Xcel Energy Minnesota
DSM Market Potential Assessment

Final Report – Volume 1

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1. Executive Summary

Xcel Energy Minnesota engaged KEMA to assess the potential for electric energy (kWh) and demand (kW) savings from company-sponsored demand side management (DSM) programs over a ten-year horizon. The assessment produced:

- Estimates of the magnitude of potential savings on an annual basis under a range of program design scenarios;
- Estimates of the costs associated with achieving those savings;
- Calculation of the cost-effectiveness of the measures and programs based on the estimates above.

KEMA used its proprietary DSM ASSYST™ to produce these outputs. To supplement the results of the DSM ASSYST™ analysis, which include only measures with known inputs (e.g. savings, cost, and adoption rates), KEMA developed a bounded estimate of the potential that might be achieved from emerging technologies, those that are likely to be in the market in the foreseeable future. KEMA also developed an estimate of the potential for additional demand savings from demand response (DR) programs by using company-specific inputs to the Federal Energy Regulatory Commission's *National Demand Response Potential Model* (NADR model).

KEMA undertook an extensive data collection effort to determine the inputs for the modeling effort. This included on-site inventories of energy-using equipment and systems at customer facilities and homes; telephone surveys of residential customers and market actors; and intensive review, interpretation, and analysis of Xcel Energy public and confidential data in concert with Xcel Energy staff. The result of this process was detailed, comprehensive, and accurate set of model inputs.

1.1 Scope and Approach

In this study, three basic types of energy-efficiency potential were estimated:

- **Technical potential,** defined as the *complete* penetration of all measures analyzed in applications where they were deemed *technically* feasible from an *engineering* perspective
- **Economic potential,** defined as the *technical potential* of those energy-efficiency measures that are *cost-effective* when compared to supply-side alternatives
- **Achievable program potential,** the amount of savings that would occur in response to specific program funding, marketing, and measure incentive levels.

DSM ASSYST™ develops an estimate of naturally occurring savings, those savings that are projected to result from normal market forces in the absence of any intervention by utility sponsors. These savings are not included in the estimate of achievable program potential. At the request of Xcel Energy, KEMA developed a refinement on the economic potential estimate, denominated "*net economic potential.*" Net economic potential is the portion of economic potential that is available to be captured by program intervention. It is calculated by subtracting the naturally occurring savings, developed during the analysis of achievable potential, from the estimates of total economic potential.

The method used for estimating potential is a "bottom-up" approach in which energy-efficiency costs and savings are assessed at the customer-segment and energy-efficiency measure level. For cost-effective measures (based on the total resource cost, or TRC, test), program savings potential was estimated as a function of measure economics, rebate levels, and program marketing and education efforts. The modeling approach was implemented using KEMA's DSM ASSYST™ model. This model allows for efficient integration of large quantities of measure, building, and economic data to determine energy-efficiency potential.

For this study, KEMA constructed four different program funding scenarios to estimate achievable energy efficiency potential. The first scenario, the business as usual (BAU) scenario, projects the current program design and implementation features across the forecast horizon. Xcel Energy and KEMA staff went through several cycles of data exchange and model iteration to calibrate the model under the BAU scenario. Once calibrated, the model produces outputs closely in alignment with the known program savings results of the most recent program. This assures that the model, to the extent possible, can appropriately represent reality under a set of known conditions.

KEMA estimated the results of program efforts under three additional incentive scenarios using the calibrated model. One scenario assumed that 50 percent of incremental measure costs are paid out in customer incentives. The second scenario allowed for incentives covering 75 percent of incremental measure costs. In the final scenario, incentives covered 100 percent of incremental measure costs. Program marketing costs were scaled upward across scenarios to reflect increasing program effort, and program administration costs were adjusted across scenarios proportional to achievable program energy savings. These scenarios are referenced, respectively, as "50-percent scenario," "75-percent scenario," and "100-percent scenario." Program energy and peak-demand savings, as well as program cost effectiveness, were assessed under all funding scenarios.

The base energy efficiency assessment addressed measures and processes that are commercially available with proven savings and customer acceptance. Emerging technologies (primarily LED lighting and commercial HVAC) and behavioral-conservation approaches were addressed separately, so that results would be isolated from the other parts of the analysis. These components show promise for future DSM program impacts but projections of their savings potentials are more uncertain than those of more standard measures

The study did not address incremental improvements in energy efficiency due to the ongoing evolution and gradual improvement of existing technologies. These improvements will lead to increased energy-efficiency potential over time. Nor did the study address the ongoing tightening of equipment and building standards (beyond those known to be effective within the study period), which will lead to a decrease in energy-efficiency potential over time. The improvements in energy-efficient technologies provide opportunities for additional program savings over a static base-case technology. However, as the market matures, codes and standards are tightened to raise base-case efficiency, and the result is subsequent reduction in program savings opportunities back to levels that were available prior to the improvements in leading technology efficiency. We feel that the effects of gradual technology improvement and ongoing tightening of codes and standards offset each other over an extended period,

To estimate demand response (DR) impacts, we reviewed impacts from the Federal Energy Regulatory Commission's *2009 National Assessment of Demand Response Potential*[1] for the State of Minnesota and customized the results to the Xcel Energy Minnesota service territory, utilizing information on Xcel Energy's peak demand, relative to Minnesota peak demand, and information on current programs being run by Xcel Energy.

We note that the results of this study are estimates of energy and demand savings potential based on certain program assumptions. The study can be used to help target measures and customer segments for DSM programs and can also be utilized by resource planners to determine to appropriate mix of demand-side and supply-side resources. The study does not attempt to provide estimates of optimal levels of DSM activity, but rather, provides estimates of the demand-side parameters that can be used for this type of analysis.

The scenarios shown in this study are also fairly broad-brush, showing potentials for incentive rates that vary by scenario but are constant for all measures within a scenario. In reality, we expect that Xcel Energy will adjust incentives and related program expenditures on a measure-by-measure basis to reflect differences in markets for different measures and to enhance the amount of savings that are achievable within limited program budgets.

1.2 Results

In Table 1-1, we present overall results of the DSM potential study, showing potentials for base energy-efficiency (that developed by the DSM Assyst™ model) and behavioral conservation programs, emerging technologies, and demand-response programs. Cumulative results from 2011 to 2020 are shown for energy efficiency, behavioral conservation, and demand response. Only technical and economic potential are shown for emerging technologies because achievable potential estimates are considered too

[1] *A National Assessment of Demand Response Potential*, Staff Report, Federal Energy Regulatory Commission, prepared by The Brattle Group, Freeman, Sullivan & Co., and Global Energy Partners, LLC, June 2009.

speculative. We also show total program costs for the base energy efficiency and behavioral conservation programs. Future emerging technology costs are not well understood, and the FERC NADR model does not product estimates of program costs, although all demand response potentials are considered to be cost effective. All results include line losses.

Table 1-1

Summary of Cumulative DSM Potentials from All Sources—2011-2020

Source of Potential		Scenario						
		Technical	Economic	Net Economic	100% Incentives	75% Incentives	50% Incentives	BAU Incentives
Energy Efficiency/ Conservation	Base Energy Efficiency - GWh	10,249	7,164	6,599	4,596	3,825	3,351	3,213
	Behavioral Conservation - GWh	175	175	175	175	152	102	102
	Total - GWh	10,424	7,339	6,774	4,771	3,977	3,453	3,315
	Base Energy Efficiency - MW	1,972	1,415	1,355	823	591	475	466
	Behavioral Conservation - MW	47	47	47	47	41	28	28
	Total - MW	2,019	1,463	1,403	871	633	503	494
	Program Costs - $ Million				$1,777	$1,154	$773	$635
Emerging Technologies	Base Cost - GWh	1,944	1,477					
	25% Cost Reduction - GWh	1,944	1,574					
	75% Cost Reduction - GWh	1,944	1,692					
	Base Cost - MW	559	395					
	25% Cost Reduction - MW	559	409					
	75% Cost Reduction - MW	559	447					
Demand Response					Full Participation	Achievable Participation	Expanded BAU	BAU
	Peak Savings - MW				1,552	1,444	1,209	941

Notes: Net economic potential is defined as economic potential minus naturally occurring savings. Behavioral-conservation measures were modeled under high, medium, and low program-effort scenarios that correspond to the 100%, 75%, and 50%/BAU incentives scenarios. All program incentive scenarios reflect net savings. Demand response utilizes four scenarios: *business–as-usual* (BAU) *expanded BAU, achievable participation, and full participation- all based on FERC NADR model categories*; we aligned with the energy efficiency scenarios based on level of potential. Emerging technologies show varying levels of economic potential depending on expected measure cost. Emerging technology potential is incremental to base potential. Emerging technology penetration was considered too speculative to include in achievable potentials.

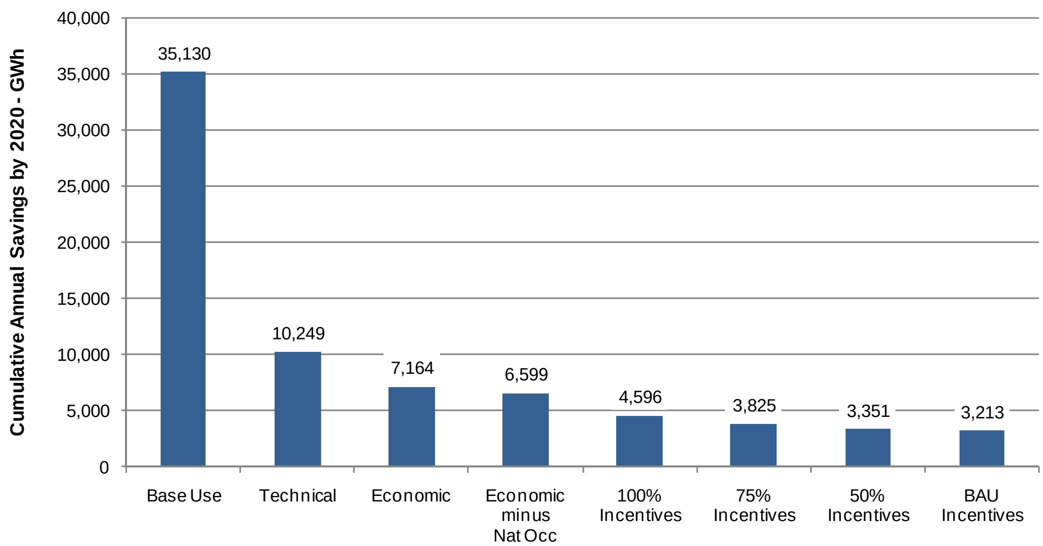
Base energy-efficiency and demand-response measures account for the majority of the net economic and achievable program potentials. These are measures where we have the most confidence in the savings estimates. Residential behavioral-conservation activities, if current assumptions hold, could increase achievable electric potentials by 3 percent to 4 percent depending on the scenario. The emerging technologies analyzed in this study could increase the pool of economic DSM savings by 20 percent to 25 percent, depending on the technology cost assumptions. However, substantive impacts from emerging technologies might not materialize for several more years.

We discuss the various aspects of DSM potentials next, with a focus on the base energy-efficiency potentials because they provide the largest, most reliable source of future savings.

1.2.1 Aggregate Base Energy-Efficiency Potential Results

Estimates of electric energy-savings potential are presented in Figure 1-1. These savings reflect cumulative annual savings over a 10-year period. Technical potential is estimated at 10,249 GWh per year by 2020; much of this potential is estimated to be economically viable. Economic potential is estimated at 7,164 GWh by 2020, and net economic potential is estimated at 6,599 GWh by 2020. Achievable program potentials range from 4,596 GWh per year by 2020 in the 100-percent incentive scenario to 3,825 GWh per year for the 75-percent incentive scenario to 3,351 GWh per year for the 50-percent incentive scenario to 3,213 GWh for the BAU scenario. Economic potential for energy savings is estimated to be 20 percent of base 2020 energy use; achievable potentials range from 13 percent of base energy use in the 100-percent incentive case to 11 percent of base usage in the 75-percent incentive case to 10 percent of base usage in the 50-percent incentive case to 9 percent of base usage in the BAU case. Note that all results include line losses.

Figure 1-1
Estimated Electric Energy-Efficiency Savings Potential, 2011-2020

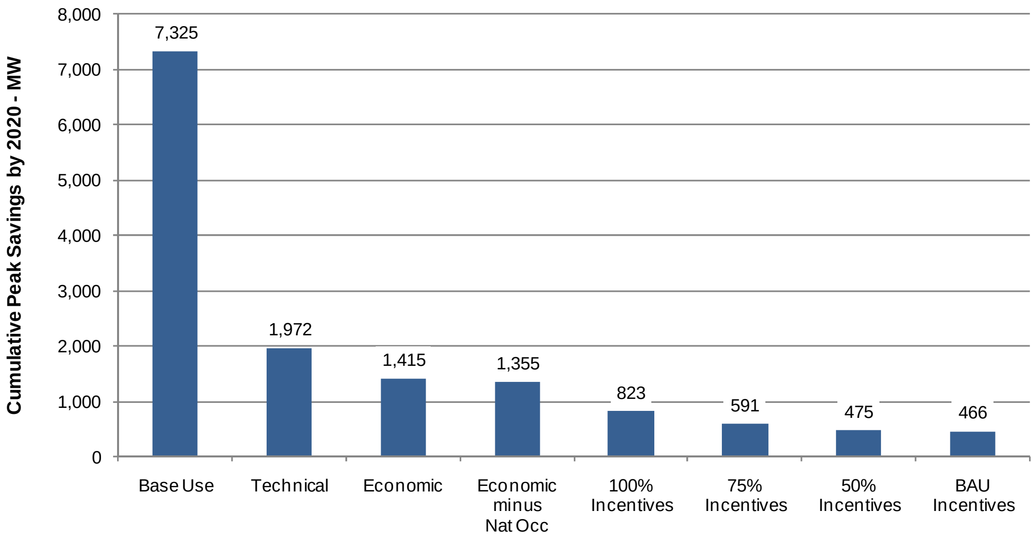


Note that base use includes 260 GWh associated with customers who have opted out of Xcel Energy's energy efficiency programs and are not included in the potentials.

Cumulative 10-year peak-demand savings potential estimates are provided in Figure 1-2. Technical potential is estimated at 1,972 MW, economic potential is estimated at 1,415 MW, and net economic potential is estimated at 1,355 MW. Achievable program potential ranges from a high of 823 MW in the 100-percent incentive case down to 466 MW in the BAU case. Economic potential for peak demand savings is estimated to be 19 percent of base 2020 peak demand; achievable potentials range from 11 percent of base peak demand in the 100-percent incentive case to 8 percent of base peak demand in the

75-percent incentive case to 6 percent of base peak demand in the 50-percent incentive case and the BAU case. All results include line losses.

Figure 1-2
Estimated Peak-Demand Savings Potential, 2011-2020

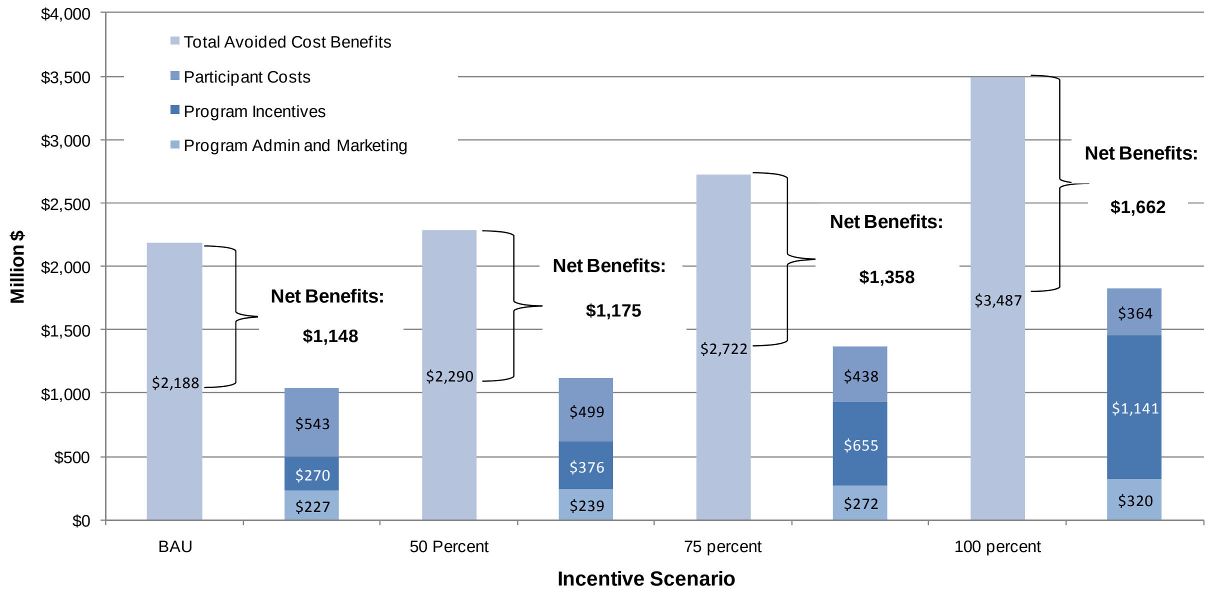


Notes: Base peak demand includes Xcel Energy's business-as-usual demand response program impacts. Base use also includes 53 MW associated with customers who have opted out of Xcel Energy's energy efficiency programs and are not included in the potentials.

Figure 1-3 depicts the cumulative costs and benefits under each program funding scenario from 2011 to 2020. The present value of program costs (including administration, marketing, and incentives) is $497 million under the BAU scenario, $615 million under the 50-percent incentive scenario, $926 million under the 75-percent incentive scenario, and $1,461 million under the 100-percent incentive scenario. The present value of total avoided-cost benefits is $2,188 million under the BAU scenario, $2,290 million under 50-percent incentives, $2,722 million under 75-percent incentives, and $3,487 million under 100-percent incentives. The present value of *net* avoided-cost benefits, i.e., the difference between total avoided-cost benefits and total costs (which include participant costs in addition to program costs), is $1,148 million under BAU, $1,175 million under 50-percent incentives, $1,358 million under 75-percent incentives, and $1,662 million under 100-percent incentives.

As a result of dramatically increasing incentive costs for higher incentive scenarios, increases in program costs outpace the increases in benefits as one moves to higher incentive scenarios. As modeled, all program participants receive the same incentives in a given scenario, even though some customers would have accepted lower incentives. (Note, there are participant costs in the 100-percent incentives scenario because the DSM Assyst model assumes measures initially purchased with program incentives are repurchased without program incentives if then burn out during the forecast period.)

Figure 1-3
Benefits and Costs of Electric Efficiency Savings—2011-2020*



* PV (present value) of benefits and costs is calculated for 2011-2020 program years using a nominal discount rate = 7.4 percent, and an assumed inflation rate = 1.9 percent.

All four of the funding scenarios are cost-effective based on the TRC test, which is the test used in this study to determine program cost-effectiveness. The TRC benefit-cost ratios are 2.1 for the BAU and 50-percent incentive scenarios, 2.0 for the 75-percent incentive scenario, and 1.9 for the 100-percent incentive scenario. This indicates that program cost-effectiveness declines somewhat with increasing program effort, reflecting increased penetration of more measures with lower cost-effectiveness levels. Key results of our efficiency scenario forecasts from 2010 to 2020 are summarized in Table 1-2 .

Table 1-2
Summary of Achievable Electric Potential Results—2011-2020

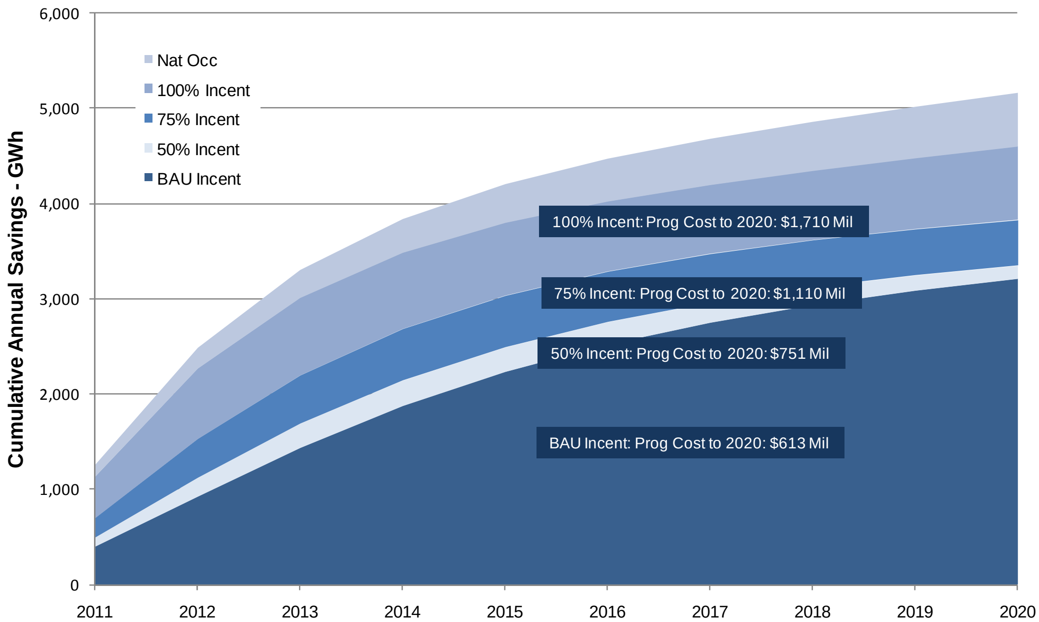
Result - Programs	Program Scenario: BAU Incentives	50 percent Incentives	75 percent Incentives	100 percent Incentives
Total Market Energy Savings - GWh	3,778	3,916	4,390	5,161
Total Market Peak Demand Savings - MW	526	535	651	883
Program Energy Savings – Net GWh	3,213	3,351	3,825	4,596
Program Peak Demand Savings – Net MW	466	475	591	823
Program Costs - Real, $ Million				
Administration	$167	$174	$200	$244
Marketing	$115	$124	$136	$150
Incentives	$330	$453	$773	$1,316
Total	$613	$751	$1,110	$1,710
PV Avoided Costs	$2,188	$2,290	$2,722	$3,487
PV Annual Program Costs (Adm/Mkt)	$227	$239	$272	$320
PV Net Measure Costs	$813	$875	$1,093	$1,505
Net Benefits	$1,148	$1,175	$1,358	$1,662
TRC Ratio	2.1	2.1	2.0	1.9

PV (present value) of benefits and costs is calculated for 2011-2020 program years using a nominal discount rate = 7.4 percent, and an assumed inflation rate = 1.9 percent; GWh and MW savings are cumulative through 2020.

1.2.2 Achievable Savings Potentials over Time

Figure 1-4 shows our estimates of achievable program potential energy savings over time. (Peak demand savings follow a similar pattern but are not shown.) Naturally occurring savings are also shown to provide a picture of total market potential. The figure shows that the rate of increase in cumulative savings declines over time. This result occurs because retrofit measures (measures that are not dependent on equipment turnover cycles and can be added at any time) reach high saturations over time, reducing the available pool for these opportunities, and making it more difficult to capture additional savings. While the decline in additional savings is fairly modest in the BAU scenario, it is more pronounced in the higher incentive cases. For the 100-percent incentives scenario, savings accumulate rapidly during the first few years of the forecast horizon, but then flatten out considerably thereafter. This can be perceived as a boom-bust phenomenon – where a program ramps up dramatically over a few years, and then must be scaled back significantly afterwards as program participation declines due to high saturation levels. While the high incentive scenario may lead to front-loaded energy savings, it could lead to dramatically reduced program effort and funding in later years, which may affect the program's ability to evolve and continue to capture emerging opportunities.

Figure 1-4
Achievable Electric Energy-Savings: All Sectors



1.2.3 Sensitivity to Alternative Avoided-Cost Forecasts

We examined economic potential under two alternative avoided cost scenarios in addition to the base scenario. The low avoided cost scenario reflects costs that are about 5 percent below the base avoided costs, while the high avoided cost scenario reflects costs that are about 57 percent above the base avoided costs. Table 1-3 provides a summary of the results. As shown, the economic potentials are not substantially impacted by the avoided cost variations. For the high-avoided cost scenario, energy savings are only 10 percent above the base scenario and demand savings are only 7 percent above the base scenario. The low avoided-cost energy savings are only 4 percent below the base scenario, with demand savings coming in at 5 percent below the base scenario. Given the limited variation in economic potential for the alternative cases, achievable potentials were only estimated for the base avoided cost scenario.

Table 1-3
Comparison of Estimated Electricity Technical and Economic Potential for Alternative Avoided Cost Scenarios, 2020

	Base Usage	Technical Potential	Economic - High	Economic - Base	Economic - Low
Energy: GWh	35,130	10,249	7,872	7,164	6,877
% of Base Consumption		29%	22%	20%	20%
% Technical Potential			77%	70%	67%
% of Economic - Base Avoided Cost			110%	100%	96%
Demand: MW	7,325	1,972	1,510	1,415	1,345
% of Base Consumption		27%	21%	19%	18%
% Technical Potential			77%	72%	68%
% of Economic - Base Avoided Cost			107%	100%	95%

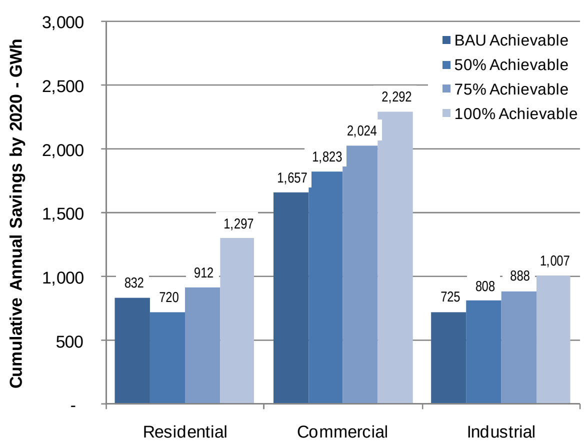
Note that base use includes 260 GWh and 53 MW associated with customers who have opted out of Xcel Energy's energy efficiency programs and are not included in the potentials.

1.2.4 Base Energy-Efficiency Results by Sector

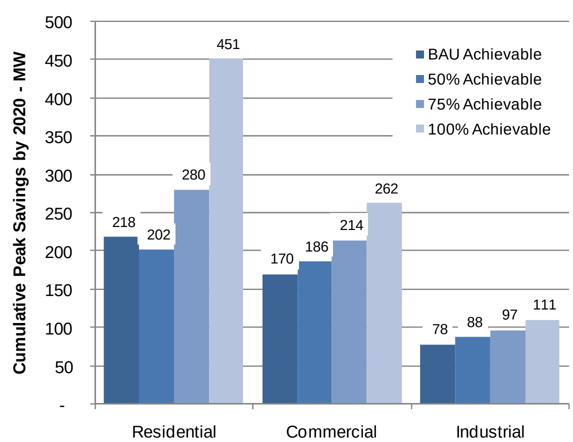
Cumulative program savings potential estimates by customer class are presented in Figure 1-5 for the 2011-2020 period. The figure shows results for each funding scenario. Achievable program energy savings are highest for the commercial sector, and peak-demand savings are similar for the residential and commercial sectors except in the 100-percent incentive scenario, where the residential sector is higher, due to a projected increase in adoption of high-efficiency quality installed air conditioners, which could show much larger penetration if the measure were offered at the same cost as a base unit.

Figure 1-5
Net Program Achievable Energy Savings (2020) by Sector

Energy – GWh



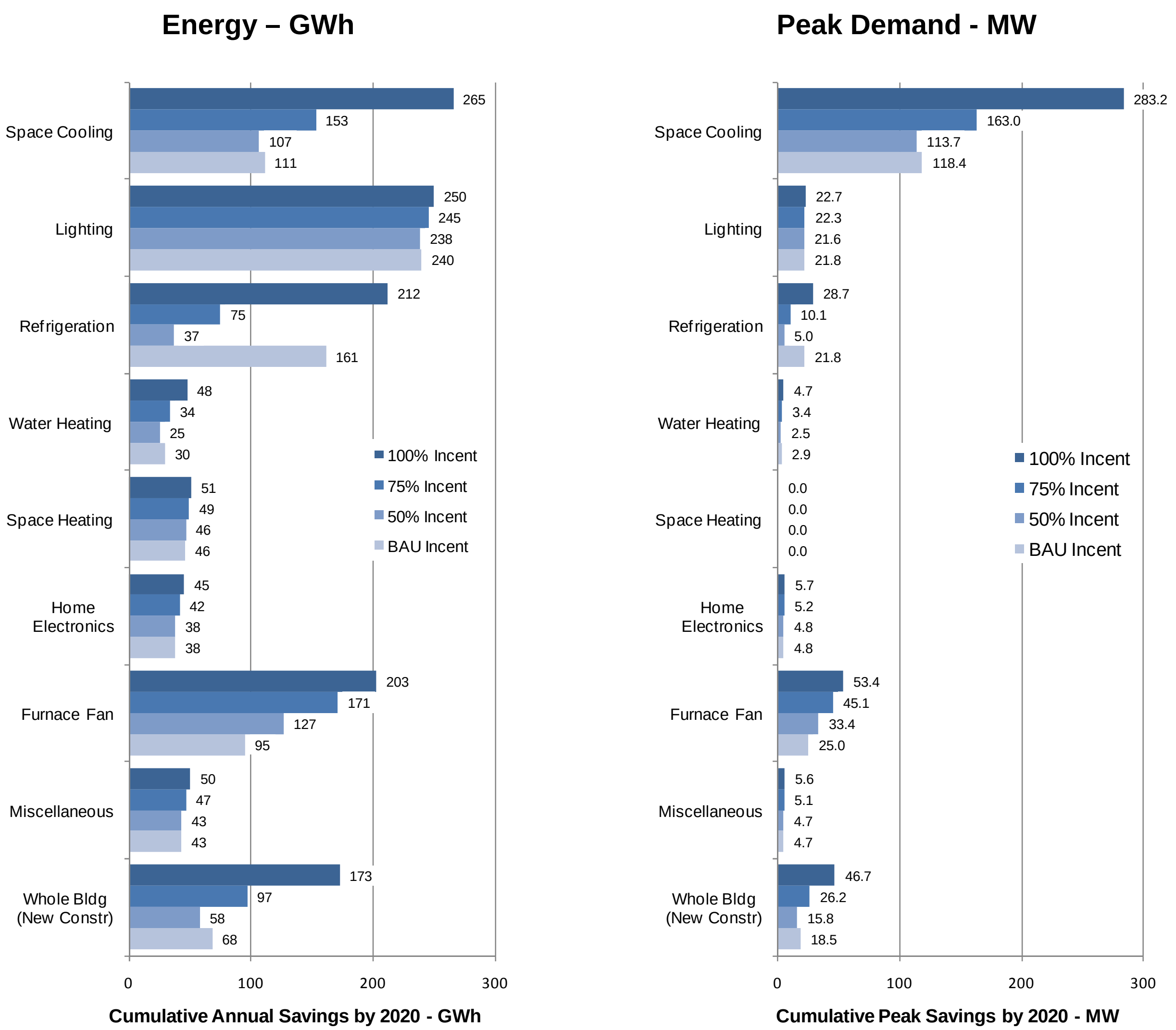
Peak Demand – MW



1.2.4.1 Residential Sector

Figure 1-6 shows the residential end-use distribution of electricity savings potential through 2020. Key end uses for energy-savings potential include lighting, cooling, refrigeration, furnace fans, and new construction measures. Cooling, furnace fans (also used for central air conditioning) and new construction measures provide much of the peak-demand savings potential. Refrigeration shows a large BAU potential because incentives are relatively high for the refrigerator recycling measure in the BAU case. Single family homes account for over 80 percent of both energy and peak demand savings potentials.

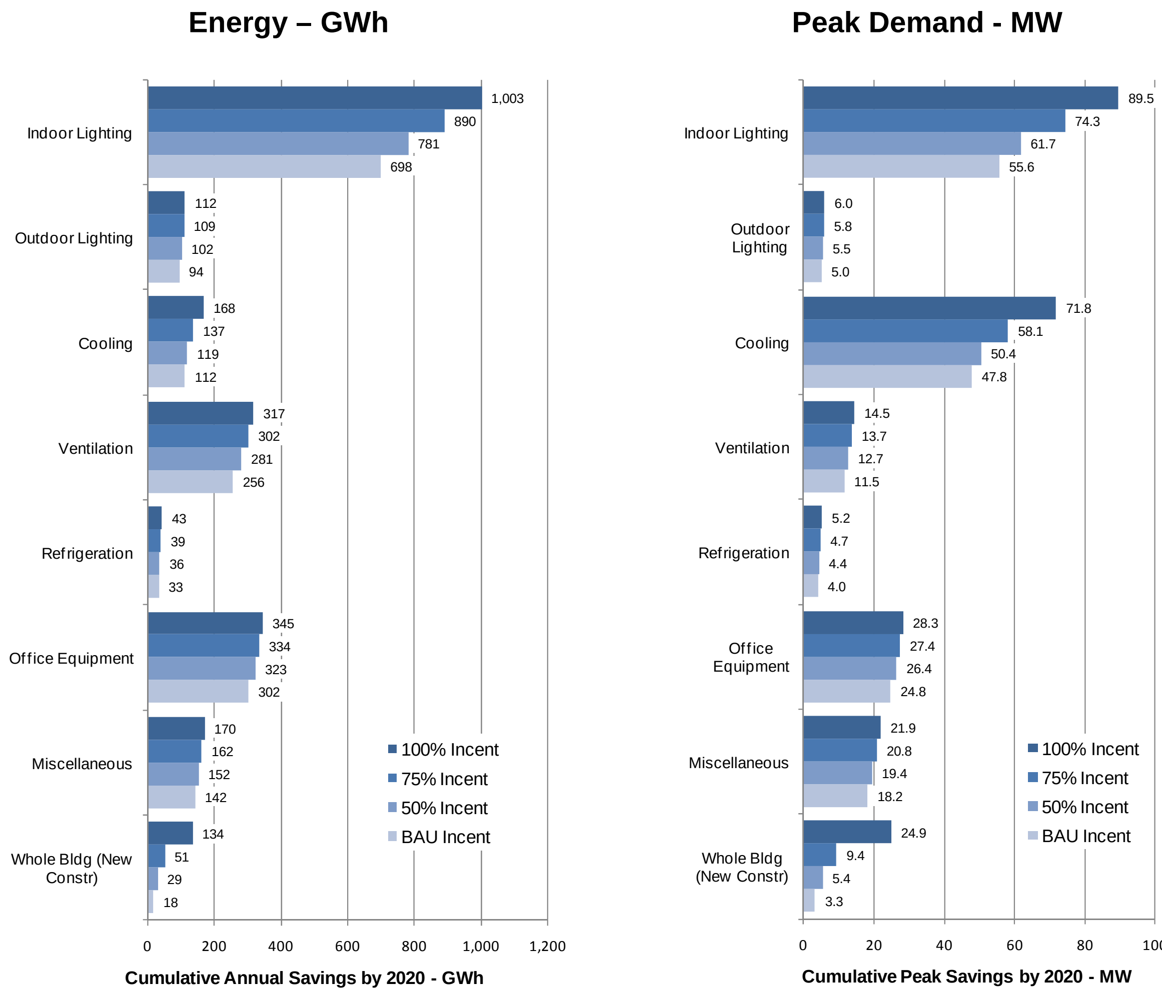
Figure 1-6
Residential Net Energy Savings Potential by End Use (2020)



1.2.4.2 Commercial Sector

Figure 1-7 shows the commercial end-use distribution of electricity savings potential through 2020. Lighting contributes most to both the energy and peak-demand savings, followed by office equipment and ventilation measures. Cooling contributes a higher share to peak-demand savings potential versus energy-savings potential. Offices account for almost half of the energy and peak demand savings potential, with the remainder of the savings potentials shared more evenly across other commercial building types.

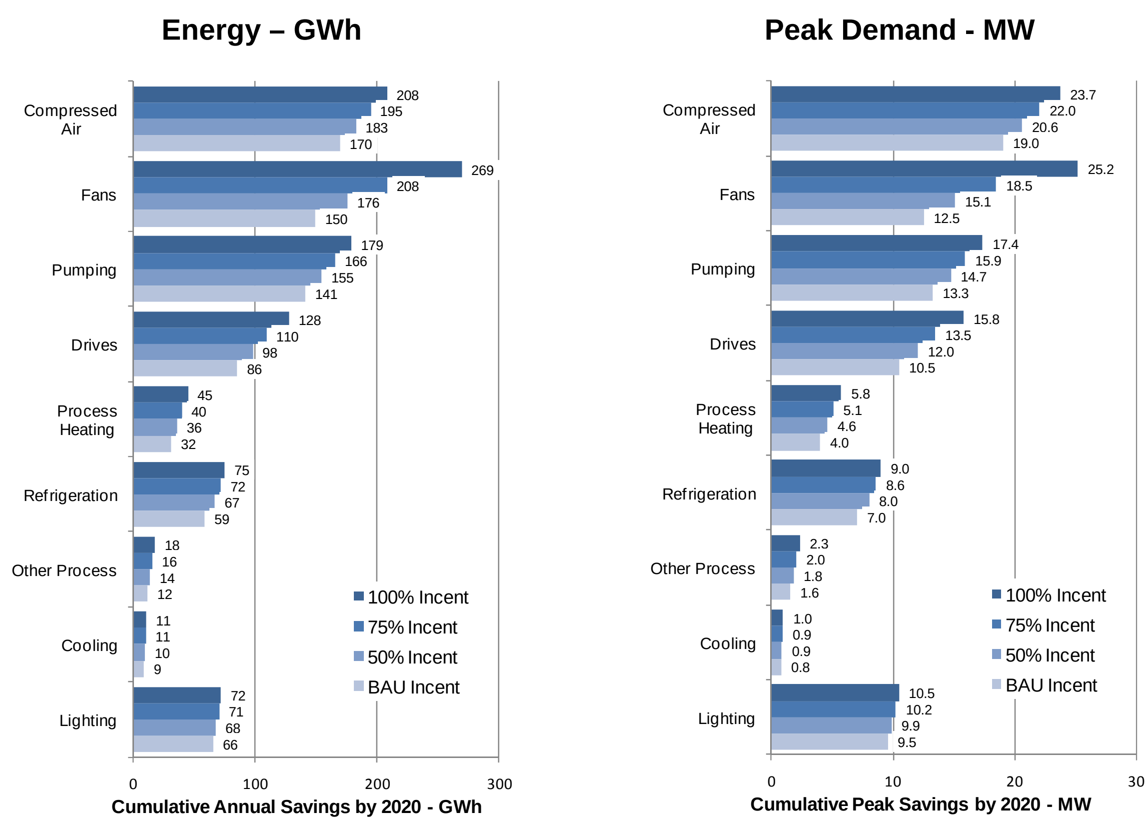
Figure 1-7
Commercial Savings Potential by End Use (2020)



1.2.4.3 Industrial Sector

Figure 1-8 shows the industrial end-use distribution of electricity savings potential through 2020. Cross-cutting motor end uses (compressed air, fans, and pumps) account for the majority of savings. The largest industries in terms of savings potential are the food processing and petroleum refining industries, followed by chemicals, plastics, industrial machinery, and electronics.

Figure 1-8
Industrial Savings Potential by End Use (2020)



1.2.5 Behavioral-Conservation Results

Residential behavioral-conservation programs have shown some promise in motivating customers to use less energy. However, factors such as persistence and the realized amount of energy savings have not been confirmed over a significant period of time or across a wide range of customers. Program designs include indirect feedback approaches, which feature periodic energy information reports, sometimes with comparative information to stimulate competitive behaviors, and direct feedback interventions, such use of in-home energy-use monitors. Both types theoretically result in behaviors that decrease energy usage. For this analysis, we focused on indirect feedback methods since these are experiencing wider adoption by utilities across the U.S. While there is probably overlap in the impacts of these two methods, this overlap is not well understood. Consequently, we present potential impacts from the indirect approach, with the understanding that these impacts may serve as a proxy for savings from both types of behavior-motivation methods.

For the analysis, we assumed two-percent energy savings at a cost of $7 per home per year (after netting out the portion of program costs that could be directed toward natural gas savings) and modeled three levels of effort that: (1) target only the highest energy users; (2) target the high and medium energy users; and (3) target all residential customers.

Table 1-4 presents the behavioral conservation results for the 2011-2020 period. As shown, behavioral-conservation potentials – if the assumptions outlined above hold up – could save between 102 and 175 GWh on annual program costs averaging between $22 million and $67 million dollars, depending on how many customers are targeted for the interventions.

Table 1-4
Achievable Potentials for Electric Behavioral Conservation (2011-2020)

Result	Scenario: Low: Large Users Only	Scenario: Medium: Lrg-Med Users	Scenario: High: All Customers
Total Market Energy Savings - GWh	102.03	152.27	174.67
Total Market Peak Demand Savings - MW	27.64	41.25	47.31
Program Energy Savings – Net GWh	102.03	152.27	174.67
Program Peak Demand Savings – Net MW	27.64	41.25	47.31
Program Costs - Real, $ Million			
Administration	$0.20	$0.35	$0.51
Marketing	$21.85	$43.70	$66.31
Incentives	$0.00	$0.00	$0.00
Total	$22.05	$44.05	$66.81
PV Avoided Costs	$53.86	$80.39	$92.21
PV Annual Program Costs (Adm/Mkt)	$17.14	$34.24	$51.94
PV Net Measure Costs	$0.00	$0.00	$0.00
Net Benefits	$36.72	$46.15	$40.27
TRC Ratio	3.1	2.3	1.8

PV (present value) of benefits and costs is calculated for 2011-2020 program years using a nominal discount rate = 7.4 percent, and an assumed inflation rate = 1.9 percent; GWh and MW savings are cumulative through 2020.

1.2.6 Emerging Technology Results

The ultimate impacts and timing of emerging technologies are very uncertain due to both technological and market barriers. Despite the uncertainties associated with particular technologies, history shows that energy-efficiency measures will continue to evolve, and emerging technologies will play a significant role in future program years.

In order to address the possible effects of emerging energy-efficiency measures, KEMA developed a modeling approach that combines a bottom-up method for estimating technical and economic potential of emerging technologies with a technology diffusion analysis to estimate possible market penetration for these technologies over time. A total of 41 technologies were researched for the study, with 14 technologies included in the final analysis (4 HVAC, 1 motor, and 9 lighting, all targeting the commercial sector). The key HVAC technologies involve combining cooling and dehumidification into a single process; the key lighting technologies involve various types of LED lighting; and the motor measure involves a motor with efficiencies above current premium motors. All 14 measures should be commercially available by 2014.

A key factor driving adoption of emerging technologies is equipment cost. In the model we developed, the incremental costs influence the number of years to capture 50 percent of the market. The working assumption was that emerging technology prices will come down over time, but as payback increased, we extended the number of years to capture 50 percent of the market because greater improvements or efficiencies need to be made to make the technologies more competitive. Three simulations were run to assess the emerging technologies at varying cost assumptions, as compared to the market-standard measure:

- Baseline: incremental costs at 100 percent
- Scenario 1: incremental costs at 75 percent of baseline
- Scenario 2: incremental costs at 25 percent

Table 1-5 summarizes the emerging technology simulations that were developed. Overall, these technologies have economic potential of over 3,000 GWh and 800 MW (depending on eventual measure cost). Since these technologies overlap measures that are included in the base energy efficiency potential analysis, incremental affects were assessed and estimated to be over 1,450 GWh and 390 MW. The diffusion analysis predicts that about 38% of this potential could be captured within 10 years under base cost assumptions and could increase to 47 percent if incremental costs decline to the 25 percent level.

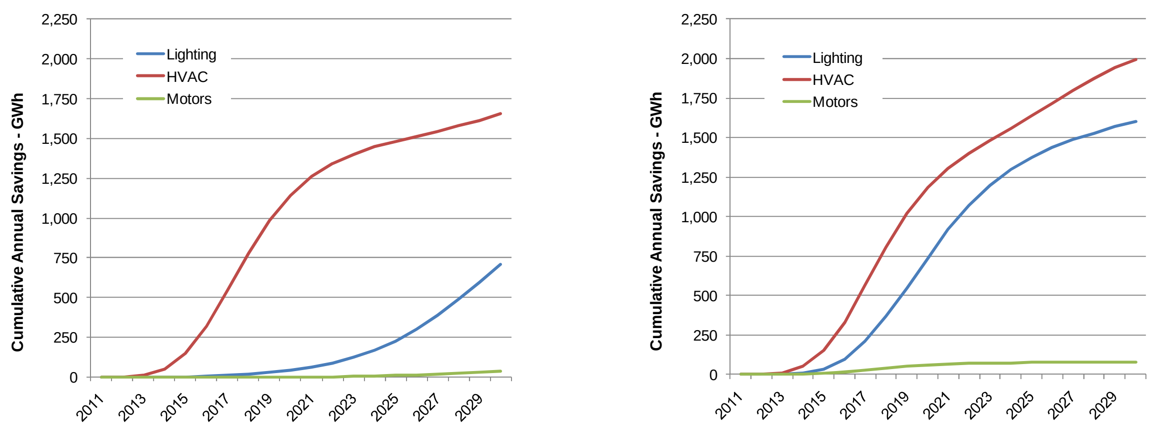
Table 1-5
Summary of Emerging Technology Simulations

Scenario	Total Economic Potential		Incremental Economic Potential		Capture
	GWh	MW	GWh	MW	(10 Yr)
Baseline	3,143	840	1,477	395	38%
Scenario 1 - little change	3,349	870	1,574	409	41%
Scenario 2 - competition	3,601	950	1,692	447	47%

Figure 1-9 shows possible adoption paths for the emerging technologies under the baseline scenario and under Scenario 2, which reflects a 75 percent reduction in the incremental cost of the emerging technologies. (Note that the adoption path for Scenario 1, with a 25 percent cost reduction, was not very different than the baseline adoption path.) The figure shows that the HVAC measures are only affected somewhat by the drop in cost; these technologies already appear to be very cost effective with current equipment price assumptions. However, both the lighting and motor measures show substantially increased penetration if costs could drop significantly – either through market forces or from utility-provided incentives.

Figure 1-9
Emerging Technology Adoption Paths

Baseline **Scenario 2 – 75% Cost Reduction**



1.2.7 Demand Response Results

Demand response potential estimates were developed using the NADR model as noted above. The model estimates impacts for four customer segments (residential and small, medium, and large nonresidential) and five DR program categories (direct load control, interruptible rates, dynamic pricing with enabling technologies, dynamic pricing without enabling technologies, and other DR programs such as demand bidding). Estimates are developed for four different scenarios:

- Business-as-usual (BAU): current programs and tariffs are held constant.
- Expanded BAU (EBAU): BAU program participation rates are increased to equal the 75th percentile of ranked participation rates of similar programs across the U.S.
- Achievable Participation (AP): further assumes advanced metering infrastructure (AMI) is universally deployed, and dynamic pricing is the opt-out default tariff.

- Full Participation (FP): similar to the AP scenario, except that dynamic pricing and the acceptance of enabling technology is mandatory. This scenario quantifies the maximum cost-effective DR potential, absent any regulatory and market barriers.

Table 1-6 summarizes the results of the DR potential analysis. Potential demand reductions by 2020 range from 941 MW in the BAU case to 1,209 MW in the Expanded BAU case to 1,444 MW in the Achievable Participation case to 1,552 in the Full Participation case. The primary sources of savings potential are interruptible rates and direct load control, with the pricing without enabling technologies mechanism also showing substantial savings for the Achievable and Full Participation scenarios. Pricing with enabling technologies was only cost effective for the medium C&I segment and does not contribute much to the DR potential. The residential segment accounts for between 32 percent and 44 percent of total DR potentials and the large C&I segment accounts for between 50 percent and 63 percent of total DR potentials, depending on the scenario.

Table 1-6
Summary of Demand Response Potential by 2020 - MW

DR Mechanism	BAU	Expanded BAU	Achievable Participation*	Full Participation
Pricing with Technology	0	0	13	37
Pricing without Technology	0	11	304	422
Automated/Direct Load Control	438	465	440	438
Interruptible/Curtailable Tariffs	503	643	643	643
Other DR Programs	0	90	44	12
Total	941	1,209	1,444	1,552

* Achievable Participation is the name given to a specific scenario in the FERC NADR study; these potentials are only achievable under the specific assumptions that define this scenario.

There are a number of barriers to achieving the DR potentials developed in this study, including:

- Limits to AMI installations required for critical peak pricing;
- Regulatory barriers that include reluctance to adopt dramatically different pricing structures and reluctance fund investments in AMI installations or in customer-side enabling technologies;
- Technology barriers such as the limitations on cost-effective enabling technologies; and,
- Customer barriers including: lack of awareness regarding DR, risk aversion to new technologies and pricing strategies, and perceived lack of ability to respond to DR events.

In addition, the analysis does not address the need for DR. It just shows the peak savings reductions possible if a number of different DR strategies are implemented. Identifying the optimal amount of DR for Xcel Energy's Minnesota service territory, taking into account DR resources and existing generation and T&D capacity, is a planning exercise that is not part of this potential study.

1.2.8 Uncertainty of Results

We want to caution the reader that there is inherent uncertainty in the results presented in this report because they are forecasts of what could happen in the future. Our estimates of technical and economic potential have the lowest degree of uncertainty. These are estimates that account for savings, costs, and current saturations of DSM measures but do not factor in human behavior.

The achievable program estimates do take into account behavior, as our modeling efforts try to predict program participation levels while factoring in measure awareness and economics, as well as barriers to measure uptake. Hence, the uncertainty in our achievable potential estimates is greater. This uncertainty is lowest for the BAU scenario as these results are most consistent with current program experience. Uncertainty is higher for the 75-percent and 100-percent incentive scenarios, as these scenarios are based on projections from limited historical experience. Uncertainty is greatest for the 100-percent incentive scenario because there is no “real world” program experience where all the incremental measure costs for all customer segments are paid for by the utility over an extended period of time. Typically, a utility may offer the equivalent of 100-percent incentives for limited measures and customer segments in order to overcome high barriers in specific markets and to gain a high level of program participation while limiting program costs.

Uncertainty around the results of the behavioral conservation analysis is rooted in the persistence of the measure. Early findings have shown that these types of measures can save in the neighborhood of two percent per year in the near term, but it is not clear whether ongoing customer feedback messages will be able to maintain the savings.

Emerging technologies have many inherent uncertainties, including: technology performance, corporate interest in supporting R&D efforts, equipment cost, and customer acceptance. Our efforts in this study attempted to minimize the first two sources on uncertainty by focusing on products that should be commercially viable in the next few years and that have sufficient producer support to ensure the likelihood of market deployment.

1.3 Conclusions

As the results of this study indicate, there is a significant amount of DSM potential remaining in the Xcel Energy Minnesota service territory. The residential and commercial sectors provide the largest sources of identified potential savings. While savings potentials in the industrial sector are lower, this segment is more complex and less understood that the other sectors, and it is likely that our bottom-up analysis understates, to some degree, all the custom energy efficiency opportunities available in this sector.

We note that Xcel Energy's current programs, as modeled in the business-as-usual scenario, are expected to capture a significant amount of the available savings (about nine percent of base energy usage by 2020) at current program expenditure levels. These programs have developed over a number of years and appear to utilize program funding efficiently. While increased achievable savings are possible at increased levels of program effort, we caution that these increases could be expensive. The 75-percent incentive scenario shows a 16-percent increase in energy savings by 2020, but comes with a 181-percent increase in program costs. The 100-percent incentive scenario shows a 37-percent increase in energy savings by 2020, but comes with a 279-percent increase in program costs.

We also note that a dramatic increase in program activity over an extended period does not seem to be supported by the available energy efficiency resources. While the higher-incentive scenarios show large amounts of achievable potential over the first few years of the forecast horizon, an accelerated program approach is likely to lead to a substantial drop-off in program accomplishments in later years as many of the retrofit measure reach high saturation levels. This boom-bust phenomenon could be detrimental to long-term program sustainability and would likely reduce the ability of Xcel Energy's program structure to accommodate emerging technologies and adapt to other market developments.

Additional conclusions, by topic area, are summarized below:

- Savings opportunities
  - Residential sector – The potential is greatest for cooling, lighting, and furnace fan end use measures. Whole-building new constructions measures are also a large source of potential savings.
  - Commercial sector – Lighting and HVAC measures continue to provide the largest sources of energy efficiency potential. Office equipment, including data center and server measures, also appears to be a substantial source of savings.
  - Industrial sector – Cross-cutting motor-driven end uses (fans, pumps, and compressed air) offer the greatest potential in this sector, and are associated with measures that apply to a wide variety of industrial classifications.
- Behavioral conservation measures may also play a role in reducing energy consumption in Xcel Energy's service territory. However, the persistence of behavior-oriented measures has not been tested over an extended period of time, so continued evaluation of behavioral conservation programs will be necessary to ensure that savings don't dissipate over time.
- Emerging technologies will play an increasing role in the energy efficiency portfolio as traditional measures reach high market saturation levels. It may be necessary to initially offer fairly high incentives to promote some of the emerging technologies, especially the LED lighting technologies that have a high first cost compared to base technologies.

- Demand response is already a significant part of Xcel Energy's DSM portfolio, as shown by projected demand reductions of over 900 MW of by 2020 under business as usual. Additional savings of up to 300MW could possibly be acquired through current program augmentation, but further additions to savings that are tied to critical peak pricing would require investments in AMI, and those investments would need to be evaluated on many parameters in addition to the DR benefit.

2. Introduction

2.1 Overview

KEMA, Inc. (KEMA) was retained by Xcel Energy to conduct this demand-side management (DSM) market potential study. The study provides estimates of potential electricity and peak-demand savings from DSM measures in Xcel Energy's Minnesota service territory.

The study was designed to:

1. Help determine how much electric technical, economic, achievable (market), and naturally occurring potential exists within Xcel Energy's Minnesota service territory for cost-effective energy-efficiency and demand-response resources.
2. Be used to help inform the Company's 2013 - 2015 triennial filings
3. Assist in establishing mechanisms by which the company can continuously evaluate opportunities for cost-effective DSM, including but not limited to financial modeling.
4. Assess the impact of factors that may affect baseline assumption since the last potential study. These factors may include changes in codes, standards and rates.

The scope of this study includes new and existing residential and nonresidential buildings, as well as industrial process savings. The study covers an 10-year period spanning 2011-2020. Given the near- to mid-term focus, the base potential analysis was restricted to DSM measures that are presently commercially available. In addition, a number of measures were evaluated as emerging technologies, for example LED lighting. While commercially available (or soon to be commercially available), these products are characterized by limited availability, low consumer awareness, uncertainty about average energy savings, and high current costs that have the potential to drop significantly with market adoption.

Data for the study come from a number of different sources, including primary data collected for this project, secondary sources that include internal Xcel Energy studies and data, as well as a variety of information from third parties. The primary data collection efforts for this study involved 300 residential on-site, 150 commercial on-site surveys, 50 industrial on-site surveys, 804 residential decision-maker telephone surveys, and 41 market actor interviews.

2.2 Study Approach

This study involved identification and development of baseline end-use and measure data and development of estimates of future energy-efficiency impacts under varying levels of program effort. Residential, commercial, and industrial on-site surveys were utilized, in conjunction with telephone interviews of market actors and information from secondary sources, to aid in development of the baseline and measure data.

The baseline characterization allowed us to identify the types and approximate sizes of the various market segments that are the most likely sources of DSM potential in Xcel Energy's Minnesota service territory. These characteristics then served as inputs to a modeling process that incorporated Xcel Energy energy-cost parameters and specific energy-efficiency measure characteristics (such as costs, savings, and existing penetration estimates) to provide more detailed potential estimates.

To aid in the analysis, we utilized the KEMA DSM ASSYST™ model. This model provides a thorough, clear, and transparent documentation database, as well as an extremely efficient data processing system for estimating technical, economic, and achievable potential. We estimated technical, economic, and achievable program potential for the residential, commercial, and industrial sectors, with a focus on energy-efficiency impacts over the next 10 years.

To estimate demand response (DR) impacts, we reviewed impacts from the Federal Energy Regulatory Commission's *2009 National Assessment of Demand Response Potential*[2] for the State of Minnesota and customized the results to the Xcel Energy Minnesota service territory, utilizing information on Xcel Energy's peak demand relative to the Minnesota peak demand and information on current programs being run by Xcel Energy.

2.3 Layout of the Report

Section 3 discusses the methodology and concepts used to develop the technical, economic, and achievable potential estimates. Section 4 provides baseline results developed for the study. Section 5 discusses the results of the electric energy-efficiency potential analysis by sector and over time. Section 6 presents demand-response potential results.

The report contains the following appendices:

- Appendix A: Detailed Methodology and Model Description – Further detail on what was discussed in Section 2.
- Appendix B: Measure Descriptions – Describes the measures included in the study.
- Appendix C: Economic Inputs – Provides avoided cost, electric rate, discount rate, and inflation rate assumptions used for the study.

[2] *A National Assessment of Demand Response Potential*, Staff Report, Federal Energy Regulatory Commission, prepared by The Brattle Group, Freeman, Sullivan & Co., and Global Energy Partners, LLC, June 2009

- Appendix D: Building and TOU Factor Inputs – Shows the base household counts, square footage estimates for commercial building types, and base energy use by industrial segment. This appendix also includes time-of-use factors by sector and end-use.
- Appendix E: Measure Inputs – Lists the electric measures included in the analysis with the costs, estimated savings, applicability, and estimated current saturation factors.
- Appendix F: Non-Additive Measure Level Results – Shows energy-efficiency potential for each measure independent of any other measure.
- Appendix G: Supply-Curve Data – Shows the data behind the energy supply curves provided in Section 5 of the report.
- Appendix H: Achievable Program Potential – Provides the forecasts for the achievable potential scenarios.
- Appendix I: Residential On-Site Surveys – Summarizes the on-site survey results.
- Appendix J: Commercial On-Site Surveys – Summarizes the on-site survey results.
- Appendix K: Industrial On-Site Surveys – Summarizes the on-site survey results.
- Appendix L: Residential Awareness Research Report – Provides results of the telephone surveys.
- Appendix M: Market Actor Research Report – Provides results of interviews with market actors.
- Appendix N: Benchmarking of Demand Response Potentials Report – Summarizes inputs and outputs of the Demand Response analysis.

3. Methods and Scenarios

This section provides a brief overview of the concepts, methods, and scenarios used to conduct this study. Additional methodological details are provided in Appendix A.

3.1 Characterizing the Energy-Efficiency Resource

Energy efficiency has been characterized for some time now as an alternative to energy supply options, such as conventional power plants that produce electricity from fossil or nuclear fuels. In the early 1980s, researchers developed and popularized the use of a conservation supply-curve paradigm to characterize the potential costs and benefits of energy conservation and efficiency. Under this framework, technologies or practices that reduced energy use through efficiency were characterized as “liberating ‘supply’ for other energy demands” and could therefore be thought of as a resource and plotted on an energy supply curve. The energy-efficiency resource paradigm argued simply that the more energy efficiency or “nega-watts” produced, the fewer new plants would be needed to meet end-users’ power demands.

3.1.1 Defining Energy-Efficiency Potential

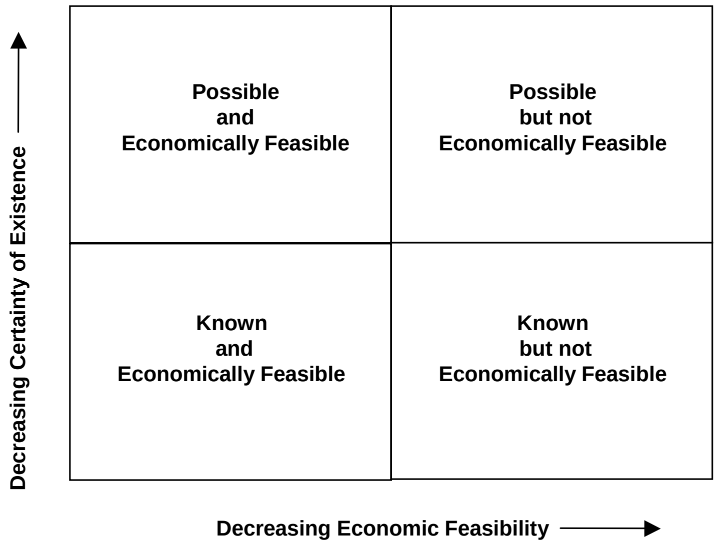
Energy-efficiency potential studies were popular throughout the utility industry from the late 1980s through the mid-1990s. This period coincided with the advent of what was called least-cost or integrated resource planning (IRP). Energy-efficiency potential studies became one of the primary means of characterizing the resource availability and value of energy efficiency within the overall resource planning process.

Like any resource, there are a number of ways in which the energy-efficiency resource can be estimated and characterized. Definitions of energy-efficiency potential are similar to definitions of potential developed for finite fossil-fuel resources, like coal, oil, and natural gas. For example, fossil-fuel resources are typically characterized along two primary dimensions: the degree of geological certainty with which resources may be found and the likelihood that extraction of the resource will be economic. This relationship is shown conceptually in Figure 3-1.

Somewhat analogously, this energy-efficiency potential study defines several different *types* of energy-efficiency *potential*, namely, technical, economic, achievable program, and naturally occurring. These potentials are shown conceptually in Figure 3-2 and described below.

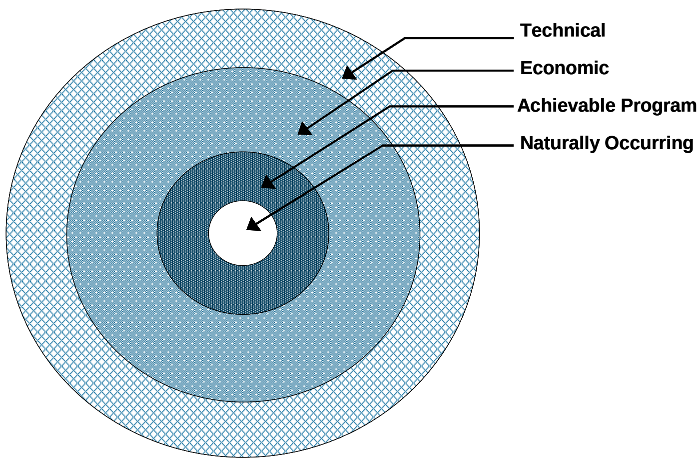
- **Technical potential** is defined in this study as the *complete* penetration of all measures analyzed in applications where they were deemed *technically* feasible from an *engineering* perspective.

Figure 3-1
Conceptual Framework for Estimates of Fossil Fuel Resources



- **Economic potential** refers to the *technical potential* of those energy conservation measures that are cost effective when compared to supply-side alternatives.
- **Achievable program potential** refers to the amount of savings that would occur in response to specific program funding and measure incentive levels. Savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention.
- **Naturally occurring potential** refers to the amount of savings estimated to occur as a result of normal market forces; that is, in the absence of any utility or governmental intervention.

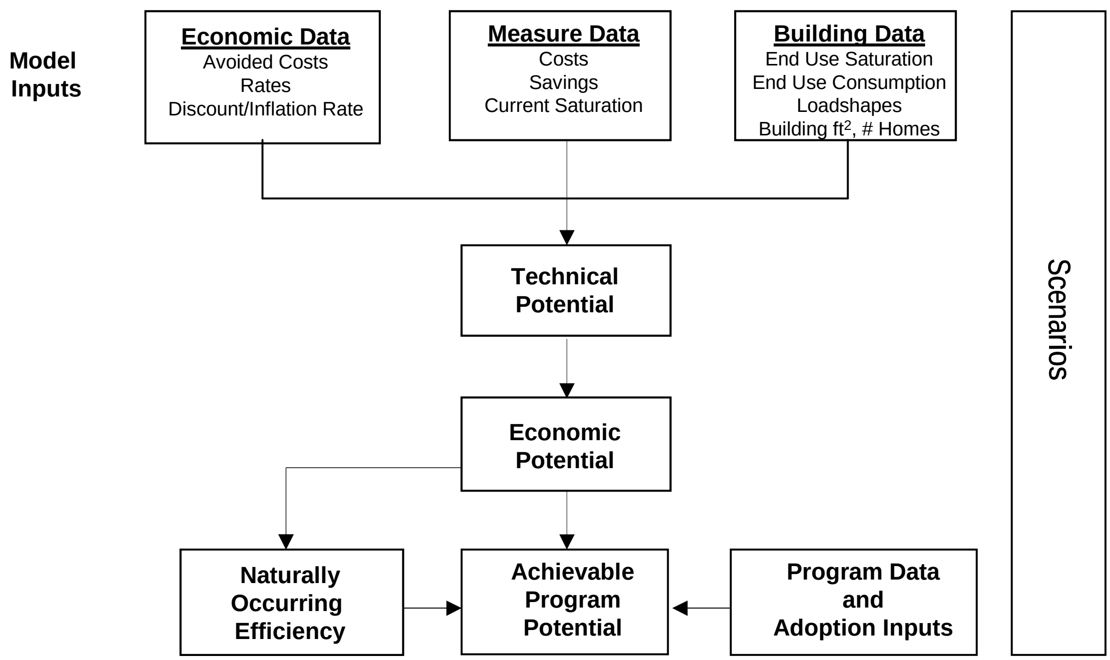
Figure 3-2
Conceptual Relationship among Energy-Efficiency Potential Definitions



3.2 Summary of Analytical Steps Used in this Study

The crux of this study involves carrying out a number of basic analytical steps to produce estimates of the energy-efficiency potentials introduced above. The basic analytical steps for this study are shown in relation to one another in Figure 3-3. The bulk of the analytical process for this study was carried out in a model developed by KEMA for conducting energy-efficiency potential studies. Details on the steps employed and analyses conducted are described in Appendix A. The model used, DSM ASSYST™, is a Microsoft Excel®-based model that integrates technology-specific engineering and customer behavior data with utility market saturation data, load shapes, rate projections, and marginal costs into an easily updated data management system.

Figure 3-3
Conceptual Overview of Study Process



The key steps implemented in this study are:

Step 1: Develop Initial Input Data

- Develop a list of energy-efficiency measure opportunities to include in scope. In this step, an initial draft measure list was developed and circulated internally within Xcel Energy and to an external advisory group. The final measure list was developed after incorporating comments.
- Gather and develop technical data (costs and savings) on efficient measure opportunities. Data on measures were gathered from a variety of sources. Measure descriptions are provided in Appendix B, and detail on measure inputs is provided in Appendix E.
- Gather, analyze, and develop information on building characteristics, including total square footage or total number of households, energy consumption and intensity by end use, end-use consumption load patterns by time of day and year (i.e., load shapes), market shares of key electric consuming equipment, and market shares of energy-efficiency technologies and practices. Section 4 of this report describes the baseline data developed for this study.

  To aid in development of baseline data for the project, several primary data collection efforts were undertaken:

- On-site surveys of 300 residential homes, 150 commercial establishments, and 50 industrial facilities to understand current equipment holdings and saturations of energy efficiency technologies
- Telephone surveys of 804 residential customers to gain an understanding of customer awareness and attitudes toward energy efficiency
- Telephone interview of 41 market actors to help characterize the current market and to inform Xcel Energy's future program designs

- Collect data on economic parameters: avoided costs, electricity rates, discount rates, and inflation rate. These inputs are provided in Appendix C of this report.

Step 2: Estimate Technical Potential and Develop Supply Curves

- Match and integrate data on efficient measures to data on existing building characteristics to produce estimates of technical potential and energy-efficiency supply curves.

Step 3: Estimate Economic Potential

- Match and integrate measure and building data with economic assumptions to produce indicators of costs from different viewpoints (e.g., societal and consumer).
- Estimate total economic potential.

Step 4: Estimate Achievable Program and Naturally Occurring Potentials

- Screen initial measures for inclusion in the program analysis. This screening may take into account factors such as cost effectiveness, potential market size, non-energy benefits, market barriers, and potentially adverse effects associated with a measure. For this study, measures were screened using the total-resource-cost test, while considering only electric avoided-cost benefits.
- Gather and develop estimates of program costs (e.g., for administration and marketing) and historic program savings.
- Develop estimates of customer adoption of energy-efficiency measures as a function of the economic attractiveness of the measures, barriers to their adoption, and the effects of program intervention.
- Estimate achievable program and naturally occurring potentials.

Step 5: Scenario Analyses

- Recalculate potentials under alternate program scenarios.

3.3 Scenario Analysis

Scenario analysis is a tool commonly used to structure the uncertainty and examine the robustness of projected outcomes to changes in key underlying assumptions. This section describes the alternative scenarios under which demand-side management (DSM) potential was estimated in this study. We developed these scenarios of DSM potential for two key reasons:

1. Our estimates of potential depend on future adoptions of energy-efficiency measures that are a function of data inputs and assumptions, which are themselves forecasts. For example, our projections depend on estimates of measure availability, measure cost, measure savings, measure saturation levels, retail rates, and avoided costs. Each of the inputs to our analysis is subject to some degree of uncertainty.
2. The ultimate achievable energy-efficiency potential depends, by definition, on policy choices, including the level of resources and strategies used to increase measure adoption.

The cost components of program funding that vary under each scenario include:

Marketing and Education Expenditures

- Customers must be aware of efficiency measures and their associated benefits in order to adopt those measures. In our analysis, program marketing expenditures are converted to increases in awareness. Thus, under higher levels of marketing expenditures, higher levels of awareness are achieved.

Incentives and Direct Implementation Expenditures

- The higher the percentage of measure costs paid by the program, the higher the participants' benefit-cost ratios and, consequently, the number of measure adoptions.

Administration Expenditures

- Purely administrative costs, though necessary and important to the program process, do not directly lead to adoptions; however, they have been included in program funding because they are an input to program benefit-cost tests.

For the study, the primary analysis focused a base case consisting of commercially available, established efficiency technologies. In addition to this base analysis, we analyzed:

- Emerging technologies
- Behavioral-conservation measures
- Demand response

For each analysis, four program-funding scenarios were considered: a business-as-usual (BAU) funding scenario, a 50-percent incentive scenario, a 75-percent incentive scenario, and a 100-percent incentive scenario. These scenarios are discussed below.

In all scenarios, a number of measures were modeled without financial incentives. These include office equipment power-management enabling, industrial operations and maintenance (O&M) measures, and Energy Star office equipment and consumer electronics for the residential sector. Because these measures are very cost effective, it was deemed that provision of an incentive would primarily benefit free riders.

Note for the low-income segment, all scenarios reflect 100 percent incentives (as a percent of incremental measure cost). Program effort was adjusted across scenarios such that low-income program potentials roughly track other residential program potentials.

3.3.1 Business as Usual (BAU) Incentive Scenario

In this scenario we modeled existing Xcel Energy programs and incentive levels. This scenario was used to calibrate the DSM Assyst model to equate current incentive and other program effort expenditures to expect program savings. Incentives (as a percent of incremental measure costs) varied by measure in this scenario. Average incentives, by sector, utilized for this scenario were: 59 percent for the residential sector, 30 percent for the commercial sector, and 28 percent for the industrial sector.

3.3.2 Fifty-percent Incentive Scenario

In the 50-percent incentive scenario, base incentive levels are set to 50 percent of incremental measure costs. Marketing/customer education and administration budgets were increased from current Xcel Energy budgets. For the behavioral conservation program, which isn't tied to incentives, we extended the program to cover only the largest residential energy users. Program administration budgets are set at modest amounts, roughly corresponding to minimum program support levels.

3.3.3 Seventy-five-percent Incentive Scenario

In this scenario, incentives were increased to cover 75 percent of incremental measure costs, except for the low-income giveaway items and measures that had constrained incentives as discussed above. For the behavioral conservation program, we extended coverage to both the large and medium sized residential energy users. Program marketing and administration budgets were also increased for this scenario.

3.3.4 One-hundred-percent Incentive Scenario

In this scenario, incentives were increased to cover 100 percent of incremental measure costs, with the exception of constrained measures. The behavioral conservation program was extended to cover all residential customers. Program marketing and administration budgets were increased again for this scenario.

3.3.5 Summary of Scenarios

Table 3-1 shows average spending on electricity programs for each of the scenarios for the 2011-2020 forecast period for the base analysis, which does not include emerging technologies, behavioral-conservation measures, or demand response.

Table 3-1
Scenario Average Spending during 2011-2020 Forecast Period ($1000s)
Electric Programs

Funding Level	Market Segment	Cost Components: Admin	Marketing	Incentives	Total	% Incremental Measure Cost Paid*
BAU Incentives	Residential Existing	$7,701	$4,499	$9,618	$21,818	58%
	Residential New Construction	$637	$949	$1,064	$2,650	58%
	Residential Low Income	$908	$726	$6,530	$8,164	100%
	Commercial Existing	$5,446	$3,218	$11,324	$19,988	30%
	Commercial New Construction	$28	$74	$296	$398	25%
	Industrial	$2,028	$2,084	$4,195	$8,308	28%
	Total	$16,750	$11,549	$33,027	$61,326	
50% Incentives	Residential Existing	$7,521	$4,323	$11,487	$23,330	50%
	Residential New Construction	$564	$902	$791	$2,257	50%
	Residential Low Income	$930	$798	$6,653	$8,382	100%
	Commercial Existing	$5,924	$3,779	$16,384	$26,088	50%
	Commercial New Construction	$42	$88	$947	$1,078	50%
	Industrial	$2,389	$2,501	$9,065	$13,954	50%
	Total	$17,371	$12,391	$45,327	$75,089	
75% Incentives	Residential Existing	$8,620	$4,755	$23,881	$37,256	75%
	Residential New Construction	$847	$992	$1,958	$3,797	75%
	Residential Low Income	$954	$878	$6,788	$8,620	100%
	Commercial Existing	$6,638	$4,157	$27,539	$38,334	75%
	Commercial New Construction	$68	$97	$2,483	$2,648	75%
	Industrial	$2,890	$2,751	$14,672	$20,313	75%
	Total	$20,017	$13,630	$77,322	$110,969	
100% Incentives	Residential Existing	$10,215	$5,230	$48,296	$63,742	100%
	Residential New Construction	$1,385	$1,091	$4,680	$7,156	100%
	Residential Low Income	$981	$966	$6,935	$8,881	100%
	Commercial Existing	$7,768	$4,573	$40,791	$53,132	100%
	Commercial New Construction	$166	$107	$8,994	$9,267	100%
	Industrial	$3,875	$3,026	$21,952	$28,853	100%
	Total	$24,390	$14,993	$131,648	$171,032	

3.3.6 Avoided-Cost Scenarios

The avoided-cost assumptions used in the study are based on the marginal energy cost forecast that Xcel Energy provided in October 2011. This base forecast resulted in a 5 percent reduction from the assumptions filed in 2010-2012 Minnesota DSM Triennial Plan. In order to test the sensitivity of the potential analysis to varying avoided costs, we also developed estimates of energy efficiency potential using lower and higher cost assumptions.

The electric avoided costs were developed by time-of-use (TOU) period. These periods are shown in Table 3-2. Figure 3-4 shows the base electric avoided-cost forecast by TOU period. Figure 3-5 provides a comparison of the base, low, and high forecasts using load-weighted averages of the TOU forecasts. Overall, the high-cost forecast is about 57 percent higher than the base forecast, and the low-cost forecast is about 5 percent lower than the base forecast (before. Note that all forecasts include adders for environmental externalities (CO_2 and SO_x) and adders for non-energy benefits. In addition to energy avoided costs, capacity avoided costs are included in the analysis, starting at $121 per kW and increasing by about 2 percent per year.

Table 3-2
Electric Time-of-Use Period Definitions

TOU Period	**Weekday Hours**	**Weekend Hours**
Summer Off-Peak	0:01-6:00	0:01-8:00
Summer Mid-Peak	6:01-7:00, 23:01-24:00	8:01-9:00, 22:01-24:00
Summer On-Peak	7:01-12:00, 17:01-23:00	9:01-22:00
Summer Super-Peak	12:01-17:00	
Winter Off-Peak	0:01-6:00, 23:01-24:00	0:01-9:00, 23:01-24:00
Winter On-Peak	6:01-23:00	9:01-23:00
Summer	June-September	
Winter	October-May	

* Time-of-use periods were determined by analysis of hourly marginal costs to identify periods that have similar prices. These periods are independent of any billing TOU rates.

Figure 3-4
Electric Avoided-Cost Forecast - Base

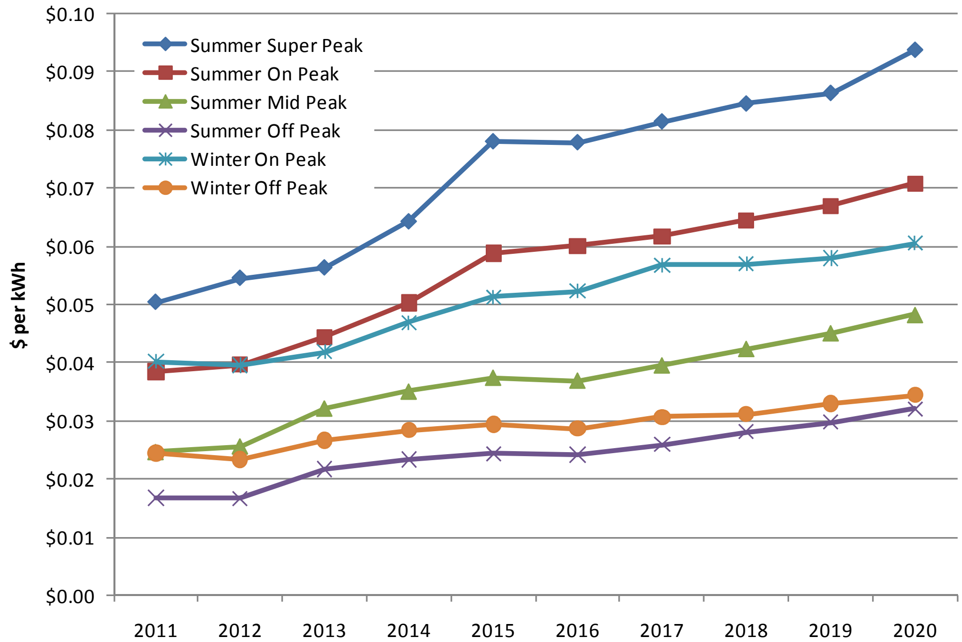
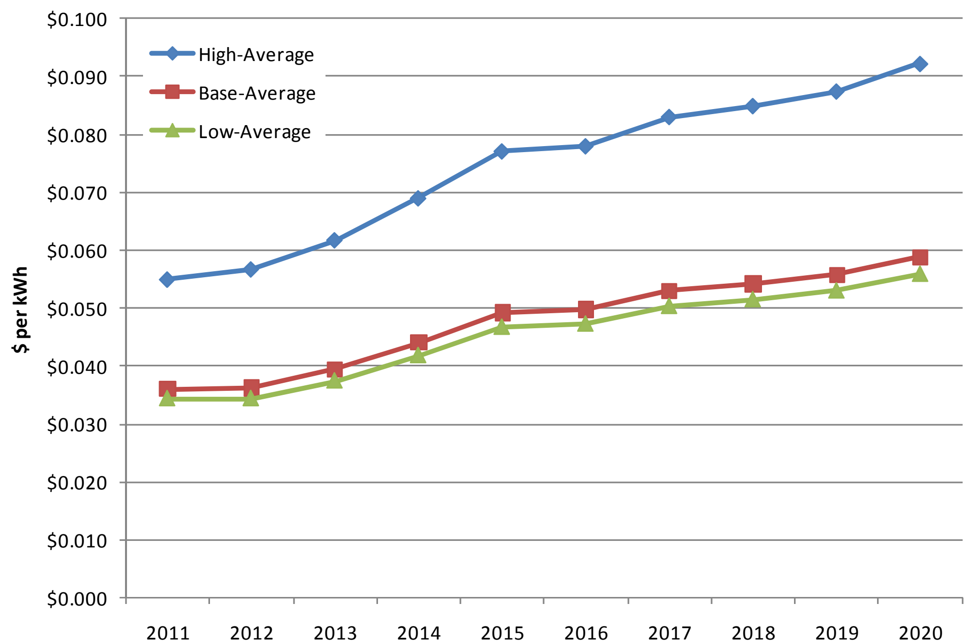


Figure 3-5
Electric Avoided-Cost Forecast Comparison



4. Baseline Results

4.1 Overview

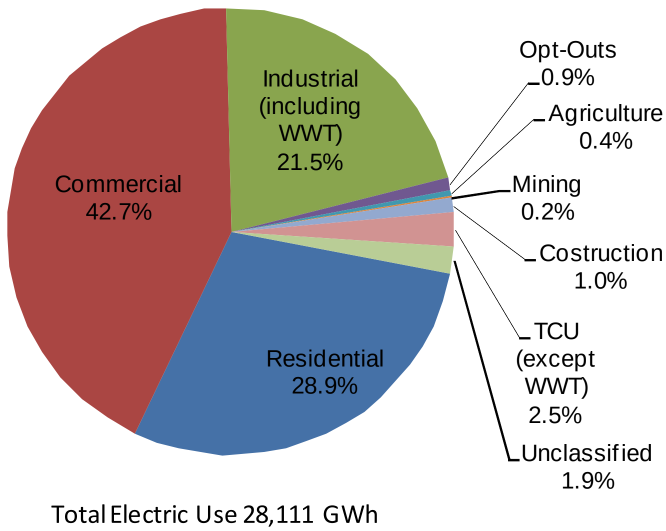
Estimating the potential for energy-efficiency improvements requires a comparison of the energy impacts of standard-efficiency technologies with those of alternative high-efficiency equipment. This, in turn, dictates a relatively detailed understanding of the energy characteristics of the marketplace. Baseline data that were required for each studied market segment includes:

- Total count of energy-consuming units (floor space of commercial buildings, number of residential dwellings, and the base kWh consumption of industrial facilities)
- Annual energy consumption for each end use studied (both in terms of total consumption in GWh and normalized for intensity on a per-unit basis (e.g., kWh/ft^2)
- End-use load shapes (that describe the amount of energy used or power demand over certain times of the day and days of the year)
- The saturation of electric end uses (e.g., the fraction of total commercial floor space with electric air conditioning)
- The market share of each base equipment type for example, the fraction of total commercial floor space served by 4-foot fluorescent lighting fixtures)
- Market share for each energy-efficiency measure in scope (for example, the fraction of total commercial floor space already served by CFLs).

Data for the baseline analysis comes from a number of sources, including Xcel Energy billing data extracts, Xcel Energy internal studies and analyses, U.S. Department of Energy studies, on-site surveys, and other secondary sources. Baseline data sources vary by sector and are described further below.

Figure 4-1 shows the overall breakdown of electricity use and peak demand by sector for the Xcel Energy Minnesota service territory. The commercial sector accounts for the largest share of energy usage, followed by the residential, industrial, and TCU (transportation, communications, and utilities) sectors. The chart breaks out "opt-out" customers. These are commercial and industrial customers that as of October 1, 2011 had opted out of Minnesota's Resource Adjustment Rider and are therefore ineligible for Xcel Energy's efficiency and demand response programs (see section 1.1 for further discussion). While we identify them here in the context of Xcel's total customer base, they are excluded from the remainder of the analysis since as opt-outs they cannot contribute to program potential.

Figure 4-1
Electricity Usage Breakdown – Xcel Energy Minnesota Service Territory



Source: Xcel Energy Billing Records

Table 4-1 shows the results of the nonresidential billing analysis. Note that at the bottom of the table we show an unclassified category. These categories account for only 2.7 percent of nonresidential electricity use. Detailed results of the billing analysis by sector are reported in the sector-specific sections below.

Table 4-1
Results of Nonresidential Billing Analysis

SECTOR	BUSINESS TYPE	# of Sites	kWh	% of kWh
AG	Agriculture	2,278	120,602,970	0.6%
COM	College	733	299,093,618	1.4%
COM	Com misc	8,543	1,181,007,404	5.6%
COM	Grocery	1,859	629,625,523	3.0%
COM	Health	701	476,726,003	2.3%
COM	Lodging	898	345,952,865	1.6%
COM	Office-L	271	2,647,088,675	12.6%
COM	Office-S	47,250	2,995,139,537	14.2%
COM	Restaurant	4,715	652,125,308	3.1%
COM	Retail-L	91	447,797,056	2.1%
COM	Retail-S	14,273	1,235,200,928	5.9%
COM	School	1,377	559,105,741	2.7%
COM	Warehouse	6,642	1,208,700,827	5.7%
CST	Construction	5,937	294,274,373	1.4%
IND	Chemicals	305	584,987,128	2.8%
IND	Electronics	481	438,973,482	2.1%
IND	Fabricated metals	648	295,426,049	1.4%
IND	Food	485	981,997,945	4.7%
IND	Ind machinery	1,198	507,483,821	2.4%
IND	Ind misc	948	420,602,887	2.0%
IND	Paper	175	389,462,178	1.8%
IND	Petroleum	55	1,073,932,634	5.1%
IND	Plastics	378	439,621,890	2.1%
IND	Primary metals	184	548,282,354	2.6%
IND	Printing	940	375,279,206	1.8%
IND	Stone-clay-glass	260	224,673,531	1.1%
IND	Textiles	223	26,557,686	0.1%
IND	Transp equip	216	131,672,489	0.6%
IND	Wood	442	167,015,964	0.8%
MIN	Mining	127	48,306,675	0.2%
TCU	Tcu	6,010	715,056,269	3.4%
TCU	Water-WWT	120	82,195,101	0.4%
UNC	Unclassified	12,610	540,897,823	2.6%
	Total NonRes	**121,373**	**21,084,865,940**	

Source: Xcel Energy Minnesota billing analysis

4.2 Residential

For this energy efficiency potential study, we are breaking the residential sector into 3 segments:

- Single family
- Multifamily
- Low income

Table 4-2 shows the results of the residential billing analysis by building type.

Table 4-2
Energy Use and Number of Customers by Building Type from Residential Billing Analysis

Building Type	Customer Count	Annual kWh	Avg kWh per household
Single Family	720,267	7,102,671,058	9,861
Multifamily	264,635	1,110,722,266	4,197
Low Income	67,610	519,884,533	7,689

Source: Xcel Energy Minnesota billing analysis

We calculated equipment saturations (percent of households having an end use) using the results of the residential on-sites. These are shown in Table 4-3.

Table 4-4 shows the end-use energy intensities for the residential sector by base measure. End-use energy intensities represent the energy use per household for households that have that end-use, for example, dishwasher annual kWh for homes with dishwashers.

We calculated energy use as the product of the number of households, equipment saturation, and the end-use energy intensity. Energy use by building type and end-use is shown in Table 4-5. Figure 4-2 shows graphically the breakout of energy use by end-use.

Load-shape data from Xcel Energy and KEMA end-use databases were utilized to allocate annual energy usage to Xcel Energy's time-of-use (TOU) periods. Peak period usage, developed on a sector-specific and end-use basis, was calibrated to equal the Xcel Energy summer peak (see Table 4-6).

Table 4-3
Residential End-Use Saturations by Base Measure

	Single Family	Multifamily	Low Income
Base Split-System Air Conditioner (11 SEER)	74%	47%	38%
Base Early Replacement Split-System Air Conditioner (11 SEER)	13%	8%	7%
Base Room Air Conditioner - EER 9.7	14%	30%	45%
Base Early Replacement Room Air Conditioner- EER 9.0	2%	5%	8%
Base Dehumidifier- New Federal Standard	8%	6%	10%
Base Furnace Fans	48%	17%	38%
Base Resistance Space Heating (Primary)	9%	9%	12%
Base High-Efficiency Incandescent Lighting,<1.15 hrs/day	100%	100%	100%
Base High-Efficiency Incandescent Lighting,1.15-2.15 hrs/day	100%	100%	100%
Base High-Efficiency Incandescent Lighting,2.15-5 hrs/day	100%	100%	100%
Base High-Efficiency Incandescent Lighting,>5 hrs/day	100%	100%	100%
Base Lighting 15 Watt CFL, <1.15 hrs/day	100%	100%	100%
Base Lighting 15 Watt CFL, 1.15-2.15 hrs/day	100%	100%	100%
Base Lighting 15 Watt CFL, 2.15-5 hrs/day	100%	100%	100%
Base Lighting 15 Watt CFL, >5 hrs/day	100%	100%	100%
Base Fluorescent Fixture 1.8 hrs/day	100%	100%	100%
Base Refrigerator	85%	85%	85%
Base Early Replacement Refrigerator	15%	15%	15%
Base Second Refrigerator	18%	33%	27%
Base Freezer	33%	38%	31%
Base Early Replacement Freezer	6%	7%	6%
Base 40 gal. Water Heating (EF=0.88)	7%	7%	3%
Base Early Replacement Water Heating to Heat Pump Water Heater	1%	1%	0%
Base Clothes Washer (MEF=1.26)	83%	87%	83%
Base Clothes Dryer (EF=3.01)	45%	43%	40%
Base Dishwasher (EF=0.65)	67%	80%	81%
Base Single Speed Pool Pump (RET)	0%	0%	0%
Base Two Speed Pool Pump (1.5 hp) (ROB)	0%	0%	0%
Base Plasma TV	10%	13%	9%
Base LCD TV	68%	56%	64%
Base CRT TV	79%	62%	78%
Base Set-Top Box	73%	67%	71%
Base DVD Player	84%	80%	72%
Base Desktop PC	68%	62%	51%
Base Laptop PC	72%	66%	35%
Base Cooking	61%	65%	53%
Base Miscellaneous	100%	100%	100%
Base House Practices	100%	100%	100%

Source: Residential on-site survey data

Table 4-4
Residential End-Use Energy Intensities (kWh/household with end-use)

	Single Family	Multifamily	Low Income
Base Split-System Air Conditioner (11 SEER)	1,789	322	1,321
Base Early Replacement Split-System Air Conditioner (11 SEER)	2,236	403	1,652
Base Room Air Conditioner - EER 9.7	773	315	736
Base Early Replacement Room Air Conditioner- EER 9.0	827	337	788
Base Dehumidifier- New Federal Standard	1,064	351	851
Base Furnace Fans	1,105	332	978
Base Resistance Space Heating (Primary)	5,658	1,700	5,007
Base High-Efficiency Incandescent Lighting,<1.15 hrs/day	133	66	64
Base High-Efficiency Incandescent Lighting,1.15-2.15 hrs/day	575	284	277
Base High-Efficiency Incandescent Lighting,2.15-5 hrs/day	249	123	120
Base High-Efficiency Incandescent Lighting,>5 hrs/day	377	186	182
Base Lighting 15 Watt CFL, <1.15 hrs/day	6	3	4
Base Lighting 15 Watt CFL, 1.15-2.15 hrs/day	51	22	29
Base Lighting 15 Watt CFL, 2.15-5 hrs/day	45	19	25
Base Lighting 15 Watt CFL, >5 hrs/day	67	29	38
Base Fluorescent Fixture 1.8 hrs/day	242	62	84
Base Refrigerator	790	575	773
Base Early Replacement Refrigerator	790	575	773
Base Second Refrigerator	1,071	842	1,089
Base Freezer	549	549	549
Base Early Replacement Freezer	549	549	549
Base 40 gal. Water Heating (EF=0.88)	4,516	3,447	4,516
Base Early Replacement Water Heating to Heat Pump Water Heater	4,516	3,447	4,516
Base Clothes Washer (MEF=1.26)	81	81	81
Base Clothes Dryer (EF=3.01)	969	583	776
Base Dishwasher (EF=0.65)	162	162	162
Base Single Speed Pool Pump (RET)	822	822	822
Base Two Speed Pool Pump (1.5 hp) (ROB)	419	419	419
Base Plasma TV	235	235	268
Base LCD TV	158	142	165
Base CRT TV	186	123	208
Base Set-Top Box	234	197	233
Base DVD Player	33	26	34
Base Desktop PC	729.5	571.8	684.6
Base Laptop PC	191.9	168.5	170.2
Base Cooking	316	316	316
Base Miscellaneous	1,803	34	1,800
Base House Practices	9,861	4,197	7,689

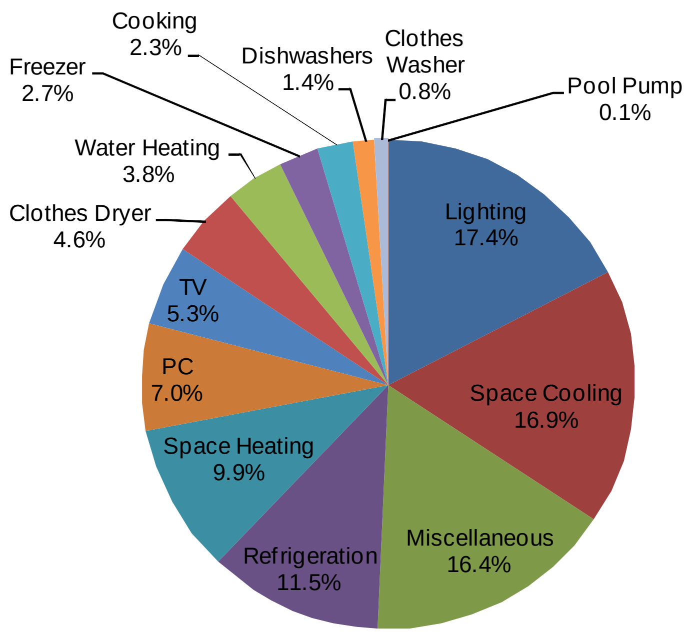
Source: Various sources, calibrated to overall Xcel Energy consumption per household

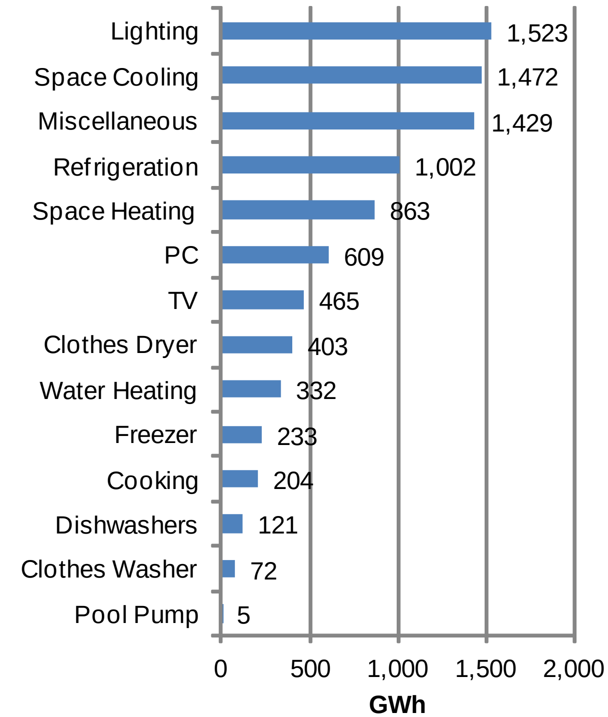
Table 4-5
Residential Energy Use by Building Type and End-Use

	Single Family	Multifamily	Low Income	Total
Base Split-System Air Conditioner (11 SEER)	949,555	39,908	34,176	1,023,639
Base Early Repl Split-System Air Conditioner (11 SEER)	209,461	8,803	7,539	225,803
Base Room Air Conditioner - EER 9.7	76,694	24,941	22,240	123,875
Base Early Replacement Room Air Conditioner- EER 9.0	14,482	4,710	4,199	23,391
Base Dehumidifier- New Federal Standard	63,148	5,984	5,795	74,928
Base Furnace Fans	386,034	15,090	25,368	426,492
Base Resistance Space Heating (Primary)	355,364	39,050	41,638	436,052
Base High-Efficiency Incandescent Lighting,<1.15 hrs/day	96,014	17,397	4,339	117,750
Base High-Efficiency Incandescent Lighting,1.15-2.15 hrs/day	414,177	75,045	18,718	507,940
Base High-Efficiency Incandescent Lighting,2.15-5 hrs/day	179,513	32,526	8,113	220,152
Base High-Efficiency Incandescent Lighting,>5 hrs/day	271,532	49,199	12,271	333,003
Base Lighting 15 Watt CFL, <1.15 hrs/day	4,545	723	240	5,508
Base Lighting 15 Watt CFL, 1.15-2.15 hrs/day	36,868	5,863	1,951	44,682
Base Lighting 15 Watt CFL, 2.15-5 hrs/day	32,067	5,100	1,697	38,864
Base Lighting 15 Watt CFL, >5 hrs/day	48,505	7,714	2,567	58,786
Base Fluorescent Fixture 1.8 hrs/day	174,235	16,496	5,685	196,417
Base Refrigerator	483,874	129,295	44,395	657,564
Base Early Replacement Refrigerator	85,389	22,817	7,834	116,041
Base Second Refrigerator	135,815	73,268	19,587	228,670
Base Freezer	130,507	55,748	11,635	197,889
Base Early Replacement Freezer	23,031	9,838	2,053	34,922
Base 40 gal. Water Heating (EF=0.88)	223,074	66,752	9,178	299,004
Base Early Repl Water Heating to Heat Pump Water Heater	24,786	7,417	1,020	33,223
Base Clothes Washer (MEF=1.26)	48,465	18,496	4,549	71,510
Base Clothes Dryer (EF=3.01)	314,980	67,024	21,128	403,132
Base Dishwasher (EF=0.65)	78,178	34,262	8,827	121,267
Base Single Speed Pool Pump (RET)	2,368	870	-	3,238
Base Two Speed Pool Pump (1.5 hp) (ROB)	1,208	444	-	1,651
Base Plasma TV	16,934	7,770	1,660	26,363
Base LCD TV	77,158	20,961	7,114	105,233
Base CRT TV	106,235	20,018	10,944	137,197
Base Set-Top Box	123,215	34,770	11,106	169,091
Base DVD Player	20,083	5,581	1,645	27,309
Base Desktop PC	359,468	93,777	23,533	476,778
Base Laptop PC	98,900	29,530	4,077	132,507
Base Cooking	138,224	54,440	11,383	204,047
Base Miscellaneous	1,298,586	9,094	121,680	1,429,360
Base House Practices	7,102,671	1,110,722	519,885	8,733,278
Total	7,102,671	1,110,722	519,885	8,733,278

Source: KEMA analysis, calibrated to overall Xcel Energy residential consumption

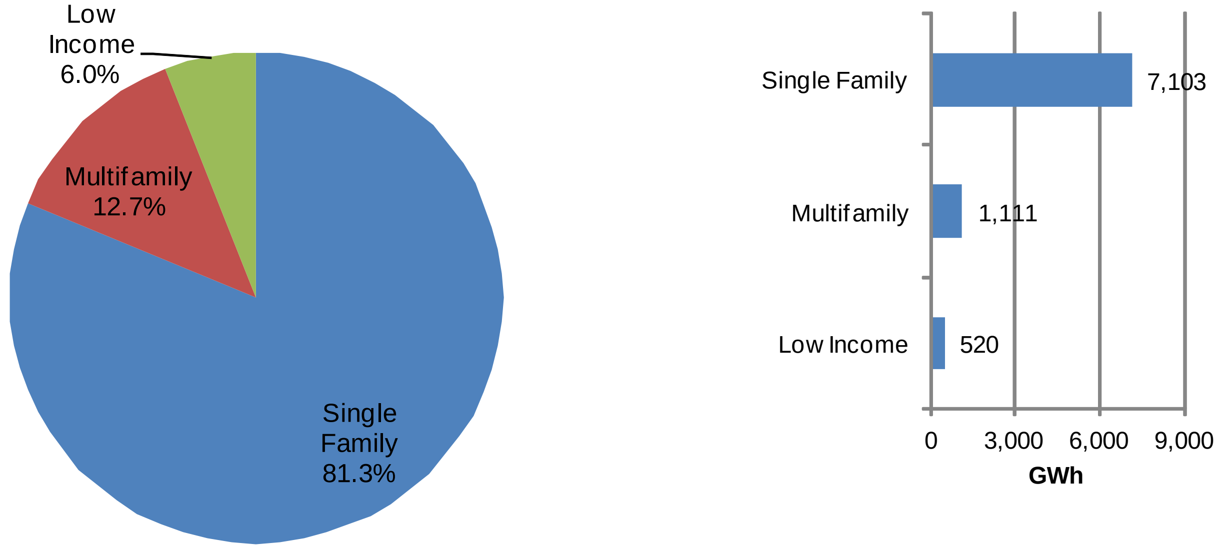
Figure 4-2
Residential Energy Use by End-Use





Source: KEMA analysis, calibrated to overall Xcel Energy residential consumption

Figure 4-3
Residential Energy Use by Building Type



Source: Xcel Energy Minnesota billing analysis

Table 4-6
Residential Peak Demand by Building Type and End Use (MW)

	Single Family	Multifamily	Low Income	Total
Base Split-System Air Conditioner (11 SEER)	1,013	43	36	1,092
Base Early Replacement Split-System Air Conditioner (11 SEER)	224	9	8	241
Base Room Air Conditioner - EER 9.7	82	27	24	132
Base Early Replacement Room Air Conditioner- EER 9.0	15	5	4	25
Base Dehumidifier- New Federal Standard	7	1	1	8
Base Furnace Fans	105	4	7	116
Base Resistance Space Heating (Primary)	0	0	0	0
Base High-Efficiency Incandescent Lighting,<1.15 hrs/day	9	2	0	11
Base High-Efficiency Incandescent Lighting,1.15-2.15 hrs/day	38	7	2	46
Base High-Efficiency Incandescent Lighting,2.15-5 hrs/day	16	3	1	20
Base High-Efficiency Incandescent Lighting,>5 hrs/day	25	4	1	30
Base Lighting 15 Watt CFL, <1.15 hrs/day	0	0	0	0
Base Lighting 15 Watt CFL, 1.15-2.15 hrs/day	3	1	0	4
Base Lighting 15 Watt CFL, 2.15-5 hrs/day	3	0	0	4
Base Lighting 15 Watt CFL, >5 hrs/day	4	1	0	5
Base Fluorescent Fixture 1.8 hrs/day	16	1	1	18
Base Refrigerator	65	17	6	89
Base Early Replacement Refrigerator	12	3	1	16
Base Second Refrigerator	18	10	3	31
Base Freezer	18	8	2	27
Base Early Replacement Freezer	3	1	0	5
Base 40 gal. Water Heating (EF=0.88)	22	7	1	30
Base Early Replacement Water Heating to Heat Pump Water Heater	2	1	0	3
Base Clothes Washer (MEF=1.26)	7	2	1	10
Base Clothes Dryer (EF=3.01)	41	9	3	52
Base Dishwasher (EF=0.65)	11	5	1	18
Base Single Speed Pool Pump (RET)	0	0	0	0
Base Two Speed Pool Pump (1.5 hp) (ROB)	0	0	0	0
Base Plasma TV	2	1	0	3
Base LCD TV	10	3	1	13
Base CRT TV	13	3	1	17
Base Set-Top Box	15	4	1	21
Base DVD Player	3	1	0	3
Base Desktop PC	39	10	3	52
Base Laptop PC	11	3	0	15
Base Cooking	37	14	3	54
Base Miscellaneous	142	1	13	157
Base House Practices	1,924	301	141	2,366
Total	2,032	211	126	2,369

Source: KEMA analysis, calibrated to overall Xcel Energy peak load

4.3 Commercial

For this energy efficiency potential study, we broke the commercial sector into 12 segments, including small and large categories for office and retail buildings, with large defined as customers using more than 3,000,000 kWh per year.

We calculated equipment saturations (percent of households having an end use) from the results of the commercial onsite surveys. These are shown in Table 4-7.

Table 4-8 shows the end-use energy intensities for the commercial sector by base measure. End-use energy intensities represent the energy use per square foot for buildings that have that end-use.

Commercial floorspace is shown in Table 4-9 and energy use by building type and end-use is shown in Table 4-10. Figure 4-4 and Figure 4-5 show graphically the breakout of energy use by end-use and building type, respectively.

KEMA utilized load shape data from Xcel Energy to allocate annual energy usage to Xcel Energy's time-of-use (TOU) periods. Peak-period usage, developed on a sector-specific and end-use basis, was calibrated to equal the Xcel Energy summer peak. Table 4-11shows the commercial peak electricity consumption results developed for the study.

Table 4-7
Commercial Sector Equipment Saturations

End Use	Office-S	Office-L	Restaurant	Retail-S	Retail-L	Grocery	Warehouse	School	College	Health	Lodging	Other
Base Fluorescent Fixture, 4L4'T8	61%	57%	6%	35%	34%	85%	70%	39%	15%	49%	2%	24%
Base Fluorescent Fixture, 2L4'T8, 1 EB	2%	1%	70%	12%	0%	0%	0%	4%	23%	12%	9%	22%
Base Other Fluorescent Fixture	5%	1%	0%	0%	0%	0%	0%	1%	3%	4%	0%	1%
Base High-Efficiency Incandescent Flood, 53W to Screw-in Replacement	1%	1%	15%	10%	0%	0%	0%	2%	16%	1%	2%	2%
Base High-Efficiency Incandescent Flood, 53W to Hardwired Replacement	1%	0%	54%	2%	0%	0%	0%	1%	6%	11%	7%	21%
Base CFL	3%	8%	7%	9%	0%	0%	0%	4%	10%	9%	64%	9%
Base High Bay Metal Halide, 400W	0%	0%	16%	0%	24%	4%	2%	3%	0%	1%	2%	10%
Base Parking Garage Metal Halide, 250 W	0%	44%	0%	0%	0%	0%	0%	0%	18%	7%	0%	0%
Base Parking Garage Fluorescent	10%	32%	0%	0%	0%	0%	0%	0%	0%	0%	2%	7%
Base Exit Sign	82%	100%	79%	42%	100%	99%	100%	100%	100%	100%	100%	98%
Base Outdoor High Pressure Sodium 250W Lamp	42%	35%	100%	45%	100%	99%	43%	93%	52%	93%	74%	87%
Base Streetlighting High Pressure Sodium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0%	67%	0%	7%	0%	42%	0%	30%	23%	30%	39%	11%
Base DX Packaged System, EER=10.3, 10 tons	39%	18%	85%	46%	135%	54%	19%	57%	44%	62%	19%	48%
Base PTAC, EER=8.3, 1 ton	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	16%
Base Fan Motor, 5hp, 1800rpm, 87.5%	42%	48%	50%	43%	100%	97%	30%	33%	82%	19%	65%	54%
Base Fan Motor, 15hp, 1800rpm, 91.0%	7%	21%	0%	2%	0%	0%	0%	89%	69%	65%	0%	43%
Base Fan Motor, 40hp, 1800rpm, 93.0%	5%	36%	0%	2%	0%	96%	10%	37%	69%	69%	11%	34%
Base Built-Up Refrigeration System	0%	1%	38%	0%	10%	11%	3%	8%	1%	1%	2%	0%
Base Self-Contained Refrigeration	2%	0%	40%	5%	100%	100%	0%	57%	0%	5%	41%	1%
Base Desktop PC	100%	84%	95%	62%	100%	97%	100%	93%	99%	92%	100%	96%
Base Monitor, CRT	24%	0%	27%	29%	41%	2%	92%	75%	36%	67%	27%	38%
Base Monitor, LCD	100%	57%	95%	62%	100%	97%	100%	93%	99%	92%	100%	100%
Base Copier	87%	57%	70%	53%	100%	97%	99%	92%	68%	88%	95%	88%
Base Laser Printer	84%	25%	25%	29%	100%	2%	95%	88%	51%	92%	100%	86%

Table 4-7

Commercial Sector Equipment Saturations

End Use	Office-S	Office-L	Restaurant	Retail-S	Retail-L	Grocery	Warehouse	School	College	Health	Lodging	Other
Base Data Center/Server Room	0.3%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.2%	0.0%	0%
Base Water Heating	51%	65%	17%	34%	0%	5%	63%	11%	3%	0%	0%	32%
Base Vending Machines	100%	69%	24%	100%	100%	100%	73%	83%	37%	88%	18%	69%
Base Cooking	2%	31%	67%	7%	75%	97%	0%	90%	30%	22%	33%	6%
Base Heating	0%	32%	7%	2%	0%	0%	0%	0%	0%	0%	33%	1%
Base Miscellaneous	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Commercial on-site survey data

Table 4-8
Commercial End-Use Energy Intensities (kWh per End-Use Square Foot)

	Office-S	Office-L	Restaurant	Retail-S	Retail-L	Grocery	Warehouse	School	College	Health	Lodging	Other
Base Fluorescent Fixture, 4L4'T8	8.0	7.8	6.8	3.7	3.4	7.5	1.6	3.2	8.5	5.6	1.8	2.6
Base Fluorescent Fixture, 2L4'T8, 1 EB	4.6	4.6	3.0	2.2	3.1	6.2	1.4	2.2	5.3	2.7	1.3	2.1
Base Other Fluorescent Fixture	3.6	1.7	0.0	1.0	0.0	0.0	2.1	0.4	2.2	2.1	0.6	0.5
Base High-Efficiency Incandescent Flood, 53W to Screw-in Replacement	24.3	6.8	3.0	3.9	10.4	5.1	0.0	0.2	4.3	2.7	3.6	3.1
Base High-Efficiency Incandescent Flood, 53W to Hardwired Replacement	24.3	0.0	3.0	3.9	0.0	5.1	2.8	0.2	4.3	2.7	3.6	3.1
Base CFL	1.4	2.3	0.8	0.6	0.0	6.3	0.7	1.3	1.3	0.9	0.6	0.6
Base High Bay Metal Halide, 400W	0.0	4.7	0.1	0.0	3.3	11.0	1.2	3.3	13.5	0.0	2.0	1.1
Base Parking Garage Metal Halide, 250 W	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.0
Base Parking Garage fluorescent	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7
Base Exit Sign	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Base Outdoor Metal Halide 295W Lamp	1.0	0.2	3.6	1.2	0.5	0.4	0.6	0.8	0.7	0.4	0.4	0.4
Base Street Lighting High Pressure Sodium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	2.9	2.9	3.8	2.3	0.9	1.7	1.0	0.9	1.7	3.1	0.9	0.9
Base DX Packaged System, EER=10.3, 10 tons	4.9	4.9	6.7	4.0	1.6	2.9	1.7	1.5	2.9	5.3	1.6	1.6
Base PTAC, EER=8.3, 1 ton	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.9	0.0	1.8	1.4
Base Fan Motor, 5hp, 1800rpm, 87.5%	2.4	3.2	6.1	4.1	1.9	1.1	0.7	0.6	1.0	2.0	2.7	0.6
Base Fan Motor, 15hp, 1800rpm, 91.0%	2.2	2.9	5.6	3.8	1.8	1.0	0.6	0.6	0.9	1.9	2.5	0.6
Base Fan Motor, 40hp, 1800rpm, 93.0%	2.2	2.9	5.5	3.7	1.7	1.0	0.6	0.6	0.9	1.9	2.5	0.6
Base Built-Up Refrigeration System	13.0	0.4	7.0	8.0	1.6	16.2	18.0	0.3	0.5	0.7	0.8	2.0
Base Self-Contained Refrigeration	0.1	0.1	4.5	3.1	3.0	2.4	0.1	0.2	0.2	0.2	0.2	0.1
Base Desktop PC	1.2	1.8	0.3	0.1	0.1	0.1	0.2	0.2	0.1	0.7	0.0	0.1
Base Monitor, CRT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Base Monitor, LCD	0.4	0.5	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.0	0.0
Base Copier	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Base Laser Printer	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Base Data Center/Server Room	236.0	236.0	265.8	282.2	282.2	407.5	25.9	94.6	75.2	118.3	194.9	116.2

Table 4-8

Commercial End-Use Energy Intensities (kWh per End-Use Square Foot)

	Office-S	Office-L	Restaurant	Retail-S	Retail-L	Grocery	Warehouse	School	College	Health	Lodging	Other
Base Water Heating	0.4	0.2	2.2	0.3	0.3	0.5	0.1	0.2	0.2	0.4	1.0	0.4
Base Vending Machines	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.0
Base Cooking	0.1	0.1	10.4	0.3	0.3	1.6	0.0	0.2	0.3	0.4	0.7	0.3
Base Heating	0.4	1.6	0.7	11.1	0.4	0.6	10.2	0.2	10.4	1.0	1.5	10.0
Base Miscellaneous	1.0	0.7	1.4	0.8	0.8	0.7	0.4	0.3	0.5	2.5	1.1	1.1

Source: Various sources, calibrated to estimates of overall building energy intensity per square foot.

Table 4-9
Commercial Sector Floorspace (1000 sf) by Building Type

	Office-S	Office-L	Restau-rant	Retail-S	Retail-L	Grocery	Ware-house	School	College	Health	Lodging	Other	Total
Floorspace (1000 sf)	235,208	171,167	21,851	157,204	40,659	34,749	359,597	106,866	34,360	31,790	55,723	214,634	1,463,808

Source: KEMA analysis

Table 4-10
Commercial Sector Energy Use (MWh) by End-Use and Building Type

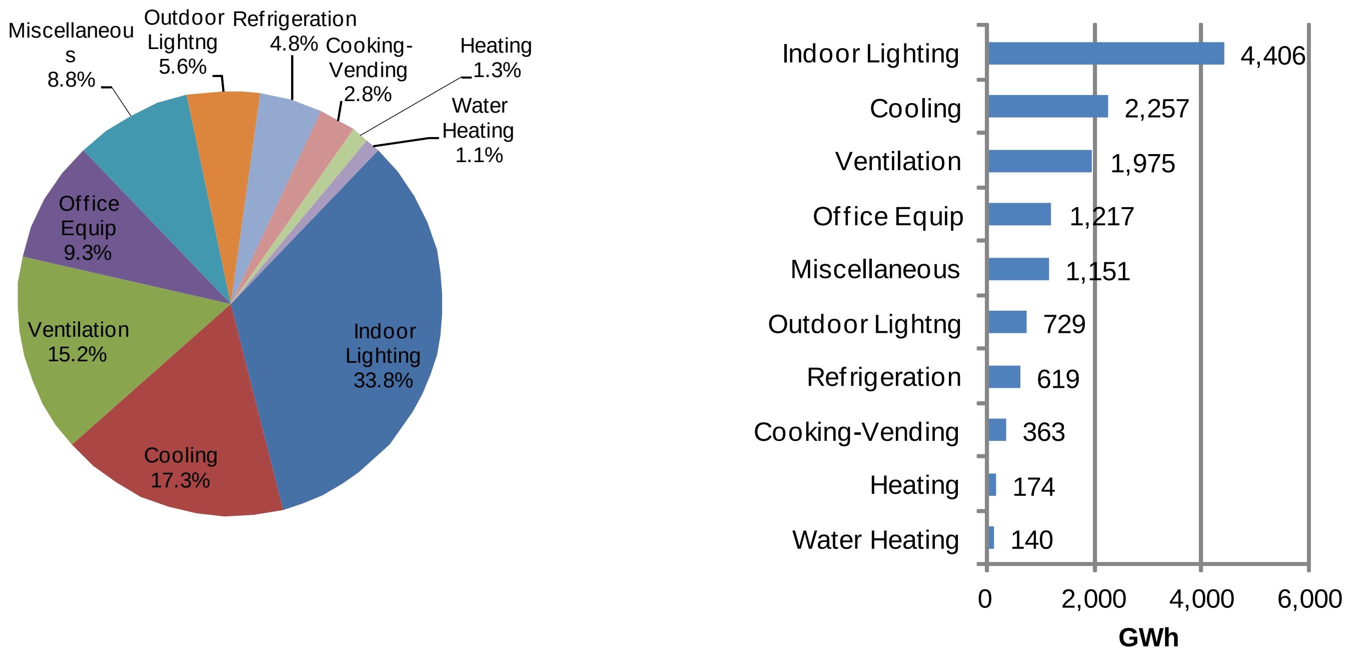
	Office-S	Office-L	Restau-rant	Retail-S	Retail-L	Grocery	Ware-house	School	College	Health	Lodging	Other	Total
Base Fluorescent Fixture, 4L4'T8	1,148,900	756,385	8,330	204,417	46,766	221,859	393,477	136,257	43,760	87,238	1,497	134,666	3,183,553
Base Fluorescent Fixture, 2L4'T8, 1 EB	19,208	4,585	46,043	40,736	433	775	2,596	8,529	40,874	10,668	6,156	100,297	280,898
Base Other Fluorescent Fixture	41,041	1,783	0	294	0	0	367	678	2,017	2,822	118	1,280	50,400
Base High-Efficiency Incandescent Flood, 53W to Screw-in Replacement	68,936	6,774	9,971	60,106	1,464	157	0	390	24,417	1,100	3,334	11,981	188,631
Base High-Efficiency Incandescent Flood, 53W to Hardwired Replacement	32,599	0	35,721	12,308	0	477	5,061	194	9,078	9,338	13,753	139,680	258,210
Base CFL	8,851	32,170	1,142	9,192	0	506	67	5,793	4,416	2,583	22,494	11,170	98,385
Base High Bay Metal Halide, 400W	0	1,665	237	0	32,120	14,844	8,688	10,369	584	0	2,561	21,849	92,916
Base Parking Garage Metal Halide, 250 W	0	226,267	0	0	0	0	0	0	688	935	0	0	227,890
Base Parking Garage Fluorescent	3,798	11,505	0	0	0	0	0	0	0	0	418	9,212	24,931
Base Exit Sign	2,889	2,550	1,005	966	591	379	1,388	1,125	776	862	1,388	653	14,572
Base Outdoor High Pressure Sodium 250W Lamp	102,310	9,277	78,714	84,907	21,978	14,889	85,831	78,158	13,072	11,166	15,070	72,944	588,316
Base Street Lighting High Pressure Sodium	0	0	0	0	0	0	0	0	0	0	0	141,146	141,146
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0	325,084	0	26,818	0	24,575	703	27,520	13,145	28,823	20,058	21,659	488,384
Base DX Packaged System, EER=10.3, 10 tons	452,042	150,049	123,607	293,428	85,163	55,366	115,833	90,600	44,544	104,274	16,756	161,142	1,692,805
Base PTAC, EER=8.3, 1 ton	0	0	0	0	0	0	0	547	266	0	25,209	49,900	75,921
Base Fan Motor, 5hp, 1800rpm, 87.5%	236,615	257,726	66,769	276,043	76,867	35,349	72,461	22,073	28,618	12,252	100,040	69,501	1,254,315

Table 4-10
Commercial Sector Energy Use (MWh) by End-Use and Building Type

	Office-S	Office-L	Restau-rant	Retail-S	Retail-L	Grocery	Ware-house	School	College	Health	Lodging	Other	Total
Base Fan Motor, 15hp, 1800rpm, 91.0%	38,001	102,723	0	8,917	0	0	0	54,770	22,367	39,475	0	51,358	317,610
Base Fan Motor, 40hp, 1800rpm, 93.0%	23,560	175,482	0	8,769	0	31,861	21,909	22,452	21,996	41,249	15,766	40,079	403,124
Base Built-Up Refrigeration System	3,455	793	58,585	6,125	6,587	60,031	191,464	2,465	152	247	907	270	331,082
Base Self-Contained Refrigeration	776	0	39,800	26,369	121,247	83,365	0	11,170	0	367	4,736	295	288,125
Base Desktop PC	272,332	256,373	5,383	6,888	2,574	1,781	68,275	23,910	2,799	20,061	2,329	16,127	678,832
Base Monitor, CRT	544	0	120	160	207	8	4,228	190	131	805	71	0	6,466
Base Monitor, LCD	105,818	51,434	1,772	3,117	698	513	20,252	6,286	769	5,914	632	4,562	201,767
Base Copier	8,017	7,147	724	1,637	293	524	7,211	489	102	1,645	196	1,324	29,308
Base Laser Printer	32,143	3,588	119	1,225	667	6	9,192	1,226	157	2,335	458	2,206	53,323
Base Data Center/Server Room	185,733	23,009	1,002	7,996	4,126	9,596	2,090	838	1,876	8,001	2,447	132	246,845
Base Water Heating	49,182	26,702	8,246	13,362	0	886	15,285	2,469	247	0	0	24,039	140,419
Base Vending Machines	13,459	10,771	745	16,106	5,537	5,715	24,085	11,277	1,495	1,619	1,166	6,094	98,068
Base Cooking	582	6,408	153,435	3,029	7,952	53,090	0	17,283	3,332	3,019	13,272	3,580	264,982
Base Heating	0	89,355	1,134	29,776	0	0	13,475	0	808	0	27,855	11,377	173,779
Base Miscellaneous	232,856	111,258	30,373	125,764	32,527	25,839	157,471	27,785	17,180	80,747	62,410	231,805	1,136,014
Total	3,083,648	2,650,863	672,975	1,268,455	447,797	642,391	1,221,409	564,846	299,664	477,545	361,099	1,340,327	13,031,018

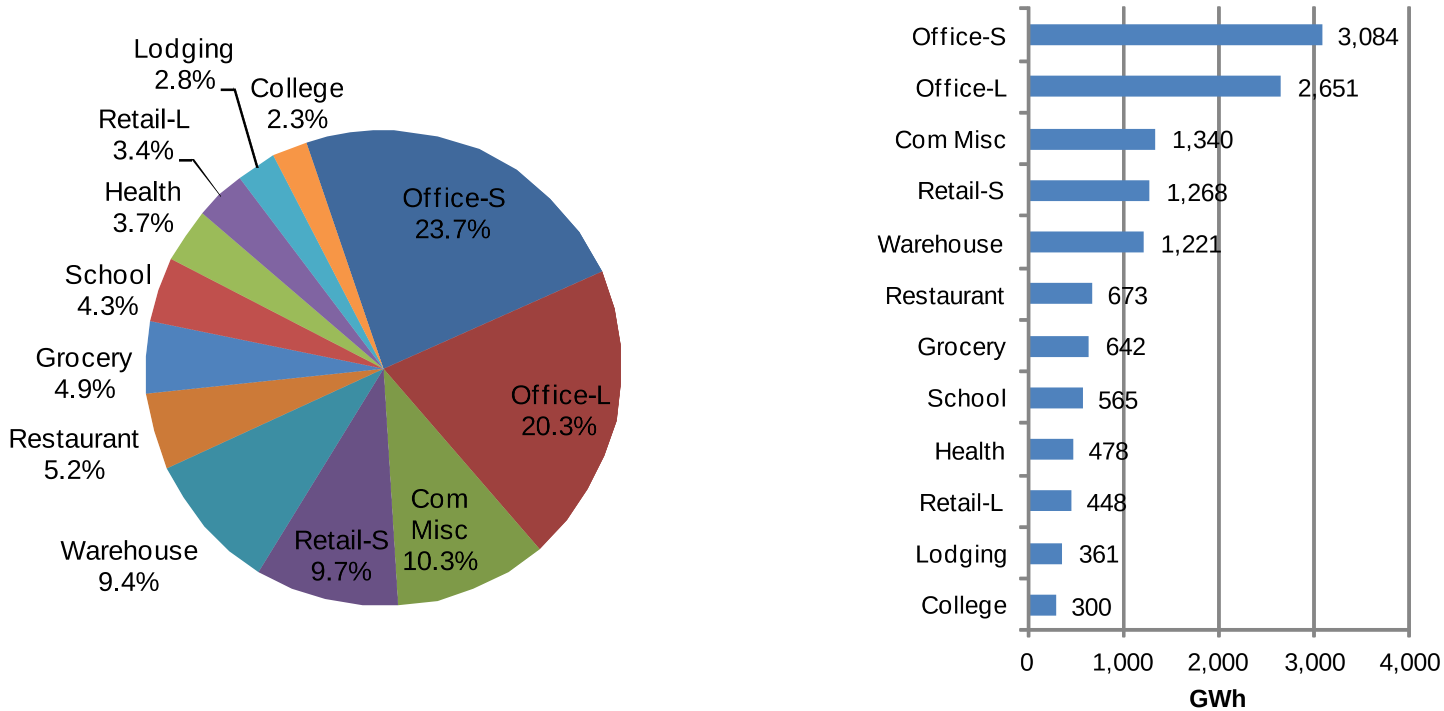
Source: KEMA analysis, calibrated to overall energy use by building type from the analysis of Xcel Energy's billing data

Figure 4-4
Commercial Energy Use by End-Use



Source: KEMA analysis, calibrated to total commercial energy use

Figure 4-5
Commercial Energy Use by Building Type



Source: Xcel Energy Minnesota billing analysis

Table 4-11
Commercial Peak Demand by Building Type and End Use (MW)

Peak demand estimates MW	Office-S	Office-L	Restau-rant	Retail-S	Retail-L	Grocery	Ware-house	School	College	Health	Lodging	Other	Total
Base Fluorescent Fixture, 4L4'T8	178.3	117.4	1.4	30.8	7.0	28.2	58.0	15.6	7.7	11.1	0.2	19.1	474.7
Base Fluorescent Fixture, 2L4'T8, 1 EB	3.0	0.7	7.6	6.1	0.1	0.1	0.4	1.0	7.2	1.4	0.7	14.2	42.4
Base Other Fluorescent Fixture	6.4	0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.4	0.0	0.2	7.7
Base High-Efficiency Incandescent Flood, 53W to Screw-in Replacement	10.7	1.1	1.6	9.0	0.2	0.0	0.0	0.0	4.3	0.1	0.4	1.7	29.3
Base High-Efficiency Incandescent Flood, 53W to Hardwired Replacement	5.1	0.0	5.9	1.9	0.0	0.1	0.7	0.0	1.6	1.2	1.6	19.8	37.8
Base CFL	1.4	5.0	0.2	1.4	0.0	0.1	0.0	0.7	0.8	0.3	2.7	1.6	14.0
Base High Bay Metal Halide, 400W	0.0	0.3	0.0	0.0	4.8	1.9	1.3	1.2	0.1	0.0	0.3	3.1	13.0
Base Parking Garage Metal Halide, 175 W	0.0	27.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	27.7
Base Parking Garage Fluorescent	0.5	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.3	3.2
Base Exit Sign	0.4	0.3	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	1.9
Base Outdoor High Pressure Sodium 250W Lamp	1.2	0.1	4.3	4.6	1.2	0.3	1.0	2.6	0.0	0.1	0.1	4.7	20.2
Base Street Lighting High Pressure Sodium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	9.1
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.0	110.6	0.0	12.5	0.0	11.5	0.3	12.9	6.1	13.5	9.4	10.1	186.9
Base DX Packaged System, EER=10.3, 10 tons	226.6	51.0	57.8	137.2	39.8	25.9	54.1	42.3	20.8	48.7	7.8	75.3	787.4
Base PTAC, EER=8.3, 1 ton	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	11.8	23.3	35.5
Base Fan Motor, 5hp, 1800rpm, 87.5%	42.5	46.3	10.1	45.5	12.7	4.5	13.2	2.5	4.7	1.5	12.5	11.8	207.8
Base Fan Motor, 15hp, 1800rpm, 91.0%	6.8	18.4	0.0	1.5	0.0	0.0	0.0	6.3	3.7	4.7	0.0	8.7	50.1
Base Fan Motor, 40hp, 1800rpm, 93.0%	4.2	31.5	0.0	1.4	0.0	4.0	4.0	2.6	3.6	4.9	2.0	6.8	65.1
Base Built-Up Refrigeration System	0.4	0.1	7.0	0.7	0.8	7.7	29.1	0.3	0.0	0.0	0.1	0.0	46.3
Base Self-Contained Refrigeration	0.1	0.0	4.8	3.2	14.7	10.7	0.0	1.2	0.0	0.0	0.6	0.0	35.3
Base Desktop PC	31.5	29.6	0.9	1.0	0.4	0.3	9.5	1.7	0.4	2.4	0.3	2.1	80.0
Base Monitor, CRT	0.1	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.1	0.0	0.0	0.9
Base Monitor, LCD	12.2	5.9	0.3	0.5	0.1	0.1	2.8	0.5	0.1	0.7	0.1	0.6	23.8
Base Copier	0.9	0.8	0.1	0.2	0.0	0.1	1.0	0.0	0.0	0.2	0.0	0.2	3.7

Table 4-11
Commercial Peak Demand by Building Type and End Use (MW)

Peak demand estimates MW	Office-S	Office-L	Restau-rant	Retail-S	Retail-L	Grocery	Ware-house	School	College	Health	Lodging	Other	Total
Base Laser Printer	3.7	0.4	0.0	0.2	0.1	0.0	1.3	0.1	0.0	0.3	0.1	0.3	6.4
Base Data Center/Server Room	21.5	2.7	0.2	1.2	0.6	1.4	0.3	0.1	0.3	0.9	0.3	0.0	29.4
Base Water Heating	5.5	3.0	1.2	1.8	0.0	0.1	2.0	0.2	0.0	0.0	0.0	3.0	16.8
Base Vending Machines	1.6	1.3	0.1	2.4	0.8	0.8	3.8	0.8	0.2	0.2	0.2	0.8	13.1
Base Cooking	0.1	0.8	26.2	0.5	1.2	6.1	0.0	1.1	0.6	0.5	2.3	0.5	39.7
Base Heating	0.0	5.1	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.7	0.3	6.2
Base Miscellaneous	28.2	13.5	5.0	18.7	4.8	3.4	24.7	2.1	2.7	9.4	8.4	32.2	153.1
Total	592.7	475.0	134.7	282.7	89.6	107.2	208.3	96.1	65.9	102.7	62.6	251.0	2,468.5

Source: KEMA analysis, calibrated to overall Xcel Energy peak demand

4.4 Industrial

We broke out the share of energy use by industry and end use using the results of the industrial on-site surveys. Due to the small sample size at the industry level, these were calculated based on a breakdown of industries into assembly and process industries. These results were used to calibrate industry-level estimates from the Department of Energy's Manufacturing End Use Consumption Survey (MECS). The results of this analysis are shown in Table 4-12.

We applied these breakout percents to energy use by industry from the billing analysis to obtain energy use by end-use and industry, shown in Table 4-13. Industrial energy use by end-use and by industry are shown in Figure 4-6 and Figure 4-7, respectively.

Table 4-12
Percent of Industrial Energy Use by Industry and End-Use

	Compressed Air	Fans	Pumps	Drives	Process Heating	Process Cooling	Other Process	Chiller	DX	Lighting	Other	Total
Food	7%	26%	8%	18%	8%	20%	1%	0%	2%	5%	5%	100%
Textiles	10%	9%	7%	30%	11%	10%	2%	0%	5%	14%	2%	100%
Wood	4%	23%	5%	43%	8%	1%	1%	0%	1%	5%	9%	100%
Paper	3%	36%	11%	32%	10%	1%	2%	0%	1%	2%	2%	100%
Printing	11%	10%	7%	33%	4%	5%	1%	0%	7%	16%	6%	100%
Chemicals	8%	9%	21%	21%	10%	7%	15%	0%	2%	5%	2%	100%
Petroleum	12%	25%	30%	18%	6%	5%	1%	0%	1%	2%	2%	100%
Plastics	10%	9%	7%	31%	16%	7%	2%	0%	4%	11%	3%	100%
Stone, Clay, Glass	4%	36%	8%	21%	18%	2%	3%	0%	1%	3%	3%	100%
Prim Metals	9%	10%	7%	10%	27%	1%	31%	0%	1%	4%	1%	100%
Fab Metals	29%	8%	6%	18%	17%	2%	4%	0%	3%	10%	2%	100%
Ind Mach	36%	6%	5%	15%	6%	2%	2%	0%	6%	16%	4%	100%
Electronics	28%	4%	3%	8%	15%	7%	8%	0%	8%	14%	6%	100%
Transp Equip	32%	7%	5%	10%	13%	5%	3%	0%	6%	16%	4%	100%
Misc.	15%	10%	9%	42%	9%	6%	0%	0%	4%	5%	0%	100%
WWTP	0%	41%	57%	0%	1%	0%	0%	0%	0%	1%	0%	100%

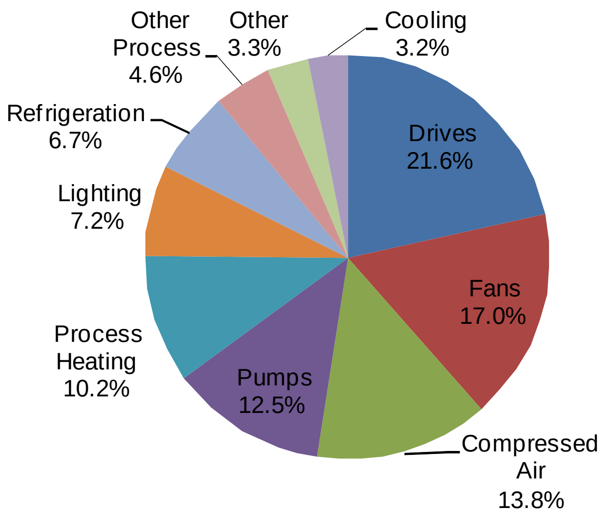
Source: Billing data analysis, on-site survey results, and Department of Energy's Manufacturer Energy Consumption Survey data

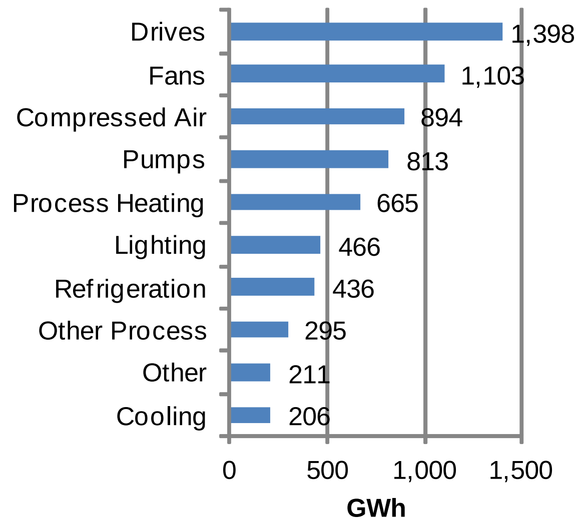
Table 4-13
Industrial Energy Use by Industry and End-Use

	Compressed Air	Fans	Pumps	Drives	Process Heating	Process Cooling	Other Process	Chiller	DX	Lighting	Other	Total
Food	67,745	251,375	78,786	173,443	81,719	199,069	11,319	0	19,448	49,216	52,705	984,825
Textiles	2,808	2,512	1,863	8,058	2,846	2,620	421	77	1,248	3,663	659	26,774
Wood	5,886	37,770	8,822	72,704	13,457	1,502	1,328	0	2,231	8,200	15,544	167,443
Paper	10,251	141,122	41,830	125,922	37,229	3,892	7,542	0	3,192	8,433	9,062	388,477
Printing	41,816	37,403	27,183	123,597	14,240	19,119	3,129	1,536	24,834	61,047	22,366	376,269
Chemicals	45,423	54,447	122,443	123,598	56,245	39,989	90,266	746	12,069	28,636	12,553	586,416
Petroleum	131,636	267,768	317,949	194,258	60,126	49,902	7,584	0	9,836	18,669	16,732	1,074,461
Plastics	46,004	41,148	29,905	135,975	71,038	33,051	7,802	999	16,156	49,108	13,676	444,860
Stone, Clay, Glass	10,139	80,781	18,265	47,460	41,801	3,973	7,225	0	2,759	6,606	7,230	226,240
Prim Metals	28,003	31,097	21,879	31,364	85,312	2,243	97,210	210	3,389	13,231	2,848	316,786
Fab Metals	88,688	23,343	16,965	54,315	50,790	7,400	12,585	533	8,628	30,794	6,743	300,784
Ind Mach	185,506	31,740	23,067	78,194	30,636	10,174	11,296	2,040	32,993	82,182	21,933	509,760
Electronics	124,115	17,772	12,916	34,924	63,793	29,894	33,646	2,082	33,664	62,426	24,287	439,520
Transp Equip	41,774	8,838	6,423	13,335	16,762	5,969	4,047	462	7,474	21,736	4,953	131,773
Misc.	64,398	42,352	37,238	181,335	38,197	26,617	0	474	18,535	21,876	0	431,022
WWTP	160	33,864	47,045	0	416	99	0	18	134	463	0	82,200
Total	894,352	1,103,331	812,579	1,398,481	664,607	435,512	295,399	9,177	196,591	466,288	211,293	6,487,611

Source: KEMA analysis, calibrated to Xcel Energy total industrial energy use by building type from billing analysis

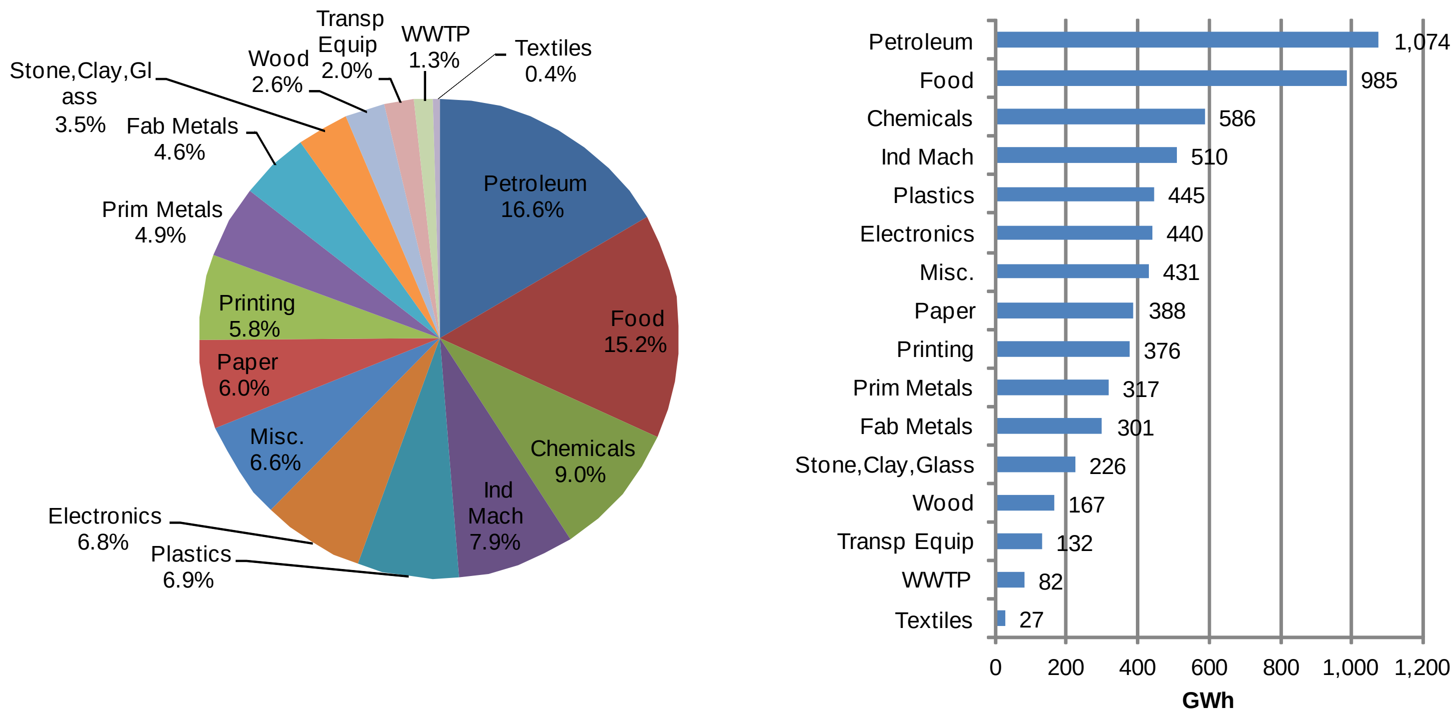
Figure 4-6
Industrial Energy Use by End-Use





Source: On-site survey results and Department of Energy's Manufacturer Energy Consumption Survey data

Figure 4-7
Industrial Energy Use by Industry



Source: Xcel Energy Minnesota billing analysis

Table 4-14
Industrial Peak Demand by Industry and End-Use (MW)

	Compressed Air	Fans	Pumps	Drives	Process Heating	Process Cooling	Other Process	Chiller	DX	Lighting	Other	Total
Food	8.0	29.6	9.3	20.4	9.6	23.5	1.3	0.0	2.3	5.8	6.2	116.1
Textiles	1.1	1.0	0.8	3.2	1.1	1.1	0.2	0.0	0.5	1.5	0.3	10.8
Lumber	0.9	5.5	1.3	10.6	2.0	0.2	0.2	0.0	0.3	1.2	2.3	24.3
Paper	0.8	11.0	3.3	9.8	2.9	0.3	0.6	0.0	0.2	0.7	0.7	30.3
Printing	5.4	4.8	3.5	15.8	1.8	2.4	0.4	0.2	3.2	7.8	2.9	48.2
Chemicals	5.0	6.1	13.6	13.7	6.3	4.4	10.0	0.1	1.3	3.2	1.4	65.2
Petroleum	14.6	29.8	35.3	21.6	6.7	5.5	0.8	0.0	1.1	2.1	1.9	119.4
Plastics	6.2	5.5	4.0	18.3	9.6	4.4	1.1	0.1	2.2	6.6	1.8	59.9
Stone-clay-glass	1.1	8.8	2.0	5.2	4.6	0.4	0.8	0.0	0.3	0.7	0.8	24.7
Primary Metals	3.9	4.3	3.0	4.4	11.9	0.3	13.5	0.0	0.5	1.8	0.4	44.1
Fab Metals	12.0	3.2	2.3	7.3	6.9	1.0	1.7	0.1	1.2	4.2	0.9	40.6
Ind Machinery	40.1	6.9	5.0	16.9	6.6	2.2	2.4	0.4	7.1	17.8	4.7	110.2
Electronics	15.4	2.2	1.6	4.3	7.9	3.7	4.2	0.3	4.2	7.7	3.0	54.5
Transp Equip	5.6	1.2	0.9	1.8	2.2	0.8	0.5	0.1	1.0	2.9	0.7	17.7
Misc	7.1	4.7	4.1	19.9	4.2	2.9	0.0	0.1	2.0	2.4	0.0	47.4
WWT	0.0	3.7	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	9.0
Total	127.2	128.2	95.1	173.4	84.3	53.3	37.8	1.4	27.5	66.4	27.9	822.5

Source: KEMA analysis, calibrated to overall Xcel Energy peak demand

4.5 Opt-Out Analysis

The analysis above was the basis for the potential analysis presented in this report. Xcel Energy requested that KEMA also look at the potential impacts of additional customers opting out of Minnesota's Resource Adjustment Rider under the Omnibus Energy Policy bill. The bill exempts customers with electric demand over 20 MW or gas use over 500,000 Dth. These customers can elect to opt out of the rider and in doing so would be ineligible for any Xcel Energy energy efficiency or demand response programs.

The analysis above already excludes existing opt-out customers; however, Xcel Energy was concerned about the impact of potential additional customers opting out. KEMA reanalyzed the billing data, omitting customers identified by Xcel Energy as being exempt, or possibly exempt, from the rider. The result was a change in the building stock for the industrial sector, but no change to saturations or EUIs. This section presents the results of that analysis.

Table 4-15 compares the results of the nonresidential billing analysis for all nonresidential customers, nonresidential customers minus the current opt outs, and finally nonresidential customers minus existing and potential new opt outs.

Table 4-15
Results of Nonresidential Billing Analysis with and without Likely Opt-Outs

		All Customers		Minus existing Opt-outs		Minus existing and potential opt-outs	
Sector	Business Type	Accounts	kWh	Accounts	kWh	Accounts	kWh
AG	Agriculture	2,278	121,456,178	2,278	121,456,178	2,278	121,456,178
COM	College	733	299,663,809	733	299,663,809	733	299,663,809
COM	Com misc	8,543	1,199,180,803	8,543	1,199,180,803	8,543	1,199,180,803
COM	Grocery	1,859	642,391,389	1,859	642,391,389	1,859	642,391,389
COM	Health	701	477,545,281	701	477,545,281	701	477,545,281
COM	Lodging	898	361,098,555	898	361,098,555	898	361,098,555
COM	Office-L	271	2,650,863,075	271	2,650,863,075	271	2,650,863,075
COM	Office-S	47,250	3,083,647,936	47,250	3,083,647,936	47,250	3,083,647,936
COM	Restaurant	4,715	672,974,975	4,715	672,974,975	4,715	672,974,975
COM	Retail-L	91	447,797,056	91	447,797,056	91	447,797,056
COM	Retail-S	14,273	1,268,454,809	14,273	1,268,454,809	14,273	1,268,454,809
COM	School	1,377	564,845,806	1,377	564,845,806	1,377	564,845,806
COM	Warehouse	6,642	1,221,408,759	6,642	1,221,408,759	6,642	1,221,408,759
CST	Construction	5,937	299,645,047	5,937	299,645,047	5,937	299,645,047
IND	Chemicals	305	586,415,802	305	586,415,802	293	523,660,664
IND	Electronics	481	439,520,166	481	439,520,166	481	439,520,166
IND	Fabricated metals	648	300,783,758	648	300,783,758	648	300,783,758
IND	Food	485	984,825,485	485	984,825,485	485	984,825,485
IND	Ind machinery	1,198	509,760,023	1,198	509,760,023	1,198	509,760,023
IND	Ind misc	948	431,021,652	948	431,021,652	948	431,021,652
IND	Paper	175	399,082,548	168	388,476,763	168	388,476,763
IND	Petroleum	55	1,079,088,762	41	1,074,460,742	40	37,104,895
IND	Plastics	378	444,860,498	378	444,860,498	378	444,860,498
IND	Primary metals	184	563,765,842	173	316,786,010	173	316,786,010
IND	Printing	940	376,268,923	940	376,268,923	940	376,268,923
IND	Stone-clay-glass	260	226,240,094	260	226,240,094	260	226,240,094
IND	Textiles	223	26,774,298	223	26,774,298	223	26,774,298
IND	Transp equip	216	131,773,344	216	131,773,344	216	131,773,344
IND	Wood	442	167,442,509	442	167,442,509	442	167,442,509
MIN	Mining	127	56,024,350	127	56,024,350	127	56,024,350
TCU	TCU	6,010	744,868,411	6,010	744,868,411	6,010	744,868,411
TCU	Water-WWT	120	82,200,449	120	82,200,449	120	82,200,449
UNC	Unclassified	12,610	586,111,213	12,610	586,111,213	12,610	586,111,213
	Total	**121,373**	**21,447,801,605**	**121,341**	**21,185,587,968**	**121,328**	**20,085,476,983**

The potential opt-outs are all industrial customers in the chemical and petroleum industries, so only those building types show a change from the current opt-out scenario to the current and potential opt-out scenario. Figure 4-8 and Figure 4-8 and compare industrial energy use with just the current opt-outs and with both the current and potential new opt-outs. The petroleum industry is dramatically affected, while the chemical industry has a much smaller change.

Figure 4-8
Comparison of Industrial Energy Use before and After Likely Opt-Outs

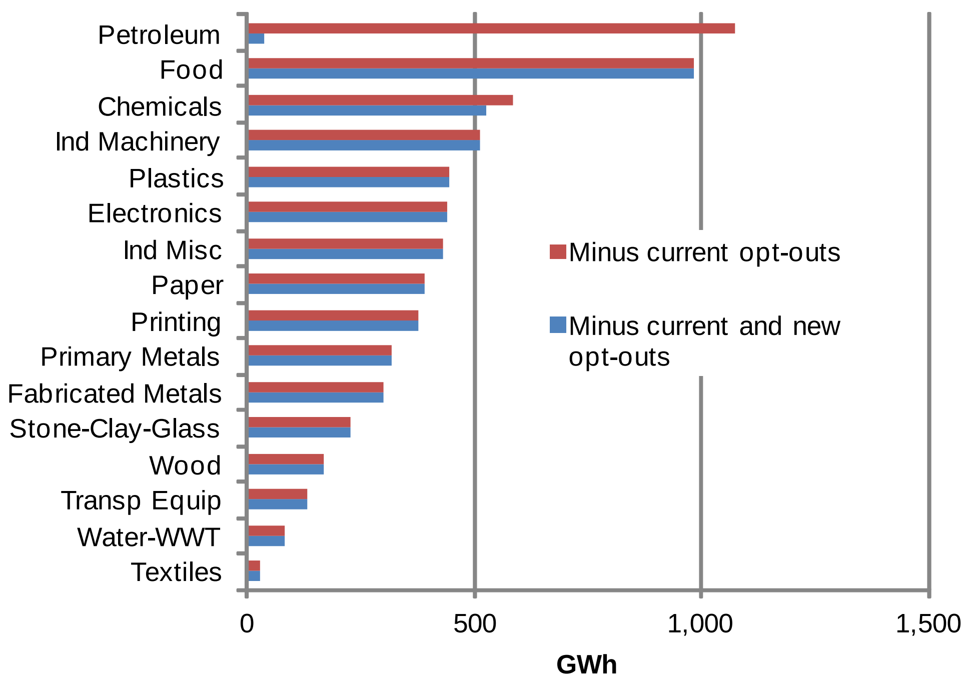
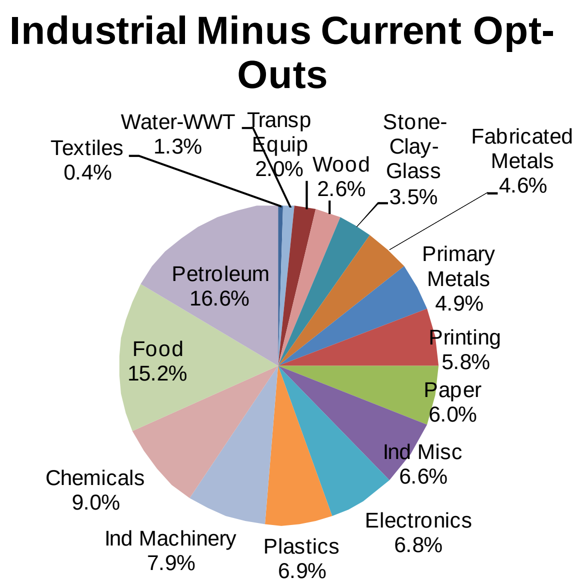


Figure 4-9

Industrial Energy Use by Industry with and without Likely Additional Opt-Out Customers



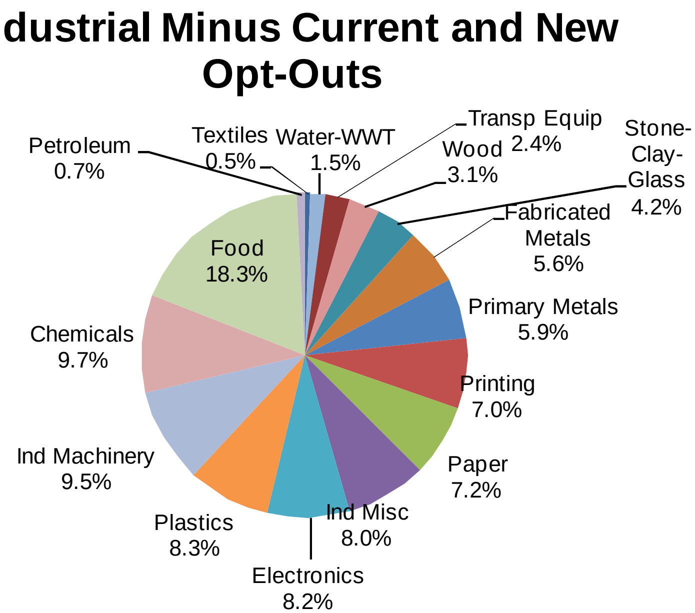


Table 4-16 shows the new building stock for the industrial sector after the potential additional opt outs.

Table 4-16
Industrial Building Stock for Opt-Out Analysis

	Base Energy Use (kWh)
Food	912,252,445
Textiles	26,557,686
Wood	167,015,964
Paper	389,462,178
Printing	375,279,206
Chemicals	193,497,871
Petroleum	36,576,787
Plastics	439,621,890
Stone,Clay,Glass	144,886,780
Prim Metals	475,417,489
Fab Metals	295,426,049
Ind Mach	507,483,821
Electronics	438,973,482
Transp Equip	76,300,383
Misc.	420,602,887
WWTP	82,195,101
Total	4,981,550,019

5. Electric Energy-Efficiency Potential Results

In this section, we present estimates of electric energy-efficiency potential. First, we present technical and economic potential results for all electric measures considered in the study. Next, we present estimates of achievable program potential under different program funding scenarios. The base energy-efficiency results exclude impacts from behavioral-conservation programs and from emerging technologies. These additional elements are discussed separately, since these measures do not have the track record of more proven energy-efficiency technologies, and their impacts are more uncertain.

5.1 Technical and Economic Potential

Estimates of overall energy-efficiency *technical* and *economic* potential are discussed in section 5.1.1. More detail on these potentials is presented in section 5.1.2. Energy-efficiency supply curves are shown in section 5.1.3.

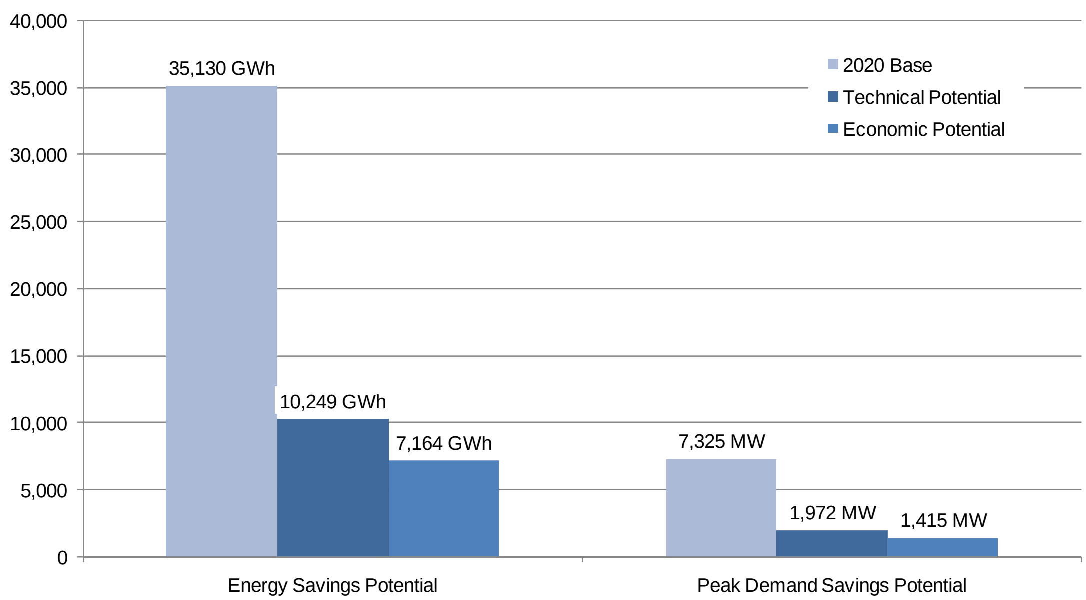
5.1.1 Overall Technical and Economic Potential

Figure 5-1 presents our overall estimates of total technical and economic potential for electrical energy and peak-demand savings for the Xcel Energy Minnesota service territory. *Technical potential* represents the sum of all savings from all of the measures deemed applicable and technically feasible. *Economic potential* is based on efficiency measures that are cost-effective, which is based on the total resource cost (TRC) test—a benefit-cost test that compares the value of avoided energy production and power-plant construction to the costs of energy-efficiency measures and program activities necessary to deliver them. The values of both energy savings and peak-demand reductions are incorporated in the TRC test.

Energy Savings. Technical potential is estimated at about 10,249 GWh per year, and economic potential at 7,164 GWh per year by 2020 (about 29 and 20 percent of base 2020 usage, respectively).

Peak-Demand Savings. Technical potential is estimated at about 1,972 MW, and economic potential at 1,415 MW by 2020 (about 27 and 19 percent of base 2020 demand, respectively).

Figure 5-1
Estimated Electric Technical and Economic Potential, 2020
Xcel Energy Minnesota Service Territory



5.1.2 Technical and Economic Potential Detail

In this subsection, we explore technical and economic potential in more detail, looking at potentials by sector and by end use.

5.1.2.1 Potentials by Sector

Figure 5-2 and Figure 5-3 show estimates of technical- and economic-energy and demand savings potential by sector. Figure 5-4 and Figure 5-5 show the same potentials as a percentage of 2020 base energy and base peak demand.

The commercial sector provides the largest contribution to both technical and economic potential for energy savings, accounting for just under 50 percent of these potentials. The residential sector contributes the most to the technical and economic potential for peak-demand savings, accounting for over 55 percent of these potentials. While the industrial sector contributes low amounts to the potentials, we note that industrial facilities typically contain complex custom measures that are difficult to completely capture in a bottom-up study such as this one, and this effect could lead to an understatement of industrial potentials.

Figure 5-2
Technical and Economic Potential (2020)
Energy Savings by Sector—GWh per Year

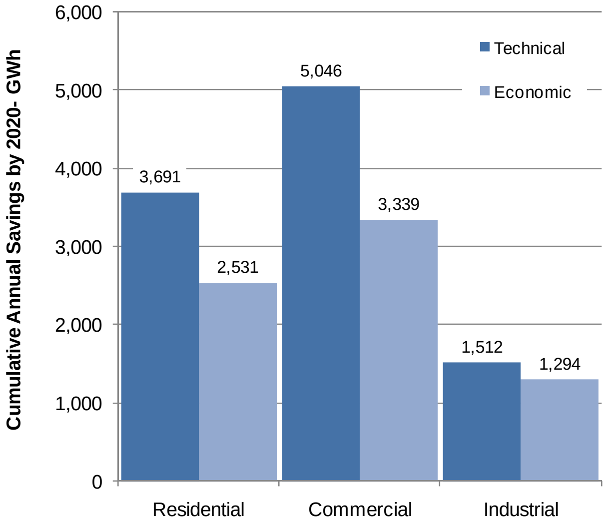
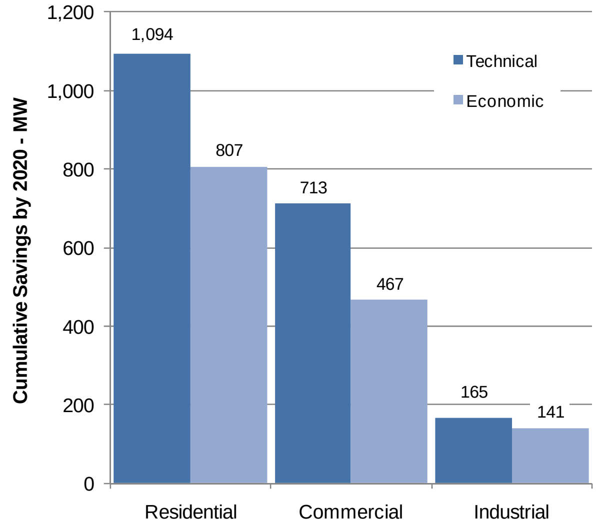


Figure 5-3
Technical and Economic Potential (2020)
Demand Savings by Sector—MW



As shown in Figure 5-4 and Figure 5-5, the residential and commercial sectors have a similar savings potential in relation to base energy use. The estimated savings fraction is lowest for the industrial sector, but this potential is in the range of the 14 to 22 percent of cost-effective industrial savings estimated by the National Academy of Sciences[3].

[3] *Real Prospects for Energy Efficiency in the United States*, America's Energy Future Energy Efficiency Subcommittee, Nation Academy of Sciences, National Academy of Engineering, National Research Council, 2009.

Figure 5-4
Technical and Economic Potential (2020)
Percentage of Base Energy Use

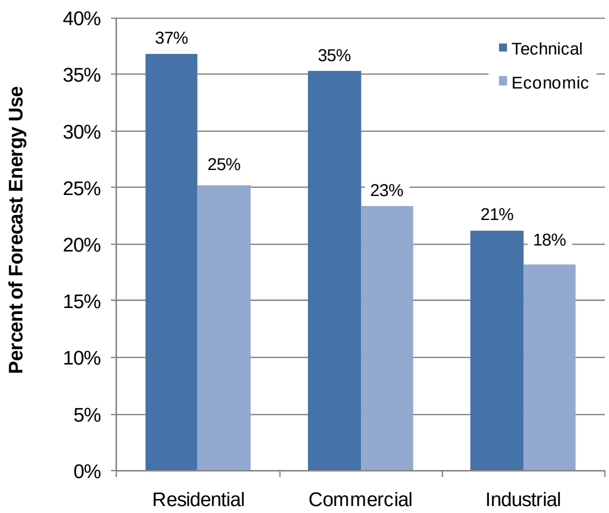
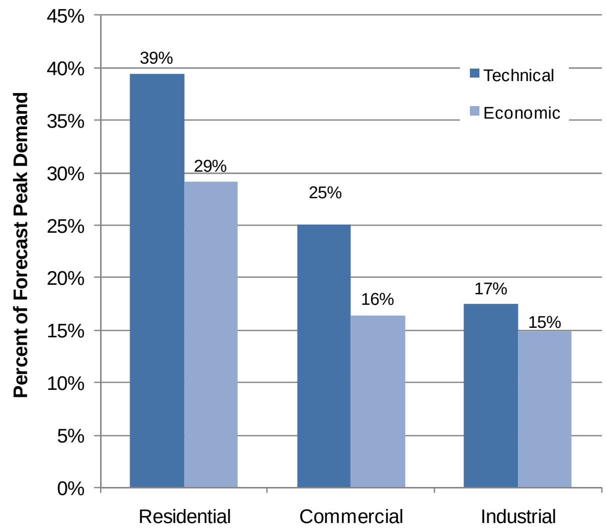


Figure 5-5
Technical and Economic Potential (2020)
Percentage of Base Peak Demand



5.1.2.2 Potentials by Building Type

Figure 5-6 and Figure 5-7 show the potentials in the residential sector by building type. Single-family homes account for about 84 percent of the economic potential, and low-income homes account for about 5 percent of the potential.

Figure 5-6
Residential Energy-Savings Potential by Building Type (2020)

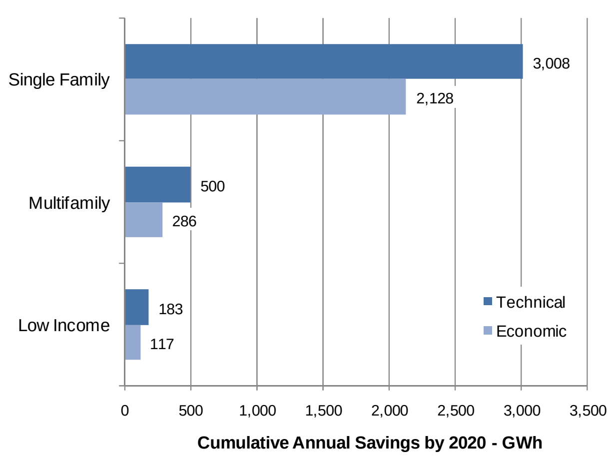


Figure 5-7
Residential Demand-Savings Potential by Building Type (2020)

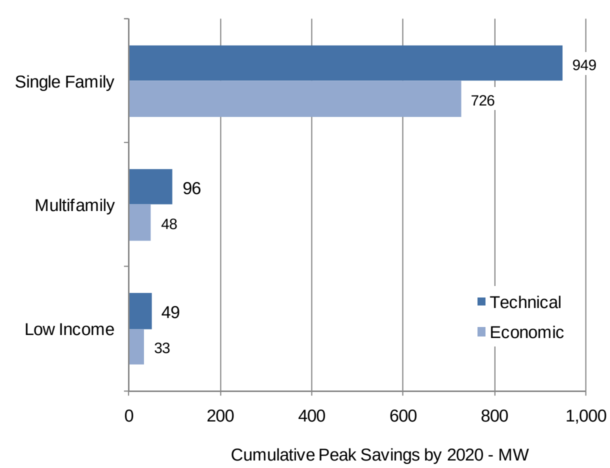


Figure 5-8 and Figure 5-9 show the building-type breakdown of commercial potential. Offices account for almost 60 percent of the economic energy savings potential, with small offices (office accounts under 3 GWh per year consumption) accounting for over 30 percent of total potential. The retail and restaurant segments account for the next largest shares of potential.

Figure 5-8
Commercial Economic Energy-Savings Potential by Building Type (2014)

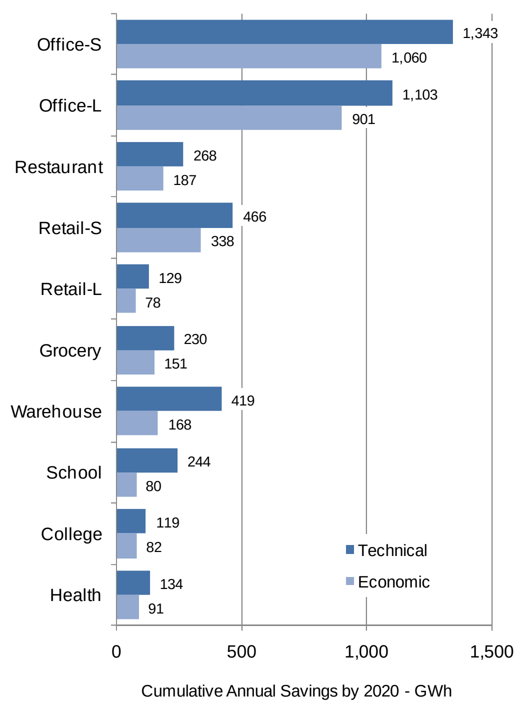


Figure 5-9
Commercial Economic Demand-Savings Potential by Building Type (2014)

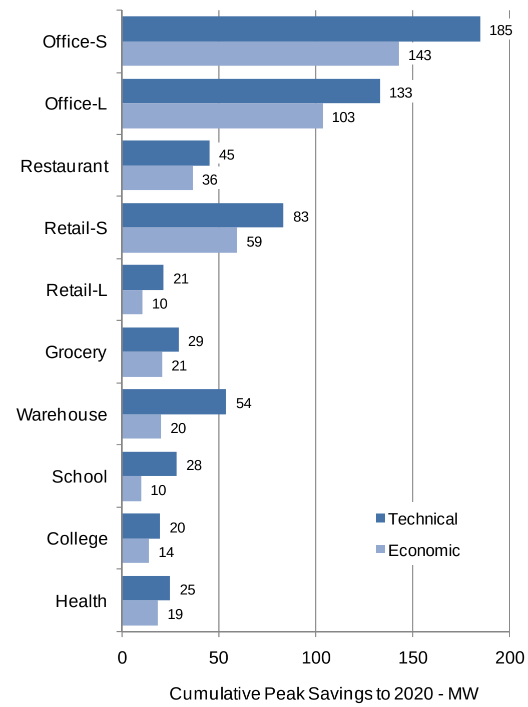


Figure 5-10 and Figure 5-11 show the business-type breakdown of industrial potential. Key industries in terms of economic potential include food processing and petroleum refining, plastics, chemicals, industrial machinery, and electronics.

Figure 5-10
Industrial Economic Energy-Savings Potential by Business Type (2020)

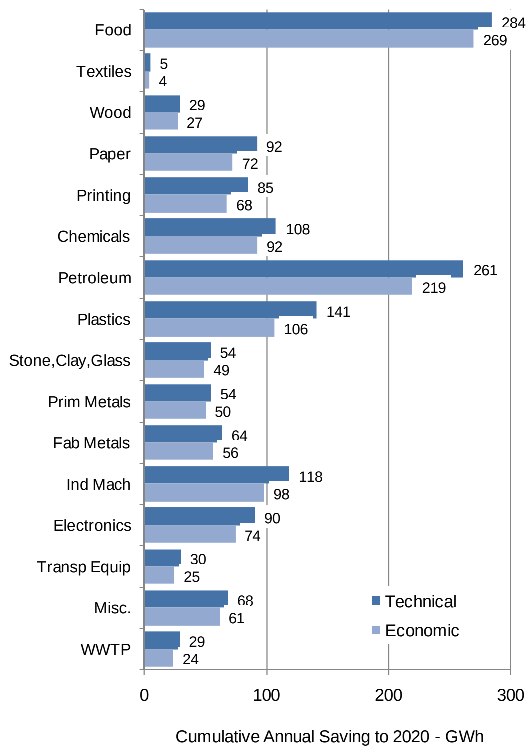
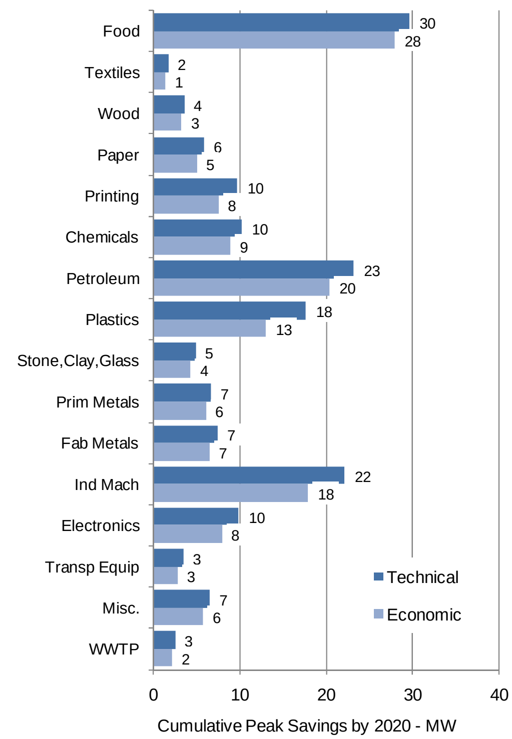


Figure 5-11
Industrial Economic Demand-Savings Potential by Business Type (2020)



5.1.2.3 Potentials by End Use

Figure 5-12 and Figure 5-13 show the end-use breakdown of technical and economic potential in the residential sector. Energy savings potential for existing construction applications is split fairly evenly among the lighting and cooling end uses, followed by refrigeration, furnace fans, and home electronics. Cooling accounts for most of the peak-demand savings potential, since very little lighting is used on warm summer afternoons. Whole-building new construction measures account for significant amounts of both energy and peak-demand potential.

Figure 5-12
Residential Economic Energy-Savings Potential by End Use (2020)

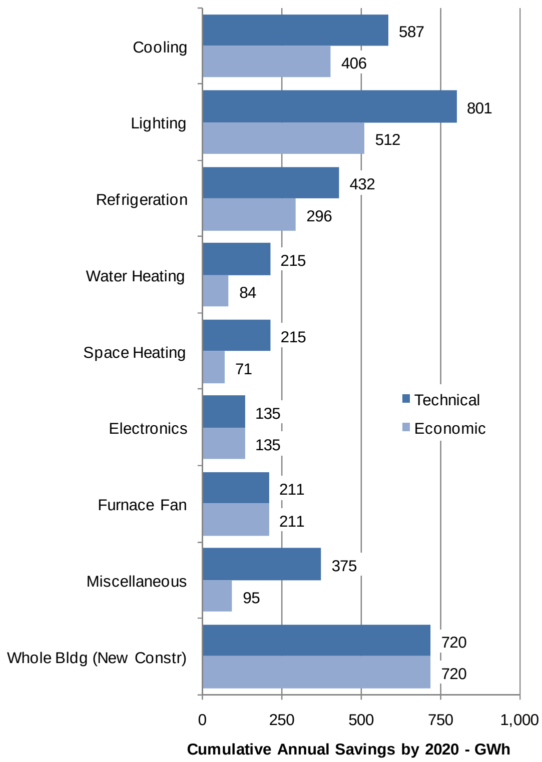


Figure 5-13
Residential Economic Demand-Savings Potential by End Use (2020)

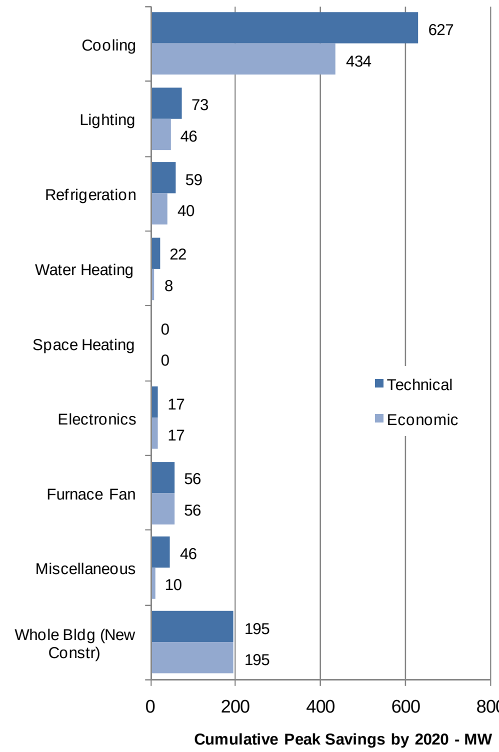


Figure 5-14 and Figure 5-15 show the end-use breakdown of commercial potential. The lighting end use is the largest contributor to both energy savings potential while space cooling accounts for the largest share of demand savings potential. Despite more stringent lighting standards coming into play, we still expect premium T8 lamps with electronic ballasts and CFLs to be key lighting measures. Office equipment (including commercial-sector data centers), ventilation, and new construction measure also provide substantial sources of potential savings.

Figure 5-14
Commercial Economic Energy Savings Potential by End Use (2020)

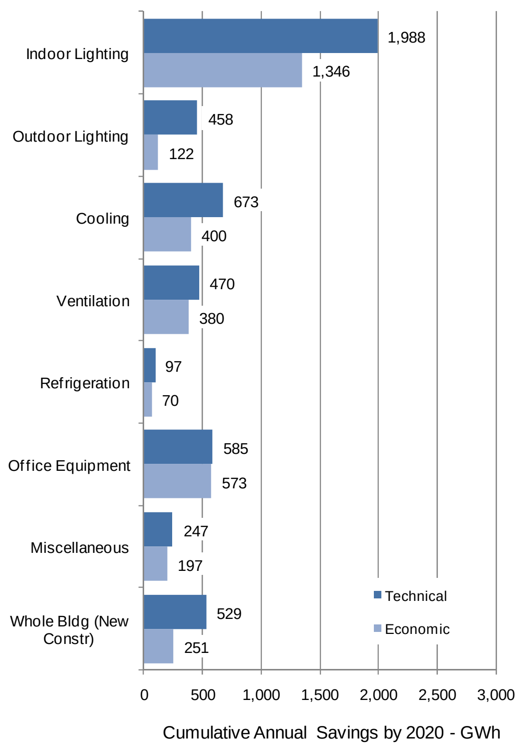


Figure 5-15
Commercial Economic Demand Savings Potential by End Use (2020)

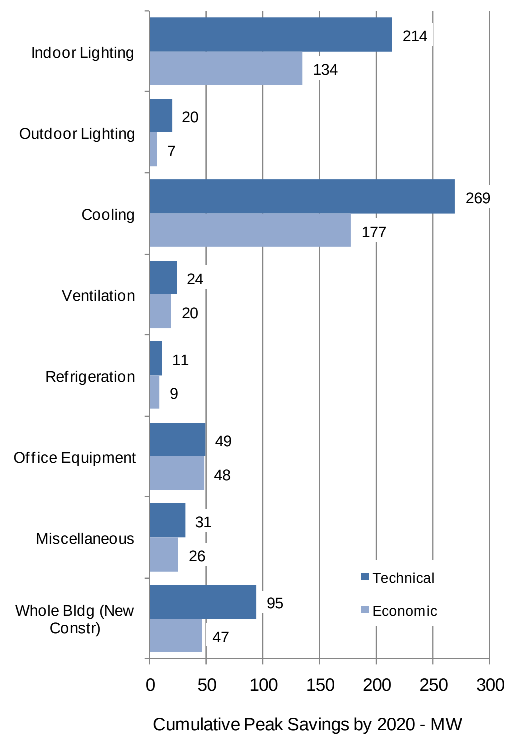


Figure 5-16 and Figure 5-17 show the end-use breakdown of industrial potential. Cross-cutting motor-based end uses (fans, compressed air, and pumps) provide the largest source of economic potential. These are end uses that are fairly common and similar across industries, and the measures directed at them are better understood. Other process end uses (drives, heating, refrigeration, and "other") are more heterogeneous across industries, often involve more complex technologies and systems, and are therefore more difficult to develop bottom-up potentials savings estimates for. It is possible that our analysis may be conservative on the low side for these less-understood measures.

Figure 5-16
Industrial Economic Energy-Savings Potential by End Use (2020)

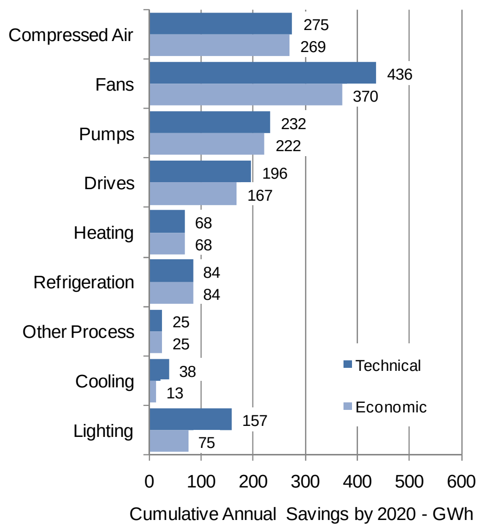
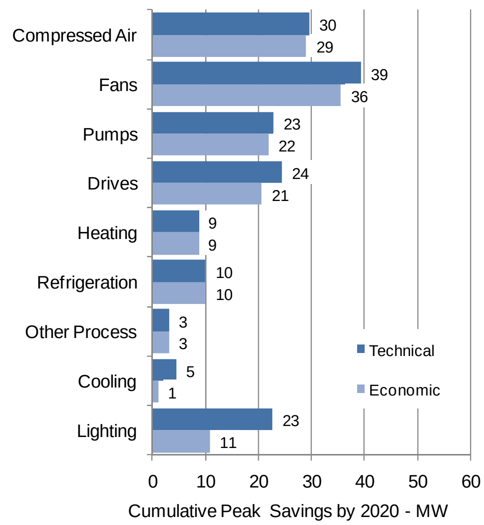


Figure 5-17
Industrial Economic Demand-Savings Potential by End Use (2020)



5.1.3 Avoided Cost Scenarios

We examined two alternative avoided cost scenarios in addition to the base scenario. As indicated above in Section 3, the low avoided cost scenario reflects costs that are about 5 percent below the base avoided costs, while the high avoided cost scenario reflects costs that are about 57 percent above the base avoided costs. Figure 5-18 shows technical potential and economic potential for the three scenarios. (Technical potential does not vary across scenario.) Table 5-1 provides similar information in tabular form. As shown, the economic potentials are not substantially impacted by the avoided cost variations. For the high-avoided cost scenario, energy savings are only 10 percent above the base scenario and demand savings are only 7 percent above the base scenario. The low avoided-cost energy savings are only 4 percent below the base scenario, with demand savings coming in a 5 percent below the base scenario. Given the limited variation in economic potential for the alternative cases, achievable potentials were only estimated for the base avoided cost scenario.

Figure 5-18
Estimated Electric Technical and Economic Potential for Alternative Avoided Cost Scenarios, 2020

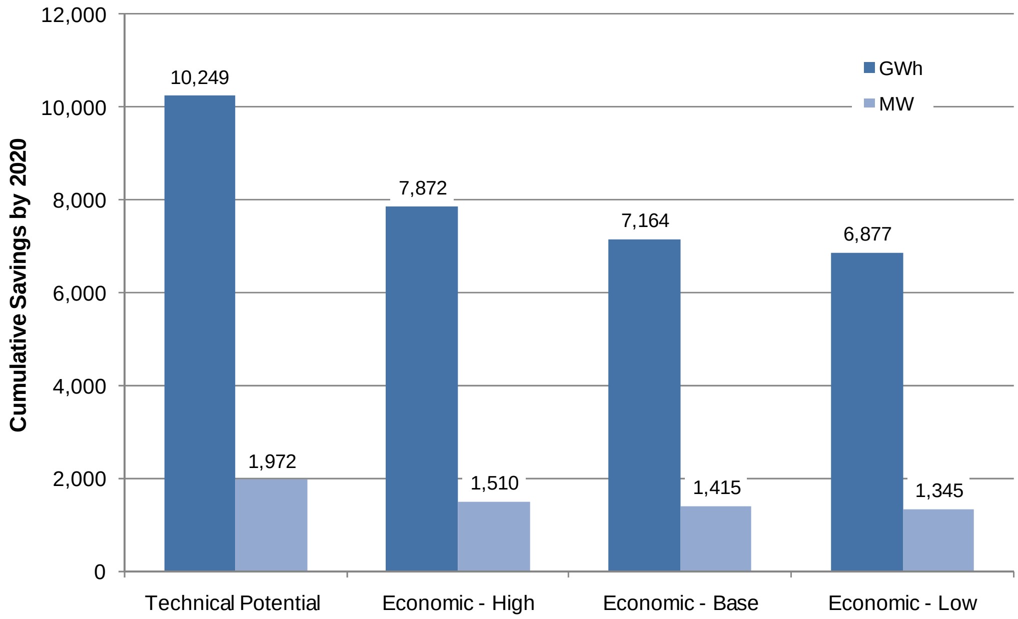


Table 5-1
Comparison of Estimated Electricity Technical and Economic Potential for Alternative Avoided Cost Scenarios, 2020

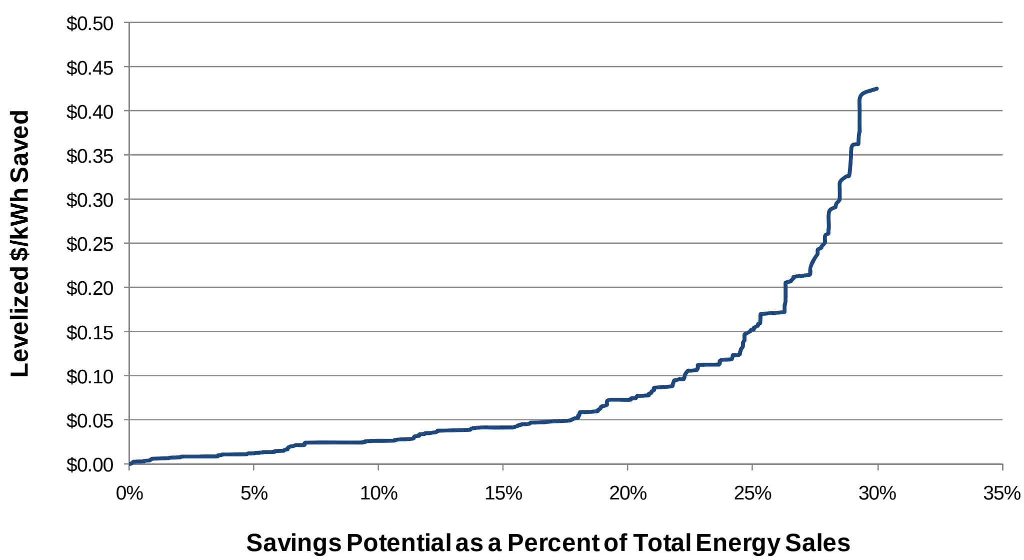
	Base Usage	Technical Potential	Economic - High	Economic - Base	Economic - Low
Energy: GWh	35,130	10,249	7,872	7,164	6,877
% of Base Consumption		29%	22%	20%	20%
% Technical Potential			77%	70%	67%
% of Economic - Base Avoided Cost			110%	100%	96%
Demand: MW	7,325	1,972	1,510	1,415	1,345
% of Base Consumption		27%	21%	19%	18%
% Technical Potential			77%	72%	68%
% of Economic - Base Avoided Cost			107%	100%	95%

5.1.4 Energy-Efficiency Supply Curves

A common way to illustrate the amount of energy savings per dollar spent is to construct an energy-efficiency supply curve. A supply curve typically is depicted on two axes: one captures the cost per unit of saved energy (e.g., levelized $/kWh saved), and the other shows energy savings at each level of cost. Measures are sorted on a least-cost basis, and total savings are calculated incrementally with respect to measures that precede them. The costs of the measures are levelized over the life of the savings achieved.

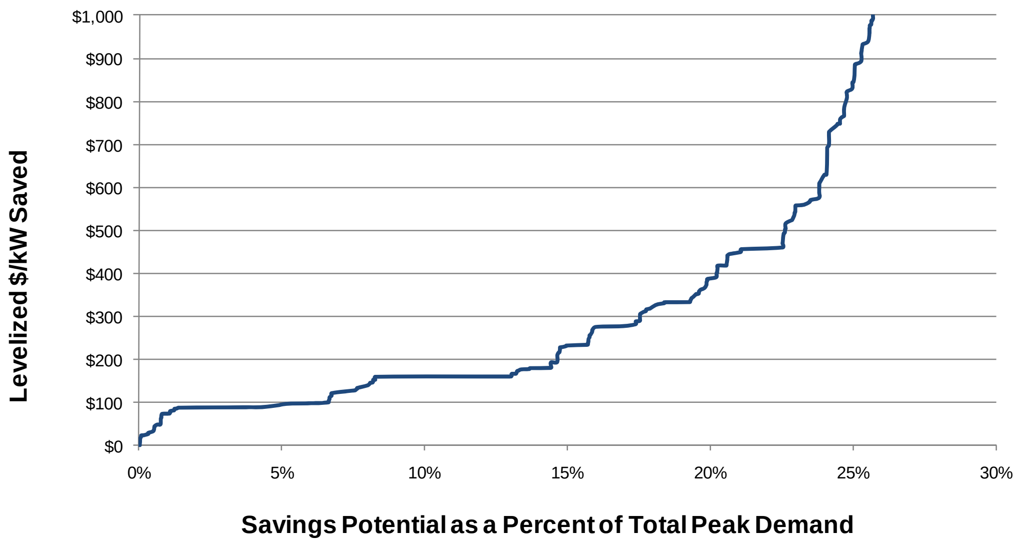
Figure 5-19 and Figure 5-20 present the supply curves constructed for this study for electric energy-efficiency and peak-demand efficiency, respectively. Each curve represents savings as a percentage of total energy or peak demand. These curves show that energy savings of about 18 percent are available at under $0.05 per kWh, and peak demand savings of about 5 percent are available at under $100 per MW. Savings potentials and levelized costs for the individual measures that comprise the supply curves are provided in Appendix G.

Figure 5-19
Electric Energy Supply Curve*



*Levelized cost per kWh saved is calculated using a 7.4 percent nominal discount rate.

Figure 5-20
Peak-Demand Supply Curve*



*Levelized cost per kW saved is calculated using a 7.4 percent nominal discount rate.

5.2 Achievable (Program) Potential

In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect the adoption of efficiency measures. Our method of estimating measure adoption takes into account market barriers and reflects actual consumer- and business-implicit discount rates. This section presents results for achievable program potential, first at the summary level and then by sector. More detail on achievable program potential is shown in Appendix H.

Achievable program potential refers to the amount of savings that would occur in response to one or more specific program interventions. These are savings that are projected beyond those that would occur naturally in the absence of any market intervention. Because achievable potential depends on the type and degree of intervention applied, we developed potential estimates under alternative funding scenarios: Business as Usual (BAU) incentives, 50-percent incentives, 75-percent incentives, and 100-percent incentives. These scenarios reflect the percentage of incremental measure cost that is assumed to be paid in customer incentives. Adjustments to program marketing and administration costs were also made across scenarios. (The low-income market segment was modeled using 100-percent incentives for each scenario, but the level of program effort increased across scenarios in line with increases in other market segments.) We estimated program energy and peak-demand savings under each scenario for the 2011-2020 period.

Figure 5-21 shows our estimates of achievable potential energy savings over time. Peak demand savings follow a similar pattern. Naturally occurring savings is also shown to provide a picture of total market potential. As shown in Figure 5-21, by 2020, cumulative program energy savings are projected to be 3,213 GWh under the BAU scenario, 3,351 under the 50-percent incentive scenario, 3,825 GWh under the 75-percent incentive scenario, and 4,596 GWh under the 100-percent incentive scenario. (Program costs increase substantially as one moves to higher-incentive scenarios as the analysis assumes you need to increase incentives to capture additional potential but also have to pay all other customers the higher incentives as well.)

Figure 5-21
Achievable Electric Energy-Savings: All Sectors

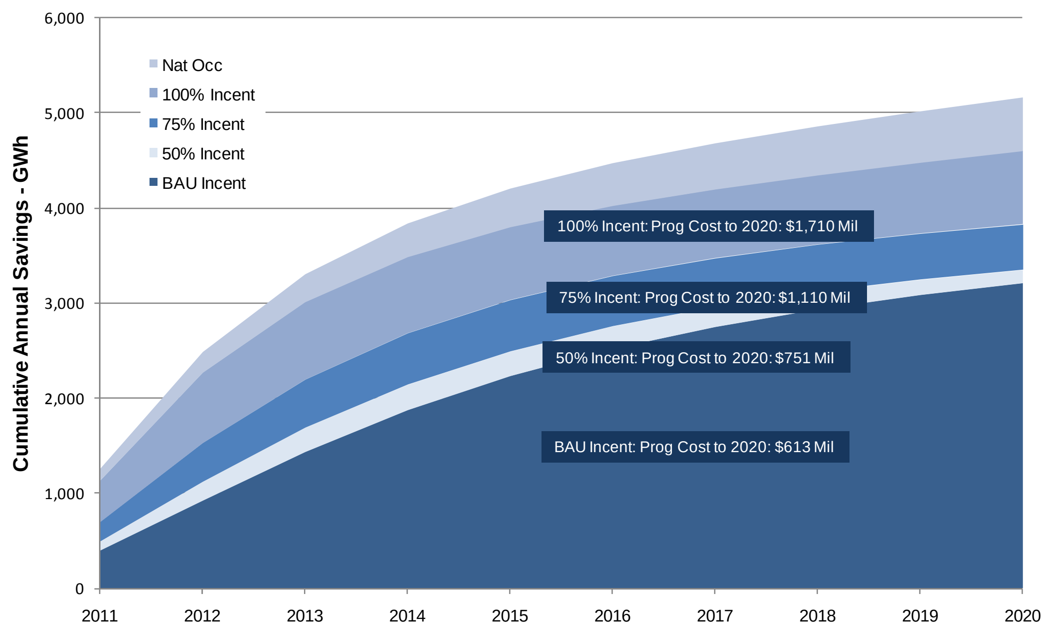
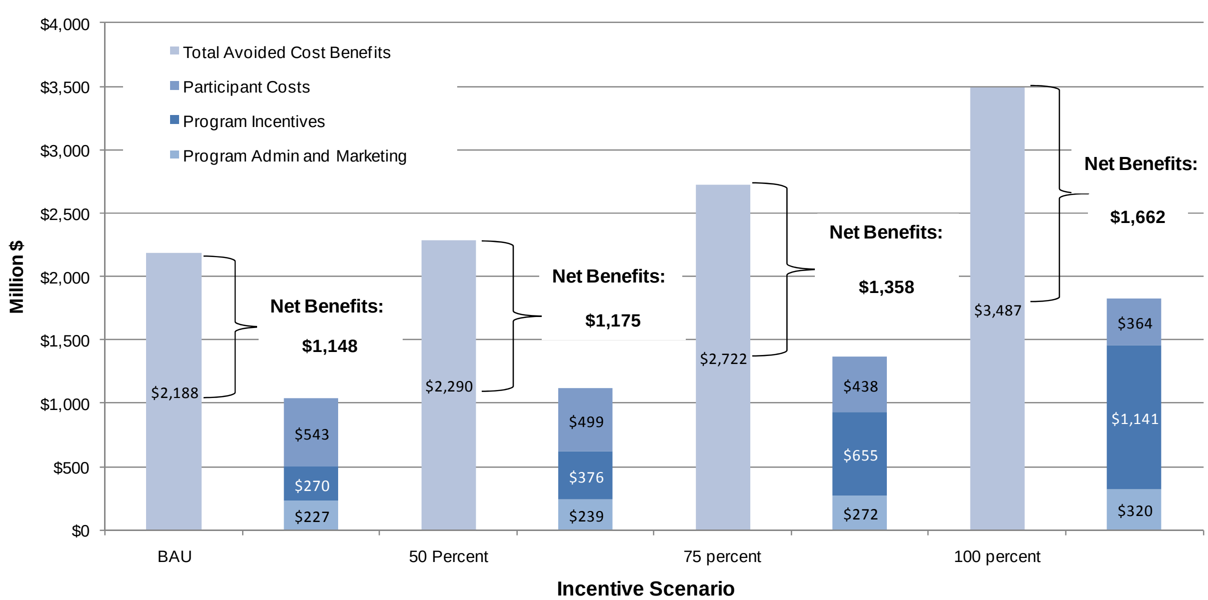


Figure 5-21 also shows that the increase in cumulative savings declines over time. This result occurs because retrofit measures (measures that are not dependent on equipment turnover cycles and can be added at any time) begin reaching high saturations over time, and it becomes more difficult to capture additional savings as the retrofit opportunities diminish. While the decline in additional savings is fairly modest in the BAU scenario, it is more pronounced in the higher incentive cases. For the 100-percent incentives scenario, savings accumulate rapidly during the first few years of the forecast horizon, but then flatten out considerably thereafter. This can be perceived as a boom-bust phenomenon – where a program ramps up dramatically over a few years, and then must be scaled back significantly afterwards as program participation declines due to high saturation levels. While the high incentive scenario may lead to front-loaded energy savings (a good thing), it could lead to dramatically reduced program effort and funding in later years, which may affect the program's ability to evolve and continue to capture emerging opportunities.

Figure 5-22 depicts costs and benefits under each funding scenario from 2011 to 2020. The present value of program costs (including administration, marketing, and incentives) is $497 million under the BAU scenario, $615 million under the 50-percent incentive scenario, $926 million under the 75-percent incentive scenario, and $1,461 million under the 100-percent incentive scenario. The present value of total avoided-cost benefits is $2,188 million under the BAU scenario, $2,290 million under 50-percent incentives, $2,722 million under 75-percent incentives, and $3,487 million under 100-percent incentives. The present value of *net* avoided-cost benefits, i.e., the difference between total avoided-cost benefits and total costs (which include participant costs in addition to program costs), is $1,148 million under BAU, $1,175 million under 50-percent incentives, $1,358 million under 75-percent incentives, and $1,662 million under 100-percent incentives. As a result of dramatically increasing incentive costs for higher incentive scenarios, increases in program costs outpace the increases in benefits as one moves to higher scenarios. (Note, there are participant costs in the 100-percent incentives scenario because the DSM Assyst model assumes measures initially purchased with program incentives are repurchased without program incentives if then burn out during the forecast period.)

Figure 5-22
Benefits and Costs of Energy-Efficiency Savings—2011-2020*



* PV (present value) of benefits and costs is calculated for 2011-2020 program years using a nominal discount rate = 7.4 percent, and an assumed inflation rate = 1.9 percent.

All four of the funding scenarios are cost-effective based on the TRC test, which is the test used in this study to determine program cost-effectiveness. The TRC benefit-cost ratios are 2.1 for the BAU and 50-percent incentive scenarios, 2.0 for the 75-percent incentive scenario, and 1.9 for the 100-percent incentive scenario. This indicates that program cost-effectiveness declines somewhat with increasing program effort, reflecting penetration of more measures with lower cost-effectiveness levels. Key results of our efficiency scenario forecasts from 2010 to 2020 are summarized in Table 5-2.

Table 5-2
Summary of Achievable Potential Results—2011-2020

Result - Programs	Program Scenario:			
	BAU Incentives	50 percent Incentives	75 percent Incentives	100 percent Incentives
Total Market Energy Savings - GWh	3,778	3,916	4,390	5,161
Total Market Peak Demand Savings - MW	526	535	651	883
Program Energy Savings – Net GWh	3,213	3,351	3,825	4,596
Program Peak Demand Savings – Net MW	466	475	591	823
Program Costs - Real, $ Million				
Administration	$167	$174	$200	$244
Marketing	$115	$124	$136	$150
Incentives	$330	$453	$773	$1,316
Total	$613	$751	$1,110	$1,710
PV Avoided Costs	$2,188	$2,290	$2,722	$3,487
PV Annual Program Costs (Adm/Mkt)	$227	$239	$272	$320
PV Net Measure Costs	$813	$875	$1,093	$1,505
Net Benefits	$1,148	$1,175	$1,358	$1,662
TRC Ratio	2.1	2.1	2.0	1.9

PV (present value) of benefits and costs is calculated for 2011-2020 program years using a nominal discount rate = 7.4 percent, and an assumed inflation rate = 1.9 percent; GWh and MW savings are cumulative through 2020.

5.2.1 Breakdown of Achievable Potential

Cumulative net achievable potential estimates by customer class for the period of 2011-2020 are presented in Figure 5-23 and Figure 5-24. These figures show results for each funding scenario. Under the program assumptions developed for this study, achievable energy savings are highest for the commercial sector, while peak-demand savings are similar for the residential and commercial sectors except in the 100-percent incentive scenario, where the residential sector is substantially higher. The increase in residential potential between the 75-percent and 100-percent incentive scenarios is largely driven by projected increase uptake of high-efficiency quality installed air conditioners, which could show much larger penetration if the measure were offered at the same cost as a base unit.

Figure 5-23
Achievable Energy Savings (2020) by Sector—GWh per Year

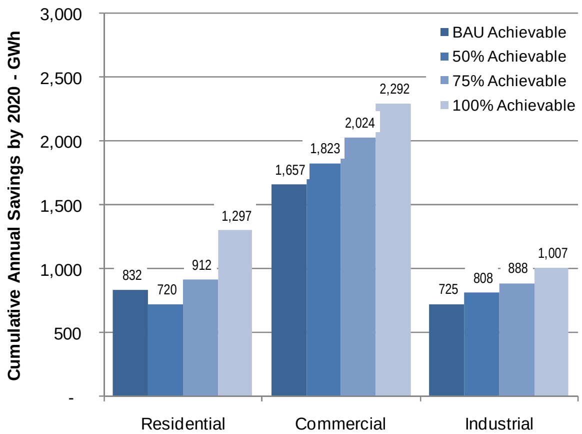


Figure 5-24
Achievable Peak-Demand Savings (2020) by Sector—MW

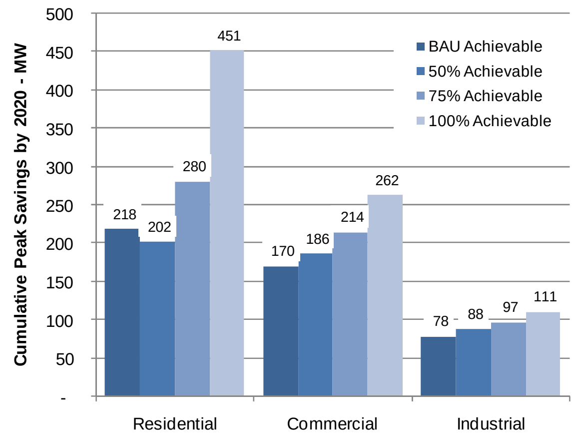


Table 5-3 and Table 5-4 show similar information as the previous figures, but also compare potentials to 2020 base energy use. Overall, achievable energy savings potentials range between 10 percent of base use for the BAU scenario (equating to about 1 percent savings per year) and 15 percent of base use for the 100-percent incentive scenario (equation to about 1.5 percent savings per year).Achievable residential energy savings potentials range between 7 percent and 13 percent of base usage, with commercial potentials ranging between 12 percent and 16 percent of base use, and industrial potentials ranging between 10 percent and 15 percent of base use.

Total achievable demand savings range between 7 percent of peak demand for the BAU scenario and 13 percent of peak demand for the 100-percent incentive scenario. The residential sector show the widest range in demand savings relative to base demand, with less variation for the commercial and industrial sectors.

Table 5-3
Achievable Energy Savings (2020) by Sector– GWh per Year

Sector	2020 Base Energy Use (GWH)	Ten Year Cumulative Potential - GWh			
		BAU Achievable (Program)	50% Achievable (Program)	75% Achievable (Program)	100% Achievable (Program)
Residential	10,020	832	720	912	1,297
Savings % of Base		**8%**	**7%**	**9%**	**13%**
Commercial	14,309	1,657	1,823	2,024	2,292
Savings % of Base		**12%**	**13%**	**14%**	**16%**
Industrial	7,124	725	808	888	1,007
Savings % of Base		**10%**	**11%**	**12%**	**14%**
Total	35,130*	3,213	3,351	3,825	4,596
Savings % of Base		**9%**	**10%**	**11%**	**13%**

* Base use includes 3,678 GWh of “Other” sector usage that is not addressed in the potential study. Base use also includes 260 GWh associated with customers who have opted out of Xcel Energy’s energy efficiency programs and are not included in the potentials.

Table 5-4
Achievable Energy Savings (2020) by Sector – MW

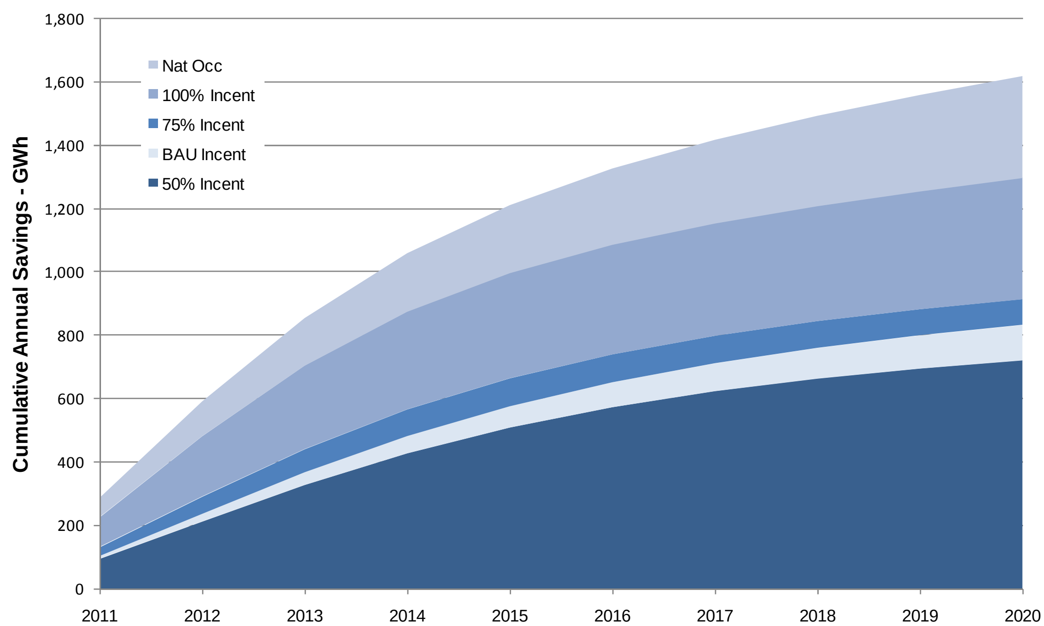
Sector	2020 Base Demand (MW)	Ten Year Cumulative Potential - MW			
		BAU Achievable (Program)	50% Achievable (Program)	75% Achievable (Program)	100% Achievable (Program)
Residential	2,772	218	202	280	451
Savings % of Base		**8%**	**7%**	**10%**	**16%**
Commercial	2,841	170	186	214	262
Savings % of Base		**6%**	**7%**	**8%**	**9%**
Industrial	947	78	88	97	111
Savings % of Base		**8%**	**9%**	**10%**	**12%**
Total	7,325*	466	475	591	823
Savings % of Base		**6%**	**6%**	**8%**	**11%**

* Base use includes 765 MW of “Other” sector usage that is not addressed in the potential study. Base use also includes 53 MW associated with customers who have opted out of Xcel Energy’s energy efficiency programs and are not included in the potentials.

5.2.1.1 Residential Sector

Figure 5-25 shows cumulative net achievable program energy savings by program scenario for the residential sector. Demand savings show a similar yearly pattern. By 2020, net energy savings reach 832 GWh under the BAU scenario, 720 GWh under the 50-percent incentive scenario, 912 GWh under the 75-percent incentive scenario, and 1,297 GWh under the 100-percent incentive scenario. Energy savings are most sensitive to changes in incentives in the 75- to 100-percent range. Key measures driving this sensitivity are Energy Star homes, high efficiency air conditioning with quality install, variable speed furnace fans, refrigerator recycling, and high efficiency refrigerators. Most of these measures are for higher efficiency (and higher quality) equipment that would be made available at the same cost as standard efficiency equipment under the 100-percent incentive scenario.

Figure 5-25
Achievable Energy Savings: Residential Sector



Note the order of scenarios is different for the residential sector versus similar charts for total potentials and for commercial and industrial potentials. The 50-percent incentive scenario is the lowest scenario for residential while the BAU scenario is lowest for the others.

Figure 5-26 and Figure 5-27 show the end-use distribution of energy and peak-demand savings, cumulative to 2020. Key end uses for energy-savings potential include lighting, cooling, refrigeration, furnace fans, and new construction measures. Cooling, furnace fans (also used for central air conditioning) and new construction measures provide much of the peak-demand savings potential. The figures also show that our models predict a large increase in savings for certain end uses when incentives are increased from 75 percent to 100 percent of incremental measure cost. This is mainly due to the replace-on-burnout measures where customers are much more likely to choose energy-efficient equipment at the time of replacement if there is no cost premium over standard-efficiency equipment. Refrigeration shows a large BAU potential because incentives are high for this measure in the BAU case.

Figure 5-26
Residential Energy-Savings Potential by End Use (2020)

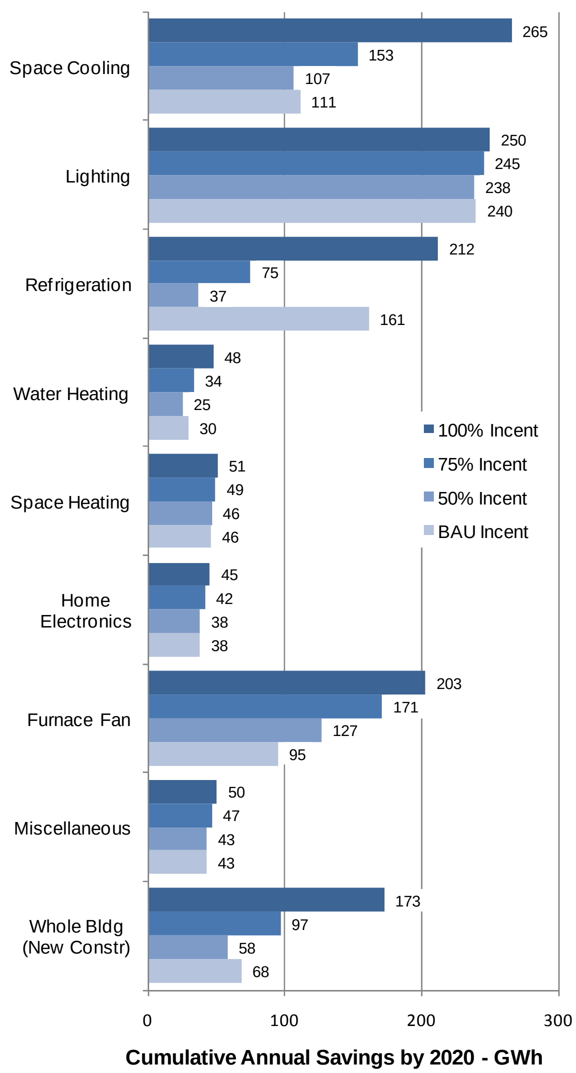


Figure 5-27
Residential Peak-Savings Potential by End Use (2020)

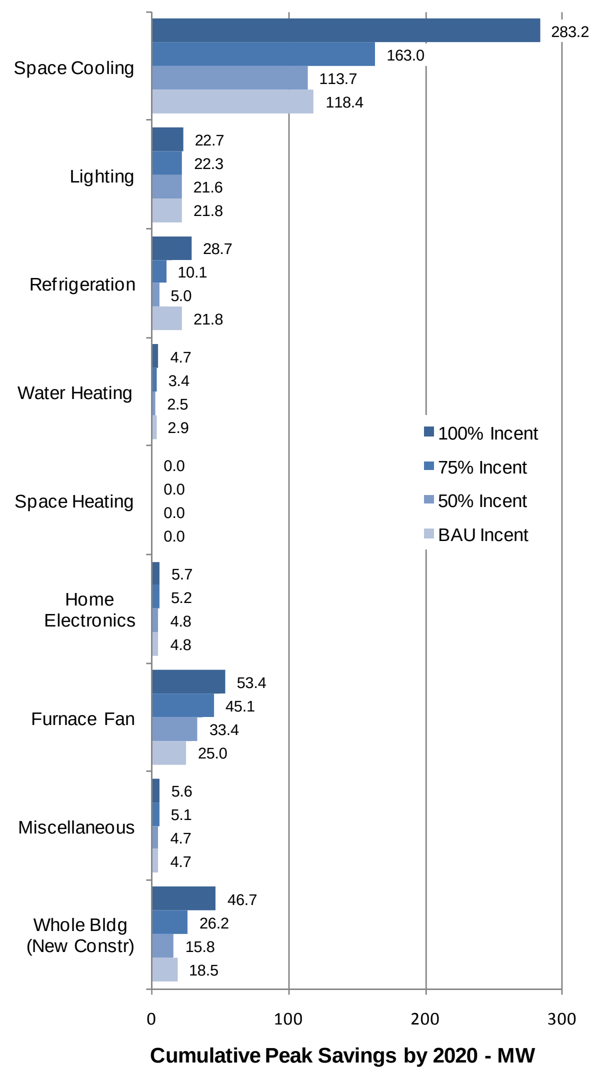


Figure 5-28 and Figure 5-29 show how results vary by building type. Single family homes account for between 80 and 85 percent of achievable energy savings and between 87 and 92 percent of achievable demand savings. The low-income segment accounts between 5 and 7 percent of energy and demand savings. Note that the low-income segment was not modeled using varying incentive levels. Rather, this segment was assumed to receive incentives equal to 100 percent of incremental measure cost for all program scenarios, and the level of program effort was adjusted to allow for the low-income potentials to track other residential segments in terms of program achievements.

Figure 5-28
Residential Energy-Savings Potential by Building Type (2020)

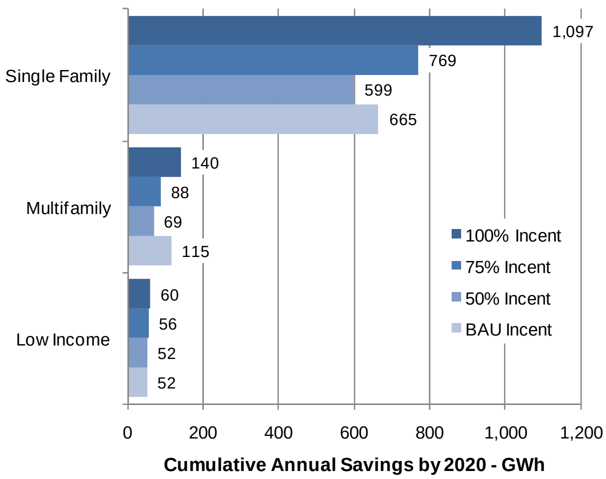


Figure 5-29
Residential Peak-Savings Potential by Building Type (2020)

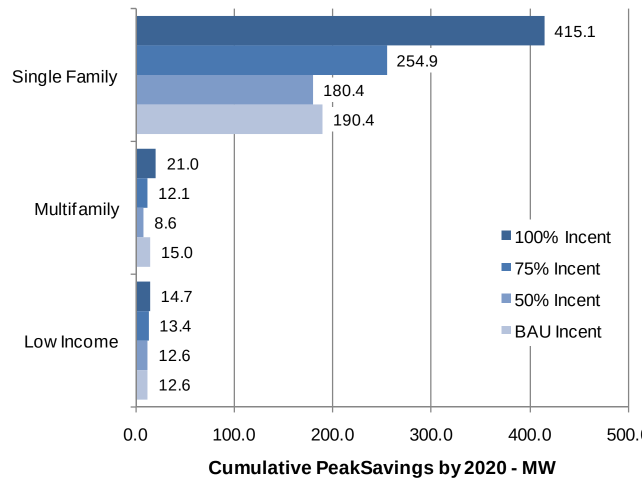


Table 5-5 lists the various potentials for residential measures. The list is sorted by economic potential.

Table 5-5
Measure-Specific Residential Results (Cumulative to 2020) – GWh

Measure	Average TRC Ratio	Technical	Economic	Econ Net of Nat Occ	Ach @ 100% Incentives	% of Net Econ	Ach @ 75% Incentives	% of Net Econ	Ach @ 50% Incentives	% of Net Econ	Ach @ BAU Incentives	% of Net Econ	Nat Occ
Energy Star New Home	3.5	720.3	720.3	711.5	172.5	24%	96.8	14%	58.2	8%	68.2	10%	8.8
CFLs - Standard	8.7	481.1	481.1	240.0	237.7	99%	235.6	98%	230.1	96%	231.5	96%	241.2
HE AC with Quality Install	1.4	277.3	266.3	265.5	133.8	50%	45.2	17%	25.1	9%	25.9	10%	0.8
Variable Speed Furnace Fans	1.1	210.6	210.6	201.1	202.7	101%	171.1	85%	126.8	63%	95.0	47%	9.5
Refrigerator Recycling	2.0	197.3	197.3	197.2	147.6	75%	41.8	21%	15.9	8%	140.2	71%	0.1
HE Refrigerator	0.7	202.3	99.1	98.3	63.9	65%	32.8	33%	20.8	21%	20.8	21%	0.8
Energy Star PC	20.5	88.9	88.9	74.9	41.7	56%	38.7	52%	35.9	48%	35.9	48%	14.0
Quality AC Install	2.3	78.1	75.3	71.6	67.3	94%	57.5	80%	44.5	62%	46.6	65%	3.8
Energy Star TV	13.3	74.9	74.9	67.7	26.9	40%	24.7	36%	22.6	33%	22.6	33%	7.1
Weatherization	3.6	92.0	60.7	39.9	39.4	99%	38.5	96%	36.5	92%	35.9	90%	20.8
Energy Star Set-Top Box	24.8	45.6	45.6	41.0	15.7	38%	14.4	35%	13.1	32%	13.1	32%	4.6
HE AC - Early Replace	1.1	47.6	44.4	43.1	44.1	102%	31.9	74%	21.6	50%	22.8	53%	1.3
Tankless Water Heater	1.0	52.3	39.4	39.3	12.3	31%	5.7	15%	3.4	9%	3.5	9%	0.1
T8 Lighting	1.8	31.1	31.1	31.0	5.9	19%	3.5	11%	2.3	7%	2.3	7%	0.1
Prog Thermostat	2.0	18.1	16.4	14.3	15.1	105%	13.3	93%	10.9	76%	11.3	79%	2.1
HE Water Heater	1.4	13.1	13.1	12.9	9.5	73%	5.5	43%	3.6	28%	3.7	28%	0.2
Low Flow Showerhead	1.5	11.8	11.8	10.9	10.3	95%	8.7	79%	6.9	63%	10.1	92%	0.8
Energy Star Dehumidifier	9.2	10.7	10.7	10.2	4.4	43%	3.6	36%	3.0	29%	3.0	30%	0.6
Drain Water Heat Recov (GFX)	1.8	10.4	10.4	9.6	9.4	98%	8.2	85%	6.6	69%	6.9	72%	0.8
Energy Star DVD Player	5.7	10.2	10.2	9.7	2.9	29%	2.6	27%	2.4	25%	2.4	24%	0.5
Floor Insulation	1.6	10.2	9.4	8.2	8.0	98%	7.7	94%	6.9	83%	7.0	85%	1.2
Pipe Wrap	29.2	6.5	6.5	3.1	2.9	95%	2.8	92%	2.7	87%	2.8	89%	3.4
Ductless Heat Pump	2.2	3.3	3.3	3.2	3.0	92%	2.5	77%	1.9	60%	2.0	62%	0.1
Faucet Aerators	0.8	4.3	1.6	1.5	1.4	92%	1.1	75%	0.9	59%	1.4	90%	0.1
Heat Pump Water Heater	0.8	32.9	1.6	1.5	1.6	105%	1.3	88%	1.0	68%	1.1	71%	0.1
HE Windows	0.2	132.8	0.8	0.8	2.1	264%	2.1	259%	2.0	255%	2.0	251%	0.0
AC Maintenance	0.4	48.2	0.0	0.0	0.9	0%	0.8	0%	0.8	0%	0.8	0%	0.0
Ceiling Fans	0.2	5.7	0.0	0.0	0.2	0%	0.2	0%	0.2	0%	0.2	0%	0.0
Ceiling Insulation	0.3	16.9	0.0	0.0	0.4	0%	0.4	0%	0.4	0%	0.4	0%	0.0
Duct Insulation/Repair	0.3	13.3	0.0	0.0	0.2	0%	0.2	0%	0.2	0%	0.2	0%	0.0

Table 5-5
Measure-Specific Residential Results (Cumulative to 2020) – GWh

Measure	Average TRC Ratio	Technical	Economic	Econ Net of Nat Occ	Ach @ 100% Incentives	% of Net Econ	Ach @ 75% Incentives	% of Net Econ	Ach @ 50% Incentives	% of Net Econ	Ach @ BAU Incentives	% of Net Econ	Nat Occ
Wall Insulation	0.3	54.1	0.0	0.0	2.0	0%	1.9	0%	1.9	0%	1.9	0%	0.0
HE Room AC	0.7	4.6	0.0	0.0	0.1	0%	0.1	0%	0.1	0%	0.1	0%	0.0
CFLs - Specialty	0.5	17.4	0.0	0.0	0.4	0%	0.4	0%	0.4	0%	0.4	0%	0.0
LEDs	0.4	262.6	0.0	0.0	5.7	0%	5.6	0%	5.5	0%	5.4	0%	0.0
Photocell/timeclock	0.1	8.5	0.0	0.0	0.1	0%	0.1	0%	0.1	0%	0.1	0%	0.0
HE Freezer	0.8	32.5	0.0	0.0	0.4	0%	0.4	0%	0.4	0%	0.4	0%	0.0
Solar Water Heating	0.2	76.3	0.0	0.0	0.2	0%	0.2	0%	0.2	0%	0.2	0%	0.0
HE Clothes Washer	0.1	27.6	0.0	0.0	0.2	0%	0.2	0%	0.2	0%	0.2	0%	0.0
HE Dishwasher	0.1	1.2	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Heat Pump Dryer	0.2	187.6	0.0	0.0	1.1	0%	1.1	0%	1.0	0%	1.0	0%	0.0
HE Clothes Dryer	0.4	31.0	0.0	0.0	0.2	0%	0.2	0%	0.1	0%	0.1	0%	0.0
Variable Speed Pool Pump	0.5	3.2	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Plug Load Controls	0.4	27.2	0.0	0.0	2.9	0%	2.8	0%	2.8	0%	2.7	0%	0.0
Energy Star Ventilating Fans	0.1	9.3	0.0	0.0	0.1	0%	0.1	0%	0.1	0%	0.1	0%	0.0

Note: TRC ratios are averages across multiple market segments. In some cases, the average TRC ratio may be below 1.0, but the measure is cost effective for some market segments, and thus, economic savings can be positive. Some measures show achievable savings potential although economic potential is zero; these results occur because all measures were included in the achievable potential for low income customers, regardless of their economic potential. This is also why achievable savings potentials exceed net economic potential for some measures.

5.2.1.2 Commercial Sector

Figure 5-30 shows cumulative net achievable program savings by commercial program scenario. By 2020, achievable energy savings reach 1,657 GWh under the BAU scenario, 1,823 GWh under the 50-percent incentive scenario, 2,024 GWh under the 75-percent incentive scenario, and 2,292 GWh under the 100-percent incentive scenario. Growth in savings levels off considerably after the first few years in both the 75-percent incentive scenario and the 100-percent incentive scenario.

Figure 5-30
Achievable Energy Savings: Commercial Sector

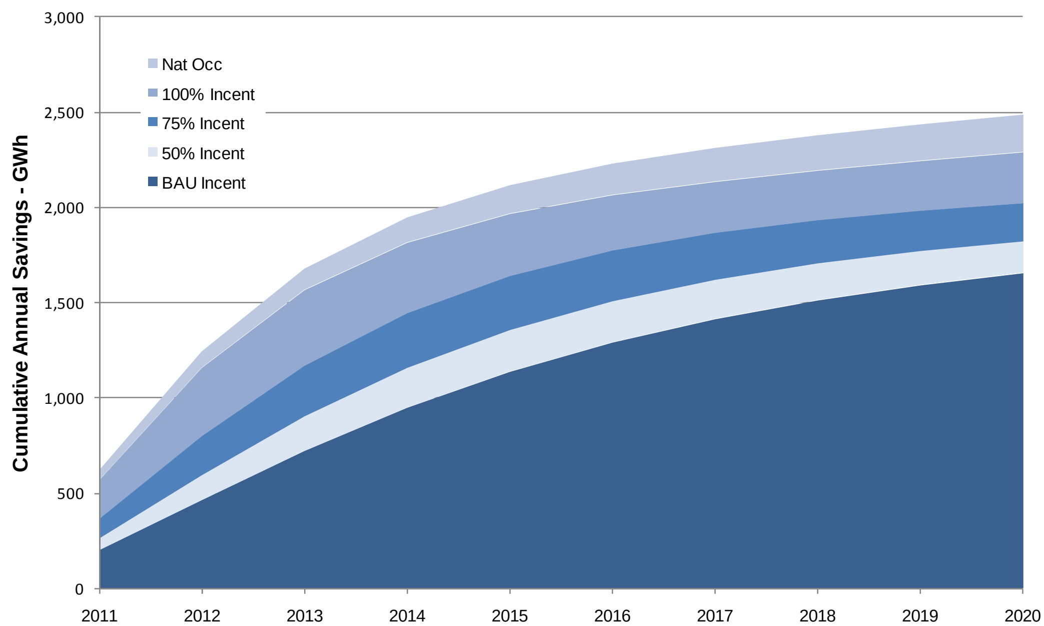


Figure 5-31 and Figure 5-32 show the end-use distribution of energy and peak-demand savings. Lighting contributes most to both the energy and peak-demand savings, followed by office equipment and ventilation measures. Cooling contributes a higher share to peak-demand savings potential versus energy-savings potential. While office equipment measures (including data center measures) are shown to be a contributor to achievable savings, incentives are only provided for data center measures and not for computer, monitor, copier, and printer measures. Results for the zero-incentive measures show effects of program marketing and education efforts to make customers more aware of the benefits of implementing equipment power-management capabilities.

Figure 5-31
Commercial Energy-Savings Potential by End Use (2020)

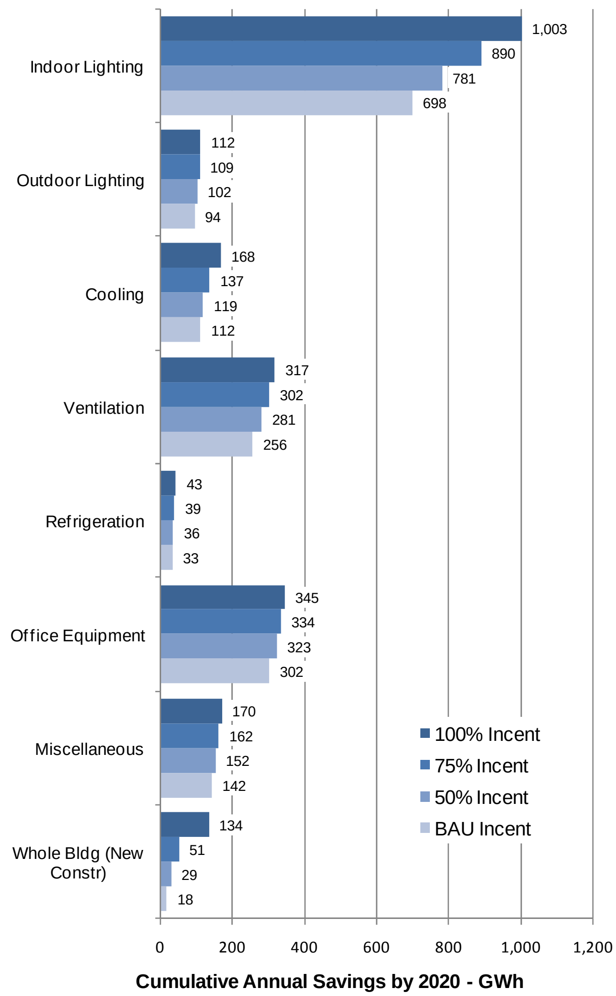


Figure 5-32
Commercial Peak-Savings Potential by End-Use (2020)

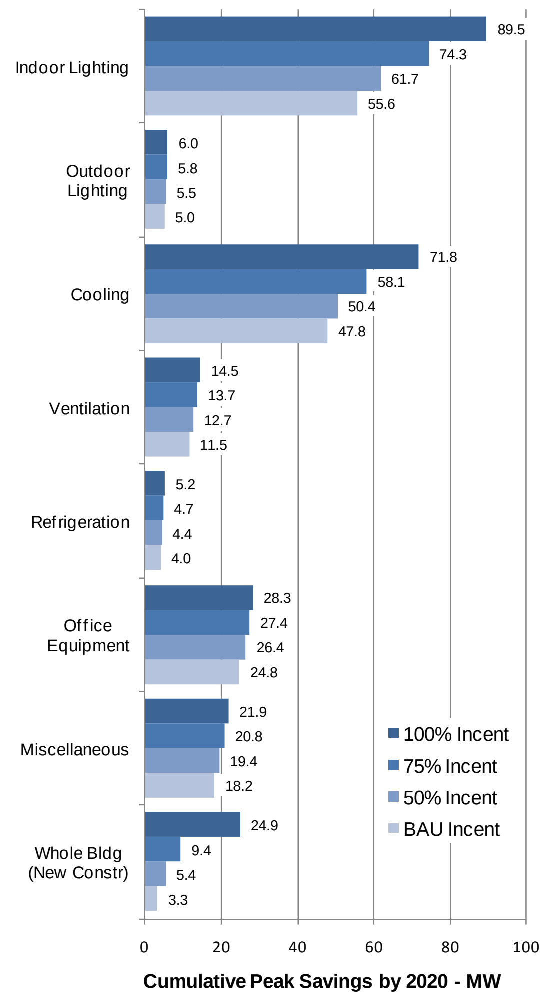


Figure 5-33 and Figure 5-34 show achievable potential by commercial building type. Similar to technical and economic potentials, the office segments present the largest source of savings potential. What is also clear from these figures is that savings start out fairly high for the BAU scenario, across building types, and increasing incentives does not result in a commensurate increase in potential savings. Similar to residential, a spike is seen in the savings increase between the 75-percent and 100-percent incentives scenarios, which is again driven by replace-on-burnout measures that are made cost-equivalent to base equipment with the high level of incentives.

Figure 5-33
Commercial Net Energy-Savings Potential by Building Type (2020)

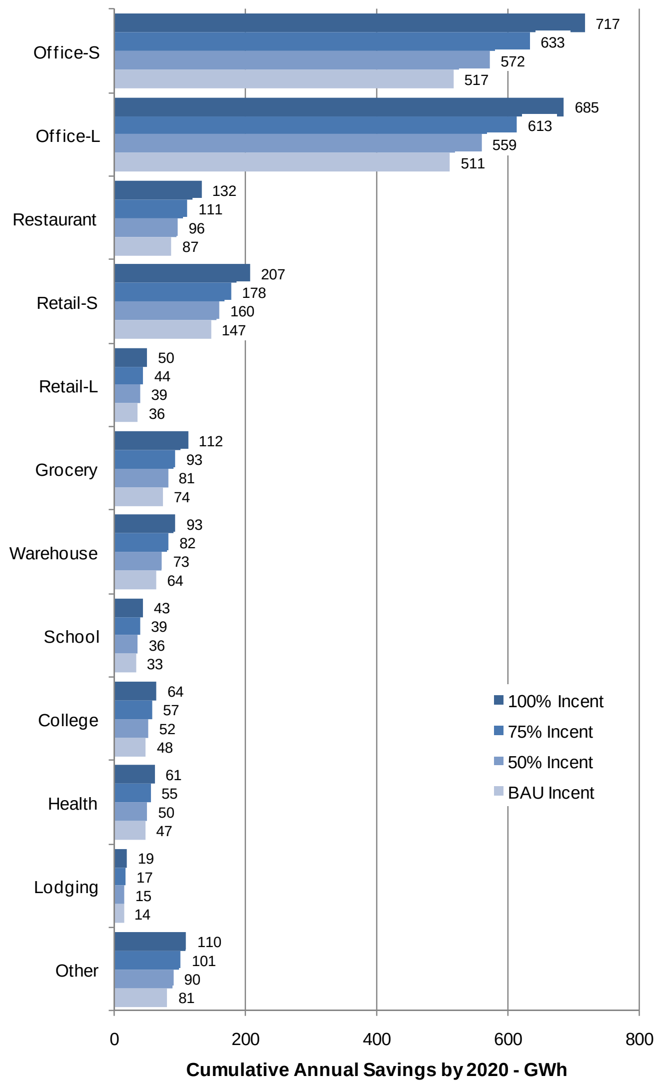


Figure 5-34
Commercial Net Peak-Savings Potential by Building Type (2020)

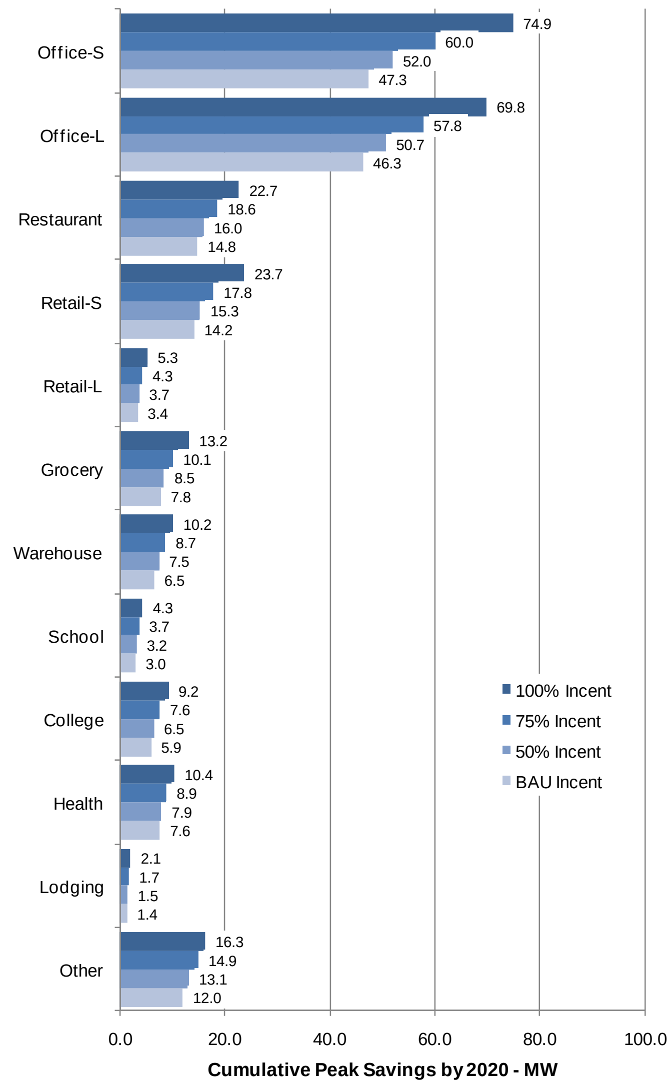


Table 5-6 lists the various potentials for commercial measures. Lighting measures, especially the premium T8 lighting with electronic ballast, CFLs and lighting controls, account for a significant amount of the achievable savings potential. Other measures with substantial contributions to achievable potential include VSDs for ventilation motors and office equipment power management. Lower achievable program potentials for some replace-on-burnout measures (such as air conditioners, chillers, and ventilation motors) reflect the fact that these measures that have limited opportunities due to equipment lifecycles.

Table 5-6
Measure-Specific Commercial Results (Cumulative to 2020) – GWh

Measure	Average TRC Ratio	Technical	Economic	Econ Net of Nat OCC	Ach @ 100% Incentives	% of Net Econ	Ach @ 75% Incentives	% of Net Econ	Ach @ 50% Incentives	% of Net Econ	Ach @ BAU Incentives	% of Net Econ	Nat Occ
T8 Lighting	2.2	582.1	582.1	571.9	342.0	60%	258.8	45%	204.1	36%	188.1	33%	10.2
Office Equip Power Management	5.1	340.9	329.5	280.9	259.5	92%	253.4	90%	246.4	88%	230.9	82%	48.6
VSD - Ventilation	3.5	351.0	292.8	270.3	271.0	100%	261.2	97%	244.9	91%	224.8	83%	22.5
HE DX Cooling	2.5	317.3	251.6	251.1	49.9	20%	26.7	11%	18.2	7%	18.4	7%	0.4
Occupancy Sensor	7.4	221.3	220.5	180.3	180.6	100%	173.8	96%	164.1	91%	148.7	82%	40.2
Continuous Dimming	0.9	281.4	194.9	189.5	190.5	101%	185.4	98%	168.4	89%	139.7	74%	5.3
Energy Star Office Equipment	2.5	180.7	180.5	177.5	37.7	21%	34.9	20%	32.3	18%	29.9	17%	3.1
CFLs	2.2	176.6	176.6	168.0	155.4	93%	144.7	86%	125.8	75%	114.7	68%	8.6
High-Perm Lighting Remodel	2.3	215.3	167.9	159.8	160.6	101%	156.8	98%	148.6	93%	138.5	87%	8.1
High Perf Building Design - 30% Savings	1.1	256.9	166.8	166.2	88.9	54%	33.9	20%	19.5	12%	11.9	7%	0.6
Outdoor Lighting Controls	6.0	79.4	78.2	69.1	69.5	101%	67.5	98%	64.9	94%	60.1	87%	9.1
Lighting Control Tuneup	2.1	92.6	70.9	66.0	66.3	101%	64.8	98%	62.5	95%	57.6	87%	4.9
High Perf Building Design - 50% Savings	1.0	96.3	62.6	62.4	33.3	53%	12.4	20%	7.1	11%	4.3	7%	0.2
LEDs	0.4	770.6	48.5	46.6	46.8	101%	45.5	98%	41.3	89%	37.9	81%	1.9
Duct Sealing	6.5	36.5	34.1	31.6	31.8	101%	31.0	98%	29.7	94%	29.0	92%	2.5
HE Chiller	1.8	36.4	34.0	34.0	8.2	24%	3.9	11%	2.4	7%	2.4	7%	0.0
Efficient Steamer	7.2	44.0	32.6	31.8	22.1	69%	19.6	61%	17.5	55%	16.4	52%	0.8
High Bay T5	3.8	31.2	31.2	31.1	7.0	22%	4.7	15%	3.4	11%	3.1	10%	0.1
ECM on Air Handler Unit	2.3	33.5	29.0	28.9	8.8	31%	5.5	19%	3.8	13%	3.2	11%	0.1
DX Coil Cleaning	2.2	33.3	28.3	27.5	27.6	101%	26.9	98%	25.1	91%	24.3	88%	0.8
Data Center Best Practices	17.8	27.9	27.9	21.4	21.4	100%	20.6	96%	19.8	93%	18.6	87%	6.5
Energy-Star Refrigerator/Freezer	140.7	26.8	26.8	25.5	12.9	51%	11.1	43%	9.9	39%	9.1	36%	1.3
Demand Controlled Ventilation	1.1	36.0	24.3	23.7	23.8	101%	23.1	98%	21.0	89%	18.2	77%	0.7
Data Center Improved Operations	40.9	24.2	24.2	17.1	17.1	100%	16.6	97%	16.0	93%	15.0	87%	7.1
HE Fan Motor	8.0	25.6	24.0	23.8	4.9	20%	3.6	15%	2.8	12%	2.4	10%	0.2
Solar Water Heater	1.1	36.3	21.0	20.7	20.8	101%	20.0	97%	17.5	84%	14.7	71%	0.3
High Perf Building Design - 15% Savings	0.8	160.5	17.2	17.2	9.3	54%	3.9	23%	2.3	13%	1.4	8%	0.1
Cool Roof	1.2	45.4	13.6	13.1	13.1	101%	12.6	97%	11.4	88%	10.1	77%	0.5
Oversized Air Cooled Refrig Condenser	12.6	13.4	13.4	11.4	11.5	101%	11.0	97%	10.1	89%	9.1	80%	1.9

Table 5-6
Measure-Specific Commercial Results (Cumulative to 2020) – GWh

Measure	Average TRC Ratio	Technical	Economic	Econ Net of Nat OCC	Ach @ 100% Incentives	% of Net Econ	Ach @ 75% Incentives	% of Net Econ	Ach @ 50% Incentives	% of Net Econ	Ach @ BAU Incentives	% of Net Econ	Nat Occ
VSD - Chiller Pumps/Towers	2.2	13.0	13.0	12.6	12.7	101%	12.3	98%	11.2	89%	9.9	79%	0.4
HE Refrig Fan Motors	9.3	11.6	11.6	11.5	2.6	23%	1.5	13%	1.0	9%	0.9	8%	0.1
Data Center State of the Art practices	10.5	10.8	10.8	9.0	9.0	100%	8.7	97%	8.3	93%	7.8	87%	1.9
Air Handler Tuneups	1.3	15.2	9.3	9.0	9.0	101%	8.8	98%	8.3	93%	7.5	83%	0.4
Freezer-Cooler Replacement Gaskets	9.2	9.3	9.3	7.8	7.9	101%	7.6	97%	7.3	94%	6.9	89%	1.5
Delamping	0.8	110.7	8.4	8.4	2.6	31%	1.3	16%	0.9	10%	0.8	9%	0.0
Heat Recovery Unit	4.1	11.0	7.9	7.3	7.3	101%	7.1	97%	6.6	91%	6.0	82%	0.6
Ceiling Insulation	2.7	7.3	6.8	6.2	6.2	101%	5.7	93%	4.8	77%	3.9	63%	0.7
Heat Trap	4.7	7.2	6.4	5.9	6.0	101%	5.8	98%	5.6	95%	5.3	90%	0.5
Cooling Tuneup	0.7	19.3	5.9	5.8	5.8	101%	5.6	97%	5.1	88%	4.2	73%	0.1
Cooling Controls	0.7	22.9	5.9	5.8	5.8	101%	5.5	96%	4.9	84%	3.9	68%	0.1
Efficient Fryer	5.7	5.6	5.5	5.4	3.7	69%	3.1	58%	2.7	49%	2.4	45%	0.1
Tankless Water Heater	1.3	7.6	5.1	5.1	0.7	13%	0.3	6%	0.2	4%	0.1	3%	0.0
High Perf Building Design - Near ZNE	0.9	15.0	4.5	4.5	2.4	54%	0.9	21%	0.5	12%	0.3	7%	0.0
Window Film	1.2	12.4	3.6	3.5	3.5	101%	3.4	98%	3.2	93%	2.9	85%	0.1
HE Chiller Motors	2.1	3.5	3.4	3.3	3.3	101%	3.2	97%	2.9	86%	2.8	83%	0.1
Cold Cathode Lamps	1.3	3.4	3.4	3.4	1.5	46%	0.9	25%	0.5	16%	0.5	14%	0.0
Demand Hot Gas Defrost	16.3	3.4	3.4	3.0	3.0	101%	2.9	98%	2.8	94%	2.7	90%	0.4
High Efficiency Water Heater	2.1	2.5	2.2	2.2	0.5	21%	0.3	12%	0.2	8%	0.1	6%	0.0
Night Covers for Display Cases	2.2	4.7	2.0	1.8	1.8	101%	1.7	98%	1.7	94%	1.6	90%	0.2
Energy Star Hot Food Holding Cabinets	0.5	6.5	1.7	1.7	1.2	67%	0.6	34%	0.4	22%	0.3	18%	0.0
Fiber Optic Case Lighting	0.3	15.7	1.5	1.4	1.4	101%	1.4	98%	1.3	90%	1.1	79%	0.0
Refrigeration Commissioning	6.2	1.6	1.0	0.9	0.9	101%	0.8	97%	0.8	94%	0.8	89%	0.2
Refrig Controls	2.5	0.6	0.6	0.6	0.6	101%	0.6	98%	0.5	94%	0.5	87%	0.0
Refrig Compressor VSD	2.8	7.1	0.6	0.5	0.5	101%	0.5	97%	0.4	94%	0.4	89%	0.1
Demand Defrost Electric	44.6	0.3	0.3	0.2	0.2	101%	0.2	97%	0.2	93%	0.2	88%	0.1
HE Refrig Compressor	6.7	0.1	0.1	0.1	0.1	69%	0.1	60%	0.1	52%	0.1	49%	0.0
HE PTAC Cooling	0.5	10.2	0.0	0.0	0.0	32%	0.0	13%	0.0	8%	0.0	9%	0.0
Demand controlled circulating systems	0.2	2.0	0.0	0.0	0.0	101%	0.0	96%	0.0	83%	0.0	69%	0.0

Table 5-6
Measure-Specific Commercial Results (Cumulative to 2020) – GWh

Measure	Average TRC Ratio	Technical	Economic	Econ Net of Nat OCC	Ach @ 100% Incentives	% of Net Econ	Ach @ 75% Incentives	% of Net Econ	Ach @ 50% Incentives	% of Net Econ	Ach @ BAU Incentives	% of Net Econ	Nat Occ
Economizer	0.7	94.1	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Duct/Pipe Insulation	0.1	10.5	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Geothermal Heat Pump	0.3	11.3	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Energy Recovery Vent	0.3	8.5	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
High R-Value Refrig Glass Doors	0.1	0.7	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Multiplex Refrig Compressor System	0.5	0.7	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Refrig Strip Curtains	0.0	0.4	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
LED Refrig Case Lighting	0.3	1.0	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Hot Water Pipe Insulation	0.5	0.8	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Vending Misers	0.4	3.4	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Convection Oven	0.2	1.3	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0

Note: TRC ratios are averages across multiple market segments. In some cases, the average TRC ratio may be below 1.0, but the measure is cost effective for some market segments, and thus, economic savings can be positive. In some cases achievable potential at the 100% incentives scenario exceeds net economic potential by a small amount; this is due to rounding error.

5.2.1.3 Industrial Sector

Figure 5-35 shows cumulative net achievable program savings by industrial program scenario. By 2020, energy savings reach 725 GWh under the BAU scenario, 808 GWh under the 50-percent incentive scenario, 888 GWh under the 75-percent incentive scenario, and 1,007 GWh under the 100-percent incentive scenario.

Figure 5-35
Achievable Energy Savings: Industrial Sector

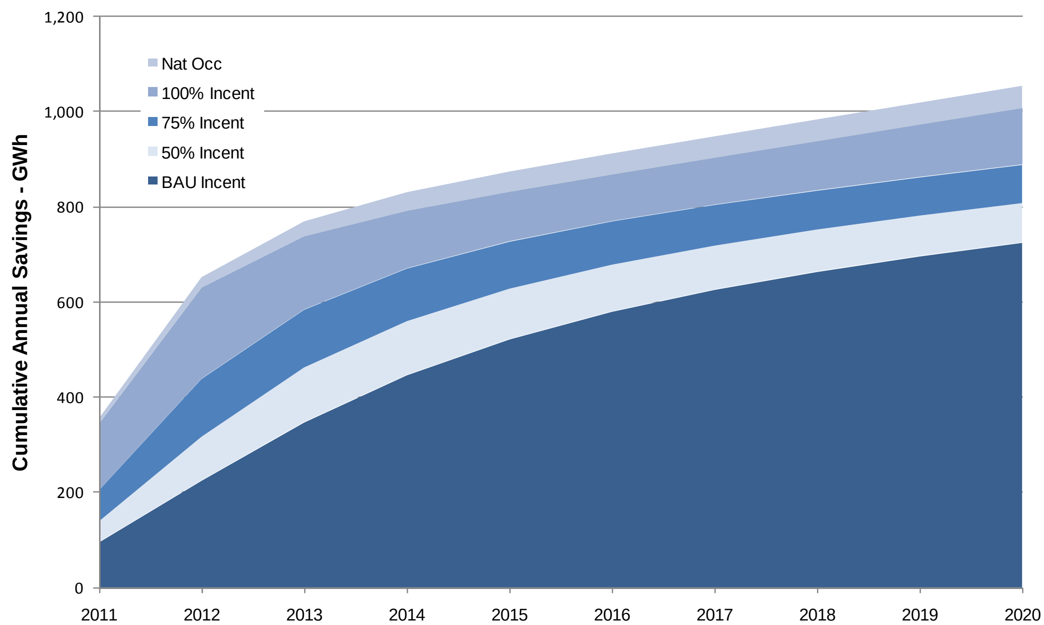


Figure 5-36 and Figure 5-37 show the end-use distribution of energy and peak-demand savings in the industrial sector. Similar to technical and economic potential, cross-cutting motor end uses (compressed air, fans, and pumps) account for the majority of savings. The fan end use shows a large increase between the 75-percent and 100-percent incentive scenarios due to fan control measures being offered at no incremental cost.

Figure 5-36
Industrial Energy-Savings Potential by End-Use (2020)

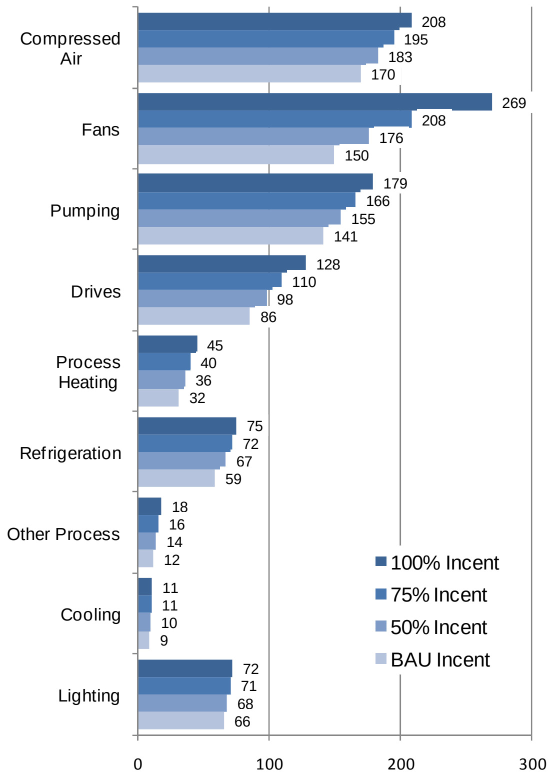


Figure 5-37
Industrial Peak-Savings Potential by End-Use (2020)

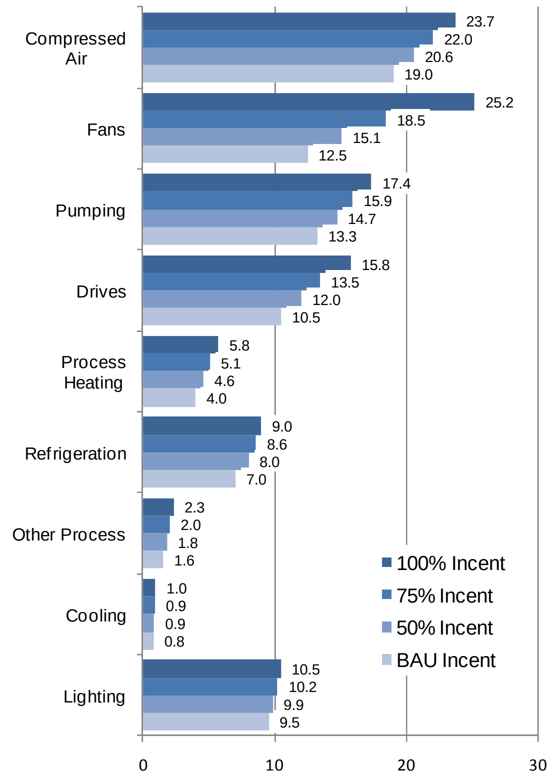


Figure 5-38 and Figure 5-39 show industrial savings by industry type. Food processing and petroleum are the leading sources of potential. Similar to the commercial sector, savings potentials start our fairly high for the BAU scenario and increase gradually with higher program-effort scenarios.

Figure 5-38
Industrial Energy-Savings Potential by End-Use (2020)

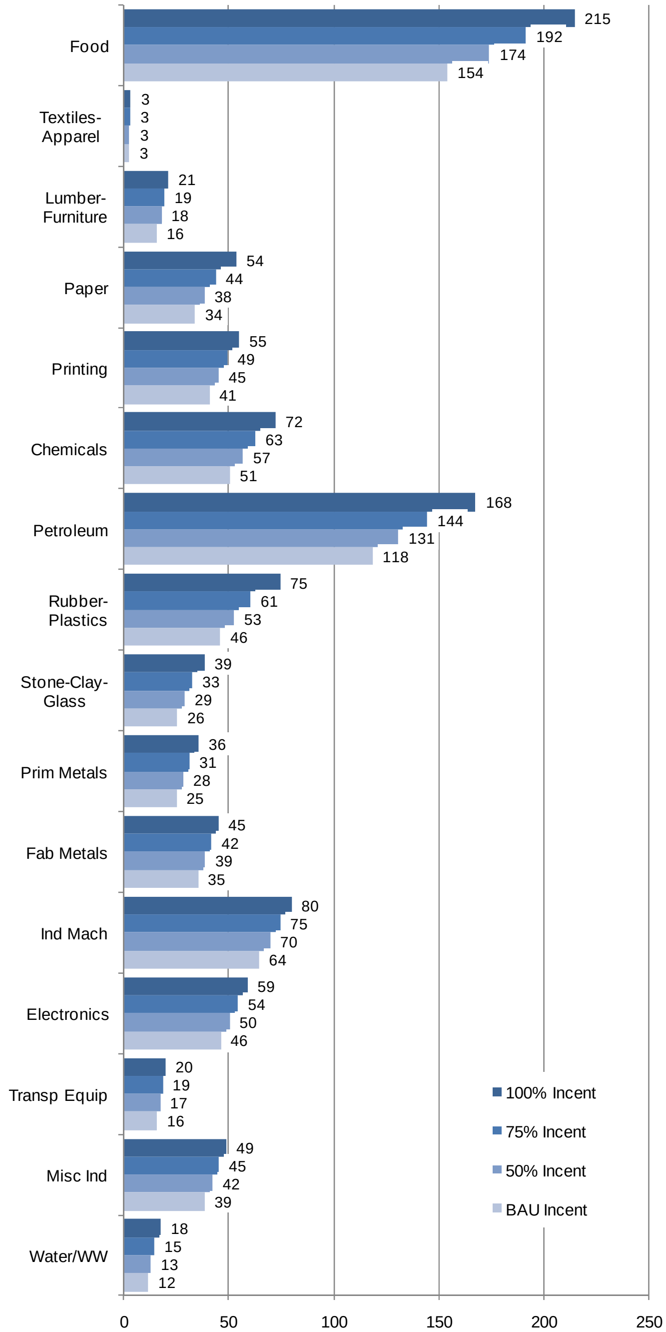


Figure 5-39
Industrial Peak-Savings Potential by End-Use (2020)

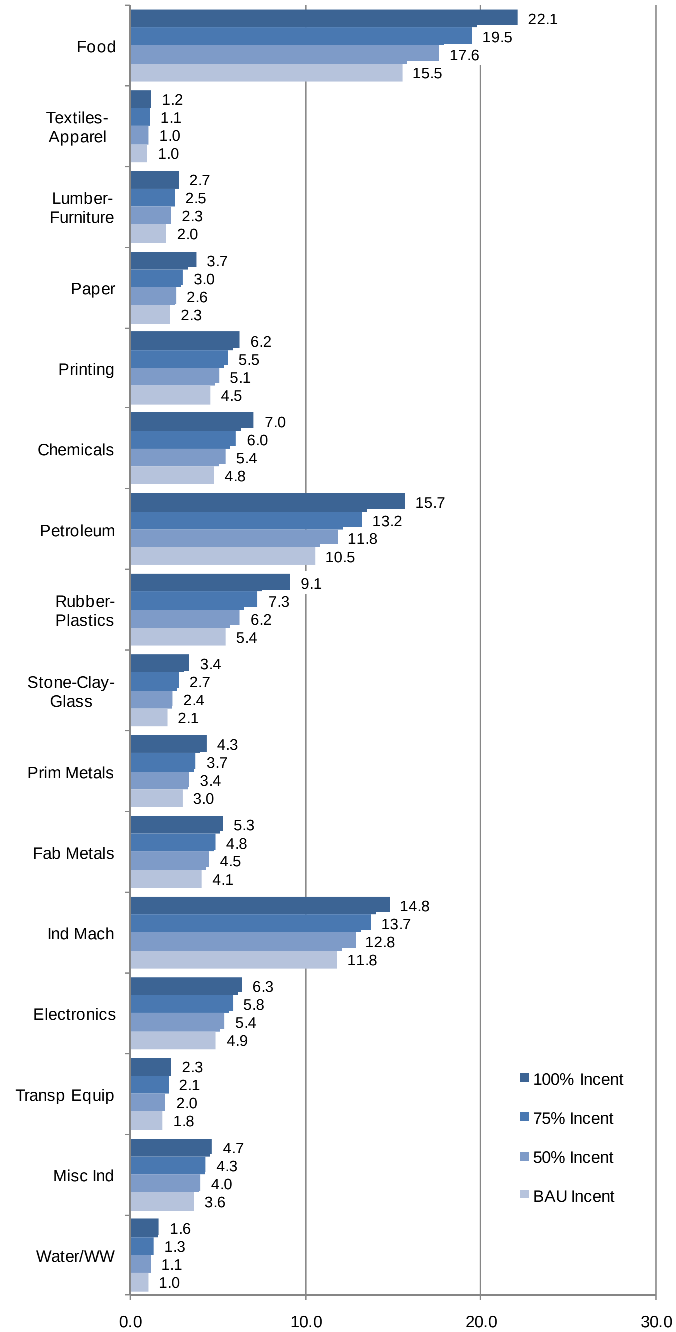


Table 5-7 lists the various potentials for industrial measures. There are a large number of industrial measures that contribute to industrial savings potential. Limited penetration of some industrial measures is, in part, due equipment turnover cycles that limit energy-efficiency opportunities.

Table 5-7
Measure-Specific Industrial Results (Cumulative to 2020) – GWh

Measure	Average TRC Ratio	Technical	Economic	Econ Net of Nat Occ	Ach @ 100% Incentives	% of Net Econ	Ach @ 75% Incentives	% of Net Econ	Ach @ 50% Incentives	% of Net Econ	Ach @ BAU Incentives	% of Net Econ	Nat Occ
Fans - Controls	1.5	182.3	182.3	181.3	120.0	66%	69.4	38%	47.4	26%	34.5	19%	0.9
Comp Air - System Optimization	5.5	97.0	97.0	87.5	87.5	100%	84.7	97%	81.8	93%	78.4	90%	9.5
Comp Air - ASD	8.5	75.6	73.7	69.6	46.3	66%	44.2	63%	42.0	60%	39.5	57%	4.1
Lighting - T8s	1.8	65.1	65.1	63.2	63.2	100%	61.8	98%	59.5	94%	58.0	92%	1.9
Drives - Alt EE Equipment	2.1	87.7	62.6	61.5	37.2	60%	24.8	40%	18.9	31%	14.8	24%	1.0
Pumps - System Optimization	2.1	61.8	61.8	59.3	59.3	100%	57.9	98%	56.3	95%	52.9	89%	2.4
Fans - System Optimization	1.1	118.1	61.7	60.3	60.3	100%	58.9	98%	55.2	92%	48.1	80%	1.4
Drives - Custom Measures	1.6	57.5	57.5	56.0	55.9	100%	54.7	98%	52.2	93%	46.6	83%	1.5
Pumps - Controls	6.9	47.8	47.8	46.4	30.4	65%	25.7	55%	21.8	47%	18.1	39%	1.4
Refrig - Optimization	1.4	44.8	44.8	43.8	43.7	100%	42.7	98%	40.1	92%	35.0	80%	1.0
Pumps - ASD	6.8	45.7	43.9	38.6	38.6	100%	37.3	97%	36.1	93%	34.9	90%	5.3
Fans - ASD	5.2	43.2	41.2	38.6	30.2	78%	28.9	75%	27.6	72%	26.7	69%	2.6
Pumps - Sizing	5.2	37.3	37.3	36.5	24.1	66%	19.6	54%	16.1	44%	12.8	35%	0.8
Fans - Improve components	4.7	36.5	36.5	35.8	23.9	67%	19.2	53%	15.7	44%	12.5	35%	0.7
Comp Air - O&M	1.5	34.8	34.8	33.7	33.7	100%	32.9	98%	31.9	95%	29.9	89%	1.1
Proc Heat - Custom Measures	1.6	27.6	27.6	26.9	26.9	100%	26.3	98%	25.1	93%	22.4	84%	0.7
Comp Air- Sizing	10.3	25.5	25.5	24.5	14.9	61%	12.6	51%	10.3	42%	8.0	33%	1.0
Comp Air - Controls	3.1	24.2	24.2	23.9	15.2	64%	10.6	44%	7.7	32%	5.6	24%	0.3
Drives - O&M	9.6	21.9	21.9	19.8	16.2	82%	15.4	78%	14.5	73%	13.5	68%	2.2
Proc Heat - System Optimization	5.8	21.9	21.9	21.4	10.9	51%	9.3	44%	8.1	38%	7.0	33%	0.5
Refrig - EE Operations	8.1	21.2	21.2	20.5	13.9	68%	12.1	59%	10.6	52%	9.2	45%	0.7
Refrig - Custom Measures	1.6	18.3	18.3	17.8	17.8	100%	17.4	98%	16.6	93%	14.9	84%	0.5
Fans - Replace Motor	1.9	25.7	18.2	18.2	6.0	33%	3.8	21%	2.7	15%	2.3	13%	0.1
Fans - O&M	1.7	15.3	15.3	14.7	14.7	100%	14.3	98%	14.0	95%	13.2	90%	0.6
Pumps - O&M	1.5	15.1	15.1	14.6	14.6	100%	14.2	98%	13.8	95%	12.9	88%	0.5
Proc Heat - EE Equipment	2.2	14.8	14.8	14.8	5.4	37%	3.2	22%	2.2	15%	1.4	10%	0.1
Fans - Motor Practices	2.5	14.8	14.8	14.3	14.3	100%	13.9	98%	13.4	94%	12.5	87%	0.5
Other Ind - Custom Measures	1.7	12.6	12.6	12.3	12.3	100%	12.0	98%	11.5	94%	10.3	84%	0.3
Pumps - Motor Practices	3.1	11.0	11.0	10.5	10.5	100%	10.2	97%	9.9	94%	9.4	89%	0.5

Table 5-7
Measure-Specific Industrial Results (Cumulative to 2020) – GWh

Measure	Average TRC Ratio	Technical	Economic	Econ Net of Nat Occ	Ach @ 100% Incentives	% of Net Econ	Ach @ 75% Incentives	% of Net Econ	Ach @ 50% Incentives	% of Net Econ	Ach @ BAU Incentives	% of Net Econ	Nat Occ
Other Ind - EE Equipment	3.8	9.2	9.2	9.1	4.0	44%	2.9	31%	2.0	22%	1.4	15%	0.1
Drives - Controls	1.8	10.1	8.9	8.8	5.5	63%	3.4	39%	2.4	27%	1.7	19%	0.1
Comp Air - Motor Practices	2.7	8.7	8.7	8.4	8.4	100%	8.2	97%	7.8	94%	7.4	88%	0.3
Lighting - Controls	1.7	8.5	8.5	8.2	8.2	100%	8.0	98%	7.7	94%	7.1	86%	0.2
Drives - System Optimization	3.2	8.5	8.5	8.0	8.0	100%	7.8	97%	7.5	94%	6.9	87%	0.5
Drives - EE Equipment	2.3	10.2	7.9	7.8	5.2	66%	3.7	48%	2.8	36%	2.3	29%	0.1
Cooling - Controls	6.4	7.5	7.0	5.8	5.8	100%	5.5	96%	5.3	92%	5.0	86%	1.2
Cooling - Window Film	1.6	5.4	5.1	5.0	5.0	100%	4.9	98%	4.7	94%	4.2	85%	0.1
Pumps - Replace Motor	1.2	13.0	4.8	4.7	1.5	33%	0.9	20%	0.6	14%	0.5	11%	0.0
Comp Air - Replace Motor	1.4	8.4	4.4	4.3	1.4	31%	0.8	18%	0.5	12%	0.4	8%	0.0
Other Ind - Controls	1.5	3.2	3.2	3.2	2.1	65%	1.2	38%	0.8	26%	0.6	17%	0.0
Proc Heat - Controls	2.2	2.1	2.1	2.1	0.9	44%	0.6	27%	0.4	19%	0.3	14%	0.0
Proc Heat - Alt EE Equipment	3.9	2.1	2.1	2.0	1.1	54%	0.8	39%	0.6	31%	0.5	24%	0.0
Cooling - HE Chiller	3.2	1.2	1.2	1.2	0.4	31%	0.2	21%	0.2	14%	0.1	13%	0.0
Lighting - CFLs	1.4	1.0	0.9	0.9	0.9	100%	0.9	98%	0.9	94%	0.8	92%	0.0
Comp Air - Power recovery	1.1	0.8	0.8	0.8	0.8	100%	0.8	97%	0.8	91%	0.6	78%	0.0
Cooling - EE DX	0.8	10.6	0.1	0.1	0.0	33%	0.0	11%	0.0	6%	0.0	6%	0.0
Other EE Measures	2.2	0.0	0.0	0.0	0.0	74%	0.0	53%	0.0	39%	0.0	28%	0.0
Cooling - Equipment Tuneup	0.2	7.1	0.0	0.0	0.0	100%	0.0	95%	0.0	82%	0.0	81%	0.0
Cooling - Cool Roof	0.4	5.8	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Cooling - VSD Pumps	0.3	0.3	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0
Lighting - Metal Halide	0.2	82.9	0.0	0.0	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0

Note: TRC ratios are averages across multiple market segments. In some cases, the average TRC ratio may be below 1.0, but the measure is cost effective for some market segments, and thus, economic savings can be positive.

5.3 Behavioral Conservation and Emerging Technologies

In addition to the base energy-efficiency potential forecast described above, we also investigated the effects of behavioral conservation and emerging technologies. The impacts of these components are much more uncertain than the impacts of the more standard, commercially available measures that are included in the base analysis, and this is why they receive separate treatment.

5.3.1 Behavioral Conservation

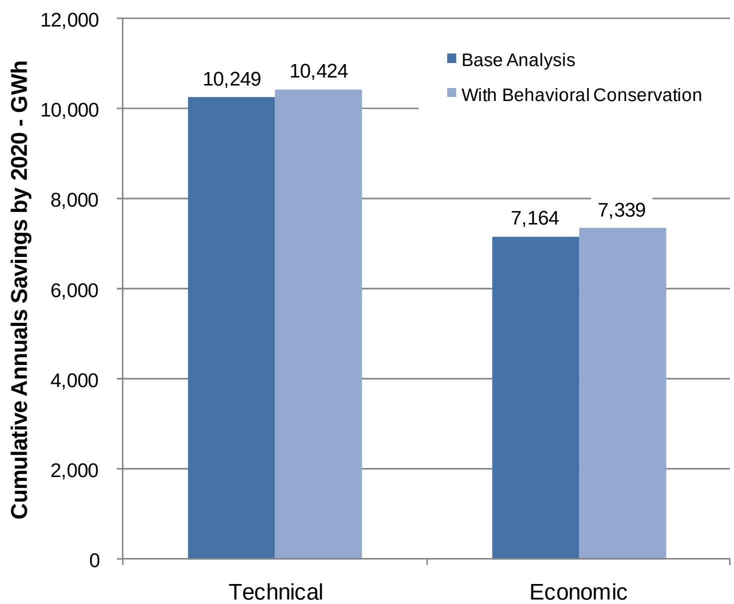
Residential behavioral-conservation programs have shown some promise in motivating customers to use less energy. However, factors such as persistence and the expected amount of energy savings have not been tested over a significant period of time or across a wide range of customers. Programs can include both direct and indirect feedback methods. The direct methods involve in-home installation of feedback devices that monitor energy usage and provide the customer with real time information on consumption. Indirect methods involve periodic reporting to customers, providing information such as: comparisons to neighbors' energy usage, assessment of energy usage by appliance, tips for reducing energy consumption, and information about programs that can be utilized to help in the energy reduction effort.

For this analysis, we focused on indirect feedback methods since these are experiencing wider adoption by utilities across the U.S. Also, there is probably a lot of overlap in the impacts of these two methods, but this overlap is not well understood, so we present potential impacts from the indirect approach, with the understanding that these impacts can serve as a proxy for savings from both types of behavior-motivation methods.

We assumed that the indirect measures would save about two percent of household energy consumption at a cost of about $7 per customer per year (after netting out the portion of program costs that could be allocated to natural gas savings). These measures could be offered to the entire residential population, or targeted to strategic subsets of the population. Direct methods could save somewhat more energy, about five percent per year, at an equipment cost of about $140 per customer, with a measure life of four years. These direct methods could be applied to between five and ten percent of the residential population, and are sometimes considered most effective for customer groups that are already very interested in energy usage and energy reduction efforts. Both direct and indirect measure parameters noted above are consistent with findings from recent pilot studies being conducted in various locales over the past several years.[4]

Figure 5-40 shows the effects on technical and economic potential from adding indirect behavioral-conservation measures to the energy efficiency potential analysis. Behavioral conservation adds 175 GWh of technical potential and economic potential to the base amounts, increase technical potential in 2020 by 1.7 percent and economic potential in 2020 by 2.4 percent.

Figure 5-40
Electric Technical and Economic Potentials with Behavioral-Conservation Activities



For the achievable potential assessment of the behavioral-conservation measures, we developed three scenarios:

- A low scenario that targets only the largest residential electricity users, one-third of the residential population or about 0.35 million customers with average use of about 14,700 kWh per year
- A mid scenario that targets both large and medium residential electricity users, about 0.7 million customers with combined average electricity use of 11,000 kWh per year
- A high scenario that targets all residential customers, about 1.1 million customers with average electricity use of 8,300 kWh per year

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[4] For example see Franklyn Energy, *Research Study: Residential Energy Use Behavior Change Pilot*, Presented to the Minnesota Department of Commerce, Office of Energy Security, April 2009.

In each case, program efforts were ramped up over a three-year period. Table 5-8 summarizes the results of the analysis over the 2011-2020 time period. As shown, behavioral-conservation potentials—if the assumptions outlined above hold up—could save between 102 and 174 GWh per year, with annual program costs ranging between $22 million and $67 million dollars over a 10-year period, depending on how many customers are targeted for the indirect interventions. (It is also possible that Xcel Energy could reduce program costs by better targeting customers, so these estimates are probably an upper-bound of program costs.) All scenarios have TRC ratios that are greater than 1.0, the cutoff for cost-effectiveness. The scenarios that target the larger users show the highest TRC ratios because energy savings per customer are assumed to be higher, while program costs are the same as for lower-use customers.

Table 5-8
Achievable Potentials for Electric Behavioral Conservation

Result	Scenario:		
	Low: Large Users Only	Medium: Lrg-Med Users	High: All Customers
Total Market Energy Savings - GWh	102.03	152.27	174.67
Total Market Peak Demand Savings - MW	27.64	41.25	47.31
Program Energy Savings – Net GWh	102.03	152.27	174.67
Program Peak Demand Savings – Net MW	27.64	41.25	47.31
Program Costs - Real, $ Million			
Administration	$0.20	$0.35	$0.51
Marketing	$21.85	$43.70	$66.31
Incentives	$0.00	$0.00	$0.00
Total	$22.05	$44.05	$66.81
PV Avoided Costs	$53.86	$80.39	$92.21
PV Annual Program Costs (Adm/Mkt)	$17.14	$34.24	$51.94
PV Net Measure Costs	$0.00	$0.00	$0.00
Net Benefits	$36.72	$46.15	$40.27
TRC Ratio	3.1	2.3	1.8

PV (present value) of benefits and costs is calculated for 2011-2020 program years using a nominal discount rate = 7.4 percent, and an assumed inflation rate = 1.9 percent; GWh and MW savings are cumulative through 2020.

5.3.2 Emerging Technologies

The ultimate impacts and timing of emerging technologies are very uncertain due to both technological and market barriers. Despite these uncertainties associated with particular technologies, we know that energy-efficiency measures will continue to evolve, and emerging technologies will play a significant role in future program years.

In order to address the possible effects of emerging energy-efficiency measures, KEMA developed a modeling approach that combines a bottom-up method for estimating technical and economic potential of emerging technologies with a technology diffusion analysis to estimate possible market penetration for these technologies over time.

The following steps were utilized in the analysis:

Identification of technologies and applications to be used in the study: A list of 41 technologies that are expected to be commercially available by 2014 were taken from a U.S. Department of Energy publication[5] and augmented with 4 additional technologies requested by Xcel Energy to provide a total of 45 technologies to be investigated in the study.

Segment the selected technologies by market and end use: Each measure was categorized by its end use and the market segment it applied to. Baseline measures and energy use were determined from this categorization, consistent with the base energy efficiency potential analysis.

Populate the model: We researched publications and contacted research groups and manufacturers to get an understanding of product commercialization dates, pricing structures, and estimated savings. For technologies already in the market, pricing, estimated useful life, expected payback period, power draw, and likely application were gathered from manufacturers' catalogues. For technologies still in development, KEMA research similar competitor products and projected necessary model inputs based on trends and patterns. At this point some products were removed from the research list because their introduction to the market was deemed not feasible given current R&D and funding efforts. Fourteen measures (4 HVAC, 1 Motor, and 9 Lighting) were included in the final model, all directed toward the commercial sector.

Estimate market potential: Technical potential was calculated is a similar fashion to the base energy efficiency potential analysis. Economic potential was also calculated using the same benefit/cost screening as the base analysis.

Estimate market penetration: The market penetration calculation uses a logit functional form (an S-shaped curve), based on the traditional BASS technology diffusion curve, to trace the adoption path of the technologies. In a variation on the BASS curve, the functional form used in this study uses the first year of practical market availability and the number of years to capture 50 percent of the technical potential as input parameters instead of the traditional BASS coefficients of innovation and imitation. For emerging technologies, this provides a more intuitive approach to understanding the process and outputs of the forecast.

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[5] Buildings R&D Breakthroughs: Technologies and Products Supported by the Building Technologies Program, U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, June, 22, 2011.

Simulation: to summarize the possible energy savings and adoption paths into the future, we varied one key modeling parameter, the incremental cost of the emerging technology, and generated three forecast scenarios. In the model, the incremental costs influence the number of years to capture 50 percent of the market. The working assumption was that emerging technology prices will come down over time, but as payback increased, we extended the number of years to capture 50 percent of the market because greater improvements or efficiencies need to be made to make the technologies more competitive. We adjusted the initial year of earnest sales in a similar fashion. Table 5-9 lists the diffusion parameters used in the analysis:

Table 5-9
Emerging Technology Diffusion Parameters

Simple payback	Years to capture 50% of market	Sales start year (earnest)
=< 2.0 years	7	year + 0
=< 2.5 years	10	---
=< 3.0 years	12	year + 3
> 3.0 years	15	---
=< 5.0 years	15	year + 4

5.3.2.1 Results

The following 14 technologies were included in the final analysis:

1. HVAC: Liquid Desiccant Air Conditioner (2.5 hp)
2. HVAC: Liquid Desiccant Air Conditioner (5hp)
3. HVAC: Ammonia Absorption Technologies for HVAC systems
4. HVAC: Hypak: A high efficiency rooftop packaged HVAC system
5. Lighting: LED High-Bay fixtures
6. Lighting: LED replacement fixture for linear fluorescent area lighting
7. Lighting: LED replacement for linear fluorescent lamps in existing fixtures
8. Lighting: Electro-Ceramescent, low power Light-Emitting Device
9. Lighting: 100 Lumen/ Watt warm white LED (lamp only)
10. Lighting: 100 Lumen/ Watt warm white LED (lamp and fixture)
11. Lighting: HE solid-state down light luminaires w/ novel cooling
12. Lighting: Efficient LED System-in-Module for general lighting
13. Lighting: Kilo-Lumen SSL exceeding 100 lumens per Watt

14. Motors: Nova Torque highly efficient electric motor

The three simulations run for the analysis are described here and summarized in Table 5-10 and Figure 5-41 through Figure 5-43. (Note that the emerging technology savings potential estimates do not factor in overlap with the base energy efficiency potential results. A subsequent analysis was conducted to determine that approximately half of the emerging technology potentials could be incremental to measures already addressed in the base analysis. The incremental results are presented in Table 5-11 below.)

- Baseline: incremental costs at 100 percent (baseline) and potential of success at 100 percent.
- Scenario 1: incremental costs at 75 percent of baseline and potential of success at 100 percent.
- Scenario 2: incremental costs at 25 percent of baseline and potential of success at 100 percent.

Table 5-10
Summary of Emerging Technology Simulations

Scenario	Technical Potential		Economic Potential		Capture	Capture
	MW	GWh	(20 Yr)	GWh	(10 Yr)	(20 Yr)
Baseline	1,190	4,137	840	3,143	38%	76%
Scenario 1 - little change	1,190	4,137	870	3,349	41%	81%
Scenario 2 - competition	1,190	4,137	950	3,601	47%	87%

Note: Potentials reflect savings over base technologies and are not adjusted for overlap with base energy efficiency results.

Figure 5-41
Emerging Technology: Baseline Adoption Path

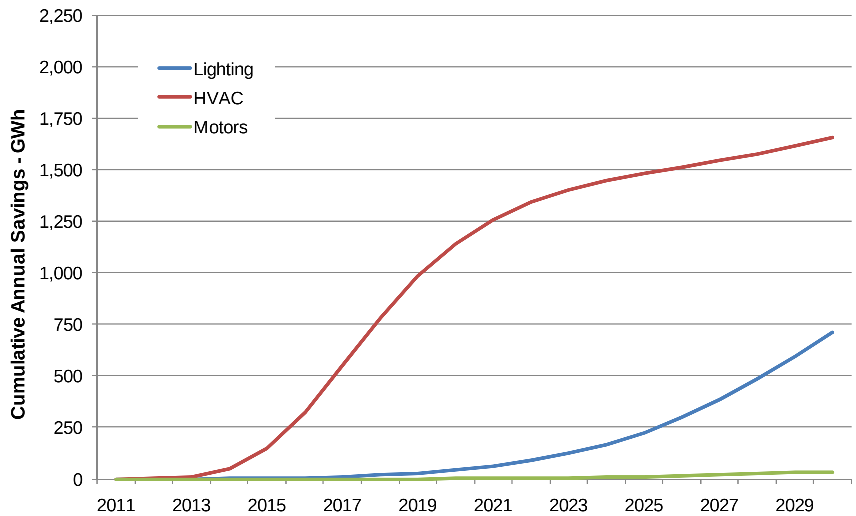


Figure 5-42
Emerging Technology: Scenario 1 (Little Change) Path - 25% Cost Reduction

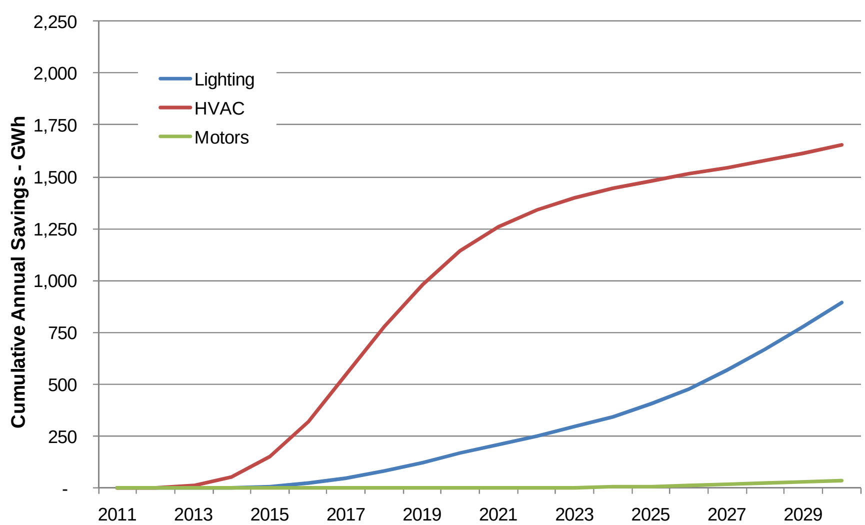
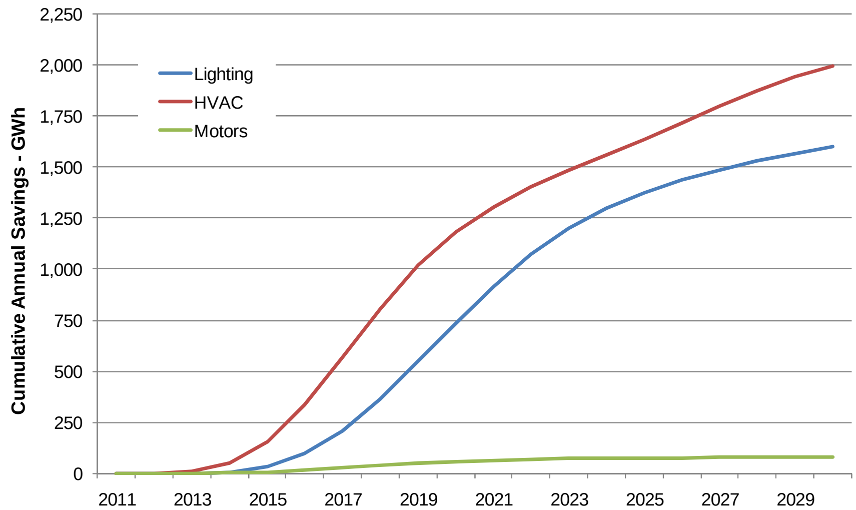


Figure 5-43
Emerging Technology: Scenario 2 (Competition) Path – 75% Cost Reduction



The emerging technology analysis focused on measure saving in relation to base technology, but this analysis double counts with some savings already contained in base energy efficiency potential results discuss in prior subsections. A review of the emerging technology savings in relation to competing energy efficiency technologies revealed that just under 50 percent of the emerging technology savings presented above could be incremental to the base energy efficiency analysis. Incremental savings estimates are presented in the last two columns of Table 5-11.

Table 5-11
Incremental Emerging Technology Savings Potentials

Scenario	Total Economic Potential		Incremental Economic Potential	
	MW	GWh	MW	GWh
Baseline	840	3,143	395	1,477
Scenario 1 - Little Change	870	3,349	409	1,574
Scenario 2 - Competition	950	3,601	447	1,692

5.3.2.2 Discussion of Results

The availability, timing and ultimate adoption of emerging technologies is inherently uncertain. We know that many of these technologies will improve and evolve. We also know that most incumbent technologies will not give away their market share quietly. These technologies also will innovate to keep their current pricing and applicability advantages.

As Figure 5-41 to Figure 5-43 show, the HVAC measures under review showlarge penetration across all three scenarios. The measure contributing most to HVAC potential promises very good cost savings over existing technologies and should find fairly good market acceptance. The Scenario 1 adoption path is not very different from the Baseline path, indication that further price reductions (either by the manufacturer or through utility incentives) will not do much to push the market. Only under larger cost reductions (Scenario 2) does the penetration increase in a significant way.

For the lighting and motor measures, large cost reductions or incentives may be necessary to move the market substantially beyond the baseline path, as illustrated by the Baseline and Scenario 1 figure not showing much difference and only the Scenario 2 with 75 percent cost reductions leading to a significant increase in penetration.

Overall, the emerging technologies may provide a significant boost to future energy efficiency portfolios, and market developments should be monitored. Depending on cost assumptions, the emerging technologies studied here could increase base energy efficiency potential of 7,164 GWh by over 20 percent.

As these emerging technologies become market-ready, the use of program incentives may be useful in acceleration measure uptake, but it is likely that, at least initially, incentives would need to cover a large portion of the incremental measure cost.

6. Demand Response Potential Results

KEMA estimated the potential of demand response (DR) programs by customizing inputs to the model developed to support the Federal Energy Regulatory Commission's *2009 National Assessment of Demand Response Potential*[6].KEMA customized inputs to the National Assessment of Demand Response (NADR) model to represent the Xcel Energy Minnesota service territory by using information on Xcel Energy data, forecasts, and current program accomplishments.

The NADR model uses a bottom-up approach to estimate DR resources. The model estimates impacts for four customer segments (residential and small, medium, and large nonresidential segments) and five DR program categories (direct load control, interruptible rates, dynamic pricing with enabling technologies, dynamic pricing without enabling technologies, and other DR programs such as demand bidding). Estimates are developed for four different scenarios:

- Business-as-usual (BAU): current programs and tariffs are held constant;.
- Expanded BAU (EBAU): BAU program participation rates are increased to equal the 75th percentile of ranked participation rates of similar programs across the U.S.
- Achievable Participation (AP): further assumes advanced metering infrastructure (AMI) is universally deployed, and dynamic pricing is the opt-out default tariff.
- Full Participation (FP): similar to the AP scenario, except that dynamic pricing and the acceptance of enabling technology is mandatory. This scenario quantifies the maximum cost-effective DR potential, absent any regulatory and market barriers.

For the Xcel Energy Minnesota analysis, we recalibrated the NADR model's default Minnesota parameters to reflect Xcel Energy customer characteristics and adjusted the BAU scenario to reflect Xcel Energy's current demand response program projections. For the other 3 scenarios (EBUA, AP, and FP), we applied the NADR model's default assumptions to the Xcel Energy customer base to develop estimates of DR potential under expanded program offerings.

We note that the NADR model results should be qualified. As stated on page 18 of the 2009 NADR report:

> "It is important to note that the results of the four scenarios are in fact estimates of potential, rather than projections of what is likely to occur. The numbers reported in this study should be interpreted

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[6] *A National Assessment of Demand Response Potential*, Staff Report, Federal Energy Regulatory Commission, prepared by The Brattle Group, Freeman, Sullivan & Co., and Global Energy Partners, LLC, June 2009.

as the amount of demand response that could potentially be achieved under a variety of assumptions about the types of programs pursued, market acceptance of the programs, and the overall cost-effectiveness of the programs. This report does not advocate what programs/measures should be adopted/implemented by regulators; it only sets forth estimates should certain things occur.

As such, the estimates of potential in this report should not be interpreted as targets, goals, or requirements for individual states or utilities. However, by quantifying potential opportunities that exist in each state, these estimates can serve as a reference for understanding the various pathways for pursuing increased levels of demand response.

As with any model-based analysis in economics, the estimates in this Assessment are subject to a number of uncertainties, most of them arising from limitations in the data that are used to estimate the model parameters. Demand response studies performed with accurate utility data have had error ranges of up to ten percent of the estimated response per participating customer. In this analysis, the use of largely publicly-available, secondary data sources makes it likely that the error range for any particular estimate in each of the scenarios studied is larger, perhaps as high as twenty percent."

There are a number of barriers to achieving the DR potentials developed in this study. These include:

- Constraints on the number of AMI installations which are required for critical peak pricing, with the understanding that there are many other factors with more significant costs and benefits that influence the decision to install AMI, beyond DR
- Regulatory barriers that include reluctance to adopt dramatically different pricing structures such as mandatory critical peak pricing and reluctance fund investments in AMI installations or in customer-side enabling technologies
- Technology barriers such as the limitations on cost-effective enabling technologies
- Customer barriers including: lack of awareness regarding DR, risk aversion to new technologies and pricing strategies, and perceived lack of ability to respond to DR events

These barriers may limit the ability to achieve the potentials developed in this analysis. In addition, the analysis does not address the need for DR. It just shows the peak savings reductions possible if a number of different DR strategies are implemented. Identifying the optimal amount of DR for Xcel Energy's Minnesota service territory, taking into account DR resources and existing generation and T&D capacity, is outside the scope of this study.

6.1 DR Potential Results

Table 6-1 summarizes demand response potential estimates by scenario, DR mechanism and sector. Total DR potentials by 2020 increase from 941 MW in the BAU case to 1,209 MW in the Expanded BAU case to 1,444 MW in the Achievable Potential case to 1,552 MW in the Full Participation case. Potential reductions could increase from 12 percent of system peak in the BAU scenario up to 20 percent of system peak in the Full Participation scenario if these types of capacity reductions were needed on the Xcel Energy system.

Table 6-1
Demand Response Potential Results by Scenario, Mechanism, and Sector - 2020

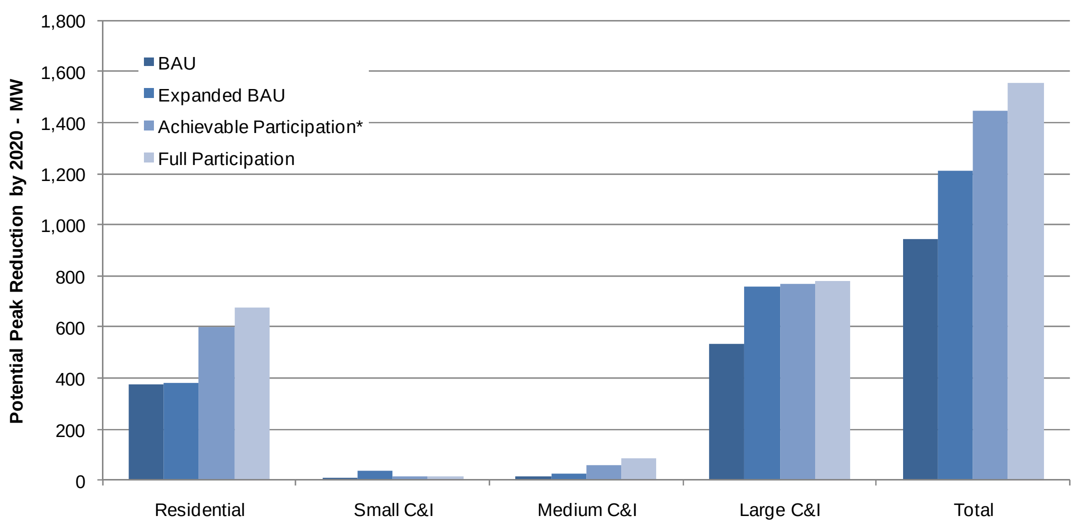
	Residential (MW)	Residential (% of system)	Small C&I (MW)	Small C&I (% of system)	Med. C&I (MW)	Med C&I (% of system)	Large C&I (MW)	Large C&I (% of system)	Total (MW)	Total (% of system)
BAU										
Pricing with Technology	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pricing without Technology	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Automated/Direct Load Control	375	4.8%	12	0.2%	18	0.2%	33	0.4%	438	5.6%
Interruptible/Curtailable Tariffs	0	0.0%	0	0.0%	0	0.0%	503	6.5%	503	6.5%
Other DR Programs	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total	375	4.8%	12	0.2%	18	0.2%	536	6.9%	941	12.1%
Expanded BAU										
Pricing with Technology	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pricing without Technology	7	0.1%	0	0.0%	1	0.0%	3	0.0%	11	0.1%
Automated/Direct Load Control	375	4.8%	39	0.5%	18	0.2%	33	0.4%	465	6.0%
Interruptible/Curtailable Tariffs	0	0.0%	0	0.0%	10	0.1%	634	8.1%	643	8.3%
Other DR Programs	0	0.0%	0	0.0%	0	0.0%	90	1.2%	90	1.2%
Total	382	4.9%	39	0.5%	29	0.4%	758	9.7%	1,209	15.5%
Achievable Participation*										
Pricing with Technology	0	0.0%	0	0.0%	13	0.2%	0	0.0%	13	0.2%
Pricing without Technology	225	2.9%	1	0.0%	18	0.2%	60	0.8%	304	3.9%
Automated/Direct Load Control	375	4.8%	14	0.2%	18	0.2%	33	0.4%	440	5.6%
Interruptible/Curtailable Tariffs	0	0.0%	0	0.0%	10	0.1%	634	8.1%	643	8.3%
Other DR Programs	0	0.0%	0	0.0%	0	0.0%	44	0.6%	44	0.6%
Total	600	7.7%	15	0.2%	59	0.8%	770	9.9%	1,444	18.5%
Full Participation										
Pricing with Technology	0	0.0%	0	0.0%	37	0.5%	0	0.0%	37	0.5%
Pricing without Technology	301	3.9%	1	0.0%	19	0.2%	100	1.3%	422	5.4%
Automated/Direct Load Control	375	4.8%	12	0.2%	18	0.2%	33	0.4%	438	5.6%
Interruptible/Curtailable Tariffs	0	0.0%	0	0.0%	10	0.1%	634	8.1%	643	8.3%
Other DR Programs	0	0.0%	0	0.0%	0	0.0%	12	0.1%	12	0.1%
Total	676	8.7%	13	0.2%	85	1.1%	778	10.0%	1,552	19.9%

* Achievable Participation is the name given to a specific scenario in the FERC NADR study; these potentials are only achievable under the specific assumptions that define this scenario.

Figure 6-1 shows potential demand reductions in 2020 by DR scenario and sector. Most of the savings are concentrated in the residential and large C&I segments. As shown in the table above, most of the residential potential in the BAU and Expanded BAU scenarios comes from direct control activities, and the jump in potentials between these scenarios and the Achievable and Full Participation scenarios is due to expanded pricing without enabling technologies. These pricing potentials are modeled to be incremental to the direct load control potentials, as the latter program is assumed, in the FERC study, to continue through all scenarios as unchanged potential. However, we have some concern that potentials for the pricing mechanisms may overstate the incremental potential in the AP and FP scenarios. These pricing mechanisms target similar end uses as the direct load control mechanism (mainly HVAC), which is already achieving high levels of participation and savings. We also note the assumption that direct load control potentials may not remain unchanged in the AP and FP scenarios, as assumed in the NADR analysis, but that some of these potentials may shift to the pricing programs if dynamic pricing is pursued by Xcel Energy.

For the large C&I segment, most of the potential reductions are through interruptible rates, with some incremental potentials from pricing without enabling technologies in the Achievable and Full Participation scenarios. Xcel Energy's BAU potential is somewhat below the Expanded BAU benchmark (which is tied to the highest 75 percentile of participation rates across U.S utilities) due mainly to lower nonresidential potentials associated with interruptible rates and "other" DR programs. We note that the Expanded BAU case is partly driven by high DR participation for utilities that are more demand-constrained than Xcel Energy, and that the optimal level of DR program activity must be determined by assessing both DR and supply-side resources, which is outside the scope of this study.

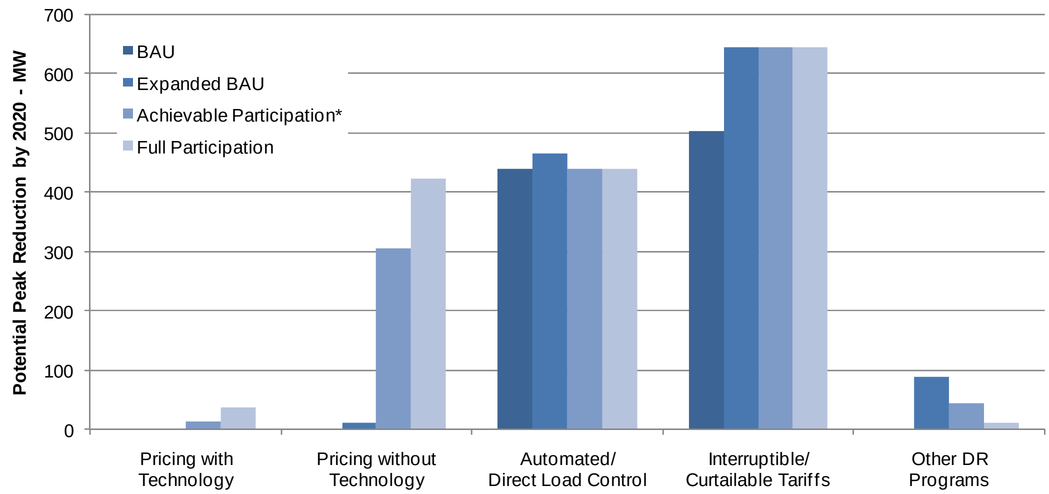
Figure 6-1
Demand Response Potential Results by Scenario and Sector - 2020



* Achievable Participation is the name given to a specific scenario in the FERC NADR study; these potentials are only achievable under the specific assumptions that define this scenario.

Figure 6-2 shows potential demand reductions in 2020 by scenario and DR mechanism. The largest contributors to potential for all scenarios are direct load control activities and interruptible rates. Dynamic pricing without enabling technologies shows increased contribution to potentials for the Achievable and Full Participation scenarios. Pricing with enabling technologies was determined to be cost effective only for the medium C&I segment. Potentials from Other DR programs decreases in the AP and FP scenarios as customers are assumed to move out of these programs into the pricing programs.

Figure 6-2
Demand Response Potential Results by Scenario and Mechanism - 2020



* Achievable Participation is the name given to a specific scenario in the FERC NADR study; these potentials are only achievable under the specific assumptions that define this scenario.