

Review of Recent Midwest DSM Potential Studies

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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%

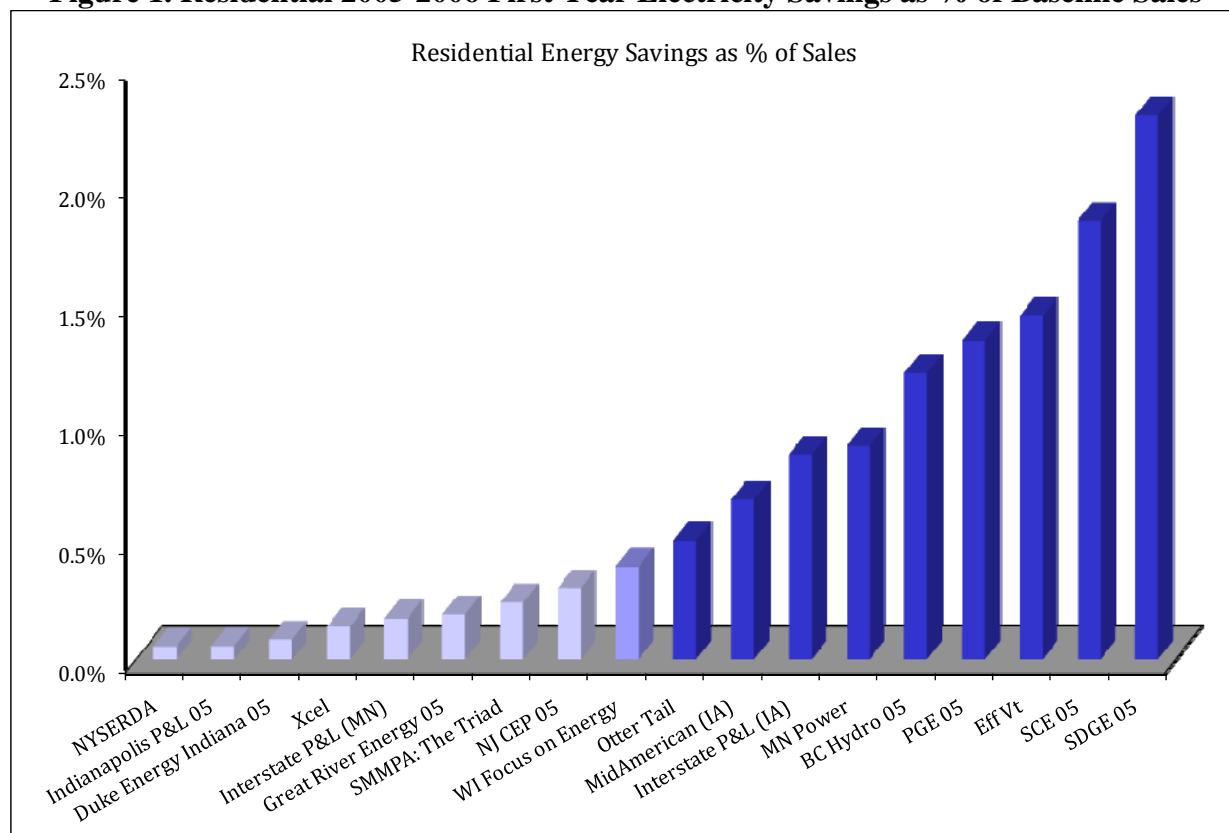
The consulting team for the IUA study conducted an in-depth review and analysis of 18 utility and public benefits 2005-2006 electric DSM program results, which focused on Midwestern programs, but also included other selected jurisdictions across North America. The

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

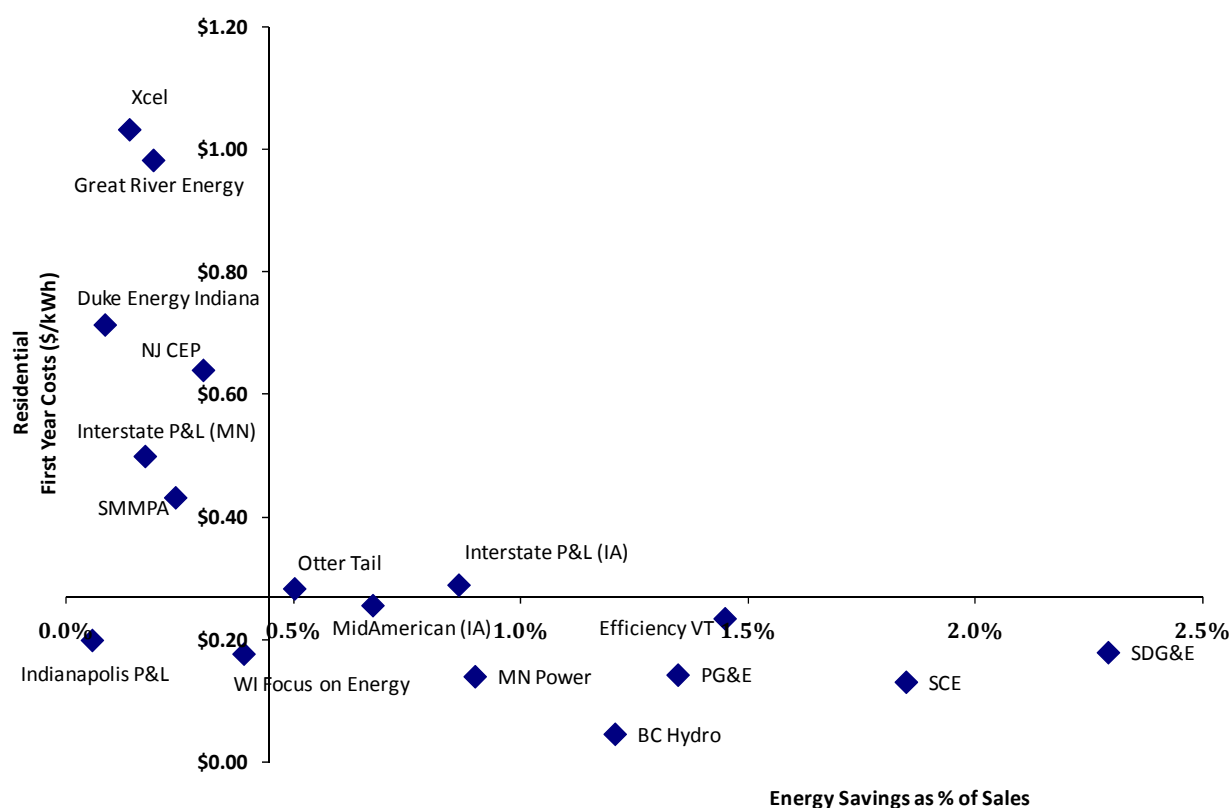


How DSM program costs are estimated and presented varies considerably between the studies reviewed. The Duke and Wisconsin studies present total program costs over the study period, and the Duke study shows program and end use level detail regarding estimated program costs. The Iowa and MEEA regional 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

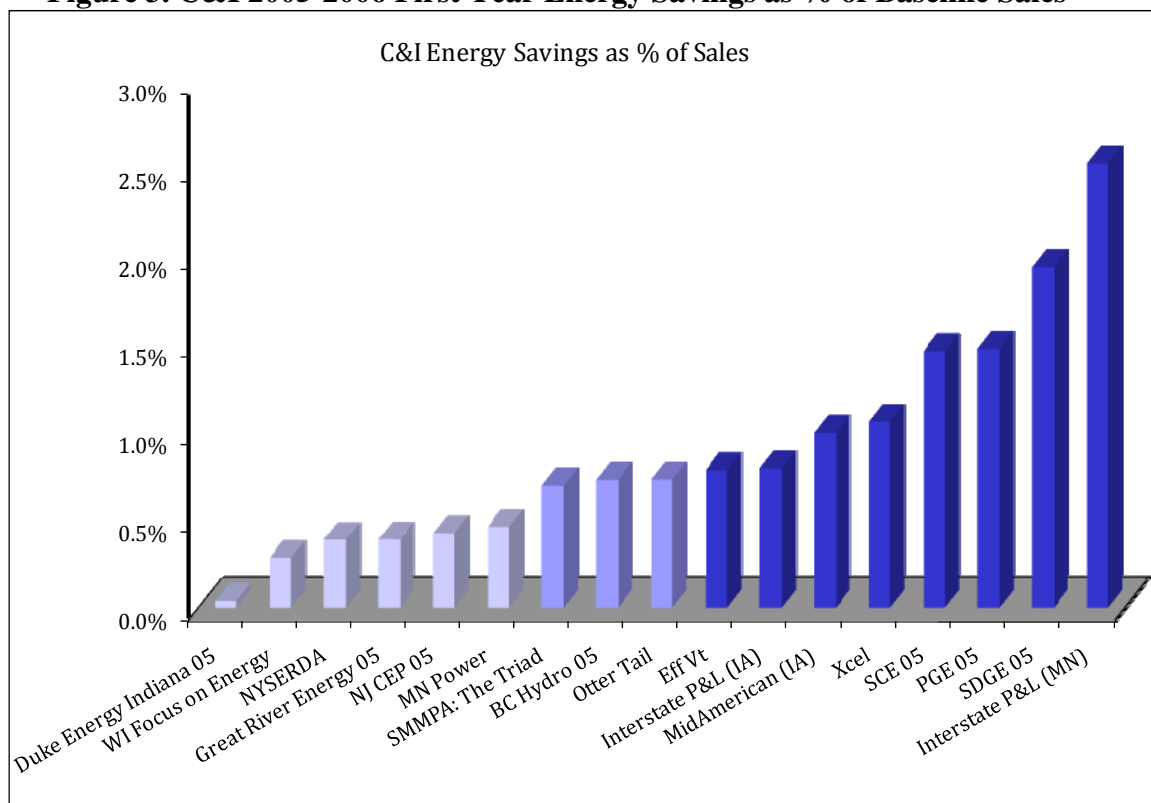
Four of the seven studies reviewed also present commercial/industrial (C/I) DSM potential results in addition to residential results. These studies include Duke Energy, ECW, the IUA, and Xcel Energy. The electric energy savings potential across these four studies range from low estimates of about 1% 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 be 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.

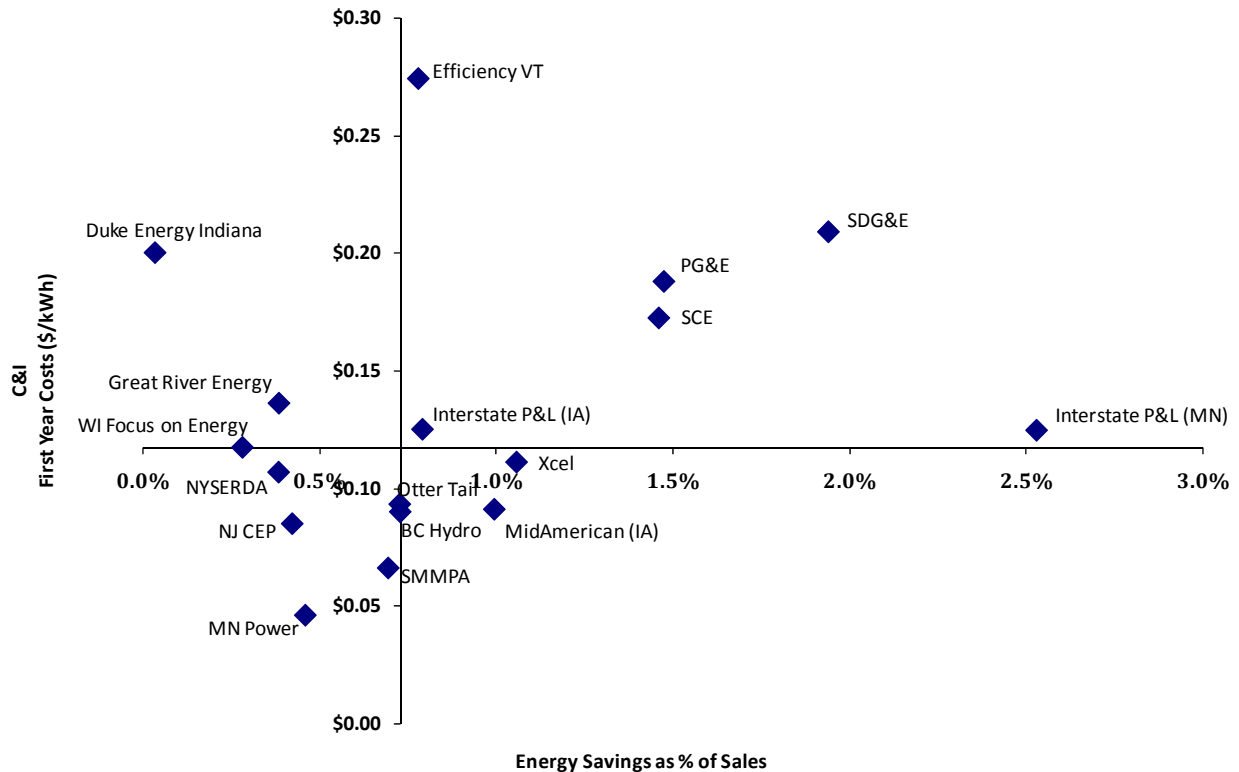
Future C/I DSM potential study estimates will likely be more consistent with the recent actual C/I program results than the results of the studies reviewed for this paper. This has been the case for private DSM potential studies that the authors have recently completed in the Midwest.

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 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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