Missouri River Energy Services

DSM Potential Study

Final Report

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1. EXECUTIVE SUMMARY

This section provides a brief summary of the project goals, methods, and results.

1.1 Project Goals

Missouri River Energy Services' (MRES) goals for this project are:

1. To develop the DSM section of the Company's revised Resource Plan for the State of Minnesota.

2. To complete the project in a two month timeframe, and at a modest cost.

1.2 Methodology

One of the most challenging aspects of this project was that MRES has very little information on the end use customers of the municipal utilities that MRES serves. MRES has historical billing information on about the largest 150 end use customers for their municipal utility clients. This situation, combined with the quick project timeframe, required using existing customer information from previous Summit Blue projects to characterize MRES' end use customer base. Summit Blue primarily used three previous data sources for this purposes:

- Data on residential customers and residential DSM measures from Summit Blue's Midwest Residential Market Assessment that we conducted for the Midwest Energy Efficiency Alliance in 2004-2006[1].

- Data on commercial and industrial customers from Summit Blue's DSM potential study for Otter Tail Power Company that we conducted in 2001-2002.

- Data on commercial and industrial DSM measures from a variety of Summit Blue's recent DSM projects, including our 2005 project to develop DSM measure costs for the California Database of Energy Efficiency Resources (DEER)[2].

For commercial and industrial DSM measures that are climate related, such as building envelope measures like insulation, Summit Blue calculated DSM measure savings using a building simulation model called EQUEST. EQUEST is essentially a user-friendly "front-end" to the DOE-2 building simulation model.

Throughout the analysis process, Summit Blue provided preliminary analytical results, both for MRES customer characterizations, DSM measure impacts, and DSM program costs, to MRES staff for review. In several cases, MRES staff suggesting changing the customer characterization assumptions, the DSM measure impacts, or the DSM programs included in the overall DSM plan. For example, MRES staff suggested considerably reducing air compressors' demand savings based on the results of their air compressor DSM program. As a second example, MRES staff suggested excluding residential refrigeration, envelope measures, and clothes washers/dishwashers in the overall DSM plan. This was

[1] Midwest Energy Efficiency Alliance, "Midwest Residential Market Assessment and DSM Potential Study" (Midwest Energy Efficiency Alliance, Chicago, IL, March 2006). Available at www.mwalliance.org.

[2] The overall report is available at www.energy.ca.gov/deer.

done because the estimated program costs per kilowatt of demand reduced were $1,000 /kW or more for those programs, a level that MRES staff did not believe would be cost effective.

1.3 Results

In total, the DSM potential in 2020 is estimated to be **[TRADE SECRET DATA HAS BEEN EXCISED]**

As expected, more DSM potential was found for the commercial/industrial customers over the 2006-2020 forecast period than was found for the residential sector. In total, **[TRADE SECRET HAS BEEN EXCISED]** of the forecast C&I energy consumption in 2020. For the purposes of this analysis, the C&I sector is assumed to account for **[TRADE SECRET DATA HAS BEEN EXCISED]** of MRES' peak demand and energy use in 2020, the sector's current share of MRES' total system energy sales.

For residential customers, we estimate the achievable DSM potential to be about **[TRADE SECRET DATA HAS BEEN EXCISED]** This represents **[TRADE SECRET DATA HAS BEEN EXCISED]** of the forecast for residential peak demand and **[TRADE SECRET DATA HAS BEEN EXCISED]** of residential energy use forecast for 2020. For the purposes of this analysis, the residential sector is assumed to account for about **[TRADE SECRET DATA HAS BEEN EXCISED]** of MRES' peak demand and energy use in 2020, the sector's current share of MRES' total system energy sales. See Table 1 below for the DSM potential by sector and end use.

Table 1. MRES Resource Plan Summary 2006-2020

C&I End Uses	**2006-2020 Demand Savings (kW)**	**2006-2020 Energy Savings (kWh)**	**2006-2020 Program Costs ($)**
Lighting	**[TRADE SECRET DATA BEGINS**		
Cooling			
Refrigeration			
Process			
Envelope and Misc.	**TRADE**	**SECRET DATA HAS**	**BEEN EXCISED**
Load Management			
Subtotal			
Residential End Uses	**2006-2020 Demand Savings (kW)**	**2006-2020 Energy Savings (kWh)**	**2006-2020 Program Costs ($)**
Lighting			
Cooling			
Water Heating			
Load Management			
Subtotal			**TRADE SECRET DATA ENDS]**
Totals	**85,158**	**233,239,691**	**$24,892,964**

2. INTRODUCTION

Missouri River has not had to develop DSM sections for their previous integrated resource plans for Minnesota because their member utilities conduct DSM programs themselves, in part to comply with Minnesota's CIP requirements. MRES staff supported its member utilities' DSM programs with technical assistance, but MRES did not operate any DSM programs for its member utilities.

The Minnesota Department of Commerce indicated in their November 8, 2005 comments that Department staff do not consider MRES' previous 2006-2020 resource plan to "constitute a sufficient basis for CN (certificate of need) proceedings". Department staff cited the lack of DSM plans and documentation that DSM cannot meet MRES system needs more cost effectively than adding additional generation resources.

The main goal of the current project is to develop the DSM section for MRES' 2006-2020 IRP to respond to the Department's concerns. MRES is particularly interested in completing this project within two months to meet an anticipated April 1, 2006 regulatory filing date. MRES contacted Summit Blue about this project in late December 2005, Summit Blue prepared a project proposal on December 29th, held a project initiation meeting with MRES staff at their Sioux Falls offices on January 11th, and prepared a draft project report on March 7, 2006.

3. METHODOLOGY

This section describes the DSM potential analysis approach and methods. There are three primary aspects to the DSM potential analysis conducted: characterizing residential and commercial/industrial customers, characterizing applicable DSM measures for each customer sector, and estimating DSM potentials from those two sets of inputs. The approach for the residential sector will be discussed first, then for the commercial/industrial sector.

3.1 Residential Analysis

The residential customer and DSM measure characterizations will be discussed in this section.

3.1.1 Residential Customer Characterization

Summit Blue used the residential DSM potential information from the Midwest Residential Market Assessment project that Summit Blue conducted for the Midwest Energy Efficiency Alliance in 2004-2006 for this project for MRES[3]. Customer data for the MEEA project were drawn from a combination of telephone surveys with samples of about 100 residential customers per Midwestern state, telephone surveys of 5-10 residential energy auditors from each state, and information from publicly available DSM potential studies or market assessments that had been conducted in the Midwest from 1999-2003.

The MEEA residential customer survey instrument was designed to collect information such as household characteristics; energy payments; familiarity with conservation activities; conservation measures already in practice; a resident's heating/cooling system usage; a resident's water heating system usage; and type of fuel or energy source used for major appliances or household equipment. The customer samples were designed to achieve statistical reliability of +/- 10% with 95% confidence for each state.

The 2005 MEEA trade ally interviews were conducted to provide data to augment the information collected in the 2004 MEEA Residential Appliance Saturation Survey (RASS). The trade ally interviews were designed to provide feedback on analytical factors that residents would generally not know: stock and trends in equipment as well as measure efficiencies for HVAC equipment, water heaters, appliances, and insulation.

To gather this information, the Summit Blue team conducted a telephone survey of energy auditors. The survey asked detailed questions about the saturation rates of a variety of efficiency levels for appliances and energy saving measures present in single family and multifamily homes in Indiana, Kentucky, Michigan, Missouri, and Ohio.

Summit Blue used the results from Ohio to characterize MRES' residential customers, for two primary reasons: first, Ohio residential customers' average annual electric use of 11,100 kWh[4] is closest to MRES' residential customers' average annual electric use of **[TRADE SECRET DATA HAS BEEN EXCISED]**. Second, Ohio residents have participated in limited energy efficiency programs over the past several years, somewhat similar to the case for MRES residential customers.

[3] Midwest Energy Efficiency Alliance (MEEA): 2006,*op.cit.*, Chapter 3.

[4] *Ibid.*, p. 32.

3.1.2 Characterizing Residential DSM Measures

Summit Blue also used the residential DSM measure information that we developed for the MEEA project in 2005 for this project for MRES[5]. Characterizing DSM measures required 1) determining the list of DSM measures to evaluate, and 2) estimating the incremental savings from each measure - improving from the baseline to the new technology(ies). In addition, the baselines must consider that different classes of homes have different penetrations of technologies, such as existing homes compared to new construction.

For MEEA, the project team first drew up a list of prospective measures from past experience and added to and subtracted from that list as necessary for the project. Additions included new technologies or improvements to existing technologies, subtractions included measures that were made obsolete by shifting baselines. The goal was a comprehensive list of DSM measures applied in different segments of the residential market: new versus existing construction and single-family versus multi-family housing.

Once identified, the project team determined which measures would have a significant climate-dependent savings component. Those measures that were determined to be climate-*independent* (lighting, appliances, and domestic hot water) were characterized using engineering calculations and assumptions for energy savings. Climate-dependent measures (HVAC equipment, insulation, air-sealing etc) were simulated with a computer model (Energy 10) to determine savings.

Climate-independent DSM measures are described in many resources, including: the US Department of Energy, EnergyStar Program[6], the California Database of Energy-efficient Resources[7], various utility on-line audit services and manufacturer data. These resources were particularly useful for appliances. Other end-uses were analyzed using engineering principles such as steady-state heat loss, rated power and hours of operation.

For climate-independent measures, savings was permitted to vary according to construction type, e.g., single- family versus multi-family or new homes versus existing construction.

Climate-*dependent* DSM measures were modeled using Energy-10 software, an hourly simulation tool designed specifically for small commercial and residential structures. The project team made three baseline models reflecting typical constructions of three building types: new single-family homes, existing single family homes, and multi-family construction, for the Minneapolis climate zone.

Model input parameters, such as building size, installed equipment type and age and insulation levels, were based on survey results and building code (new construction) information. The models were then calibrated to produce energy consumption that corresponded to published consumption for Minnesota residences.

[5] *Ibid.*, p. 20-21.

[6] http://www.energystar.gov/

[7] http://www.energy.ca.gov/deer/

The project team has determined that there is general uniformity of measure cost and lifetimes across the geography considered in this study. Variations in costs exist for certain higher cost measures such as HVAC equipment and insulation where labor costs factor in more heavily. Measure cost estimates for these measures were weighted by factors contained in industry sources such as the RS Means Mechanical Cost Data.

The project team estimated measure lifetimes from a combination of resources including: manufacturer data, typical economic depreciation assumptions, the California DEER database, various studies reviewed for this report and survey responses from residential customers.

3.2 Commercial/Industrial Analysis

The commercial/industrial customer and DSM measure characterizations will be discussed in this section.

3.2.1 Commercial/Industrial Customer Characterization

Summit Blue relied on two primary information sources for characterizing MRES's commercial and industrial customers: electric billing information that MRES provided for their largest 150 end use customers, and information from previous Summit Blue's DSM potential studies. Information from two previous studies was particularly useful for this project: a commercial/industrial DSM potential study that we conducted for Otter Tail Power Company in 2001-2002 and one for Arizona Public Service Company in 2005. From MRES's customer billing information, we noted that the organization's C&I customer base is dominated by industrial customers, who account for about **[TRADE SECRET DATA HAS BEEN EXCISED]** of sales for the top 150 customers.

Summit Blue intended to use Otter Tail Power's C&I customer information that we collected as part of the DSM potential study that we conducted for them previously to estimate energy equipment and DSM measure saturations for MRES' C&I customers. However, Summit Blue had returned all such data to Otter Tail at the conclusion of the DSM potential study in 2002, and Otter Tail could not quickly locate that information. After several weeks of inquiries, Otter Tail did finally locate several CDs with C&I customer information in early February, and provided such to Summit Blue. However, MRES had previously requested that Summit Blue provide its draft C&I DSM potential estimates by February 10th, which left very little time to analyze the Otter Tail data. Summit Blue did use the DSM measure load shapes from the Otter Tail project for most C&I measures for the current project.

Summit Blue made the following key assumptions to characterize MRES' C&I customers based on information provided by MRES staff, the MRES billing information provided, and results from previous Summit Blue DSM potential studies:

- The end use sales and peak demand allocation is approximately **[TRADE SECRET DATA HAS BEEN EXCISED]** process loads, including motors and air compressors, 20% lighting, and 10% for cooling and refrigeration each.

- The saturation rates for most energy conservation measures (ECMs) are modest, **[TRADE SECRET DATA HAS BEEN EXCISED]** or less for almost all measures, given the limited historical availability of energy conservation programs in MRES' service area to assist customers with installing ECMs.

3.2.2 Characterizing Commercial/Industrial DSM Measures

Summit Blue started the commercial/industrial DSM measure characterization process by developing a list of DSM measures from MRES member utilities' DSM programs and previous Summit Blue projects. After the individual measures were assigned to a primary end use category (i.e. lighting, cooling, etc.), the project team estimated the following parameters for each measure:

- Per-unit energy and demand savings
- Coincidence factors
- Typical operating hours
- Measure lifetimes
- Measure costs

To do this, the project team first separated the measures into two categories: weather-dependent measures and weather-independent measures. Much of the research and analysis for the weather-independent measures had been conducted by Summit Blue in 2005 for a separate study, and this data was mostly reused with slight modifications for Missouri River's service territory. The research consisted of Internet searches and phone calls for manufacturer data concerning end-use demand and energy consumption, and Internet searches and phone calls for retailer data concerning equipment costs. Other research included reviewing estimates of measure lifetimes, operating hours, and coincidence factors for a variety of end-uses and market sectors and from a number of different sources. All of this data was then compiled into a spreadsheet with outputs for per-unit energy and demand savings, net present value, incremental cost, payback periods, and benefit-cost ratios. These measure spreadsheets were used as the basis for the values required by the MRES DSM Potential Study.

These DSM measure spreadsheets were also used as the starting point for the analysis of the weather-dependent measures, such as insulation, windows, etc. Some of the values, such as coincidence factor, measure life, and incremental cost were reused for this potential study. Because of their inherent sensitivity to climate, however, the per-unit energy and demand savings were re-calculated by creating a simulation model using the DOE-2 powered eQuest software package. Summit Blue chose Sioux Falls, SD as the center of MRES's service territory. Based on the billing data provided by MRES, the project team modeled the energy consumption with a **[TRADE SECRET DATA HAS BEEN EXCISED]** sector, MRES largest commercial building segment. For each measure, a baseline case and an energy-efficient case were modeled separately, and the difference in peak demand and energy consumption per unit was calculated and entered into the measure characterization spreadsheet.

3.3 Estimate Technical, Economic, and Market DSM Potential

The general approach for derivation of DSM resource potentials consisted of three steps: (1) estimate technical DSM potential, (2) estimate market penetration and the resulting achievable potential for each measure, (3) verify that the annual DSM potential estimates are reasonable by comparing the savings for each end use and sector to the recent actual DSM program results for MRES, Otter Tail Power, Xcel Energy, and SMMPA. For the latter benchmarking analysis, each utility's DSM program savings and costs were normalized for each utility's recent residential or commercial/industrial sector sales.

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 MRES' service area, and 100% - the measure's current market saturation. Achievable potential is an estimate of the amount of DSM potential that could be captured by realistic DSM programs over the 15 year forecast period (2006-2020) covered by MRES' Resource Plan. The key parameter that must be estimated to forecast achievable DSM potential is the market penetration for each DSM measure at the end of the forecast period in 2020. Summit Blue estimated this parameter for each DSM measure based on our previous DSM potential projects, as well as MRES' staff expectations regarding what would be reasonable to expect in their service area over the forecast period. For most measures, a maximum market penetration of 20% over the forecast period was assumed, except for selected DSM measures like T8 lamps and electronic ballasts that have achieved higher market penetrations due to DSM programs in many service areas in the Midwest and across the country.

Both technical potential and achievable potential estimates were calculated using a spreadsheet analysis approach that Summit Blue previously developed for a fast-track DSM potential project for Arizona Public Service Company. Summit Blue modified the DSM measure inputs to account for the smaller size of MRES' commercial/industrial customers, as well as MRES' more northern climate, as previously discussed in the DSM measure characterization sections.

4. DSM POTENTIAL RESULTS

This section provides the DSM potential results separately for the commercial/industrial and residential sectors.

4.1 Commercial and Industrial Results

The commercial/industrial DSM potential results are summarized in Table 2. Table 2 shows the total DSM potential results by end use for existing customers, new customers, and the combined sector total. The results show that for C&I customers, load management and lighting DSM measures are estimated to contribute the largest and approximately equal shares of demand reduction potential. Load management DSM potential is estimated at **[TRADE SECRET DATA HAS BEEN EXCISED]** over the 15 year period, while the lighting DSM potential is estimated at **[TRADE SECRET DATA HAS BEEN EXCISED]**. Together these two types of DSM programs account for approximately **[TRADE SECRET DATA HAS BEEN EXCISED]** of the total C&I demand reduction potential.

4.1.1 Commercial and Industrial Demand Response Results

About **[TRADE SECRET DATA HAS BEEN EXCISED]** MRES' utility customers have been conducting DLC programs for C&I customers for many years (as well as for residential customers) but have just started implementing interruptible rates in the last few years. To date, only four customers on MRES' system are participating in interruptible rate programs.

Summit Blue conducted two types of benchmarking assessments on the C&I demand response (DR) potential that we estimated for MRES. First, we compared MRES' 2004 DR program results to those for SMMPA[8], Otter Tail Power Company[9], and Xcel Energy[10]. We divided each utility's approximate 2004

[8] Austin Utilities, Owatonna Public Utilities, Rochester Public Utilities (The Triad), "The Triad's 2005-2006 Conservation Improvement Program Overview" (SMMPA, Rochester, MN, October 20, 2004.)

[9] Otter Tail Power Company, "Status Report, 2004 CIP Activities", (Otter Tail Power Company, Fergus Falls, MN, April 1, 2005.)

DR peak demand reduction impact estimates by their approximate C&I peak demands to determine the percent of each Company's C&I peak demands that they were able to reduce through their 2004 DR program results.

MRES was able to achieve about 925 kW of peak demand reduction in 2004, according to analysis of information provided to Summit Blue by Company staff. That represents about **[TRADE SECRET DATA HAS BEEN EXCISED]** C&I peak demand. The latter estimate assumes that C&I customers account for about **[TRADE SECRET DATA HAS BEEN EXCISED]** of the Company's total peak demand. Xcel Energy achieved larger results from their C&I DR programs, as their program impacts accounted for about 1.0% of their C&I peak demand. About 90% of Xcel Energy's 2004 DR program impacts were from their interruptible rates program, while the remaining 10% of their C&I DR program impacts were from their Business Saver's Switch DLC program. Neither Otter Tail Power nor SMMPA estimated peak demand impacts from their C&I DR programs in their 2004 CIP status reports, so their information was not useful for benchmarking purposes.

The second type of benchmarking assessment that Summit Blue conducted used the results from Summit Blue's demand response potential assessment for the International Energy Agency's Demand Response Resources project[11]. As part of that project, Summit Blue surveyed 40 North American utilities on their demand response programs. We found that the top-performing C&I interruptible rate programs had achieved impacts that amounted to 10% or more of the utilities' C&I peak demands. A few of the utilities surveyed with large steel plant loads had achieved impacts from their interruptible rate programs that slightly exceeded 20% of their C&I peak demands, but such accomplishments are dependent on having a highly industrial C&I customer base. These results indicate the MRES may be able to significantly expand the impacts of its interruptible rates programs over time.

4.1.2 Commercial/Industrial Energy Efficiency Results

Efficient lighting measures account for **[TRADE SECRET DATA HAS BEEN EXCISED]** of the total estimated C&I energy conservation potential. Of the C&I lighting DSM measures, T8 lamps and electronic ballasts and compact fluorescent lamps (CFLs) together account for **[TRADE SECRET DATA HAS BEEN EXCISED]** of the total lighting potential. Existing C&I facilities account for **[TRADE SECRET DATA HAS BEEN EXCISED]** of total C&I lighting energy conservation potential.

Efficient motors, adjustable speed drives, and air compressor measures account for the next largest share of C&I energy conservation potential at 42% of the total. However, process measures only account for about 10% of the total C&I demand reduction potential, as MRES' experience with its air compressor program indicates that the peak demand reduction impacts from air compressor system improvements are limited.

Efficient cooling and roofing measures account for 13% of the total C&I peak demand reduction potential and 4% of the C&I energy conservation potential. Efficient C&I refrigeration measures and efficient building envelope measures like insulation each account for single digit percentages of the total C&I DSM potential.

[10] Xcel Energy Corporation, "2004 Status Report & Associated Compliance Filings, Minnesota Natural Gas and Electric Conservation Improvement Program", (Xcel Energy Corporation, Minneapolis, MN, April 1, 2005.)

[11] R. Gunn, "North American Utility Demand Response Survey Results", (Association of Energy Services Professionals, February 6, 2006, San Diego, CA.)

Summit Blue conducted two types of benchmarking assessments on the C&I energy efficiency (EE) potential that we estimated for MRES. First, we compared MRES' 2004 EE program results to those for SMMPA[12], Otter Tail Power Company[13], and Xcel Energy[14]. We divided each utility's approximate 2004 EE energy savings impact estimates by their approximate 2004 C&I energy sales to determine the percent of each Company's C&I energy sales that they were able to reduce through their 2004 EE program results. Secondly, we examined how each utility's total C&I energy savings were distributed across their different C&I EE programs.

MRES was able to achieve about 12.5 GWh of energy conservation savings in 2004 according to analysis of information provided to Summit Blue by Company staff. That represents about 0.4% of the Company's approximate 2,794 GWh of C&I energy sales. Slightly more than half of MRES' 2004 energy savings came from the Company's compressed air program in 2004. Street lighting accounted for almost 25% of MRES' C&I EE program impacts, while (interior) Lighting conservation, and Custom programs approximately equally divided the other 25% of the Company's C&I EE program energy savings.

SMMPA achieved a very similar overall level of C&I energy savings from its C&I DSM programs in 2003 as MRES did in 2004, as its C&I EE program results also were approximately 0.4% of their C&I energy sales. Slightly more than 80% of SMMPA's C&I energy savings were achieved through their C&I lighting DSM program.

Otter Tail Power achieved energy savings from its C&I EE programs totaling about 0.9% of its Minnesota C&I sales in 2004, according to Summit Blue's analysis of data provided in the Company's 2004 CIP status report. Interestingly, Otter Tail's distribution of C&I energy savings by program was rather different than SMMPA's, in that slightly more than 70% of Otter Tail's C&I energy savings came from its Custom program, while only about 16% of their C&I energy savings came from their C&I lighting program.

Xcel Energy achieved the largest C&I EE program results in 2004 of the four Minnesota utilities assessed. Their 2004 program impacts totaled about 1.1% of their Minnesota C&I energy sales. Xcel Energy's C&I lighting programs accounted for about 45% of their C&I EE program impacts, while three of their other C&I EE programs, Motors/Drives, Custom, and New Construction, each accounted for about 13%-14% of their total C&I energy savings in 2004.

While the actual results of the Minnesota utilities' C&I EE program vary considerably in their overall magnitudes, and in the distribution of impacts by program, the other utilities' results generally validate the C&I DSM potential estimates for MRES. The **[TRADE SECRET DATA HAS BEEN EXCISED]** of C&I energy sales energy conservation potential forecast for MRES over the Resource Plan forecast period is equivalent to annual impacts of about **[TRADE SECRET DATA HAS BEEN EXCISED]** per year, and is about the same as MRES' and SMMPA's actual EE program results in 2004 and 2003 respectively. Otter Tail Power and Xcel Energy have achieved larger C&I EE program results in 2004, in part due to their longer experience managing these programs than MRES or SMMPA. On average, the distribution of energy conservation potential estimates by end use for MRES is similar to the average actual impacts achieved by SMMPA, Otter Tail, and Xcel Energy in 2004 or 2003.

[12] SMMPA: 2004, *op.cit.*

[13] Otter Tail Power Company: 2005, *op.cit.*

[14] Xcel Energy Corporation: 2005, *op.cit.*

4.2 Residential Results

The residential DSM potential results are shown in Table 3. Table 3 shows the total DSM potential results by end use for existing customers, new customers, and the combined sector total. The DSM potential results for residential customers are somewhat simpler than for commercial/industrial customers. Load management measures account for **[TRADE SECRET DATA HAS BEEN EXCISED]** of residential demand reduction potential, amounting to a total of **[TRADE SECRET DATA HAS BEEN EXCISED]** of peak demand reduction over the 15 year forecast period, or an average of **[TRADE SECRET DATA HAS BEEN EXCISED]** per year. Residential lighting accounts for a similar **[TRADE SECRET DATA HAS BEEN EXCISED]** of the energy conservation potential for residential customers as direct load control does for demand reduction potential, totaling **[TRADE SECRET DATA HAS BEEN EXCISED]** of energy conservation over the forecast period, or an average of **[TRADE SECRET DATA HAS BEEN EXCISED]** per year.

4.2.1 Residential Demand Response Results

Direct load control of residential central air conditioners accounts for about 85% of estimated residential load management demand reduction potential, while direct load control of residential electric water heaters accounts for the remaining 15% of residential load management potential. Central air conditioners' larger share of demand reduction potential than water heaters is due to air conditioners' estimated market saturation being two to three times that for electric water heaters, and the peak demand reduction per unit being estimated at to be approximately double that for electric water heaters. Interestingly, the demand reduction potential for new construction is greater than the potential for existing customers, due to the significant current penetrations of DLC systems among existing customers.

Summit Blue conducted two types of benchmarking assessments on the residential DLC DSM potential that we estimated for MRES. First, we compared MRES' 2004 DLC program results to those for SMMPA, Otter Tail Power Company, and Xcel Energy from their CIP Status Reports. We divided each utility's approximate 2004 DLC peak demand reduction impact estimates by their approximate residential peak demands to determine the percent of each Company's residential peak demands that they were able to reduce through their 2004 DLC program results. MRES was able to achieve about 3 MW of peak demand reduction in 2004 according to analysis of information provided to Summit Blue by Company staff. That represents **[TRADE SECRET DATA HAS BEEN EXCISED]** of the Company's approximate **[TRADE SECRET DATA HAS BEEN EXCISED]** residential peak demand. The latter estimate assumes that residential customers account for **[TRADE SECRET DATA HAS BEEN EXCISED]** of the Company's total peak demand. Xcel Energy achieved similar results from their residential Saver's Switch DLC program, as their 2004 program impacts accounted for about 1.4% of their residential peak demand. Otter Tail's 2004 DLC peak impacts that were reported in their 2004 CIP Status Report were small, less than 0.1% of their residential peak demand. SMMPA did not estimate peak demand impacts from any of their DSM programs in their latest CIP status report, so their information was not useful for this purpose.

The second type of benchmarking assessment that Summit Blue conducted used the results from Summit Blue's demand response potential assessment for the International Energy Agency's demand response resources project. As part of that project, Summit Blue surveyed 40 North American utilities on their demand response programs. We found that the top-performing residential direct load control programs had achieved impacts that amounted to 10% or more of the utilities' residential peak demands.

MRES has already achieved about 53 MW of total load management peak demand reductions, according to information provided to Summit Blue by Company staff. Most of the Company's load management impacts have come from residential direct load control programs. If 75% of the Company's historical load management impacts came from the residential sector, or about 40 MW, that would amount to about 18% of the Company's approximate 223 MW residential peak demand in 2005. (This calculation assumes that the residential sector accounts for **[TRADE SECRET DATA HAS BEEN EXCISED]** of the Company's 2005 total peak demand of about 743 MW.) The MRES system's residential DLC program results are similar in magnitude to the group of top-performing utilities' DLC program results from Summit Blue's IEA demand response project. Given the magnitude of MRES's historical DLC program results, it is reasonable to expect that most residential DLC potential has already been achieved from existing customers, and that most of the remaining residential DLC potential will be achieved from new construction over the Resource Plan forecast period.

4.2.2 Residential Energy Efficiency Results

As previously stated, lighting accounts for the large majority of residential energy efficiency potential. For residential lighting systems, compact fluorescent lamps (CFLs) are the only DSM measure considered. However, DSM potential estimates were separately developed for lamps that are on an average of six hours per day, 2.5 hours per day, and one-half hour per day. The great majority (about 85%) of lamps in a typical residential home are the low use lamps of the latter category. However, the highest use lamps account for about 60% of the total lighting energy conservation potential despite their relatively low numbers in most homes. Residential lighting demand reduction potential only amounts to about 4% of the total residential demand reduction potential from all types of DSM measures because residential lamps have low coincidence factors, about 3% overall, and only about 8% for even the longest use lamps that are on an average of six hours per day.

The market penetration rates for CFLs in MRES' residential homes are likely to considerably increase from low baseline rates of about 1% currently. This expectation is due to the considerable cost reductions that manufacturers of CFLs have realized over the past few years. One can now purchase a six pack of CFLs at Home Depot for only $10 in total, which used to be the typical price of a single CFL as recently as about five years ago.

Residential air conditioners only account for **[TRADE SECRET DATA HAS BEEN EXCISED]** of total estimated residential demand reduction potential and **[TRADE SECRET DATA HAS BEEN EXCISED]** of total energy conservation potential for MRES. These somewhat low estimates are primarily due to the adoption of the recent federal energy efficiency standard for central air conditioners of 13 SEER that just went into effect in January 2006. The incremental savings of 14 SEER central air conditioners from a 13 SEER baseline is much less than the recent situation before the standards took effect. The incremental costs of 14 SEER units relative to SEER 13 units are not yet very clear due to the recent effective date for the new standard, so the cost effectiveness of the 14 SEER units is still somewhat uncertain.

Water heating DSM measures are estimated to have limited DSM potential due to the **[TRADE SECRET DATA HAS BEEN EXCISED]** incremental implementation rates assumed for most such measures. These somewhat low estimates are due to either the measures' limited energy savings, or some water heater measures' currently high market penetration rates, such as for faucet aerators and low-flow showerheads.

The benchmarking analysis that Summit Blue conducted for residential energy efficiency programs focused on the overall magnitude of energy conservation savings that Minnesota utilities have achieved from such programs. We did not conduct a program-by-program residential DSM benchmarking assessment since the mix of DSM programs that MRES would consider cost effective was somewhat in flux until near the end of the analysis period, and the overall magnitude of residential energy savings compared to overall residential sales is much lower than for demand response programs, which were discussed in the previous section.

The results of the residential DSM program benchmarking included the following findings:

- In 2004, the MRES utilities' residential DSM program energy savings amounted to approximately 0.2% of residential energy sales for the MRES system.

- SMMPA's 2003 residential DSM energy savings amounted to approximately 0.3% of their system's residential energy sales. Their residential cooling program accounted for slightly more than 75% of their total residential energy savings.

- Xcel Energy's 2004 Minnesota residential DSM energy savings amounted to approximately 0.1% of their system's residential energy sales. Their residential air conditioning program accounted for slightly less than half of their residential DSM energy savings.

- Otter Tail Power's 2004 Minnesota residential DSM energy savings amounted to approximately 0.5% of their Minnesota residential energy sales. Their residential lighting DSM program accounted for slightly more than half of their total residential energy savings.

Table 2. Commercial and Industrial Achievable Potential Estimates

C&I Existing Customers	15 Year Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Lighting	[TRADE SECRET DATA BEGINS															
Achievable Potential Demand Savings (kW)	[redacted]															
Achievable Potential Energy Savings (kWh)																
Program Costs																
Cooling/Roofing																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Refrigeration																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Process (Motors/Drives/Compressed Air)																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Load Management/DLC																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Envelope/Miscellaneous																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																

C&I New Construction	15 Year Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Lighting																
Achievable Potential Demand Savings (kW)	[redacted]															
Achievable Potential Energy Savings (kWh)																
Program Costs																
Cooling/Roofing																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Refrigeration																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Process (Motors/Drives/Compressed Air)																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Load Management/DLC																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Envelope/Miscellaneous																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																

TRADE SECRET DATA ENDS

PUBLIC DOCUMENT—TRADE SECRET DATA HAS BEEN EXCISED

Table 2. Commercial and Industrial Achievable Potential Estimates, continued

C&I Total	15 Year Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Lighting	[TRADE SECRET DATA BEGINS [redacted]															
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (MWh)																
Program Costs																
Cooling/Roofing																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (MWh)																
Program Costs																
Refrigeration																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (MWh)																
Program Costs																
Process (Motors/Drives/Compressed Air)																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (MWh)																
Program Costs																
Load Management/DLC																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (MWh)																
Program Costs																
Envelope/Miscellaneous																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (MWh)																
Program Costs																

TRADE SECRET DATA ENDS]

PUBLIC DOCUMENT—TRADE SECRET DATA HAS BEEN EXCISED

Table 3. Residential Achievable DSM Potential Estimates

[TRADE SECRET DATA BEGINS

Existing Residential	15 Year Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Lighting																
Achievable Potential Demand Savings (kW)	[redacted]															
Achievable Potential Energy Savings (kWh)																
Program Costs																
Cooling/Heat Pumps																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Water Heating																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Load Management/DLC																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																

esidential New Constructio	15 Year Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Lighting	[redacted]															
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Cooling/Heat Pumps																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Water Heating																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																
Load Management/DLC																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (kWh)																
Program Costs																

Total Residential	15 Year Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Lighting																
Achievable Potential Demand Savings (kW)	[redacted]															
Achievable Potential Energy Savings (mWh)																
Program Costs																
Cooling/Heat Pumps																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (mWh)																
Program Costs																
Water Heating																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (mWh)																
Program Costs																
Load Management/DLC																
Achievable Potential Demand Savings (kW)																
Achievable Potential Energy Savings (mWh)																
Program Costs																

TRADE SECRET DATA ENDS]

PUBLIC DOCUMENT—TRADE SECRET DATA HAS BEEN EXCISED

MRES Appendix A: Brief DSM Measure Descriptions

Lighting Measures

Most of the lighting measures discussed below are only used for DSM potential estimates for the commercial and industrial sector. CFLs are the only lighting measure that also apply to the residential sector.

T8 Lamps and Electronic Ballasts

T8 lamps and electronic ballasts are the most common alternative for standard T12 lamp and magnetic ballast tubular fluorescent lighting systems. T8 fluorescent lamps are one inch in diameter, and are thinner than T12 lamps, which are 1.5 inches in diameter. T8 systems are approximately 30% more efficient than standard T12 systems.

T5 Lamps and Electronic Ballasts

T5 lamps and electronic ballasts are a newer alternative tubular 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 available in metric lengths.

Compact Fluorescent Lamps

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. The newer “spiral” CFLs are also generally about the same size as incandescent lamps of similar light output.

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.

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.

Pulse Start Metal Halide

Pulse start metal halide lamps are a newer type of metal halide systems that use formed body arc tubes and require an ignitor to start the lamps. Pulse start metal halide lamps are more efficient than standard metal halide systems, and also provide better light output maintenance over the lifetime of the lamp, as well as a longer lamp lifetime.

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 fixture. This measure is intended for areas that are currently over-lit. Lighting reflectors are often used as part of delamping projects.

Commercial and Industrial Cooling Measures

Efficient Packaged AC Systems

Efficient air conditioners are generally defined relative to minimum efficiency standards set by either the federal DOE or state governments. Both the U.S. DOE and Minnesota Department of Commerce are in the process of updating their minimum air conditioner efficiency standards. However, the current Minnesota standards are:

- 9.7 EER for single packaged units less than 65,000 BTUs in size.
- 10.0 SEER for split system units less than 65,000 BTUs in size.
- 8.9 EER for single packaged and split systems greater than 65,000 BTUs in size[15].

As a point of reference, Xcel Energy defines their minimum qualifying standards for rooftop air conditioners on a sliding scale:

- Units less than 65,000 BTUs: 11.0 SEER.
- Units > 65,000 BTUs and < 135,000 BTUs: 10.3 EER
- Units > 135,000 BTUs and < 240,000 BTUs: 9.7 EER
- Units > 240,000 BTUs and < 760,000 BTUs: 9.5 EER
- Units > 760,000 BTUs: 9.2 EER[16]

Efficient Chiller Systems

Chiller efficiency varies by compressor type (centrifugal, reciprocating or screw), condenser type (water-cooled or air-cooled) and vintage (age). Newer, water-cooled centrifugal machines tend to be the most efficient[17]. Chillers are not generally covered by government efficiency standards, so efficient units are usually defined relative to a utility or state-specific baseline. For purposes of this project, Summit Blue used Xcel Energy's definitions of efficient chillers: 0.65 kW/ton for units less than 150 tons, and 0.60 kW/ton for units of 150 tons or more[18].

Energy Management Systems

[15] From the 1999 Minnesota Energy Code. Information is available at: www.revisor.leg.state.mn.us/arule/7678.

[16] Xcel Energy Corporation, "2005/2006 Biennial Plan, Minnesota Natural Gas and Electric Conservation Improvement Program", (Xcel Energy, Minneapolis, MN, June 1, 2004) p.25.

[17] Itron, Inc. "Database for Energy Efficiency Resources (DEER) Update Study" (Itron Inc., Vancouver, WA, December 2005), p. 7-26. Available at www.energy.ca.gov/deer.

[18] Xcel Energy, 2004, *op.cit.*, p. 25.

Energy management systems are automated control systems that customers use to control the energy systems in their facilities. EMS systems most commonly control HVAC systems and lighting systems. They save energy by shutting energy using equipment off at pre-set times, by monitoring and controlling HVAC system operation so that the equipment is operated as efficiently as possible, and by cycling equipment so that energy usage is reduced during peak periods.

Residential Cooling Measures

Efficient Central Air Conditioners

Efficient central air conditioners are defined as units with an SEER rating of 14 or higher. A new U.S. DOE minimum efficiency standard of 13 SEER just went into effect in January 2006.

Efficient Room Air Conditioners

Efficient room air conditioners are defined as units with an EER rating of 10.7 or higher. The current U.S. DOE minimum efficiency standards for room air conditioners generally range fro 8.5 EER to 9.8 EER depending on the unit size and type. These standards went into effect in 2000.

Commercial and Industrial Refrigeration Measures

The following measures are most applicable to grocery stores. Secondary markets include restaurants or cafeterias in office buildings.

High Efficiency Evaporative Fan Motors

This measure involves replacing shade-pole evaporator fan motors with either permanent split-capacitor (PSC) or electrically commutated (EC) motors. According to the California DEER database, the incremental cost for these measures is small[19].

Efficient Ice Makers

Energy-efficient ice-makers come as either air-cooled or water-cooled units and are rated based on the pounds of ice produced in a 24-hour period. Energy-efficient ice-makers are defined by the use of high-efficiency compressors, high-efficiency fan motors, and thicker insulation. Energy savings vary by type and capacity and range from 18-28% in most cases.[20]

Strip Curtains and Night Covers

The majority of heat loss from an open display fixture is through infiltration. Covering open fixtures with plastic curtains during low traffic periods and at night can reduce convection by 50% or more when they are applied, thereby reducing refrigeration loads[21].

Efficient Refrigeration Compressors

[19] Itron: 2005, *op.cit.*, p. 7-72.

[20] "Packaged Commercial Refrigeration Equipment", ACEEE, December 2002

[21] Itron: 2005, *op.cit.*, p. 7-74.

This measure involves the use of high-efficiency compressors in the place of standard compressors in the refrigeration cycle. Energy-savings potential is in the range of 6-16%.[22]

High Efficiency Multiplex Rack Compressor System

A multiplex-compressor system consists of multiple compressors drawing from a common suction header (suction-group), and serving any number of display fixtures. The suction group is controlled to satisfy the lowest temperature required by any of the attached display fixtures. For this reason the display fixtures served by a given suction group usually have similar temperature requirements; separate suction-groups are typically used for low-temperature and medium-temperature demands[23].

Commercial and Industrial Process Measures

Compressed Air Leak Maintenance/Detection

Compressed air leak maintenance or detection includes helping customers identify and repair leaks in their air compressor systems. MRES currently offers such a program to its utility clients that uses an ultrasonic inspection device.

Efficient Air Compressors

Efficient compressors come in a variety of system types. There are three primary factors determining a compressor's overall efficiency: the compressor type, partial loading controls, and the efficiency of the motor. Incentives for efficient compressors can be most effective as part of evaluating an entire air compressor system, and not just considering the compressor in isolation.

Custom Measures

For purposes of this assignment, Summit Blue has defined "custom" measures as other energy efficiency measures beyond those specifically defined in this section. Generally, "custom" measures are somewhat unique or have application-specific components that make developing generic savings or cost estimates difficult, or subject to considerable judgment. Utilities' definitions of "custom" measures vary, as do their engineering analysis or assistance offers and requirements to screen and evaluate potential custom measures. For example, Otter Tail Power includes adjustable speed drives (ASDs) in its C&I Grants (custom) program, while Xcel Energy includes ASDs in its Motor Efficiency program, with qualification requirements.

Energy Efficient Motors

NEMA has defined "Premium" efficiency motors, which many utilities, such as Otter Tail Power Company and Xcel Energy, use for their Motor DSM programs. Xcel Energy included the NEMA definitions in its 2005/2006 Biennial CIP Filing[24].

Variable Frequency Drives (VFDs)

[22] http://www.aps.com/images/pdf/Refrigeration.pdf

[23] Itron: 2005, *op.cit.*, p. 7-67.

[24] Xcel Energy: 2004, *op.cit.*, p. 38.

Variable frequency drives 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. So if a motor is running at half speed and is controlled by a VFD, it will only use one-eighth of its full speed energy use (as one-half cubed equals one-eighth). Without a VFD, the motor running at half load will use about one-half of its full load energy use.

Energy Information Assistance

Providing energy information to customers can be done in various ways. One of the most common ways for utilities to do so is through energy audits, which utilities often subsidize with DSM program funding.

Demand Response or Load Management Measures

Direct load control measures apply to both residential and commercial/industrial customers. Interruptible rates are just for C&I customers.

Direct Load Control (DLC)

DLC programs involve cycling or shutting off customers' air conditioners, water heaters, pool pumps, electric heating systems, or other electrical equipment during utilities' peak demand periods. MRES' member utilities have been conducting DLC programs for many years.

Interruptible Rates

Interruptible rate programs generally offer customers electric price discounts for reducing their loads during peak demand periods. The terms of the electric price discounts vary widely, from discounts that are constant throughout the year, to those that are only in effect during utilities' peak demand season, such as the summer, to discounts that are only offered during periods in which customers actually have to reduce their loads. MRES started an interruptible rates program several years ago.

Building Envelope Measures

Ceiling Insulation

Ceiling insulation includes both insulating uninsulated roof areas and adding insulation to under-insulated roof areas. In Minnesota, the general rule of thumb is that the proper amount of ceiling insulation is an R-value of about 38.

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[25].

[25] Itron: 2005, *op.cit.,* p. 7-17.

Reflective or Cool Roofing

Installing a light colored roof can reduce the required cooling energy by reducing the absorbtance of the roof's exterior surface. This measure is often included in utilities' Custom programs, but Xcel Energy includes this measure in its prescriptive programs[26].

Water Heating Measures

Most of the water heater measures discussed below are just included as part of the residential DSM potential estimates. Only efficient water heaters were included in the C&I DSM potential estimates.

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.

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

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 exceed 5.0 gallons per minute.

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.

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.

[26] Xcel Energy: 2004, *op.cit.*, p. 40.

Hot Water Set-back Thermostat

Similar to a HVAC set-back thermostat, a water heater setback thermostat reduces the temperature setpoint of the water tank during periods when full service is not required. Savings accrue from reduced stand-by and distribution system losses.