector. These three and the other organizations that achieved above median percentage of peak demand savings at very near or below the median are listed below:

1. SDG&E: 2.1%, $932/kW
2. SCE: 1.7%, $577/kW
3. Interstate P&L (IA): 1.5%, $867/kW
4. PG&E: 1.4%, $664/kW
5. Xcel Energy: 1.4%, $400/kW
6. MidAmerican (IA): 1.1%, $615/kW
7. Duke Energy Indiana: 1.0%, $250/kW

Xcel Energy, Duke Energy Indiana, and MidAmerican (IA) achieved significant amounts of their electricity DSM peak demand savings from direct load control programs, which tend to have low costs of conserved peak demand.

Figure 3-22: Scatter Plot of Residential Peak Demand Savings and First Year Costs ($/kW)

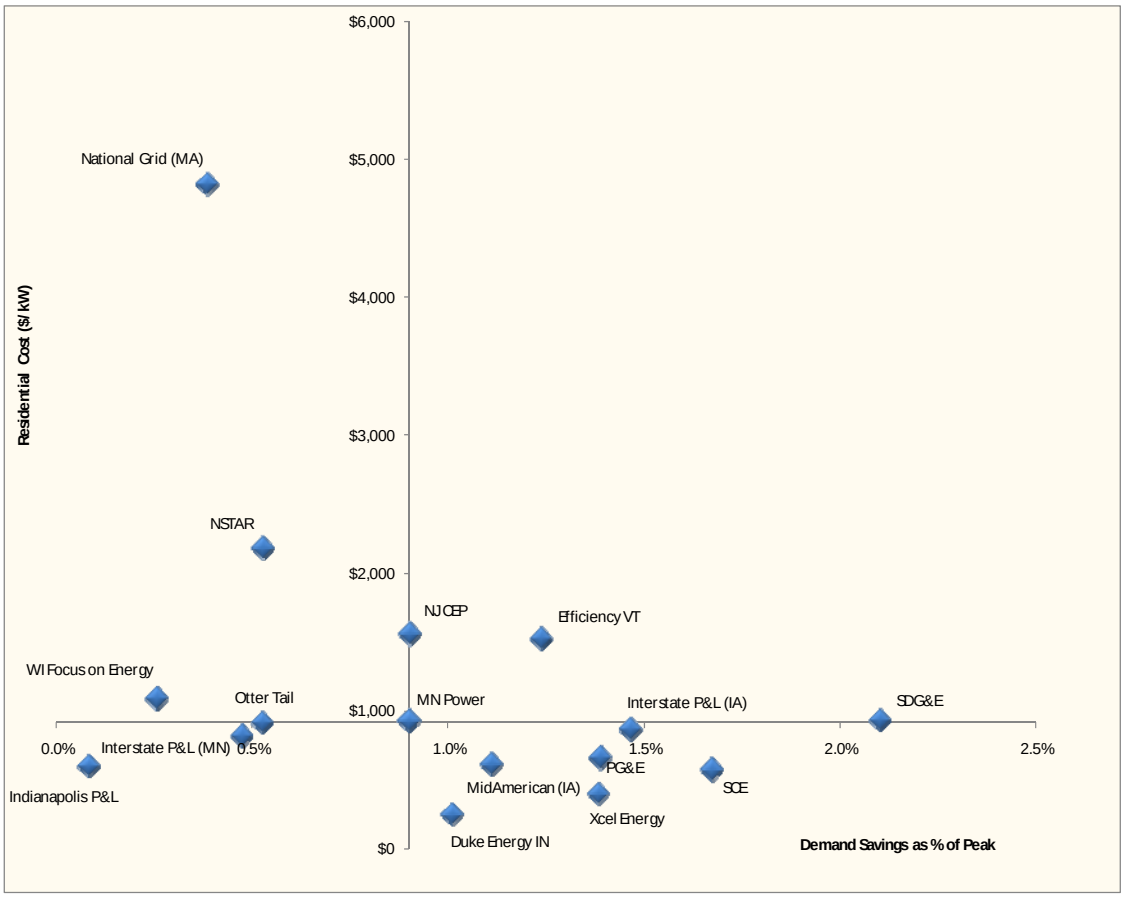


Table 3-20 and Table 3-21 show results and costs by program of organizations that had higher than median percentage of peak demand savings at costs below the median: Duke Energy Indiana, Interstate P&L (IA), MidAmerican (IA), MN Power, PG&E, SCE, and Xcel Energy. Duke Energy Indiana and Xcel Energy achieved most of their residential peak demand savings with direct load control programs at costs well below the median. Xcel Energy also achieved significant savings with their cooling/heating/roofing programs at below median costs. MidAmerican (IA) achieved most of its savings with energy audits and new construction programs at costs well below the median. SCE also achieved high rate of peak demand savings at below median costs with its new construction program and with its combination programs. Interstate P&L (IA), MN Power, and PG&E achieved most of their peak demand savings at low cost from their combination programs.

Table 3-20: Residential Peak Demand Savings by Type of Program

Residential Program/Measures	Duke Energy	Interstate P&L (IA)	MidAmerican (IA)	MN Power	PGE 05	SCE 05	Xcel Energy
Lighting							0.01%
Cooling/Heating/Roofing			0.14%			0.02%	0.34%
Refrigerator/Freezer Removal		0.17%					
Energy Audit		0.01%	0.27%				
Combination	0.07%	0.89%		0.74%	1.36%	1.48%	
Low Income	0.01%	0.13%	0.02%	0.16%			0.03%
New Construction	0.01%	0.26%	0.52%		0.03%	0.18%	
Res Direct Load Control	0.91%	0.01%	0.16%				1.00%
Total Res Savings (MW)	20.0	11.4	15.1	1.6	94.9	122.1	33.5
Annual Res Peak Demand (MW)	1,984.0	776.4	1,364.8	176.8	6,838.9	7,306.5	2,420.2
Res Savings as % of Res Peak Demand	1.01%	1.47%	1.11%	0.90%	1.39%	1.67%	1.38%

Table 3-21: Costs of Residential Peak Demand Savings by Type of Program[27]

Residential Program/Measures	Duke Energy	Interstate P&L (IA)	MidAmerican (IA)	MN Power	PGE 05	SCE 05	Xcel Energy
Lighting							$1,590
Cooling/Heating/Roofing			$1,235			$1,157	$701
Refrigerator/Freezer Removal		$572					
Energy Audit		$6,440	$516				
Combination	$1,063	$755		$678	$566	$536	
Low Income	$2,082	$399	$1,453	$1,239			$1,234
New Construction	$175	$584	$387		$1,165	$732	$14,700
Res Direct Load Control	$153	$3,070	$560				$220
Total Res Savings (MW)	20.0	11.4	15.1	1.6	94.9	122.1	33.5
Total Costs ($M)	5.0	9.9	9.3	1.5	63.0	70.4	13.4
Costs of Res Savings ($/kW)	$250	$867	$615	$932	$664	$577	$400

[27] Total costs include costs of indirect impact programs, i.e., programs for which energy and peak demand savings are not accountable.

Residential Best Practices by Program

This section reviews best practices by program of utilities that achieved significant residential impacts.

Table 3-22: Distribution of Residential Electricity DSM Costs by Program[28]

% of total budget Residential Program/Measures	Efficiency VT	MidAmerican (IA)	Interstate P&L (IA)	MN Power	NSTAR 05	PGE 05	SDGE 05	SCE 05	Xcel Energy
Lighting					25.4%				2.4%
Cooling/Heating/Roofing		25.2%			7.2%			2.2%	43.0%
Refrigerator/Freezer Removal			7.5%				5.0%		
ES Appliances					10.8%				
Combination	53.2%		52.7%	59.6%		83.8%	60.0%	82.0%	
Energy Audit		20.5%	6.5%		19.2%				
Low Income		4.7%	4.0%	24.2%	26.7%		21.4%		7.0%
New Construction	36.5%	29.5%	11.8%		10.6%	3.2%	12.0%	13.4%	0.1%
Indirect Impact		2.1%	9.1%			4.3%	0.9%	2.4%	4.7%
Fuel Switch	6.2%								
Res Direct Load Control		12.9%	3.1%						40.1%
Total Residential Savings (GWh)	29.7	34.3	32.4	9.1	80.4	400.6	163.0	534.1	12.3
Total Costs ($M)	7.3	9.3	9.9	1.5	17.1	63.0	29.5	70.4	13.4
Costs of Residential Savings ($/kWh)	$0.25	$0.27	$0.30	$0.16	$0.21	$0.16	$0.18	$0.13	$1.09

Note: All Cost Savings ($/kWh) are from first year savings results.

Table 3-23: Distribution of Residential Electricity DSM Energy Savings by Program

% of savings Residential Program/Measures	Efficiency VT	MidAmerican (IA)	Interstate P&L (IA)	MN Power	NSTAR 05	PGE 05	SDGE 05	SCE 05	Xcel Energy
Lighting					78.9%				37.4%
Cooling/Heating/Roofing		16.6%			0.7%			1.4%	38.2%
Refrigerator/Freezer Removal			17.3%				4.3%		
ES Appliances					4.9%				
Combination	84.5%		58.6%	80.4%		99.6%	91.4%	96.4%	
Energy Audit		45.2%	7.7%		5.6%				
Low Income		5.8%	6.2%	19.6%	9.1%		3.0%		20.3%
New Construction	7.3%	28.9%	10.2%		0.8%	0.4%	1.3%	2.2%	0.1%
Fuel Switch	8.2%								
Res Direct Load Control		3.5%	0.0%						4.1%
Total Residential Savings (GWh)	29.7	34.3	32.4	9.1	80.4	400.6	163.0	534.1	12.3
Annual Residential Sales (GWh)	2,051.1	5,086.4	3,750.5	1,011.7	6,773.8	29,752.3	7,104.6	28,888.9	8,876.5
Residential Savings as % of Residential Sales	1.45%	0.67%	0.86%	0.90%	1.19%	1.35%	2.29%	1.85%	0.14%

[28] Total costs include costs of indirect impact programs, i.e., programs for which energy and peak demand savings are not accountable.

Residential Prescriptive Rebate Programs

Prescriptive rebate programs offer pre-determined rebates for specific types of high-efficiency equipment. Typical prescriptive rebate programs offer rebates for high efficiency lighting, heating and cooling systems, and appliances. Rebates may be in the form of point of sale coupon, mail-in rebate, or retailer/distributor buy down. In the residential sector, prescriptive rebate programs may be administered and reported by specific channel (e.g. lighting or appliances) or many channels may be bundled into one program.

Prescriptive rebate programs form the basis of any residential electricity DSM portfolio and account for most of the energy savings for residential electricity DSM portfolios of top performing organizations reviewed in this study. Costs for prescriptive rebate programs range from 25-70% of total residential electricity DSM costs.

The prescriptive rebate programs reviewed here are those of top performers in residential energy savings that achieved above median energy savings rates by prescriptive rebate programs at or below median costs: Efficiency VT, Interstate P&L (IA), MidAmerican (IA), MN Power, NSTAR, PG&E, SDG&E, and SCE.

Efficiency VT offered prescriptive rebate programs through Efficient Products program. Efficient Products offered incentives for Energy Star products, especially lighting, via customer rebates, retailer buy-downs, and manufacturer markdowns. Efficiency VT established partnerships with suppliers and manufacturers of Energy Star products and especially with retailers; Efficiency VT supported retailers with cooperative promotions such as offering in-store incentives that did not require having to process coupons. Efficiency VT also educated retailers of the current range of CFLs, resulting in the stocking and increased sales of higher quality and specialty CFLs (three-way, dimmable, encapsulated, etc). Efficient Products also promoted other Energy Star appliances and products: clothes washers with a Tier 3a rating had a $50 mail-in rebate; Energy Star air conditioners had a $25 mail-in rebate; and Energy Star lighting fixtures, ceiling fans, and torch floor lamps had a $10 instant coupon. Over 90% of energy savings for the Efficient Products program was earned by lighting.

In 2006 energy savings of Efficient Products accounted for 80% of Efficiency VT's total residential energy savings at about 23% of Efficiency VT's total residential DSM costs; costs for the program, at $0.07/kWh, are very low. Incentives composed only 50% of total costs for Efficient Products; this is a considerably smaller percentage than typical and may be explained by the fact that the program included substantial indirect impact objectives in addition to incentives.

Interstate P&L (IA) offered cash rebates for high efficiency equipment for a variety of end-uses through their Residential Prescriptive Rebates program. Cash rebates were available for heating, cooling, fans, programmable thermostats, lighting, replacement windows, doors, washers, water heaters, refrigerators and freezers. Interstate P&L (IA) promoted the program to residential customers via their website, PowerHouse newspaper feature and television program, direct mail, bill inserts, newsletters, trade shows, and community workshops. Interstate P&L (IA) partnered with MidAmerican (IA) and other utilities in the Energy Star "Change a Light, Change the World" campaign and contributed matching grants in the Iowa Weatherization Challenge and included the costs and impacts of those involvements in the Prescriptive Rebates program results.

Interstate P&L (IA)'s Appliance Recycling program paid an incentive for removing operative but inefficient refrigerators and freezers and promoted the program via the website, PowerHouse newspaper feature, emails, brochures, and tradeshows.

In 2006 energy savings of Prescriptive Rebates and Appliance Recycling programs accounted for 76% of Interstate P&L (IA)'s total residential energy savings at about 63% of Interstate P&L (IA)'s total residential electricity DSM costs; combined costs for the two programs, at $0.24/kWh, are below the median. Incentives composed 80% of total costs for the two programs combined.

MidAmerican (IA) offered prescriptive rebates through a traditional prescriptive rebate program, Residential Equipment. Residential Equipment offered incentives in the form of rebates and financing for high efficiency space conditioning and water heating for new and existing housing. Incentives were offered for central AC, window AC, air-source heat pumps, ground-source heat pumps, and add-on heat pumps. MidAmerican (IA) promoted the program to residential customers via their "Save Some Green" print and broadcast ad campaign, bill inserts, and web site. As the program was delivered through a network of HVAC trade allies, MidAmerican (IA) supported HVAC dealers with sponsored training and education. MidAmerican (IA) also reviewed the program in terms of efficiency requirements, rebate structure, and newer technologies as base efficiency standards rise.

In 2006 energy savings of Residential Equipment counted for 17% of MidAmerican (IA)'s total residential energy savings at about 27% of the utility's total residential electricity DSM costs; costs for Residential Equipment were $0.41/kWh, and incentives composed 83% of program costs.

MN Power offered prescriptive rebates bundled within its Triple E Plus Program. Triple E Plus was MN Power's brand for a comprehensive residential program which included prescriptive rebates for efficient HVAC systems and Energy Star lighting and appliances. MN Power promoted the Energy Star products program with training, support, and incentives for retailers, education for customers, and by leveraging regional and national energy efficiency promotions. The HVAC program offered mail-in rebates for customers through HVAC contractors. Thus MN Power worked closely with HVAC distributors and contractors and provided them with training on energy efficient technologies and on the rebate program; MN Power also offered seasonal promotions.

In 2006 Triple E Plus achieved 80% of MN Power's total residential energy savings at about 70% of the utility's total residential electricity DSM costs; at $0.12/kWh, Triple E Plus's energy savings are very reasonable. About 60% of program costs were for incentives.

NSTAR offered prescriptive rebates through its Energy Star (ES) Appliances, ES Lighting, and ES HVAC programs.

The ES Appliances and ES Lighting programs offered rebates to customers purchasing ES clothes washers and air conditioners and leveraged manufacturer, retailer, and national ES promotional campaigns. The ES Lighting program also increased penetration of ES lighting through its mail order and website catalogs and through negotiated cooperative promotions (buy-downs). ES Appliances and ES Lighting were administered and promoted by the Massachusetts electric Program Administrators (which included NSTAR, Fitchburg Gas and Electric, National Grid, Western Massachusetts Electric, and the Cape Light Compact).

ES HVAC, administered by NSTAR, offered incentives to customers, certified technicians, and contractors; customers were offered mail-in rebates for purchasing qualifying equipment, North American Technical Excellence-certified technicians were offered reimbursements for installing qualifying equipment, and contractors were offered incentives for performing Quality Installation Verifications on new air conditioners and heat pumps. The ES HVAC coordinated with NSTAR's new construction program and with other utilities' HVAC programs when possible.

In 2005 energy savings for NSTAR's prescriptive rebates programs accounted for about 85% of NSTAR's total residential energy savings at about only 44% of the utility's total residential electricity DSM costs; incentives composed 46 % of program costs, the lowest percentage among the best practice programs. However, while the lighting program accounted for about 93% of NSTAR's prescriptive rebates programs' energy savings, it composed only 58% of NSTAR's prescriptive rebates programs' costs; at $0.07/kWh, lighting achieved significant savings at very low costs.

PG&E SDG&E and SCE offered several statewide prescriptive rebate programs, and each utility reported impacts and costs for these programs under the umbrella Energy Efficiency Incentives Rebates program (EEI Rebates). The program included Single Family Energy Efficiency Rebates (SFEER), Multifamily Energy Efficiency Rebates (MFEER), and Residential Appliance Recycling program (for which SDG&E reported separately from EEI Rebates). SFEER provided rebates on Energy Star appliances, lighting, HVAC systems, pool equipment, and other home improvement products. The program worked with retailers and manufactures to offer point-of-sale discounts for lighting and other qualifying Energy Star products. MFEER provided mail-in cash rebates to property owners of multi-family housing of five or more units for energy efficiency measures for apartments and common areas, including lighting fixtures, CFLs, ceiling fans, clothes washers, dishwashers, exit signs, occupancy sensors, high performance windows, and mechanical and HVAC improvements. The Appliance Recycling program offered $35 to customers who turned in working refrigerator or freezer between 14-27 cubic feet manufactured before 1990, two units limited per customer. JACO Environmental was contracted to dispose of the refrigerators.

In 2006 energy savings for EEI Rebates accounted for about 90% of each utility's total residential energy savings at 60-70% of the utility's total residential electricity DSM costs; incentives composed about 80% of EEI Rebates total costs.

Xcel Energy offered prescriptive rebates through its Home Lighting Direct Purchase program and its Energy Star program for heating and cooling system. The Energy Star program provided rebates for installing qualifying air conditioners, ground source heat pumps, air source heat pumps, and window/room air conditioners. Xcel Energy increased awareness of the program and promotions among the vendor and contractor communities to drive participation. The program was promoted to customers through bill inserts, newsletters, and local events.

The Home Lighting program offered customers two ways to purchase competitively priced CFLs: via direct sales and via in-store instant rebates. Through the Direct Sales program, customers could order from 25 models of CFLs by phone, mail, or internet through a third party vendor that managed and owned the inventory and sales. Xcel Energy promoted the direct sales program via direct mail, bill inserts, newsletters, and the Internet.

Through Xcel Energy's in-store instant rebate programs, including the national Energy Star Change-A-Light promotion, customers could purchase CFLs at prices as low as $0.99 per bulb for a limited time; rebates were funded by CFL manufacturers, big box retailers, chain stores, and Xcel Energy. Xcel Energy promoted the CFL programs through print advertising, public relation efforts, and leveraged the marketing of the Change-A-Light campaign.

In 2006 energy savings for Xcel Energy's prescriptive rebates programs accounted for about 75% of Xcel Energy's total residential energy savings at about 47% of the utility's total residential electricity DSM costs; incentives composed about 80% of total costs. However, while the lighting program accounted for about half of Xcel Energy's prescriptive rebates programs' energy savings, it composed only 5% of Xcel Energy's prescriptive rebates programs' costs; at $0.07/kWh, lighting achieved significant savings at very low costs.

Table 3-24: Costs Distribution and $/kWh (First Year) per Cost Component for Prescriptive Rebate Programs

Residential Prescriptive Rebates Utility/Agency	Program Name	Incentives Costs as % of Total	Incentives $/kWh	Admin & Other Costs as % of Total	Admin & Other $/kWh	Program Total $/kWh
Efficiency VT	Efficient Products	**49.1%**	**$0.03**	**50.9%**	**$0.04**	**$0.07**
Interstate P&L (IA)	Prescriptive Rebates	77.8%	$0.21	22.2%	$0.06	$0.27
Interstate P&L (IA)	Appliance Recycling	93.3%	$0.12	6.7%	$0.01	$0.13
	Interstate P&L (IA) Total	**79.7%**	**$0.19**	**20.3%**	**$0.05**	**$0.24**
MidAmerican (IA)	Residential Equipment	**82.9%**	**$0.34**	**17.1%**	**$0.07**	**$0.41**
MN Power	Triple E Plus	**57.0%**	**$0.07**	**43.0%**	**$0.05**	**$0.12**
NSTAR 05	ES Lighting	57.7%	$0.04	42.3%	$0.03	$0.07
NSTAR 05	ES HVAC	33.5%	$0.77	66.5%	$1.52	$2.29
NSTAR 05	ES Appliances	27.4%	$0.13	72.6%	$0.34	$0.47
	NSTAR 05 Total	**46.1%**	**$0.05**	**53.9%**	**$0.06**	**$0.11**
PGE 05	EEI Rebates	**81.0%**	**$0.09**	**19.0%**	**$0.02**	**$0.12**
SDGE 05	EEI Rebates	82.5%	$0.09	17.5%	$0.02	$0.11
SDGE 05	Residential Appliance Recycling	23.8%	$0.05	76.2%	$0.16	$0.21
	SDGE Total	**77.2%**	**$0.09**	**22.8%**	**$0.03**	**$0.12**
SCE 05	EEI Rebates	**85.2%**	**$0.08**	**14.8%**	**$0.01**	**$0.10**
Xcel Energy (MN)	Energy Star	84.0%	$1.03	16.0%	$0.20	$1.22
Xcel Energy (MN)	Home Lighting Direct Purchase	0.0%	$0.00	100.0%	$0.07	$0.07
	Xcel Energy (MN) Total	**79.6%**	**$0.52**	**20.4%**	**$0.13**	**$0.65**

Table 3-25: Prescriptive Rebate Program Costs and First Year Energy Savings as a % of Total Residential Electricity DSM

Residential Prescriptive Rebates Utility/Agency	Program Name	Program's Costs ($M)	% of Total Res DSM Costs	Program's Energy Savings	% of Total Res Energy
Efficiency VT	Efficient Products	**1.6**	**23.4%**	**23.5**	**79.2%**
Interstate P&L (IA)	Prescriptive Rebates	5.2	55.6%	19.0	58.6%
Interstate P&L (IA)	Appliance Recycling	0.7	7.9%	5.6	17.3%
	Interstate P&L (IA) Total	**6.0**	**63.5%**	**24.6**	**75.9%**
MidAmerican (IA)	Residential Equipment	**2.3**	**26.5%**	**5.7**	**16.6%**
MN Power	Triple E Plus	**0.9**	**71.1%**	**7.3**	**80.4%**
NSTAR 05	ES Lighting	4.3	25.4%	63.4	78.9%
NSTAR 05	ES HVAC	1.2	7.2%	0.5	0.7%
NSTAR 05	ES Appliances	1.9	10.8%	4.0	4.9%
	NSTAR 05 Total	**7.4**	**43.5%**	**67.9**	**84.5%**
PGE 05	EEI Rebates	**40.9**	**71.2%**	**355.5**	**88.7%**
SDGE 05	EEI Rebates	15.2	51.8%	137.2	84.2%
SDGE 05	Residential Appliance Recycling	1.5	5.1%	7.0	4.3%
	SDGE Total	**16.7**	**56.9%**	**144.1**	**88.4%**
SCE 05	EEI Rebates	**49.2**	**69.9%**	**496.1**	**92.9%**
Xcel Energy (MN)	Energy Star	5.7	44.2%	4.7	38.2%
Xcel Energy (MN)	Home Lighting Direct Purchase	0.3	2.4%	4.6	37.4%
	Xcel Energy (MN) Total	**6.1**	**46.6%**	**9.3**	**75.6%**

Residential Energy Audit and Retrofit Programs

Residential energy audit and retrofit programs typically provide an on-site energy audit and incentives for retrofit measures for existing housing. The program typically includes:

- free direct installation of low-cost measures, and
- incentives in the form of rebates or low interest financing for retrofit measures.

Residential audit and retrofit programs can provide significant savings, but only four of the organizations with top performing residential portfolios reviewed here had audit and retrofit programs with impacts.

Efficiency VT's Existing Homes program included a home energy audit and included promoting Home Performance with Energy Star to both local contractors and homeowners. To local contractors, Efficiency VT promoted the program by offering free introductory trainings about the program and certification, paying the cost of certification, offering 10% rebates or 0% financing on home energy audit equipment, and providing co-op advertising funds to certified contractors. Efficiency VT promoted Home Performance with Energy Star to customers through print ads and by providing contractor lists. In addition to the audit, services to customers included direct installation of some lighting and water conservation measures and incentives for other measures such as replacing inefficient refrigerators, electric heating systems, and cooling systems with Energy Star or better systems. (Although fuel switching for hot water, space heat, and other systems was incentivized in Existing Homes, fuel switching impacts and costs are not included in this audit/retrofit rebate analysis.)

In 2006 energy savings of Existing Homes accounted for 5% of Efficiency VT's total residential energy savings at about 32% of Efficiency VT's total residential electricity DSM costs. Incentives for Existing Homes composed only 20% of total costs for the program; this is a considerably smaller percentage than typical and may be explained by the fact that the program included substantial indirect impact objectives in addition to incentives.

Interstate P&L (IA)'s Home Energy Audit offered a free walk-through audit, expert energy efficiency recommendations, and direct installation of low cost measures as indicated, including programmable thermostat, water conservation measures, and CFLs. Participants were also eligible for insulation rebates, if indicated by the audit; participants who did not take advantage of the insulation rebate after six months received an automatic callback. Interstate P&L (IA) promoted the program through their website, PowerHouse newspaper feature, brochures, and trade shows.

In 2006 energy savings of Home Energy Audit accounted for 8% of Interstate P&L (IA)'s total residential energy savings at about 7% of Interstate P&L (IA)'s total residential electricity DSM costs. Incentives for Home Energy Audit composed over 90% of total costs for the program.

MidAmerican (IA) offered a home energy audit and retrofit program, Home Check, which included free on-site energy audits and free installation of low-cost efficiency measures to homes built before 1994. These free direct installs included CFLs, halogen bulbs, faucet aerators, low-flow shower heads, water heater blankets, and hot water pipe insulation. Incentives for additional measures were offered as indicated: rebate or financing for installing insulation, financing for energy efficient windows, subsidized installation of programmable thermostat, and information about other relevant MidAmerican (IA) programs. Post-audit, participants received follow-up contacts regarding any recommended incentivized measures that were not yet installed. MidAmerican (IA) promoted Home Check via print and broadcast ads of the Save Some Green ad campaign, community events, and its website.

In 2006 MidAmerican (IA) participated in the statewide Change a Light, Change the World promotion in which Iowa utilities contracted Wisconsin Energy Conservation Corporation to set up and manage the promotion with retailers: customers received in-store instant rebates for Energy Star CFLs. MidAmerican (IA) reported its costs and impacts of this promotion within the Home Check 2006 data.

In 2006 Home Check energy savings accounted for 45% of MidAmerican (IA)'s total residential energy savings at about 22% of the utility's total residential electricity DSM costs; costs for Home Check, at $0.12/kWh, are very reasonable. Incentives composed 77% of total costs.

NSTAR offered two audit programs: Residential Conservation Services (RCS)/MassSAVE, available to any residential customer, and Residential Multi Family Assessment, for non-low income residential customers.

RCS/Mass SAVE was a state mandated, fuel-blind program which was implemented for NSTAR customers by NSTAR under the statewide oversight of the Division of Energy Resources. The program offered two tiers of services. Tier One offered low cost education and tools for energy efficiency, including technical information, self-audit tools, online resources, and phone support. NSTAR screened Tier One participants to determine need for Tier Two services, in-home energy audits. Tier Two offered a Home Energy Assessment which included 1) an audit of HVAC, water heating, building envelope, appliances, lighting and refrigeration; 2) recommendations of energy efficiency measures; and 3) incentives to implement them.

The Residential Multi Family Assessment, for non-low income residential customers, was similar to RCS/Mass Save Tier Two in that it offered an energy assessment and recommendation of energy efficiency measures. It additionally offered free direct installation of low cost measures and discounts up to 75% on installation of higher cost measures.

In 2005 energy savings of NSTAR's two energy audit programs accounted for about 6% of NSTAR's total residential energy savings at about 20% of NSTAR's total residential electricity DSM costs. Incentives for Home Energy Audit composed only 45% of total costs for the program, the lowest percentage among the best practice energy audit programs.

Xcel Energy offered two home energy audit tools to their electric customers: the Home Energy Audit and the online Home Analysis. Xcel Energy considered its audit programs to have indirect impacts and, thus, did not calculate impacts for the programs. Through the Home Energy Audit, customers paid $35 through their energy bill for an audit that included the following: bill analysis, education, shell assessment, mechanical and electrical equipment review, and written energy savings recommendations. Xcel Energy marketed the Home Energy Audit via customer inquiries regarding their bill, bill inserts, newsletters, and through Xcel Energy's other residential programs. The free online Home Analysis walked customers through a 10-minute online audit that solicited information specific to their home (square footage, heating, AC, appliances, etc.) and ultimately offered energy saving recommendations, general maintenance tips, and the opportunity to enroll for the in-home audit and get information of Xcel Energy's other residential programs.

In 2006 Xcel Energy's home energy audit program accounted for about 3% of Xcel Energy's total residential electricity DSM costs. (There were no incentive costs for Xcel Energy's home energy audit program.)

Table 3-26: Costs Distribution and $/kWh per Cost Component for Energy Audit and Retrofit Programs

Residential Audit and Retrofit Utility/Agency	Program Name	Incentives Costs as % of Total	Incentives $/kWh	Admin & Other Costs as % of Total	Admin & Other $/kWh	Program Total $/kWh
Efficiency VT	Existing Homes-Rebates	20.3%	$0.29	79.7%	$1.14	$1.43
Interstate P&L (IA)	Home Audits	93.5%	$0.24	6.5%	$0.02	$0.26
MidAmerican (IA)	Home Check	77.2%	$0.10	22.8%	$0.03	$0.12
NSTAR 05	Res Conservation Services & Multi-Family	45.4%	$0.33	54.6%	$0.40	$0.73

Table 3-27: Energy Audit and Retrofit Costs and Energy Savings as a % of Total Residential Electricity DSM

Residential Audit and Retrofit Utility/Agency	Program Name	Program's Costs ($M)	% of Total Res DSM Costs	Program's Energy Savings	% of Total Res Energy
Efficiency VT	Existing Homes-Rebates	2.2	32.1%	1.6	5.3%
Interstate P&L (IA)	Home Audits	0.6	6.9%	2.5	7.7%
MidAmerican (IA)	Home Check	1.9	21.6%	15.5	45.2%
NSTAR 05	Res Conservation Services & Multi-Family	3.3	19.2%	4.5	5.6%

New Construction Programs

New construction programs can provide significant savings to a residential electricity DSM portfolio; for organizations reviewed here with top performing residential electricity DSM portfolios, savings from new construction programs ranged widely from 1-30% of total residential energy savings. New construction programs are key to any residential portfolio because they realize the most cost-effective energy efficiencies in a building at the most cost-effective time to do so, as it is planned and built.

The new construction programs reviewed here are of the top performers in residential energy savings: Efficiency VT, Interstate P&L (IA), MidAmerican (IA), NSTAR, PG&E, SDG&E, and SCE.[29]

Efficiency VT offered a new construction program with Vermont Gas, Vermont Energy Star Homes (VESH). Through VESH, Efficiency VT offered Energy Star certification for qualified homes, energy code support, plan reviews, technical assistance, site inspections, energy ratings, and performance testing. Efficiency VT promoted energy efficient new construction through direct mailings to builders, articles in local builder publications, and workshops at trade conferences.

In 2006 new construction accounted for 7% of Efficiency VT's total residential energy savings at 38% of total residential electricity DSM costs; incentives composed only 25% of program costs.

Interstate P&L (IA)'s New Home Construction program offered incentives through three options: a "base incentive" for achieving a HERS rating of 5 stars, a "bonus incentive" for meeting the base requirement and incorporating a bundle of measures which included Energy Star appliances, and a "super bonus incentive" for meeting the base requirement and incorporating all defined measures. Interstate P&L (IA) promoted the program to customers via their website, brochures, PowerHouse newspaper feature, and account managers and promoted the program to trade allies via brochures, program documentation, trade shows, and seminars.

In 2006 New Home Construction accounted for 10% of Interstate P&L (IA)'s total residential energy savings at 13% of total residential electricity DSM costs; incentives composed 90% of program costs.

MidAmerican (IA)'s new construction program offered incentives to home builders through two options: 1) a Builder Option Package in which the builder must meet all program requirements to receive the comprehensive rebate and 2) an Energy Star performance path which required individual modeling of the home's energy savings; buildings that met the performance path requirement earned the Energy Star rating. MidAmerican (IA) also promoted energy efficient new construction by educating builders on efficient design and best construction practices including measures such as duct sealing, foundation insulation, energy efficient HVAC and water heating, energy efficient windows, and higher levels of ceiling and sidewall insulation. MidAmerican (IA) promoted the program via the Save Some Green print and broadcast ad campaign, bill inserts, distributing program material to trade allies, local building meetings and events, and recognized leading builders through its Builder of the Year award program.

In 2006 MidAmerican (IA)'s new construction program accounted for about 30% of its total residential energy savings at about 30% of total residential electricity DSM costs; incentives composed 90% of new construction program costs.

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[29] MN Power's Triple E Plus program did include a new construction component, an Energy Star builder option program, but data on this component were not available.

NSTAR's new construction program, ES Homes, provided rebates to home buyers and to builders for the design and construction of energy efficient single- and multi-family new homes, independent of heating fuel. Incentives covered HVAC, water heating, appliances, and lighting. ES Homes also provided technical assistance and quality assurance inspections.

In 2005, ES Homes accounted for less than 1% of NSTAR's total residential energy savings at about 11% of NSTAR's total residential electricity DSM costs, and incentives composed only 22% of new construction program costs.

PG&E SDG&E and SCE offered their new construction program through the statewide California Energy Star New Homes program (CESNHP). The program encourages builders to exceed California's 2001 Residential Energy Efficiency Standards by 15% or 20% in single family and multifamily construction. Through CESNHP the utilities offered financial incentives, design assistance, and education, working with builders, architects, energy analysts, and other building industry professionals. The utilities promoted CESNHP through building industry events and trainings.

In 2005 CESNHP accounted for 0.5% - 2% of each California IOU's total residential energy savings. New construction program costs composed about 13% of total residential electricity DSM costs for SCE and SDG&E but only 4% of total residential electricity DSM costs for PG&E. Cost of incentives ranged from 60-70% of total new construction program costs.

Xcel Energy's new construction program, Home Efficiency, provided incentives for the installation of energy efficient equipment, appliances, and lighting including ECM motors, ES refrigerators, ES dishwashers, ES clothes washers, and ES lighting (fixtures and bulbs of CFLs and LEDs.) Builders received a $500 rebate per home for the installation of five bundled components.

In 2006, Home Efficiency was still relatively new and little known, thus it accounted for less than 1% of Xcel Energy's total residential energy savings at less than 1% of Xcel Energy's total residential electricity DSM costs, and incentives composed only 5% of new construction program costs.

Table 3-28: Costs Distribution and $/kWh per Cost Component for New Construction Programs

Residential New Construction Utility/Agency	Program Name	Incentives Costs as % of Total	Incentives $/kWh	Admin & Other Costs as % of Total	Admin & Other $/kWh	Program Total $/kWh
Efficiency VT	New Construction	25.0%	$0.31	75.0%	$0.92	$1.23
Interstate P&L (IA)	New Construction	89.1%	$0.32	10.9%	$0.04	$0.35
MidAmerican (IA)	New Construction	89.9%	$0.25	10.1%	$0.03	$0.28
NSTAR 05	ES Homes	22.1%	$0.61	77.9%	$2.16	$2.78
PGE 05	CA Energy Star New Homes	59.8%	$0.73	40.2%	$0.49	$1.23
SCE 05	CA Energy Star New Homes	73.2%	$0.58	26.8%	$0.21	$0.79
SDGE 05	CA Energy Star New Homes	67.8%	$1.13	32.2%	$0.54	$1.67
Xcel Energy (MN)	Home Efficiency	4.8%	$0.09	95.2%	$1.75	$1.84

Table 3-29: New Construction Program Costs and Energy Savings as a % of Total Residential Electricity DSM

Residential New Construction Utility/Agency	Program Name	Program's Costs ($M)	% of Total Res DSM Costs	Program's Energy Savings	% of Total Res Energy
Efficiency VT	New Construction	2.7	38.0%	2.2	7.3%
Interstate P&L (IA)	New Construction	1.2	12.5%	3.3	10.2%
MidAmerican (IA)	New Construction	2.8	31.1%	9.9	28.9%
NSTAR 05	ES Homes	1.8	10.6%	0.7	0.8%
PGE 05	CA Energy Star New Homes	2.0	3.5%	1.6	0.4%
SCE 05	CA Energy Star New Homes	9.5	13.4%	12.0	2.2%
SDGE 05	CA Energy Star New Homes	3.5	12.1%	2.1	1.3%
Xcel Energy (MN)	Home Efficiency	0.0	0.1%	0.0	0.1%

Low Income Programs

Low income programs can provide significant savings to a residential electricity DSM portfolio; for organizations reviewed here with top performing residential electricity DSM portfolios, savings from low income programs ranged widely from 6-20% of total residential energy savings. Low income programs are typically promoted and delivered by community organizations and jointly funded with federal, state, and/or other utilities. Low income programs are key because, with proper incentives, they can realize efficiencies that otherwise would remain untapped due to owner/tenant split incentives.

The low income programs reviewed here are of the top performers in residential energy savings: Interstate P&L (IA), MidAmerican (IA), MN Power, and NSTAR. Otter Tail and NYSERDA are included here for the significant impacts they achieved in low income programs.

Interstate P&L (IA), in partnership with other organizations, offered three low income programs: Weatherization Assistance, Multi-Family Energy Efficiency, and Energy Education.

In the Weatherization Assistance Program (WAP), Interstate P&L provided funding to the Iowa Department of Human Rights which distributed the funds to community organizations that promoted and delivered the WAP services. Thus IPL supplemented federal, state, and other utility funding for the program. The services were offered free to qualifying households and included inspecting and adjusting building envelope and heating system (cleaning furnace, caulking, etc); insulating ceiling, wall, foundation, or crawlspace; replacing space and water heating; installing programmable thermostats; replacing refrigerators and freezers; installing energy-efficient lighting; turning down hot water temperature; installing water heater traps, pipe insulation, low-flow showerheads, and faucet aerators. The Energy Group provided auditing services.

Multi-Family Energy Efficiency offered incentives that covered up to 40% of total project cost to multi-family property owners and developers. Interstate P&L (IA) worked with MidAmerican (IA), Aquila, and the Iowa Finance Authority since 2004 on this pilot program which included low cost measures, such as caulking and weather stripping, and energy efficiency investments, such as installing ceiling and in-wall insulation. The Iowa Utility Association (IUA) facilitated multi-family and institutional projects.

Interstate P&L (IA) partnered with other IUA member utilities in the Energy Education – Energy Wise program which offered education and materials about low-cost efficiency measures to customers that qualified for Iowa's Low Income Home Energy Assistance. Quantec provided support and training for the delivery of Energy Wise kits and materials to community groups which promoted the program and distributed the materials to clients via workshops and one-on-one consulting. The kit included two CFLs (14-watt and 19-watt); low-flow showerhead; faucet aerators for kitchen and bath; furnace filter alarm; temperature cards to test temperature for a room, refrigerator, freezer, and water heater; and a water-flow measurement tool.

The WAP achieved about half of Interstate P&L (IA)'s total energy savings from low income programs while the multi-family program achieved about 20% and the education program about 30% of total low income program energy savings.[30]

In 2006, the three low income programs together accounted for 6% of Interstate P&L (IA)'s total residential energy savings at about 4% of the utility's total residential electricity DSM costs; costs for the three programs combined, at $0.20/kWh, are very reasonable. Incentives composed about 86% of total program costs.

MidAmerican (IA), as a member of the Iowa Utility Association, offered the same three low income programs that Interstate P&L (IA) offered through funding, management, delivery, and support structures that were also similar to those of IPL.

In 2006, MidAmerican (IA)'s results and costs for the three low income programs are also similar to those of Interstate P&L (IA): MidAmerican (IA)'s three low income programs together accounted for 6% of MidAmerican (IA)'s total residential energy savings at about 5% of the utility's total residential electricity DSM costs; costs for the three programs combined, at $0.22/kWh, are very reasonable. Incentives composed about 80% of total program costs.

MN Power's low income program, Energy Partners, offered energy audits and installation of efficiency measures to qualifying households (low income status, single-family home or in two- to four-unit dwelling, and responsible for bills) at little or no cost to participants. MN Power promoted the program through several community-wide energy expos and community organizations and encouraged participation from households that traditionally have not participated in low income programs (working poor and those unaware of the program). Services included in-home audits with blower door analysis, caulking, and weather stripping; installation of low-cost measures such as low-flow showerheads, faucet aerators, pipe wrap, and water heater blankets; and replacement of qualifying water heaters and refrigerators.

MN Power's low income programming also included site-specific efficiency events for multi-family dwellings where MN Power offered CFLs, funding for common area lighting upgrades, and replacement of qualifying refrigerators.

In 2006, MN Power's Energy Partners program accounted for 20% of MN Power's total residential energy savings at only 8% of the utility's total residential electricity DSM costs; costs for the program, at $0.20/kWh, are very reasonable. Incentives composed about 70% of total program costs.

[30] Costs for Interstate P&L (IA)'s three low income programs were available only in aggregate.

NSTAR offered three low income programs: Low Income New Construction, Low Income Single-Family, and Low Income Multi-Family.

The Low Income New Construction was for construction of new buildings and major renovation of existing buildings with at least 50% low income residents (i.e., residents having 60% or less of the median income) and for single-family homes for low income customers (as with Habitat for Humanity). The program coordinated with NSTAR's standard residential new construction program, ES Homes, and covered building envelope, insulation, windows, HVAC, appliances, water heating, lighting and best practice construction techniques to minimize leakage, infiltration, and heat loss.

Low Income Single-Family and Low Income Multi-Family delivered energy efficient products and measures directly into homes, including weatherization measures, lighting, and appliances. The programs also included non-energy benefits like improved comfort. The Single-Family program was for low income customers living in 1-4 unit dwellings. The Multi-Family program was for customers in buildings with at least 50% low income residents.

In 2005, NSTAR's three low income programs accounted for about 10% of NSTAR's total residential energy savings at about 27% of the utility's total residential electricity DSM costs. Costs for the program, at $0.62/kWh, are the highest among the best practice low income programs. Incentives composed about 65% of total program costs.

NYSERDA's principal low income program, EmPower New York, offered efficiency education, products, and services to qualifying property owners and tenants (household incomes below 60% of state median income and houses enrolled in low income payment assistance). Every participant who was referred to the program received a kit which included information about the program, educational materials on efficiency, three CFLs, a water thermometer, and a nightlight. Those that were expected to benefit from home performance treatments received energy audits and, as indicated, insulation, heating system repair and replacement, air-sealing, additional CFLs, and refrigerator replacement. Health and safety measures (e.g. carbon monoxide detectors) and emergency repairs were also implemented as needed. Measures were prioritized by cost-effectiveness, and services and costs were shared with WAP, as possible. Services that directly benefited tenants were offered at no cost while other services generally required a 25% landlord contribution. The program targeted one-to four- family homes and multi-family buildings with fewer than 100 units with priority given to

- -households participating in utility low income programs
- -seniors referred by Offices for the Aging due to financial hardship
- -eligible households receiving services coordinated or co-funded by the WAP (run by NY Division of Housing and Community Renewal and funded by the US Department of Energy)
- -eligible households in buildings not eligible for services through WAP
- -smaller buildings eligible for Multifamily building performance program that NYSERDA determined would be better served through EmPower New York

EmPower also offered free workshops on energy use and efficiency. Audit and installation services were provided through a network of weatherization agencies and private energy services contractors, all BPI accredited.

NYSERDA also offered low income programs within their other residential programs. In NYSERDA's Single Family Performance, the Assisted Home Performance with Energy Star program and the Assisted New York Energy Star Labeled Homes program provided incentives up to 50% of approved work and

provided access to the New York Energy Smart Loan Fund. These low income initiatives were available to households with up to 80% of the state's median income.

NYSERDA's Multifamily Building Performance Program offered low income programming for new and existing buildings. For new buildings, the low income programming offered financial assistance during design and construction stages, training to building owners and managers, and monitoring of energy savings. For existing buildings, the low income programming offered technical and financial assistance for efficiency improvements.

NYSERDA also ran four low income programs with indirect impact: Buying Strategies, to reduce costs of home heating oil purchased for LIHEAP customers; Targeted Marketing and Outreach, to increase participation in all Federal-, State-, NYSERDA-, utility-, and community-based efficiency programs by hard-to-reach (low income and non-English speaking) customers; Low Income Forum on Energy (LIFE), to share information on low income efficiency among industry professionals; and Energy Smart Students, to provide efficiency curricula and facilities improvements to K-12 schools.

In 2006, EmPower accounted for 64% of NYSERDA's total residential energy savings at only 19% of the utility's total residential electricity DSM costs; costs for the program, at $0.45/kWh, are reasonable[31].

Otter Tail's low income program, House Therapy, sponsored efficiency improvements, primarily weatherization installations, for low-income homes and apartments. Qualifying participants received an energy analysis and, as warranted, improvements including installation of insulation, CFLs, low-flow shower heads, faucet aerators, and engine-block heater timers. House Therapy was promoted and administered through community organizations.

In 2006, House Therapy accounted for 15% of Otter Tail's total residential energy savings at 28% of the utility's total residential electricity DSM costs; costs for the program, at $0.54/kWh, are reasonable. Incentives composed about 4% of total program costs.

For three of these six organizations, low income programs achieved 15-65% of the organization's total residential energy savings at only 15-30% of the organization's total residential electricity DSM costs. And for most, the cost of the incentives composed 70-85% of total low income programs costs.

The Iowa IOUs achieved modest but still significant savings with their collaborative low income programs at very reasonable costs. MN Power's Energy Partner program achieved greater energy saved as a percentage of energy sales possibly due to its site-specific multi-family programs.

[31] Of all of NYSERDA's low income programming, 2006 incremental costs and results were available only for the EmPower program.

Table 3-30: Costs Distribution and $/kWh per Cost Component for Low Income Programs

Residential Low Income Utility/Agency	Program Name	Incentives Costs as % of Total	Incentives $/kWh	Admin & Other Costs as % of Total	Admin & Other $/kWh	Program Total $/kWh
Interstate P&L (IA)	Low Income	86.2%	$0.17	13.8%	$0.03	$0.20
MidAmerican (IA)	Low Income	78.3%	$0.17	21.7%	$0.05	$0.22
MN Power	Energy Partners	68.2%	$0.14	31.8%	$0.06	$0.20
NSTAR 05	Total Low-Income Programs	64.8%	$0.40	35.2%	$0.22	$0.62
NYSERDA	EmPower New York	NA	NA	NA	NA	$0.45
Otter Tail	House Therapy	3.8%	$0.02	96.2%	$0.52	$0.54

Table 3-31: Low Income Program Costs and Energy Savings as a % of Total Residential Electricity DSM

Residential Low Income Utility/Agency	Program Name	Program's Costs ($M)	% of Total Res DSM Costs	Program's Energy Savings	% of Total Res Energy
Interstate P&L (IA)	Low Income	0.4	4.0%	2.0	6.2%
MidAmerican (IA)	Low Income	0.4	4.7%	2.0	5.8%
MN Power	Energy Partners	0.4	24.2%	1.8	19.6%
NSTAR 05	Total Low-Income Programs	4.6	26.7%	7.3	9.1%
NYSERDA	EmPower New York	8.4	13.4%	18.6	63.7%
Otter Tail	House Therapy	0.2	25.5%	0.4	14.8%

Residential Demand Response Programs

Residential demand response (DR) programs are typically comprised of incentives for direct load control of central air conditioning systems, but DR programs may also include direct load control of other appliances including water heaters and pool pumps.

DR programs in the residential sector can provide significant peak demand savings at very low costs. A best practice residential DR program that demonstrates this is Xcel Energy's, which achieved 73% of Xcel Energy's total residential electricity DSM peak demand savings at $220/kW, just 42% of its total residential electricity DSM costs.

The demand response programs reviewed here are those of top performers in residential electricity DSM that had DR programs: MidAmerican (IA), Interstate P&L (IA), and Xcel Energy[32].

Interstate P&L (IA)'s demand response program, Appliance Cycling program, offered incentives for direct load control of customers' air conditioner compressor and/or water heater. Participants agreed to the direct cycling off of their appliance every other 15-minute period from 1pm to 7pm on days when weather.com forecasted temperatures exceeding each regional zone's threshold temperature (e.g. 94F for

[32] Data for DR programs of the California IOUs were not available.

the Southern zone). Switches were controlled over FM radio, but in 2006 Interstate P&L began converting the control technology to Canon paging. Interstate P&L (IA) promoted the program via bill inserts and direct mail.

In 2006, the Appliance Cycling program cycled on 6 days, saving 20 MW of peak demand. Appliance Cycling's incremental savings, .145 MW, composed about 1% of Interstate P&L (IA)'s total residential electricity DSM peak demand savings at $4,000/kW, about 4% of the utility's total residential electricity DSM costs.

MidAmerican (IA)'s SummerSaver offered owner-occupiers of single-family homes incentives for direct load control of their central air conditioner or air source heat pump. The switch, controlled by FM radio or pager (for all new installs), cycled off only the system's compressor and not the fan to minimize any discomfort. Participants received $40 bill credits their first year and $30 thereafter. MidAmerican (IA) promoted SummerSaver by direct mailing a brochure with a postage paid response card in January and February; MidAmerican (IA) minimized attrition by transience by following up with participating customers that moved into a non-controlled home and enrolling by default any new owner of a controlled home.

In 2006 SummerSaver cycled 5 days with a total peak demand savings capacity of 50 MW. Incremental peak demand savings for SummerSaver in 2006, 1 MW, composed 7% of MidAmerican (IA)'s total residential electricity DSM peak demand savings at $1,200/kW, 14% of the utility's total residential electricity DSM costs.

Xcel Energy's Saver's Switch program offered customers incentives for direct load control of their central air conditioner and water heater. Central air conditioners were cycled off when pre-determined thresholds were met; water heaters were cycled off for up to five hours. Participants received 15% monthly bill credit June to September for AC control and an additional 2% monthly bill credit year-round for water heater control. From Saver's Switch's inception in 1990 to 2005, the number of cycling days averaged 10-15 days per summer. Xcel Energy's survey indicated a high level of customer satisfaction and no difference in comfort between control periods and non-control periods. Saver's Switch is promoted via direct mail, bill inserts, newsletters, call campaigns, and Xcel Energy's website.

In 2006, Saver's Switch's incremental peak demand savings, 24 MW, composed 73% of Xcel Energy's total residential electricity DSM peak demand savings at only $220/kW, 42% of Xcel Energy's total residential electricity DSM costs.

3.3.3 Overall Natural Gas DSM Results

Table 3-32 shows the median result for natural gas DSM spending, savings, costs, and energy costs over all customer sectors for the reviewed organizations.

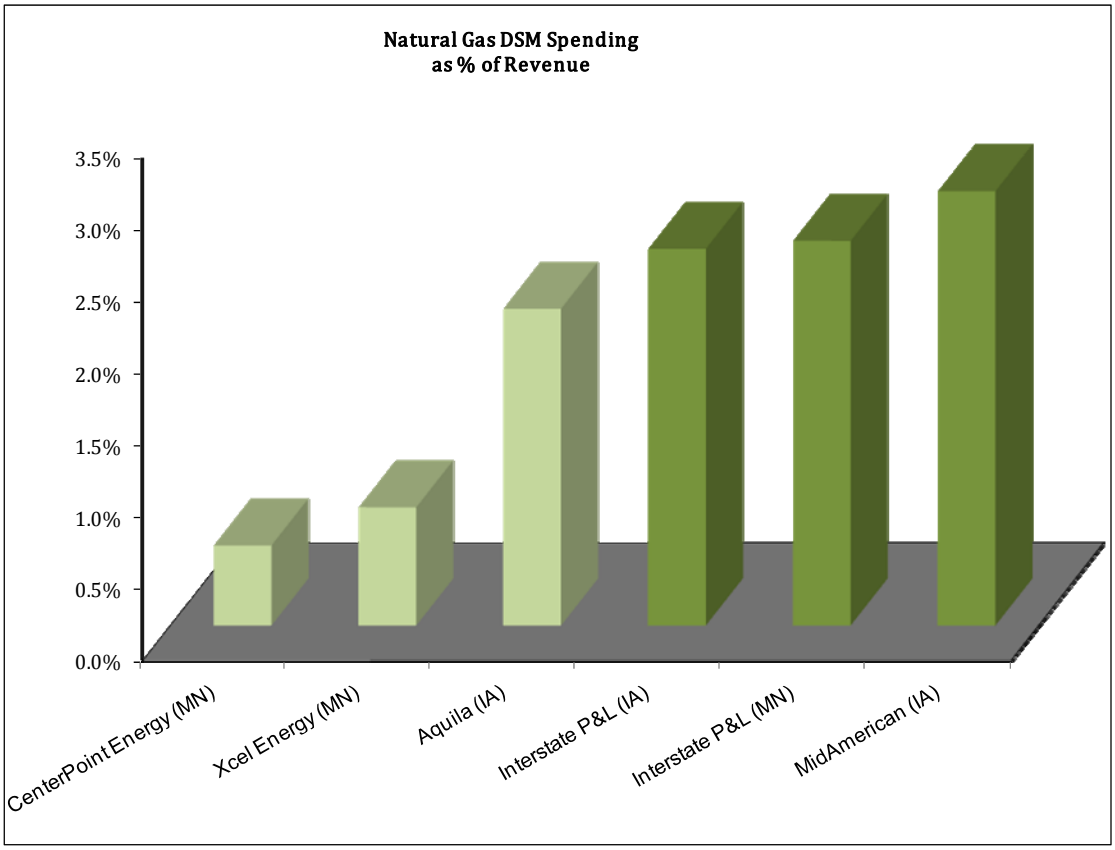
Table 3-32: Medians for Overall Results

Spending as % of Revenue	Energy Savings as % of Sales	Cost of Energy $/Mcf	First Year Cost of Savings $/Mcf
2.4%	1.0%	$10.99	$22.17

Natural Gas DSM Spending

The spending on natural gas DSM as a percentage of revenue for the organizations reviewed ranges from 0.6% to 3.0% with the median at 2.4%. Figure 3-23 below shows the distribution of spending on natural gas DSM as a percentage of annual revenues. Interstate P&L (IA), Interstate P&L (MN), and MidAmerican (IA) have spending rates above the median.

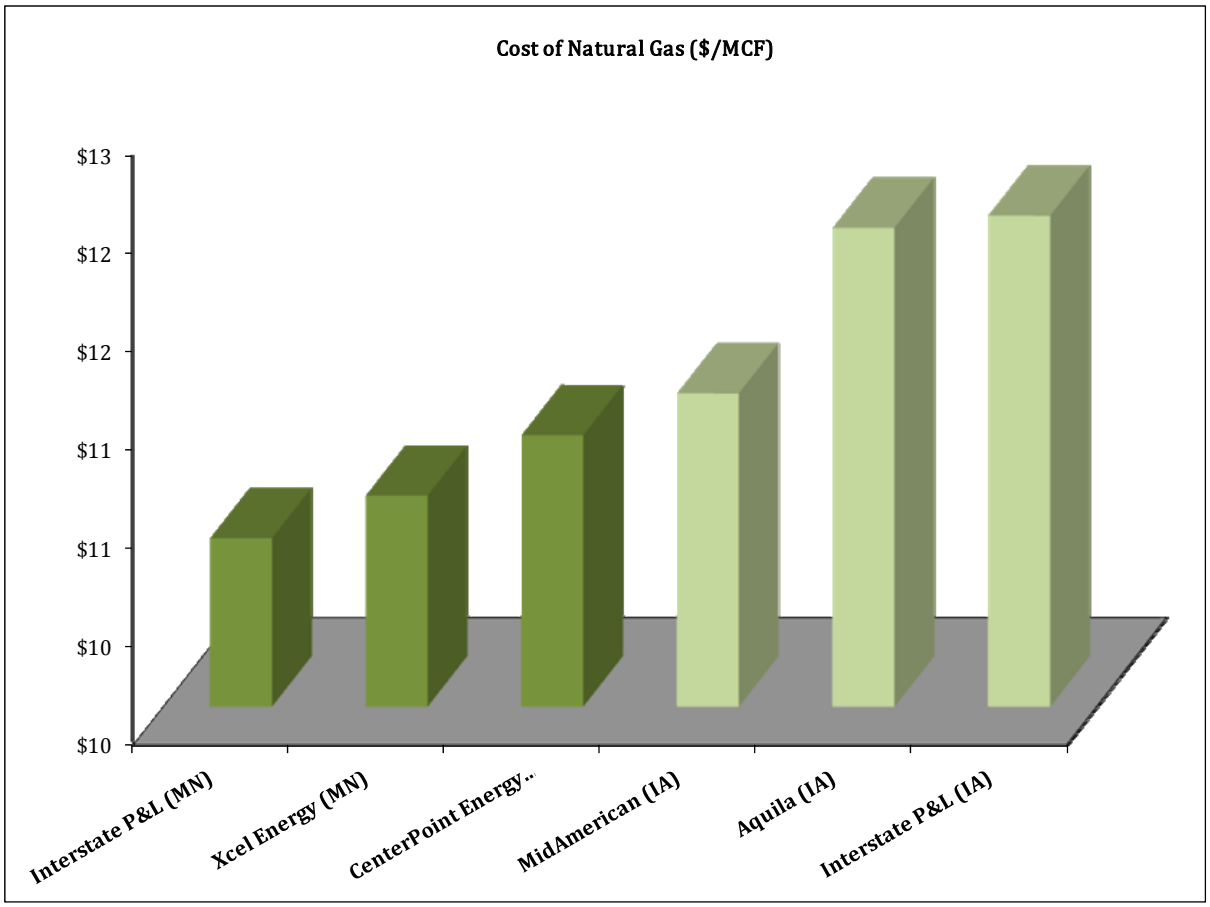
Figure 3-23: Natural Gas DSM Spending as % of Revenue



Cost of Natural Gas

The cost of energy for the six organizations reviewed ranges from $10.36/MCF to $12.00/MCF (Figure 3-24). Organizations with energy costs below the median are Interstate P&L (MN), Xcel Energy, and CenterPoint Energy.

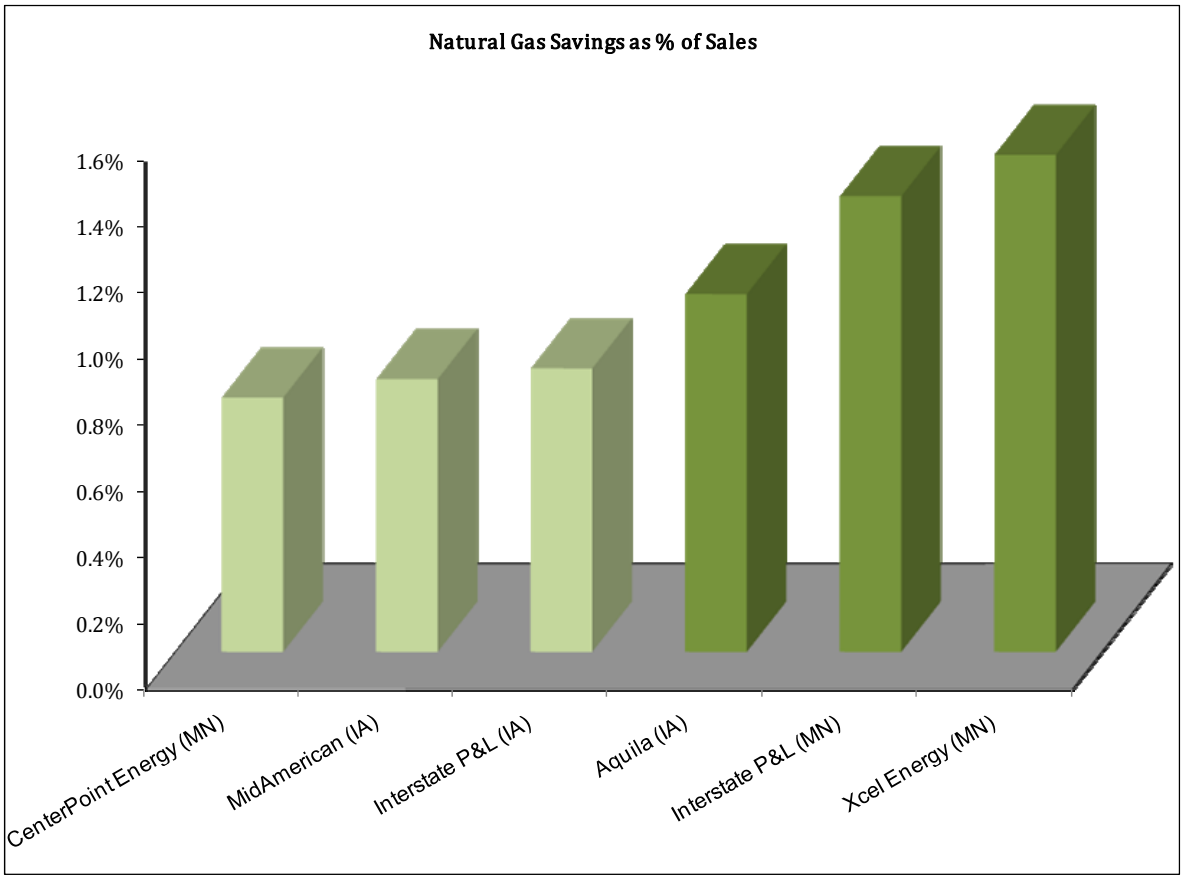
Figure 3-24: Cost of Natural Gas



Natural Gas Savings

Energy saved as a percentage of sales ranges from 0.8% to 1.5% with the median at 1.0%. Only one of the organizations with above median natural gas DSM spending rates also achieved above median energy savings as a percentage of sales: Interstate P&L (MN). One organization achieved above median energy savings as a percentage of sales (the highest) and has very low natural gas DSM spending as a percentage of revenue: Xcel Energy. Aquila (IA) also conserved energy as a percentage of sales above the median (Figure 3-25).

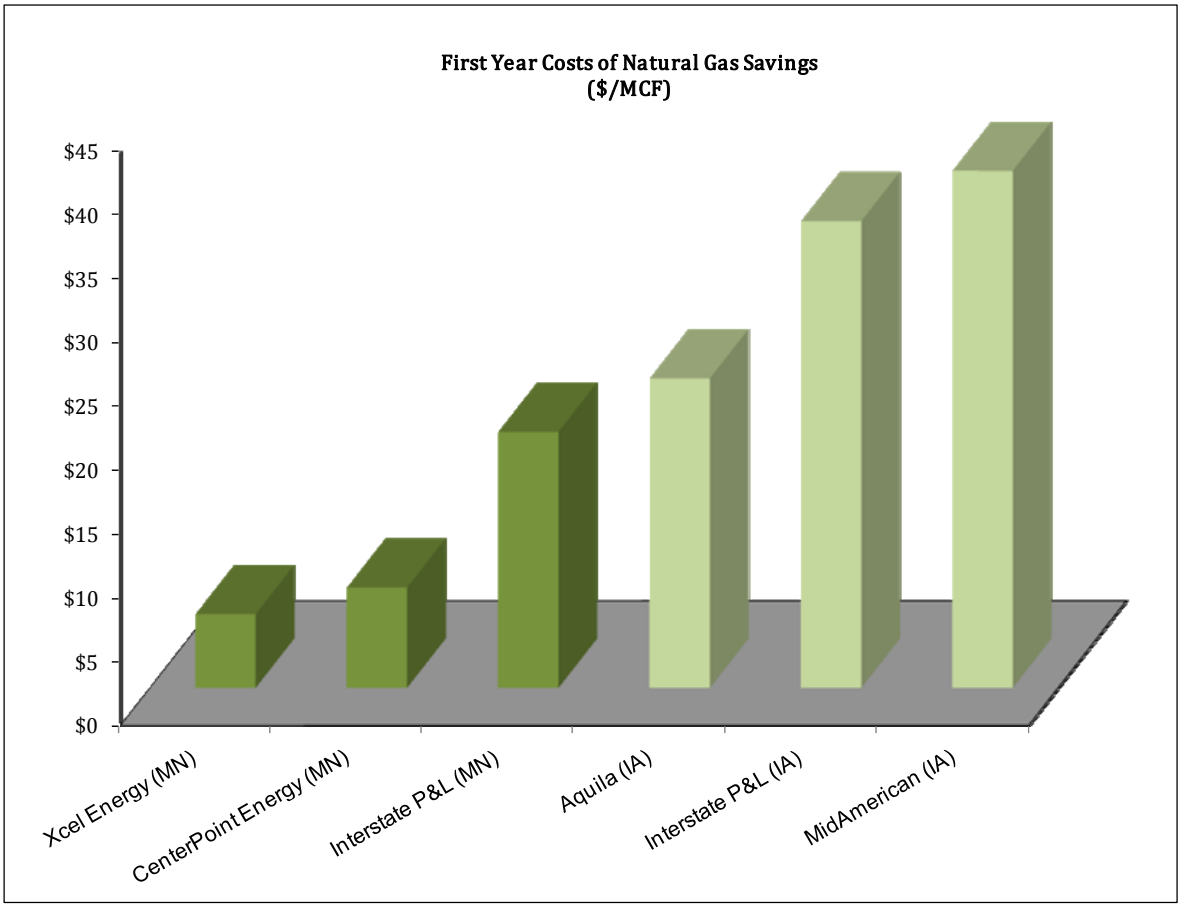
Figure 3-25: Natural Gas DSM Energy Savings as % of Sales First Year



Cost of Natural Gas Savings

As shown in Figure 3-26 below, the cost of first year energy savings ranges widely from $5.78/MCF to $40.54/MCF, with the median at $22.17/MCF. Xcel Energy achieved the lowest cost of energy savings, less than one-third the median. CenterPoint Energy also achieved very low cost of energy savings and, as Xcel Energy, spent a very low percentage of revenue on natural gas DSM. Interstate P&L (MN), having spent and saved above median, also achieved costs of conserved energy below the median.

Figure 3-26: Cost of Natural Gas Savings ($/MCF) First Year



The scatter plot in Figure 3-27 below illustrates where each organization falls relative to median energy savings and median costs. The utilities listed below achieved above median energy savings as a percentage of sales at costs lower than the median cost:

3. Interstate P&L (MN): 1.4%, $20.07/MCF
4. Xcel Energy: 1.5%, $5.78/MCF

Figure 3-27: Scatter Plot of Natural Gas Savings and First Year Costs ($/MCF)

3.3.4 Sector Analysis for Natural Gas DSM

This section compares 2006 natural gas DSM program results for the non-residential (also referred to as Commercial & Industrial– C&I) and residential sectors and reviews program-level detail for those organizations that achieved high savings at low costs.

C&I Sector

Table 3-33 shows the median results for spending, savings, and costs for the C&I sector for all reviewed organizations.

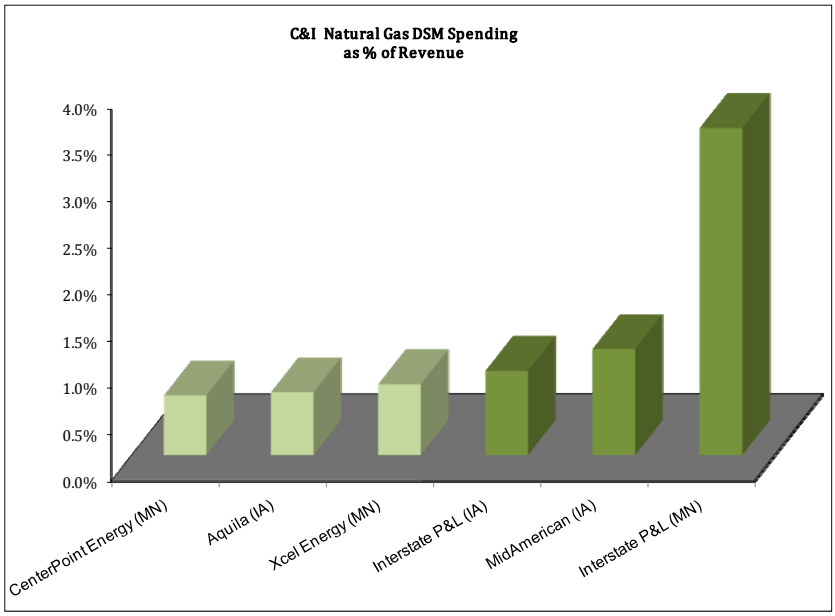
Table 3-33: Medians for C&I Results

Spending as % of Revenue	Energy Savings as % of Sales	Cost of Energy $/Mcf	First Year Cost of Savings $/Mcf
0.8%	0.9%	$9.70	$16.28

C&I Natural Gas DSM Spending

Natural Gas DSM spending in the C&I sector, as a percentage of annual revenue of retail energy sales, ranges from 0.6% to 3.5%, with the median at 0.8% (Figure 3-28). Organizations with above median spending rates are Interstate P&L (IA), MidAmerican (IA), and Interstate P&L (MN) which has the highest spending rate, about three times the median. Interstate P&L (MN) also achieved above median energy savings as a percentage of sales (Figure 3-29).

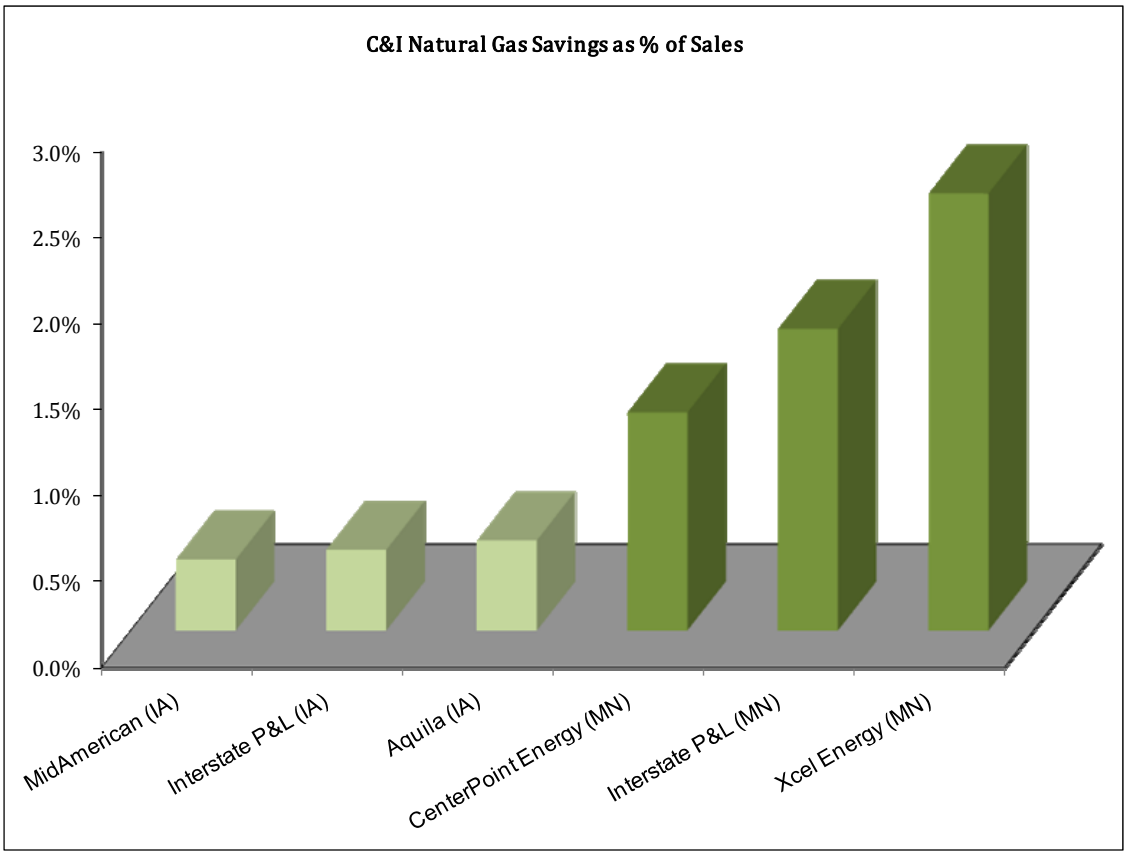
Figure 3-28: C&I Natural Gas DSM Spending as % of Revenue



C&I Natural Gas Savings

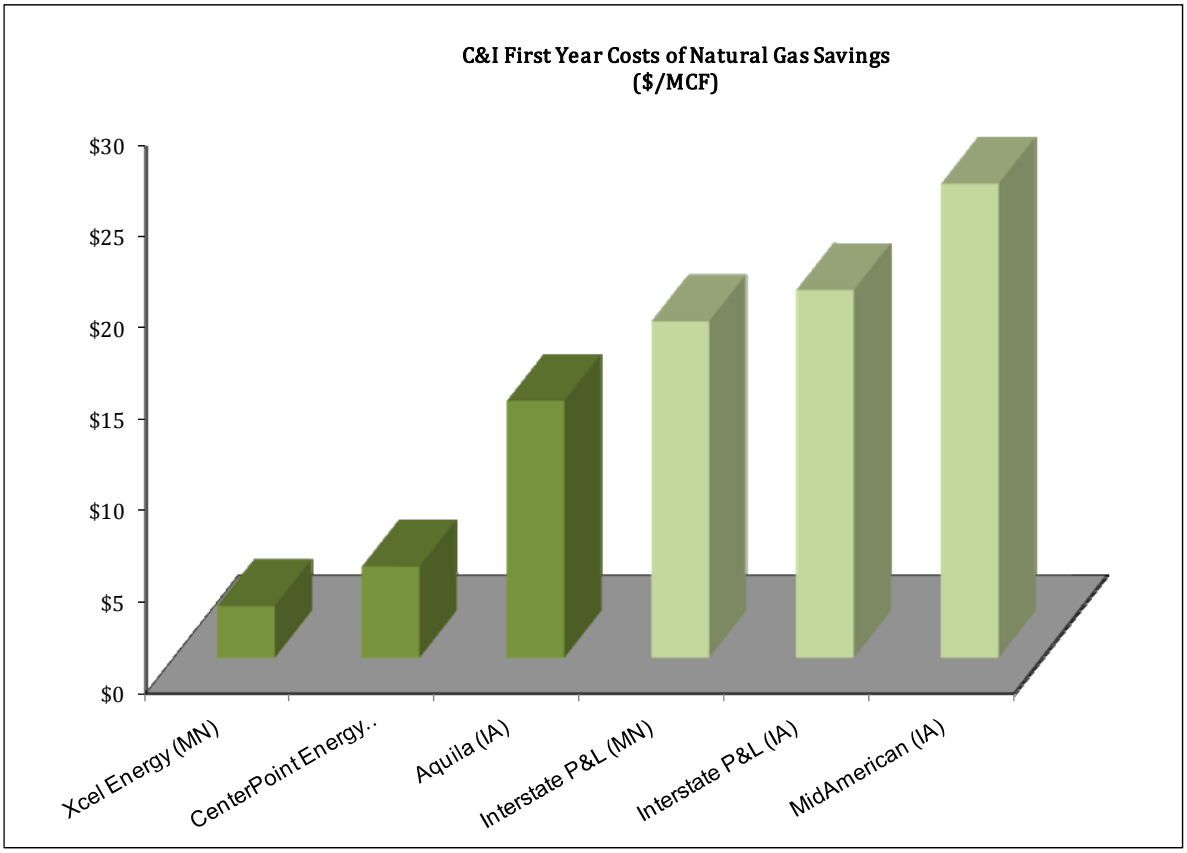
Figure 3-29 and Figure 3-30 show the energy savings as a percentage of sales and the cost of these savings across the various organizations. Energy savings as a percentage of sales ranges from 0.4% to 2.5% with the median at 0.9%. Xcel Energy has the highest savings rate, more than twice the median, and spent at a rate below median. CenterPoint Energy and Interstate P&L (MN) also achieved above median energy savings as a percentage of sales.

Figure 3-29: C&I Natural Gas Savings as % of Sales First Year



The costs of first year C&I energy savings range widely from $2.84/MCF to $26.01/MCF with the median at $16.28/MCF. Xcel Energy and CenterPoint Energy, with very low natural gas DSM spending rates and high energy savings rates, achieved their savings at very low costs, about $4/MCF.

Figure 3-30: C&I Cost of Natural Gas Savings ($/MCF) First Year



The scatter plot shown in Figure 3-31 below illustrates where each organization falls relative to median energy savings and median costs. The utilities listed below achieved above median energy savings as a percentage of sales at costs lower than the median cost:

1. Xcel Energy: 2.5%, $2.84/MCF
2. CenterPoint Energy: 1.3%, $5.00/MCF

Figure 3-31: Scatter Plot of C&I Natural Gas Savings and First Year Costs ($/MCF)

Table 3-34 and Table 3-35 below show results for programs delivered by the utilities that achieved above median energy savings rates at costs near or below the median in the C&I sector. CenterPoint Energy achieved its savings from their combination program which included engineering assistance, audits, training, and rebates for heating systems and maintenance. Xcel Energy achieved most of its savings from its custom and boiler programs. Interstate P&L (MN) also achieved most of its savings from its custom programs, however with only six customers, a unique market/participant profile. Costs for each of CenterPoint Energy's and Xcel Energy's programs are well below the median.

Table 3-34: Natural Gas Savings for C&I Programs as % of Sales

C&I Program/Measures	CenterPoint Energy (MN)	Interstate P&L (MN)	Xcel Energy (MN)
Heating			2.06%
Combination	1.27%	0.04%	
Custom Rebates		1.71%	0.36%
Energy Audit			
New Construction			0.12%
Total C&I Savings (MCF)	759,112	16,024	768,986
Annual C&I Sales (MCF)	59,787,078	912,245	30,220,124
C&I Savings as % of C&I Sales	1.27%	1.76%	2.54%

Table 3-35: Costs of C&I Natural Gas Savings by Type of Program

C&I Program/Measures	CenterPoint Energy (MN)	Interstate P&L (MN)	Xcel Energy (MN)
Heating			$2.06
Combination	$4.71	$25.72	
Custom Rebates		$18.10	$4.61
Energy Audit			
New Construction			$5.62
Total C&I Savings (MCF)	759,112	16,024	768,986
Total Costs ($M)	3.8	0.3	2.2
Costs of C&I Savings ($/MCF)	$5.00	$18.46	$2.84

Residential Sector

Table 3-36 shows the median result for spending, savings, and costs for the residential sector for the eighteen reviewed organizations.

Table 3-36: Medians for Residential Results

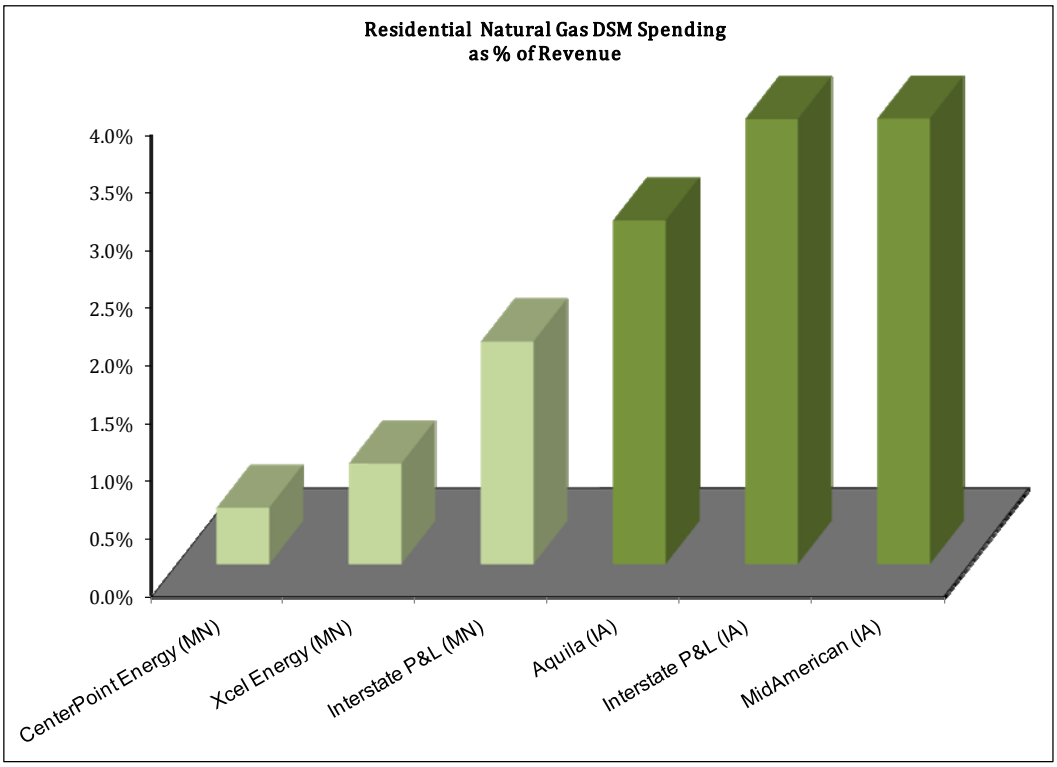
Spending as % of Revenue	Energy Savings as % of Sales	Cost of Energy $/Mcf	First Year Cost of Savings $/Mcf
2.5%	1.0%	$11.92	$24.93

Residential Natural Gas DSM Spending

Natural gas DSM spending in the residential sector as a percentage of annual revenue of retail energy sales ranges from 0.5% to 3.9%, with the median at 2.5% (Figure 3-32).

As in the C&I sector, Interstate P&L (IA) and MidAmerican (IA) have above median natural gas DSM spending as a percentage of sector revenue. Aquila (IA)'s natural gas DSM spending rate is also above the median. These three organizations also achieved above median energy savings rates.

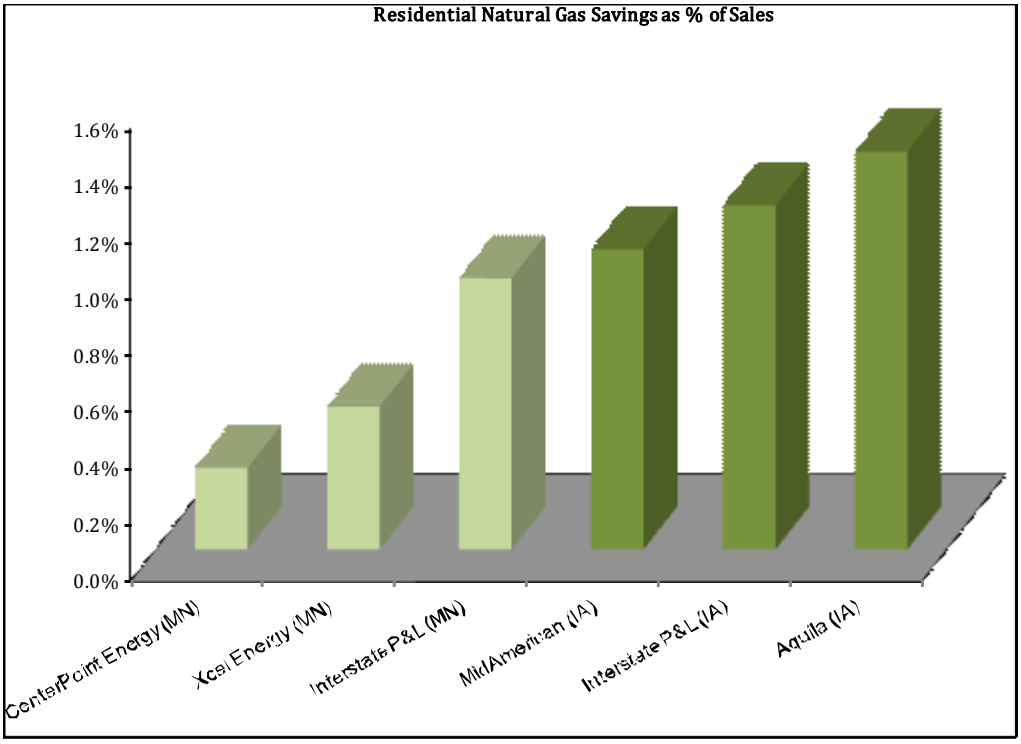
Figure 3-32: Residential Natural Gas DSM Spending as % of Revenue



Residential Natural Gas Savings

Figure 3-33 and Figure 3-34 show the residential energy savings as a percentage of sales and the cost of these savings across the various organizations. Energy savings as a percentage of sales ranges from 0.3% to 1.4% with the median at 1.0%. The three organizations from Iowa achieved above median energy savings as a percentage of sales.

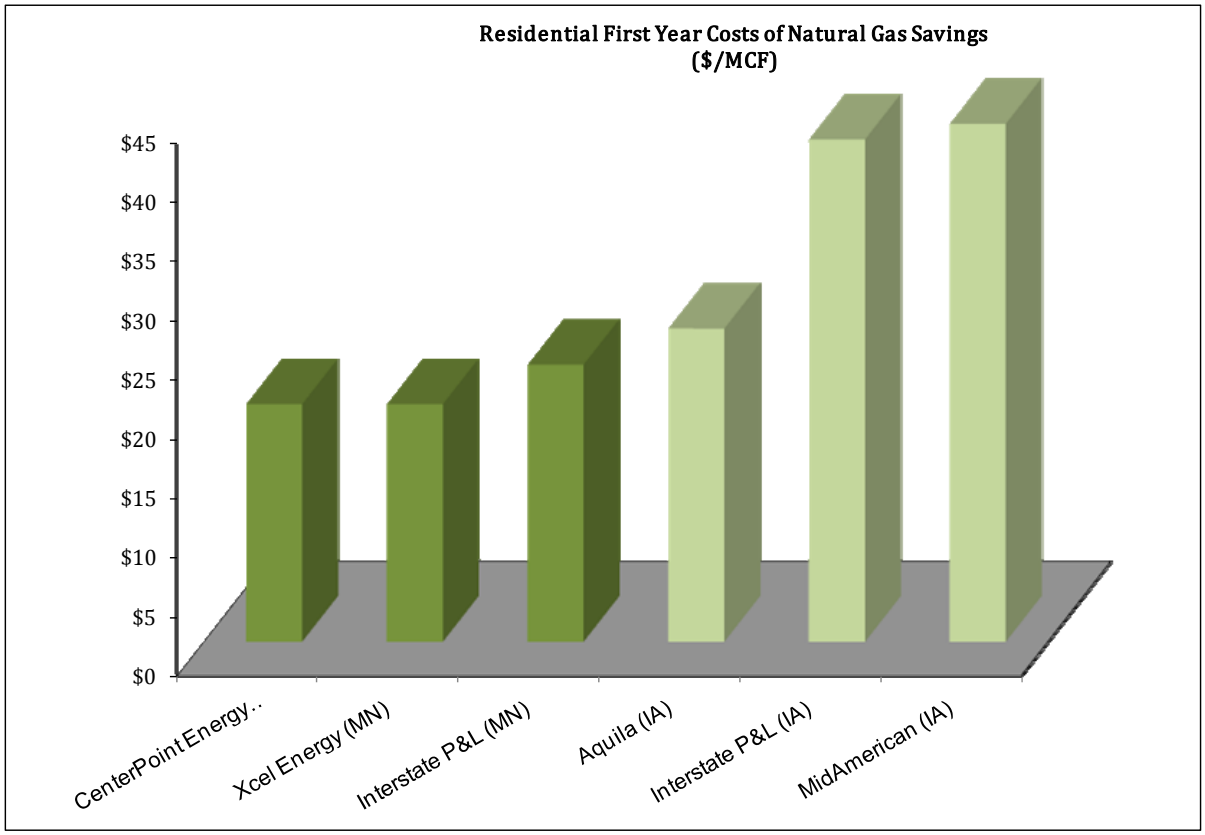
Figure 3-33: Residential Natural Gas Savings as % of Annual Sales First Year



Cost of energy savings ranges widely from $20.07/MCF to $43.74/MCF with the median at $24.93/MCF.

As in the C&I sector, CenterPoint Energy and Xcel Energy achieved below median costs of energy savings in the residential sector, CenterPoint Energy achieving the lowest costs/MCF. Interstate P&L (MN) also achieved residential energy savings below the median cost.

Figure 3-34: Residential Costs of Natural Gas Savings ($/MCF) First Year



The scatter plot shown in Figure 3-35 below illustrates where each organization falls relative to median energy savings and median costs. No organization achieved energy savings rates above median and at costs/MCF below median. The Iowa organizations achieved above median energy savings at above median costs, and the Minnesota organizations achieved below median energy savings at below median costs. This reflects the two states' regulatory environments. Interstate P&L (MN)'s savings rate and costs are close to the medians. Aquila (IA) achieved the highest rate of savings, 1.4%, at $26.45/MCF, costs above but close to the median.

Figure 3-35: Scatter Plot of Residential Natural Gas Savings and First Year Costs ($/MCF)

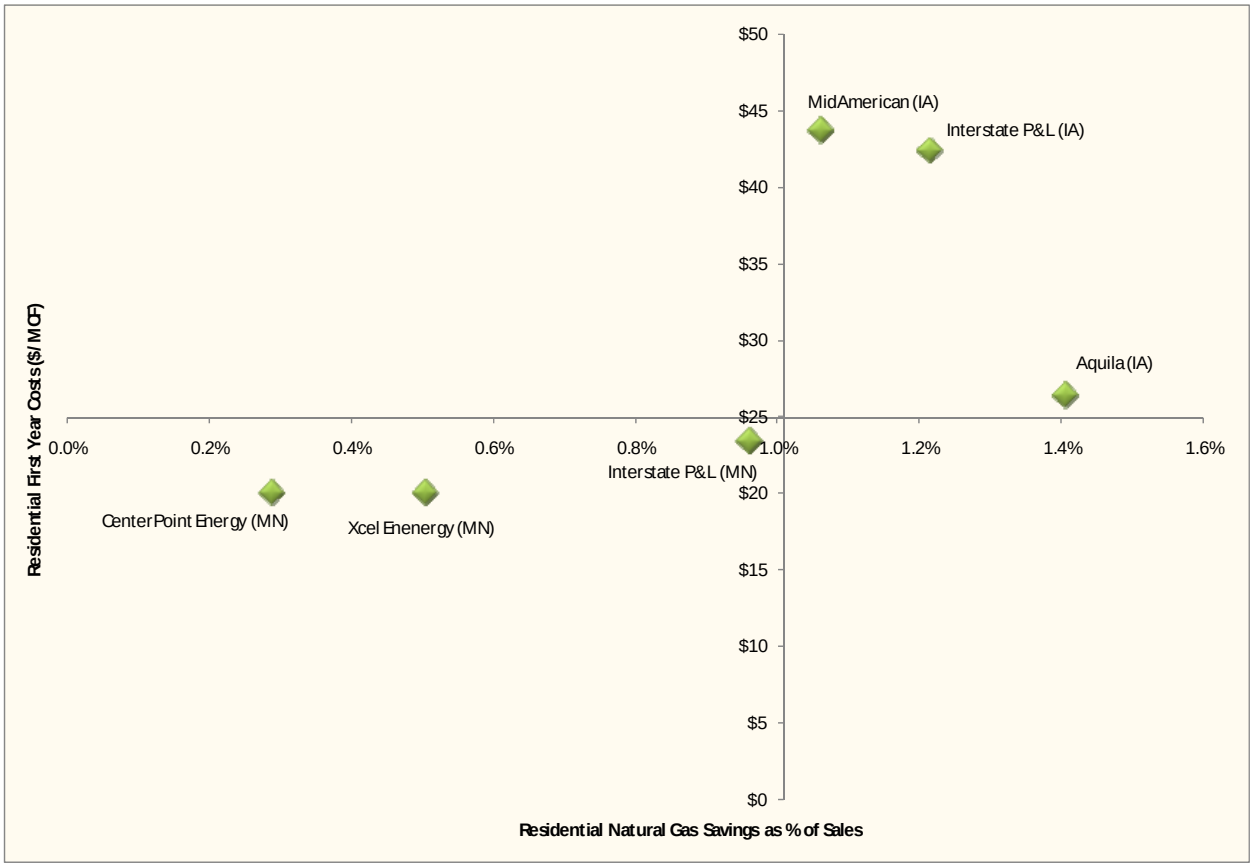


Table 3-37 and Table 3-38 below show the results and costs for Interstate P&L (MN) and Aquila (IA): the organizations that achieved the greatest savings rates at the lowest costs among organizations from their respective state.

Interstate P&L (MN) achieved most of its savings through its two combination programs, Residential Equipment Incentives Project and Residential Consumer Services and Audit Project. The Equipment Incentives program offered prescriptive rebates for high efficiency space heating, water heating (including appliances), and building envelope measures; most of the program's savings were earned from heating measures. The Services and Audit program offered efficiency education through multiple channels and energy audits; most of the program's savings were earned from attic insulation and water heater measures. Interstate P&L (MN)'s two combination programs achieved significant savings below median costs.

For Aquila (IA), the programs that achieved most of its savings were those that implemented measures similar to those of Interstate P&L (MN)'s high-saving programs: heating, building envelope, and energy audits. These Aquila (IA) programs include Furnace Rebate, Envelope Measures Retrofit, Setback Thermostat and Furnace Maintenance, and Residential Audit. Most of these programs achieved energy savings at costs just above the median, except Setback Thermostat and Furnace Maintenance which achieved very low first year costs, about $5/MCF.

Table 3-37: Natural Gas Savings for Residential Programs as % of Energy Sales

Residential Program/Measures	Interstate P&L (MN)	Aquila (IA)
Heating		0.71%
Building Envelope		0.38%
Water Heating		0.01%
Energy Audit		0.11%
Combination	0.91%	
Low Income	0.05%	0.08%
New Construction		0.08%
Total Res Savings (MCF)	7,764	138,014
Annual Res Sales (MCF)	809,836	9,816,211
Res Savings as % of Res Sales	0.96%	1.41%

Table 3-38: Costs of Residential Natural Gas Savings by Type of Program

Residential Program/Measures	Interstate P&L (MN)	Aquila (IA)
Heating		$15.22
Building Envelope		$30.23
Water Heating		$27.71
Energy Audit		$33.01
Combination	$20.63	
Low Income	$70.89	$67.85
New Construction		$40.14
Total Res Savings (MCF)	7,764	138,014
Total Costs ($M)	0.2	3.7
Costs of Res Savings ($/MCF)	$23.40	$26.45

3.4 Summary and Conclusion

For the 22 electricity DSM programs reviewed, the overall median energy savings as a percentage of annual sales for 2006 is 0.8%, and the median first year costs for energy savings is $0.18/kWh, but the organizations with the largest relative energy savings and below median costs achieved their energy savings at about 1.3% of annual sales. The results for demand savings as a percentage of peak demand are similar: the median savings is 0.6% of peak demand and the median cost is $836/kW, but the organizations with the largest relative peak demand savings and below median costs saved about 1.1% of peak demand.

The organizations with above median relative energy savings at costs at or below the median in the C&I sector, Interstate P&L (IA), Interstate P&L (MN), MidAmerican (IA), and Xcel Energy, achieved most of their energy savings with custom rebates, lighting, and new construction. These programs also provided most of the C&I peak demand savings, however Xcel Energy achieved significant peak demand savings with very low cost load management programs.

In the residential sector, several organizations achieved high energy savings as a percentage of sales at low costs: BC Hydro, Efficiency VT, MidAmerican (IA), MN Power, NSTAR, PG&E, SCE, SDG&E. These savings were achieved with programs that combined a range of product incentives and services (and, in one case, an energy audit service), the majority of activity and impacts of these programs being lighting measures. Delivery approaches which leverage community and national resources may have been especially cost-effective for MN Power and the California IOUs.

High rates of peak demand savings at low costs were achieved in the residential sector by SCE, MidAmerican (IA), PG&E, Xcel Energy, and Duke Energy Indiana. Xcel Energy and Duke Energy Indiana achieved most of their peak demand savings by direct load control programs at about $200/kW, well below the median costs; PG&E and SCE achieved most of their peak demand savings with low cost combination programs; and MidAmerican (IA) achieved most of their peak demand savings with low cost direct load control, energy audit, and new construction programs.

Most of the benchmarked organizations have been conducting electricity DSM programs for an extended period. Over the time these organizations have been conducting electricity DSM programs, they have realized savings from a lot of the “low hanging fruit” among DSM measures, such as T12 lighting system conversions to T8 systems.

For the 6 natural gas DSM programs reviewed, the overall median energy savings as a percentage of annual sales for 2006 is 1.0%, and the median costs first year costs for energy savings is $22/MCF, but the organizations with the largest relative energy savings and below median costs achieved their energy savings at about 1.4% of annual sales.

In the C&I sector, the organizations that achieved above median energy savings below median costs, CenterPoint Energy, Interstate P&L (MN), and Xcel Energy, did so with custom programs and boiler programs.

In the residential sector, the top performing organizations, Aquila (IA) and Interstate P&L (MN), achieved their savings with low cost heating measures such as programmable thermostats and furnace maintenance.

4 BASELINE CONSUMPTION PROFILES AND INITIAL BUILDING SIMULATION MODEL SPECIFICATIONS

In this section, we describe the development of baseline market profiles, baseline technology profiles, and initial building simulation model specifications.

4.1 Baseline Market Profiles

We developed profiles for each sector—residential and non-residential—for the state of Kansas. Key data sources included:

- State-level electricity sales data by sector from Form EIA-861, Annual Electric Power Industry Report, file 2. http://www.eia.doe.gov/cneaf/electricity/page/eia861.html
- State-level natural gas sales data by sector from EIA http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_SKS_a.htm
- Energy Insights' proprietary Energy Market Profiles data are presented and described in Appendix A.
- Results from Midwest Energy's 2007 Residential Appliance Saturation Survey, provided in a PowerPoint file by Michael Volker via email.
- Westar Energy 2006 Residential Appliance Saturation Report Final Draft-6-30-07
- Westar Energy 2006 Commercial Appliance Saturation Report Draft-7-11-07

The resulting profiles for each sector and fuel are shown below.

Table 4-1: Residential Market Profile – Electricity

End Use	Share (% of HH)	UECs (kWh/HH)	Intensity (kWh/HH)	Kansas Sales (GWh)
Space Heating	13.1%	6,843	899	1,083
Central Cooling	76.4%	1,954	1,493	1,797
Room Cooling	19.4%	779	151	182
Both (CAC & room)	0.6%	1,673	11	13
Water Heating	22.6%	2,588	585	704
Refrigeration	99.9%	929	928	1,117
Freezers	64.2%	934	599	722
Cooking	71.9%	439	315	380
Clothes Washers	91.5%	105	96	115
Clothes Dryers	80.3%	1,040	835	1,005
Dishwashers	62.9%	122	76	92
Personal Computers	78.5%	261	205	247
Lighting	100.0%	1,998	1,998	2,405
Color Televisions	100.0%	772	772	929
Furnace Fans	81.1%	332	269	324
Other Uses	100.0%	1,995	1,995	2,401
Total			**11,217**	**13,503**

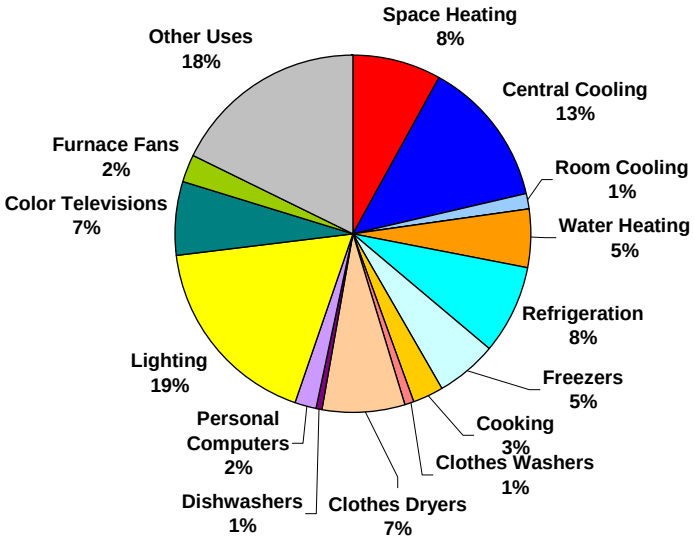


Table 4-2: Residential Market Profile – Natural Gas

End Use	Share (% of HH)	UECs (kBtu/HH)	Intensity (kBtu/HH)	Kansas Sales (BBtu)
Space Heating	71.9%	67,801	48,767	42,047
Water Heating	69.1%	21,064	14,559	12,553
Cooking	31.5%	6,356	1,999	1,724
Clothes Dryers	12.6%	4,096	515	444
Other Uses	15.1%	2,374	360	310
Total			**66,200**	**57,078**

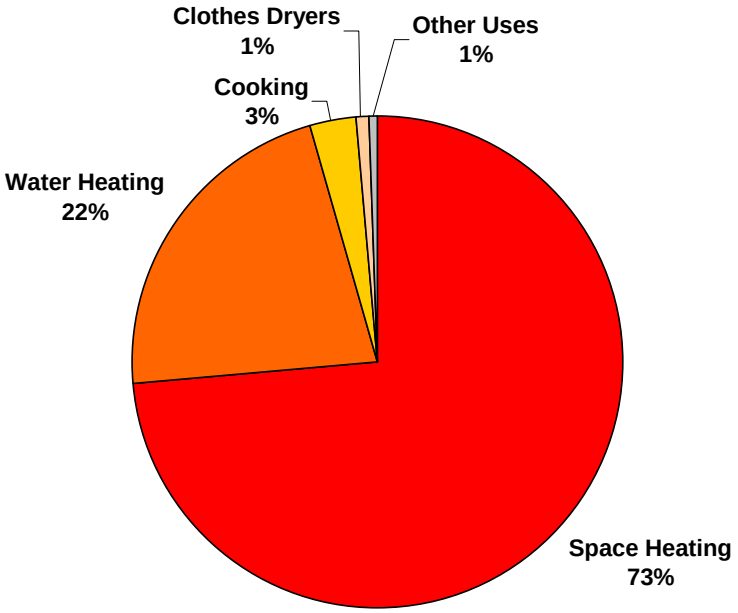


Table 4-3: Commercial Market Profile – Electricity

End Use	Share (% of sq.ft.)	UECs (kWh/sq.ft.)	Intensity (kWh/sq.ft.)	Kansas Sales (GWh)
Space Heating	17.3%	4.48	0.77	724
Space Cooling	63.6%	2.68	1.71	1,594
Water Heating	35.3%	1.31	0.46	430
Ventilation	100.0%	0.65	0.65	607
Cooking	13.5%	0.74	0.10	94
Lighting	100.0%	4.49	4.49	4,199
Refrigeration	41.3%	2.16	0.89	835
Office Equipment (PC)	89.4%	0.56	0.50	464
Office Equip. (non-PC)	100.0%	1.04	1.04	976
Other Uses	100.0%	5.20	5.20	4,862
Total			**15.82**	**14,786**

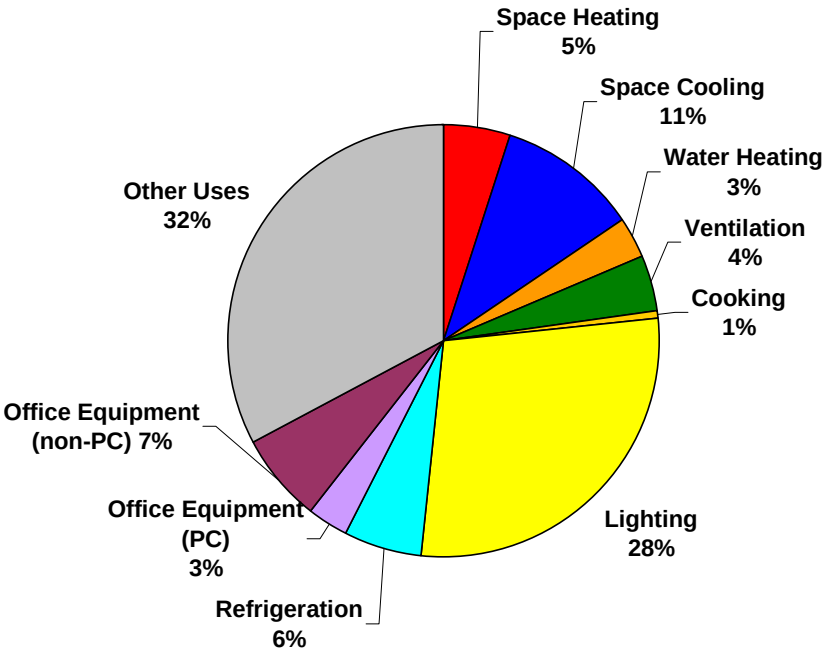


Table 4-4: Commercial Market Profile – Natural Gas

End Use	Share (% of sq.ft.)	UECs (kBtu/sq.ft.)	Intensity (kBtu/sq.ft.)	Kansas Sales (BBtu)
Space Heating	71.1%	30.62	21.76	12,737
Space Cooling	3.8%	5.74	0.22	129
Water Heating	48.5%	11.70	5.68	3,324
Cooking	13.7%	17.98	2.46	1,441
Other Uses	8.4%	201.90	16.93	9,910
Total			**47.06**	**27,540**

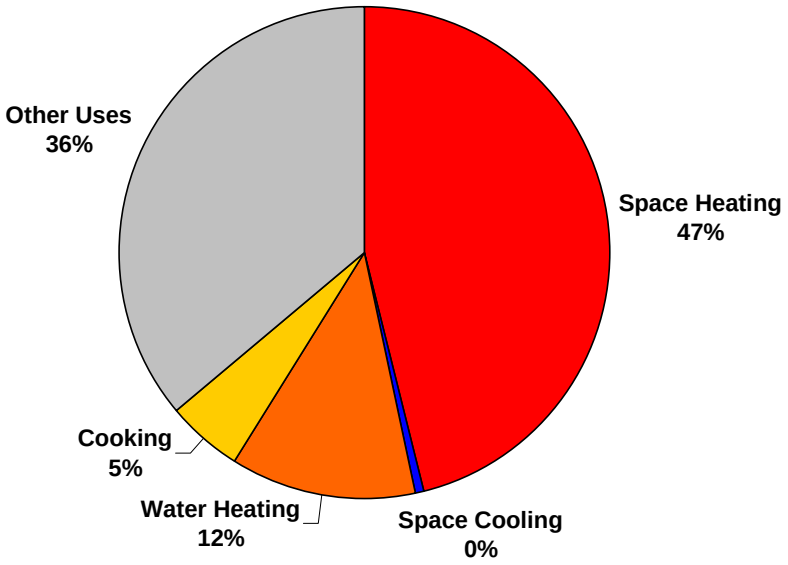


Table 4-5: Industrial Market Profile – Electricity

End Use	Midwest Electricity Shares	Kansas Sales (GWh)
Indirect Uses-Boiler Fuel	0.5%	62
Process Heating	13.8%	1,587
Process Cooling and Refrigeration	6.4%	731
Machine Drive	50.3%	5,769
Electro-Chemical Processes	7.1%	816
Other Process Use	0.5%	59
Facility HVAC	8.6%	990
Facility Lighting	7.6%	873
Other Facility Support	1.7%	195
Onsite Transportation	0.2%	22
Conventional Electricity Generation	0.0%	-
Other Non-process Use	0.2%	21
End Use Not Reported	2.9%	338
Total	**100.0%**	**11,462**

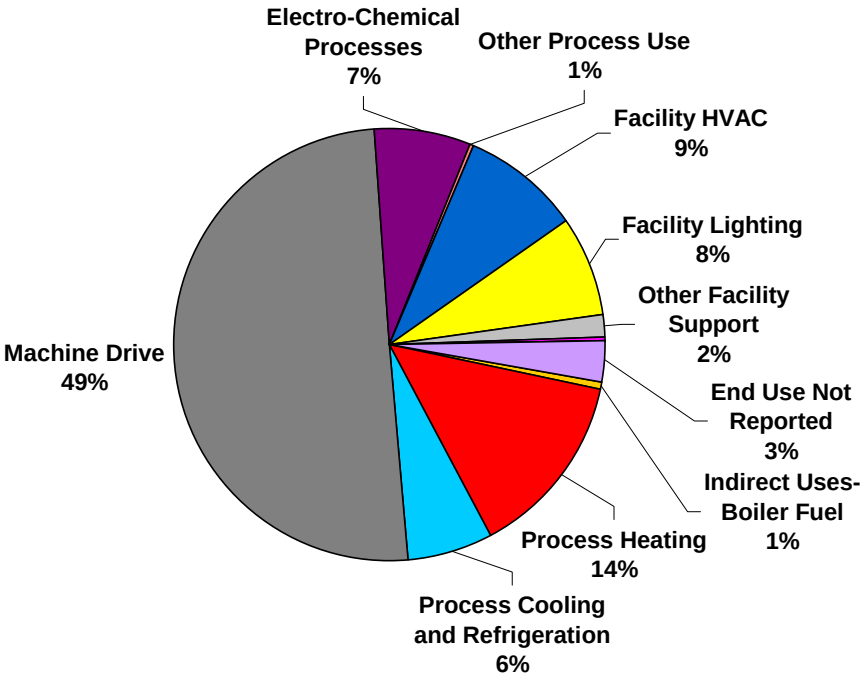
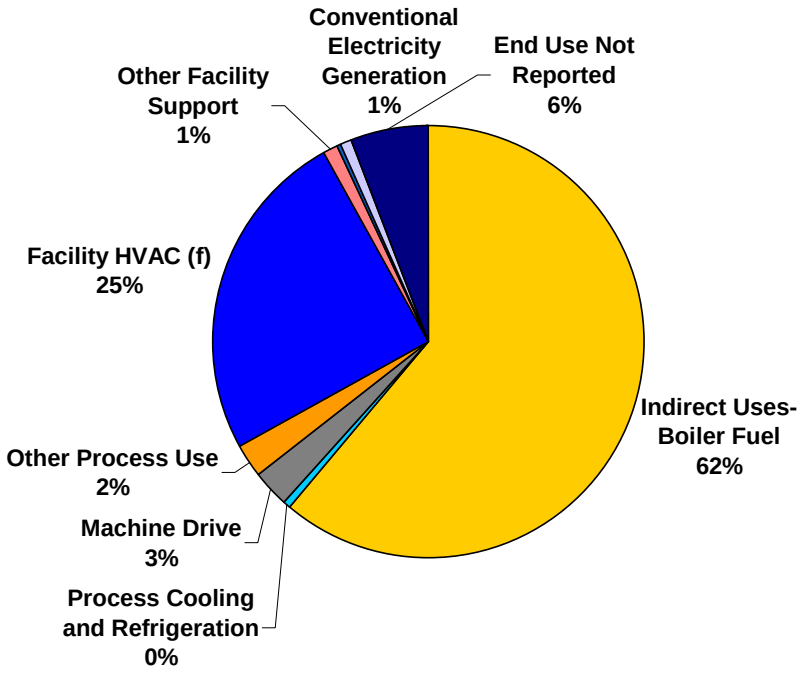


Table 4-6: Industrial Market Profile – Natural Gas

End Use	Midwest Natural Gas Shares	Kansas Sales (BBtu)
Indirect Uses-Boiler Fuel	61.2%	63,970
Process Cooling and Refrigeration	0.4%	430
Machine Drive	2.9%	3,080
Other Process Use	2.4%	2,504
Facility HVAC	25.1%	26,216
Other Facility Support	1.2%	1,234
Onsite Transportation	0.0%	40
Conventional Electricity Generation	0.8%	863
Other Non-process Use	0.0%	-
End Use Not Reported	6.0%	6,232
Total	**100.0%**	**104,569**



4.2 Baseline Technology Profiles

To estimate the potential for energy savings, it is desirable to have a snapshot of the appliance and equipment inventory in the area of study, including type of equipment and efficiency level. In absence of primary market research, we must rely on secondary sources, none of which provides adequate information by itself. For example, the EIA surveys, RECS and CBECS, have some information about technologies used in residential and non-residential buildings and the age of appliances and equipment which we can use to infer efficiency levels. Other sources, including publicly-available utility studies, statewide studies, and research papers, also have some limited information about efficiency levels. We used a variety of sources, together with our experience and judgment, to develop technology profiles for the key end uses presented below. These sources include:

- Residential Energy Consumption Survey, Energy Information Administration
- Commercial Building Energy Consumption Survey, Energy Information Administration,
- 2007 Buildings Energy Databook, Department of Energy, Energy Efficiency and Renewable Energy, September 2007.
- Assessment of Long-Term Electric Energy Efficiency Potential in California's Residential Sector, PIER Project Report, prepared by Itron, February 2007.
- 2005 California Statewide Residential Lighting and Appliance Efficiency Saturation Study, prepared by RLW Analytics, August 2005.
- California Residential Efficiency Market Share Tracking (HVAC), prepared by Itron, December 2006.
- California Residential Efficiency Market Share Tracking (Appliances), prepared by Itron, October 2006
- California Statewide Residential Appliance Saturation Study, prepared by KEMA-Xenergy, Itron, RoperASW, June 2004.
- 2007 Residential Appliance Saturation Survey, Midwest Energy
- 2006 Characteristics of New Housing, U.S. Census Bureau

Table 4-7: Residential Technology Shares

End Use	Technology	Technology Share	Fraction not efficient
Cooling	Heat pump	1.0%	70%
	Central AC	81.0%	95%
	Room AC	14.0%	63%
	Other	2.0%	
Space heat	Heat pump	1.0%	70%
	Electric furnace	11.0%	0%
	Electric other	1.0%	0%
	Gas furnace	70.0%	65%
Lighting	Incandescent	85%	
	CFL	3%	
	Halogen	3%	
	Fluorescent	9%	50%
Water Heater	Electric		86%
	Gas		67%
Appliances	Dishwasher		6%
	Clothes Washer		44%
	Freezer		57%
	Clothes Dryer		60%
	Refrigerator		68%

Table 4-8: Non-Residential Technology Shares

End Use	Technology	Technology Share	Fraction not efficient
Space heat	Heat pump	9.5%	88%
	Other electric	7.5%	0%
	Gas furnaces	43.2%	90%
	Gas boilers	27.8%	90%
Cooling	Heat pumps	2.7%	88%
	Packaged DX	46.2%	88%
	Chiller	14.0%	88%
	Other	1.1%	88%
Water heating	Electric		88%
	Gas		88%
Lighting	Incandescent	10%	100%
	Fluorescent	70%	60%
	CFL	5%	0%
	HID	10%	0%
	Other lighting	5%	0%

4.3 Building Simulation Model Specifications

To estimate the savings from installing high-efficiency equipment, we used the eQuest building simulation model. eQuest is a widely used commercial building simulation model based on the DOE-2 model. The starting point for the analysis was a set of prototypes that are calibrated to the market and technology profiles presented above. We calibrated the models by adjusting the equipment inventories in the eQuest files to be consistent with the baseline annual energy use by end use and technology profiles. This involved adjustments to five end uses: space heating, space cooling, water heating, interior lighting, and miscellaneous use.

5 DSM MEASURE CHARACTERIZATIONS

This chapter describes the DSM measures analyzed for this study and the methods used to estimate savings. The chapter is organized by customer sector and major-end uses.

5.1 Residential DSM Measure Characterizations - Electricity

This section describes the residential electric DSM measures analyzed for this study and the methods used to estimate savings. The section is organized by major end-uses such as HVAC, building shell, lighting, and domestic hot water.

Domestic Hot Water Measures – Electric

In the Kansas utility service territories most water heaters are gas-fired, but about 15% are powered by electricity. Savings can occur through reducing the amount of hot water consumed or by improving the efficiency of the water heating/storage/distribution process. Total hot water energy use is based on a the Baseline Market Profiles described in the prior section of this report and a 2000 Central Florida study[33] modified to reflect the cooler ground water temperatures found in Kansas. All savings estimates were determined using engineering methods such as steady-state heat transfer and mass flow. Measure lives are based on the Database for Energy Efficient Resources (DEER).[34]

Efficient Water Heaters

Traditional electric water heaters have an overall efficiency of about 90% including standby and distribution losses. High efficiency units achieve 95% efficiency with improved insulation and heat traps that minimize convection into under insulated distribution pipes. The savings estimate for the high-efficiency unit is calculated from the total hot water energy use and the unit efficiencies.

Heat Pump Water Heaters

Heat pump water heaters use compressed refrigerants to extract heat from ambient air (or water) and move that heat to stored hot water. During warm weather these machines can move 4 units of heat for every one comparable unit of input energy, thus achieving a coefficient of performance (COP) up to 4.0. COP decreases as ambient air temperature decreases. At about 10-20°F, heat pumps become ineffective. At cold ambient temperatures, traditional electric resistance heating elements back-up the heat pump compressor. Savings was determined using engineering

[33] Masiello, John and Danny Parker, *Factors Influencing Water Heating Energy Use and Peak Demand in a Large Scale Residential Monitoring Study*, Florida Solar Energy Center, 2000.

[34] The Database for Energy Efficient Resources (DEER), sponsored by the California Energy Commission and the California Public Utilities Commission, is a widely used reference for well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL).

estimates with a linear relationship between COP and outdoor air temperature until 20°F at which point we assumed electric resistance heat would take over.

Low Flow Showerheads

Low flow showerheads use an orifice plate inside the fixture to restrict the water flow to a maximum 2.5 gallons per minute versus a 3.5 gallon per minute permitted with standard new showerheads. Water flow from older showerheads typically exceeds 5.0 gallons per minute. Engineering methods were used to estimate savings between the 2.5 and 3.5 gpm showerheads assuming one seven-minute shower per occupant per day.

Faucet Aerators

Faucet aerators introduce air into the water as it leaves the faucet. The result is perceived full flow at a much reduced actual flow rate. We estimated that a faucet aerator reduces flow from 2 gallons per minute to 1 gallon per minute during five minutes of water use per occupant per day.

Hot Water Pipe Insulation

Pre-formed segments of foam insulation are placed around hot water distribution pipes to minimize heat loss. While useful for the entire length of hot water piping, it is most cost-effective in the first 5-10 feet of pipe extending from the hot water heater. Engineering estimates of steady state heat loss from the pipes to conditioned indoor air were used to estimate savings.

Drain Water Heat Recovery

These systems recover some of the heat from drain pipe hot water. Savings and costs are based on US Department of Energy information and manufacturer data.[35]

Table 5-1: Residential Hot Water Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
Faucet Aerators	No Faucet Aerators	RET	99.95	21.99	9	$12.69	$7.12
Heat Pump Water Heater	Electric water heater, EF=0.88	ROB/NEW	2320.64	510.54	10	$1,410.85	$1,288.02
Pipe Wrap	No pipe wrap	RET	133.26	29.32	15	$2.81	$0.37
Low Flow Showerhead	Standard showerhead	RET	133.26	29.32	10	$37.95	$22.95
High Efficiency Water Heater	Electric water heater, EF=0.88	ROB/NEW	179.12	39.41	15	$72.30	$72.30
Drain Water Heat Recovery	None	RET/NEW	540.00	119.00	20	$590.00	$400.00

[35] http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13040 and http://gfxtechnology.com/ELWH.pdf

Residential HVAC Measures – Electric

In the State of Kansas, most space heating is by natural gas furnace, but about 15% of residential customers report electricity as their primary heat energy source, both for electric resistance and via heat-pumps. Savings can occur through reducing the amount of heating and cooling required by improving the building shell or by improving the efficiency of the equipment and/or distribution process.

Since HVAC savings are climate dependent, most of the savings for the following measures were determined by modifying the baseline simulation model first to reflect the less efficient option then to reflect the improved efficiency measure. Savings is the difference between the two. Incremental costs are mostly based on the DEER database.

Energy Star Residential Room Air Conditioners

Energy Star room air conditioners must be at least 10% more efficient than standard U.S. models which are defined as units with a minimum EER rating of 9.4-10.8 depending upon the size and type of the unit.[36] Minimum efficiency standards for room air conditioners range from 8.5 EER to 9.8 EER depending on the unit size and type. Savings is determined by simulation models improving equipment from 9.5 to 10.7 EER.

Energy Star Residential Air Source Heat Pumps

Energy Star air source heat pumps are units with minimum ratings of 14 SEER, EER ratings of 11.0-11.5, and heating system performance factors of 8.0-8.2 or higher[37]. Since 2006, minimum efficiency standards for heat pumps are 13 SEER and 7.7 HSPF. Savings is determined by modeling SEER 18 equipment versus the minimum efficiency.

High Efficiency Central Air Conditioning

Since 2006, the minimum efficiency standard for central air conditioners is 13 SEER. More efficient models are available in the market. Savings is determined by modeling SEER 18 equipment versus the minimum efficiency.

HVAC Diagnostic Repair, Testing, and Maintenance

Many residential and non-residential HVAC systems are not operating as efficiently as possible due to inadequate maintenance. This package of services includes ensuring proper refrigerant charge, lubrication, cleanliness and fan operation. The savings estimate assumes that the tune-up improves efficiency by 10% which is consistent with refrigerant over-charge and undercharge savings.

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[36] See US DoE Energy Star web site: http://www.energystar.gov/index.cfm?c=roomac.pr_room_ac .

[37] *Ibid*.

HVAC Duct Sealing, Operations and Maintenance

Many HVAC ducts are not sealed well and leak conditioned air into conditioned and unconditioned spaces such as basements and attics failing to properly deliver heating and cooling to the occupied areas of the home. Duct sealing reduces such heat loss and reduces fan power. Savings estimates are determined by modeling well sealed ductwork vs. systems with typical leakage, about 5%.

Ceiling Insulation

Ceiling insulation includes both insulating un-insulated roof areas and adding insulation to under-insulated roof areas. In Kansas, the recommended amount of ceiling insulation is an R-value of about R-38[38]. Savings is determined by modeling.

Wall Insulation

Wall insulation is most cost-effective when insulating un-insulated wall areas. In Kansas, the recommended amount of wall insulation is R-13 to R-19 with the greater insulation recommended in the northwest portion of the state[39]. Savings is determined by modeling.

Floor Insulation

Many residential basement floors are un-insulated, which results in heat loss to the ground underneath the home. Floor insulation reduces this heat loss. Savings is determined by modeling un-insulated basements and basements with R-11 walls.

Efficient Windows

Efficient windows are generally considered to be either triple paned windows, windows with a radiant barrier to reflect heat back into the conditioned space, or windows with low "shading coefficients". Reducing the shading coefficients of glass will reduce the amount of solar heat gain into the building. This reduced solar gain will decrease the cooling load for the building, but may increase the heating load. On the other hand these windows usually have a higher R-value than the windows they replace, thus heating energy can decrease. Savings is determined by modeling.

Comprehensive Shell Air Sealing

This measure includes caulking, weather stripping, and sealing other visible cracks and penetrations in the building shell. Practically speaking a house should be able to breathe to purge contaminants so a lower limit of 0.35 air-changes per hour (ACH) is advised without the addition of mechanical ventilation. Savings is determined by modeling 0.5 ACH versus 0.35 ACH.

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[38] *International Energy Efficiency Code 2006*, International Code Council, 2006.

[39] *Ibid*.

Table 5-2: Residential Electric Space Heating and Cooling Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
Central A/C	13 SEER CAC	ROB/NEW	405.00	452.00	18	$1,213.10	$596.00
Room A/C	Standard Room AC	ROB/NEW	232.00	245.00	12	$80.00	$30.00
Heat Pump	13 SEER HP	ROB/NEW	895.00	732.00	18	$1,302.10	$685.00
Duct Sealing and Repair - CAC	Supply/return/OA leakage 20/16/4% of AHU flow	RET	653.00	325.00	15	$500.00	$500.00
Duct Sealing and Repair - HP	Supply/return/OA leakage 20/16/4% of AHU flow	RET	2428.00	380.00	15	$500.00	$500.00
HVAC Diagnostics - CAC	R19 Insulation Batt	RET	310.00	418.00	10	$90.00	$25.00
HVAC Diagnostics - HP	No Night Ventilation/Economizer	RET	931.00	451.00	10	$90.00	$25.00
HE Windows - CAC Only	U-0.82 / SHGC-0.79 (clear) Window	RET	66.00	38.00	25	$1,561.00	$1,361.00
HE Windows - El Heat w/CAC	U-0.82 / SHGC-0.79 (clear) Window	RET	535.00	38.00	25	$1,561.00	$1,361.00
HE Windows - Heat Pump	U-0.82 / SHGC-0.79 (clear) Window	RET	477.00	0.00	25	$1,561.00	$1,361.00
Ceiling Insulation (R-0 to R-38) -El Heat	R0 Insulation Batt	RET	9561.00	0.00	25	$1,720.00	$1,400.00
Ceiling Insulation (R-0 to R-38) - Heat Pump	R0 Insulation Batt	RET	6560.00	0.00	25	$1,720.00	$1,400.00
Ceiling Insulation (R-19 to R-38) -El Heat	R19 Insulation Batt	RET	677.00	0.00	25	$1,080.00	$760.00
Ceiling Insulation (R-19 to R-38) - Heat Pump	R19 Insulation Batt	RET	414.00	0.00	25	$1,080.00	$760.00
Wall Insulation (R-0 to R-19) -El Heat	R0 Insulation Batt	RET	4575.00	0.00	25	$595.00	$275.00
Wall Insulation (R-0 to R-19) - Heat Pump	R0 Insulation Batt	RET	2235.00	0.00	25	$595.00	$275.00
Floor Insulation (R-0 to R-19) -El Heat	R0 Insulation Batt	RET	4417.00	0.00	25	$1,080.00	$760.00
Floor Insulation (R-0 to R-19) - Heat Pump	R0 Insulation Batt	RET	2402.00	0.00	25	$1,080.00	$760.00
Infiltration Reduction - CAC Only	One ACH	RET	225.00	32.00	10	$175.00	$175.00
Infiltration Reduction - CAC w/El Heat	One ACH	RET	3369.00	32.00	10	$175.00	$175.00
Infiltration Reduction - Heat Pump	One ACH	RET	2081.00	9.00	10	$175.00	$175.00

Lighting Measures – Residential

Each of the residential energy efficient lighting options is some form of replacement of incandescent lighting with compact fluorescent lamps (CFLs). Savings calculations are entirely engineering estimates using rated input Watts and hours of operation, and are based on DEER assumptions of hours of operation by type of lamp and base wattage by type of CFL. The DEER methodology has a small adjustment for interactive effects and for what is known as an "in-use" factor. The "in-use" factor is a percentage of total CFLs that may be provided in a program that are actually installed and used. Costs are based on the DEER database.

Compact Fluorescent Light Bulbs and Hard-Wired Fixtures (CFLs):

Compact fluorescent lamps are designed to replace standard incandescent lamps. They are approximately four times more efficient than incandescent light sources. The lamps come in two configurations: screw-in and hard-wired. The screw-in lamps are designed to directly replace screw-in incandescent lamps with the CFL ballast in the screw-in base. The hard-wired configuration has the lamp and ballast separate and only a CFL lamp (without ballast) can be installed into the fixture. Several different wattage ranges are included in the analysis. They are modeled in generic groups as follows:

- **9-16W Screw-in CFL (RET, NEW)**: a 13 Watt <=800 Lumens - screw-in CFL replacing a 40W Incandescent
- **9-16W Screw-in CFL (RET, NEW)**: a 13 Watt >=800 Lumens - screw-in CFL replacing a 60W Incandescent
- **17-24W Screw-in CFL (RET, NEW)**: a 20 Watt - screw-in CFL replacing a 75W Incandescent
- **25-34W Screw-in CFL (RET, NEW)**: a 30 Watt - screw-in CFL replacing a 100W

Incandescent

- **Over 34W Screw-in CFL (RET, NEW)**: a 40 Watt - screw-in CFL replacing a 120W Incandescent
- **9-16W pin-based CFL (RET, NEW)**: a 13 Watt <=800 Lumens - pin based CFL replacing a 40W Incandescent
- **9-16W pin-based CFL (RET, NEW)**: a 13 Watt >=800 Lumens - pin based CFL replacing a 60W Incandescent
- **17-24W pin-based CFL (RET, NEW)**: a 20 Watt - pin based CFL replacing a 75W Incandescent
- **25-34W pin-based CFL (RET, NEW)**: a 30 Watt - pin based CFL replacing a 100W Incandescent
- **35-44W pin-based CFL (RET, NEW)**: a 40 Watt - pin based CFL replacing a 120W Incandescent
- **45-54W pin-based CFL (RET, NEW)**: a 55 Watt - pin based CFL replacing a 200W Incandescent
- **Over 54W pin-based CFL (RET, NEW)**: a 65 Watt - pin based CFL replacing a 200W Incandescent
- **9-16W Screw-in CFL - Outdoor (RET, NEW)**: a 13 Watt >=800 Lumens - screw-in - Outdoor CFL replacing a 60W Incandescent
- **17-24W Screw-in CFL - Outdoor (RET, NEW)**: a 20 Watt - screw-in - Outdoor CFL replacing a 75W Incandescent
- **25-34W Screw-in CFL - Outdoor (RET, NEW)**: a 30 Watt - screw-in - Outdoor CFL replacing a 100W Incandescent
- **Over 34W Screw-in CFL - Outdoor (RET, NEW)**: a 40 Watt - screw-in - Outdoor CFL replacing a 150W Incandescent
- **9-16W pin-based CFL - Outdoor (RET, NEW)**: a 13 Watt <=800 Lumens - pin based hardwire fixture - Outdoor CFL replacing a 40W Incandescent
- **9-16W pin-based CFL - Outdoor (RET, NEW)**: a 13 Watt >=800 Lumens - pin based hardwire fixture - Outdoor CFL replacing a 60W Incandescent
- **17-24W pin-based CFL - Outdoor (RET, NEW)**: a 20 Watt - pin based hardwire fixture - Outdoor CFL replacing a 75W Incandescent
- **25-34W pin-based CFL - Outdoor (RET, NEW)**: a 30 Watt - pin based hardwire fixture - Outdoor CFL replacing a 120W Incandescent
- **35-44W pin-based CFL - Outdoor (RET, NEW)**: a 40 Watt - pin based hardwire fixture - Outdoor CFL replacing a 120W Incandescent
- **45-60W pin-based CFL - Outdoor (RET, NEW)**: a 55 Watt - pin based hardwire fixture - Outdoor CFL replacing a 200W Incandescent
- **Over 60W pin-based CFL - Outdoor (RET, NEW)**: a 65 Watt - pin based hardwire fixture - Outdoor CFL replacing a 200W Incandescent
- **20W pin-based CFL Table Lamp (RET):** a 20W CFL Table Lamp - pin based CFL replacing a 75W Incandescent Table Lamp
- **25W pin-based CFL Table Lamp (RET):** a 25W CFL Table Lamp - pin based CFL replacing a 100W Incandescent Table Lamp
- **30W pin-based CFL Table Lamp (RET):** a 30W CFL Table Lamp - pin based CFL replacing a 120W Incandescent Table Lamp
- **55W pin-based CFL Table Lamp (RET):** a 55W CFL Table Lamp - pin based CFL replacing a 200W Incandescent Table Lamp

Torchieres:

Torchieres provide high lumen lighting and have traditionally been outfitted with halogen lamps of about 300W or incandescent lamps of about 200W. Analysis for this measure is represented by the configuration of a base 300W halogen torchiere replaced by a 55W CFL torchiere. The CFL torchiere is hard-wired.

Table 5-3: Residential Lighting Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
9-16W Screw-in CFL	60W Incandescent	ROB/NEW	36.13	3.43	9.4	$9.96	$6.18
17-24W Screw-in CFL	75W Incandescent	ROB/NEW	42.28	4.01	9.4	$11.79	$8.01
25-34W Screw-in CFL	100W Incandescent	ROB/NEW	53.81	5.10	9.4	$13.29	$9.51
Over 34W Screw-in CFL	150W Incandescent	ROB/NEW	84.56	8.02	9.4	$14.22	$10.44
9-16W pin-based CFL	60W Incandescent	RET/NEW	36.13	3.43	16	$21.66	$17.88
17-24W pin-based CFL	75W Incandescent	RET/NEW	42.28	4.01	16	$25.11	$21.34
25-34W pin-based CFL	120W Incandescent	RET/NEW	69.18	6.56	16	$30.05	$26.27
35-44W pin-based CFL	120W Incandescent	RET/NEW	61.50	5.83	16	$34.98	$31.20
45-54W pin-based CFL	200W Incandescent	RET/NEW	111.46	10.57	16	$42.38	$38.60
Over 54W pin-based CFL	200W Incandescent	RET/NEW	103.77	9.84	16	$47.31	$43.54
9-16W Screw-in CFL - Outdoor	60W Incandescent	ROB/NEW	47.86	0.00	7.1	$11.62	$7.84
17-24W Screw-in CFL - Outdoor	75W Incandescent	ROB/NEW	56.01	0.00	7.1	$12.56	$8.78
25-34W Screw-in CFL - Outdoor	100W Incandescent	ROB/NEW	71.28	0.00	7.1	$14.43	$10.65
Over 34W Screw-in CFL - Outdoor	150W Incandescent	ROB/NEW	112.02	0.00	7.1	$14.32	$10.55
9-16W pin-based CFL - Outdoor	60W Incandescent	RET/NEW	53.18	0.00	16	$21.66	$17.88
17-24W pin-based CFL - Outdoor	75W Incandescent	RET/NEW	62.23	0.00	16	$25.11	$21.34
25-34W pin-based CFL - Outdoor	120W Incandescent	RET/NEW	101.84	0.00	16	$30.05	$26.27
35-44W pin-based CFL - Outdoor	120W Incandescent	RET/NEW	90.52	0.00	16	$34.98	$31.20
45-60W pin-based CFL - Outdoor	200W Incandescent	RET/NEW	164.07	0.00	16	$42.38	$38.60
Over 60W pin-based CFL - Outdoor	200W Incandescent	RET/NEW	152.75	0.00	16	$47.31	$43.54
20W pin-based CFL Table Lamp	75W Incandescent Table Lamp	RET	45.77	4.46	16	$50.43	$50.43
25W pin-based CFL Table Lamp	100W Incandescent Table Lamp	RET	62.42	6.08	16	$61.13	$61.13
30W pin-based CFL Table Lamp	120W Incandescent Table Lamp	RET	74.90	7.29	16	$63.20	$63.20
55W pin-based CFL Table Lamp	200W Incandescent Table Lamp	RET	120.67	11.75	16	$122.96	$122.96
CFL Torchiere 70W	300W Halogen LAMP Torchiere	RET	191.41	18.63	9	$55.76	$55.76

Residential Refrigeration, Pool, and Appliance Measures – Electric

In the State of Kansas, all residential customers have at least one refrigerator and about 27% have two or more.[40] Minimum refrigerator and freezer efficiency has progressed substantially in the past 20 years, with older units consuming at least twice as much energy as comparable new machines. Savings calculations are based on the DEER database for all appliance measures.

Energy Star Refrigerators

Energy Star refrigerators must exceed current federal energy efficiency standards by at least 15% for full-size units, and 20% for compact size units[41].

[40] *2005 Residential Energy Consumption Survey*, U.S Department of Energy, Energy Information Administration, April 2008

[41] See Energy Star web site: http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators.

Remove Secondary Refrigerators and Freezers

Second refrigerators and freezers that customers own are often older and less efficient appliances. For example, the most common refrigerator sold in 1990 used between 60-70 kWh per cubic foot, compared to 2003, when the most common refrigerator sold used less than 30 kWh per cubic foot.[42]

Two-Speed Pool Pump and Motor:

This measure involves the replacement of a standard efficiency single speed pool pump and motor with a new high efficiency two-speed pump and motor. New efficient pumps and motors have high efficiency capacitor start, capacitor run motors, high efficiency permanent split capacitor motors, and newer closed face impeller pumps. It is assumed that the measure requires installation of a two-speed pump and motor with compatible time clock to insure that most of the pool pump run time is at low speed. The analysis was performed under the assumption that the two-speed pool pump and mother saves 1,400 kWh/year.

Energy Star Clothes Washers

Energy Star clothes washers must exceed the minimum energy efficiency standards by at least 37% and, since January 1, 2007, meet water efficiency criteria. The federal standard sets the minimum Modified Energy Factor (MEF) at 1.26, Energy Star sets the minimum MEF at 1.72 with a maximum water factor of 8.0. Savings are not climate dependent and are based on DEER estimates.

Energy Star Dishwashers

Energy Star dishwashers must exceed minimum energy efficiency standards by at least 41%. Energy Star, since January 1, 2007, requires a minimum Energy Factor (EF) of .65 for standard models and .88 for compact models. Savings are not climate dependent and are based on Energy Star estimates.

Clothes Dryer with Moisture Sensor

Clothes dryers with moisture sensors tend to run fewer hours than those without because they sense when the clothes are dry rather than operating a fixed period of time.

[42] Natural Resources Canada, "Energy Consumption of Major Household Appliances Shipped in Canada, Trends for 1990-2003 ", (NRCAN, Gatineau, QC, December 2005) p.8. U.S. and Canadian efficiency standards and availability very similar; therefore, we conclude that the old equipment stock that would be removed is similar as well.

Table 5-4: Residential Refrigeration, Pool Pump, and Appliances Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
Pool Pump - Two Speed	Inefficient Single Speed Pool Pump	ROB/NEW	1400.00	540.00	10	$539.30	$182.18
H.E. Refrigerator	Refrigerator: Side Mount Freezer without through-the-door ice. Fresh volume=18cf, Freezer volume=5cf	ROB/NEW	64.00	10.88	18	$98.38	$98.38
Refrigerator Recycling	Standard Refrigerator	RET	1946.00	300.00	10	$147.75	$0.00
Freezer Recycling	Standard Freezer	RET	1662.00	256.00	10	$147.75	$0.00
H.E. Clothes Dryer	Electric Clothes Dryer EF=3.01. Single Family, 416 dry cycles	ROB/NEW	48.00	18.30	13	$238.24	$238.24
H.E. Clothes Washer (El WH, El Dry)	MEF=1.04, 2.65 capacity, electric water heat and electric dryer	ROB/NEW	447.00	186.40	13	$592.77	$592.77
H.E. Clothes Washer (El WH, Gas Dry)	MEF=1.04, 2.65 capacity, electric water heat and gas dryer	ROB/NEW	321.36	134.01	13	$592.77	$592.77
H.E. Clothes Washer (Gas WH, El Dry)	MEF=1.04, 2.65 capacity, gas water heat and electric dryer	ROB/NEW	127.58	53.20	13	$592.77	$592.77
Energy Star Dish Washer	EF=0.46, 215 wash cycles	ROB/NEW	97.00	30.75	13	$133.64	$133.64

5.2 Residential DSM Measure Characterizations - Gas

This section describes the residential gas DSM measures analyzed for this study and the methods used to estimate savings. The section is organized by major end-uses such as HVAC, building shell, lighting, and domestic hot water.

Domestic Hot Water Measures – Gas

In the Kansas utility service territories, about 69% of the water heaters are gas-fired. Savings can occur through reducing the amount of hot water consumed or by improving the efficiency of the water heating/storage/distribution process. All savings estimates were determined using engineering methods such as steady-state heat transfer and mass flow. Measure lives are based on the Database for Energy Efficient Resources (DEER).[43]

Efficient Water Heaters

This measure involves substitution of a standard efficiency water heater with a high efficiency unit. For gas water heaters, this involves moving from a base Energy Factor (EF) of 0.6 to an efficient EF of 0.63; for electric water heaters, moving from a base EF of 0.88 to an efficient EF of 0.93. Energy factors are a measure of water heater efficiency that combines recovery efficiency with standby losses.

[43] The Database for Energy Efficient Resources (DEER), sponsored by the California Energy Commission and the California Public Utilities Commission, is a widely used reference for well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL).

Point-of-Use Water Heaters

Point-of-use water heaters eliminate the standby tank (and associated losses) of a standard water heater. The water is heated instantaneously at the point of use by a high energy heat source that can be either gas or electric.

Low Flow Showerheads

Low flow showerheads use an orifice plate inside the fixture to restrict the water flow to a maximum 2.5 gallons per minute versus a 3.5 gallon per minute permitted with standard new showerheads. Water flow from older showerheads typically exceeds 5.0 gallons per minute. Engineering methods were used to estimate savings between the 2.5 and 3.5 gpm showerheads assuming one seven-minute shower per occupant per day.

Faucet Aerators

Faucet aerators introduce air into the water as it leaves the faucet. The result is perceived full flow at a much reduced actual flow rate. We estimated that a faucet aerator reduces flow from 2 gallons per minute to 1 gallon per minute during five minutes of water use per occupant per day.

Hot Water Pipe Insulation

Pre-formed segments of foam insulation are placed around hot water distribution pipes to minimize heat loss. While useful for the entire length of hot water piping, it is most cost-effective in the first 5-10 feet of pipe extending from the hot water heater. Engineering estimates of steady state heat loss from the pipes to conditioned indoor air were used to estimate savings.

Table 5-5: Residential Hot Water Measure Characteristics - Gas

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
Faucet Aerators	No Faucet Aerators	RET	0.56	0.00	9	$12.69	$7.12
Point of Use Water Heater	Gas Water Heater EF=.594	RET	2.78	0.00	20	$622.00	$371.00
Pipe Wrap	No pipe wrap	RET	0.74	0.00	15	$210.75	$27.75
Low Flow Showerhead	Standard showerhead	RET/NEW	0.74	0.00	10	$37.95	$22.95
High Efficiency Water Heater	Gas Water Heater EF=.594	ROB/NEW	0.93	0.00	15	$72.30	$72.30

Residential HVAC Measures – Gas

In the State of Kansas, about 72% of space heating is by natural gas furnace. Savings can occur through reducing the amount of heating required by improving the building shell or by improving the efficiency of the equipment and/or distribution process.

Since HVAC savings are climate dependent, most of the savings for the following measures were determined by modifying the baseline simulation model first to reflect the less efficient option then to reflect the improved efficiency measure. Savings is the difference between the two. Incremental costs are mostly based on the DEER database.

Natural Gas Furnace

Standard efficiency natural gas furnaces have Annual Fuel Use Efficiencies (AFUEs) of 80. Efficiency is dependent on vent type, burner type, and heat transfer surface. The efficient units considered for this analysis have AFUEs of 92 and 96.

HVAC Diagnostic Repair, Testing, and Maintenance

Many residential and non-residential HVAC systems are not operating as efficiently as possible due to inadequate maintenance. This package of services includes ensuring proper lubrication, cleanliness and fan operation. The savings estimate assumes that the tune-up improves efficiency by 10%.

HVAC Duct Sealing, Operations and Maintenance

Many HVAC ducts are not sealed well and leak conditioned air into conditioned and unconditioned spaces such as basements and attics failing to properly deliver heating and cooling to the occupied areas of the home. Duct sealing reduces such heat loss and reduces fan power. Savings estimates are determined by modeling well sealed ductwork vs. systems with typical leakage, about 5%.

Ceiling Insulation

Ceiling insulation includes both insulating un-insulated roof areas and adding insulation to under-insulated roof areas. In Kansas, the recommended amount of ceiling insulation is an R-value of about R-38[44]. Savings is determined by modeling.

Wall Insulation

Wall insulation is most cost-effective when insulating un-insulated wall areas. In Kansas, the recommended amount of wall insulation is R-13 to R-19 with the greater insulation recommended in the northwest portion of the state[45]. Savings is determined by modeling.

Floor Insulation

Many residential basement floors are un-insulated, which results in heat loss to the ground underneath the home. Floor insulation reduces this heat loss. Savings is determined by modeling un-insulated basements and basements with R-11 walls.

[44] *International Energy Efficiency Code 2006*, International Code Council, 2006.

[45] *Ibid*.

Efficient Windows

Efficient windows are generally considered to be either triple paned windows, windows with a radiant barrier to reflect heat back into the conditioned space, or windows with low "shading coefficients". Reducing the shading coefficients of glass will reduce the amount of solar heat gain into the building. This reduced solar gain will decrease the cooling load for the building, but may increase the heating load. On the other hand these windows usually have a higher R-value than the windows they replace, thus heating energy can decrease. Savings is determined by modeling.

Comprehensive Shell Air Sealing

This measure includes caulking, weather stripping, and sealing other visible cracks and penetrations in the building shell. Practically speaking a house should be able to breathe to purge contaminants so a lower limit of 0.35 air-changes per hour (ACH) is advised without the addition of mechanical ventilation. Savings is determined by modeling 0.5 ACH versus 0.35 ACH.

Table 5-6: Residential Gas Space Heating and Cooling Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
Natural Gas Furnace - 92 AFUE	Gas Furnace - AFUE 78	ROB/NEW	3.10	0.00	18	$650.00	$300.00
Natural Gas Furnace - 96 AFUE	Gas Furnace - AFUE 78	ROB/NEW	4.10	0.00	18	$850.00	$500.00
Duct Sealing and Repair - Gas Heat	Supply/return/OA leakage 20/16/4% of AHU flow	RET	48.30	0.00	15	$500.00	$500.00
HVAC Diagnostics - Gas Heat	No Diagnostics	RET	2.30	0.00	10	$90.00	$25.00
HE Windows - Gas Heat	U-0.82 / SHGC-0.79 (clear) Window	RET	2.40	0.00	25	$1,561.00	$1,361.00
Gas Heat	R0 Insulation Batt	RET	55.30	0.00	25	$1,720.00	$1,400.00
Gas Heat	R19 Insulation Batt	RET	4.30	0.00	25	$1,080.00	$760.00
Heat	R0 Insulation Batt	RET	19.90	0.00	25	$595.00	$275.00
Heat	R0 Insulation Batt	RET	21.90	0.00	25	$1,080.00	$760.00
Infiltration Reduction - Gas Heat	One ACH	RET	14.20	0.00	10	$175.00	$175.00

Residential Appliance Measures – Gas

Gas savings for appliance measures accrue from reduced levels of water consumption for clothes washers and dishwashers and reduced or more efficient clothes drying from moisture sensors and the use of horizontal axis clothes washers.

Energy Star Clothes Washers

Energy Star clothes washers must exceed the minimum energy efficiency standards by at least 37% and, since January 1, 2007, meet water efficiency criteria. The federal standard sets the minimum Modified Energy Factor (MEF) at 1.26, Energy Star sets the minimum MEF at 1.72 with a maximum water factor of 8.0. Savings are not climate dependent and are based on DEER estimates.

Energy Star Dishwashers

Energy Star dishwashers must exceed minimum energy efficiency standards by at least 41%. Energy Star, since January 1, 2007, requires a minimum Energy Factor (EF) of .65 for standard

models and .88 for compact models. Savings are not climate dependent and are based on Energy Star estimates.

Table 5-7: Residential Gas Appliance Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
H.E. Clothes Washer (Gas WH, Gas Dry)	MEF=1.04, 2.65 capacity, gas water heat and gas dryer	ROB/NEW	1.90	0.00	13	$592.77	$592.77
H.E. Clothes Washer (Gas WH, El Dry)	MEF=1.04, 2.65 capacity, gas water heat and electric dryer	ROB/NEW	1.45	0.00	13	$592.77	$592.77
Energy Star Dish Washer	EF=0.46, 215 wash cycles	ROB/NEW	0.40	0.00	13	$133.64	$133.64

5.3 Non-Residential DSM Measure Characterizations - Electricity

This section describes the non-residential energy efficiency measures analyzed for this study and the methods used to estimate savings. The section is organized by major end-uses such as HVAC, lighting and hot water. This section focuses on prescriptive measures, which are generally simple measures that have largely uniform energy and peak demand savings on a per unit basis from application to application. However, even prescriptive measures' savings will have some variability, depending on the specific application and baseline equipment replaced. For this assignment Summit Blue has based our measure analysis on a typical small office building with non-residential lighting fixtures and HVAC equipment.

Custom measures have more variable energy and peak demand savings on a per unit basis from application to application. Calculating energy and peak demand savings for custom measures on a site-specific basis will significantly improve the accuracy of the energy and peak demand savings estimates, versus using standard per unit estimates for custom measures.

Lighting Measures – Non-Residential

The following lighting measures are often part of utilities' prescriptive non-residential lighting energy efficiency programs. In our potential analysis we assume 3100 annual operating hours for lighting systems. We also assume a peak coincidence factor of 90%. Most savings are estimated by calculating the difference between the input watts for the efficient technology and the standard technology and multiplying by coincidence (or hours for energy, kWh). Exceptions for this general rule apply in two cases: (1) lighting controls and (2) general lighting systems in areas that are both heated and cooled. In the latter case the high number of connected Watts impacts the heating and cooling loads in the building. In both cases computer simulations are used to determine the combined effects of direct lighting efficiency savings, and the cross-impacts on heating and cooling loads. The size of the electric cross-impacts depends on the heating energy source, i.e. electricity or natural gas.

Measure costs are based on the California DEER database adjusted to the Kansas area by regional cost factors from *RS Means Cost Data.*

T8 Lamps and Electronic Ballasts- Premium

Premium T8 lamps and electronic ballasts have the same market as regular T8 systems. They gain efficiency over regular T8 systems by the co-development of lamps and ballasts that optimize the efficiency of both when used together. This measure qualifies under the general lighting category, and direct lighting savings and indirect heating and cooling impacts are estimated by eQuest simulations.

T5 Lamps and Electronic Ballasts

T5 lamps and electronic ballasts are a newer alternative linear fluorescent lighting system. T5 fluorescent lamps are 5/8 of an inch in diameter, thinner than both T8 lamps and T12 lamps. T5 lighting systems are primarily used in new construction, and are not appropriate for most retrofit situations, as the lamps are only generally available in metric lengths. This measure qualifies under the general lighting category, and direct lighting savings and indirect heating and cooling impacts are estimated by eQuest simulations.

Compact Fluorescent Lamp – Screw-in and Fixtures

Compact fluorescent lamps (CFLs) are the most common alternatives to standard incandescent lamps. CFLs are generally about four times as efficient as incandescent lamps, and last about 10 times as long. CFLs can either be screw-in replacements for incandescent lamps or plug-in lamps in fixtures specifically designed around CFL technology. Savings is determined by subtracting the input CFL Wattage from the lamp or fixture Wattage of the incandescent lamps they are replacing. The measure life for a screw-in CFL is the life of the bulb or two to three years depending on the application. Plug-in lamps in CFL fixtures are assumed to last the life of the fixture, because failed lamps must be replaced with comparable CFLs.

Occupancy Sensors

Occupancy sensors automatically turn off the lights in a room or an area when the area is unoccupied. Occupancy sensors are an alternative to standard wall mounted on/off lighting switches. Savings were determined by eQuest simulation assuming that 10% of lighting is controlled by occupancy sensors with an average reduction of four hours of use per day. HVAC interactions are included in the estimates.

Daylight Sensors

Lighting systems are designed assuming no contribution from ambient daylight. In areas where daylight is available, artificial light is unnecessary and possibly detrimental to occupant comfort. Daylight sensors measure the contribution of ambient daylight and either turn-off or dim the lamps of the artificial lighting system. Savings were determined by eQuest simulations, assuming that perimeter zone (less than 12 feet from an exterior fenestrated wall) lighting is controlled by daylight sensors to maintain required lighting levels with continuous lighting level control. eQuest input data include location specification for the solar incidence angles and hourly cloud cover to describe available sunlight. HVAC interactions are included in the estimates.

Delamping

The definition of delamping used for this project is replacing a four lamp, four foot fluorescent lighting fixture with a similar two lamp or three lamp fixtures. This measure is intended for areas that are currently over-lit. Lighting reflectors are often used as part of delamping projects. The measure life for this measure is shorter because the fixture is assumed to have been in place for a period of time already. Savings were determined by eQuest simulation. HVAC interactions are included in the estimates.

LED Exit Signs

LED exit signs are one of the most efficient types of exit signs on the market. They generally only draw about two to three watts of power, compared to 10 watts or more for CFLs, or 20 watts or more for incandescent exit signs.

Table 5-8: Non-Residential Lighting Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
9-24W Screw-in CFL	75W Incandescent	ROB/NEW	160.40	55.70	3.2	$10.25	$6.47
Over 24W Pin-Based CFL	120W Incandescent	ROB/NEW	204.10	70.90	12	$53.41	$26.27
T5 w/Electronic Ballast	Premium T8 w/EB	ROB/NEW	32.90	10.10	11	$44.31	$40.54
Premium T8 w/Electronic Balast	T12 w/MB	ROB/NEW	131.60	40.40	11	$67.96	$51.00
Delamping w/Reflectors (2 lamp)	All Lamps w/o reflector	RET/NEW	78.80	24.30	16	$25.60	$3.00
LED Exit	Inc Exit	RET/NEW	351.30	42.50	16	$65.00	$31.50
Occupancy Sensor (8 hrs/day)	No sensor	RET/NEW	213.00	76.00	8	$77.30	$42.30
Daylighting (perimiter zone)	No controls	RET/NEW	1747.00	790.00	16	$1,226.00	$1,139.00

Non-Residential Water Heating Measures – Electric

These measures are essentially more efficient replacements for residential water heaters, which can also be installed in non-residential facilities. Typical non-residential hot water use is much lower than residential use – about 1.5 gallons per occupant per day. For applications where water use is high, for example in food preparation or clean-up, these measures might be considered custom measures analyzed with site-specific data.

Measure costs are based on the California DEER database adjusted to the Nebraska area by regional cost factors from *RS Means Cost Data.*

Efficient Water Heaters

Traditional electric water heaters have an overall efficiency of about 90% including standby and distribution losses. High efficiency units achieve 94% efficiency with improved insulation and heat traps that minimize convection into under insulated distribution pipes. The savings estimate for the high-efficiency unit is calculated from the total hot water energy use and the unit efficiencies.

Heat Pump Water Heaters

Heat pump water heaters use compressed refrigerants to extract heat from ambient air (or water) and move that heat to stored hot water. During warm weather these machines can move four units of heat for every one comparable unit of input energy, thus achieving a coefficient of performance (COP) up to 4.0. COP decreases as ambient air temperature decreases. At about 10-20°F, heat pumps become ineffective. At cold ambient temperatures, traditional electric resistance heating elements back-up the heat pump compressor. Savings was determined using engineering estimates with a linear relationship between COP and outdoor air temperature until 20°F at which point we assumed electric resistance heat would take over.

Tankless Water Heaters

Tankless water heaters are more efficient than standard water heaters since they avoid the energy lost from the hot water that is stored in conventional tanks. Tankless water heaters have "energy factors" of about 98%. The savings estimate for the high-efficiency unit is calculated from the total hot water energy use and the unit efficiencies. The longer measure life for this measure reflects the cost hurdle for re-piping water distribution for reverting to the standard tank water heater.

Table 5-9: Non-Residential Hot Water Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
High Efficiency Water Heater	No Faucet Aerators	ROB/NEW	640.00	50.00	15	$195.00	$72.00
Heat Pump Water Heater	Electric water heater, EF=0.88	ROB/NEW	1229.00	95.00	10	$1,411.00	$1,288.00
Tankless Water Heat	No pipe wrap	ROB/NEW	1281.00	0.00	20	$863.00	$613.00

Non-Residential HVAC Measures – Electric

In the Kansas most non-residential space heating is by natural gas. Savings can occur through reducing the amount of heating/cooling required with insulation and setting back thermostat settings or by improving the efficiency of the equipment and/or distribution process.

Since HVAC savings is climate dependent, all of the savings for the following measures were determined with eQuest computer energy simulations. Savings is the difference between the simulation with the efficient technology and the simulation with the standard technology. Incremental costs are mostly based on the DEER database adjusted with *RS Means Mechanical Cost Data* 'location factors' to reflect Kansas labor and/or equipment costs.[46]

[46] *RS Means Mechanical Cost Databook, 2006*.

Efficient Packaged Commercial Air Conditioning Systems

Standard efficiency units are specified as units with EER ratings of 9.0. Efficient units are specified as units with EER ratings of 10.4-13.0 depending on the equipment size. Summit Blue characterized a high efficiency unit with an EER of 12.2.

Economizers

Economizers use outside air for cooling instead of operating the air conditioning compressors on mild days, particularly during the spring and early fall seasons. The analysis assumed an integrated economizer where 100% outdoor air is used up to 65°F ambient temperature. During peak summer conditions economizers produce no peak demand savings.

Programmable Thermostats

Programmable thermostats allow temperatures to be automatically set warmer or colder during unoccupied periods to reduce heating and cooling energy use when facilities are unoccupied. We analyzed 5°F setbacks (set-ups in the summer). Since the impact of set-backs is typically off-peak, these thermostats do not have discernable peak benefits.

Table 5-10: Non-Residential HVAC Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
Packaged A/C 12.2 EER	13 SEER CAC	ROB/NEW	405.00	452.00	15	$565.00	$105.00
Economizer Control	Standard Room AC	ROB/NEW	232.00	245.00	15	$170.00	$127.00
Programable Thermostat	13 SEER HP	RET/NEW	895.00	732.00	11	$142.00	$50.00

Custom and Other Non-Residential Measures

Custom efficiency

"Custom" is a generic name for consumer-specific conservation projects. The magnitude of estimated potential savings is scaled to kW saved and is based on Midwestern utility custom program results.

Motor efficiency

Motor efficiency improvements can be achieved effectively during system specification and installation when new motors are purchased. Premium efficiency motors can be installed in place of motors that only meet minimum federal efficiency standards detailed in the Energy Policy Act. Since many larger motors (greater than 30 HP) are rewound after failure rather than replaced, an additional opportunity exists by ensuring rewinds are performed to maintain motor efficiency. Steps like close control of baking temperatures, careful winding removal, and use of high-quality materials will help ensure that efficiency will not diminish during rewinds.

High Efficiency HVAC Motors

Premium efficiency motors used in HVAC fan and pump applications. These motors typically exceed mandated EPACT efficiencies by 1-3%.

Variable Speed Drives Used in HVAC Fan and Pump Applications

Variable frequency drives (VFDs) or adjustable speed drives (ASDs) vary the speed of motors so that their speeds are proportionate to the loads the motors are serving. This saves energy because motor energy use varies with the cube of the speed for applications such as HVAC fans and pumps. This application of variable speed drives (VFDs) to HVAC equipment has more predictable energy and peak demand savings impacts than many industrial process VFD applications. So some utilities include this measure as part of prescriptive HVAC programs.

Table 5-11: Custom & Motors Measure Characteristics

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
Custom Efficiency		ROB	25,000.00	5,000.00	15	$7,000.00	$7,000.00
Prem Motor < 10 HP	EPACT < 10 HP	ROB/NEW	311.00	148.00	15	$74.50	$74.50
Prem Motor > 10HP	EPACT > 10 HP	ROB/NEW	547.30	191.50	15	$468.00	$468.00
High Efficiency Fan Motors	Supply/return/OA leakage 20/16/4% of AHU flow	ROB/NEW	653.00	325.00	15	$27.00	$27.00
VFDs Supply Fans	Supply/return/OA leakage 20/16/4% of AHU flow	RET/NEW	2428.00	380.00	10	$222.00	$156.00

5.4 Non-Residential DSM Measure Characterizations - Gas

This section describes the non-residential gas DSM measures analyzed for this study and the methods used to estimate savings. The section is organized into domestic hot water and HVAC measures.

Non-Residential Hot Water Measures – Gas

In the Kansas utility service territories, about 43% of the non-residential water heaters are gas-fired. Savings can occur through reducing the amount of hot water consumed or by improving the efficiency of the water heating/storage/distribution process. All savings estimates were determined using engineering methods. Measure lives are based on the DEER Database.

Efficient Water Heaters

This measure involves substitution of a standard efficiency water heater with a high efficiency unit. For gas water heaters, this involves moving from a base Energy Factor (EF) of 0.6 to an efficient EF of 0.63; for electric water heaters, moving from a base EF of 0.88 to an efficient EF of 0.93. Energy factors are a measure of water heater efficiency that combines recovery efficiency with standby losses.

Point-of-Use Water Heaters

Point-of-use water heaters eliminate the standby tank (and associated losses) of a standard water heater. The water is heated instantaneously at the point of use by a high energy heat source that can be either gas or electric.

Table 5-12: Non-Residential Hot Water Measure Characteristics - Gas

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
High Eff Water Heating Tank - EF=0.64	Gas Water Heater EF=.594	ROB/NEW	3.80	0.00	15	$175.00	$175.00
Point of Use Water Heating	Gas Water Heater EF=.594	RET/NEW	5.40	0.00	20	$571.00	$371.00

Non-Residential HVAC Measures – Gas

In the State of Kansas, about 43% of non-residential space heating is by natural gas furnace. Savings can occur through reducing the amount of heating required by improving the building shell or by improving the efficiency of the equipment and/or distribution process.

Since HVAC savings are climate dependent, most of the savings for the following measures were determined by modifying the baseline simulation model first to reflect the less efficient option then to reflect the improved efficiency measure. Savings is the difference between the two. Incremental costs are primarily based on the DEER database.

Efficient Boilers

Standard efficiency units are specified as units that meet the minimum requirements of ASHRAE 90.1and match the base efficiency of most boiler manufacturers (80%). High efficiency units exceed this minimum depending to the boiler type by a small amount without condensing corrosive flue gasses.

Boilers Tune-up

Boiler tune-ups can include a range of activities that contribute to improved system efficiency: cleaning, sealing combustion chambers, adjusting draft control and measuring combustion efficiency, reducing excessive flue gas temperatures and servicing moving parts.

Boiler Outdoor Air Temperature Reset

Matching the temperature of the water produced by a boiler to its load can reduce stand-by losses and improve the heat-transfer efficiency within a boiler. The controls typically are applied to boilers with primary HVAC service for comfort.

Oxygen Trim

Oxygen trim is a dynamic computerized control system that constantly adjusts the amount of combustion air to optimum levels for high efficiency and safe operation.

Steam Trap Maintenance

Poorly serviced steam traps are a large source of steam system inefficiency. Failed traps can vent steam to atmosphere and reduce the volume of condensate returning to the boiler adding additional heat load to the system.

High-Efficiency Commercial Furnaces

High-efficiency furnaces are similar to the residential efficient furnace measure. They are generally applied with split systems where acidic condensate can be drained directly from facility assets. The savings are greater than residential units due to the constant ventilation with outdoor air and subsequent heating loads in a commercial setting.

Table 5-13: Non-Residential HVAC Measure Characteristics – Gas

Measure Name	Base Technology	Program Decision Type	Energy Impact (kWh/Unit)	Peak Impact (W/Unit)	Technology Life	Cost if Retrofit (RET)	Cost if Replace on Burnout (ROB) or NEW
Boiler Tune-up <1MMBtu	none	RET	10.80	0.00	2	$650.00	$650.00
Boiler Tune-up 1-10 MMBtu	none	RET	46.90	0.00	2	$750.00	$750.00
Boiler Tune-up >10 MMBtu	none	RET	468.50	0.00	2	$1,500.00	$1,500.00
O2 Trim Control >10 MMBtu	none	RET	292.80	0.00	15	$8,687.00	$8,687.00
OA Reset <1MMBtu	none	RET	10.90	0.00	15	$1,261.00	$1,261.00
OA Reset 1-10 MMBtu	none	RET	82.50	0.00	15	$1,211.00	$1,211.00
OA Reset >10 MMBtu	none	RET	1179.90	0.00	15	$2,061.00	$2,061.00
Steam Trap Maintenance >10 MMBtu	none	RET	2.30	0.00	15	$58.00	$58.00
Boiler Replacement <1MMBtu	Old Boiler	ROB	55.70	0.00	15	$1,909.00	$1,909.00
Boiler Replacement 1-10 MMBtu	Old Boiler	ROB	144.80	0.00	15	$3,593.00	$3,593.00
Boiler Replacement >10 MMBtu	Old Boiler	ROB	1220.10	0.00	15	$18,253.00	$18,253.00
High Efficiency Gas Furnace AFUE 94%	Old Furnace	ROB	17.70	0.00	12	$515.00	$515.00

6 DSM MEASURE COST-EFFECTIVENESS ANALYSIS

The cost-effectiveness analysis of the energy conservation and peak demand response measures involved developing a list of possible measures, quantifying the necessary data inputs, and then applying tests to determine the cost-effectiveness of each measure given the input parameters. This section of the report summarizes this procedure and presents the results of the cost-effectiveness analysis.

The discussion begins with a brief overview of the inputs into the model, starting with the general inputs that are common across all measures.

6.1 Key General Inputs

Key values of general inputs (i.e., inputs that are common across multiple measures) in the cost-effectiveness analysis are listed below in Table 6-1. These general inputs include electric and gas prices by sector, avoided costs by fuel type, and the assumed cost of capital.

Table 6-1: General Cost-Effectiveness Inputs

INPUT	Averaged Value
Electric Price: $/kWh	
Residential	$0.0732
Commercial	$0.0623
Avoided Energy Cost,: $/MWh	
Summer On	$0.4797
Summer Off	$0.0222
Winter On	$0.2143
Winter Off	$0.0270
Avoided Generation Cost: $/kW	$90.09
Avoided T&D Cost: $/kW	$57.12
Natural Gas Price: $/Mcf	
Residential	$13.02
Commercial	$12.19
Avoided Commodity Cost,: $/Mcf	$10.10
Avoided Demand Cost: $/Mcf	$1.42
Cost of Capital	5%

The source for the electric and gas prices is the federal Energy Information Administration. The avoided costs come from Xcel Energy, Minnesota. The *Cost of Capital* percentage refers to the *Cost of Debt*.

The key inputs into the cost-effectiveness analysis that are measure-specific are the measure's energy and peak demand savings, lifetime, and incremental cost. These inputs are presented in the measure characterization chapter.

The final input into the cost-effectiveness analysis is the program cost. Based on the program benchmarking results, Summit Blue estimated both an incentive cost and an administrative cost for each measure. These costs are identified within the cost-effectiveness results tables that follow in the next section.

6.2 Cost Effectiveness Results by Measure

This section summarizes the results of the cost-effectiveness analysis at the measure level. The phrase "passing the test" means that the benefit-cost ratio for a given measure is at least 1.0. Following are four cost-effectiveness test results:

- **The Participant Test** – describes the value of the DSM program to the participant. The benefit for the participant test is any rebate plus the electric bill savings due to the conserved energy and peak demand caused by the DSM measure/program. The cost for the participant test is only the participant's incremental cost to install the measure.
- **The Utility Test** – describes the value of the DSM program to the utility. The benefits for the utility test are the avoided costs of generation, transmission, and distribution investments, and avoided fuel costs due to the conserved energy and peak demand caused by the DSM program. The cost for the UT is just the DSM program costs (administrative and rebate).
- **The Ratepayer Impact Test (RIM)** – describes the DSM program's potential impact on the utility's long-term electric rates. The benefits for the RIM test are the avoided costs of generation, transmission, and distribution investments, and avoided fuel costs due to the conserved energy and peak demand caused by the DSM program. The cost for the RIM test is the DSM program cost plus the lost revenues due to the DSM program.
- **The Total Resource Cost Test (TRC)** – describes the combined value of the DSM program to both participants and non-participants. The benefit for the TRC test is the avoided costs of generation, transmission, and distribution investments, and avoided fuel costs due to the conserved energy and peak demand caused by the DSM program. The costs for the TRC test is the participant's incremental DSM measure cost plus the program administrative cost. Customer rebates or incentives offered through DSM programs are not counted as part of the costs for the TRC test.

In line with standard industry practice, Summit Blue uses the TRC test to determine which DSM measures will be included in a portfolio of DSM programs.

The results for each measure for residential electric measures are presented in Tables 6-2 through 6-5. The results for residential and non-residential electric measures are presented in Tables 6-6 through 6-9. The results for residential and non-residential gas measures are presented in Tables 6-10 and Tables 6-11 respectively.

Table 6-2: Residential Lighting Cost-Effectiveness Results - Electric

Residential Lighting						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
9-16W Screw-in CFL	$1.75	$0.30	3.05	6.46	0.69	2.04
17-24W Screw-in CFL	$1.75	$0.36	2.72	7.37	0.70	1.85
25-34W Screw-in CFL	$1.75	$0.45	2.86	8.97	0.71	1.98
Over 34W Screw-in CFL	$1.75	$0.71	4.01	12.62	0.73	2.78
9-16W pin-based CFL	$7.00	$0.30	1.49	2.67	0.60	0.89
17-24W pin-based CFL	$10.00	$0.36	1.57	2.21	0.57	0.90
25-34W pin-based CFL	$10.00	$0.58	1.94	3.54	0.64	1.22
35-44W pin-based CFL	$10.00	$0.52	1.51	3.16	0.62	0.94
45-54W pin-based CFL	$10.00	$0.94	2.07	5.51	0.68	1.39
Over 54W pin-based CFL	$10.00	$0.87	1.74	5.16	0.67	1.16
9-16W Screw-in CFL - Outdoor	$1.75	$0.40	2.53	5.54	0.59	1.45
17-24W Screw-in CFL - Outdoor	$1.75	$0.47	2.60	6.28	0.60	1.51
25-34W Screw-in CFL - Outdoor	$1.75	$0.60	2.69	7.56	0.61	1.58
Over 34W Screw-in CFL - Outdoor	$1.75	$0.94	4.17	10.37	0.62	2.43
9-16W pin-based CFL - Outdoor	$7.00	$0.45	2.04	3.29	0.55	1.11
17-24W pin-based CFL - Outdoor	$10.00	$0.52	2.13	2.73	0.53	1.12
25-34W pin-based CFL - Outdoor	$10.00	$0.86	2.70	4.32	0.57	1.52
35-44W pin-based CFL - Outdoor	$10.00	$0.76	2.09	3.88	0.56	1.17
45-60W pin-based CFL - Outdoor	$10.00	$1.38	2.94	6.65	0.60	1.73
Over 60W pin-based CFL - Outdoor	$10.00	$1.28	2.47	6.24	0.60	1.45
20W pin-based CFL Table Lamp	$10.00	$0.38	0.83	2.39	0.59	0.49
25W pin-based CFL Table Lamp	$10.00	$0.52	0.88	3.22	0.63	0.55
30W pin-based CFL Table Lamp	$10.00	$0.63	0.99	3.83	0.65	0.64
55W pin-based CFL Table Lamp	$10.00	$1.01	0.77	5.95	0.69	0.53
CFL Torchiere 70W	$10.00	$1.61	1.75	5.87	0.69	1.19

Table 6-3: Residential Appliance Cost-Effectiveness Results - Electric

Residential Appliances						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
Pool Pump - Two Speed	$45.54	$11.76	3.72	10.91	0.91	3.22
H.E. Refrigerator	$50.00	$0.54	1.04	1.37	0.67	0.70
Refrigerator Recycling	$35.00	$16.35	3.21	12.48	1.31	3.90
Freezer Recycling	$35.00	$13.96	3.84	15.88	1.34	4.81
H.E. Clothes Dryer	$59.56	$0.40	0.37	0.96	0.66	0.24
H.E. Clothes Washer (El WH, El Dry)	$35.00	$3.75	0.52	14.20	1.78	0.92
H.E. Clothes Washer (El WH, Gas Dry)	$35.00	$2.70	0.39	10.49	1.70	0.66
H.E. Clothes Washer (Gas WH, El Dry)	$35.00	$1.07	0.19	4.35	1.39	0.26
Energy Star Dish Washer	$25.00	$0.81	0.63	4.40	1.34	0.84

Table 6-4: Residential Water Heat Cost-Effectiveness Results - Electric

Residential Water Heat						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
Faucet Aerators	$1.78	$0.84	3.42	24.33	1.44	4.71
Heat Pump Water Heater	$322.00	$19.49	1.06	4.71	1.16	1.23
Pipe Wrap	$0.09	$1.12	28.87	102.37	1.51	31.58
Low Flow Showerhead	$5.74	$1.12	1.74	13.46	1.37	2.36
High Efficiency Water Heater	$18.08	$1.50	1.76	8.52	1.30	2.26
Drain Water Heat Recovery	$100.00	$4.54	0.84	5.77	1.21	1.02

Table 6-5: Residential HVAC/Shell Cost-Effectiveness Results - Electric

Residential HVAC/Shell						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
Central A/C	$330.00	$3.40	1.02	2.84	1.55	1.58
Room A/C	$25.00	$1.95	4.85	14.90	2.72	12.57
Heat Pump	$330.00	$7.52	1.38	6.56	2.33	3.20
Duct Sealing and Repair - CAC	$350.00	$5.49	1.49	2.84	1.34	2.00
Duct Sealing and Repair - HP	$350.00	$20.40	3.65	10.43	2.09	7.43
HVAC Diagnostics - CAC	$25.00	$2.60	1.84	16.27	2.68	4.85
HVAC Diagnostics - HP	$25.00	$7.82	4.96	40.32	2.92	13.53
HE Windows - CAC Only	$300.00	$0.55	0.23	0.48	0.41	0.09
HE Windows - El Heat w/CAC	$300.00	$4.49	0.48	3.71	1.52	0.72
HE Windows - Heat Pump	$300.00	$4.01	0.44	3.19	1.39	0.62
Ceiling Insulation (R-0 to R-38) -El Heat	$300.00	$80.31	4.76	51.07	2.35	10.79
Ceiling Insulation (R-0 to R-38) - Heat Pump	$300.00	$55.10	3.32	37.53	2.31	7.51
Ceiling Insulation (R-19 to R-38) -El Heat	$300.00	$5.69	0.80	4.50	1.59	1.27
Ceiling Insulation (R-19 to R-38) - Heat Pump	$300.00	$3.48	0.59	2.77	1.30	0.78
Wall Insulation (R-0 to R-19) -El Heat	$60.00	$38.43	6.45	94.41	2.40	14.67
Wall Insulation (R-0 to R-19) - Heat Pump	$60.00	$18.77	3.20	57.63	2.36	7.40
Floor Insulation (R-0 to R-19) -El Heat	$300.00	$37.10	3.65	26.62	2.25	8.03
Floor Insulation (R-0 to R-19) - Heat Pump	$300.00	$20.18	2.11	15.24	2.12	4.43
Inflitration Reduction - CAC Only	$50.00	$1.89	0.87	4.01	1.36	1.18
Inflitration Reduction - CAC w/El Heat	$50.00	$28.30	8.99	48.15	2.35	18.54
Inflitration Reduction - Heat Pump	$50.00	$17.48	5.66	34.41	2.30	12.06

The results for residential electric measures show that most of these measures are very cost-effective from all aspects but the RIM test. 74% of all measures for existing residential passed the participant test, 97% passed the utility test, 72% passed the TRC test, and 52% passed the RIM test. All but three measures that failed the participant test also failed the TRC test, and all measures that failed the utility test failed the TRC test.

Table 6-6: Non-Residential Lighting Cost-Effectiveness Results - Electric

Non-Residential Lighting						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
9-24W Screw-in CFL	$1.75	$1.35	4.25	10.41	1.12	4.12
Over 24W Pin-Based CFL	$10.00	$1.71	4.21	10.74	1.12	4.49
T5 w/Electronic Ballast	$15.00	$0.28	0.74	1.19	0.60	0.44
Premium T8 w/Electronic Balast	$15.00	$1.11	1.48	4.51	0.95	1.39
Delamping w/Reflectors (2 lamp)	$0.75	$0.66	1.88	40.22	1.16	2.16
LED Exit	$6.00	$2.95	3.32	22.09	0.90	2.91
Occupancy Sensor (8 hrs/day)	$12.00	$1.79	1.14	7.01	1.07	1.22
Daylighting (perimiter zone)	$284.75	$14.67	1.09	4.91	1.09	1.19

Table 6-7: Non-Residential Motor/Custom Cost-Effectiveness Results - Electric

Non-Residential Motors/Custom						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
Custom Efficiency	$2,250.00	$210.00	2.18	5.87	0.93	2.00
Prem Motor < 10 HP	$40.00	$2.61	2.73	4.46	0.92	2.46
Prem Motor > 10HP	$100.00	$4.60	0.95	5.70	1.33	1.26
High Efficiency Fan Motors	$21.75	$5.49	13.54	37.13	2.73	31.13
VFDs Supply Fans	$39.00	$20.40	4.41	48.40	2.87	11.86

Table 6-8: Non-Residential Water Heat Cost-Effectiveness Results - Electric

Non-Residential Water Heat						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
High Efficiency Water Heater	$75.00	$5.38	5.66	7.00	1.36	7.27
Heat Pump Water Heater	$300.00	$10.32	0.60	2.59	1.02	0.62
Tankless Water Heat	$200.00	$10.76	1.63	6.20	1.30	2.10

Table 6-9: Non-Residential HVAC/Shell Cost-Effectiveness Results - Electric

Non-Residential HVAC/Shell						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
Packaged A/C 12.2 EER	$226.75	$3.40	4.23	3.66	1.88	7.76
Economizer Control	$31.75	$1.95	1.23	13.95	2.97	3.65
Programable Thermostat	$20.50	$7.52	2.83	56.13	3.84	10.52

The results for non-residential electric measures show that most of these measures are very cost-effective from all aspects including the RIM test. 84% of all measures for existing non-residential passed the participant test, all passed the utility test, 89% passed the TRC test, and 74% passed the RIM test. All but one measure that failed the participant test also failed the TRC test, and all measures that failed the utility test failed the TRC test.

Table 6-10: Residential Gas Measures Cost-Effectiveness Results

Residential Appliances						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
H.E. Clothes Washer (Gas WH, Gas Dry)	$35.00	$3.50	0.37	4.26	0.73	0.28
H.E. Clothes Washer (Gas WH, El Dry)	$35.00	$3.50	0.30	3.27	0.70	0.21
Energy Star Dish Washer	$25.00	$2.50	0.48	1.26	0.52	0.25
Residential Water Heat						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
Faucet Aerators	$1.78	$0.18	3.39	18.62	0.84	2.83
Point of Use Water Heater	$200.00	$20.00	0.90	1.45	0.55	0.50
Pipe Wrap	$6.94	$0.69	0.41	9.30	0.81	0.34
Low Flow Showerhead	$5.74	$0.57	1.72	8.37	0.80	1.37
High Efficiency Water Heater	$30.00	$3.00	1.80	2.69	0.67	1.18
Residential HVAC/Shell						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
Natural Gas Furnace - 92 AFUE	$200.00	$20.00	1.92	1.52	0.56	1.04
Natural Gas Furnace - 96 AFUE	$400.00	$40.00	1.80	1.00	0.47	0.82
Duct Sealing and Repair - Gas Heat	$350.00	$35.00	11.14	12.00	0.82	8.63
HVAC Diagnostics - Gas Heat	$25.00	$2.50	2.33	5.95	0.77	1.77
HE Windows - Gas Heat	$300.00	$30.00	0.42	0.94	0.46	0.20
Ceiling Insulation (R-0 to R-38) -Gas Heat	$300.00	$30.00	4.89	21.76	0.85	4.10
Ceiling Insulation (R-19 to R-38) -Gas Heat	$300.00	$30.00	0.86	1.69	0.58	0.50
Wall Insulation (R-0 to R-11) -Gas Heat	$60.00	$6.00	5.01	39.15	0.86	4.30
Floor Insulation (R-0 to R-11) -Gas Heat	$300.00	$30.00	3.25	8.62	0.80	2.56
Infiltration Reduction - Gas Heat	$50.00	$5.00	6.81	18.37	0.84	5.61

The results for residential gas measures show that cost effectiveness varies significantly by test. 61% of all measures for existing residential passed the participant test. 94% passed the utility test, 56% passed the TRC test, but none of the measures passed the RIM test. All measures that failed either the participant test or the utility cost test also failed the TRC test.

Table 6-11: Non-Residential Gas Measures Cost-Effectiveness Results

Commercial Water Heat						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
High Eff Water Heating Tank - EF=0.64	$137.75	$13.78	2.98	2.40	0.68	1.92
Point of Use Water Heating	$216.00	$21.60	1.53	2.61	0.69	1.05
Commercial HVAC/Shell						
Technology	Incentive Cost	Administrative Cost	Participant Cost Test	Utility Cost Test	Rate Impact Measure Test	Total Resource Cost Test
Boiler Tune-up <1MMBtu	$162.50	$16.25	0.55	1.04	0.49	0.28
Boiler Tune-up 1-10 MMBtu	$187.50	$18.75	1.38	3.90	0.76	1.05
Boiler Tune-up >10 MMBtu	$250.00	$25.00	5.83	29.18	0.92	5.26
O2 Trim Control >10 MMBtu	$2,171.75	$217.18	3.66	11.72	0.87	3.14
OA Reset <1MMBtu	$315.25	$31.53	1.12	3.01	0.72	0.81
OA Reset 1-10 MMBtu	$302.75	$30.28	7.15	23.69	0.91	6.36
OA Reset >10 MMBtu	$500.00	$50.00	58.19	205.15	0.94	53.45
Steam Trap Maintenance >10 MMBtu	$14.50	$1.45	4.26	13.79	0.88	3.70
Boiler Replacement <1MMBtu	$477.25	$47.73	3.20	10.15	0.86	2.72
Boiler Replacement 1-10 MMBtu	$898.25	$89.83	4.33	14.01	0.89	3.76
Boiler Replacement >10 MMBtu	$2,440.20	$244.02	6.90	43.47	0.92	6.31
High Efficiency Gas Furnace AFUE 94%	$100.00	$10.00	3.16	13.14	0.88	2.75

The results for non-residential gas measures show that most of these measures are very cost-effective from all aspects excluding the RIM test. 93% of all measures for existing non-residential passed the participant test, all passed the utility test, 86% passed the TRC test, but all failed the RIM test. The RIM test is difficult to pass in almost all jurisdictions, as it is the only test that includes estimates of lost revenue in its calculations.

7 DSM POTENTIAL METHODOLOGY AND RESULTS

This section presents a high-level overview of the methods and data sources used to conduct the study.

7.1 Methodology – DSM-RAM

The Summit Blue DSM Resource Assessment Model (DSM-RAM) is an Excel spreadsheet model based on the integration of DSM measure impacts and costs, utility customer characteristics, utility load forecasts, and utility avoided costs and rate schedules. Excel is used as the modeling platform to provide transparency to the estimation process. Using Excel also allows the model to be customized to each client's unique characteristics as well as their ability to provide specific model input data. The model utilizes a "bottoms-up" approach in that the starting points are the study area building stocks and equipment saturation estimates, forecasts of building stock decay and new construction, DSM technology data, past DSM program accomplishments, and decision maker variables that help drive the market scenarios.

The baseline estimates of building stocks and energy consumption for the state of Kansas by fuel type and sector was obtained from the federal Energy Information Administration (EIA) for the year 2006. For electricity, the forecast of growth was based on estimates received from some Kansas utilities. For natural gas, the forecast was based on the consumption trend for the state of Kansas since the year 2000 as provided by EIA.

DSM-RAM estimates DSM Resource Potential for a number of different perspectives. These include:

- **Technical DSM potential** means the amount of DSM savings that could be achieved, not considering economic and market barriers, to customers installing DSM measures. Technical potential is calculated as the product of the DSM measures' savings per unit, the quantity of applicable equipment in each facility, the number of facilities in a utility's service area, and 100% - the measure's current market saturation. Technical potential estimates include DSM measures that may not be cost effective, and technical potential does not consider market barriers such as customer's lack of awareness of DSM measures. Therefore, technical DSM potential estimates do not provide a realistic basis for setting DSM program goals.

- **Economic DSM potential** means the amount of technical DSM potential that is "cost-effective," as defined by the results of the Total Resource Cost (TRC) test (or other preferred cost test). The program benefits for the TRC test include the avoided costs of generation, transmission and distribution investments and avoided fuel costs due to the conserved energy caused by the DSM programs. The costs for the TRC test are the DSM measure costs plus the DSM program administration costs. The TRC test does not consider economic or market barriers to customers installing DSM measures.

- **Achievable DSM market potential** is an estimate of the amount of DSM potential that could be captured by realistic DSM programs that include cost effective DSM measures over the forecast period covered by this DSM potential analysis. Achievable DSM potential can vary with DSM program parameters, such as the magnitude of rebates or incentives offered to customers for installing DSM measures and thus, many different scenarios can be modeled.

For this study, five different achievable DSM market potential scenarios were developed. The five scenarios are different multipliers to the assumed base case incentive level. In all scenario cases, the incentive is capped at the incremental cost of the measure.

- **The Base Case Incentive Scenario:** is either the incentive level currently found in many utilities across the country as identified in the "Best Practices" review, or set at 25% of the incremental capital cost of the measure.

- **Scenario 1.5 * the Incentive Scenario:** has an incentive level one and one-half times larger than the base case (capped at incremental cost).

- **Scenario 2.0 * the Incentive Scenario:** has an incentive level twice as large as the base case (capped at incremental cost).

- **Scenario 2.5 * the Incentive Scenario:** has an incentive level two and one-half times larger than the base case (capped at incremental cost).

- **Scenario 3.0 * the Incentive Scenario:** has an incentive level three times larger than the base case (capped at incremental cost).

Within the achievable DSM potential assessment, the individual measures are modeled by expected type of DSM program design. Three different program design options are included in DSM-RAM.

- **Replace on Burnout (ROB)** means that a DSM measure is not implemented until the existing technology it is replacing fails. An example would be an energy efficient clothes washer being purchased after the failure of the existing clothes washer.

- **Retrofit (RET)** means that the DSM measure could be implemented immediately. For instance, installing a low flow showerhead is usually implemented before an existing shower head fails. Replacing incandescent lamps may be an ROB but can be treated as a RET because of the relatively short lifetime for incandescent bulbs.

- **New Construction (New)** means measures that are installed at the time of new construction. Baseline technologies may be different in the new construction market and implementation costs are often different because a technology, either the energy efficient or base technology

Within DSM-RAM, a number of financial tests and calculations are performed and reported. These include:

- Total Resource Cost Test (TRC)
- Rate Impact Measure Test (RIM)
- Utility Cost Test (UTC)
- Participant Cost Test (PTC)
- Simple customer payback
- Levelized cost/kWh

Total Resource Cost Test (TRC)

The Total Resource Cost Test (TRC) is the most commonly used measure of cost effectiveness for assessing DSM resources by state Public Utility Commissions and electric utilities. The TRC includes all quantifiable costs and benefits regardless of who accrues them. The present value of avoided costs (the benefits) is divided by the technology cost and the program administrative costs. A TRC value of greater than 1.0 indicates that the resource is cost effective.

Rate Impact Measure Test (RIM)

The Rate Impact Measure Test (RIM) measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely, rates or bills will go up if revenues collected after program implementation is less than the total costs incurred by the utility in implementing the program. This test indicates the direction and magnitude of the expected change in customer bills or rate levels. It is calculated by taking the present value of avoided costs (the benefits) and dividing by the sum of the present value of lost revenues plus the incentive cost plus the program administrative cost. The RIM test measures the impact of DSM measures and programs on rates, while the TRC test measures the impacts of DSM measures and programs on customers' overall bills.

Utility Cost Test (UCT)

The Utility Cost Test (UCT) measures the net costs of a demand-side management program as a resource option based on the costs incurred by the program administrator (including incentive costs) and excluding any net costs incurred by the participant. The benefits are similar to the TRC benefits. However, the costs are defined more narrowly. In the TRC, the full incremental measure cost is included, along with program administrative costs. In the UTC, the program administrative costs are included but only the incentive paid by the utility is included as the measure cost.

Participant Cost Test (PTC)

The Participants Test is the measure of the quantifiable benefits and costs to the customer due to participation in a program. The present value of the utility bill reduction over the life of the DSM measure plus the value of the incentive received is divided by the incremental cost of the DSM measure. However, since many customers do not base their decision to participate in a program entirely on quantifiable variables, this test cannot be a complete measure of the benefits and costs of a program to a customer.

Simple Customer Payback

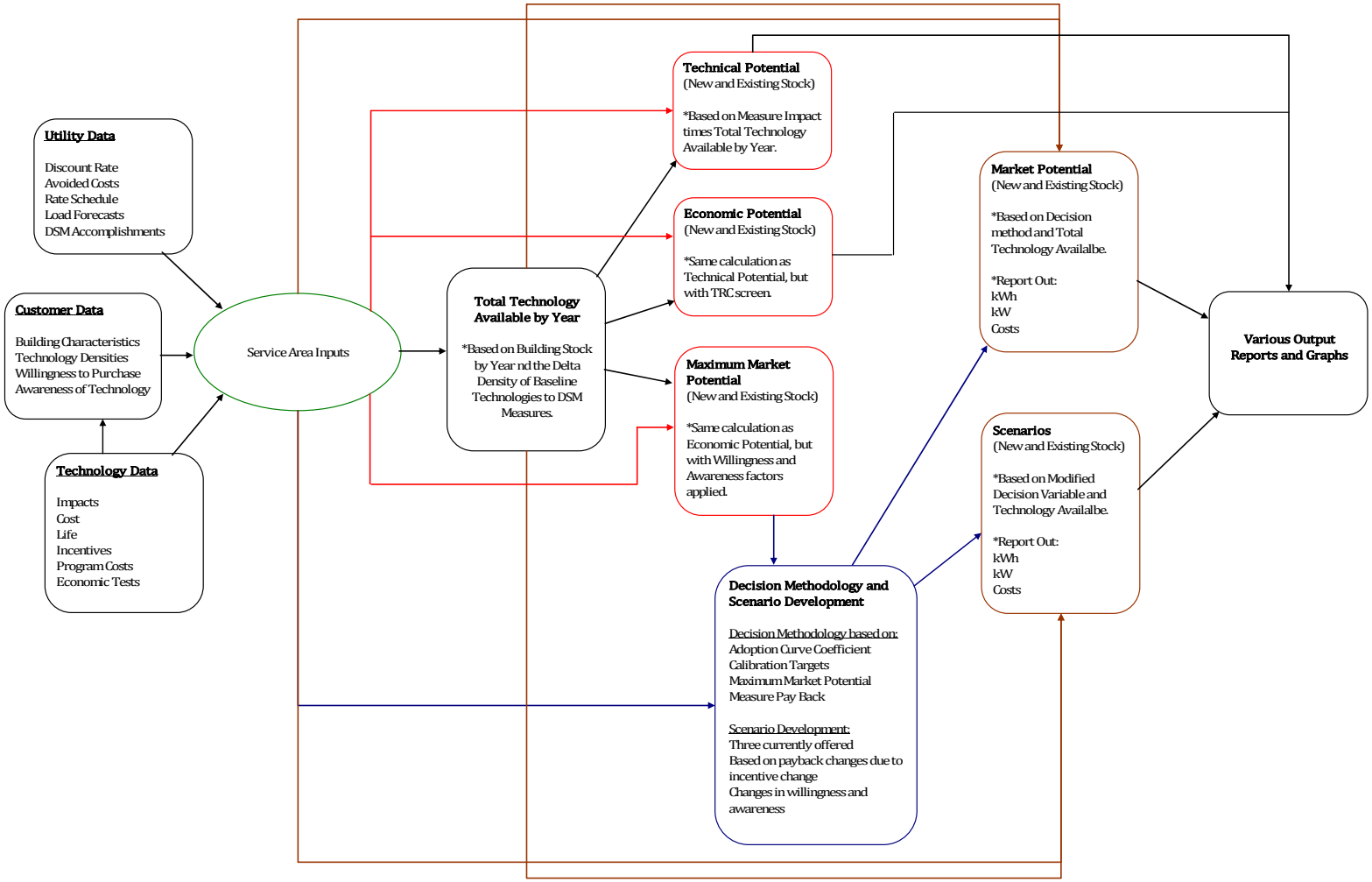
The decision model of DSM-RAM includes simple customer payback as part of its equation. The calculation takes measure cost less the incentive received and divides it by first year energy bill savings.

DSM Measure Levelized Cost/kWh

DSM supply curves are based on the DSM measure cost per kWh, levelized over the lifetime of the measure. It is calculated by multiplying DSM measure costs by the Capital Recovery Factor (CRF) then dividing by the first year kWh savings.

Figure 7-1 illustrates the flow of information in and out of DSM-RAM. The model is well suited to provide the KEC with realistic estimates of DSM potential for each measure by building type.

Figure 7-1: DSM-RAM Process Flow Overview



7.2 Residential Electric DSM Potential Results

This section provides the electric DSM potential results for the residential sector. Figure 7-2 illustrates the DSM potential in the year 2028 for technical and economic potential along with the five different DSM achievable market scenarios. For comparison purposes, the residential sector sales forecast for the year 2028 is also provided as the first column in the chart.

Figure 7-2: Residential Sector Energy Savings (MWh) for 2028

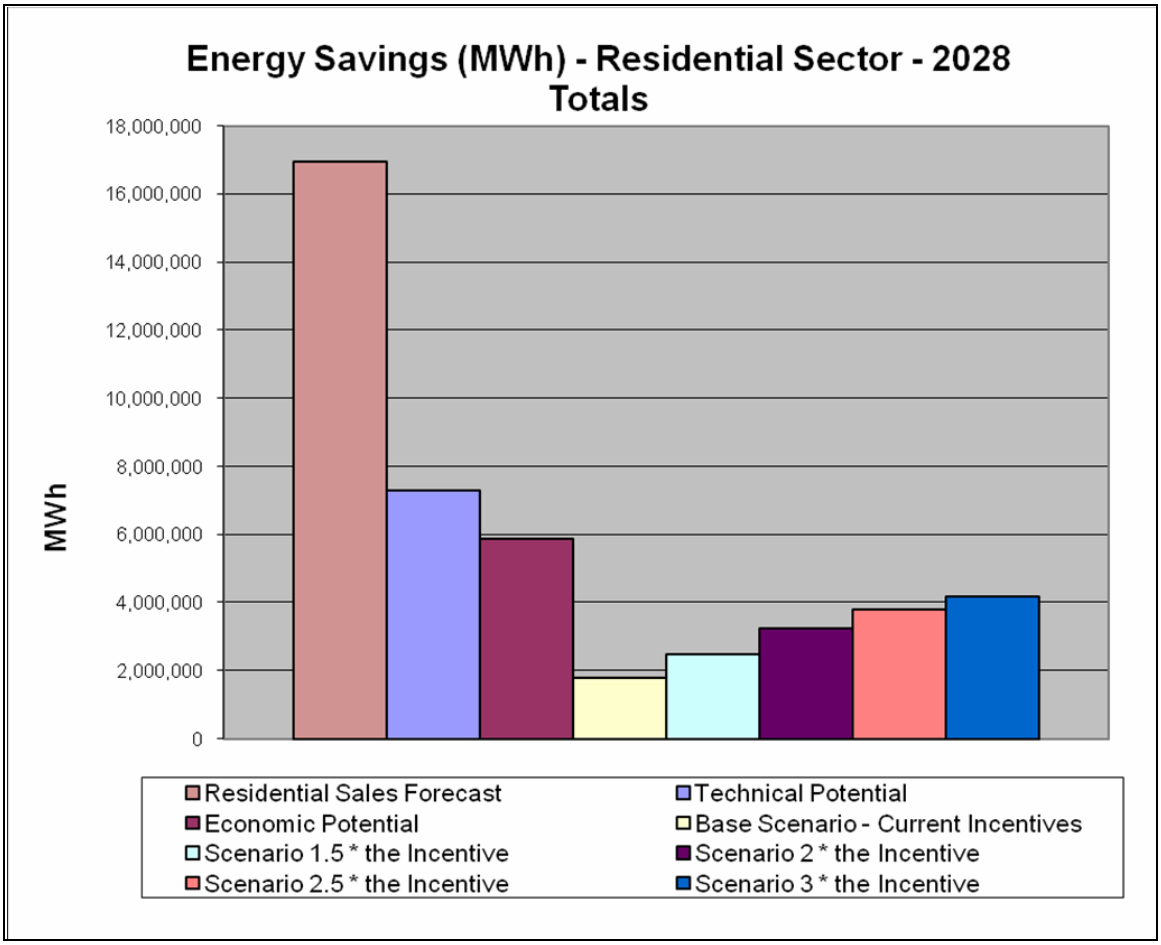


Table 7-1 provides the values illustrated in Figure 7-2. Technical potential is about 43% of forecasted 2028 residential sales. Economic potential is about 35% and the scenarios range from 11% to 25% of residential sales.

Table 7-1: Residential Sector Energy Savings (MWh) for 2028

Energy Savings - Res Sector - 2028 Totals							
Residential Sales Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
16,946,778	7,300,604	5,873,088	1,810,652	2,479,647	3,266,360	3,807,367	4,179,867

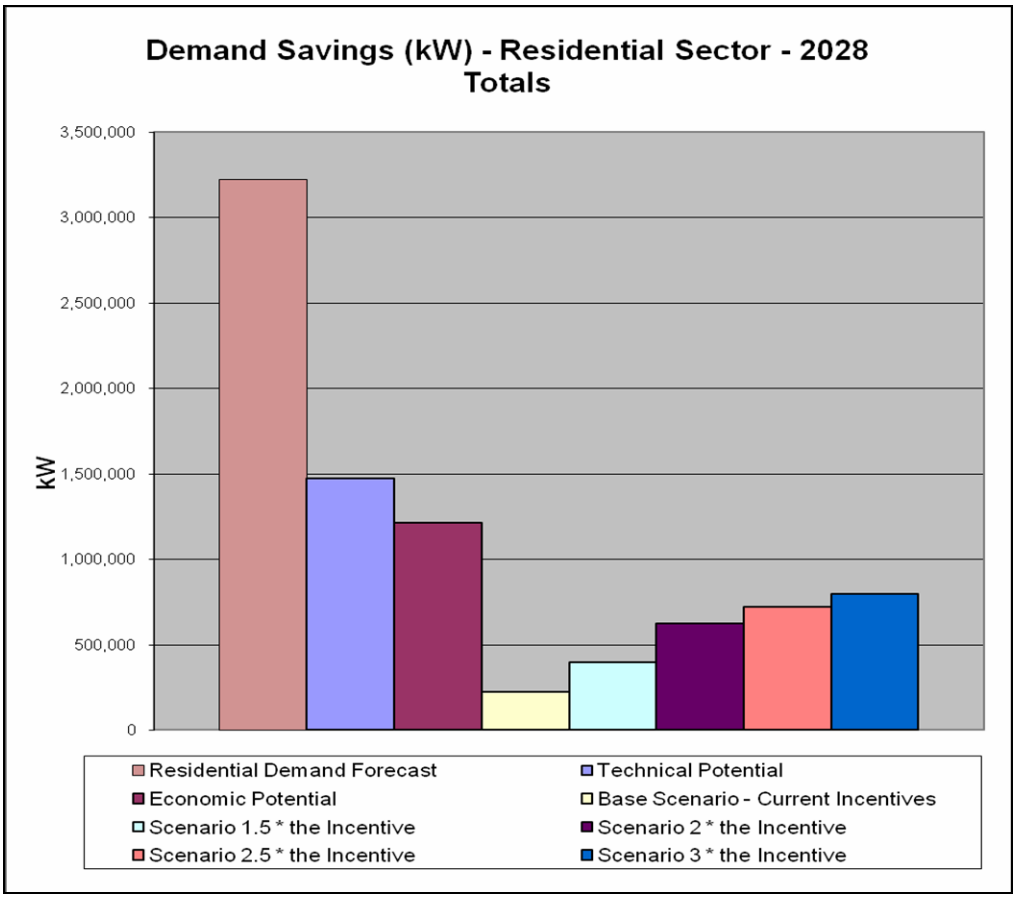
Figure 7-3 illustrates the DSM peak demand reduction potential in the year 2028 for technical and economic potential along with five different DSM achievable market scenarios.[47] As with Figure 7-2, the residential sector peak demand forecast for the year 2028 is also provided as the first column in the chart. Table 7-2 provides the values illustrated in Figure 7-3.

Table 7-2: Residential Sector Peak Demand Savings (MW) for 2028

Demand Savings - Res Sector - 2028 Totals							
Residential Demand Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
3,226,531	1,471,035	1,209,959	222,735	394,008	620,269	717,185	795,444

The potential estimates for peak demand are similar to those for energy when compared to the peak demand forecast. Technical potential is slightly higher at about 46% of forecasted 2028 residential peak demand. Economic potential is also slightly higher at about 38% and the scenarios range from 11% to 25% of residential peak demand.

Figure 7-3: Residential Sector Peak Demand Savings (MW) for 2028



[47] For purposes of this report and the DSM findings, the term "Demand" is used interchangeably with "Peak Demand." That is, when discussing Demand Savings, we are referring ultimately to "Peak Demand" Savings.

Figure 7-4 illustrates the DSM potential by specific years for technical and economic potential as well as the five achievable market potential estimates. The specific years provided are 2008, 2011, 2016, 2021, and 2028. Table 7-3 provides the values illustrated in Figure 7-4.

The 2008 base case market potential estimates are calibrated to the estimates of savings found in other utility programs as identified through the Best Practices review described earlier. As can be seen, the increase in the incentive provided does have a positive impact on anticipated participation. However, the impact is not linear as the incentive is increased. In 2028, the 1.5 scenario has savings potential estimates that are about 37% larger than the base case. The 2.0 scenario also has an increased savings potential estimate at about 32% more than the 1.5 scenario. The incremental increases are smaller in the 2.5 and the 3.0 scenarios with larger savings potential estimates of 17% for the 2.5 scenario compared to the 2.0 and 10% for the 3.0 scenario compared to the 2.5 scenario. Overall, the 3.0 scenario is about 131% larger than the base case scenario in 2028 for energy. The slowing down is reflective of some measures reaching their incremental cost incentive cap as well as some measures reaching saturation within the marketplace.

Figure 7-4: Residential Sector Energy Savings (MWh) for Key Program Years

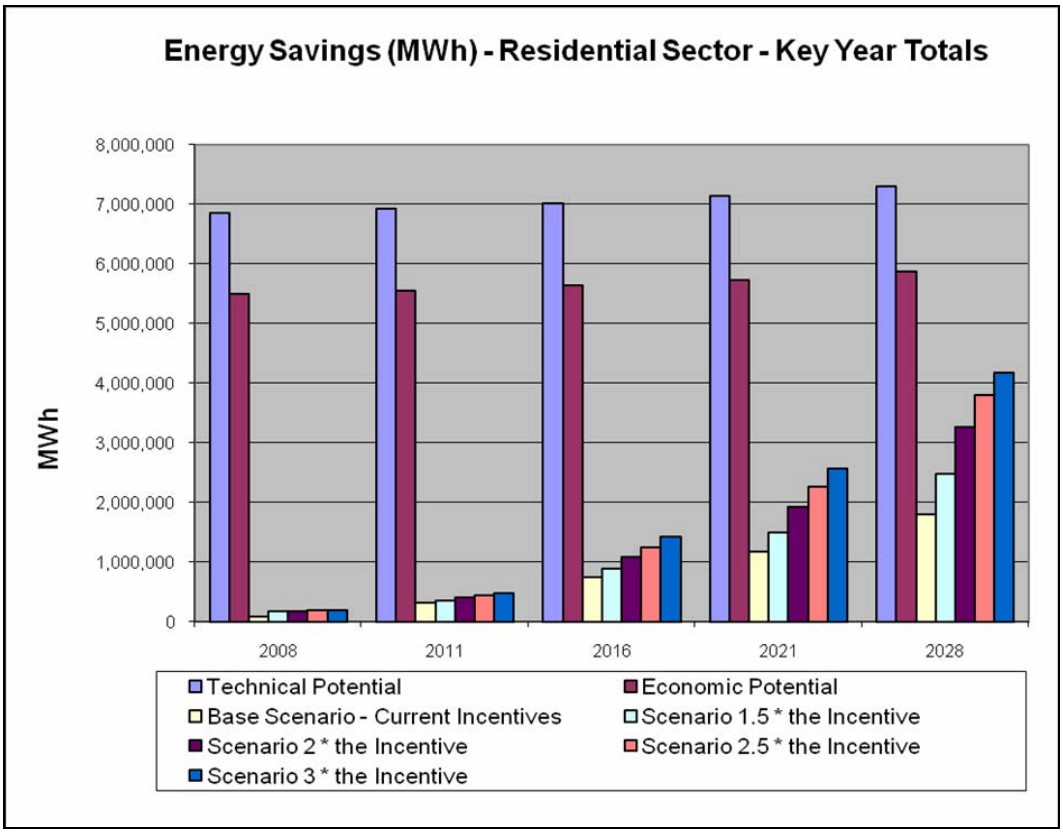


Table 7-3: Residential Sector Energy Savings (MWh) for Key Program Years

Energy Savings - Res Sector - Key Year Totals							
Key Year	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
2008	6,861,574	5,495,724	81,749	173,482	184,635	192,661	201,506
2011	6,920,515	5,546,490	329,662	365,327	409,315	445,164	484,648
2016	7,023,953	5,635,493	751,798	895,836	1,087,641	1,258,151	1,425,501
2021	7,134,186	5,730,236	1,185,230	1,502,081	1,924,076	2,259,844	2,570,557
2028	7,300,604	5,873,088	1,810,652	2,479,647	3,266,360	3,807,367	4,179,867

Figure 7-5 illustrates the DSM peak demand reduction potential by specific years for technical and economic potential along with five different DSM achievable market scenarios. Table 7-4 provides the values illustrated in Figure 7-5.

As with the energy savings estimates, peak demand reduction potential estimates increase with each scenario of higher rebates. The percentage increase also decreases with each higher incentive level, as it does with energy savings potential. However, the increases from incentive level scenario to the next incentive level scenario are much greater that what is seen with energy savings potential.

Figure 7-5: Residential Sector Peak Demand Savings (MW) for Key Program Years

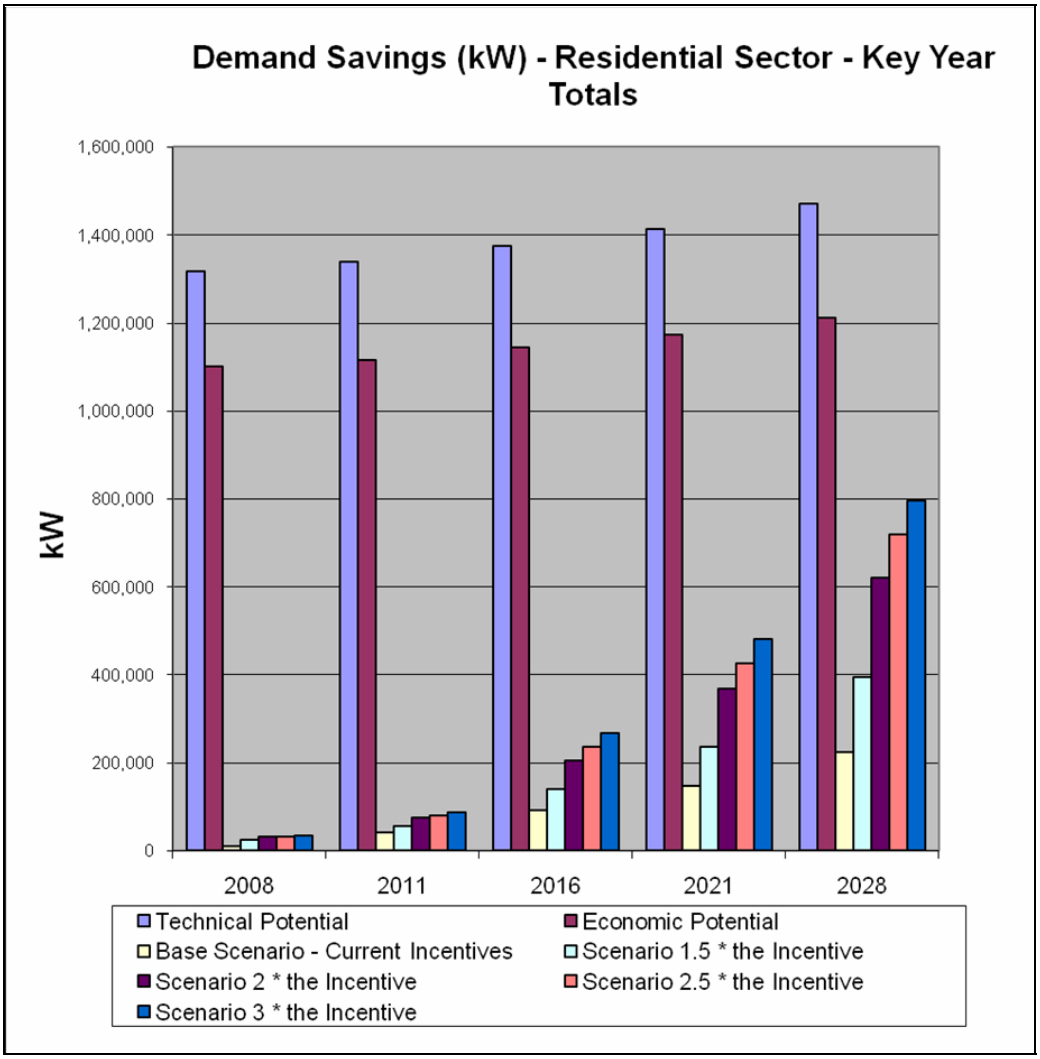


Table 7-4: Residential Sector Peak Demand Savings (MW) for Key Program Years

Demand Savings - Res Sector - Key Year Totals							
Key Year	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
2008	1,316,084	1,100,095	10,004	24,596	30,039	31,423	33,063
2011	1,337,171	1,115,898	40,375	55,130	73,695	80,045	87,461
2016	1,373,938	1,143,474	92,201	139,676	205,285	236,533	266,806
2021	1,412,824	1,172,668	145,556	236,593	366,983	424,907	480,837
2028	1,471,035	1,209,959	222,735	394,008	620,269	717,185	795,444

In 2028, the 1.5 scenario has peak demand savings potential estimates that are about 77% larger than the base case. The 2.0 scenario also has a large increased savings potential estimate of about 57% more than the 1.5 scenario. The incremental increases are still significant, though much smaller in the 2.5 and the 3.0 scenarios with larger peak demand savings potential estimates of 16% for the 2.5 scenario compared to the 2.0 and 11% for the 3.0 scenario compared to the 2.5 scenario. Overall, the 3.0 scenario is about 257% larger than the base case scenario in 2028 for peak demand. This compares to energy in the 3.0 scenario being about 131% larger than the base case scenario in 2028. The reason for this dramatic difference between energy savings potential and peak demand savings potential lies with the shifting of the share of end-use potential among the different end-uses.

Figure 7-6 and Figure 7-7 illustrate the residential economic potential by end-use for energy and peak demand; respectively. As seen in Figure 7-6, lighting is the predominant end-use at about 45% of the total economic potential followed by HVAC at about 37%.

Figure 7-6: Residential Sector Economic Energy Potential (MWh) for 2028

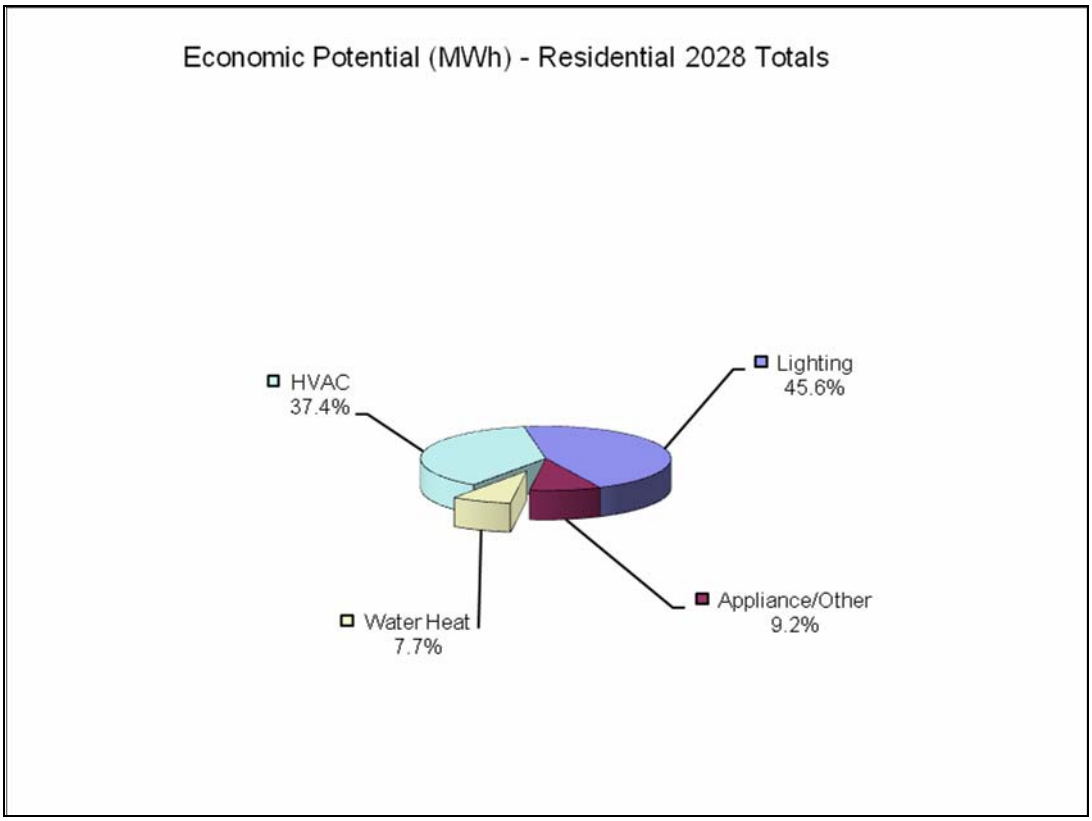
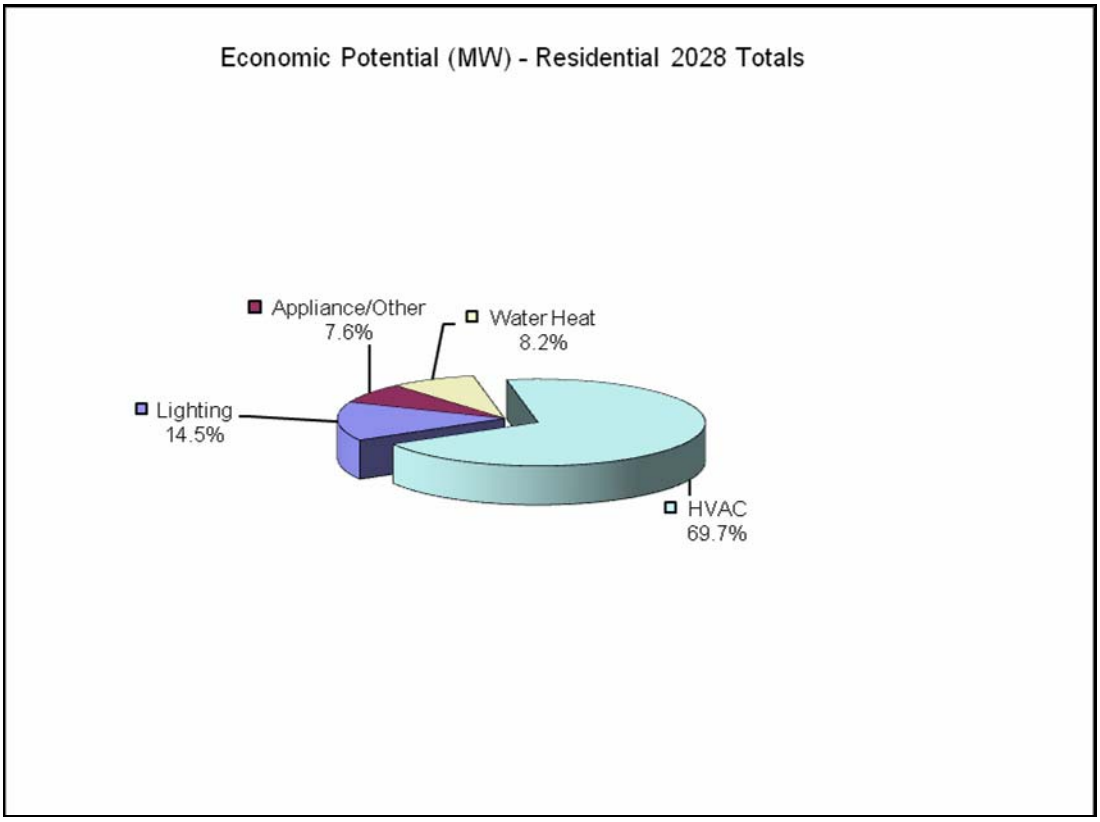


Figure 7-7 illustrates a much different picture of end-use share of economic potential for peak demand savings. This figure illustrates that HVAC is the predominant end-use with nearly 70% of the economic potential while lighting is a distant second at about 15%. These different shares of potential by end-use between energy and peak demand illustrate the high contribution to peak demand provided by HVAC measures as compared to lighting measures. For lighting, the ratio of peak watt to annual energy savings (KWh) is about 0.1. For central A/C, this ratio is a much higher 1.0.

Figure 7-7: Residential Sector Economic Peak Demand Potential (MW) for 2028



The calibration targets used in developing the different market potential estimates reflect the higher incidence of achieved savings from lighting programs as compared to the other end uses. Lighting measures represent 70% of the initial calibrated energy savings potential as compared to 20% for HVAC measures. The calibration within the base scenario also defines the decision making choice coefficients as determined by the current market place. Figure 7-8 reflects this initial calibration of decision making with lighting contributing a 70% share of 2028 base incentive market potential and HVAC 20%. These values translate into peak demand potential savings of about 40% for lighting and 44% for HVAC, as shown in Figure 7-9.

Figure 7-8: Residential Sector Base Scenario - Current Incentives; Share of Potential Energy Savings (MWh) by End-Use for 2028

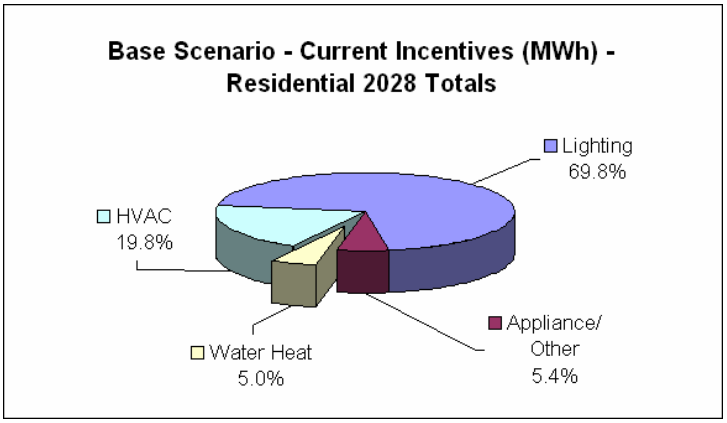
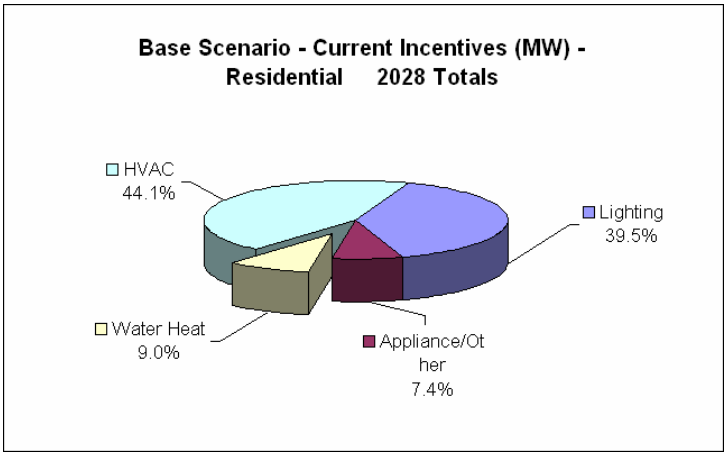


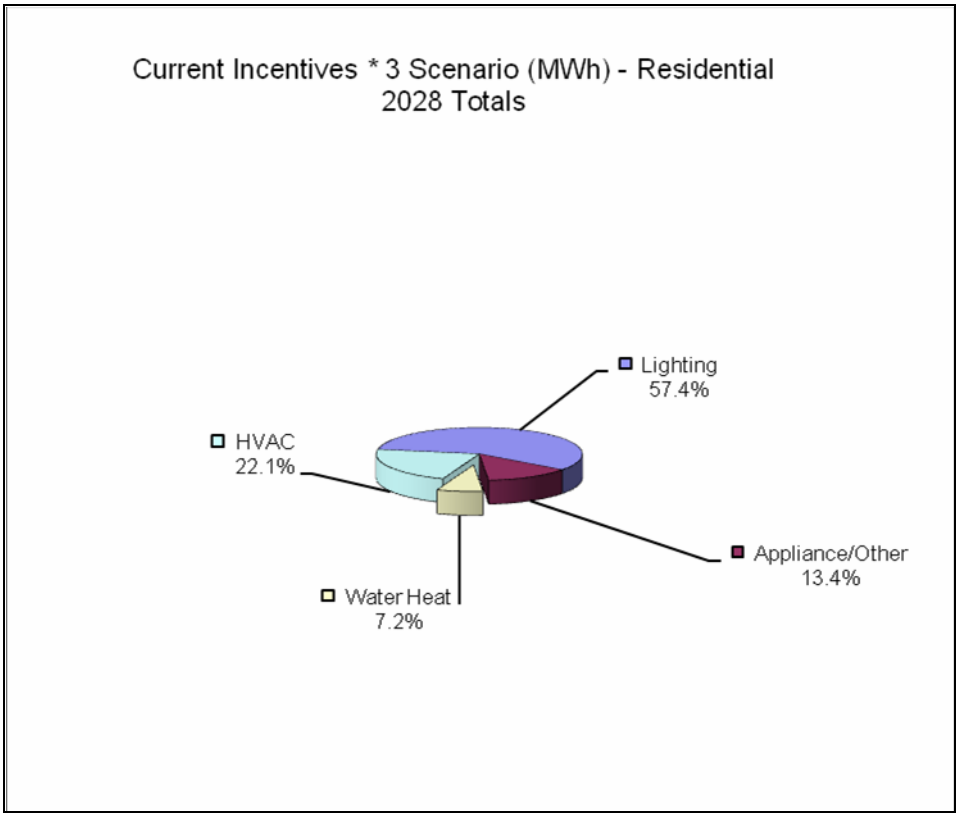
Figure 7-9: Residential Sector Base Scenario - Current Incentives; Share of Potential Peak Demand Savings (MW) by End-Use for 2028



Changing the level of incentive in the other market potential scenarios changes consumer payback values, which change the decision maker coefficients for participating in the DSM programs. The ultimate effect in Kansas is that the latent potential for non-lighting measures, as seen in Figure 7-6 and Figure 7-7, comes into play. These measures become more cost effective and the share of HVAC measures adopted (as well as water heat and appliance measures, which also have larger peak demand impacts compared to lighting measures) becomes larger relative to lighting measures.

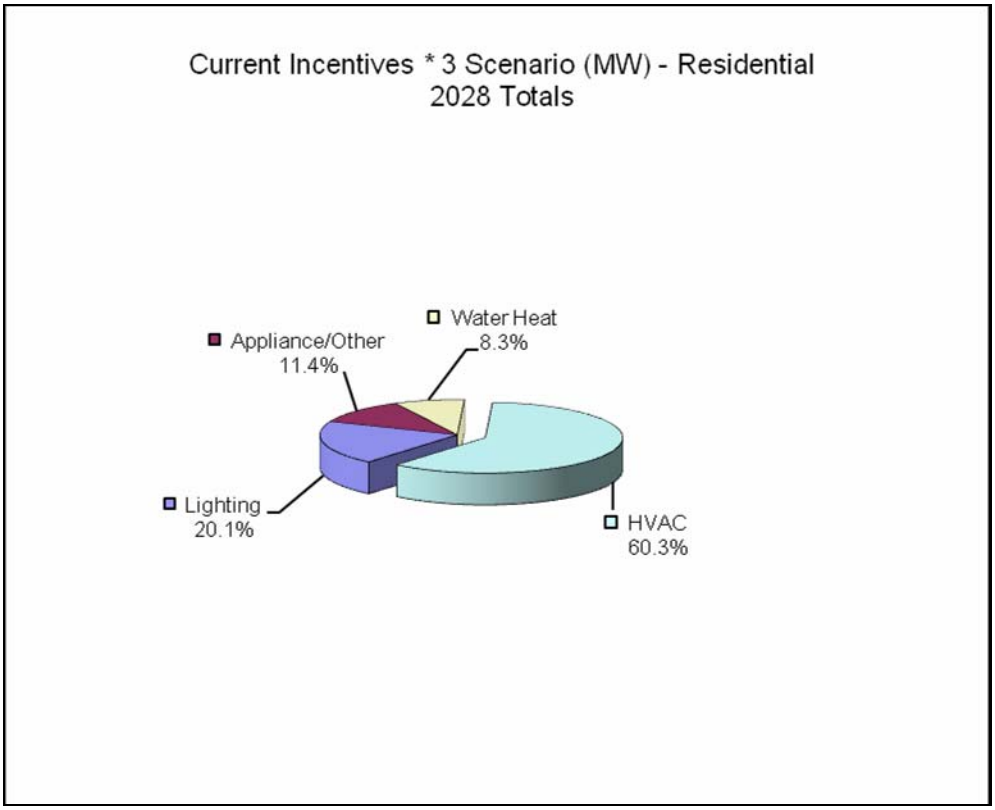
Figure 7-10 and 7-11 reflect these changes in consumer behavior with higher incentives. Compared to the base scenario, the share of lighting measures drops from 70% in the base scenario to 57% in the incentives * 3 scenario for energy.

Figure 7-10: Residential Sector 3x the Current Incentive; Share of Potential Energy Savings (MWh) by End-Use for 2028



The share change is even more dramatic for peak demand, as illustrated in Figure 7-11. For peak demand, the savings potential share of 40% found in the base scenario falls to less than 15% for the incentives * 3 scenario. HVAC provides around 60% share of the peak demand potential for 2028 in the incentives * 3 scenario.

Figure 7-11: Residential Sector 3x the Current Incentive; Share of Potential Peak Demand Savings (MW) by End-Use for 2028



Tables 7-5 and 7-6 provide the values illustrated in Figures 7-6 through 7-11.

Table 7-5: Electricity Potential Energy Savings (MWh) for 2028 by End-Use – Residential Sector

Energy Savings - Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Lighting	3,584,026	2,680,176	1,262,990	1,638,937	2,051,307	2,295,689	2,399,646
Appliance/Other	965,444	540,702	98,007	168,564	288,667	443,800	558,129
Water Heat	453,491	453,491	90,988	127,057	172,204	228,018	300,228
HVAC	2,297,644	2,198,719	358,668	545,089	754,181	839,860	921,863

Table 7-6: Electricity Potential Peak Demand Savings (KW) for 2028 by End-Use – Residential Sector

Demand Savings - Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Lighting	275,125	175,586	88,071	113,714	141,407	156,321	159,561
Appliance/Other	235,894	91,601	16,514	28,193	47,894	72,579	90,430
Water Heat	103,028	99,800	20,024	27,961	37,896	50,176	66,064
HVAC	856,988	842,973	98,125	224,140	393,072	438,109	479,389

7.3 Residential Gas DSM Potential Results

This section provides the gas DSM potential results for the residential sector. Figure 7-12 illustrates the DSM potential in the year 2028 for technical and economic potential along with the five different DSM achievable market scenarios. For comparison purposes, the residential sector sales forecast for the year 2028 is also provided as the first column in the chart.

Figure 7-12: Residential Sector Gas Savings (MMcf) for 2028

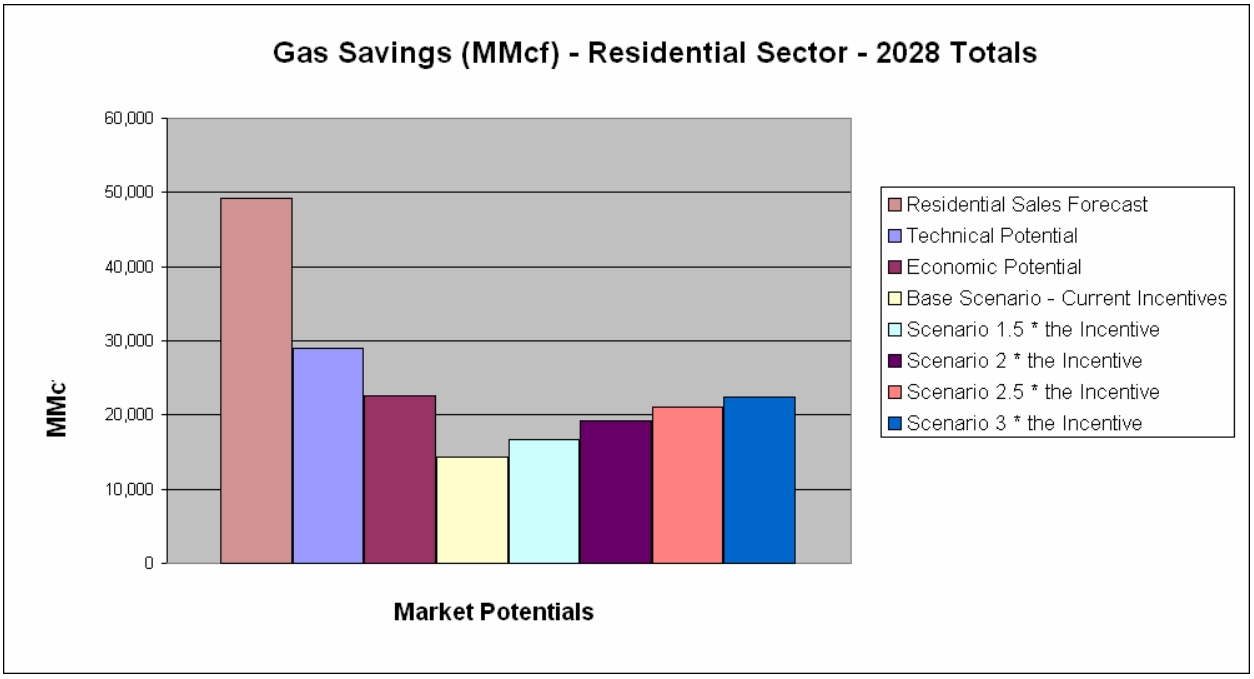


Table 7-7 provides the values illustrated in Figure 7-12. Technical potential is about 59% of forecasted 2028 residential sales. Economic potential is about 45% and the scenarios range from 30% to 45% of residential sales.

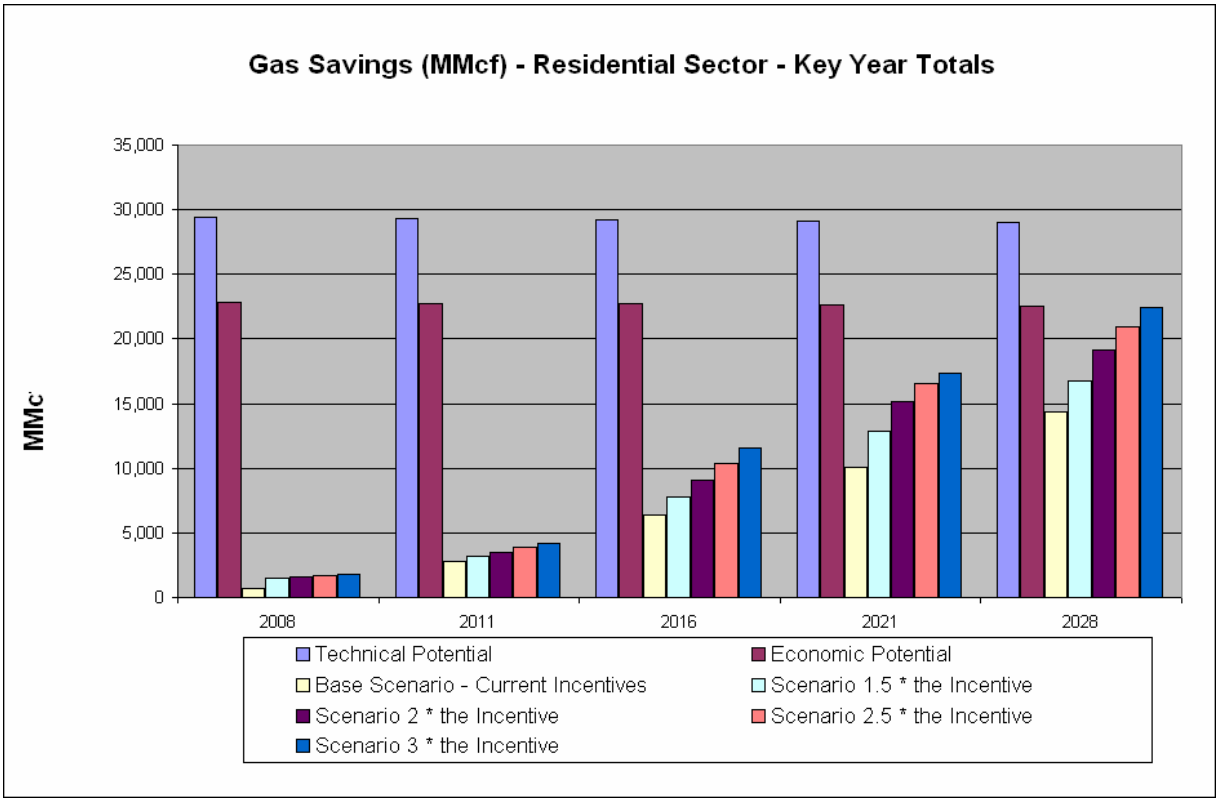
Table 7-7: Residential Sector Gas Savings (MMcf) for 2028

Gas Savings (MMcf) - Res Sector - 2028 Totals							
Residential Sales Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
49,231	28,999	22,500	14,353	16,756	19,139	20,984	22,456

Figure 7-13 illustrates the DSM potential by specific years for technical and economic potential as well as the five achievable market potential estimates. The specific years provided are 2008, 2011, 2016, 2021, and 2028. Table 7-8 provides the values illustrated in Figure 7-13.

The 2008 base case market potential estimates are calibrated to the estimates of savings found in other utility programs as identified through the Best Practices review described earlier. As can be seen, the increase in the incentive provided does have a positive impact on anticipated participation. However, the impact is not linear as the incentive is increased.

Figure 7-13: Residential Sector Gas Savings (MMcf) for Key Program Years



As shown by the values in Table 7-8, the 1.5 scenario has savings potential estimates that are about 27% larger than the base case in 2028. The 2.0 scenario also has an increased savings potential estimate, but a smaller 18% more than the 1.5 scenario. The incremental increases continue to decline for the 2.5 and the 3.0 scenarios with savings potential estimates of 9% for the 2.5 scenario compared to the 2.0 and 5% for the 3.0 scenario compared to the 2.5 scenario. The slowing down is reflective of some measures reaching their incremental cost incentive cap as well as some measures reaching saturation within the marketplace.

Each of the five scenarios estimates that a large share of the economic potential can be captured. For the base case scenario, it is estimated that 64% of the economic potential can be captured by 2028. For the 3.0 scenario, the estimate grows to nearly 100%. This compares to residential electric where the base case is about 31% of economic potential in 2028 and the 3.0 scenario is about 71% of economic potential in 2028. There are two primary reasons for this difference. The first is the beginning calibration targets. For electricity, the calibration targets are about 1% of total sector sales while for gas the targets are about

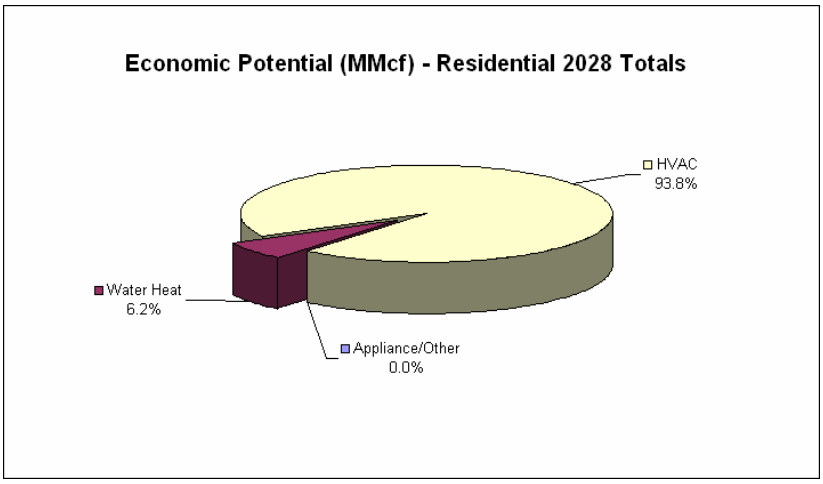
1.3% of total sector sales. The other primary reason is a projected growth in annual electricity sales of about 1% per year while gas utilization is projected to decline by about 0.67% per year.

Table 7-8: Residential Sector Gas Savings (MMcf) for Key Program Years

Gas Savings (MMcf) - Res Sector - Key Year Totals							
Key Year	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
2008	29,399	22,818	701	1,501	1,580	1,667	1,757
2011	29,339	22,770	2,823	3,169	3,484	3,840	4,196
2016	29,238	22,690	6,428	7,738	9,055	10,376	11,599
2021	29,138	22,611	10,117	12,859	15,160	16,521	17,392
2028	28,999	22,500	14,353	16,756	19,139	20,984	22,456

Figure 7-14 illustrates the residential economic potential by end-use for the year 2028. HVAC measures account for 94% of the economic potential and water heating measures the remaining 6%. The appliance gas measures did not pass the TRC test.

Figure 7-14: Residential Sector Economic Gas Potential (MMcf) for 2028



The 2008 base case market potential estimates are calibrated to the estimates of savings found in other utility programs as identified through the Best Practices review described earlier. The calibration targets used in developing the different market potential estimates reflect the higher incidence of achieved savings from HVAC programs as compared to the other end uses. HVAC measures represent 95% of the initial calibrated energy savings potential as compared to 5% for Water Heat measures.

As shown in Figure 7-15 compared to 7-16, there is little difference in end-use share between the base case scenario and the 3.0 scenario. These end-use shares are also nearly identical to the end-use shares shown in the economic potential chart shown in Figure 7-14. Tables 7-9 provides the values illustrated in Figures 7-14 through 7-16.

Table 7-9: Potential Natural Gas Savings (MCF) for 2028 by End-Use – Residential Sector

Gas Savings (MMcf) - Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Appliance/Other	1,295	0	0	0	0	0	0
Water Heat	2,985	1,405	751	876	959	1,021	1,050
HVAC	24,720	21,095	13,602	15,457	17,404	18,940	20,607

Figure 7-15: Residential Sector Base Scenario - Current Incentives; Share of Potential Gas Savings (MMcf) by End-Use for 2028

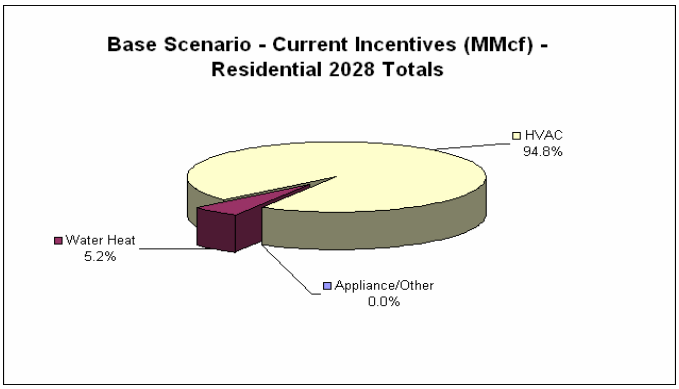
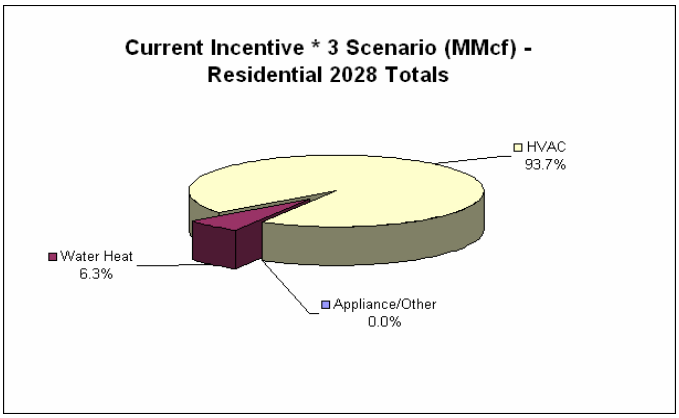


Figure 7-16: Residential Sector 3x the Current Incentive; Share of Potential Gas Savings (MMcf) by End-Use for 2028



7.4 Non-Residential Electric DSM Potential Results

This section provides the electric DSM potential results for the non-residential sector. Figure 7-17 illustrates the DSM potential in the year 2028 for technical and economic potential along with the five different DSM achievable market scenarios. For comparison purposes, the non-residential sector sales forecast for the year 2028 is also provided as the first column in the chart.

Figure 7-16: Non-Residential Sector Energy Savings (MWh) for 2028

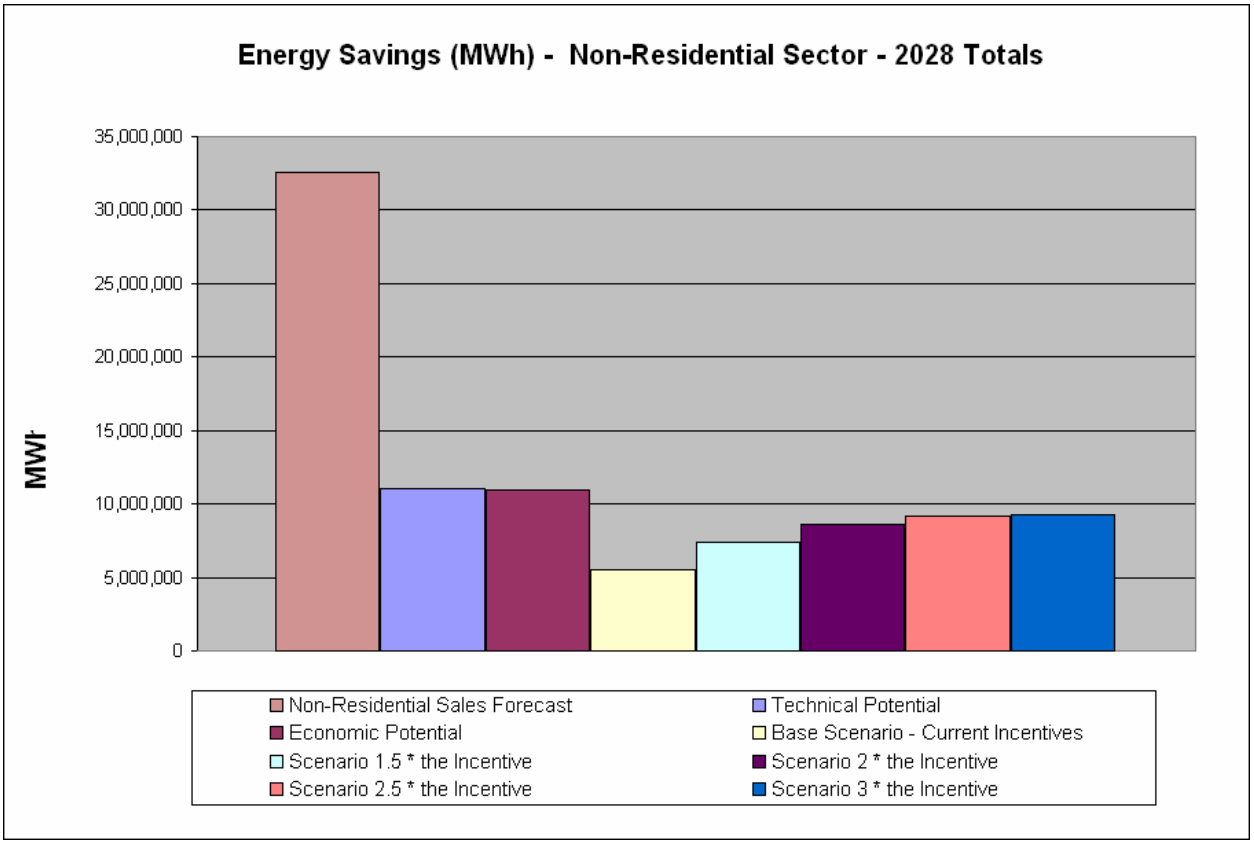


Table 7-10 provides the values illustrated in Figure 7-17. Both technical and economic potential are about 34% of forecasted 2028 residential sales. The five scenarios range from 17% to 29% of non-residential sales. The base scenario is about 50% of economic potential with the incentive*3 scenario about 84% of economic potential.

Table 7-10: Non-Residential Sector Energy Savings (MWh) for 2028

Energy Savings - Com Sector - 2028 Totals							
Non-Residential Sales Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
32,541,602	11,080,451	10,914,104	5,555,176	7,393,693	8,642,310	9,159,010	9,280,636

Figure 7-18 illustrates the DSM peak demand reduction potential in the year 2028 for technical and economic potential along with the five different DSM achievable market scenarios. As with Figure 7-17, the non-residential sector peak demand forecast for the year 2028 is also provided as the first column in the chart. Table 7-11 provides the values illustrated in Figure 7-18.

Table 7-11: Non-Residential Sector Peak Demand Savings (MW) for 2028

Demand Savings - Com Sector - 2028 Totals							
Non-Residential Demand Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
13,492,937	5,129,851	5,080,271	2,659,373	3,453,995	3,991,668	4,132,358	4,175,790

The potential estimates for peak demand savings are a similar but higher than those for energy when compared to the peak demand forecast. Both technical and economic potential are about 38% of forecasted 2028 non-residential peak demand. The scenarios range from 20% to 31% of non-residential peak demand. The base scenario is about 27% of economic potential with the incentive*3 scenario about 82% of economic potential.

Figure 7-17: Non-Residential Sector Peak Demand Savings (MW) for 2028

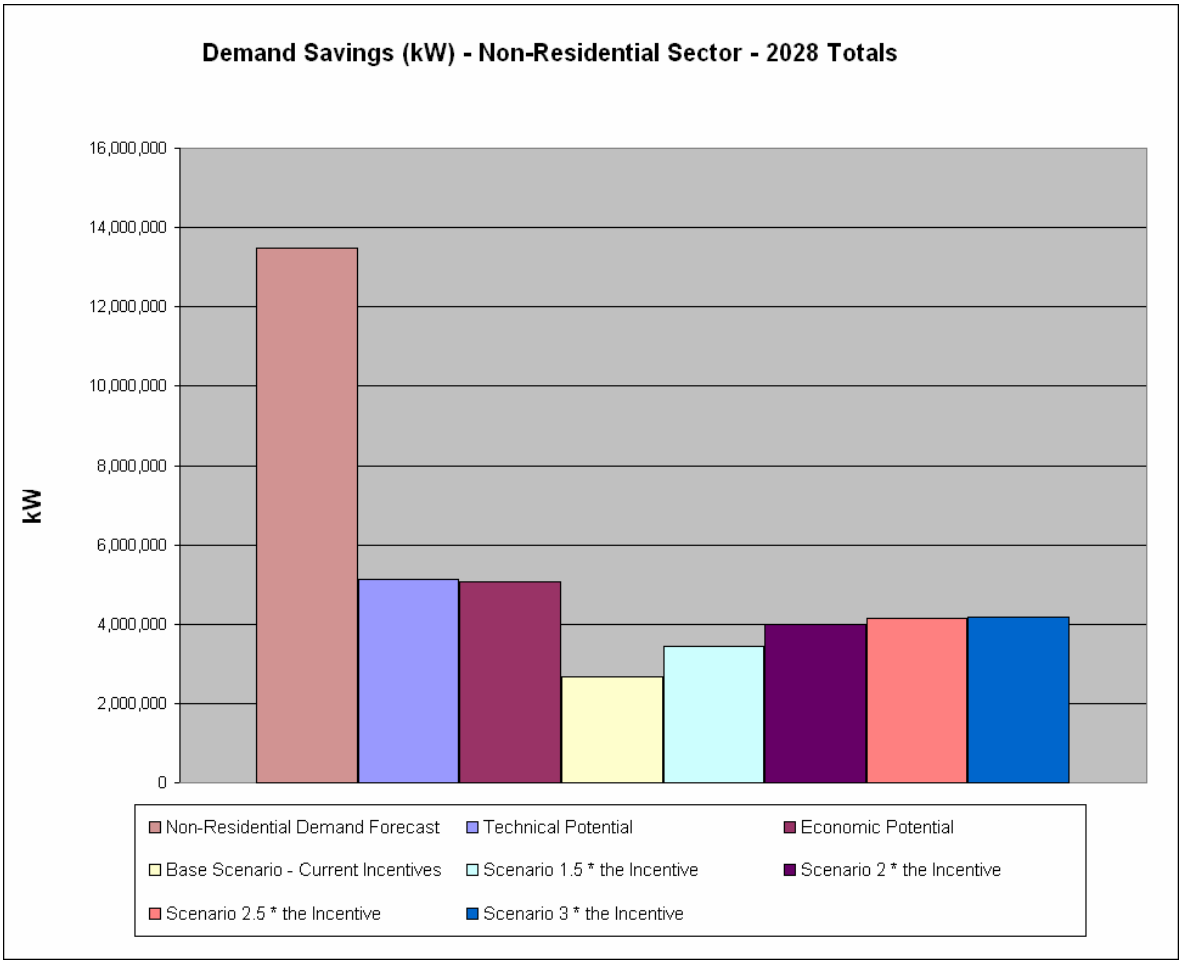


Figure 7-19 illustrates the DSM potential by specific years for technical and economic potential as well as the five achievable market potential estimates. The specific years provided are 2008, 2011, 2016, 2021, and 2028. Table 7-12 provides the values illustrated in Figure 7-19.

The 2008 base case market potential estimates are calibrated to the estimates of savings found in other utility programs as identified through the Best Practices review described earlier. As can be seen, the increase in the incentive provided does have a positive impact on anticipated participation. However, the impact is not linear as the incentive is increased. In 2008, the 1.5 scenario has savings potential estimates that are about 33% larger than the base case. The 2.0 scenario also has an increased savings potential estimate of 17% more than the 1.5 scenario. The incremental increases continue the trend to be smaller with savings potential estimates of 6% for the 2.5 scenario compared to the 2.0 and 1% for the 3.0 scenario compared to the 2.5 scenario. Overall, the 3.0 scenario is about 86% larger than the base case. The slowing down is reflective of some measures reaching their incremental cost incentive cap as well as some measures reaching saturation within the marketplace. The net effect of the different incentive levels is to primarily quicken overall adoption and not have it spread out so much over the forecast period.

Figure 7-18: Energy Savings (MWh) for Key Program Years

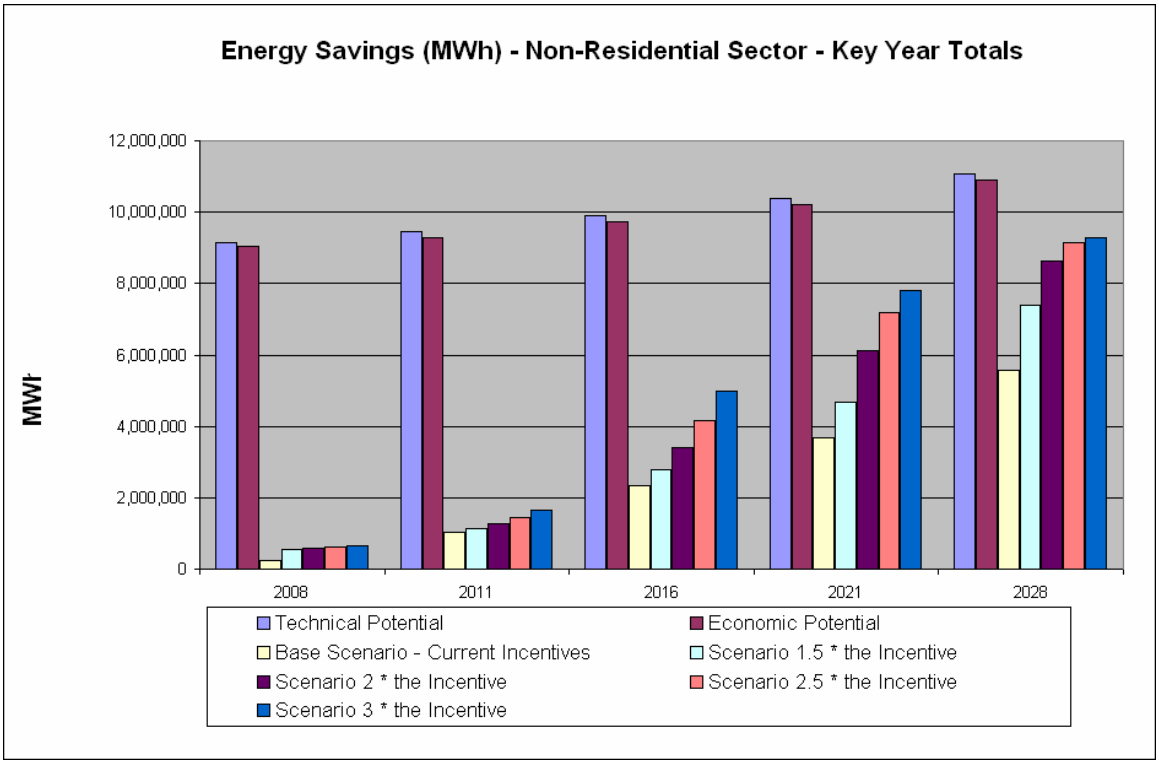


Table 7-12: Non-Residential Sector Energy Savings (MWh) for Key Program Years

Energy Savings - Non-Res Sector - Key Year Totals

Key Year	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
2008	9,162,538	9,026,210	248,914	541,913	577,772	619,068	668,886
2011	9,439,249	9,298,790	1,022,860	1,132,952	1,275,137	1,441,932	1,645,263
2016	9,893,407	9,745,783	2,326,234	2,780,264	3,415,060	4,157,971	4,978,609
2021	10,370,799	10,215,645	3,670,397	4,683,599	6,106,770	7,198,392	7,788,631
2028	11,080,451	10,914,104	5,555,176	7,393,693	8,642,310	9,159,010	9,280,636

Figure 7-20 illustrates the DSM peak demand reduction potential by specific years for technical and economic potential along with five different DSM achievable market scenarios. Table 7-13 provides the values illustrated in Figure 7-20.

As with the energy savings estimates, peak demand reduction potential estimates increase with each scenario of higher rebates. The percentage increase also decreases with each higher incentive level, as it does with energy savings potential. The pattern of increases is similar, though with slightly higher percentages, for peak demand potential savings as compared to energy potential savings.

Figure 7-20: Non-Residential Sector Peak Demand Savings (MW) for Key Program Years

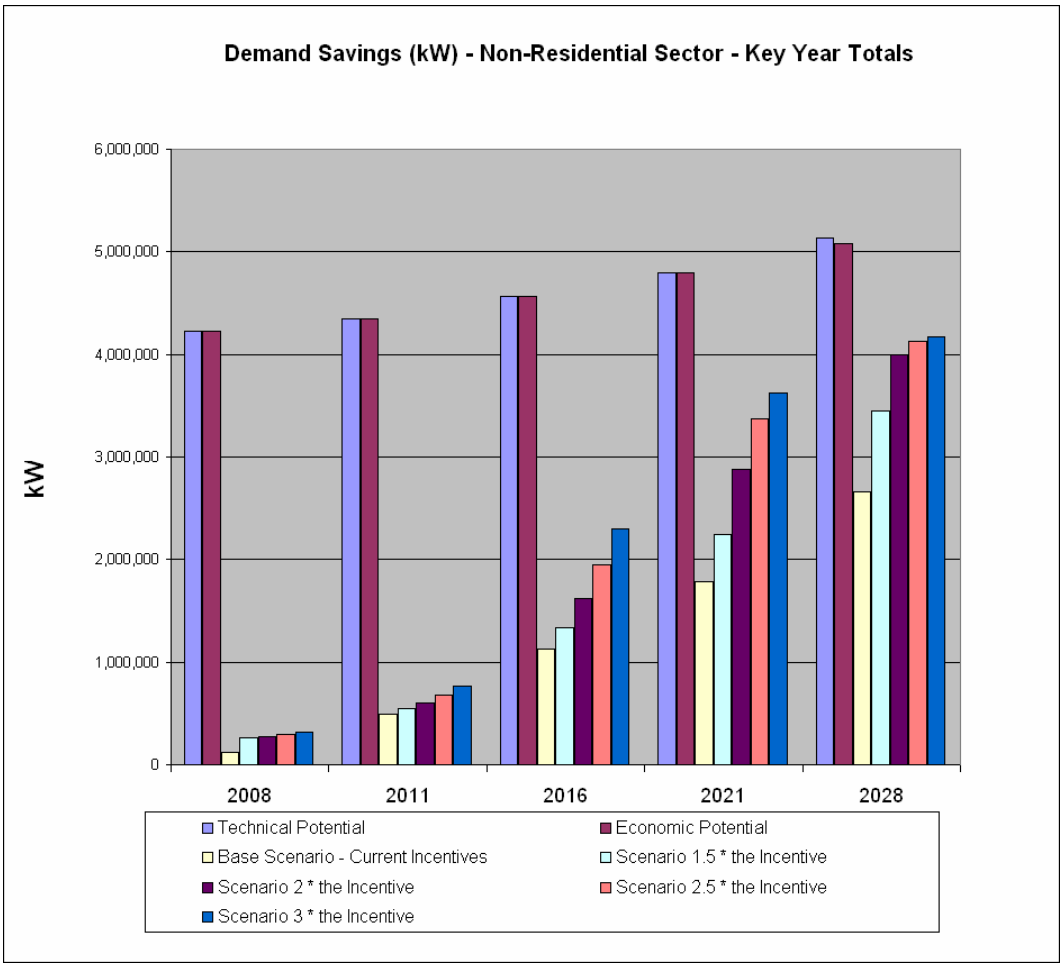


Table 7-13: Non-Residential Sector Peak Demand Savings (MW) for Key Program Years

Demand Savings - Non-Res Sector - Key Year Totals							
Key Year	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
2008	4,223,443	4,223,564	123,341	259,861	275,217	292,909	314,268
2011	4,348,163	4,348,290	496,121	544,189	606,421	679,306	768,004
2016	4,564,496	4,564,631	1,131,107	1,334,242	1,618,240	1,947,082	2,302,600
2021	4,791,877	4,792,022	1,785,249	2,243,717	2,882,136	3,370,432	3,622,825
2028	5,129,851	5,080,271	2,659,373	3,453,995	3,991,668	4,132,358	4,175,790

In 2008, the 1.5 scenario has savings potential estimates that are about 30% larger than the base case. The 2.0 scenario also has an increased savings potential estimate of 16% more than the 1.5 scenario. The incremental increases continue the trend to be smaller with savings potential estimates of 4% for the 2.5 scenario compared to the 2.0 and 1% for the 3.0 scenario compared to the 2.5 scenario. Overall, the 3.0 scenario is about 57% larger than the base case.

Figure 7-21 and Figure 7-22 illustrate the non-residential sector economic potential by end-use for energy and peak demand; respectively. As seen in Figure 7-21, lighting is the predominant end-use at about 44% of the total economic potential followed by motors and custom measures at about 33% and HVAC at 22%.

Figure 7-21: Non-Residential Sector Economic Energy Potential (MWh) for 2028

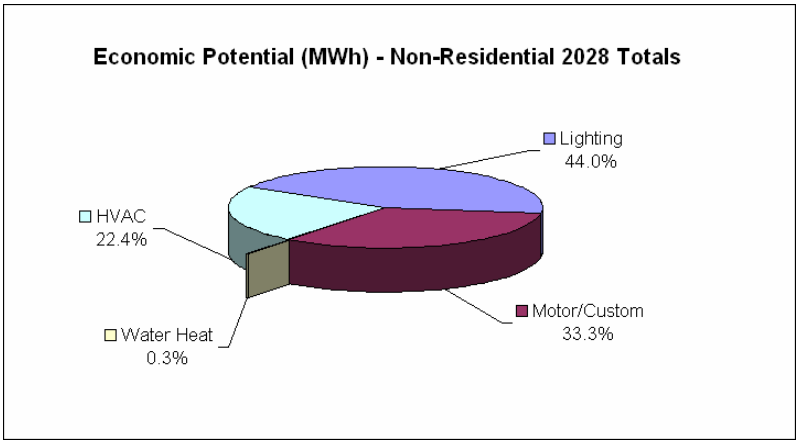
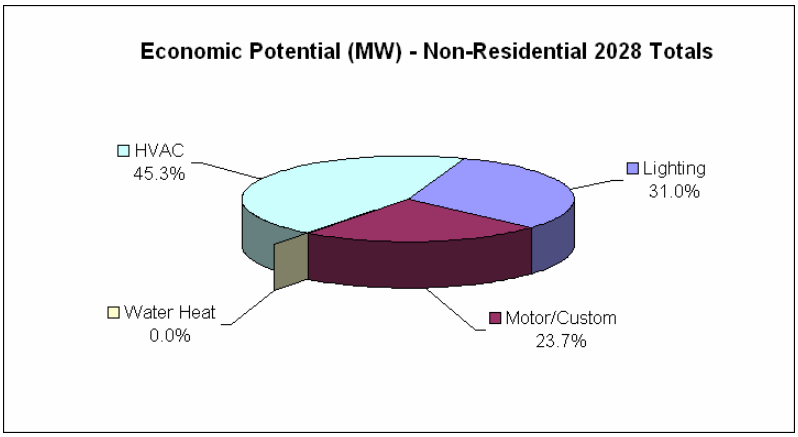


Figure 7-22 illustrates a different picture of end-use share of economic potential for peak demand savings. This figure illustrates that HVAC is now the largest end-use with about a 45% share of the economic potential with lighting now in second at 31%, and motors/custom measures at about 24%. This pattern is similar to the pattern found in the residential sector and illustrate the different contributions to peak demand provided by HVAC measures as compared to lighting measures.

Figure 7-19: Non-Residential Sector Economic Peak Demand Potential (MW) for 2028



The calibration targets used in developing the different market potential estimates reflect the higher incidence of achieved savings from lighting programs as compared to the other end uses. Lighting measures represent 40% of the initial calibrated energy savings potential as compared to 30% for motors and custom measures and 25% for HVAC measures. The calibration within the base scenario also defines the decision making choice coefficients as determined by the current market place. Figure 7-23 reflects this initial calibration of decision making with by the year 2028 giving a lighting contributing a 43% share of 2028 base incentive market potential, motors/custom 32%, and HVAC 25%. These values translate into peak demand potential savings of about 29% for lighting, 19% for motors/custom, and 51% for HVAC, as shown in Figure 7-24.

Figure 7-20: Non-Residential Sector Base Scenario - Current Incentives; Share of Potential Energy Savings (MWh) by End-Use for 2028

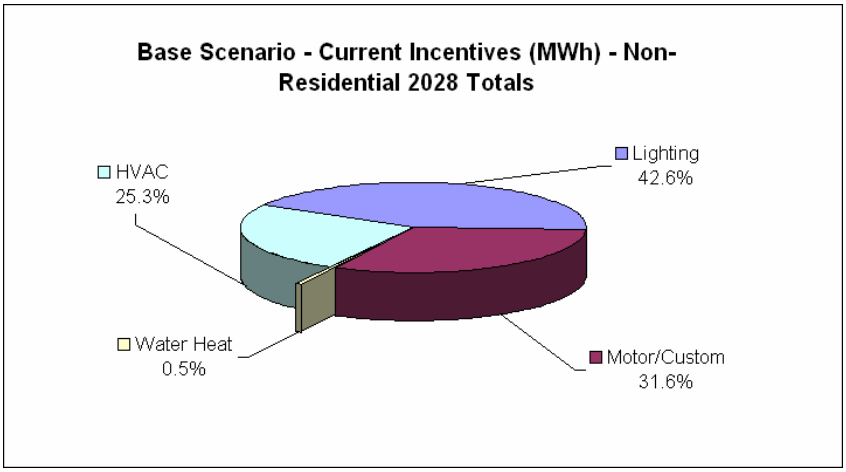
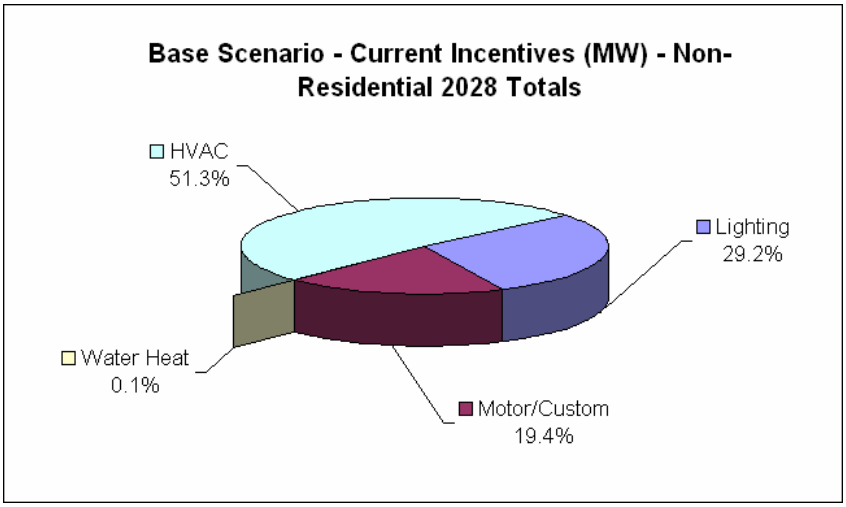


Figure 7-21: Non-Residential Sector Base Scenario - Current Incentives; Share of Potential Peak Demand Savings (MW) by End-Use for 2028



Changing the level of incentive in the other market potential scenarios changes consumer payback values, which change the decision maker coefficients for participating in the DSM programs. However, the effect of these changes is to only slightly modify the end use shares of both energy and peak demand potential savings. Figure 7-25 and Figure 7-26 illustrate these changes for the incentives * 3 scenario.

For energy, as shown in Figures 7-23 and 7-25, when compared to the base scenario, the share for lighting measures shifts from 42.6% in the base scenario to 43.5% in the incentives * 3 scenario for energy. Motors/custome measures grows slightly from 31.6% to 34.3%. HVAC measures fall from 25.3% in the base scenario to 21.8% in the incentives * 3 scenario. For peak demand, as shown in Figures 7-24 and 7-26, the share for lighting grows from 29.2% in the base scenario to 31.7% in the incentives * 3 scenario. Motors/custom measures grows from 19.4% to 22.%%. HVAC falls from 51.3% in the base scenario to 45.7% in the incentives *3 scenario.

Figure 7-22: Non-Residential Sector 3x the Current Incentive; Share of Potential Energy Savings (MWh) by End-Use for 2028

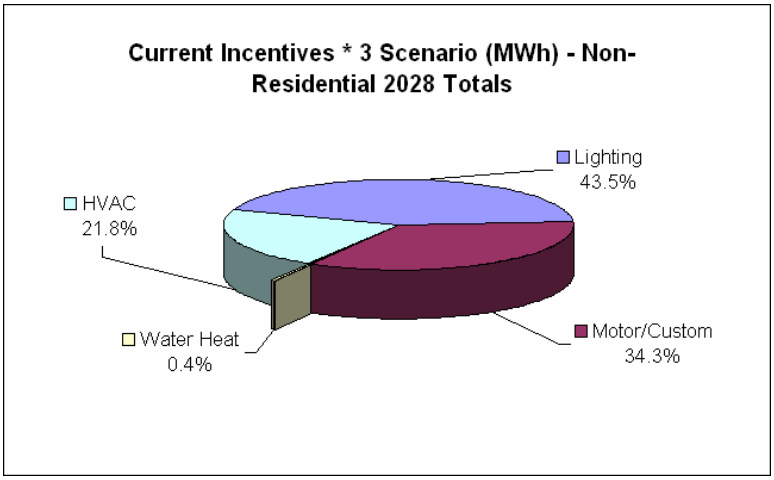
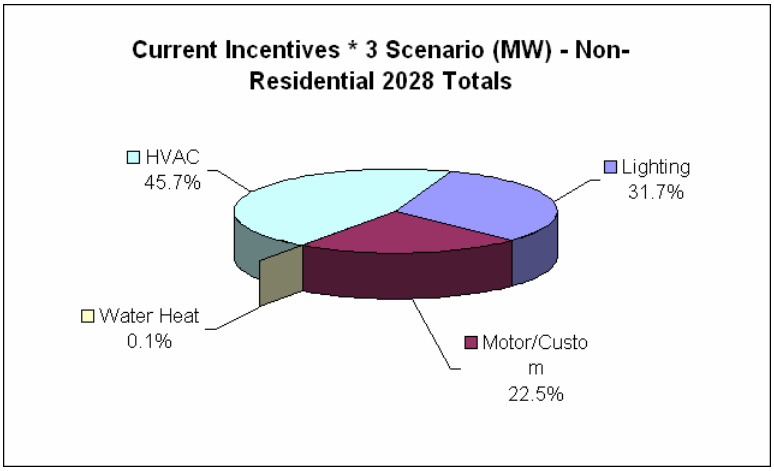


Figure 7-23: Non-Residential Sector 3x the Current Incentive; Share of Potential Peak Demand Savings (MW) by End-Use for 2028



The values used in Figures 7-21 through 7-26 can be found in Table 7-14 and Table 7-15.

Table 7-14: Electricity Potential Energy Savings (MWh) for 2028 by End-Use – Non-Residential Sector

Energy Savings - Non-Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Lighting	4,958,637	4,798,766	2,365,209	3,044,756	3,587,639	3,881,980	4,033,303
Motor/Custom	3,638,811	3,638,811	1,757,645	2,560,709	2,979,299	3,215,357	3,187,382
Water Heat	36,966	30,490	29,519	32,332	32,653	33,417	35,363
HVAC	2,446,036	2,446,036	1,402,804	1,755,896	2,042,718	2,028,257	2,024,588

Table 7-15: Electricity Potential Peak Demand Savings (KW) for 2028 by End-Use – Non-Residential Sector

Demand Savings - Non-Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Lighting	1,623,771	1,574,692	776,122	1,007,300	1,200,506	1,276,605	1,325,669
Motor/Custom	1,203,699	1,203,699	515,658	760,087	867,862	944,175	939,390
Water Heat	2,355	1,855	2,017	2,065	2,092	2,114	2,135
HVAC	2,300,025	2,300,025	1,365,575	1,684,542	1,921,209	1,909,464	1,908,596

7.5 Non-Residential Gas DSM Potential Results

This section provides the gas DSM potential results for the non-residential sector. Figure 7-27 illustrates the DSM potential in the year 2028 for technical and economic potential along with the five different DSM achievable market scenarios. For comparison purposes, the non-residential sector sales forecast for the year 2028 is also provided as the first column in the chart.

Figure 7-24: Non-Residential Sector Gas Savings (MMcf) for 2028

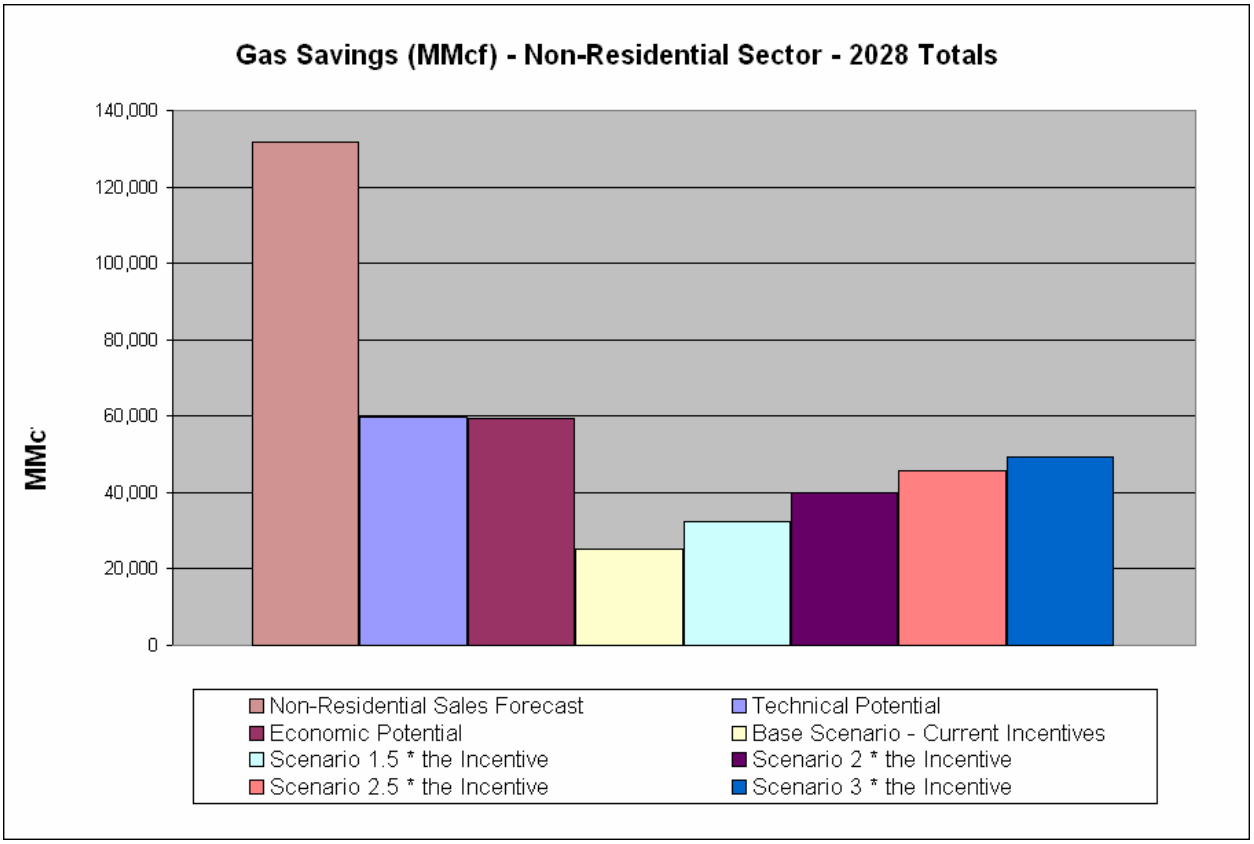


Table 7-16 provides the values illustrated in Figure 7-27. Both technical and economic potential are about 45% of forecasted 2028 non-residential sales. The five scenarios range from 19% to 37% of non-residential sales.

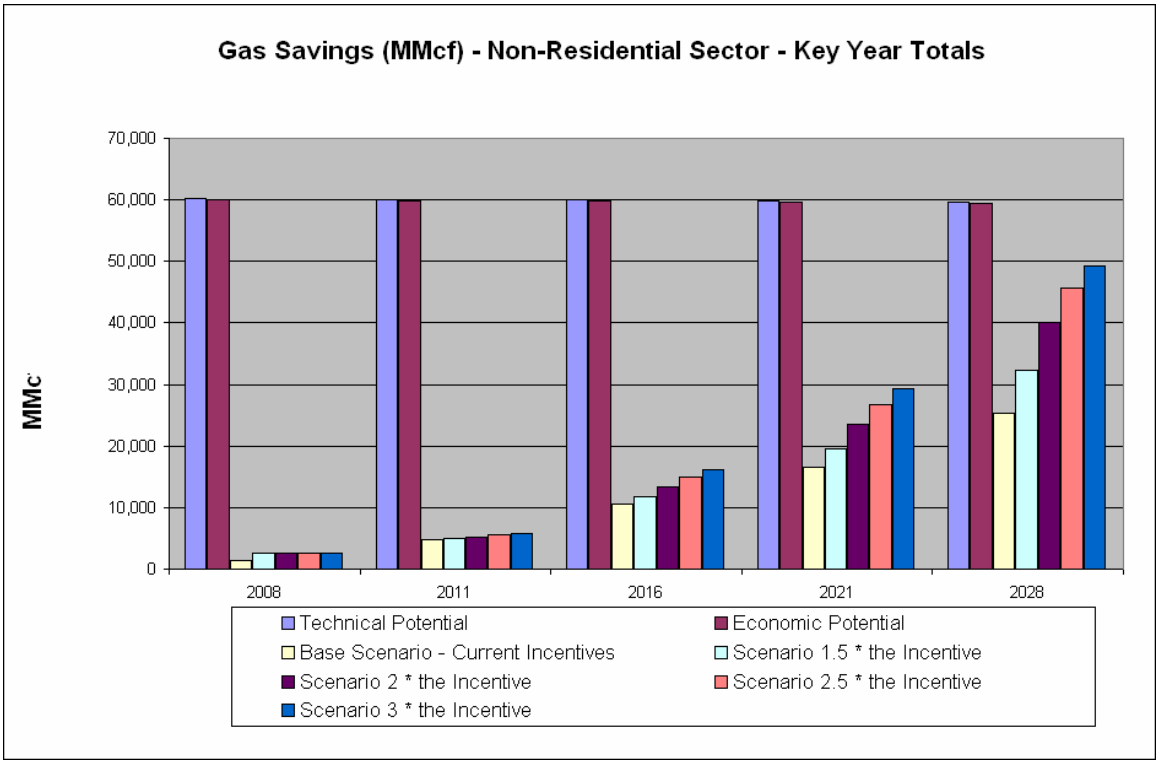
Table 7-16: Non-Residential Sector Gas Savings (MMcf) for 2028

Gas Savings (MMcf) - Non-Res Sector - 2028 Totals							
Non-Residential Sales Forecast	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
131,674	59,615	59,391	25,301	32,316	40,017	45,686	49,277

Figure 7-28 illustrates the DSM potential by specific years for technical and economic potential as well as the five achievable market potential estimates. The specific years provided are 2008, 2011, 2016, 2021, and 2028. Table 7-17 provides the values illustrated in Figure 7-28.

The 2008 base case market potential estimates are calibrated to the estimates of savings found in other utility programs as identified through the Best Practices review described earlier. As can be seen, the increase in the incentive provided does have a positive impact on anticipated participation. However, the impact is not linear as the incentive is increased.

Figure 7-25: Non-Residential Sector Gas Savings (MMcf) for Key Program Years



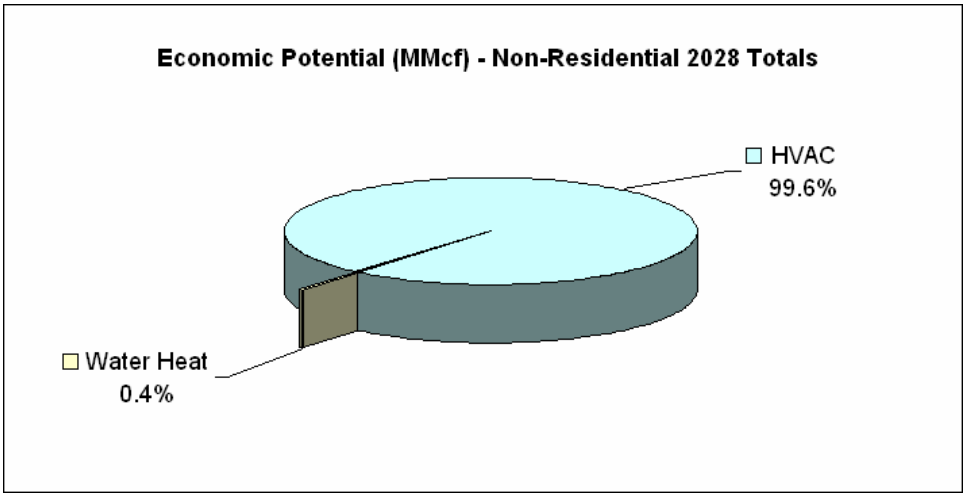
As shown by the values in Table 7-17, the 1.5 scenario has savings potential estimates that are about 28% larger than the base case in 2028. The 2.0 scenario also has an increased savings potential estimate, but a smaller 24% more than the 1.5 scenario. The incremental increases continue to decline for the 2.5 and the 3.0 scenarios with savings potential estimates of 14% for the 2.5 scenario compared to the 2.0 and 8% for the 3.0 scenario compared to the 2.5 scenario. The slowing down is reflective of some measures reaching their incremental cost incentive cap as well as some measures reaching saturation within the marketplace.

Table 7-17: Non-Residential Sector Gas Savings (MMcf) for Key Program Years

Gas Savings (MMcf) - Non-Res Sector - Key Year Totals							
Key Year	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
2008	60,214	59,988	1,320	2,509	2,555	2,603	2,649
2011	60,124	59,898	4,797	5,004	5,271	5,550	5,776
2016	59,974	59,748	10,636	11,774	13,335	14,923	16,240
2021	59,824	59,599	16,624	19,566	23,453	26,687	29,306
2028	59,615	59,391	25,301	32,316	40,017	45,686	49,277

Figure 7-29 illustrates the non-residential economic potential by end-use for the year 2028. HVAC measures account for nearly all (99.6%) of the economic potential.

Figure 7-269: Non-Residential Sector Economic Gas Potential (MMcf) for 2028



The 2008 base case market potential estimates are calibrated to the estimates of savings found in other utility programs as identified through the Best Practices review described earlier. The calibration targets used in developing the different market potential estimates reflect the higher incidence of achieved savings from HVAC programs as compared to the other end uses. HVAC measures represent 99% of the initial calibrated energy savings potential as compared to 15% for water heat measures.

As shown in Figure 7-30 compared to 7-31, there is little difference in end-use share between the base case scenario and the 3.0 scenario. These end-use shares are also nearly identical to the end-use shares shown in the economic potential chart shown in Figure 7-29. Tables 7-18 provides the values illustrated in Figures 7-29 through 7-31.

Table 7-18: Potential Natural Gas Savings (MCF) for 2028 by End-Use – Non-Residential Sector

Gas Savings (MMcf) - Non-Res Sector - by End Use							
End Use	Technical Potential	Economic Potential	Current Incentive Scenario	Current Incentive * 1.5	Current Incentive * 2.0	Current Incentive * 2.5	Current Incentive * 3.0
Water Heat	221	221	293	284	304	327	286
HVAC	59,394	59,170	25,008	32,032	39,713	45,359	48,991

Figure 7-30: Non-Residential Sector Base Scenario - Current Incentives; Share of Potential Gas Savings (MMcf) by End-Use for 2028

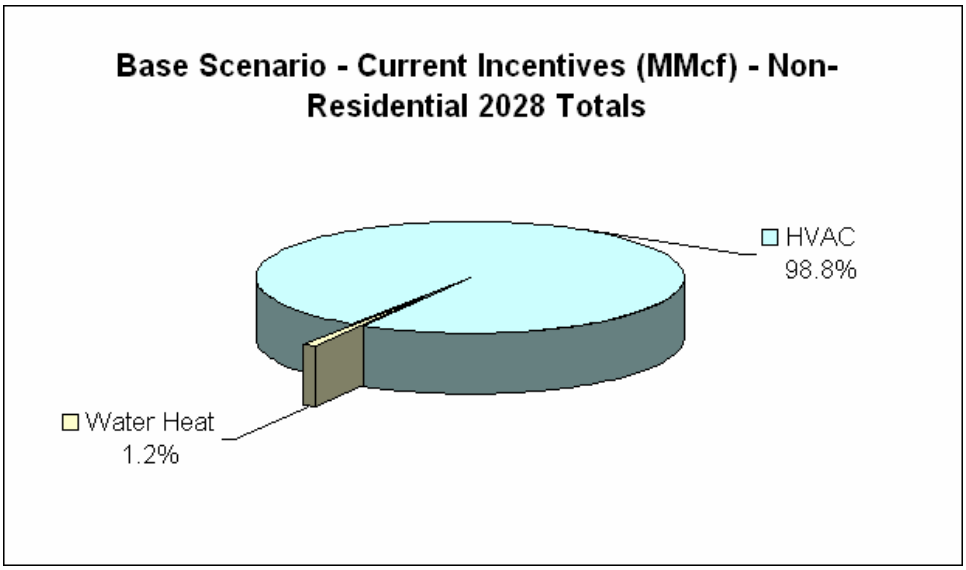
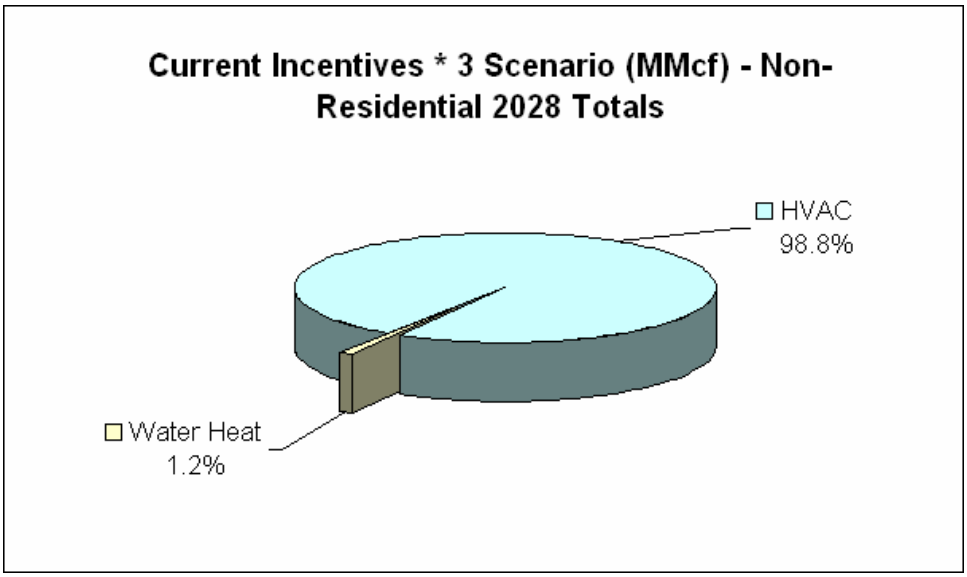


Figure 7-31: Non-Residential Sector 3x the Current Incentive; Share of Potential Gas Savings (MMcf) by End-Use for 2028



APPENDIX A:
ENERGY INSIGHTS'
ENERGY MARKET PROFILES

Energy Insights' Energy Market Profiles (EMP) provide a snapshot of annual energy use by end use and fuel and region for major customer segments in the non-residential, residential, and manufacturing segments. These profiles are not only a valuable reference for quickly defining energy-use patterns for individual customer segments, but they also provide a solid foundation for a variety of market analysis tasks, including program planning and evaluation.

The EMP spreadsheets, which have been updated for 2006, contain comprehensive demographic and energy-use profiles for each key customer sector (residential, commercial, and manufacturing). The profiles include breakdowns by building type, housing type, and North American Industry Classification System (NAICS) segment for each U.S. Census region and for both electricity and natural gas. Each sector and year combination is contained in a separate Excel spreadsheet file.

Residential Sector Data Sources

- Residential Energy Consumption Survey (RECS)
    - Household characteristics and energy use
    - Survey data collected every four years. 2005 is the most recent, with data available in 2007
- Annual Energy Outlook (AEO)
    - Annual forecast and analysis of US energy supply, demand, and prices to about 25 years out
    - Uses data from RECS and other annual data to update forecast
    - Uses National Energy Modeling System (NEMS) to develop forecast
- US Census
- American Housing Survey (Census Div)

Commercial Sector Data Sources

- Commercial Buildings Energy Consumption Survey (CBECS)
    - Commercial building characteristics and energy use
    - Survey data collected every four years. 2003 data became available this year
- Annual Energy Outlook (AEO)
    - Annual forecast and analysis of US energy supply, demand, and prices to about 25 years out
    - Uses data from CBECS and other annual data to update forecast
    - Uses National Energy Modeling System (NEMS) to develop forecast
- Economic census – every five years

Industrial Sector Data Sources

- Manufacturing Energy Consumption Survey (MECS)
    - Energy use in the manufacturing and industrial sector
    - Survey data collected every four years. 2002 data are the most recent available.

- Annual Energy Outlook (AEO)
    - Annual forecast and analysis of US energy supply, demand, and prices to about 25 years out
    - Uses data from MECS and other annual data to update forecast
    - Uses National Energy Modeling System (NEMS) to develop forecast
- Economic census
- Annual Survey of Manufacturers
    - Collected in each year that the Economic Census is not conducted
- Industry-specific organizations

2006 Residential Energy Energy Market Profiles
Sector Summary -- All Residential Homes

Census Region		**Midwest**
Census Division	**Total US**	**West North Central**
States		**IA, NB, KS, ND, MN, SD, MO**
Households (000s)	114,930	7,616
Energy Consumption		
Electricity (gWh)	1,385,997	100,834
Natural Gas (gBtu)	4,611,012	400,727
Energy Prices		
Electricity (Cents/kWh)	9.43	8.04
Natural Gas ($/mmBtu)	13.04	12.37
Energy Expenditures ($ Mill.)		
Electricity	$130,694	$8,111
Natural Gas	$60,131	$4,959
Total Electricity and Natural Gas	**$190,825**	**$13,070**
Energy Intensities		
Electricity (kWh/HH)	12,060	13,240
Natural Gas (kBtu/HH)	40,120	52,616

2006 Residential Energy Baseline
Electric End-Use Summary -- All Residential Homes

	Total US	West North Central
Households (000s)	114,930	7,616
Shares (% of Households)		
Space Heating	29.1%	11.3%
Central Cooling	57.2%	70.8%
Room Cooling	21.0%	24.9%
Both	0.8%	0.6%
All Cooling	78.9%	96.3%
Water Heating	37.6%	29.2%
Refrigeration	99.8%	99.8%
Freezers	32.4%	48.3%
Cooking	61.7%	64.8%
Clothes Washers	78.9%	86.0%
Clothes Dryers	60.3%	70.6%
Dishwashers	53.2%	56.7%
Personal Computers	77.9%	78.5%
Lighting	100.0%	100.0%
Color Televisions	98.9%	100.0%
Furnace Fans	85.0%	81.1%
Other Uses	100.0%	100.0%
UECs (kWh/HH)		
Space Heating	3,494	8,287
Central Cooling	2,997	2,367
Room Cooling	802	943
Both	3,207	6,565
All Cooling	2,416	2,027
Water Heating	2,554	3,135
Refrigeration	982	1,125
Freezers	965	1,132
Cooking	449	531
Clothes Washers	112	127
Clothes Dryers	1,066	1,259
Dishwashers	120	147
Personal Computers	272	317
Lighting	1,864	2,419
Color Televisions	805	935
Furnace Fans	250	402
Other Uses	2,726	2,415
Intensities (kWh/HH)		
Space Heating	1,016	935
Central Cooling	1,714	1,675
Room Cooling	168	234
Both Cooling	25	42
All Cooling	1,907	1,951
Water Heating	961	915
Refrigeration	980	1,123
Freezers	313	547
Cooking	277	344
Clothes Washers	89	109
Clothes Dryers	642	888
Dishwashers	64	84
Personal Computers	212	248
Lighting	1,864	2,419
Color Televisions	796	935
Furnace Fans	213	326
Other Uses	2,726	2,415
Total	**12,060**	**13,240**

2006 Residential Energy Baseline
Natural Gas End-Use Summary -- All Residential Homes

	Total US	West North Central
Households (000s)	114,930	7,616
Shares (% of Households)		
Space Heating	55.9%	69.9%
Water Heating	55.2%	61.2%
Cooking	33.5%	26.9%
Clothes Dryers	16.5%	15.1%
Miscellaneous	17.7%	15.1%
UECs (kBtu/HH)		
Space Heating	49,053	56,669
Water Heating	17,758	17,605
Cooking	5,660	5,313
Clothes Dryers	3,701	3,424
Miscellaneous	2,111	1,984
Intensities (kBtu/HH)		
Space Heating	27,439	39,585
Water Heating	9,798	10,782
Cooking	1,898	1,429
Clothes Dryers	611	519
Miscellaneous	374	301
Total	**40,120**	**52,616**
Sales (Billion BTU)		
Space Heating	3,153,606	301,486
Water Heating	1,126,045	82,117
Cooking	218,143	10,887
Clothes Dryers	70,242	3,949
Miscellaneous	42,976	2,289
Total	**4,611,012**	**400,727**

2006 Commercial Energy Market Profiles
Segment Summary -- All Commercial Buildings

Census Region		**Midwest**
Census Division	**Total US**	**West North Central**
States		**IA, NB, KS, ND, MN, SD, MO**
Floor Space (MSqFt)	75,956	6,021
Energy Consumption		
Electricity (TWh)	1,285.5	94.4
Natural Gas (TBtu)	3,008.3	283.7
Energy Intensities		
Electricity (kWh/SqFt)	16.9	15.7
Natural Gas (kBtu/SqFt)	39.6	47.1

2006 Commercial Energy Market Profiles
Electric End-Use Summary -- All Commercial Buildings

	Total US	West North Central
Floor Space (MSqFt)	75,956	6,021
Shares (% of Floor Space)		
Space Heating	22.8%	17.3%
Space Cooling	61.1%	63.6%
Water Heating	39.3%	35.3%
Ventilation	100.0%	100.0%
Cooking	16.5%	13.5%
Lighting	100.0%	100.0%
Refrigeration	40.5%	41.3%
Office Equipment (PC	89.4%	89.4%
Office Equipment (nor	100.0%	100.0%
Other Uses	100.0%	100.0%
EUIs (kWh/SqFt)		
Space Heating	2.59	4.36
Space Cooling	2.63	2.69
Water Heating	1.37	1.24
Ventilation	0.63	0.63
Cooking	0.73	0.71
Lighting	4.21	4.35
Refrigeration	2.02	2.12
Office Equipment (PC	0.82	0.63
Office Equipment (nor	1.42	1.09
Other Uses	6.25	5.19
Intensities (kWh/SqFt)		
Space Heating	0.59	0.75
Space Cooling	1.61	1.71
Water Heating	0.54	0.44
Ventilation	0.63	0.63
Cooking	0.12	0.10
Lighting	4.21	4.35
Refrigeration	0.82	0.87
Office Equipment (PC	0.73	0.56
Office Equipment (nor	1.42	1.09
Other Uses	6.25	5.19
Total	**16.92**	**15.69**
Sales (GWh)		
Space Heating	44,894	4,543
Space Cooling	121,919	10,316
Water Heating	40,923	2,640
Ventilation	48,128	3,780
Cooking	9,127	575
Lighting	320,106	26,171
Refrigeration	62,005	5,265
Office Equipment (PC	55,815	3,379
Office Equipment (nor	107,723	6,556
Other Uses	474,889	31,224
Total	**1,285,530**	**94,450**

2006 Commercial Energy Market Profiles
Natural Gas End-Use Summary -- All Commercial Buildings

	Total US	West North Central
Floor Space (MSqFt)	75,956	6,021
Shares (% of Floor Space)		
Space Heating	53.4%	71.1%
Space Cooling	2.5%	3.8%
Water Heating	45.2%	48.5%
Ventilation		
Cooking	17.9%	13.7%
Lighting		
Refrigeration		
Office Equipment (PC)		
Office Equipment (non-PC)		
Other Uses	5.0%	8.4%
EUIs (kBtu/SqFt)		
Space Heating	30.08	30.62
Space Cooling	6.11	5.74
Water Heating	15.14	11.70
Ventilation		
Cooking	18.80	17.98
Lighting		
Refrigeration		
Office Equipment (PC)		
Office Equipment (non-PC)		
Other Uses	263.83	201.90
Intensities (kBtu/SqFt)		
Space Heating	16.06	21.76
Space Cooling	0.15	0.22
Water Heating	6.84	5.68
Ventilation		
Cooking	3.37	2.46
Lighting		
Refrigeration		
Office Equipment (PC)		
Office Equipment (non-PC)		
Other Uses	13.18	16.93
Total	**39.61**	**47.06**
Sales (Billion BTU)		
Space Heating	1,220,120	131,036
Space Cooling	11,609	1,322
Water Heating	519,588	34,195
Ventilation		
Cooking	256,152	14,820
Lighting		
Refrigeration		
Office Equipment (PC)		
Office Equipment (non-PC)		
Other Uses	1,000,813	101,950
Total	**3,008,281**	**283,662**

2006 Manufacturing Energy Profiles
Energy Summary -- Midwest

	NAICS Code Total
Economic Statistics	
Employment (000's)	5,077.6
Establishments (000s)	102.6
Value Added ($Bill)	659.9
Shipments ($Bill)	1,418.5
Wages ($Bill)	206.3
Energy Consumption	
Electricity Use (TWh)	286.0
-- Utility Purchase Proportion	0.9
-- Utility Purchases	268.2
-- Generated Less Sold	17.8
Electricity Use (TBtu)	975.7
Natural Gas (TBtu)	1,445.0
Other Fuels (TBtu)	1,868.7
All Fuels (TBtu)	**4,289.3**
Energy Intensities	
Electricity (kWh/$000)	433.4
Natural Gas (kBtu/$000)	2,189.9
Other Fuels (kBtu/$000)	2,831.9
Electricity (MWh/Emp)	56.3
Electricity (MMBtu/Emp)	192.2
Natural Gas (MMBtu/Emp)	284.6
Other Fuels (MMBtu/Emp)	368.0

2006 Manufacturing Energy Profiles
Electric Summary -- Midwest

	NAICS Code Total
Employment (000's)	5,077.6
Consumption by End Use (GWh)	
Indirect Uses-Boiler Fuel	1,454
Process Heating	37,128
Process Cooling and Refrigeration	17,093
Machine Drive	134,961
Electro-Chemical Processes	19,085
Other Process Use	1,382
Facility HVAC (f)	23,164
Facility Lighting	20,425
Other Facility Support	4,562
Onsite Transportation	515
Conventional Electricity Generation	-
Other Nonprocess Use	487
End Use Not Reported	7,897
Total	**268,153**
End-Use Intensities (MWh/Employee)	
Indirect Uses-Boiler Fuel	0.31
Process Heating	7.80
Process Cooling and Refrigeration	3.59
Machine Drive	28.34
Electro-Chemical Processes	4.01
Other Process Use	0.29
Facility HVAC (f)	4.86
Facility Lighting	4.29
Other Facility Support	0.96
Onsite Transportation	0.11
Conventional Electricity Generation	0.00
Other Nonprocess Use	0.10
End Use Not Reported	1.66
Total	**56.32**
Electric End-Use Total Energy Shares	
Indirect Uses-Boiler Fuel	0.54%
Process Heating	13.85%
Process Cooling and Refrigeration	6.37%
Machine Drive	50.33%
Electro-Chemical Processes	7.12%
Other Process Use	0.52%
Facility HVAC (f)	8.64%
Facility Lighting	7.62%
Other Facility Support	1.70%
Onsite Transportation	0.19%
Conventional Electricity Generation	0.00%
Other Nonprocess Use	0.18%
End Use Not Reported	2.95%
Total	**100%**

2006 Manufacturing Energy Profiles
Natural Gas Summary -- Midwest

	NAICS Code Total
Employment (000's)	5,077.6
Gas Consumption by End Use (BBtu)	
Indirect Uses-Boiler Fuel	430,659
Process Heating	-
Process Cooling and Refrigeration	2,895
Machine Drive	20,736
Electro-Chemical Processes	-
Other Process Use	16,855
Facility HVAC (f)	176,488
Facility Lighting	-
Other Facility Support	8,309
Onsite Transportation	268
Conventional Electricity Generation	5,810
Other Nonprocess Use	-
End Use Not Reported	41,955
Total	**1,445,006**
End-Use Intensities (MMBtu/Employee)	
Indirect Uses-Boiler Fuel	84.82
Process Heating	0.00
Process Cooling and Refrigeration	0.57
Machine Drive	4.08
Electro-Chemical Processes	0.00
Other Process Use	3.32
Facility HVAC (f)	34.76
Facility Lighting	0.00
Other Facility Support	1.64
Onsite Transportation	0.05
Conventional Electricity Generation	1.14
Other Nonprocess Use	0.00
End Use Not Reported	8.26
Total	**138.64**
Natural Gas End-Use Total Energy Shares	
Indirect Uses-Boiler Fuel	29.80%
Process Heating	0.00%
Process Cooling and Refrigeration	0.20%
Machine Drive	1.43%
Electro-Chemical Processes	0.00%
Other Process Use	1.17%
Facility HVAC (f)	12.21%
Facility Lighting	0.00%
Other Facility Support	0.58%
Onsite Transportation	0.02%
Conventional Electricity Generation	0.40%
Other Nonprocess Use	0.00%
End Use Not Reported	2.90%
Total	**49%**

APPENDIX B:
DSM RESULTS BY REGION

Figure B-27: 2006 Electricity DSM Results by Region

Appendix: 2006 DSM Results by State															
Customer			DSM Results				Annual			Cost of Energy	Spending as % of	Energy Savings as	Demand Savings as	Cost of Savings	
Sector	Region	Utility/Agency	GWh	MW	Costs $M	Customers	GWh	Peak MW	Revenue $M	$/kWh	Revenue	% of Sales	% of Peak	$/kWh	$/kW
Residential		**Median**	**33.4**	**11.4**	**$11.4**	**1,005,577**	**7,686**	**1,495**	**$733.4**	**$0.10**	**1.7%**	**0.6%**	**0.9%**	**$0.27**	**$915**
	Midwest	Duke Energy Indiana 05	7.0	20.0	$5.0	619,943	8,268	1,984	$654.0	$0.08	0.8%	0.1%	1.0%	$0.71	$250
		Great River Energy 05	11.3	n/a	$11.4	515,738	5,891	1,390	$502.7	$0.09	2.3%	0.2%	-	$1.02	-
		Indianapolis P&L 05	3.0	1.0	$0.6	412,151	5,314	1,247	$344.0	$0.06	0.2%	0.1%	0.1%	$0.20	$600
		Interstate P&L (IA)	32.4	11.4	$9.9	407,313	3,751	776	$432.4	$0.12	2.3%	0.9%	1.5%	$0.30	$867
		Interstate P&L (MN)	0.6	0.3	$0.3	36,297	319	70	$32.0	$0.10	0.9%	0.2%	0.5%	$0.50	$822
		MidAmerican (IA)	34.3	15.1	$9.3	535,005	5,086	1,365	$440.4	$0.09	2.1%	0.7%	1.1%	$0.27	$615
		MN Power	9.1	1.6	$1.5	117,596	1,012	177	$71.5	$0.07	2.1%	0.9%	0.9%	$0.16	$932
		Otter Tail	2.6	0.9	$0.8	46,954	526	171	$40.1	$0.08	2.0%	0.5%	0.5%	$0.31	$915
		SMMPA: The Triad	1.2	n/a	$0.6	61,666	491	109	$43.1	$0.09	1.5%	0.2%	-	$0.55	-
		WI Focus on Energy	84.4	13.7	$15.0	2,535,293	21,779	5,424	$2,288.8	$0.11	0.7%	0.4%	0.3%	$0.18	$1,092
		Xcel Energy (MN)	12.3	33.5	$13.4	1,056,669	8,877	2,420	$812.8	$0.09	1.6%	0.1%	1.4%	$1.09	$400
	Northeast	CEEF 05	106.0	n/a	$28.1	1,473,966	13,367	3,007	$2,182.4	$0.16	1.3%	0.8%	-	$0.26	-
		Efficiency ME	45.0	n/a	$4.3	1,360,037	9,095	883	$632.8	$0.07	0.7%	0.5%	-	$0.10	-
		Efficiency VT	29.7	4.8	$7.3	290,487	2,051	385	$275.8	$0.13	2.6%	1.4%	1.2%	$0.25	$1,525
		National Grid (MA)	98.8	7.7	$37.0	1,099,119	8,477	1,990	$1,289.5	$0.15	2.9%	1.2%	0.4%	$0.37	$4,822
		NJ CEP 05	90.3	37.1	$57.8	3,275,539	29,329	4,120	$3,442.5	$0.12	1.7%	0.3%	0.9%	$0.64	$1,560
		NSTAR 05	80.4	7.8	$17.1	954,485	6,774	1,495	$956.2	$0.14	1.8%	1.2%	0.5%	$0.21	$2,182
		NYSERDA	23.7	6.7	$62.7	7,251,285	51,453	10,605	$8,121.9	$0.16	0.8%	0.0%	0.1%	$2.64	$9,354
	West	PGE 05	400.6	94.9	$63.0	4,396,800	29,752	6,839	$3,838.8	$0.13	1.6%	1.3%	1.4%	$0.16	$664
		SDGE 05	163.0	31.7	$29.5	1,183,607	7,105	1,508	$1,049.1	$0.15	2.8%	2.3%	2.1%	$0.18	$932
		SCE 05	534.1	122.1	$70.4	4,116,568	28,889	7,306	$3,707.3	$0.13	1.9%	1.8%	1.7%	$0.13	$577
	Canada	BC Hydro 05	191.0	n/a	$11.4	1,484,339	15,814	n/a	$840.0	$0.05	1.4%	1.2%	-	$0.06	-
C&I		**Median**	**120.6**	**19.7**	**$15.9**	**135,920**	**12,788**	**2,550**	**$905.9**	**$0.07**	**1.8%**	**0.7%**	**0.6%**	**$0.14**	**$680**
	Midwest	Duke Energy Indiana 05	2.0	0.4	$0.4	84,527	5,448	1,308	$97.0	$0.02	0.4%	0.0%	0.0%	$0.20	$1,000
		Great River Energy 05	18.0	n/a	$2.5	98,274	4,681	1,105	$308.5	$0.07	0.8%	0.4%	-	$0.14	-
		Indianapolis P&L 05	n/a	n/a	n/a	50,686	9,823	1,871	$536.0	$0.05	-	-	-	-	-
		Interstate P&L (IA)	87.9	17.0	$11.6	74,524	11,079	2,294	$736.6	$0.07	1.6%	0.8%	0.7%	$0.13	$680
		Interstate P&L (MN)	13.1	2.1	$1.6	7,313	517	114	$40.4	$0.08	4.0%	2.5%	1.8%	$0.12	$793
		MidAmerican (IA)	126.2	26.3	$12.2	86,635	12,665	3,398	$635.8	$0.05	1.9%	1.0%	0.8%	$0.10	$463
		MN Power	36.9	3.2	$2.0	20,870	8,066	1,409	$361.3	$0.04	0.6%	0.5%	0.2%	$0.06	$634
		Otter Tail	11.4	2.5	$1.1	11,888	1,560	509	$94.3	$0.06	1.2%	0.7%	0.5%	$0.10	$452
		SMMPA: The Triad	9.8	n/a	$0.8	6,604	1,408	313	$89.0	$0.06	0.9%	0.7%	0.0%	$0.08	-
		WI Focus on Energy	135.5	28.2	$15.9	317,484	48,041	11,965	$3,385.3	$0.07	0.5%	0.3%	0.2%	$0.12	$564
		Xcel Energy (MN)	244.0	69.2	$27.9	126,773	23,029	6,279	$1,507.0	$0.07	1.8%	1.1%	1.1%	$0.11	$402
	Northeast	CEEF 05	212.0	n/a	$52.2	159,283	19,448	4,375	$2,468.8	$0.13	2.1%	1.1%	-	$0.25	-
		Efficiency ME	29.8	7.8	$4.5	149,514	12,910	1,253	$683.8	$0.05	0.7%	0.2%	0.6%	$0.15	$580
		Efficiency VT	26.4	5.2	$7.5	45,179	3,385	634	$340.3	$0.10	2.2%	0.8%	0.8%	$0.29	$1,440
		National Grid (MA)	95.7	16.1	$42.9	152,263	13,408	3,148	$1,075.2	$0.08	4.0%	0.7%	0.5%	$0.45	$2,662
		NJ CEP 05	287.7	36.4	$24.4	460,390	49,743	6,988	$4,023.3	$0.08	0.6%	0.6%	0.5%	$0.08	$671
		NSTAR 05	120.6	19.7	$34.0	159,474	14,908	3,290	$1,464.1	$0.10	2.3%	0.8%	0.6%	$0.28	$1,727
		NYSERDA	370.0	107.4	$59.7	1,179,872	138,133	28,471	$12,814.1	$0.09	0.5%	0.3%	0.4%	$0.16	$556
	West	PGE 05	765.4	134.6	$157.5	617,603	51,841	11,916	$5,835.3	$0.11	2.7%	1.5%	1.1%	$0.21	$1,170
		SDGE 05	233.3	44.2	$49.1	145,066	12,013	2,550	$1,243.7	$0.10	3.9%	1.9%	1.7%	$0.21	$1,111
		SCE 05	838.0	142.9	$144.4	588,742	57,314	14,496	$6,118.0	$0.11	2.4%	1.5%	1.0%	$0.17	$1,010
	Canada	BC Hydro 05	258.0	n/a	$30.7	190,716	35,391	n/a	$1,395.0	$0.04	2.2%	0.7%	-	$0.12	-
Overall		**Median**	**177.5**	**28.0**	**$26.2**	**1,148,701**	**20,400**	**4,058**	**$1,775.8**	**$0.08**	**1.8%**	**0.8%**	**0.6%**	**$0.18**	**$836**
	Midwest	Duke Energy Indiana 05	9.0	20.4	$5.4	704,470	13,716	3,292	$751.0	$0.05	0.7%	0.1%	0.6%	$0.60	$265
		Great River Energy 05	29.3	n/a	$14.0	614,514	10,572	2,495	$811.2	$0.08	1.7%	0.3%	-	$0.48	-
		Indianapolis P&L 05	3.0	1.0	$0.6	462,837	15,137	3,118	$880.0	$0.06	0.1%	0.0%	0.0%	$0.20	$600
		Interstate P&L (IA)	120.3	28.4	$21.4	481,837	14,830	3,070	$1,169.0	$0.08	1.8%	0.8%	0.9%	$0.18	$755
		Interstate P&L (MN)	13.6	2.4	$2.0	43,610	835	184	$72.4	$0.09	2.8%	1.6%	1.3%	$0.15	$833
		MidAmerican (IA)	160.5	41.4	$21.5	621,640	17,751	4,763	$1,076.2	$0.06	2.0%	0.9%	0.9%	$0.13	$519
		MN Power	46.0	4.8	$3.5	138,465	9,078	1,586	$432.8	$0.05	0.8%	0.5%	0.3%	$0.08	$733
		Otter Tail	14.0	3.3	$1.9	58,841	2,086	680	$134.4	$0.06	1.4%	0.7%	0.5%	$0.14	$576
		SMMPA: The Triad	11.1	n/a	$1.5	68,270	1,900	422	$132.1	$0.07	1.1%	0.6%	-	$0.13	-
		WI Focus on Energy	219.9	41.9	$30.9	2,852,777	69,820	17,389	$5,674.1	$0.08	0.5%	0.3%	0.2%	$0.14	$737
		Xcel Energy (MN)	256.3	102.7	$41.2	1,183,442	31,905	8,699	$2,319.8	$0.07	1.8%	0.8%	1.2%	$0.16	$401
	Northeast	CEEF 05	318.0	n/a	$80.3	1,633,249	32,815	7,382	$4,651.2	$0.14	1.7%	1.0%	-	$0.25	-
		Efficiency ME	74.8	7.8	$8.9	1,509,551	22,006	2,136	$1,316.5	$0.06	0.7%	0.3%	0.4%	$0.12	$1,138
		Efficiency VT	56.1	10.0	$14.8	335,666	5,436	1,019	$616.1	$0.11	2.4%	1.0%	1.0%	$0.26	$1,481
		National Grid (MA)	194.5	23.8	$79.8	1,251,382	21,884	5,138	$2,364.7	$0.11	3.4%	0.9%	0.5%	$0.41	$3,359
		NJ CEP 05	378.0	73.5	$85.4	3,735,929	79,072	11,108	$7,465.7	$0.09	1.1%	0.5%	0.7%	$0.23	$1,163
		NSTAR 05	201.0	27.5	$51.1	1,113,959	21,681	4,785	$2,420.3	$0.11	2.1%	0.9%	0.6%	$0.25	$1,856
		NYSERDA	393.7	114.1	$122.4	8,431,157	189,586	39,076	$20,936.0	$0.11	0.6%	0.2%	0.3%	$0.31	$1,073
	West	PGE 05	1,166.0	229.5	$220.4	5,014,405	81,593	18,755	$9,674.1	$0.12	2.3%	1.4%	1.2%	$0.19	$961
		SDGE 05	396.3	75.9	$82.0	1,328,676	19,118	4,058	$2,292.8	$0.12	3.6%	2.1%	1.9%	$0.21	$1,081
		SCE 05	1,372.1	265.0	$222.3	4,705,362	86,202	21,802	$9,825.2	$0.11	2.3%	1.6%	1.2%	$0.16	$839
	Canada	BC Hydro 05	449.0	n/a	$42.1	1,675,055	51,205	n/a	$2,235.0	$0.04	1.9%	0.9%	-	$0.09	-

Figure B-28: 2006 Natural Gas DSM Results by Region

Appendix: 2006 Natural Gas DSM Results by State										
Customer Sector	Utility/Agency	DSM Results MCF	Costs $M	Customers	Annual MCF	Revenue $M	Cost of Energy $/MCF	Spending as % of Revenue	Energy Savings as % of	Cost of Savings $/MCF
Residential	**Median**	**165,690**	**$3.6**	**297,195**	**22,787,298**	**$277.4**	**$11.92**	**2.5%**	**1.0%**	**$24.93**
	Aquila (IA)	138,014	$3.7	130,507	9,816,211	$122.7	$12.50	3.0%	1.4%	$26.45
	CenterPoint Energy (MN)	178,162	$3.6	715,964	61,749,830	$729.8	$11.82	0.5%	0.3%	$20.07
	Interstate P&L (IA)	173,337	$7.4	196,212	14,257,953	$190.9	$13.39	3.9%	1.2%	$42.42
	Interstate P&L (MN)	7,764	$0.2	9,334	809,836	$9.4	$11.64	1.9%	1.0%	$23.40
	MidAmerican (IA)	367,485	$16.1	488,329	34,663,076	$416.9	$12.03	3.9%	1.1%	$43.74
	Xcel Energy (MN)	158,043	$3.2	398,178	31,316,642	$363.9	$11.62	0.9%	0.5%	$20.07
C&I	**Median**	**71,165**	**$1.7**	**29,014**	**16,298,503**	**$160.7**	**$9.70**	**0.8%**	**0.9%**	**$16.28**
	Aquila (IA)	29,663	$0.4	15,895	5,644,114	$61.8	$10.95	0.7%	0.5%	$14.09
	CenterPoint Energy (MN)	759,112	$3.8	65,441	59,787,078	$592.7	$9.91	0.6%	1.3%	$5.00
	Interstate P&L (IA)	61,453	$1.2	25,996	13,060,921	$136.9	$10.48	0.9%	0.5%	$20.17
	Interstate P&L (MN)	16,024	$0.3	1,239	912,245	$8.4	$9.22	3.5%	1.8%	$18.46
	MidAmerican (IA)	80,877	$2.1	51,365	19,536,084	$184.4	$9.44	1.1%	0.4%	$26.01
	Xcel Energy (MN)	768,986	$2.2	32,031	30,220,124	$286.9	$9.49	0.8%	2.5%	$2.84
Overall	**Median**	**341,576**	**$6.4**	**326,209**	**40,759,017**	**$464.6**	**$10.99**	**2.4%**	**1.0%**	**$22.17**
	Aquila (IA)	167,677	$4.1	146,402	15,460,325	$184.6	$11.94	2.2%	1.1%	$24.27
	CenterPoint Energy (MN)	937,274	$7.4	781,405	121,536,908	$1,322.6	$10.88	0.6%	0.8%	$7.87
	Interstate P&L (IA)	234,790	$8.6	222,208	27,318,874	$327.8	$12.00	2.6%	0.9%	$36.60
	Interstate P&L (MN)	23,788	$0.5	10,573	1,722,081	$17.8	$10.36	2.7%	1.4%	$20.07
	MidAmerican (IA)	448,361	$18.2	539,694	54,199,160	$601.4	$11.10	3.0%	0.8%	$40.54
	Xcel Energy (MN)	927,029	$5.4	430,209	61,536,766	$650.7	$10.57	0.8%	1.5%	$5.78

APPENDIX C:
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APPENDIX D:
ACEEE PAPER BY RANDY GUNN

"REVIEW OF RECENT MIDWEST DSM POTENTIAL STUDIES"

Review of Recent Midwest DSM Potential Studies

Randy Gunn and Laura Agapay, Summit Blue Consulting

ABSTRACT

This paper will summarize the results from seven publicly available DSM potential studies that have been conducted in the Midwest in the past six years. All seven studies reviewed estimated residential energy efficiency potential. The various residential electric and gas energy savings potential estimates from these studies spanned a considerable range. The residential electric achievable potential estimates ranged from 0.1% to 1.0% of residential baseline electric sales per year, with the median estimate being 0.5% of baseline electric sales per year. This range of estimates mirrors the actual results of residential electric energy efficiency programs in the region. The residential natural gas achievable potential estimates ranged from 0.2% to 1.9% of residential baseline gas sales per year, with the median estimate being 1.3% of residential baseline gas sales per year. Four of the seven studies reviewed also estimated commercial/industrial (C/I) electric energy efficiency potential. The C/I electric energy savings potential estimates span a much narrower range than the residential electric potential estimates. The C/I electric achievable potential estimates ranged from 0.3% of C/I electric baseline sales per year up to 0.7% of C/I baseline electric sales per year, with the median estimate being 0.6% of baseline electric sales per year. The paper concludes by comparing the Midwest energy efficiency potential estimates to a 2004 review of 11 similar studies conducted earlier in the decade elsewhere in the U.S.

Introduction

As part of the recent upswing in interest in DSM in the Midwest in the current decade has come considerable interest in estimating the potential for energy efficiency and demand response programs. Most of the Midwest DSM potential studies have been sponsored by utilities, state energy agencies, and nonprofit energy efficiency organizations. The studies reviewed for this paper include the most recent publicly released study for each Midwest state, where such studies are available, as well as a residential regional study conducted by the Midwest Energy Efficiency Alliance (MEEA). Publicly available utility sponsored studies that will be reviewed in this paper include multi-sector studies for Duke Energy Indiana (Summit Blue Consulting 2007), the Iowa investor-owned utilities (Quantec 2008), and Xcel Energy Minnesota (Itron 2002, 2003), as well as residential studies for the Missouri investor-owned and municipal utilities (RLW 2006), and the MEEA regional study, which was sponsored by Xcel Energy (MEEA 2006). DSM potential studies sponsored by state energy agencies or non-profit organizations that will be covered in this paper include an Illinois residential study (MEEA 2003), and a Wisconsin multi-sector study (ECW 2005). Additional similar studies have been conducted in the region, but were not included in this paper due to space limitations.

These studies were conducted for a variety of purposes. The utility-sponsored studies were generally conducted to fulfill regulatory requirements, including establishing the basis for their proposed future DSM goals, and to fulfill integrated resource planning requirements. In addition, Xcel Energy funded MEEA to conduct the regional residential market assessment and DSM potential study so that the Company could better understand how its service area and DSM potential compare to the rest of the

Midwest region. The studies sponsored by state agencies or non-profit organizations were conducted to assist with longer-term planning of energy efficiency programs, and/or to help secure or revise funding for energy efficiency programs.

Terms that will be used throughout this paper include:

- *Technical potential* means the maximum amount of energy and demand that could be saved regardless of cost effectiveness or market barriers.
- *Economic potential* means the amount of technical potential that is cost effective from the standpoint of one of the California benefit-cost analysis tests. Few of the studies reviewed present economic potential results.
- *Achievable or market potential* means the amount of energy that could be saved through actual DSM programs.

Methodologies

More than a dozen consulting firms and non-profit organizations conducted the analyses for the seven studies reviewed in this paper. Brief summaries of the methodologies and approaches used for each study are presented below.

- **MEEA Illinois Residential Market Analysis (2003).** MEEA staff worked with RLW Analytics to conduct this study. The study included on-site surveys with 309 single family homes in five different areas of the state. The savings and costs for 34 energy conservation measures were analyzed using a DOE2 building simulation model. Market potential estimates are calculated by assigning high, medium, or low market barriers to each measure, and calculate the market potential as annual savings after five to ten years of program implementation. Estimates are made for both electric and gas DSM measures. The study includes reviews of energy efficiency program features from several dozen utilities and public benefits organizations.
- **Duke Energy Indiana DSM Market Assessment and DSM Action Plan (2007).** Duke Energy and its Indiana DSM Collaborative worked with Summit Blue Consulting and Wisconsin Energy Conservation Corporation on this project. The study used the results from Duke's 2004 Indiana residential appliance saturation survey (RASS), as well as Duke billing data, and secondary information on Midwest commercial customers. Savings and costs were estimated for 40 residential electric energy efficiency and demand response measures, and 30 small commercial electric energy efficiency and demand response measures. (Only C&I customers with peak demands less than 500 kW are currently eligible for DSM programs in Indiana.) The study includes an assessment of the results of 21 utility and public benefits organizations' 2005 DSM program results, which were used to set calibration targets for the DSM potential models. The DSM potential estimates were developed using separate bottom-up spreadsheet models for residential and small commercial and industrial customers. The focus of the DSM potential analysis was on estimating achievable or market potential over a 20 year forecast period, and on developing detailed DSM program plans.
- **The Iowa Utility Association Assessment of Energy and Capacity Savings Potential in Iowa (2008).** Three of Iowa's investor-owned utilities hired a consulting team led by Quantec, and included A-Tec Energy Corporation, Britt/Makela Group, Nexant, and Summit Blue Consulting. The consulting team conducted over 840 telephone surveys and 380 on-site surveys of residential and commercial/industrial customers, trade allies, and contractors. The focus of the study was on

estimating 10 year technical and economic energy efficiency and demand response potential for both electric and gas DSM measures. The individual utilities will estimate their own achievable or market potentials as part of their forthcoming DSM program regulatory filings. The consulting team for the IUA study conducted an in-depth review and analysis of utility and public benefits DSM program results for the 2005 - 2006 program years, which was primarily done to identify best practices for different categories of top performing programs. Quantec's Energy Forecast Pro model estimates DSM potentials as decrements to utility baseline forecasts.

- **The Missouri Utility Collaborative 2006 Missouri Statewide Residential Lighting and Appliance Efficiency Saturation Survey (2006).** The Missouri Utility Collaborative includes the state's investor-owned and municipal utilities. The Collaborative hired RLW Analytics to conduct the study. The study methodology is similar to the 2003 Illinois study that RLW worked with MEEA to conduct. The study included on-site surveys with 287 residential customers in the state. The savings and costs for 32 energy conservation measures were analyzed using three DOE2 building simulation models. Market potential estimates are calculated by assigning high, medium, or low market barriers to each measure, and calculate the market potential as annual savings after five to ten years of program implementation. Estimates are made for both electric and gas DSM measures.
- **Xcel Energy Minnesota DSM Market Assessment Reports (2002-2003).** Xcel Energy hired a consulting team that included Itron, Summit Blue Consulting and Xenergy (now Kema). This study included almost 1,000 residential and commercial/industrial on site surveys and telephone surveys with trade allies and vendors. Extensive on-site surveys including short-term metering were also conducted for a small sub-sample of commercial/industrial customers to estimate the DSM potential for retro-commissioning. Twenty year energy efficiency potential estimates were developed using Itron's ASSET model, primarily for electric DSM measures. The main purpose of the study was to develop the basis for the DSM aspects for the Company's 2004 integrated resource plan.
- **Energy Center of Wisconsin Energy Efficiency and Customer-Sited Renewable Energy: Achievable Potential in Wisconsin 2006-2015 (2005).** This study was conducted for the Governor's Taskforce on Energy Efficiency and Renewables. The Energy Center of Wisconsin teamed up with GDS Associates, Glacier Consulting, and L&S Technical Associates to conduct the study. This study used a somewhat different approach from the other studies reviewed for this paper, in that the focus of the analysis was on 15 residential and 15 commercial/industrial electric and natural gas *markets*. The other studies reviewed in this paper primarily focused their analyses on DSM technologies or *measures*. The study authors included a review of primarily public benefits energy efficiency program results from around the country as part of the process for estimating energy efficiency potential. This study focuses its energy efficiency estimates on achievable or market potential for a five year period.
- **MEEA Midwest Residential Market Assessment and DSM Potential Study (2006).** MEEA worked with a consulting team that included Quantec, Skumatz Economic Research Associates, and Summit Blue Consulting. The study covered nine Midwest states. Telephone residential appliance saturation surveys (RASS) were conducted with about 480 customers in five states (Indiana, Kentucky, Michigan, Missouri, and Ohio) for which recent public RASS survey results were not available at the time the study was conducted. The savings and costs were estimated for about 40 electric DSM measures and 30 gas DSM measures. Energy efficiency potential estimates for each state and the Midwest region as a whole were conducted for electric and gas DSM measures using Quantec's Energy Forecast Pro model.

Summary of Residential Electric Results

The electric energy savings potential across the seven studies range from low estimates of about 1% of baseline sales for achievable potential for the ECW and Xcel Energy studies to a 46% technical potential estimate for the Iowa Utility Association (IUA) study. Some of the variation between studies is accounted for by the different forecast periods and different types of potential estimated between the studies. Most studies focused on estimating achievable or market potential, while three of the studies also presented technical potential estimates, and only two studies presented economic potential estimates. Forecast periods ranged from five years to 20 years. However, even annual achievable potential estimates vary between the studies from less than 0.1% to about 1.0% of residential baseline sales. Table 1 summarizes the residential electric savings estimates for each state and study. Separate state level results are shown for the 2006 MEEA regional study. Only two of the seven studies presented results for demand response (DR) potentials in addition to energy efficiency potentials, so DR potentials will not be discussed in this paper. The same is true for energy efficiency economic potential estimates.

Table 1. Summary of Residential Electric Energy Savings Potential Results

Organization	State	Year	Fuel	# Years	Technical Potential	Achievable Potential	Achievable Potential/Yr
Duke Energy	IN	2007	Electric	20	NA	15.0%	0.8%
Iowa Utility Assn	IA	2008	Electric	10	46.0%	NA	NA
Midwest EE Alliance	IL	2003	Electric	10	NA	5.0%	0.5%
Xcel Energy	MN	2003	Electric	20	3.9%	0.7%	0.0%
Utility Collaborative	MO	2006	Electric	10	NA	9.5%	1.0%
Energy Center of WI	WI	2005	Electric	5	NA	0.9% - 1.9%	0.2% - 0.4%
Midwest EE Alliance	IL	2006	Electric	20	21.4%	8.9%	0.4%
Midwest EE Alliance	IN	2006	Electric	20	24.9%	10.9%	0.5%
Midwest EE Alliance	IA	2006	Electric	20	24.1%	10.3%	0.5%
Midwest EE Alliance	KY	2006	Electric	20	30.3%	14.2%	0.7%
Midwest EE Alliance	MI	2006	Electric	20	22.0%	9.6%	0.5%
Midwest EE Alliance	MN	2006	Electric	20	20.1%	8.3%	0.4%
Midwest EE Alliance	MO	2006	Electric	20	26.8%	12.3%	0.6%
Midwest EE Alliance	OH	2006	Electric	20	23.3%	10.1%	0.5%
Midwest EE Alliance	WI	2006	Electric	20	19.8%	8.2%	0.4%
Medians			Electric	20	23.3%	9.5%	0.5%

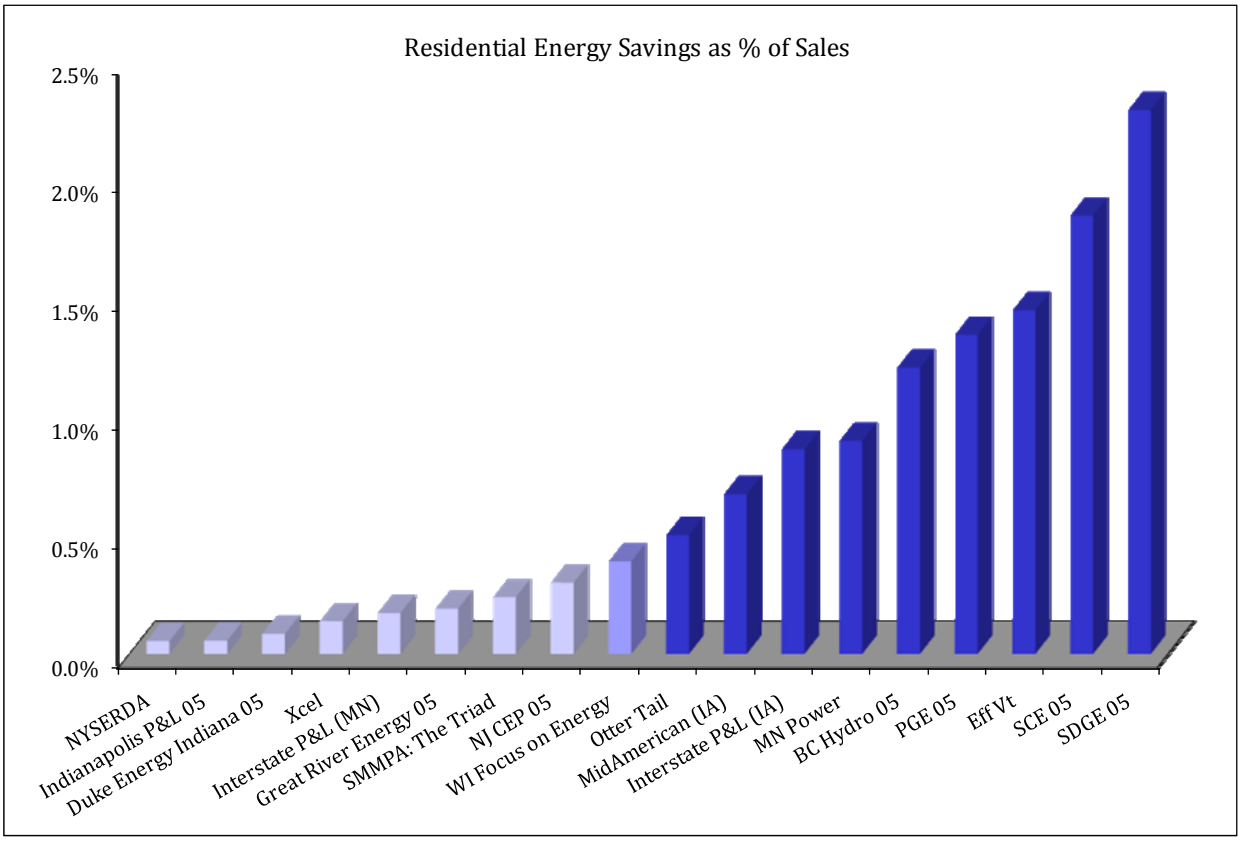
The consulting team for the IUA study conducted an in-depth review and analysis of 18 utility and public benefits 2005-2006 electric DSM program results, which focused on Midwestern programs, but also included other selected jurisdictions across North America. The results of this analysis for residential electric energy savings, shown as percentages of baseline residential electric sales for each organization, are shown in Figure 1.

These comparative actual results show that residential DSM programs are actually saving very different percentages of baseline residential sales between organizations across the Midwest, ranging from about 0.1% of baseline sales to about 0.9% of baseline sales. So the wide differences in residential

energy savings potential estimates are consistent with actual DSM program results across the region. The DSM potential estimates will vary according to the technologies or markets included in the analyses, and the DSM program budgets that are available to conduct the programs.

At the high end of the range of energy savings, the Duke Indiana and Missouri studies estimate annual energy savings potential of about 0.8% to 1.0% of baseline residential sales. This is consistent with the highest actual savings from residential DSM program results in the Midwest, which vary from about 0.7% of baseline sales for MidAmerican Energy to 0.9% of baseline sales for Interstate Power and Light (Iowa) and Minnesota Power. At the low end of the savings estimates, the 0.1% to 0.4% of baseline sales estimates from the Xcel Energy and ECW studies are consistent with many regional organization's actual 2006 residential electric energy savings results.

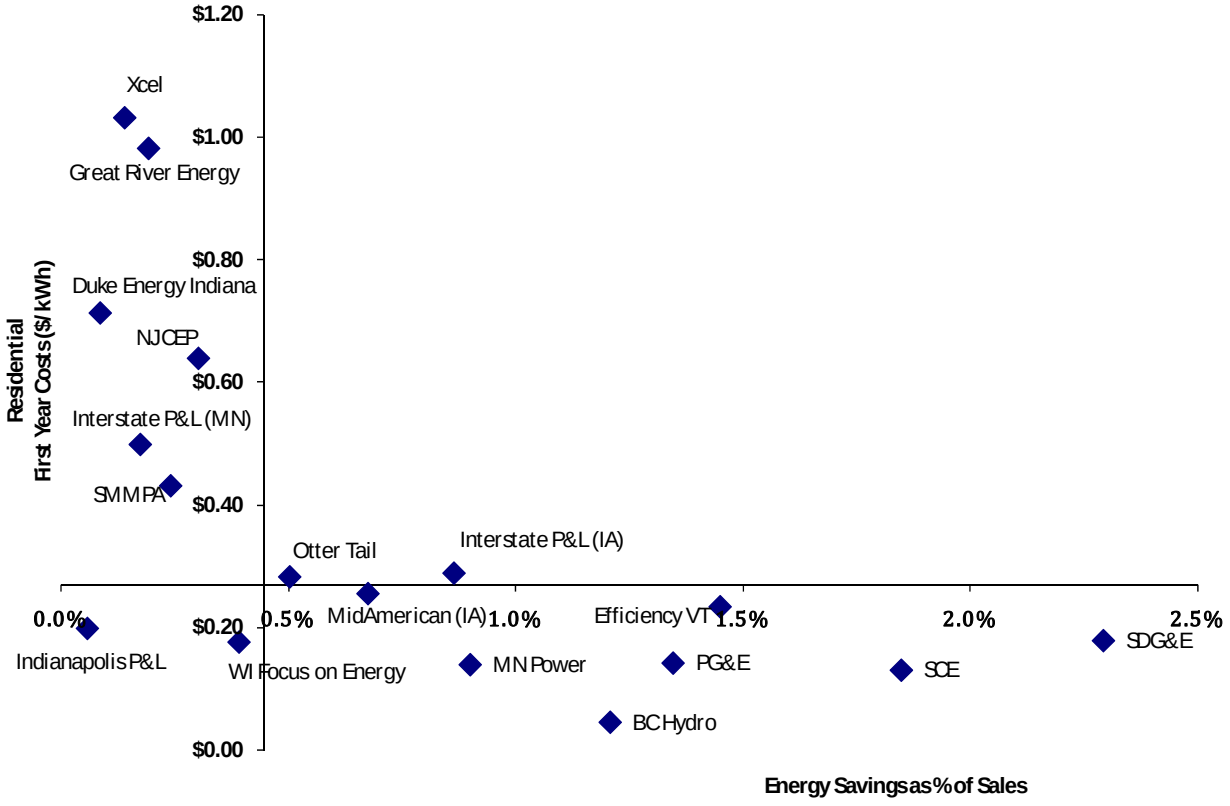
Figure 1. Residential 2005-2006 First Year Electricity Savings as % of Baseline Sales



How DSM program costs are estimated and presented varies considerably between the studies reviewed. The Duke and Wisconsin studies present total program costs over the study period, and the Duke study shows program and end use level detail regarding estimated program costs. The Iowa and MEEA regional studies present average levelized costs for DSM, which are primarily based on the costs of the DSM measures, not DSM program administrative costs or estimated rebate levels. The Illinois and Missouri studies present estimated rebate costs only, not total DSM program costs including administration costs. The Xcel Energy study does not present estimated DSM program costs of any type in the report, although such costs were estimated for the Company.

The IUA study analysis also analyzed DSM program costs, and presented the 2005 - 2006 results as program costs per first year kWh saved. The electric residential program costs are shown in Figure 2 below. The figure shows that the program costs per kWh vary over a much narrower range than the program savings. The high savings programs shown to the right of the y-axis have program costs of $0.13 to $0.29 per first year kWh saved. (The center of the graph is shown as the median results for savings and costs for the group of utilities reviewed.)

Figure 2. Scatter Plot of Residential Electric Savings and First Year Costs ($/kWh)



Summary of Residential Natural Gas Results

Five of the seven studies reviewed also present natural gas energy savings potential estimates. The gas energy savings potential across the five studies range from low estimates of about 1% of baseline sales for achievable potential for the ECW study up to 48% technical potential estimates for the regional MEEA study. Some of the variation between studies is accounted for by the different forecast periods and different types of potential estimated between the studies. Most studies focused on estimating achievable or market potential, while two of the studies also presented technical potential estimates, and only one study presented economic potential estimates. Forecast periods ranged from five years to 20 years. However, even annual achievable potential estimates vary between the studies from 0.2% to 1.9% of residential gas baseline sales. Table 2 summarizes the residential gas savings estimates for each state and study. Separate state level results are shown for the 2006 MEEA regional study.

In-depth analyses of the range of actual gas DSM program results were not conducted for any of the studies reviewed. So the gas DSM potential results cannot be compared to the actual DSM program results in any depth. However, from preliminary analyses that the authors have conducted, the range of gas DSM program results in the region is comparable to the range of electric DSM program results.

Table 2. Summary of Residential Gas Energy Savings Potential Results

Organization	State	Year	Fuel	# Years	Technical Potential	Achievable Potential	Achievable Potential/Yr
Iowa Utility Assn	IA	2008	Gas	10	40.0%	NA	NA
Midwest EE Alliance	IL	2003	Gas	10	NA	4.9%	0.5%
Utility Collaborative	MO	2006	Gas	10	NA	19.0%	1.9%
Energy Center of WI	WI	2005	Gas	5	NA	0.9% - 1.7%	0.2% - 0.4%
Midwest EE Alliance	IL	2006	Gas	20	46.9%	25.3%	1.3%
Midwest EE Alliance	IN	2006	Gas	20	48.0%	26.2%	1.3%
Midwest EE Alliance	IA	2006	Gas	20	47.7%	25.9%	1.3%
Midwest EE Alliance	KY	2006	Gas	20	47.8%	25.9%	1.3%
Midwest EE Alliance	MI	2006	Gas	20	45.3%	24.6%	1.2%
Midwest EE Alliance	MN	2006	Gas	20	44.0%	23.5%	1.2%
Midwest EE Alliance	MO	2006	Gas	20	48.1%	26.2%	1.3%
Midwest EE Alliance	OH	2006	Gas	20	47.7%	25.8%	1.3%
Midwest EE Alliance	WI	2006	Gas	20	44.8%	24.3%	1.2%
Medians			Gas	20	46.9%	25.3%	1.3%

Summary of Commercial/Industrial Electric Results

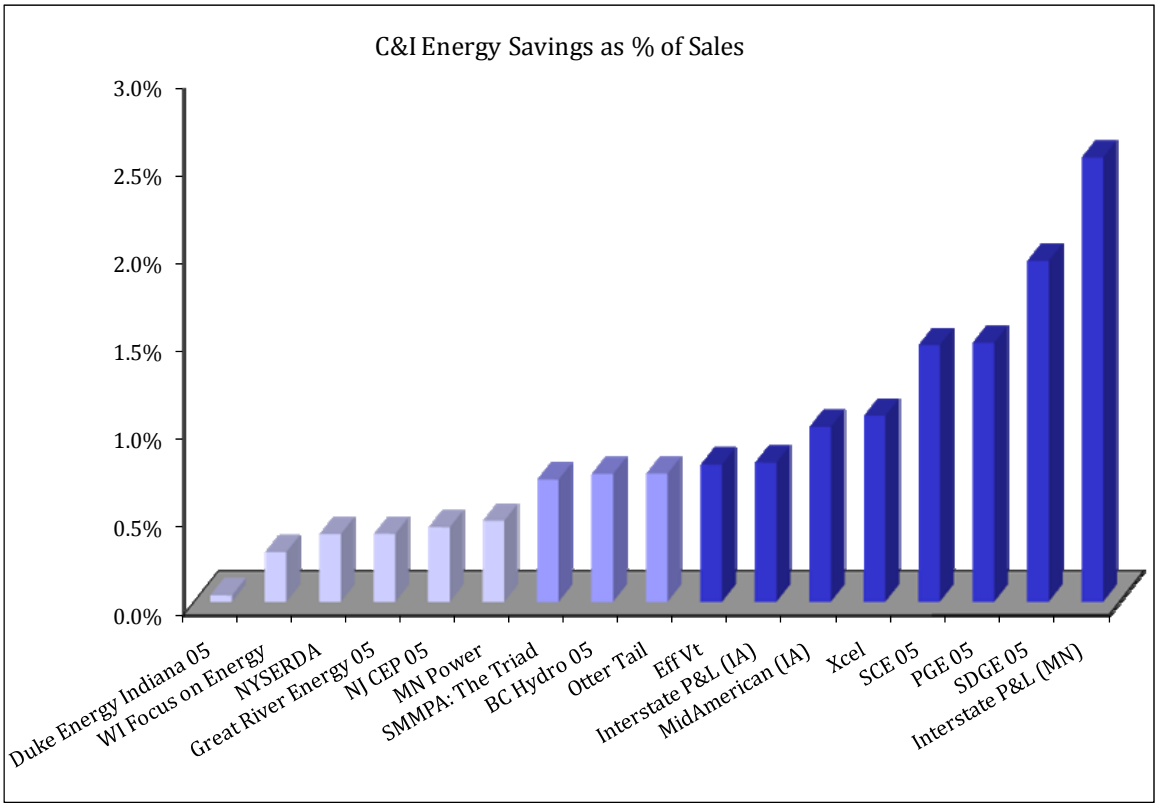
Four of the seven studies reviewed also present commercial/industrial (C/I) DSM potential results in addition to residential results. These studies include Duke Energy, ECW, the IUA, and Xcel Energy. The electric energy savings potential across these four studies range from low estimates of about 1% of baseline sales for achievable potential for the ECW study to a 50% technical potential estimate for the Xcel Energy study. The variation in achievable potential per year of the study forecast period between studies is much narrower than for the residential potential estimates, from 0.3% of baseline C/I sales for the ECW study to 0.7% of baseline C/I sales for the Xcel Energy study. Table 3 summarizes the residential electric savings estimates for each state and study.

Table 3. Summary of Commercial/Industrial Electric Energy Savings Potential Results

Organization	State	Year	Fuel	# Years	Technical Potential	Economic Potential	Achievable Potential	Achievable Potential/Yr
Duke Energy	IN	2007	Electric	20	NA	NA	12%	0.6%
Energy Center of WI	WI	2005	Electric	5	NA	NA	1.3% - 1.9%	0.3%-0.4%
Iowa Utility Assn	IA	2008	Electric	10	17%	12%	NA	NA
Xcel Energy	MN	2002	Electric	20	50%	41%	14%	0.7%
Means			Electric	14	34%	27%	9.2%	0.6%

Commercial/industrial actual program results for 2005-2006 for the 18 utility and public benefits DSM programs from IUA study, shown as percentages of baseline C/I electric sales for each organization, are shown in Figure 3 below.

Figure 3. C&I 2005-2006 First Year Energy Savings as % of Baseline Sales



The results of actual DSM programs for 2005-2006 are generally higher for the highest saving Midwest programs than the C&I DSM potential estimates. The best practice Midwest C&I DSM programs save between about 1.0% of baseline sales for MidAmerican Energy and Xcel Energy, up to 2.5% of baseline sales for Interstate P&L (MN). Interstate's results may somewhat unique, as the Company's Minnesota territory is somewhat small, and more industrial than most utilities.

There are several reasons that the potential studies are estimating lower C/I energy savings potentials than the actual best practice program results. These reasons include:

- For Duke Energy Indiana, only small C&I customers, those with peak demands of less than 500 kW, are eligible for DSM programs in the state. Small C/I customers generally participate less in DSM programs across the country than larger C/I customers. Many jurisdictions treat small C/I customers as "hard to reach", and target special programs towards them to increase their participation.
- The Xcel Energy study was completed several years ago, and the calibration targets used to fine tune the DSM potential estimates are lower than more recent analyses conducted for the Company that have not been released publicly.

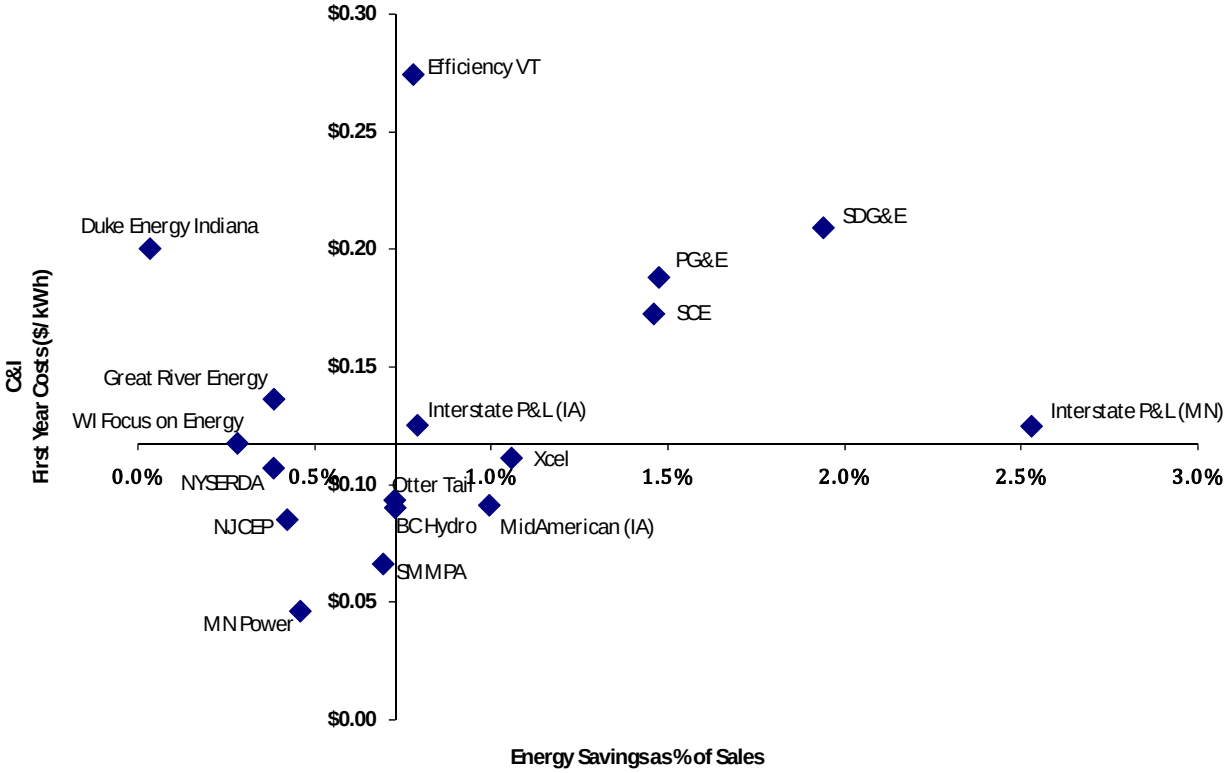
Future C/I DSM potential study estimates will likely be more consistent with the recent actual C/I program results than the results of the studies reviewed for this paper. This has been the case for private DSM potential studies that the authors have recently completed in the Midwest.

How the C/I DSM program costs are estimated and presented varies considerably between the studies reviewed, as was the case with the residential DSM potential study program cost estimates. The Duke and ECW studies present total DSM program costs over the study period, and the Duke study shows program and end use level detail regarding estimated program costs. The IUA study presents average levelized costs for DSM, which are primarily based on the costs of the DSM measures, not DSM program administrative costs or estimated rebate levels. The Xcel Energy study does not present estimated DSM program costs of any type in the report, although such costs were estimated for the Company.

The IUA study best practices analysis also analyzed C/I DSM program costs, and presents the 2005-2006 results as program costs per first year kWh saved. The C/I electric program costs are shown in Figure 4 below. The figure shows that the program costs per kWh vary over a somewhat narrow range for the high savings programs. The high savings programs shown to the right of the y-axis have program costs of $0.09 to $0.21 per first year kWh saved.

Only two of the four C/I studies estimated demand response potential or natural gas potentials, and those two studies presented different types of potential, one technical and economic potential, and the other achievable potential. Given the limited number of results for demand response and gas DSM potentials, those results will not be summarized here.

Figure 4. Scatter Plot of C&I Energy Savings and First Year Costs ($/kWh)



Conclusions

The seven recent studies reviewed in this paper show considerable variations in estimates for residential electric energy efficiency potential. Residential electric energy efficiency achievable potential estimates range from less than less than 0.1% of residential baseline sales per year up to 1.0% of residential baseline sales per year. Generally the lowest estimates are for states that have been conducting large-scale DSM programs for some time, while the highest estimates are for states that are newer to DSM , and for states with the highest saturations of electric heating and water heating. The residential energy efficiency actual program results in the region mirror the energy efficiency potential estimates, ranging from 0.1% of baseline sales saved up to 0.9% of baseline sales saved.

The Midwest residential electric energy efficiency potential results are generally lower than was found in a 2004 review of 11 energy efficiency potential studies that were conducted in the Eastern and Western U.S. (Nadel 2004). That review found the median residential electric achievable potential was 26% in total, or about 1% - 2% per year, several times the corresponding median Midwest estimate of 0.5% per year of residential baseline sales.

Residential natural gas energy efficiency achievable potential estimates also vary widely, ranging from 0.2% up to 1.9% of residential gas baseline sales per year, with the median achievable potential estimate at 1.3% of residential baseline sales per year. The gas achievable potential estimates are slightly lower for states that have been conducting large-scale gas energy efficiency programs for some time, while the highest estimates are for states that are newer to gas energy efficiency programs.

Interestingly, the Midwest residential gas energy efficiency potential results are generally *higher* than was found in a 2004 review of 11 energy efficiency potential studies that were conducted in the Eastern and Western U.S. (Nadel 2004). That review found the median achievable residential gas potential was 9% in total, or about 0.5% - 1% per year, less than the corresponding median Midwest estimate of 1.3% per year of residential baseline sales.

The four recent C/I studies reviewed in this paper show much narrower ranges in estimates for C/I electric energy efficiency potential than was the case for residential electric energy savings potential. C/I electric energy efficiency achievable potential estimates range from 0.3% of C/I baseline sales per year up to 0.7% of C/I baseline sales per year. The highest estimates are for utilities that are conducting high savings C/I DSM programs, and for studies that used such C/I program results as key inputs into their energy savings potential estimates. The C/I energy efficiency actual program results in the region tend to be somewhat higher than the C/I energy efficiency potential estimates, at least for the organizations with highest savings results, which range from 1.0% of C/I baseline sales saved up to 2.5% of C/I baseline sales saved.

The Midwest C/I electric energy efficiency potential results are generally similar to the results from the 2004 review of 11 energy efficiency potential studies that were conducted in the Eastern and Western U.S. (Nadel 2004). That review found the median C/I electric achievable potential was 8% to 9% in total, or about 0.5% - 1.0% per year, similar to the corresponding median Midwest estimate of 0.6% per year of C/I baseline sales.

Several of the studies reviewed in this paper were constrained by practical requirements in various ways, such as by regulatory requirements restricting C/I DSM programs to small C/I customers in Indiana, to requirements that at least the short-term to medium-term potential estimates be somewhat consistent with recent actual program results. The MEEA regional residential study is the closest to an academic study in that it did not include as many of those sort of practical constraints, and focused on estimating maximum achievable DSM potential.

Several utilities and one agency on the West and East Coasts are saving higher percentages of baseline sales than the highest saving programs offered by Midwestern organizations. It is not clear at this point if the higher savings results achieved by some of the coastal organizations are achievable in the Midwest or not, given disparities between electric prices and other factors between the West and East Coasts and the Midwest. However, new DSM requirements in Illinois and Minnesota will likely provide an answer to this question over the next five years. (In 2007, Illinois passed a law requiring the state's investor-owned electric utilities to conserve increasing amounts of baseline sales, ramping up to two percent of baseline sales in 2015. Also in 2007, Minnesota passed a law requiring the state's electric utilities to conserve between 1.0% and 1.5% of baseline sales, starting in 2010.)

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