# Colorado DSM Market Potential Assessment

## *Final Report*

Prepared for

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# 1. Executive Summary

This study assessed the electric and natural gas DSM (demand side management) potential for the residential, commercial, and industrial sectors in the Xcel Energy Colorado service territory. The study was commissioned by Xcel Energy and was proposed in Xcel Energy's most recent Biennial Plan as an effort that would help inform the next Biennial Plan, to be filed in 2010. The goal of this study was to determine the levels of DSM savings available in the Xcel Energy Colorado service territory, the costs associated with procuring these savings, and whether the measures delivering the savings are cost effective in Colorado. This study provides energy-efficiency and demand-response potential estimates for an 11-year period, from 2010-2020.

## 1.1 Scope and Approach

In this study, three 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 and measure incentive levels.

In addition, naturally occurring energy-efficiency impacts were estimated. These are savings that result from normal market forces. Achievable program potential reflects savings that are projected beyond those that would occur naturally in the absence of any market intervention.

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, three different program funding scenarios were constructed. The first scenario assumed 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. The final scenario allowed for incentives covering 100 percent of incremental measure costs. Program energy and peak-demand savings, as well as program cost effectiveness, were assessed under these three funding scenarios.

The base assessment addressed measures and processes that are commercially available with proven savings and customer acceptance. In addition, we examined some emerging technologies and behavioral-conservation approaches. These additional components show promise for future DSM program impacts, but projections of their savings potentials have much more uncertainty than those of more standard measures. Hence, the emerging technologies (primarily LED lighting and indirect evaporative cooling) and behavioral-conservation approaches were addressed separately, so that results would be isolated from the other parts of the analysis. The study did not address incremental improvements in energy efficiency due to the ongoing evolution and improvement of technologies. These improvements will lead to increased energy-efficiency potential, over time. Also, the study did not address the ongoing tightening of equipment and building standards, which will in turn lead to a decrease in energy-efficiency potential, over time.

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 Colorado and customized the results to the Xcel Energy Colorado service territory, utilizing information on Xcel Energy's peak demand, relative to Colorado peak demand, and information on current programs being run by Xcel Energy.

## 1.2 Results

In Table 1-1, we report overall results of the DSM potential study, showing potentials for base energy-efficiency programs, demand-response programs, behavioral-conservation efforts, and emerging technologies. Cumulative results from 2010 to 2020 are shown. Emerging technologies are shown at the bottom of the table because the results of the emerging technology analysis cover an 11-year period that does not necessarily line up with the 2010-2020 period because we are not sure when these technologies will be sufficiently developed for inclusion in full-scale energy efficiency programs.

Base energy-efficiency and demand-response measures account for the majority of the net economic[2] and achievable 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 2 percent to 4 percent and could increase natural gas potentials by 8 percent to 14 percent, depending on the scenario. (Residential behavioral conservation has a bigger proportionate affect for gas because the residential share of energy usage is much higher for gas). Emerging technologies

[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.

[2] Net economic potential is defined as economic potential minus naturally occurring savings.

could increase achievable electric DSM savings by 7 percent to 20 percent, depending on the scenario, if the emerging measures prove to be commercially successful, although, substantive impacts from emerging technologies might not materialize for several more years.

**Table 1-1**
**Summary of Cumulative DSM Potentials from All Sources—2010-2020**

| | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|
| **Fuel** | **Source of Potential** | **Technical** | **Economic** | **Net Economic** | **100% Incentives** | **75% Incentives** | **50% Incentives** |
| Electricity GWh | Base Energy Efficiency | 8,938 | 7,563 | 6,420 | 4,892 | 2,806 | 1,802 |
| | Conservation | 218 | 216 | 216 | 176 | 107 | 44 |
| | Total | 9,112 | 7,779 | 6,636 | 5,068 | 2,913 | 1,846 |
| Electricity MW | Base Energy Efficiency | 2,161 | 1,730 | 1,572 | 1,198 | 538 | 328 |
| | Base Demand Response | 689 | 689 | 689 | 478 | 478 | 300 |
| | Conservation | 46 | 44 | 42 | 43 | 26 | 11 |
| | Total | 2,892 | 2,463 | 2,303 | 1,720 | 1,043 | 639 |
| Natural Gas Million Dth | Base Energy Efficiency | 55.4 | 39.1 | 37.5 | 24.4 | 9.0 | 4.5 |
| | Conservation | 2.2 | 2.1 | 2.1 | 1.9 | 1.3 | 0.5 |
| | Total | 57.6 | 41.2 | 39.6 | 26.3 | 10.3 | 4.9 |
| *Emerging Technologies* | *GWh* | *2,207* | *1,800* | *1,781* | *991* | *335* | *119* |
| | *MW* | *635* | *628* | *627* | *262* | *95* | *48* |

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% incentives scenarios. Demand response utilizes two scenarios: *business–as-usual* (BAU) and *expanded*; the BAU lines up with the 50% incentives scenario and the *expanded* lines up with the 100% and 75% incentives scenarios. Emerging technologies are analyzed over an 11-year period that doesn't necessarily line up with the 2010-2020 period, and therefore their results are reported separately from other electric results. Substantive impacts from emerging technologies might not materialize for another five years or more.

Table 1-2 shows average annual savings accomplishment required to reach the achievable potentials presented in Table 1-1 along with average annual program costs. As shown in Table 1-2, expected average annual program costs for basic electric and gas energy efficiency programs range from $361 million for the 100-percent incentives scenario to $119 million for the 75-percent incentives scenario to $57 million for the 50-percent incentive scenario. Demand response program costs range from $49 million per year for the expanded scenario down to $31 million per year for the business-as-usual scenario. Annual behavioral conservation program costs for electricity and natural gas are $11 million, $6 million, and $1 million for the high, medium, and low program scenarios. Emerging technology costs could range from $69 million per year for the 100-percent incentives scenario down to $5 million per year for the 50-percent incentives scenario. Overall, if emerging technologies are taken into account, potential electric savings range between 551 GWh per year (100-percent incentives) to 179 GWh per year (50-percent incentives) and between 180 MW per year (100-percent incentives) to 62 MW per year (50-percent incentives). Potential gas savings range between 2.4 million Dth per year (100-percent incentives) to 0.4 million Dth per year (50-percent incentives). Overall program costs (including costs for emerging technologies) range from $489 million per year (100-percent incentives) down to $94 million per year (50-percent incentives).

**Table 1-2**
**Average Annual Achievable Potentials and Program Costs from All Sources—2010-2020**

| Fuel | Source of Potential | Savings by Scenario | | | Costs ($ Millions) by Scenario | | |
|---|---|---|---|---|---|---|---|
| | | 100% Incentives | 75% Incentives | 50% Incentives | 100% Incentives | 75% Incentives | 50% Incentives |
| Electricity GWh | Base Energy Efficiency | 444.8 | 255.1 | 163.8 | $247.7 | $87.0 | $43.1 |
| | Conservation | 16.0 | 9.8 | 4.0 | $6.2 | $3.0 | $0.8 |
| | Total | 460.8 | 264.8 | 167.8 | $253.9 | $90.0 | $43.9 |
| Electricity MW | Base Energy Efficiency | 109.0 | 49.0 | 29.8 | *Shown above under GWh* | | |
| | Demand Response | 43.5 | 43.5 | 27.3 | $48.6 | $48.6 | $31.2 |
| | Conservation | 3.9 | 2.4 | 1.0 | *Shown above under GWh* | | |
| | Total | 156.3 | 94.8 | 58.1 | *Equals GWh total plus DR costs* | | |
| Natural Gas Million Dth | Base Energy Efficiency | 2.2 | 0.8 | 0.4 | $113.3 | $32.4 | $13.5 |
| | Conservation | 0.2 | 0.1 | 0.0 | $4.6 | $2.6 | $0.7 |
| | Total | 2.4 | 0.9 | 0.4 | $118.0 | $35.0 | $14.2 |
| *Emerging Technologies* | *GWh* | *90.1* | *30.5* | *10.8* | *$68.6* | *$14.1* | *$4.6* |
| | *MW* | *23.8* | *8.6* | *4.3* | *Shown above under GWh* | | |

Also, see notes for Table 1-1.

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 Results

Estimates of electric energy-savings potential are presented in Figure 1-1. Technical potential is estimated at 8,938 GWh per year; much of this potential is estimated to be economically viable. Economic potential is estimated at 7,563 GWh. Net[3] achievable program potentials range from 4,892 GWh per year in the 100-percent incentive scenario to 2,806 GWh per year for the 75-percent incentive scenario to 1,802 GWh per year for the 50-percent incentive scenario. Economic potential is estimated to be 23 percent of base 2020 energy use; achievable potentials range from 76 percent of net economic potential (after factoring out naturally occurring savings) in the 100-percent incentive case to 44 percent

[3] *Net* refers to savings beyond those estimated to be naturally occurring; that is, from customer adoptions that would occur in the absence of any programs or standards.

of net economic potential in the 75-percent incentive case to 28 percent of net economic potential in the 50-percent incentive case.

Peak-demand savings potential estimates are provided in Figure 1-2. Technical potential is estimated at 2,161 MW, and economic potential is estimated at 1,730 MW. Net achievable program potential ranges from a high of 1,198 MW in the 100-percent incentive case down to 328 MW in the 50-percent incentive case.

**Figure 1-1**
**Estimated Electric Energy-Efficiency Savings Potential, 2010-2020**

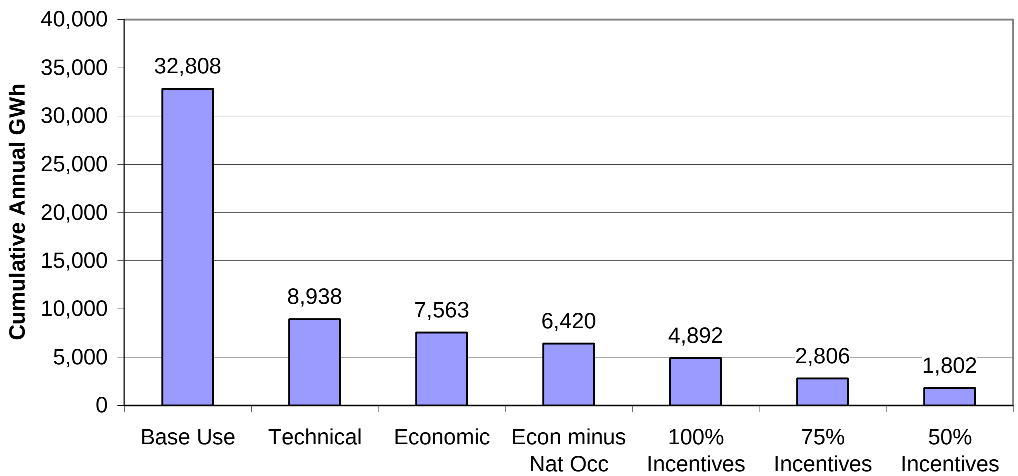
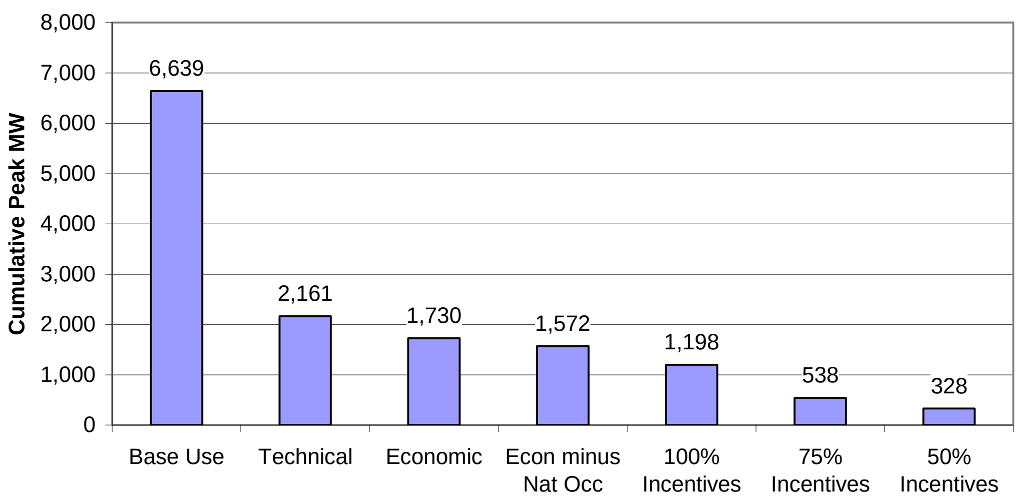



**Figure 1-2**
**Estimated Peak-Demand Savings Potential, 2010-2020**



Natural gas savings potential estimates are provided in Figure 1-3. Technical potential is estimated at 55 million Dth, and economic potential is estimated at 39 million Dth. Net achievable program potential ranges from a high of 24 million Dth in the 100-percent incentive case to 9 million Dth in the 75-percent incentive case down to 4 million Dth in the 50-percent incentive case. Economic potential is estimated to be 28 percent of base 2020 gas use; achievable potentials range from 67 percent of net economic potential in the 100-percent incentive case to 23 percent of net economic potential in the 75-percent incentive case to 11 percent of net economic potential in the 50-percent incentive case. Much of the natural gas savings is tied to long-lived equipment that will not be replaced during the 2010-2020 period, so achievable gas potentials (as a percent of net economic potential) are somewhat lower than electric potentials.

**Figure 1-3**
**Estimated Natural Gas Savings Potential, 2010-2020**

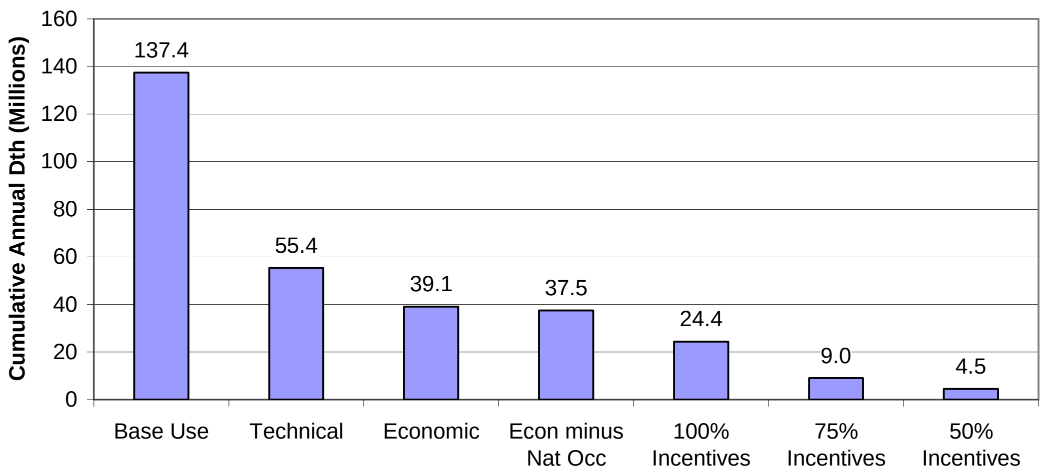
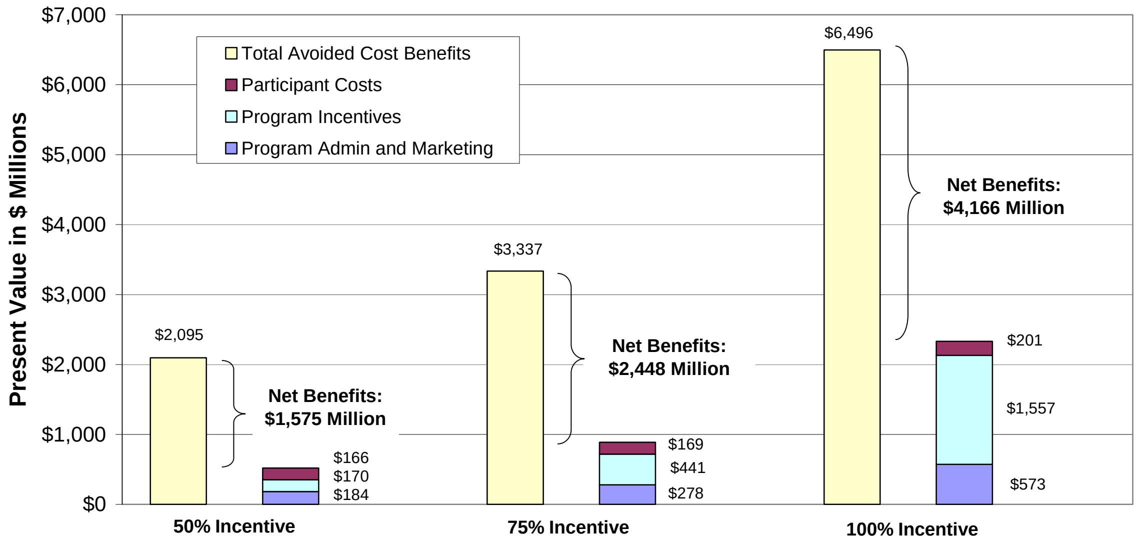



Figure 1-4 depicts costs and benefits under each program funding scenario from 2010 to 2020 for electric energy efficiency. The present value of program costs (including administration, marketing, and incentives) is $354 million under the 50-percent incentive scenario, $719 million under the 75-percent incentive scenario, and $2,130 million under the 100-percent incentive scenario. The present value of total avoided-cost benefits is $2,095 million under 50-percent incentives, $3,337 million under 75-percent incentives, and $6,496 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 $1,575 million under 50-percent incentives, $2,448 million under 75-percent incentives, and $4,166 million under 100-percent incentives.

**Figure 1-4**
**Benefits and Costs of Electric Efficiency Savings—2010-2020***



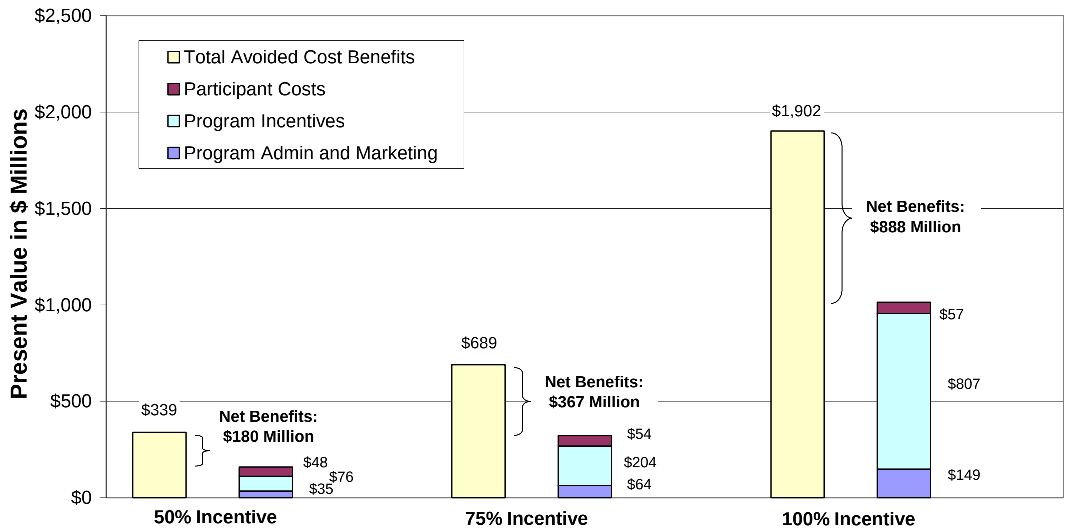

* Present value of benefits and costs over normalized 20-year measure lives; nominal discount rate is 7.9 percent, inflation rate is 1.5 percent.

Figure 1-5 shows the same sets of results for natural gas. The present value of program costs (including administration, marketing, and incentives) is $111 million under the 50-percent incentive scenario, $268 million under the 75-percent incentive scenario, and $956 million under the 100-percent incentive scenario. The present value of total avoided-cost benefits is $339 million under 50-percent incentives, $689 million under 75-percent incentives, and $1,902 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 $180 million under 50-percent incentives, $367 million under 75-percent incentives, and $888 million under 100-percent incentives.

For both electricity and natural gas, all three of the program funding scenarios are cost-effective based on the TRC (total resource cost) test, which was the test used in this study to determine program cost-effectiveness. The electric TRC benefit-cost ratios are 4.0 for the 50-percent incentive scenario, 3.8 for the 75-percent incentive scenario, and 2.8 for the 100-percent incentive scenario. The natural gas TRC ratios are 2.1 for the 50-percent incentive scenario and the 75-percent incentive scenario, and 1.9 for the 100-percent incentive scenario. Key results of our efficiency scenario forecasts from 2010 to 2020 are summarized in Table 1-3 (electricity) and Table 1-4 (natural gas).

**Figure 1-5**

**Benefits and Costs of Natural-Gas Efficiency Savings—2010-2020***




* Present value of benefits and costs over normalized 20-year measure lives; nominal discount rate is 7.7 percent, inflation rate is 1.5 percent.

**Table 1-3**

**Summary of Achievable Electric Potential Results—2010-2020**

| Result | Program Scenario 50% Incentive | 75% Incentive | 100% Incentive |
|---|---|---|---|
| **Gross Energy Savings - GWh** | 2,946 | 3,949 | 6,036 |
| **Gross Peak Demand Savings - MW** | 486 | 696 | 1,356 |
| **Net Energy Savings - GWh** | 1,802 | 2,806 | 4,892 |
| **Net Peak Demand Savings - MW** | 328 | 538 | 1,198 |
| **Program Costs - Real, $ Million** | | | |
| **Administration** | $179 | $303 | $682 |
| **Marketing** | $69 | $70 | $77 |
| **Incentives** | $227 | $584 | $1,966 |
| **Total** | $474 | $957 | $2,725 |
| **PV Avoided Costs Benefits** | $2,095 | $3,337 | $6,496 |
| **PV Annual Marketing and Admin Costs** | $184 | $278 | $573 |
| **PV Net Measure Costs** | $336 | $611 | $1,757 |
| **TRC Ratio** | 4.0 | 3.8 | 2.8 |

PV (present value) of benefits and costs is calculated over a 20-year normalized measure life for 2010-2020 program years, nominal discount rate = 7.9 percent, inflation rate = 1.5 percent; GWh and MW savings are cumulative through 2020.

**Table 1-4**
**Summary of Achievable Natural Gas Potential Results—2010-2020**

| Result | Program Scenario 50% Incentive | 75% Incentive | 100% Incentive |
|---|---|---|---|
| Gross Energy Savings - Millions of Dth | 6.1 | 10.6 | 26.0 |
| Net Energy Savings - Millions of Dth | 4.5 | 9.0 | 24.4 |
| Program Costs - Real, $ Million | | | |
| Administration | $33 | $71 | $181 |
| Marketing | $14 | $15 | $18 |
| Incentives | $101 | $271 | $1,047 |
| Total | $148 | $357 | $1,247 |
| PV Net Avoided Costs Benefits | $339 | $689 | $1,902 |
| PV Annual Marketing and Admin Costs | $35 | $64 | $149 |
| PV Measure Costs | $124 | $258 | $865 |
| TRC Ratio | 2.1 | 2.1 | 1.9 |

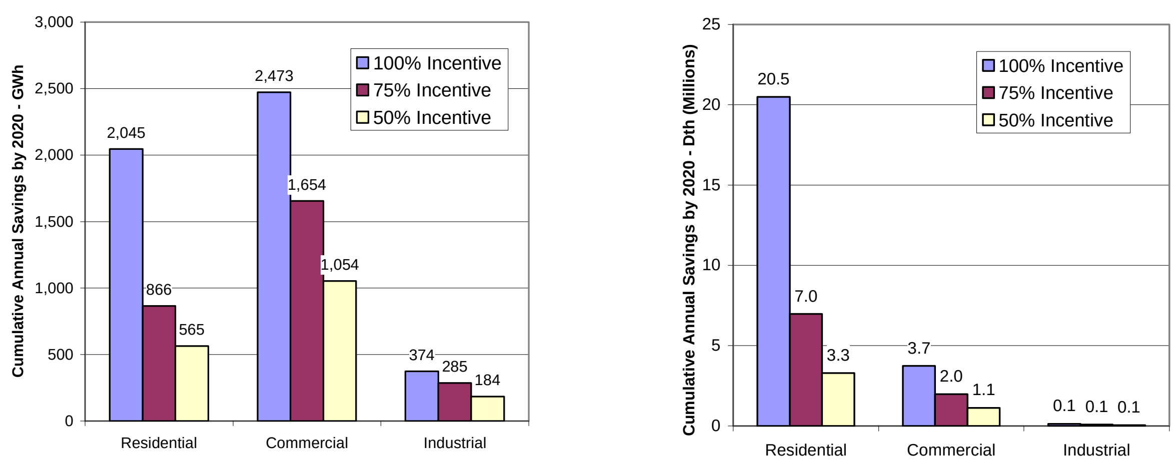
PV (present value) of benefits and costs is calculated over a 20-year normalized measure life for 2010-2020 program years, nominal discount rate = 7.7 percent, inflation rate = 1.5 percent; GWh and MW savings are cumulative through 2020.

## 1.2.2 Base Energy-Efficiency Results by Sector

Cumulative net-achievable-potential estimates by customer class are presented in Figure 1-6 for the 2010-2020 period. The figure shows results for each funding scenario. Achievable electric energy savings are highest for the commercial sector, while achievable natural gas savings are highest for the residential sector. Note that nonresidential transport-only customers are not included in the gas analysis, and hence the gas study focuses more on residential and small nonresidential potentials.

**Figure 1-6**
**Net Achievable Energy Savings (2020) by Sector**

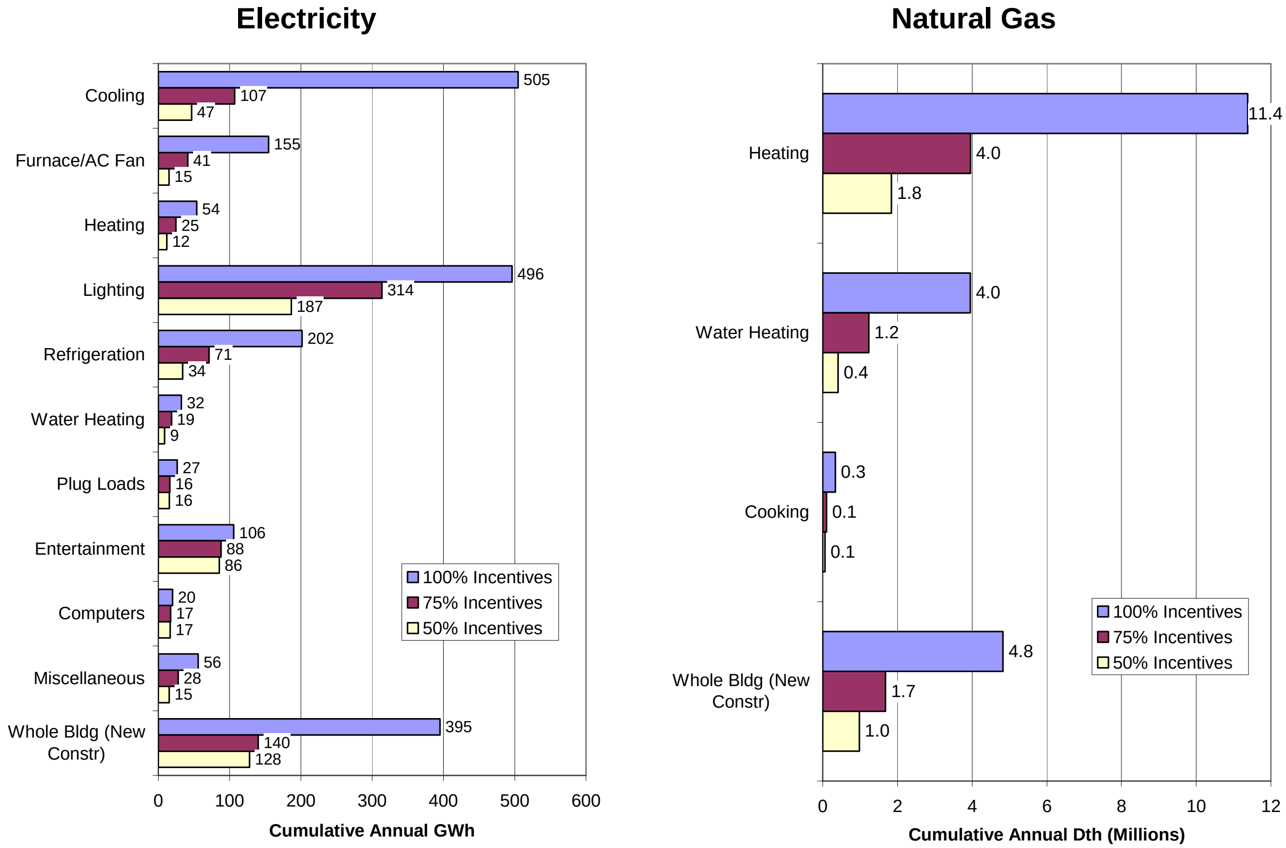
**Electricity- GWh** | **Natural Gas – Million Dth**



### 1.2.2.1 Residential Sector

Figure 1-7 shows the residential end-use distribution of electricity and natural-gas savings potential through 2020. Key electric end uses include lighting, cooling, refrigeration, and whole-building new construction measures. Key gas end uses include heating, water heating, and whole-building new construction measures.

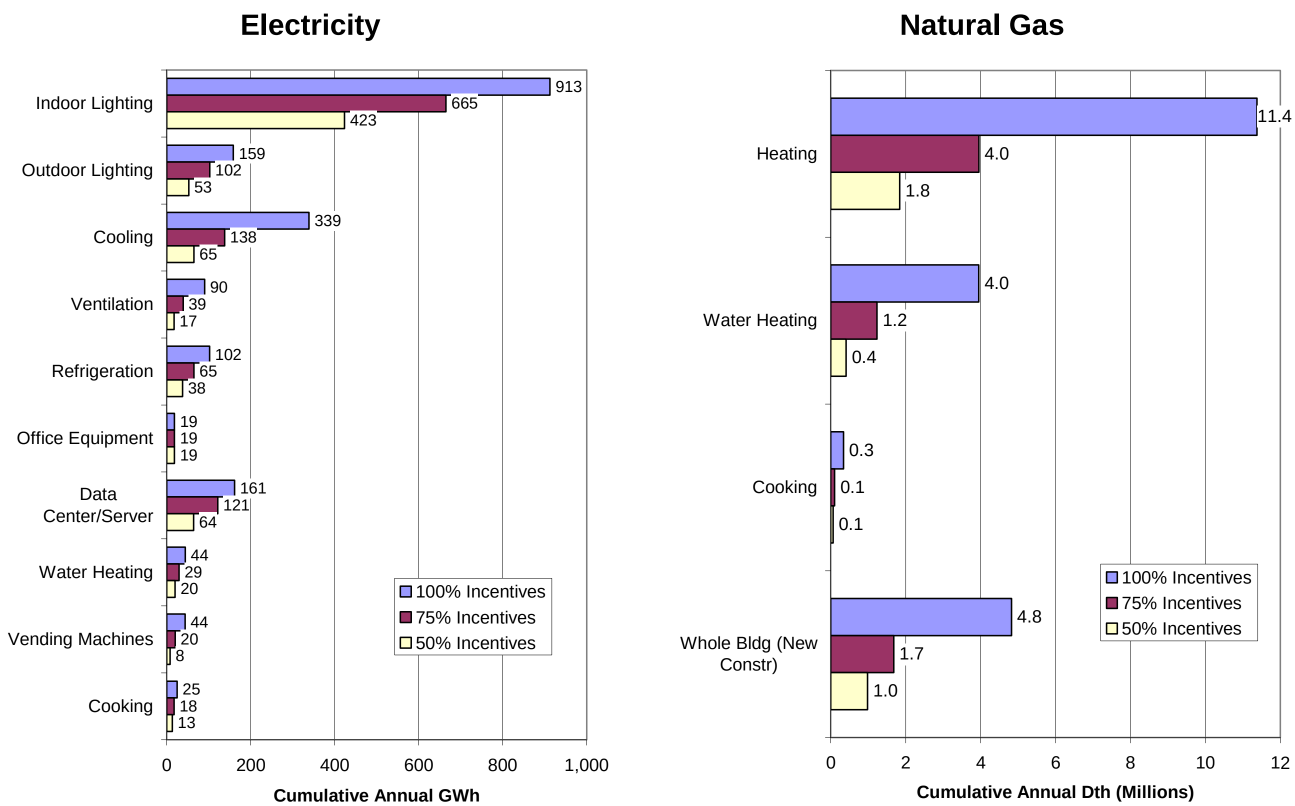
**Figure 1-7**
**Residential Net Energy Savings Potential by End Use (2020)**




### 1.2.2.2 Commercial Sector

Figure 1-8 shows the commercial end-use distribution of electricity and natural-gas savings potential through 2020. Key electric end uses include lighting, cooling, and data-center measures. Heating and water heating are the primary natural-gas end uses in terms of potential.

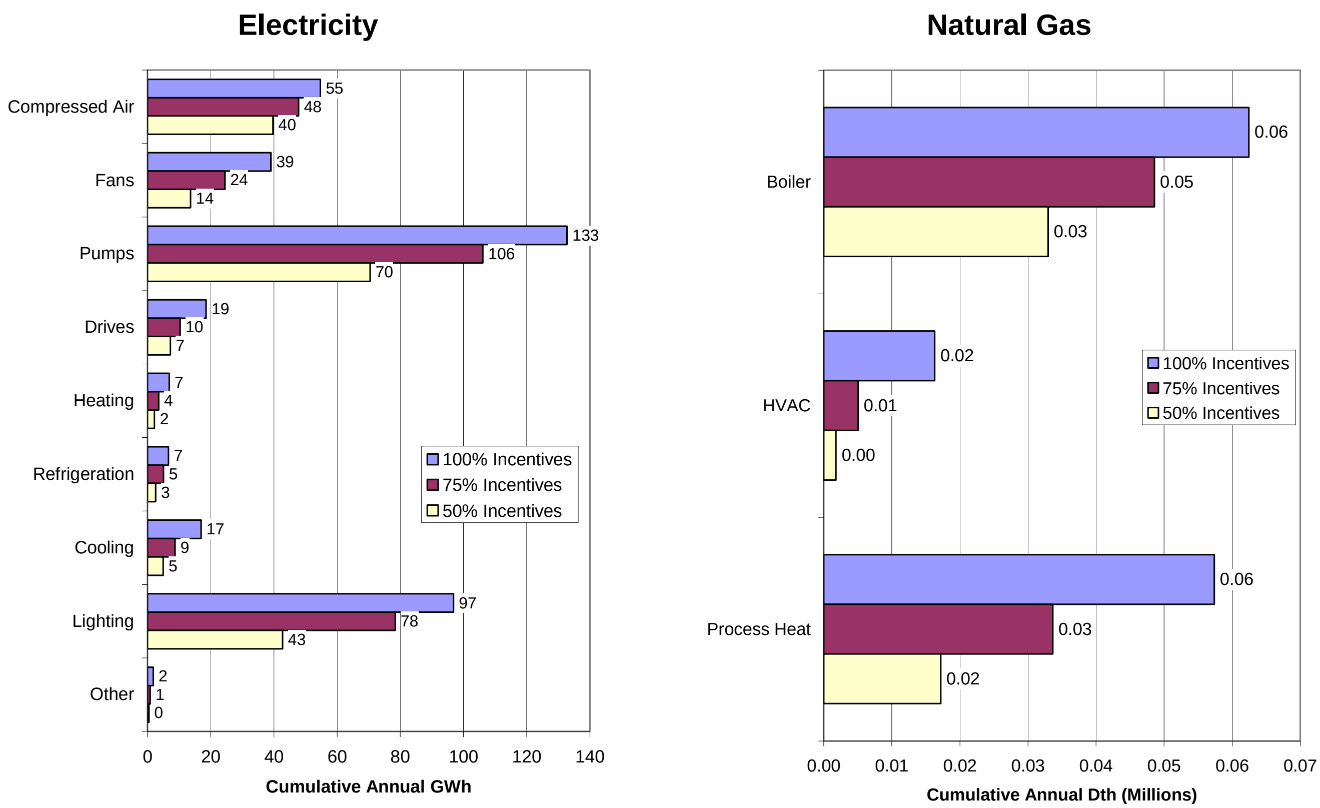
**Figure 1-8**
**Commercial Savings Potential by End Use (2020)**




### 1.2.2.3 Industrial Sector

Figure 1-9 shows the industrial end-use distribution of electricity and natural-gas savings potential through 2020. Key electric end uses include pumping, lighting, and compressed air. Boilers and process heating account for most of the natural-gas potential.

**Figure 1-9**
**Industrial Savings Potential by End Use (2020)**




## 1.2.3 Demand Response Results

Xcel Energy runs DR programs: a residential direct load control program, a non-residential direct load control program, targeted to medium-sized customers that is contracted out to a third party implementer, and an interruptible tariff program that is targeted at large customers. The residential direct load control program is currently saving about 101 MW per year and could be expanded to about 211 MW per year if Xcel Energy can capture about 50 percent of the residential central air conditioning market. The nonresidential direct load control program is currently savings about 20 MW per year and is in the process of being expanded to 40 MW. Xcel Energy does not see much added potential for expanding the program further. The interruptible tariff program is currently savings about 179 MW per year, and Xcel Energy believes it can expand this program to about 227 MW per year. Table 1-5 summarizes impacts and costs for a continuation of the current Xcel Energy programs (the business-as-usual scenario) and for an expansion of the current programs (expanded business-as-usual).

**Table 1-5**
**Summary of Demand Response Potentials for (2010-2020)**

| Result | Scenario: Business-as-Usual (BAU) | Expanded BAU |
|---|---|---|
| **Net Peak Demand Savings - MW** | 300 | 478 |
| | | |
| **Program Costs - Real, $ Million** | | |
| **Administration** | $14 | $20 |
| **Marketing** | $13 | $19 |
| **Third-Party** | $16 | $32 |
| **Incentives** | $300 | $464 |
| **Total** | $343 | $535 |
| | | |
| **PV Avoided Cost Benefits** | $494 | $646 |
| **PV Mkt, Admin, and 3rd Party Costs** | $30 | $49 |
| **PV Net Equipment Costs** | $44 | $65 |
| **TRC Ratio** | 6.7 | 5.7 |

PV (present value) of benefits and costs is calculated using a nominal discount rate = 7.9 percent, inflation rate = 1.5 percent; MW savings are cumulative through 2020.

### 1.2.4 Behavioral-conservation Results

We assessed two types of behavioral-conservation activities for the study: (1) indirect feedback approaches, which utilize energy information reports that motivate customers to use less, and (2) direct feedback interventions, such use of in-home energy-use monitors. Both of these approaches 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. The indirect feedback approaches account for 90 percent of the behavioral-conservation economic potentials since they are applicable to a much larger number of customers than the direct feedback measures. There are also significant concerns about the persistence of the direct feedback methods since many customers lose interest in monitoring home energy use through these devices. Hence, we focused on the indirect approach to estimate achievable program potential. For the analysis, we allowed for two-percent energy savings at a cost of $10 per home per year and modeled three levels of effort that: (1) targeted only the highest energy users; (2) targeted the high and medium energy users; and (3) targeted all residential customers.

Table 1-6 and Table 1-7 present the respective electric and gas results for the 2010-2020 period. As shown, electric behavioral-conservation potentials – if the assumptions outlined above hold up – could save between 44 and 176 GWh on annual program costs averaging between $9 million and $68 million dollars, depending on how many customers are targeted for indirect interventions. Natural-gas behavioral-conservation potentials could save between 0.46 and 1.90 million Dth on annual program costs averaging between $7.6 million and $51 million dollars, depending on the extent of program activities.

**Table 1-6**
**Achievable Potentials for Electric Behavioral Conservation (2010-2020)**

| Result | Scenario Low Large Users Only | Medium: Lrg-Med Users | High: All Customers |
|---|---|---|---|
| Gross Energy Savings - GWh | 43.7 | 107.4 | 175.8 |
| Gross Peak Demand Savings - MW | 10.7 | 26.3 | 43.1 |
| Net Energy Savings - GWh | 43.7 | 107.4 | 175.8 |
| Net Peak Demand Savings - MW | 10.7 | 26.3 | 43.1 |
| Program Costs - Real, $ Million | | | |
| Administration | $0.1 | $0.4 | $0.8 |
| Marketing | $8.4 | $32.6 | $67.0 |
| Incentives | $0.0 | $0.0 | $0.0 |
| Total | $8.6 | $33.0 | $67.8 |
| PV Avoided Costs Benefits | $35.1 | $86.2 | $141.0 |
| PV Annual Marketing and Admin Costs | $6.3 | $24.2 | $49.8 |
| PV Net Measure Costs | $0.0 | $0.0 | $0.0 |
| TRC Ratio | 5.6 | 3.6 | 2.8 |

PV (present value) of benefits and costs is calculated over a 20-year normalized measure life for 2010-2020 program years, nominal discount rate = 7.9 percent, inflation rate = 1.5 percent; GWh and MW savings are cumulative through 2020.

**Table 1-7**
**Achievable Potentials for Natural-Gas Behavioral Conservation (2010-2020)**

| Result | Scenario Low Large Users Only | Medium Lrg-Med Users | High All Customers |
|---|---|---|---|
| Gross Energy Savings - Millions of Dth | 0.46 | 1.29 | 1.90 |
| Net Energy Savings - Millions of Dth | 0.46 | 1.29 | 1.90 |
| Program Costs - Real, $ Million | | | |
| Administration | $0.1 | $0.4 | $0.8 |
| Marketing | $7.4 | $28.6 | $50.5 |
| Incentives | $0.0 | $0.0 | $0.0 |
| Total | $7.6 | $29.0 | $51.0 |
| PV Net Avoided Costs Benefits | $25.0 | $70.5 | $104.1 |
| PV Annual Marketing and Admin Costs | $5.6 | $21.3 | $37.4 |
| PV Measure Costs | $0.0 | $0.0 | $0.0 |
| TRC Ratio | 4.4 | 3.3 | 2.8 |

PV (present value) of benefits and costs is calculated over a 20-year normalized measure life for 2010-2020 program years, nominal discount rate = 7.9 percent, inflation rate = 1.5 percent; GWh and MW savings are cumulative through 2020.

### 1.2.5 Emerging Technology Results

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. Examples of some emerging technologies that might become available over the next 10 years include: energy-efficient smart windows, automated fault detection of air conditioners, night ventilation cooling systems, evaporative pre-condensers for air conditioners, advanced cooling refrigerants, advanced controls and sensors for industry, microwave processing of materials, and indirect evaporative cooling in the commercial sector.

In order to address the possible effects of emerging energy-efficiency measures, we focused our potential analysis on several of the more promising emerging technologies:

- LED lighting, including LED street lighting, LED replacements for incandescent/CFL lighting in the residential sector, and LED replacements for fluorescent tube lighting in the commercial sector;
- Induction street lighting, which is somewhat less efficient and also less costly than LED lighting;
- Fiber-optic refrigeration display lighting; and
- Indirect evaporative cooling in the residential sector.

For the analysis, we assumed that these measures were all commercially available and could provide claimed savings. We also assumed equipment costs that made these measures commercially viable.

Figure 1-10 and Figure 1-11 show the effects on economic potential (energy and peak demand, respectively) from the addition of emerging technologies. Overall, economic potential increases by 1,800 GWh (24 percent) and 628 MW (36 percent) when emerging technologies are considered. Economic potential for energy savings increases by about the same rate for the residential and commercial sectors, but economic peak-demand potential increases most in the residential sector (61 percent for the residential sector compared to 15 percent in the commercial sector) as a result of the indirect evaporative cooler measure. We expect that up to 55 percent of the energy savings from emerging technologies could be achieved through programs over an 11-year period once these technologies are proven to be commercially viable.

**Figure 1-10**
**Electric Energy Economic Potentials with Emerging Technologies (11 Years)**

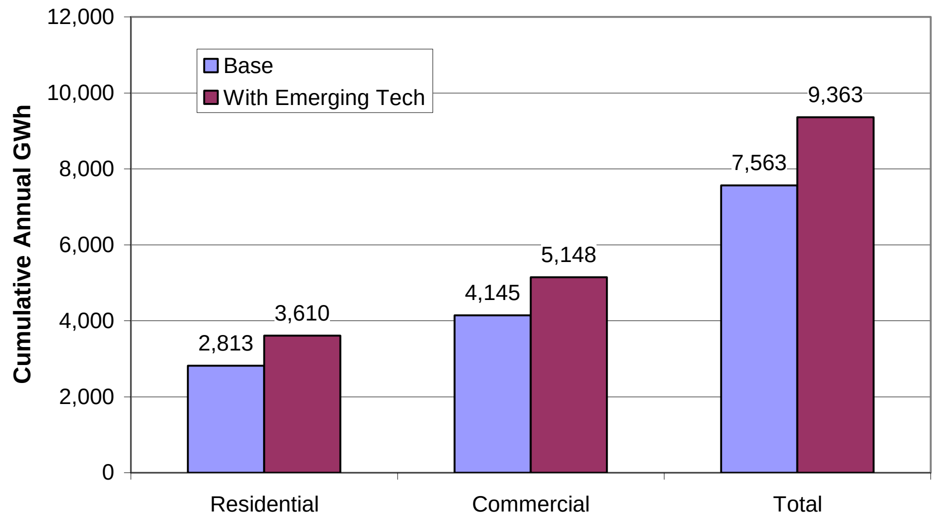
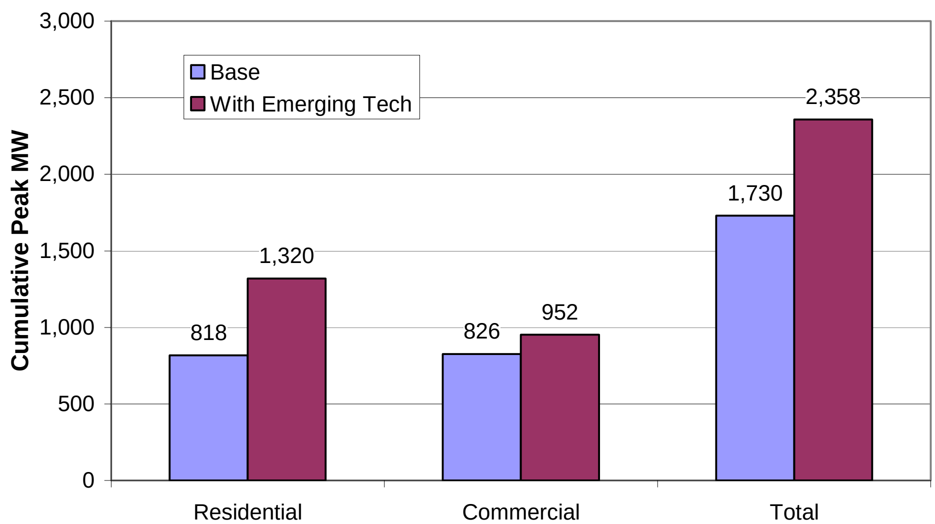



**Figure 1-11**
**Peak-Demand Economic Potentials with Emerging Technologies (11 Years)**




### 1.2.6 Sensitivity to Higher Avoided-Cost Forecasts

The avoided cost assumptions used in the potential study are based on the marginal energy cost forecast that Xcel Energy Developed in October 2009. This forecast also detailed the annual commodity cost assumption used each year for gas. This new forecast resulted in a reduction from the assumptions used in the 2009-2010 DMS Plan in the marginal energy costs used in electric avoided cost assumptions, and a reduction in the gas volumetric costs and retail rates, for years 2010-2038.

In addition to the analysis we developed using the Xcel Energy October 2009 avoided-cost forecast, we tested the sensitivity of our analysis to higher avoided costs by also examining potentials under the 2009-2010 DSM Plan avoided costs, which reflect a higher value of energy efficiency. For the higher cost scenario, we utilized electric costs that were about 35 percent higher than base costs and gas costs that were about 40 percent higher than base costs. Figure 1-12 and Figure 1-13 show how electric and gas economic potentials change as a result of the higher avoided-cost assumptions. Electric potentials increase by about 3.5 percent and gas potentials increase by about 5.1 percent. These changes are not large since many of the studied measures were already cost effective in the base avoided-cost scenario.

Table 1-8 provides a comparison of cumulative achievable potentials to 2020 for the base and high cost scenarios. Results are shown by sector and by program scenario. Overall, naturally occurring energy efficiency increases 25% for electricity and 30% for natural gas in the high cost scenario, as the higher energy prices make energy efficiency investments more attractive to customers, even without Xcel Energy programs. Program potentials also increase, in most cases, as the higher cost of energy makes it easier for Xcel Energy to promote energy efficiency. The increase is higher for natural-gas potentials. For the electric 100-percent incentives scenario, program potentials actually decrease slightly in the high cost scenario, as the effects of naturally occurring energy efficiency outweigh program effects.

**Figure 1-12**
**Economic Electric Potentials by Avoided-Cost Scenario (2020)**

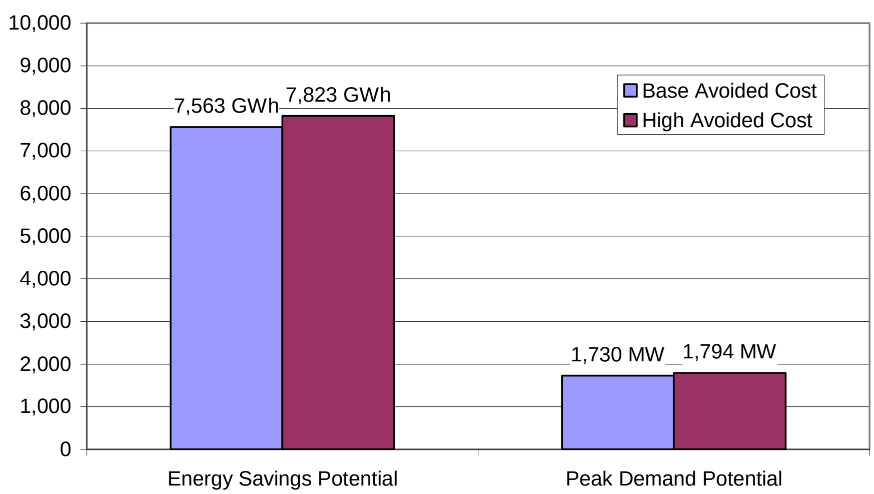


**Figure 1-13**
**Economic Gas Potentials by Avoided-Cost Scenario (2020)**

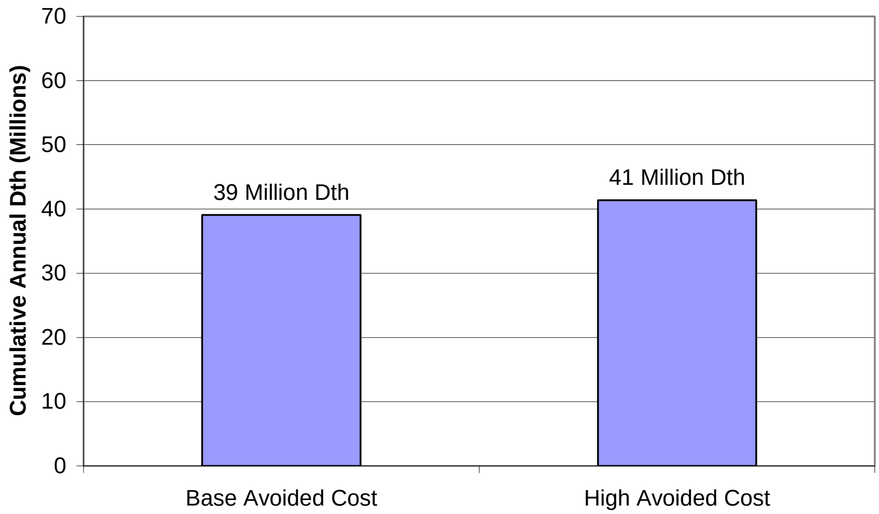


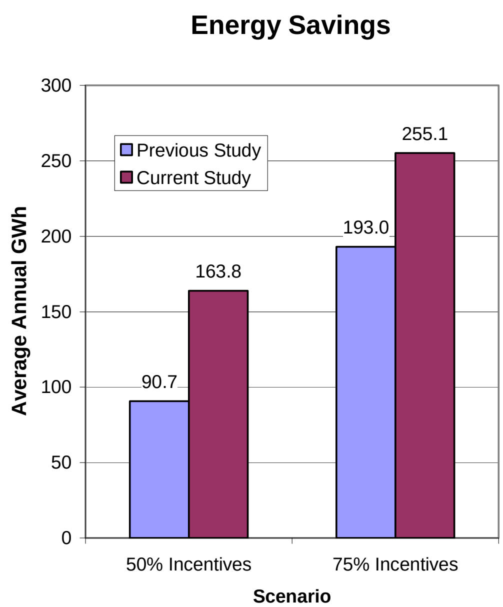

**Table 1-8**
**Comparison of Achievable Energy Potentials for Base and High Avoided Cost Scenarios**
**Cumulative to 2020**

| Sector | Program Scenario | GWh by Cost Scenario | | | Million Dth by Cost Scenario | | |
|---|---|---|---|---|---|---|---|
| | | Base | High | % Chg | Base | High | % Chg |
| Residential | 50% Incentive | 565 | 616 | 9% | 3.299 | 4.467 | 35% |
| | 75% Incentive | 866 | 964 | 11% | 6.975 | 8.934 | 28% |
| | 100% Incentive | 2,045 | 2,056 | 1% | 20.493 | 21.854 | 7% |
| | Naturally Occurring | 311 | 390 | 25% | 0.468 | 0.745 | 59% |
| Commercial | 50% Incentive | 1,054 | 1,153 | 9% | 1.131 | 1.253 | 11% |
| | 75% Incentive | 1,654 | 1,715 | 4% | 1.977 | 2.197 | 11% |
| | 100% Incentive | 2,473 | 2,439 | -1% | 3.739 | 3.831 | 2% |
| | Naturally Occurring | 754 | 922 | 22% | 1.082 | 1.277 | 18% |
| Industrial | 50% Incentive | 184 | 211 | 15% | 0.052 | 0.060 | 16% |
| | 75% Incentive | 285 | 286 | 0% | 0.087 | 0.094 | 8% |
| | 100% Incentive | 374 | 349 | -7% | 0.136 | 0.138 | 1% |
| | Naturally Occurring | 79 | 119 | 50% | 0.035 | 0.046 | 32% |
| Total | 50% Incentive | 1,802 | 1,979 | 10% | 4.483 | 5.781 | 29% |
| | 75% Incentive | 2,806 | 2,965 | 6% | 9.039 | 11.224 | 24% |
| | 100% Incentive | 4,892 | 4,845 | -1% | 24.369 | 25.823 | 6% |
| | Naturally Occurring | 1,144 | 1,431 | 25% | 1.585 | 2.068 | 30% |

### 1.2.7 Comparison to Other Analyses

Figure 1-14 provides a comparison of the results from the current DSM potential study with those of the previous study, completed in 2006. The figure shows average annual GWh savings and associated average annual program costs. (Only the 50-percent and 75-percent incentive scenarios are presented because a 100-percent incentive scenario was not developed for the 2006 study.) As shown, energy savings increase by 81 percent in the 50-percent incentives scenario and by 32 percent in the 75-percent incentives scenario. Program costs increase by 122 percent and 66 percent in the 50-percent and 75-percent incentives scenarios, respectively.

**Figure 1-14**
**Comparison of Current DSM Potential Study to the 2006 DSM Potential Study**
**Average Annual Savings and Program Costs**



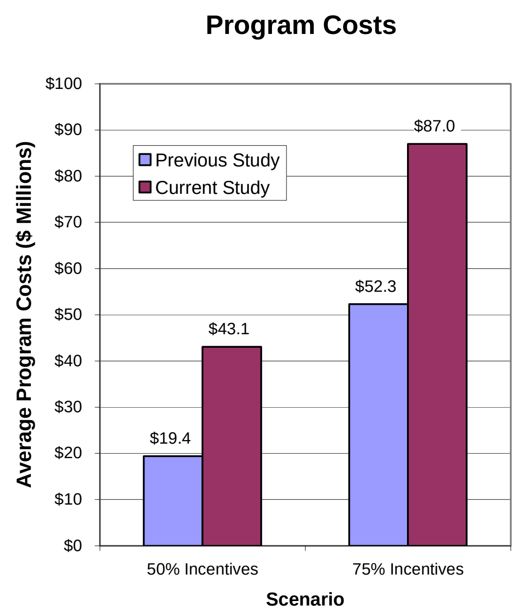




Table 1-9 provides a comparison of savings and program costs for the current DSM potential study and Xcel Energy's current DSM plan. As the table shows, the Xcel Energy electric plan estimates fall in between this study's 50-percent and 75-percent incentives scenarios. The Xcel Energy gas plan comes in very close to this study's 50-percent incentives scenario.

Table 1-9
Comparison of Current DSM Potential Study to the Current Xcel Energy DSM Plan
Average Annual Savings and Program Costs

| Scenario / Study | Electric | | Natural Gas | |
|---|---|---|---|---|
| | GWh | Program Cost ($ Million) | Million Dth | Program Cost ($ Million) |
| 50% Incentives | 163.8 | $43.1 | 0.41 | $13.5 |
| 75% Incentives | 255.1 | $87.0 | 0.82 | $32.4 |
| Plan | 237.5 | $55.5 | 0.40 | $12.8 |

### 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 in the 50-percent incentive scenario as these results are most consistent with current program experience. Uncertainty is higher in the 75-percent and 100-percent incentive scenarios, as these are projections that extend beyond the bulk of historical experience. This uncertainty is greatest for the 100-percent incentive scenario because we have no “real world” program experience where all the incremental measure costs 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.

## 1.3 Conclusions

As the results of this study indicate, there is a significant amount of energy efficiency potential remaining in the Xcel Energy Colorado service territory. For electricity, the residential and commercial sectors provide the largest sources of potential savings.

Key residential end uses, in terms of potentials, include cooling, lighting, and refrigeration. Whole-building new construction measures are also a source of large potential savings. It may be necessary to offer fairly large incentives to capture the largest amounts of residential electricity savings potential, as our modeling results show the largest jump in savings coming when incentives are increase above 75 percent of incremental measure cost. Plug loads, home entertainment equipment, and home office equipment also provide a significant of energy savings potential, but use of customer incentives for measures in these end uses does not appear to be the way to go as there is usually very little cost differential between standard-efficiency and high-efficiency equipment. Customer education and upstream activities are probably more useful approaches to increase the availability and purchases of more efficient electronic equipment.

In the commercial sector, lighting and cooling continue to provide the largest sources of electric energy efficiency potential. Data center and server measures also appear to be a growing source of potential energy savings.

Xcel Energy's demand response programs will continue to be a large source of peak demand savings. These programs account for over half the savings potential in the 50-percent incentive scenario, and provide a substantial source of savings potential in all program scenarios.

The residential sector is by far the largest source of natural-gas savings potential. (Note that gas transport customers were excluded from our analysis, and hence the residential sector comprises about 70 percent of the gas consumption under study.) The key residential end uses are space heating and water heating, and key measures include high efficiency water heaters, furnaces and boilers as well as building shell measures such as insulation and weatherization. Residential new construction measures also provide a large source of potential natural-gas savings. Similar to the electric findings, it may take fairly large incentives to capture high levels of residential gas potential.

Behavioral conservation activities 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 will be useful for Xcel Energy to run pilot programs to test both the technical effectiveness and the market acceptance of emerging technologies before rolling out full scale programs.

Finally, we investigated the effectiveness of whole-house retrofit programs on increasing energy efficiency potential in the Xcel Energy market. We've concluded that whole-house treatments will not increase the identified potentials we developed in this study using our bottom up methodology.  Rather, they may provide a way to reduce program costs by maximizing the effects of customer outreach efforts. Xcel Energy should explore ways to bundle retrofit measures into a comprehensive program offering. Pilot program costs should be carefully tracked to determine if a whole-house approach can provide savings over traditional measure-specific delivery of energy efficiency services.

# 2. Introduction

## 2.1 Overview

In its 2009-2010 Biennial DSM Plan, filed in August 2008, Public Service proposed to conduct a combined electric and natural-gas DSM market potential study in time to inform its next Biennial Plan to be filed in summer 2010 and its next Resource Plan to be filed in 2011.

The study will:

1. Help determine how much electric and natural-gas technical, economic, achievable (market), and naturally occurring potential exists within Xcel Energy's Colorado service territory for cost-effective energy-efficiency and demand-response resources.
2. Be used to inform the company's Resource Plan in 2011 as well as subsequent biennial filings in 2010 and to comply with directives from the COPUC in Decision C08-560.
3. Assist in establishing mechanisms by which the company can continuously evaluate opportunities for cost-effective DSM, including but not limited to financial modeling.

KEMA, Inc. (KEMA) was retained to conduct this demand-side management (DSM) market potential study. The study provides estimates of potential electricity and peak-demand savings and natural-gas savings from DSM measures in Xcel Energy's Colorado service territory. For electric potentials, this study is an update of work that was performed by KEMA in the 2005-2006 period.

The scope of this study includes new and existing residential and nonresidential buildings, as well as industrial process savings. The study covers an 11-year period spanning 2010-2020. Given the near- to mid-term focus, the base study was restricted to DSM measures that are presently commercially available. A number of measures were evaluated as emerging technologies, for example LED lighting. While 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. Unit energy savings and cost inputs for these measures are near-term (2-3 year) forecasts, based on current trends.

Data for the study come from a number of different sources, including primary data collected for this project, on-site data collected in 2005 for the previous DSM assessment, secondary sources that include internal Xcel Energy studies and data, as well as a variety of information from third parties. The primary data collection effort for this study involved 300 residential phone surveys and 303 commercial phone surveys.

## 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 phone surveys and commercial phone surveys were utilized, in conjunction with 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 Colorado 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*[4] for the State of Colorado and customized the results to the Xcel Energy Colorado service territory, utilizing information on Xcel Energy's peak demand relative to the Colorado 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 6 discusses the results of the electric energy-efficiency potential analysis by sector and over time. Section 6 presents similar results for gas energy-efficiency potential. Section 7 presents demand-response potential results.

[4] *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

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.
- 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: Measure Inputs—Lists the natural-gas measures included in the analysis with the costs, estimated savings, applicability, and estimated current saturation factors.
- Appendix G: Non-Additive Measure Level Results—Shows energy-efficiency potential for each measure independent of any other measure.
- Appendix H: Supply-Curve Data—Shows the data behind the energy supply curves provided in Section 1 of the report.
- Appendix I: Achievable Program Potential—Provides the forecasts for the achievable potential scenarios.

# 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

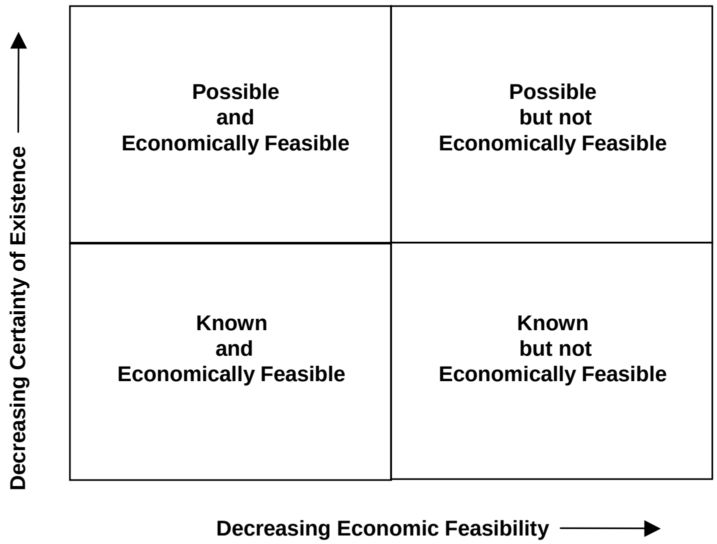
Energy-efficiency potential studies were popular throughout the utility industry from the late 1980s through the mid-1990s. This period coincided with the advent of what was called least-cost or integrated resource planning (IRP). Energy-efficiency potential studies became one of the primary means of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

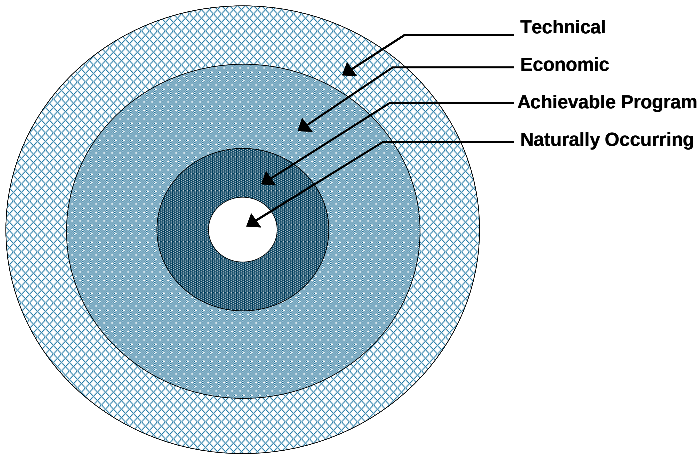
- **Technical potential** is defined in this study as the *complete* penetration of all measures analyzed in applications where they were deemed *technically* feasible from an *engineering* perspective.

**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.

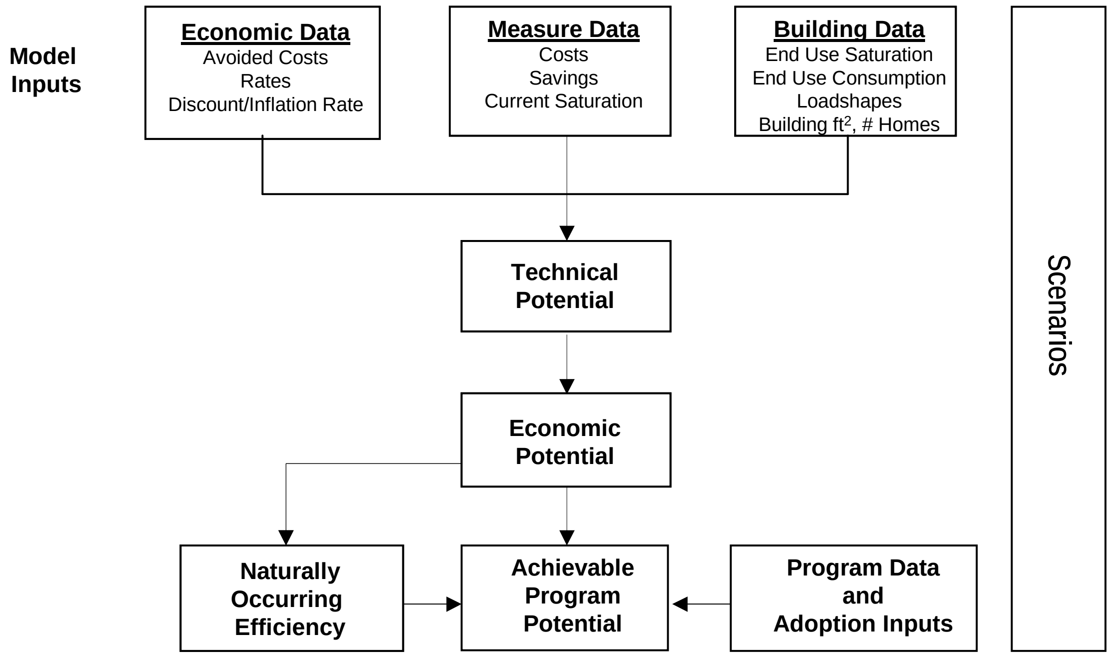
**Figure 3-2**
**Conceptual Relationship among Energy-Efficiency Potential Definitions**




## 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, two primary data collection efforts were undertaken: a phone survey of 300 residential homes and a phone survey of 303 commercial establishments.

- 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, three program-funding scenarios were considered: 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 Fifty-percent Incentive Scenario

In the 50-percent incentive scenario, base incentive levels are set to 50 percent of incremental measure costs. 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. Marketing/customer education budgets correspond to current Xcel Energy budgets.

### 3.3.2 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 administration budgets were also increased for this scenario.

### 3.3.3 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 administration budgets were increased again for this scenario.

### 3.3.4 Summary of Scenarios

Table 3-1 shows average spending on electricity programs for each of the scenarios for the 2010-2020 forecast period for the base analysis, which does not include emerging technologies, behavioral-conservation measures, or demand response. Table 3-2 shows average spending on natural-gas programs for the base analysis.

**Table 3-1**
**Scenario Average Spending during 2010-2020 Forecast Period ($1000s)**
**Electric Programs**

| Funding Level | Market Segment | Cost Components: Admin | Marketing | Incentives | Total | % Incremental Measure Cost Paid* |
|---|---|---|---|---|---|---|
| 50% Incentives | Residential Existing | $3,286 | $2,695 | $2,593 | $8,574 | 50% |
| | Residential New Construction | $889 | $200 | $3,722 | $4,811 | 50% |
| | Residential Low Income | $126 | $100 | $3,684 | $3,910 | 100% |
| | Commercial Existing | $8,203 | $2,048 | $7,041 | $17,291 | 50% |
| | Commercial New Construction | $2,569 | $600 | $2,155 | $5,323 | 50% |
| | Industrial | $1,163 | $600 | $1,448 | $3,211 | 50% |
| | Total | $16,236 | $6,243 | $20,642 | $43,121 | |
| 75% Incentives | Residential Existing | $7,038 | $2,695 | $9,632 | $19,365 | 75% |
| | Residential New Construction | $2,479 | $200 | $9,506 | $12,185 | 75% |
| | Residential Low Income | $193 | $200 | $6,057 | $6,450 | 100% |
| | Commercial Existing | $13,204 | $2,048 | $19,792 | $35,044 | 75% |
| | Commercial New Construction | $3,122 | $600 | $4,352 | $8,074 | 75% |
| | Industrial | $1,526 | $600 | $3,763 | $5,889 | 75% |
| | Total | $27,563 | $6,343 | $53,102 | $87,007 | |
| 100% Incentives | Residential Existing | $26,670 | $2,695 | $62,065 | $91,431 | 100% |
| | Residential New Construction | $8,000 | $200 | $34,600 | $42,800 | 100% |
| | Residential Low Income | $581 | $842 | $10,995 | $12,418 | 100% |
| | Commercial Existing | $21,062 | $2,048 | $55,868 | $78,977 | 100% |
| | Commercial New Construction | $3,864 | $600 | $7,959 | $12,423 | 100% |
| | Industrial | $1,854 | $600 | $7,225 | $9,679 | 100% |
| | Total | $62,031 | $6,985 | $178,712 | $247,728 | |

**Table 3-2**
**Scenario Average Spending during 2010-2020 Forecast Period ($1000s)**
**Natural-Gas Programs**

| Funding Level | Market Segment | Cost Components | | | | % Incremental Measure Cost Paid* |
|---|---|---|---|---|---|---|
| | | Admin | Marketing | Incentives | Total | |
| 50% Incentives | Residential Existing | $1,021 | $550 | $2,444 | $4,015 | 50% |
| | Residential New Construction | $1,036 | $200 | $2,309 | $3,546 | 50% |
| | Residential Low Income | $129 | $100 | $2,958 | $3,187 | 100% |
| | Commercial Existing | $626 | $240 | $1,054 | $1,920 | 50% |
| | Commercial New Construction | $205 | $130 | $387 | $721 | 50% |
| | Industrial | $22 | $20 | $42 | $83 | 50% |
| | Total | $3,038 | $1,240 | $9,194 | $13,472 | |
| 75% Incentives | Residential Existing | $2,603 | $550 | $9,552 | $12,705 | 75% |
| | Residential New Construction | $2,027 | $200 | $6,978 | $9,205 | 75% |
| | Residential Low Income | $203 | $200 | $4,050 | $4,452 | 100% |
| | Commercial Existing | $1,293 | $240 | $3,113 | $4,646 | 75% |
| | Commercial New Construction | $267 | $130 | $837 | $1,234 | 75% |
| | Industrial | $36 | $20 | $110 | $167 | 75% |
| | Total | $6,429 | $1,340 | $24,641 | $32,409 | |
| 100% Incentives | Residential Existing | $8,093 | $550 | $48,161 | $56,804 | 100% |
| | Residential New Construction | $4,027 | $200 | $25,654 | $29,881 | 100% |
| | Residential Low Income | $606 | $500 | $9,526 | $10,632 | 100% |
| | Commercial Existing | $3,281 | $240 | $9,956 | $13,478 | 100% |
| | Commercial New Construction | $417 | $130 | $1,644 | $2,191 | 100% |
| | Industrial | $57 | $20 | $276 | $353 | 100% |
| | Total | $16,483 | $1,640 | $95,217 | $113,339 | |

## 3.3.5 Avoided-Cost Scenarios

The avoided-cost assumptions used in the study are based on the marginal energy cost forecast that Xcel Energy developed in October 2009. This forecast also detailed the annual commodity cost assumption used each year for gas. This new forecast resulted in a reduction from the assumptions used in the 2009-2010 DMS Plan in the marginal energy costs used in electric avoided cost assumptions, and a reduction in the gas volumetric costs and retail rates, for years 2010-2038.

In order to test the sensitivity of the potential analysis to higher avoided costs, we also developed estimates of energy efficiency potential using the cost assumptions from the 2009-2010 DSM Plan. In this report, we refer to the most current avoided cost forecast as the base forecast and the 2009-2010 DSM Plan forecast as the high-cost forecast.

### 3.3.5.1 Electric Avoided Costs

The electric avoided costs were developed by time-of-use (TOU) period. These periods are shown in Table 3-3. Figure 3-4 shows the base electric avoided-cost forecast by TOU period, and Figure 3-5 shows the high electric avoided-cost forecast by TOU period. Figure 3-6 provides a comparison of the forecasts using load-weighted averages of the TOU forecasts. Overall, the high-cost forecast is about 35 percent higher than the base forecast. Note that both forecasts include adders for environmental externalities ($CO_2$ and $SO_x$) and also 10-percent adders for non-energy benefits (20-percent adders for the low-income market segment). In addition to energy avoided costs, capacity avoided costs are included in the analysis, starting at $179 per kW and increasing by about 3.3 percent per year.

**Table 3-3**
**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 the 2009 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**

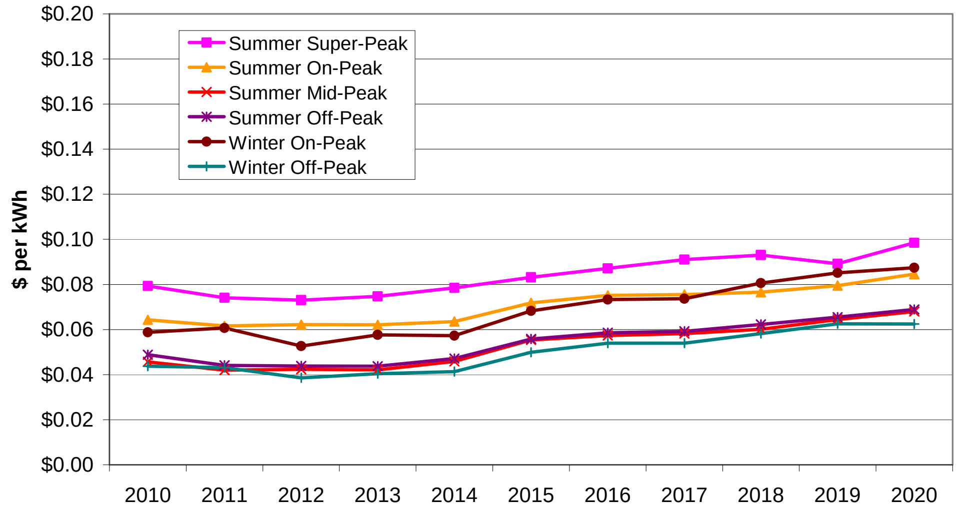



**Figure 3-5**
**Electric Avoided-Cost Forecast – High Cost**

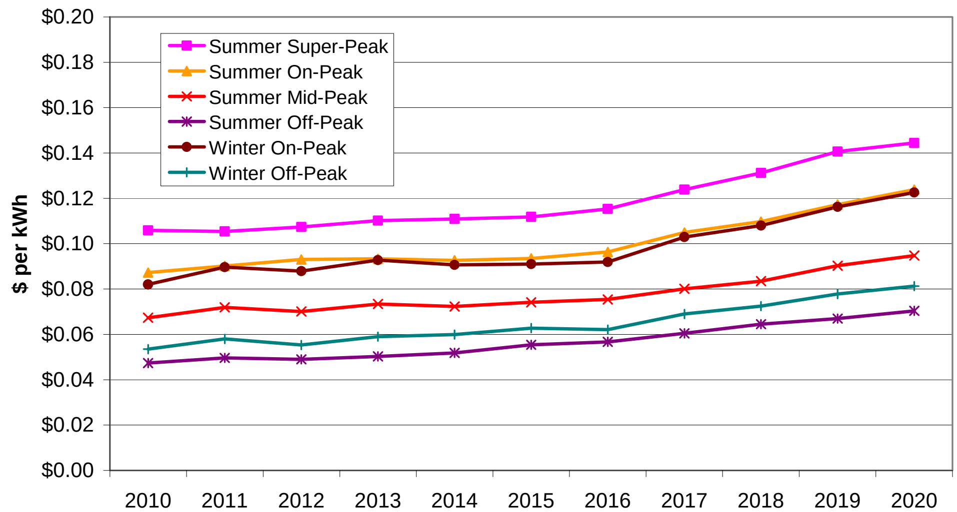
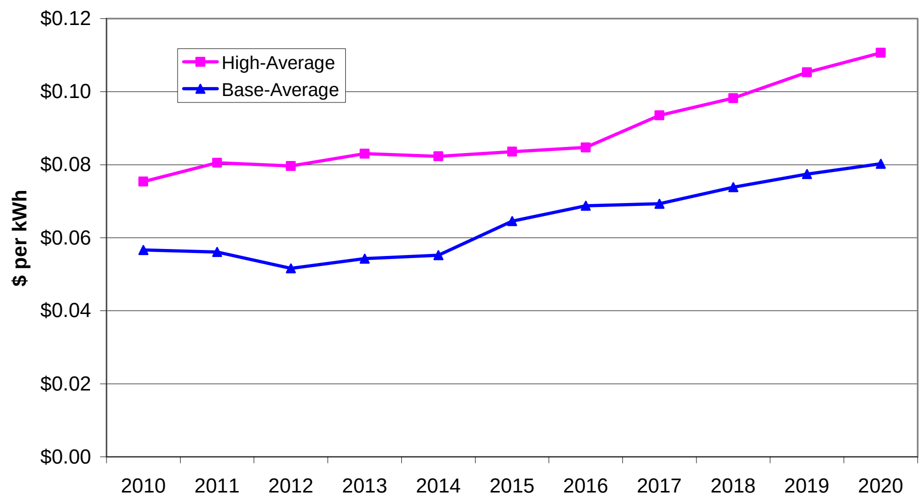


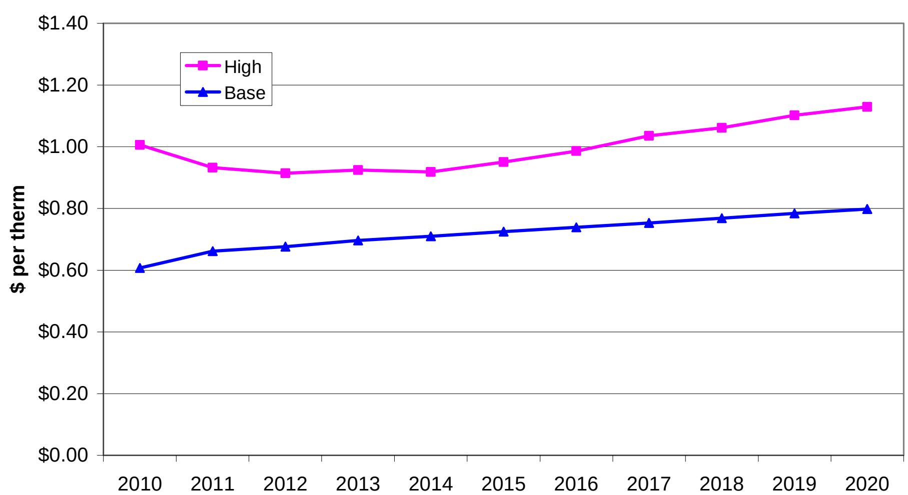
**Figure 3-6**
**Electric Avoided-Cost Forecast – Base-High Comparison**




### 3.3.5.2 Natural-Gas Avoided Costs

Figure 3-7 shows the base and high natural gas avoided-cost forecasts. Overall, the high-cost forecast is about 40 percent higher than the base forecast. Note that both forecasts include five-percent adders for non-energy benefits.

**Figure 3-7**
**Natural Gas Avoided-Cost Forecast – Base-High Comparison**



# 4. Baseline Results

## 4.1 Overview

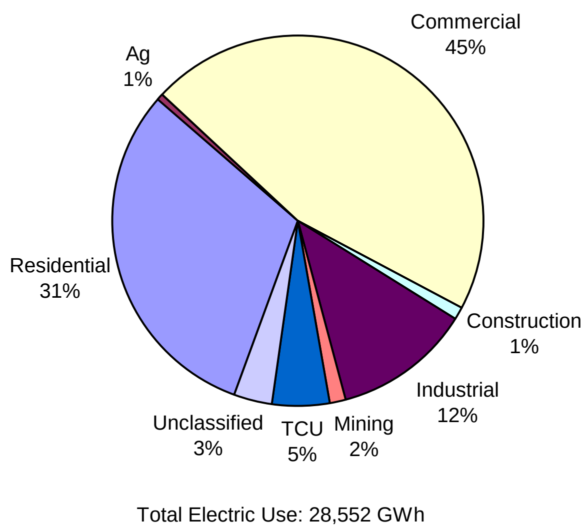
Estimating the potential for energy-efficiency improvements requires a comparison of the energy impacts of standard-efficiency technologies with those of alternative high-efficiency equipment. This, in turn, dictates a relatively detailed understanding of the energy characteristics of the marketplace. 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 conducted for the 2006 Xcel Energy Colorado DSM assessment, and telephone surveys conducted as part of this project, 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 Colorado 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.

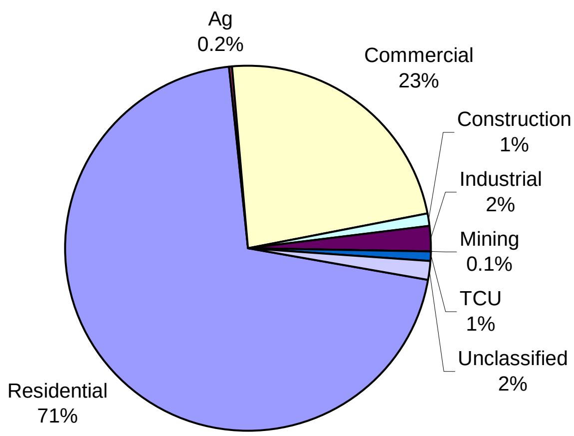
**Figure 4-1**
**Electricity Usage Breakdown – Xcel Energy Colorado Service Territory**




Source: Xcel Energy Billing Records 2008, Calibrated to 2010 Sales Forecast (from February/March 2009)

Figure 4-2 shows the overall breakdown of natural-gas use by sector for the Xcel Energy Colorado service territory. Residential accounts for the largest share of natural-gas usage, followed by the commercial and industrial sectors.

**Figure 4-2**
**Natural Gas Usage Breakdown—Xcel Energy Colorado Service Territory**




Total Gas Use: 1.348 Million Therms

Source: Xcel Energy Billing Records 2008,
Calibrated to 2010 Sales Forecast (from Feb./Mar. 2009)

## 4.2 Electricity

### 4.2.1 Residential

For the residential sector, customer counts were provided by Xcel Energy. Dwellings were split into single-family and multifamily components using data from the Xcel Energy billing system, the Xcel Energy Residential Use Study (2004), and 300 residential on-site surveys that were conducted as part of this study.

For the energy-efficiency potential study, we broke the residential sector into five segments:

- Single family–large
- Single family–medium
- Single family–small
- Multifamily
- Low income

For single-family homes, the large and small segments are designed to comprise 20 percent of the single-family homes category each, and the medium segment comprises 60 percent of the single-family homes.

The saturation analysis to derive percentage of homes that have a given end use was conducted using the most recent Xcel Energy Home Use Study. UECs (energy use per appliance) were developed using secondary source data. Household estimates for each segment were based on analysis of the Home Use Study.

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.

Table 4-1 (energy) and Table 4-2 (peak demand) summarize the residential baseline electricity consumption results developed for the study. Figure 4-3 shows the breakdown of electricity use by residential segment. Figure 4-4 breaks down electricity use by end use.

Overall consumption for energy and peak demand by customer segment is shown in Figure 4-5. Although the small single-family and large single-family segments represent the same number of homes, the energy use for the large single-family segment is more than four times that of small single-family homes, and peak demand is almost seven times as high.

Figure 4-6 shows energy use and peak demand by end use. Overall, lighting and cooling are the largest end uses in terms of electricity consumption, each with over 1,500 GWh, followed by miscellaneous, refrigeration, and TVs/entertainment. Central air conditioning (CAC) is the largest end use in terms of peak demand, with six times the peak of the next largest end use.

## Table 4-1
## Residential Baseline Consumption Summary, Electricity – kWh, 2010

| | Single Family Large | | | Single Family Medium | | | Single Family Small | | | Multifamily | | | Low Income | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| End Use | Saturation | UEC | Avg Use | Saturation | UEC | Avg Use | Saturation | UEC | Avg Use | Saturation | UEC | Avg Use | Saturation | UEC | Avg Use |
| Split-System Air Conditioner | 0.56 | 3,880 | 2,169 | 0.49 | 1,514 | 741 | 0.26 | 572 | 148 | 0.40 | 1,922 | 765 | 0.36 | 1,391 | 504 |
| Room Air Conditioner | 0.08 | 1,941 | 163 | 0.05 | 758 | 35 | 0.06 | 286 | 18 | 0.18 | 960 | 168 | 0.09 | 696 | 63 |
| Evaporative Cooler | 0.25 | 2,191 | 539 | 0.27 | 578 | 157 | 0.30 | 125 | 38 | 0.04 | 807 | 30 | 0.20 | 709 | 143 |
| Dehumidifier | 0.16 | 407 | 64 | 0.06 | 275 | 15 | 0.06 | 157 | 9 | 0.07 | 340 | 24 | 0.20 | 253 | 51 |
| Furnace Fan--Furnace + CAC | 0.52 | 1,796 | 939 | 0.47 | 765 | 357 | 0.26 | 284 | 74 | 0.29 | 792 | 228 | 0.36 | 702 | 254 |
| Resistance Space Heating | 0.13 | 4,363 | 563 | 0.07 | 1,866 | 131 | 0.04 | 692 | 30 | 0.31 | 1,908 | 589 | 0.09 | 1,714 | 161 |
| Lighting, Std Fixt | 1.00 | 2,228 | 2,228 | 1.00 | 868 | 868 | 1.00 | 270 | 270 | 1.00 | 744 | 744 | 1.00 | 897 | 897 |
| Incandescent Downlight | 0.44 | 710 | 312 | 0.44 | 409 | 180 | 0.44 | 113 | 50 | 0.20 | 304 | 61 | 0.44 | 409 | 180 |
| Fluorescent Fixture | 0.60 | 371 | 223 | 0.60 | 214 | 128 | 0.60 | 59 | 36 | 0.60 | 126 | 76 | 0.60 | 214 | 128 |
| Refrigerator | 1.66 | 811 | 1,346 | 1.32 | 737 | 972 | 1.11 | 663 | 738 | 1.02 | 546 | 558 | 1.28 | 737 | 944 |
| Freezer | 0.76 | 336 | 255 | 0.48 | 336 | 161 | 0.33 | 336 | 110 | 0.22 | 275 | 59 | 0.53 | 336 | 177 |
| Water Heating | 0.07 | 3,902 | 285 | 0.08 | 2,346 | 176 | 0.11 | 1,205 | 128 | 0.21 | 1,997 | 417 | 0.06 | 2,155 | 119 |
| Clotheswasher | 1.00 | 674 | 673 | 1.00 | 674 | 674 | 0.93 | 674 | 623 | 0.66 | 519 | 343 | 0.79 | 674 | 532 |
| Clothes Dryer | 0.78 | 526 | 408 | 0.91 | 413 | 376 | 0.81 | 177 | 143 | 0.51 | 329 | 169 | 0.74 | 451 | 336 |
| Dishwasher | 0.97 | 613 | 595 | 0.93 | 613 | 572 | 0.80 | 312 | 250 | 0.76 | 464 | 354 | 0.84 | 613 | 515 |
| Pool Pump | 0.06 | 2,629 | 158 | 0.05 | 1,673 | 77 | 0.02 | 399 | 7 | 0.00 | 0 | 0 | 0.04 | 1,673 | 69 |
| Misc. Residential | 1.00 | 2,588 | 2,588 | 1.00 | 932 | 932 | 1.00 | 373 | 373 | 1.00 | 419 | 419 | 1.00 | 857 | 857 |
| CRT TV | 2.73 | 153 | 416 | 1.96 | 153 | 300 | 1.54 | 78 | 120 | 1.50 | 153 | 229 | 1.81 | 153 | 276 |
| Plasma TV | 0.10 | 424 | 43 | 0.11 | 424 | 47 | 0.09 | 216 | 19 | 0.11 | 424 | 45 | 0.20 | 424 | 85 |
| Set-Top Box | 1.91 | 130 | 248 | 0.98 | 130 | 127 | 0.82 | 130 | 107 | 0.66 | 130 | 86 | 1.25 | 130 | 162 |
| DVD Player | 1.60 | 36 | 58 | 1.42 | 36 | 51 | 1.60 | 36 | 58 | 1.01 | 36 | 37 | 1.37 | 36 | 49 |
| Desktop PC | 1.77 | 237 | 419 | 1.34 | 237 | 317 | 0.81 | 237 | 192 | 0.83 | 237 | 197 | 1.02 | 237 | 242 |
| Laptop PC | 0.18 | 72 | 13 | 0.18 | 72 | 13 | 0.18 | 72 | 13 | 0.14 | 72 | 10 | 0.14 | 72 | 10 |
| Cooking | 0.86 | 349 | 300 | 0.78 | 302 | 234 | 0.66 | 251 | 165 | 0.88 | 255 | 224 | 0.94 | 302 | 283 |
| Use Per Home | | | 15,006 | | | 7,642 | | | 3,718 | | | 5,831 | | | 7,036 |
| Homes | | | 158,525 | | | 475,574 | | | 158,525 | | | 303,813 | | | 59,094 |
| Total Use | | | 2,378,776,897 | | | 3,634,268,607 | | | 589,385,429 | | | 1,771,538,637 | | | 415,784,005 |

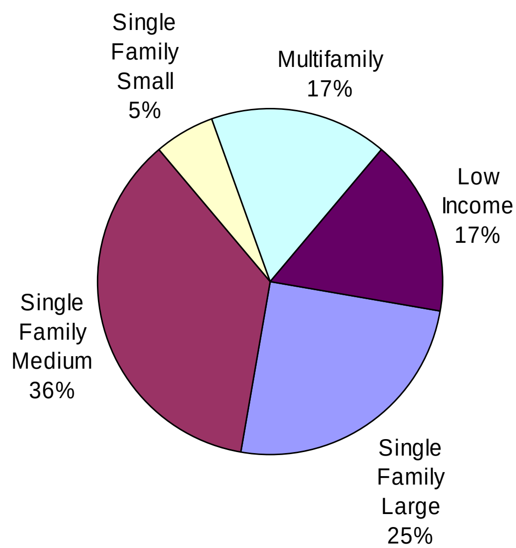
Source: Xcel Energy Billing Data-2008, Xcel Energy Home Use Data-2008, KEMA Analysis, Calibrated to 2010 Sales Forecast (from Feb/Mar 2009)

## Table 4-2
## Residential Baseline Peak Demand Summary, Electricity – kW, 2010

| | Single Family Large | | Single Family Medium | | Single Family Small | | Multifamily | | Low Income | |
|---|---|---|---|---|---|---|---|---|---|---|
| End Use | Homes with End Use | All homes | Homes with End Use | All homes | Homes with End Use | All homes | Homes with End Use | All homes | Homes with End Use | All homes |
| Split-System Air Conditioner | 3.897 | 2.178 | 1.625 | 0.795 | 0.638 | 0.165 | 1.847 | 0.735 | 1.551 | 0.562 |
| Room Air Conditioner | 1.949 | 0.164 | 0.813 | 0.037 | 0.319 | 0.020 | 0.923 | 0.162 | 0.776 | 0.070 |
| Evaporative Cooler | 1.293 | 0.318 | 0.539 | 0.147 | 0.212 | 0.064 | 0.776 | 0.029 | 0.596 | 0.120 |
| Dehumidifier | 0.057 | 0.009 | 0.041 | 0.002 | 0.024 | 0.001 | 0.045 | 0.003 | 0.039 | 0.008 |
| Furnace Fan--Furnace + CAC | 0.855 | 0.447 | 0.389 | 0.182 | 0.150 | 0.039 | 0.361 | 0.104 | 0.371 | 0.134 |
| Resistance Space Heating | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Lighting, Bulbs | 0.209 | 0.209 | 0.119 | 0.119 | 0.051 | 0.051 | 0.088 | 0.088 | 0.105 | 0.105 |
| Fluorescent Fixture | 0.039 | 0.023 | 0.022 | 0.013 | 0.010 | 0.006 | 0.012 | 0.007 | 0.022 | 0.013 |
| Refrigerator | 0.111 | 0.184 | 0.101 | 0.133 | 0.091 | 0.101 | 0.075 | 0.076 | 0.101 | 0.129 |
| Freezer | 0.047 | 0.035 | 0.047 | 0.022 | 0.047 | 0.015 | 0.038 | 0.008 | 0.047 | 0.025 |
| Water Heating | 0.496 | 0.036 | 0.318 | 0.024 | 0.170 | 0.018 | 0.243 | 0.051 | 0.304 | 0.017 |
| Clotheswasher | 0.011 | 0.011 | 0.010 | 0.010 | 0.007 | 0.007 | 0.007 | 0.005 | 0.010 | 0.008 |
| Clothes Dryer | 0.069 | 0.054 | 0.055 | 0.050 | 0.032 | 0.026 | 0.043 | 0.022 | 0.060 | 0.044 |
| Dishwasher | 0.031 | 0.030 | 0.026 | 0.025 | 0.020 | 0.016 | 0.020 | 0.015 | 0.026 | 0.022 |
| Pool Pump | 0.292 | 0.018 | 0.186 | 0.009 | 0.044 | 0.001 | 0.000 | 0.000 | 0.186 | 0.008 |
| Misc. Residential | 0.293 | 0.293 | 0.119 | 0.119 | 0.039 | 0.039 | 0.021 | 0.021 | 0.114 | 0.114 |
| TV | 0.026 | 0.044 | 0.019 | 0.029 | 0.011 | 0.017 | 0.016 | 0.024 | 0.016 | 0.029 |
| Big Screen TV | 0.093 | 0.060 | 0.067 | 0.031 | 0.040 | 0.017 | 0.057 | 0.027 | 0.057 | 0.023 |
| Set-Top Box | 0.017 | 0.029 | 0.017 | 0.016 | 0.017 | 0.031 | 0.017 | 0.026 | 0.017 | 0.028 |
| DVD Player | 0.005 | 0.007 | 0.005 | 0.007 | 0.005 | 0.007 | 0.005 | 0.005 | 0.005 | 0.006 |
| Desktop PC | 0.030 | 0.053 | 0.029 | 0.039 | 0.023 | 0.019 | 0.027 | 0.022 | 0.027 | 0.027 |
| Laptop PC | 0.008 | 0.001 | 0.008 | 0.001 | 0.008 | 0.001 | 0.008 | 0.001 | 0.008 | 0.001 |
| Cooking | 0.057 | 0.049 | 0.049 | 0.038 | 0.041 | 0.027 | 0.042 | 0.037 | 0.049 | 0.046 |
| Use Per Home | | 4.254 | | 1.847 | | 0.690 | | 1.468 | | 1.539 |
| Homes | | 145,627 | | 416,842 | | 129,697 | | 253,377 | | 210,000 |
| Total Use | | 619,520 | | 769,873 | | 89,479 | | 371,835 | | 323,167 |

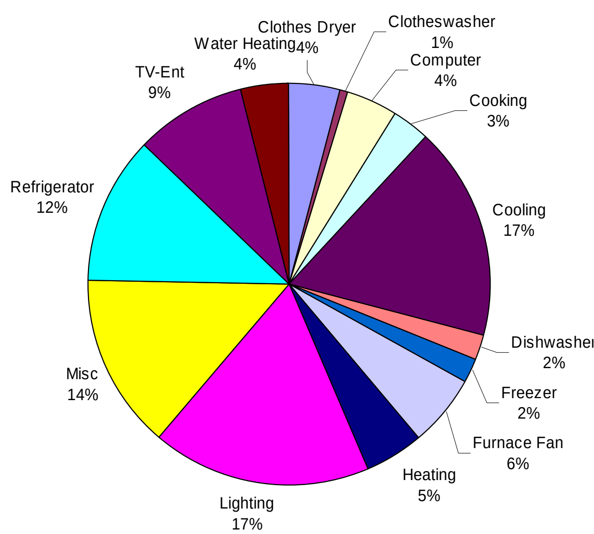
Source: Xcel Energy Billing Data-2008, Xcel Energy Home Use Data-2008, KEMA Analysis, Calibrated to 2010 Peak Demand Forecast (from Oct 2009)

**Figure 4-3**
**Residential Electricity Shares by Segment, 2010**



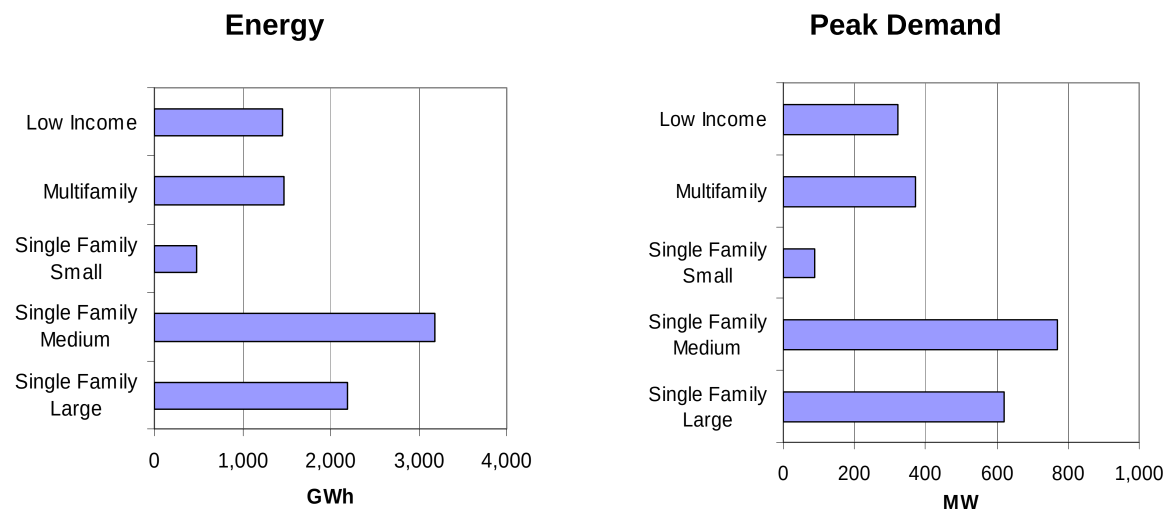

Source: Xcel Energy Billing Data-2008, Xcel Energy Home Use Data-2008, KEMA Analysis

**Figure 4-4**
**Residential Electricity Shares by End Use, 2010**

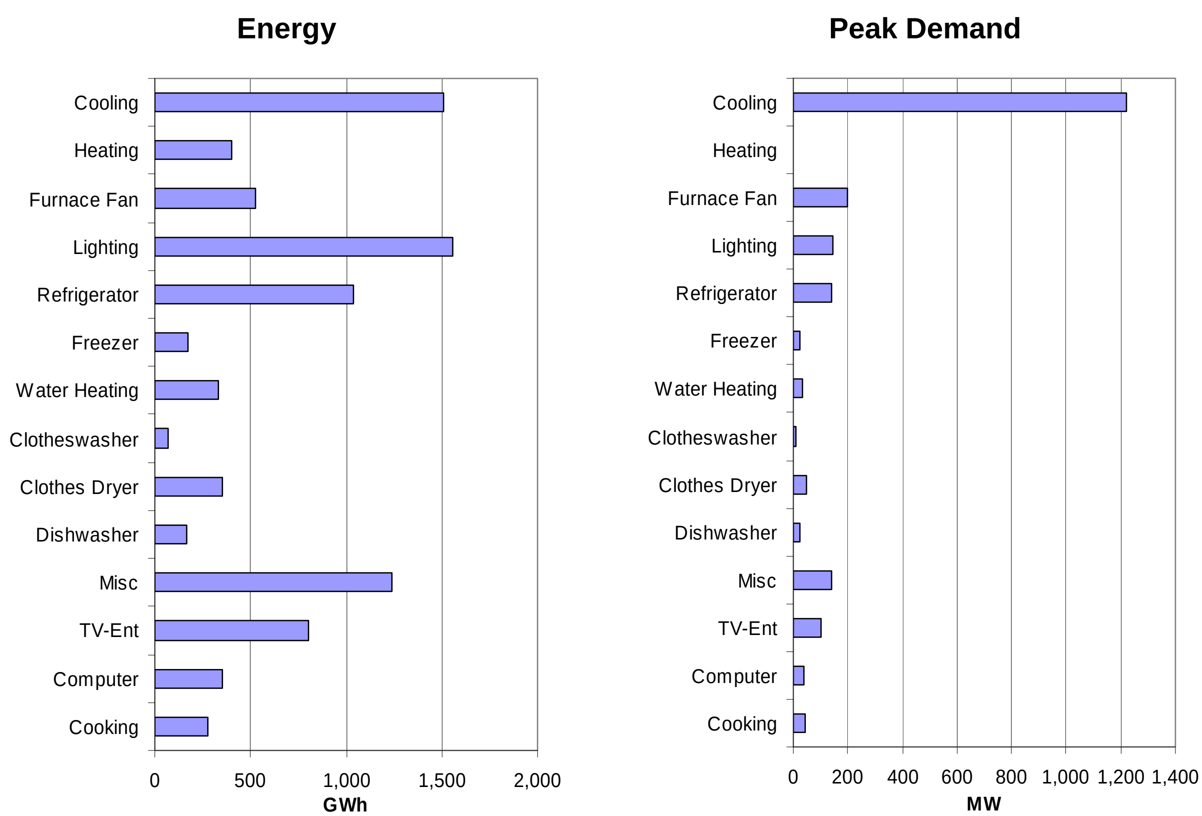



Source: Xcel Energy Billing Data-2008, Xcel Energy Home Use Data-2008, KEMA Analysis

## Figure 4-5
## Residential Electricity Usage by Customer Segment




## Figure 4-6
## Residential Electricity Usage by End Use



### 4.2.2 Commercial

The primary sources of commercial data for the Xcel Energy Colorado service area were the U.S. DOE Commercial Building Energy Consumption Survey (CBECS) and Xcel Energy's billed consumption data.

CBECS data for the Mountain Region were used to develop end-use saturation and EUI (Energy Utilization Indices in kWh per square foot) data as well as whole-building EUI estimates.

For the commercial sector, no estimates of consuming units (square feet of commercial space by building type) were available for the Xcel Energy Colorado territory. Square footage estimates were developed for each key building type by dividing Xcel Energy's energy consumption (kWh) by whole-building EUIs (kWh per square foot).

Load shape data from Xcel Energy 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.

Table 4-3 and Table 4-4 summarize the commercial baseline electricity consumption results developed for the study.

Figure 4-7 shows commercial electricity consumption and peak-demand by building type. The office and miscellaneous building types account for the largest shares of both energy and peak-demand usage.

Figure 4-8 shows commercial electricity consumption and peak demand by end use. Lighting contributes the most to electricity consumption at almost 6,000 GWh per year, followed by cooling and commercial miscellaneous at less than 2,000 GWh per year each. During peak demand, cooling contributes the largest share at almost 1,400 MW, followed by indoor lighting at about 800 MW.

## Table 4-3
## Commercial Baseline Electricity Consumption Factors

| Saturation | Office | Retail | Restaurant | Grocery | Warehouse | School | College | Health | Lodging | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Indoor Lighting | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Outdoor Lighting | 0.89 | 0.52 | 0.36 | 0.58 | 0.71 | 1.00 | 1.00 | 1.00 | 0.65 | 1.00 |
| Chillers | 0.31 | 0.01 | 0.00 | 0.00 | 0.00 | 0.45 | 0.63 | 0.82 | 0.23 | 0.12 |
| DX Packaged Systems | 0.55 | 0.56 | 0.81 | 0.81 | 0.86 | 0.55 | 0.37 | 0.18 | 0.77 | 0.73 |
| Ventilation | 0.95 | 0.97 | 0.99 | 1.00 | 0.33 | 1.00 | 1.00 | 1.00 | 1.00 | 0.77 |
| Refrigeration | 0.12 | 0.11 | 0.99 | 1.00 | 0.28 | 0.67 | 0.66 | 1.00 | 0.51 | 0.25 |
| Office Equip | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Servers-Data Centers | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.02 | 0.00 | 0.00 |
| Vending Machines | 0.39 | 0.30 | 0.47 | 0.40 | 0.73 | 0.68 | 0.41 | 0.57 | 0.36 | 0.31 |
| Cooking | 0.08 | 0.02 | 0.54 | 0.34 | 0.05 | 0.45 | 0.07 | 0.27 | 0.46 | 0.36 |
| Heating | 0.37 | 0.67 | 0.06 | 0.40 | 0.22 | 0.17 | 0.37 | 0.01 | 0.54 | 0.29 |
| Miscellaneous | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

| EUI = kWh per ft2 | Office | Retail | Restaurant | Grocery | Warehouse | School | College | Health | Lodging | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Indoor Lighting | 6.7 | 4.0 | 3.1 | 6.2 | 2.8 | 4.1 | 4.3 | 7.0 | 4.3 | 4.8 |
| Outdoor Lighting | 1.2 | 1.1 | 3.2 | 1.7 | 0.3 | 0.8 | 0.2 | 0.4 | 0.5 | 2.1 |
| Chillers | 1.8 | 0.9 | 2.5 | 1.1 | 0.5 | 1.8 | 1.7 | 2.0 | 2.0 | 1.5 |
| DX Packaged Systems | 3.1 | 1.5 | 4.3 | 1.9 | 0.9 | 3.1 | 3.0 | 3.5 | 3.5 | 2.6 |
| Ventilation | 1.8 | 0.6 | 2.0 | 0.7 | 0.2 | 1.0 | 1.0 | 1.5 | 0.6 | 1.1 |
| Refrigeration | 0.1 | 0.2 | 7.4 | 21.4 | 0.4 | 0.4 | 0.4 | 0.8 | 0.8 | 0.4 |
| Office Equip | 1.4 | 0.1 | 0.1 | 0.3 | 0.2 | 0.8 | 1.2 | 0.8 | 0.2 | 0.2 |
| Servers-Data Centers | 100.0 | 83.0 | 83.0 | 83.0 | 83.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Vending Machines | 0.8 | 0.2 | 0.9 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.5 | 0.2 |
| Cooking | 2.2 | 1.1 | 1.9 | 0.6 | 0.0 | 1.3 | 1.3 | 0.2 | 3.1 | 1.2 |
| Heating | 1.5 | 1.1 | 3.0 | 1.6 | 0.2 | 1.6 | 1.6 | 1.3 | 1.9 | 1.5 |
| Miscellaneous | 1.3 | 0.5 | 3.8 | 1.5 | 0.8 | 0.4 | 0.5 | 2.8 | 1.7 | 1.0 |

| | Office | Retail | Restaurant | Grocery | Warehouse | School | College | Health | Lodging | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Footage (1000's) | 302,169 | 170,918 | 38,799 | 21,728 | 175,719 | 53,376 | 34,899 | 46,064 | 35,096 | 135,189 |

## Table 4-4

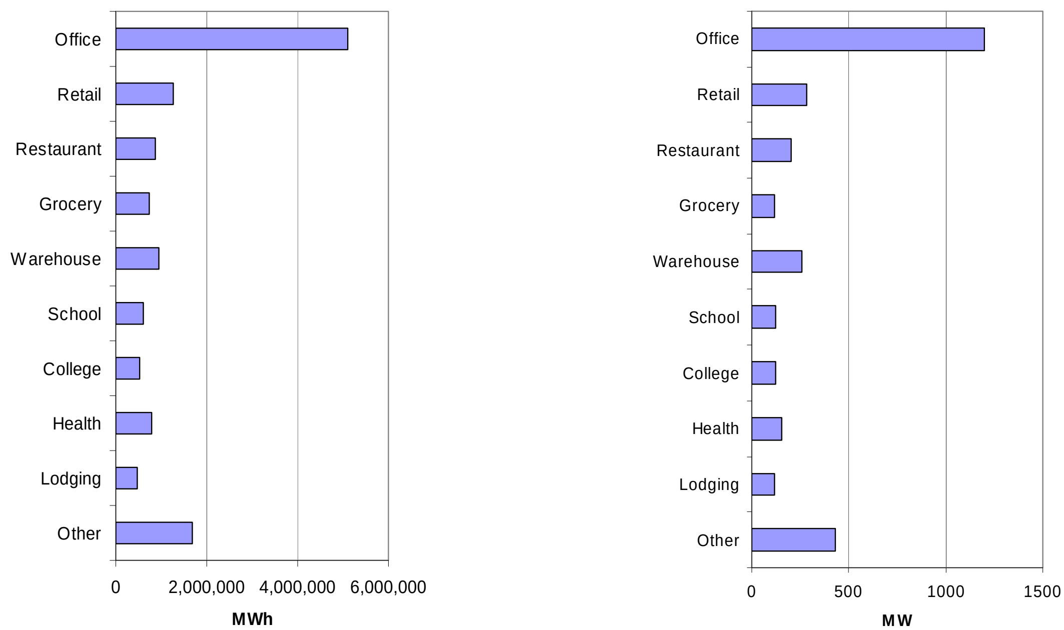
## Commercial Baseline Electricity Consumption Summary – MWh and MW

| **MWh** | Office | Retail | Restaurant | Grocery | Warehouse | School | College | Health | Lodging | Other | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Indoor Lighting | 2,039,486 | 677,762 | 120,321 | 135,600 | 487,346 | 219,033 | 151,294 | 324,211 | 149,610 | 645,611 | 4,950,274 |
| Outdoor Lighting | 319,254 | 93,077 | 45,223 | 21,417 | 37,255 | 42,128 | 6,962 | 16,618 | 11,456 | 279,087 | 872,475 |
| Chillers | 168,384 | 2,016 | 0 | 0 | 0 | 43,629 | 38,121 | 75,390 | 16,314 | 23,946 | 367,799 |
| DX Packaged Systems | 514,765 | 145,847 | 133,883 | 34,145 | 137,445 | 91,814 | 38,302 | 29,325 | 93,833 | 253,273 | 1,472,633 |
| Ventilation | 508,581 | 92,860 | 77,330 | 15,653 | 13,138 | 53,329 | 34,963 | 70,818 | 21,182 | 116,891 | 1,004,745 |
| Refrigeration | 5,199 | 3,704 | 284,717 | 465,669 | 20,314 | 12,642 | 8,119 | 35,549 | 13,551 | 13,001 | 862,465 |
| Office Equip | 409,423 | 11,675 | 2,481 | 6,259 | 28,937 | 44,761 | 42,658 | 34,549 | 7,908 | 31,067 | 619,718 |
| Servers-Data Centers | 440,495 | 0 | 0 | 5,360 | 38,408 | 24,697 | 149,484 | 79,940 | 7,372 | 58,127 | 803,883 |
| Vending Machines | 99,342 | 8,373 | 17,123 | 1,784 | 30,686 | 11,791 | 4,074 | 4,536 | 6,172 | 9,288 | 193,169 |
| Cooking | 52,303 | 3,968 | 40,322 | 4,705 | 0 | 30,343 | 3,039 | 2,332 | 50,818 | 57,721 | 245,551 |
| Heating | 165,011 | 126,963 | 7,540 | 14,210 | 8,057 | 14,216 | 20,467 | 338 | 35,379 | 58,936 | 451,116 |
| Miscellaneous | 388,738 | 84,499 | 148,418 | 31,756 | 145,719 | 23,584 | 16,215 | 127,035 | 60,133 | 136,816 | 1,162,913 |
| Total | 5,110,981 | 1,250,742 | 877,357 | 736,557 | 947,307 | 611,967 | 513,698 | 800,642 | 473,727 | 1,683,762 | 13,006,740 |

| **MW** | Office | Retail | Restaurant | Grocery | Warehouse | School | College | Health | Lodging | Other | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Indoor Lighting | 337.4 | 108.8 | 20.9 | 18.4 | 76.7 | 26.7 | 28.5 | 43.8 | 18.8 | 97.7 | 777.7 |
| Outdoor Lightng | 3.9 | 5.4 | 2.7 | 0.5 | 0.4 | 1.5 | 0.0 | 0.1 | 0.1 | 19.2 | 33.8 |
| Chillers | 126.1 | 1.7 | 0.0 | 0.0 | 0.0 | 22.9 | 23.9 | 43.3 | 10.1 | 20.1 | 247.9 |
| DX Packaged Systems | 385.4 | 123.8 | 85.7 | 23.2 | 136.7 | 48.2 | 24.0 | 16.8 | 57.8 | 212.6 | 1,114.2 |
| Ventilation | 159.5 | 26.7 | 20.5 | 3.4 | 4.2 | 10.7 | 10.0 | 14.8 | 4.6 | 34.8 | 289.2 |
| Refrigeration | 0.6 | 0.5 | 35.1 | 61.8 | 3.2 | 1.4 | 1.0 | 4.2 | 1.6 | 1.6 | 111.0 |
| Office Equip | 50.5 | 1.9 | 0.4 | 1.0 | 4.3 | 3.5 | 6.8 | 4.4 | 1.1 | 4.2 | 78.0 |
| Servers-Data Centers | 54.3 | 0.0 | 0.0 | 0.9 | 5.7 | 1.9 | 23.7 | 10.1 | 1.0 | 7.9 | 105.6 |
| Vending Machines | 12.9 | 1.3 | 3.0 | 0.3 | 5.1 | 0.9 | 0.7 | 0.6 | 0.9 | 1.4 | 27.0 |
| Cooking | 7.0 | 0.6 | 7.4 | 0.6 | 0.0 | 2.0 | 0.5 | 0.4 | 9.2 | 8.5 | 36.2 |
| Heating | 10.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.2 | 1.5 | 0.0 | 0.9 | 1.4 | 14.9 |
| Miscellaneous | 50.2 | 13.2 | 25.2 | 4.5 | 24.3 | 1.8 | 2.8 | 15.6 | 8.5 | 20.2 | 166.2 |
| Total | 1,197.8 | 284.6 | 200.9 | 114.4 | 260.6 | 121.7 | 123.4 | 154.1 | 114.5 | 429.5 | 3,001.7 |

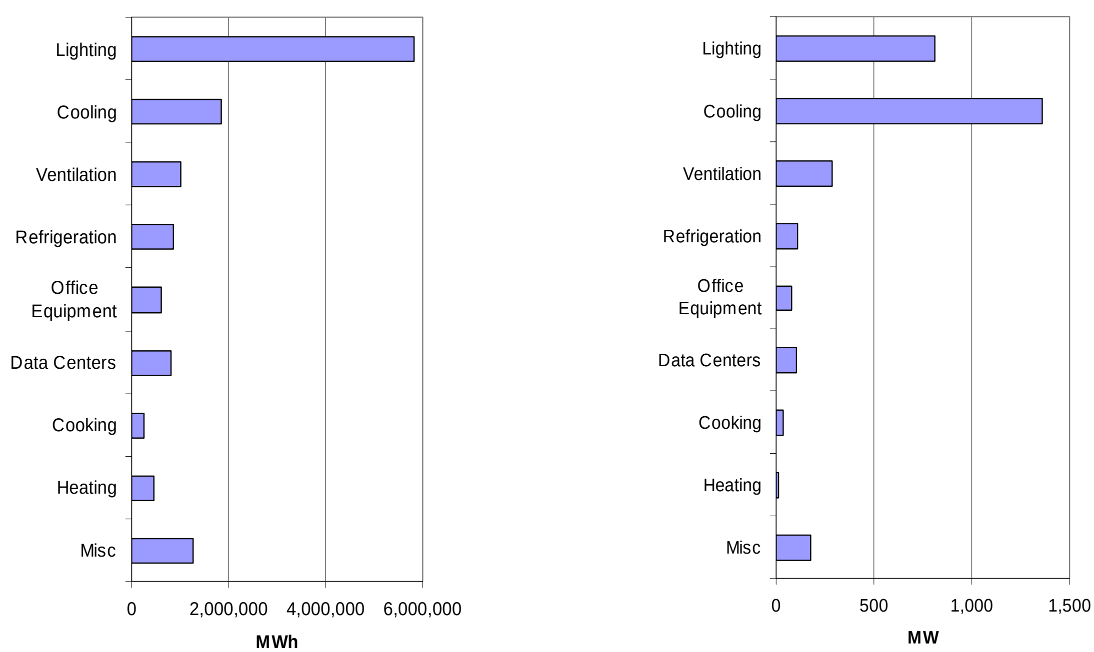
## Figure 4-7
## Commercial Electricity Usage by Building Type

**Energy** **Peak Demand**




## Figure 4-8
## Commercial Electricity Usage by End Use

**Energy** **Peak Demand**



## 4.2.3 Industrial

Data on the industrial sector consisted of Xcel Energy's billing data and end-use consumption data at the national level, developed as part of the U.S. DOE Manufacturing Energy Consumption Survey (MECS). The motors end-use data were further disaggregated using national-level data developed by KEMA as part of a U.S. Motors Assessment Study conducted for the DOE in 1998. Given the relatively small size of the Xcel Energy industrial sector relative to its residential and commercial sectors, it was determined that aggregate national-level data were sufficient for the industrial baseline work. Similar to the residential and commercial sectors, industrial peak-demand estimates were calibrated to ensure that they were consistent with Xcel Energy's system peak demand.

Figure 4-9 summarizes industrial electricity consumption and peak demand by industry type. The electronics industry accounts for the largest share of energy use, followed by the primary metals industry. Electronics, primary metals, food, mining, and fabricated metals all account for significant shares of industrial peak demand.

**Figure 4-9**
**Industrial Electricity Usage by Industry Type**

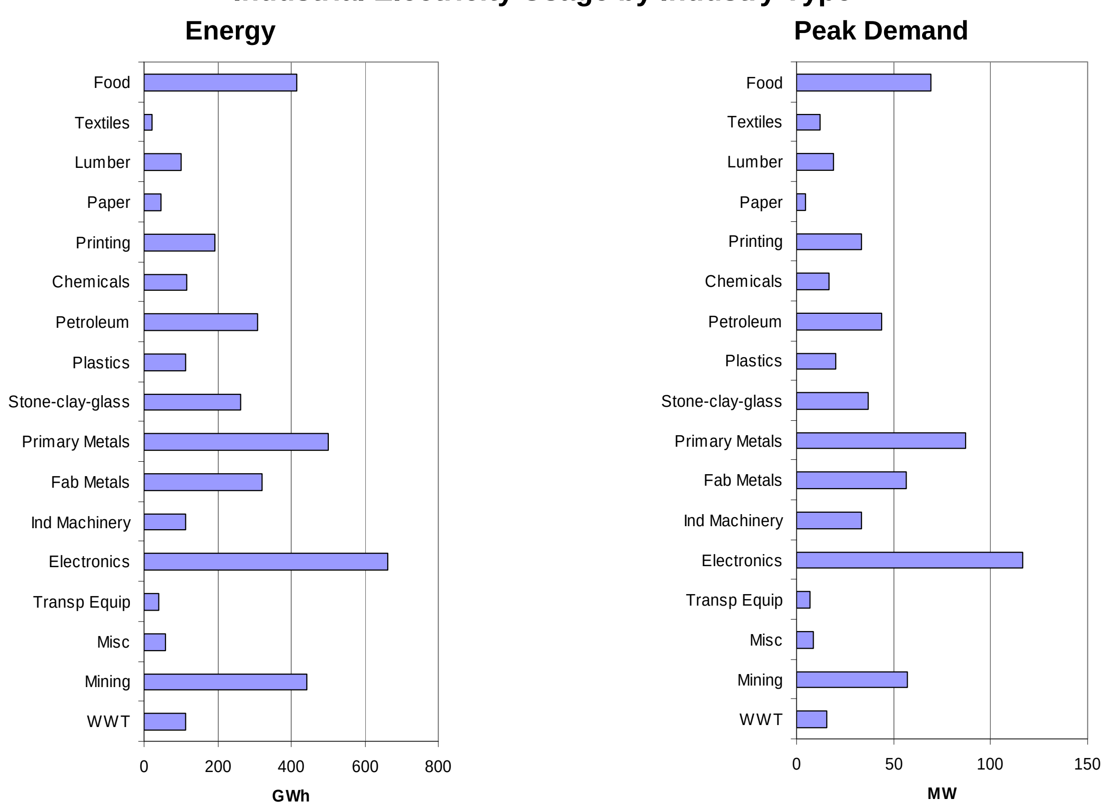
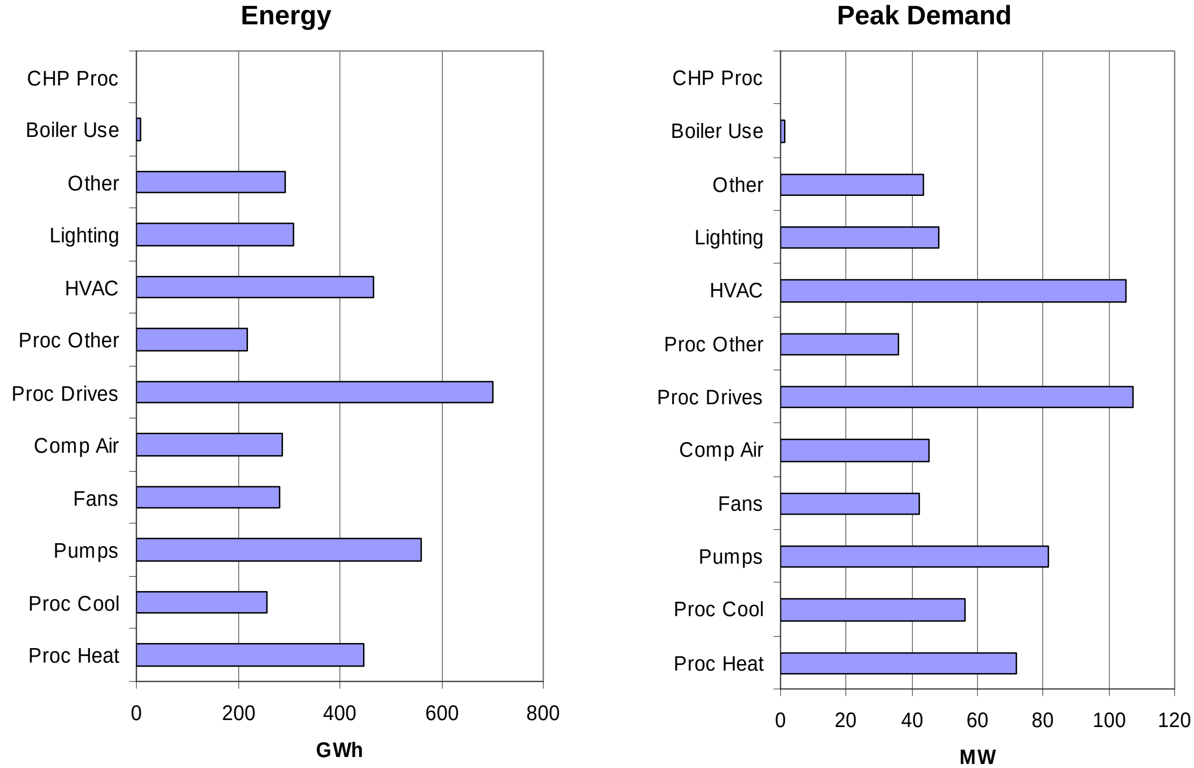


Figure 4-10 shows electricity consumption and peak demand estimates by industrial end use. Process drives account for the largest single share of energy consumption, followed by pumping systems, HVAC, and process heating. HVAC and process drives contribute most to peak demand, followed by process cooling.

**Figure 4-10**
**Industrial Electricity Usage by End Use**




# 4.3 Natural Gas

## 4.3.1 Residential

As with electricity, we broke the residential sector into five segments for the natural-gas study:

- Single family–large
- Single family–medium
- Single family–small
- Multifamily
- Low income

For single-family homes, the large and small segments are designed to comprise 20 percent of the single-family homes category each, and the medium segment comprises 60 percent of the single-family homes.

The saturation analysis to derive percentage of homes that have a given end use was conducted using the most recent Xcel Energy Home Use Study. UECs (energy use per appliance) were developed using secondary source data. Household estimates for each segment were based on analysis of the Home Use Study.

Table 4-5 summarizes the residential baseline natural-gas consumption results developed for the study. Figure 4-11 shows the breakdown of natural-gas use by residential segment. Figure 4-12 breaks down natural-gas use by end use.

Overall consumption of natural-gas and peak-day use is shown in Figure 4-13 by customer segment. Although the small single-family and large single-family segments represent the same number of homes, the natural-gas use for the large single-family segment is more than three times that of small single-family homes.

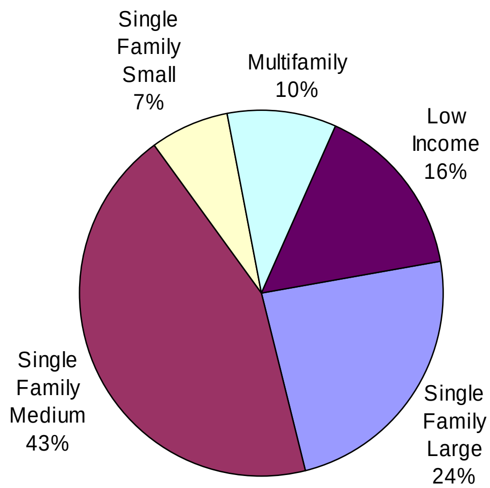
Figure 4-14 shows energy use and peak-day use for natural gas by end use. Natural-gas usage is dominated by furnace use at about 50,000 Dth, followed by water heating and boiler use. Furnaces are the largest contributors to peak-day gas use, followed by boilers.

## Table 4-5
## Residential Baseline Consumption Summary – Natural Gas - Therms

| | Single Family Large | | | Single Family Medium | | | Single Family Small | | | Multifamily | | | Low Income | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| End Use | Saturation | UEC | Avg Use | Saturation | UEC | Avg Use | Saturation | UEC | Avg Use | Saturation | UEC | Avg Use | Saturation | UEC | Avg Use |
| Furnace | 0.70 | 1,027 | 716 | 0.81 | 608 | 492 | 0.85 | 310 | 262 | 0.51 | 527 | 267 | 0.68 | 536 | 364 |
| Boiler | 0.14 | 1,258 | 177 | 0.12 | 734 | 85 | 0.02 | 368 | 6 | 0.11 | 646 | 70 | 0.15 | 648 | 94 |
| Room Heat | 0.02 | 973 | 22 | 0.00 | 575 | 0 | 0.04 | 270 | 10 | 0.07 | 434 | 30 | 0.05 | 508 | 25 |
| Water Heating | 0.95 | 345 | 330 | 0.90 | 234 | 211 | 0.90 | 134 | 120 | 0.77 | 257 | 199 | 1.00 | 206 | 205 |
| Clothes Drying | 0.20 | 56 | 11 | 0.07 | 44 | 3 | 0.08 | 37 | 3 | 0.10 | 35 | 4 | 0.05 | 44 | 2 |
| Cooking | 0.33 | 92 | 30 | 0.30 | 82 | 25 | 0.32 | 79 | 25 | 0.19 | 74 | 14 | 0.23 | 82 | 19 |
| Other | 0.05 | 295 | 14 | 0.04 | 185 | 8 | 0.02 | 140 | 3 | 0.02 | 140 | 3 | 0.07 | 185 | 12 |
| Use Per Home | | | 1,300 | | | 823 | | | 429 | | | 586 | | | 722 |
| Homes | | | 186,244 | | | 558,732 | | | 186,244 | | | 201,716 | | | 70,374 |
| Total Use | | | 242,097,338 | | | 460,073,052 | | | 79,965,483 | | | 118,193,907 | | | 50,819,794 |

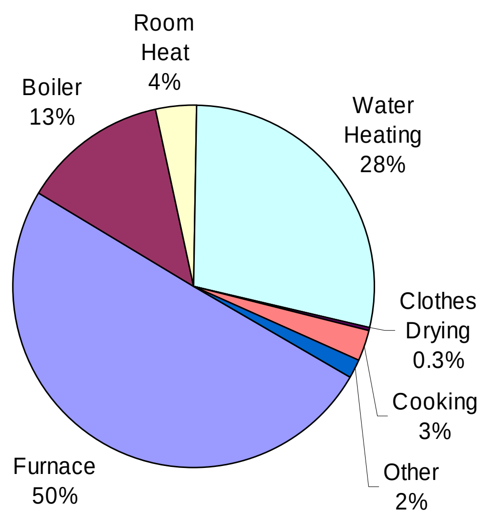
Source: Xcel Energy Billing Data-2008, Xcel Energy Home Use Data-2008, KEMA Analysis, Calibrated to 2010 Sales Forecast (from Feb./Mar. 2009)

**Figure 4-11**
**Residential Natural-Gas Shares by Segment, 2010**




Source: Xcel Energy Billing Data-2008, Xcel Energy Home Use Data-2008, KEMA Analysis

**Figure 4-12**
**Residential Natural-Gas Shares by End Use, 2010**




Source: Xcel Energy Billing Data-2008, Xcel Energy Home Use Data-2008, KEMA Analysis

**Figure 4-13**
**Residential Natural-Gas Usage by Customer Segment**

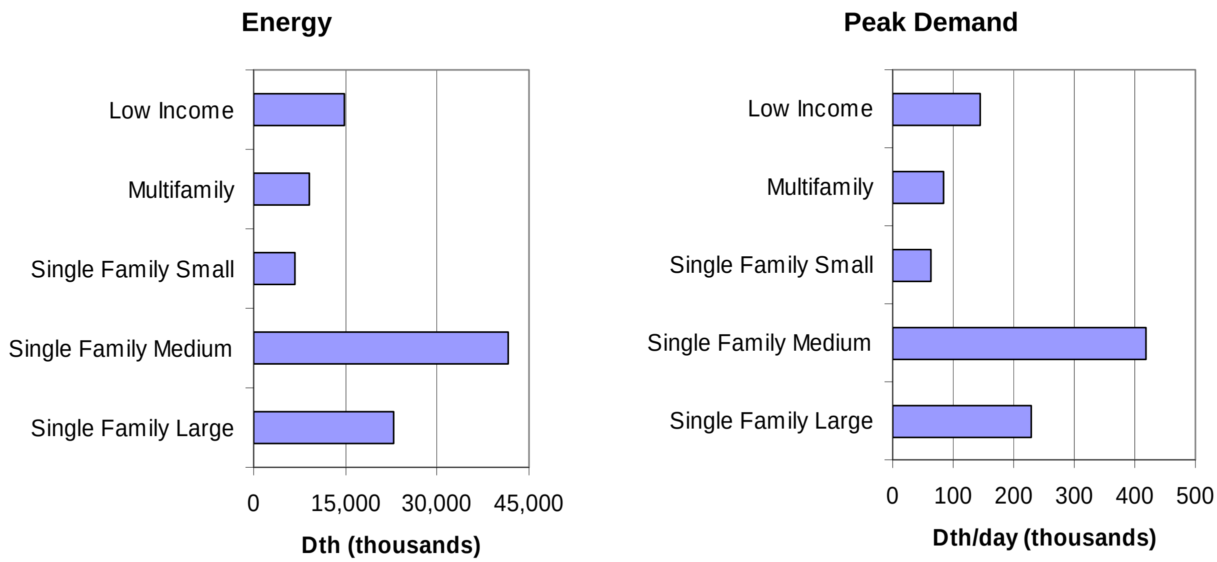
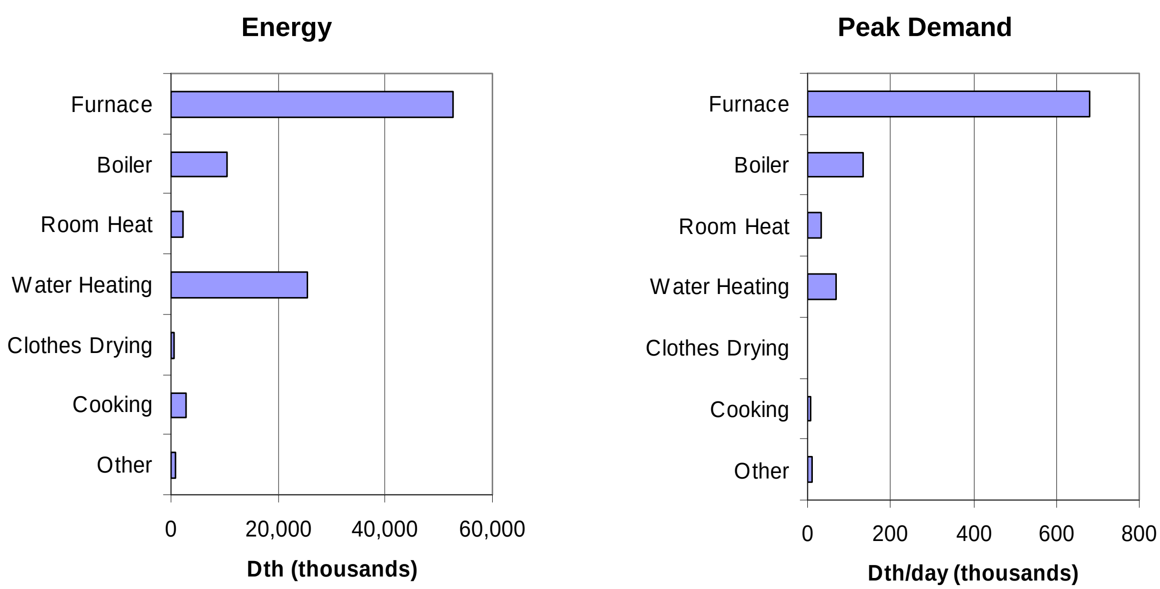



**Figure 4-14**
**Residential Natural-Gas Use by End Use**



### 4.3.2 Commercial

The primary sources of commercial data for the Xcel Energy Colorado service area were the U.S. DOE Commercial Building Energy Consumption Survey (CBECS) and Xcel Energy's billed consumption data.

CBECS data for the Mountain Region were used to develop end-use saturation and EUI (Energy Utilization Indices in therms per square foot) data as well as whole-building EUI estimates.

For the commercial sector, no estimates of consuming units (square feet of commercial space by building type) were available for the Xcel Energy Colorado territory. Square footage estimates were developed for each key building type by dividing Xcel Energy's energy consumption (kWh) by whole-building EUIs (kWh per square foot).

Load-shape data from Xcel Energy 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.

Table 4-6 summarizes the commercial baseline natural-gas consumption results developed for the study.

Figure 4-15 shows commercial natural-gas consumption and peak-day use by building type. The office and miscellaneous building types account for the largest shares of both energy and peak-day usage.

Figure 4-16 shows commercial natural-gas consumption and peak-day use by end use. Heating contributes most to energy consumption at more than 20 million Dth per year, followed by water heating at about 7 million Dth per year. For peak-day use, heating is by far the largest contributor at about 340,000 Dth per day. Water heating has the next largest impact, at only 20,000 Dth per day.

# Table 4-6
## Commercial Baseline Natural-Gas Consumption Summary

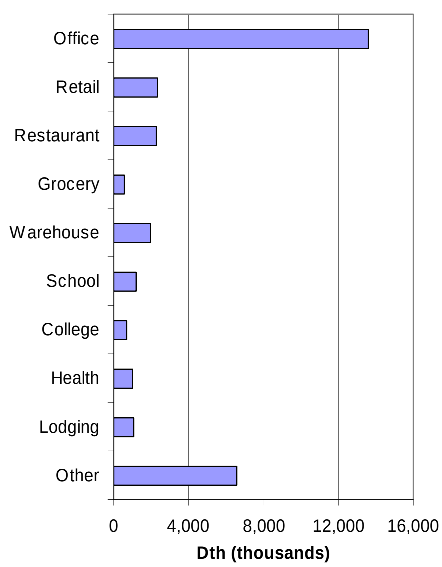
| Saturation | Office | Retail | Restaurant | Grocery | Warehouse | School | College | Health | Lodging | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Heating | 0.95 | 0.84 | 0.31 | 0.99 | 0.77 | 0.89 | 0.98 | 0.62 | 0.80 | 0.94 |
| Water Heating - high standby | 0.83 | 0.55 | 0.52 | 0.78 | 0.89 | 0.82 | 0.91 | 0.95 | 1.00 | 0.84 |
| Water Heating - low standby | 0.00 | 0.00 | 0.52 | 0.00 | 0.00 | 0.82 | 0.91 | 0.95 | 1.00 | 0.00 |
| Fryer | 0.04 | 0.10 | 0.71 | 0.00 | 0.06 | 0.24 | 0.01 | 0.39 | 0.52 | 0.15 |
| Steamer | 0.04 | 0.00 | 0.52 | 0.00 | 0.00 | 0.53 | 0.01 | 0.39 | 0.06 | 0.12 |
| Convection Oven | 0.04 | 0.09 | 0.66 | 0.32 | 0.12 | 0.56 | 0.01 | 0.35 | 0.52 | 0.17 |
| Griddle | 0.08 | 0.01 | 0.65 | 0.13 | 0.23 | 0.60 | 0.01 | 0.35 | 0.52 | 0.17 |
| Range | 0.09 | 0.10 | 0.76 | 0.32 | 0.23 | 0.51 | 0.01 | 0.33 | 0.54 | 0.20 |
| Other | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.09 | 0.33 | 0.08 | 0.03 | 0.01 |

| EUI (kBtu/End-use ft2) | Office | Retail | Restaurant | Grocery | Warehouse | School | College | Health | Lodging | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Heating | 78.0 | 18.8 | 18.8 | 13.1 | 16.5 | 32.8 | 10.8 | 2.8 | 15.0 | 44.0 |
| Water Heating - high standby | 8.9 | 4.8 | 21.9 | 20.4 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 31.5 |
| Water Heating - low standby | 0.0 | 0.0 | 27.5 | 0.0 | 0.0 | 10.0 | 12.1 | 27.0 | 24.4 | 0.0 |
| Fryer | 1.6 | 6.1 | 24.8 | 14.7 | 1.9 | 1.1 | 1.6 | 3.1 | 5.3 | 2.6 |
| Steamer | 0.9 | 3.6 | 14.5 | 8.6 | 1.1 | 0.7 | 0.9 | 1.8 | 3.1 | 1.5 |
| Convection Oven | 0.2 | 0.9 | 3.7 | 2.2 | 0.3 | 0.2 | 0.2 | 0.5 | 0.8 | 0.4 |
| Griddle | 0.6 | 2.4 | 9.9 | 5.9 | 0.8 | 0.5 | 0.6 | 1.3 | 2.1 | 1.1 |
| Range | 0.8 | 3.1 | 12.6 | 7.5 | 1.0 | 0.6 | 0.8 | 1.6 | 2.7 | 1.3 |
| Other | 0.0 | 0.0 | 14.9 | 0.0 | 0.0 | 11.8 | 9.8 | 0.0 | 0.0 | 858.5 |

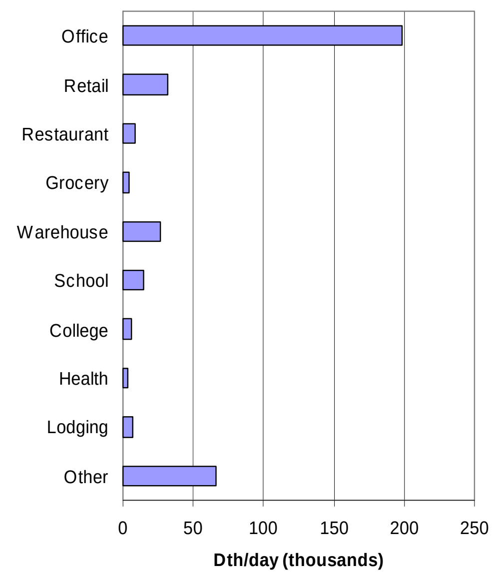
| | Office | Retail | Restaurant | Grocery | Warehouse | School | College | Health | Lodging | Other | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Square Feet (1000s) | 166,188 | 121,981 | 29,671 | 16,864 | 129,268 | 30,254 | 28,860 | 34,172 | 26,077 | 89,124 | 672,460 |
| | Dth by End Use | | | | | | | | | | |
| Heating | 12,340,476 | 1,920,287 | 174,970 | 218,848 | 1,647,324 | 883,092 | 305,791 | 59,656 | 312,224 | 3,674,850 | 21,537,518 |
| Water Heating - high standby | 1,236,327 | 316,572 | 340,055 | 268,087 | 236,571 | 0 | 0 | 0 | 0 | 2,347,910 | 4,745,523 |
| Water Heating - low standby | 0 | 0 | 426,821 | 0 | 0 | 248,172 | 318,484 | 874,380 | 637,221 | 0 | 2,505,078 |
| Fryer | 11,266 | 70,505 | 521,774 | 0 | 14,354 | 8,188 | 308 | 41,505 | 72,447 | 35,262 | 775,609 |
| Steamer | 6,574 | 0 | 224,377 | 0 | 0 | 10,656 | 180 | 24,218 | 5,057 | 17,130 | 288,192 |
| Convection Oven | 1,765 | 9,666 | 73,381 | 11,854 | 4,396 | 2,876 | 47 | 5,612 | 10,888 | 6,209 | 126,694 |
| Griddle | 8,391 | 2,556 | 190,944 | 13,274 | 23,054 | 8,228 | 123 | 14,828 | 28,766 | 16,403 | 306,567 |
| Range | 11,825 | 35,772 | 282,233 | 40,390 | 29,355 | 8,914 | 157 | 18,010 | 37,953 | 23,882 | 488,490 |
| Other | 0 | 0 | 56,768 | 0 | 0 | 33,157 | 93,629 | 0 | 0 | 443,899 | 627,452 |
| Total | 13,616,625 | 2,355,359 | 2,291,321 | 552,453 | 1,955,054 | 1,203,283 | 718,718 | 1,038,209 | 1,104,557 | 6,565,544 | 31,401,123 |

## Figure 4-15
## Commercial Natural-Gas Usage by Building Type

**Energy**

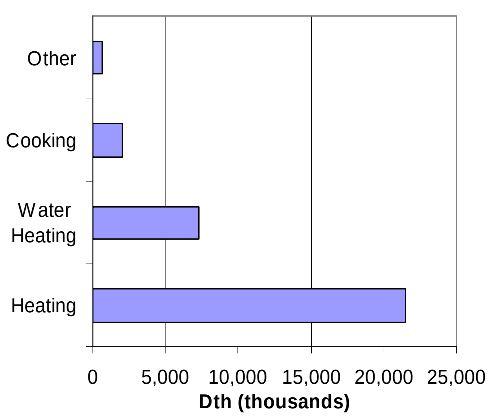



**Peak-Day Use**

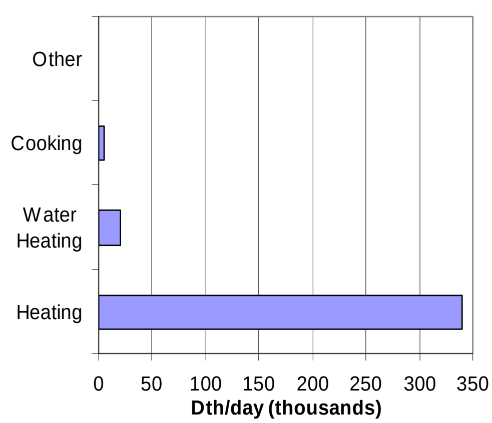



## Figure 4-16
## Commercial Natural-Gas Usage by End Use

**Energy**




**Peak-Day Use**



### 4.3.3 Industrial

Data for the industrial sector consisted of Xcel Energy's billing data and end-use consumption data at the national level developed as part of the U.S. DOE Manufacturing Energy Consumption Survey (MECS). The motors end-use data were further disaggregated using national-level data developed by KEMA as part of a U.S. Motors Assessment Study conducted for the DOE in 1998. Given the relatively small size of the Xcel Energy industrial sector relative to the residential and commercial sectors, it was determined that aggregate national-level data were sufficient for the industrial baseline work. Similar to the residential and commercial sectors, industrial peak-demand estimates were calibrated to ensure that they were consistent with Xcel Energy's system peak demand.

Figure 4-17 summarizes industrial natural-gas consumption and peak-day use by industry type. The electronics industry accounts for the largest share of industrial natural-gas use, followed by the food and fabricated-metals industry. Electronics contributes the most to industrial peak-day use, followed by fabricated metals and printing.

**Figure 4-17**
**Industrial Natural-Gas Usage by Industry Type**

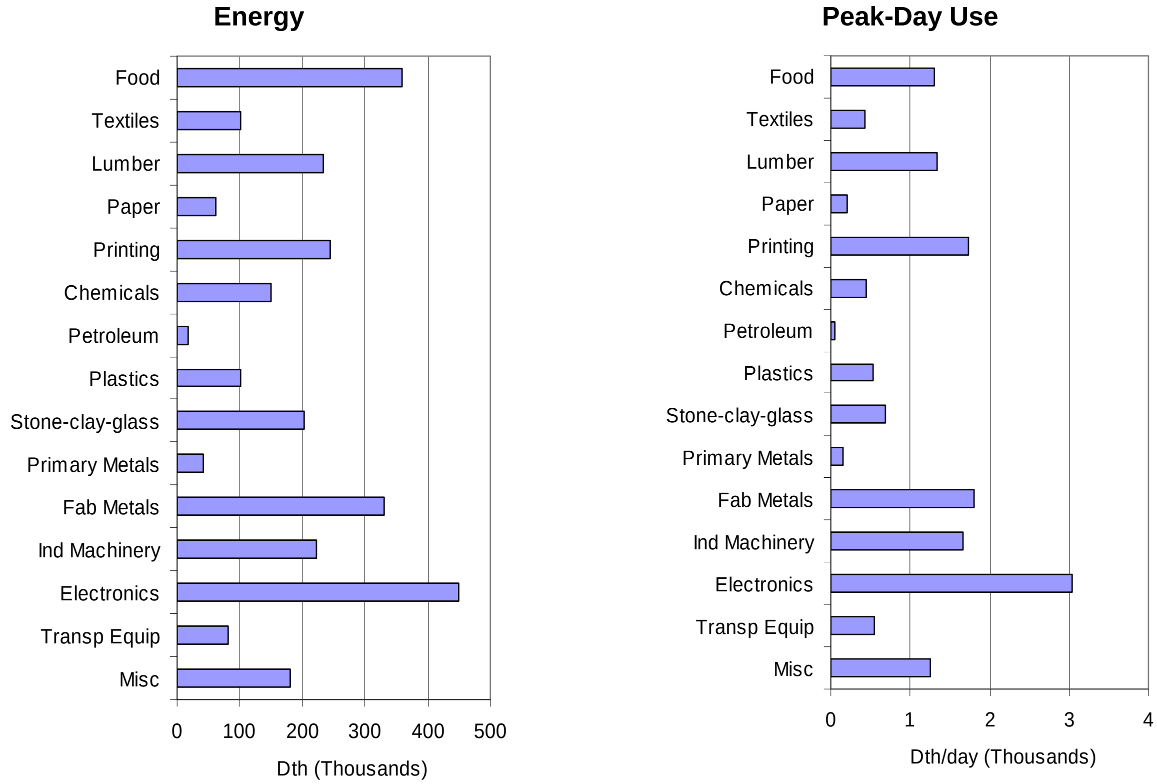
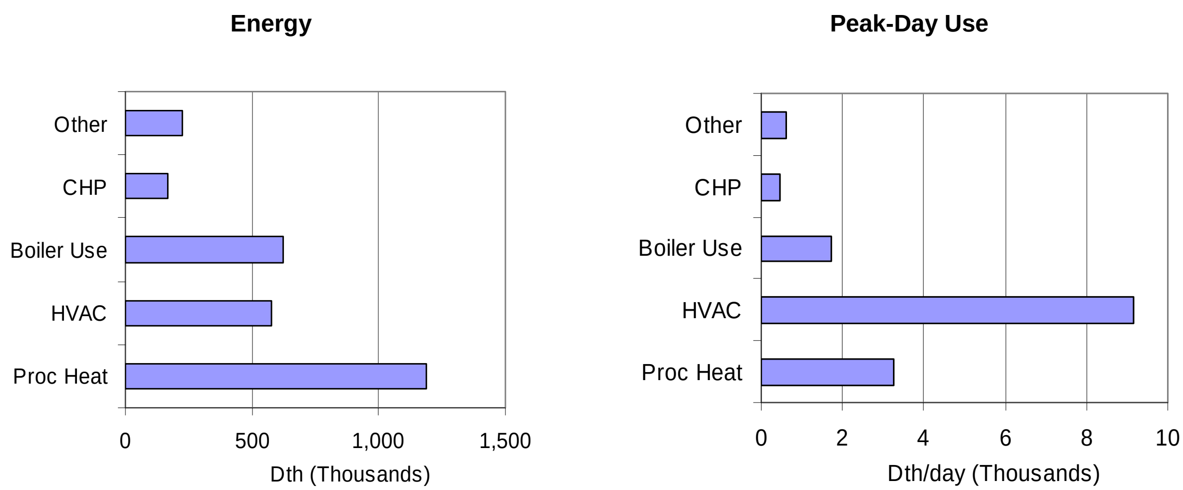


Figure 4-18 shows natural-gas consumption and peak-day use estimates by industrial end use. Process heat accounts for the largest single share of natural-gas consumption, followed by boiler systems and HVAC. HVAC is the largest contributor to peak-day use, followed by process heat and boilers.

**Figure 4-18**
**Industrial Natural Gas Usage by End Use**



# 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 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

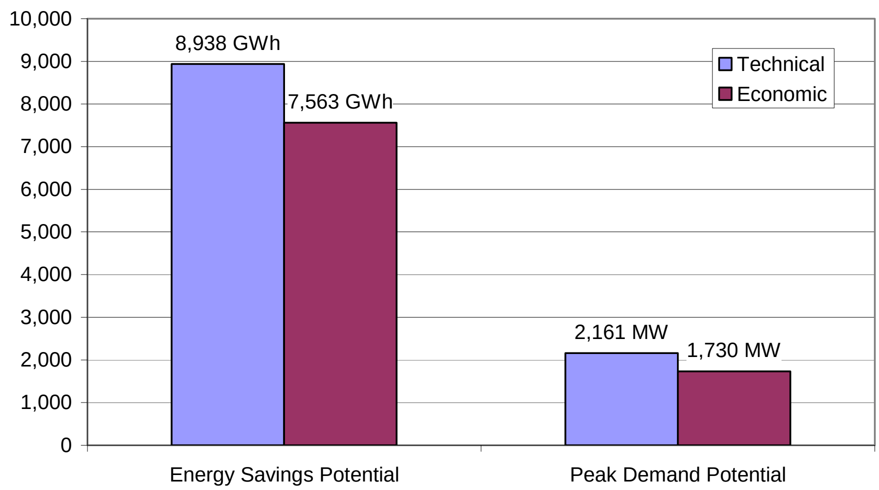
Figure 5-1 presents our overall estimates of total technical and economic potential for electrical energy and peak-demand savings for the Xcel Energy Colorado service territory. *Technical potential* represents the sum of all savings from all of the measures deemed applicable and technically feasible. *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 8,938 GWh per year, and economic potential at 7,563 GWh per year by 2020 (about 27 and 23 percent of base 2020 usage, respectively).

**Peak-Demand Savings**. Technical potential is estimated at about 2,161 MW, and economic potential at 1,730 MW by 2020 (about 33 and 26 percent of base 2020 demand, respectively).

Note that the technical and economic potentials include the effect of CFLs, although federal lighting standards may preclude much of the CFL potential in Xcel Energy programs. Overall, CFLs account for about 1,200 GWh of energy-savings potential (16 percent of total economic energy savings potential) and 150 MW of peak-demand potential (8 percent of total economic peak-demand potential) in 2020.

**Figure 5-1**
**Estimated Electric Technical and Economic Potential, 2020**
**Xcel Energy Colorado 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 about 55 percent of these potentials. The commercial sector also contributes the most to the technical and economic potential for peak-demand savings, accounting for about 45 percent of these potentials. The residential sector accounts for a similar share of economic peak-demand potential.

As shown in Figure 5-4 and Figure 5-5, the residential sector has a somewhat higher savings potential in relation to base energy use than does the commercial or industrial sectors. The estimated savings fraction is lowest for the industrial sector at around 12 percent, which is lower than the 14 to 22 percent of cost-effective industrial savings estimated by the National Academy of Sciences[5], but is in line with industrial savings fractions estimated by EPRI[6].

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

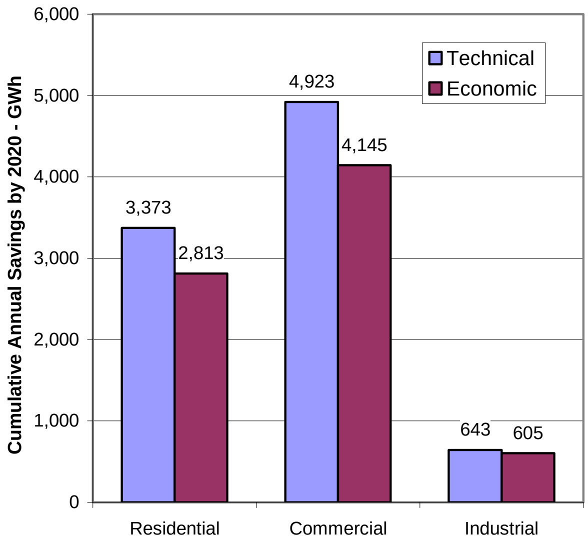
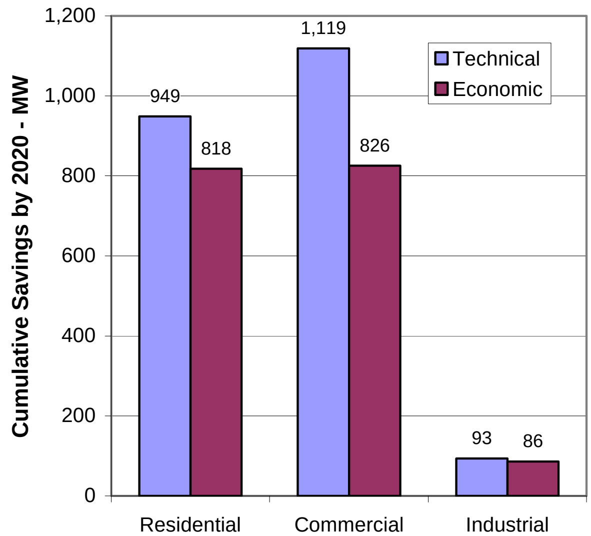



**Figure 5-3**
**Technical and Economic Potential (2020)**
**Demand Savings by Sector—MW**




[5] *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.

[6] *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.*, EPRI, 2009.

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

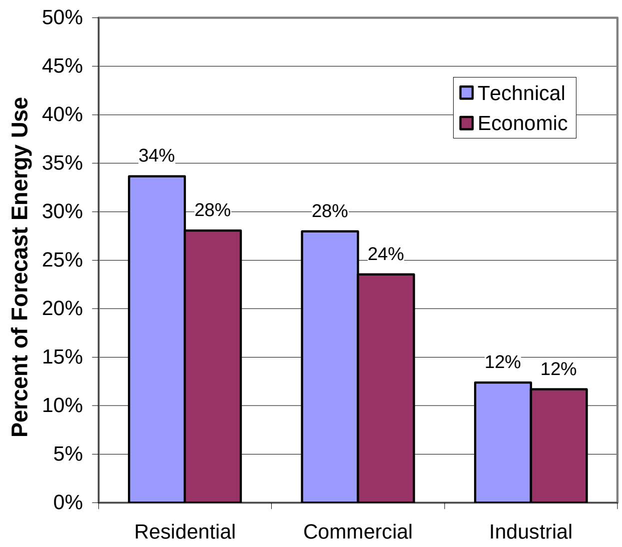
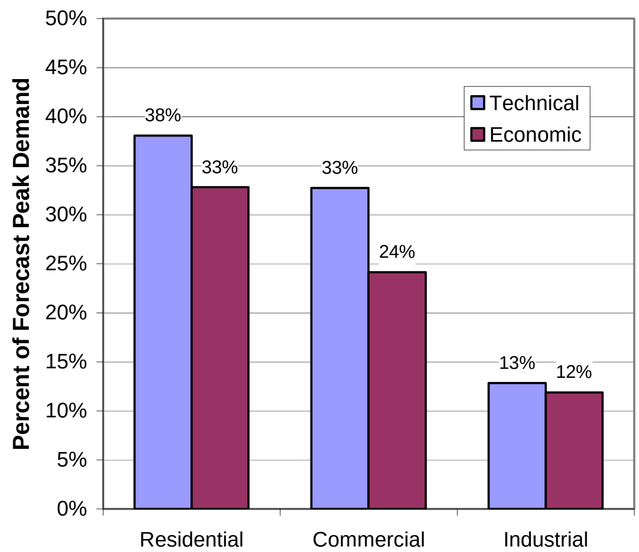



**Figure 5-5**
**Technical and Economic Potential (2020)**
**Percentage of Base Peak Demand**




### 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 two-thirds of the potential, and low-income homes account for about 15 percent of the potential.

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

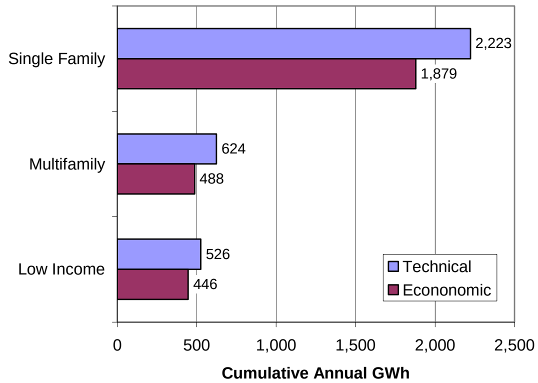



**Figure 5-7**
**Residential Demand-Savings Potential by Building Type (2020)**

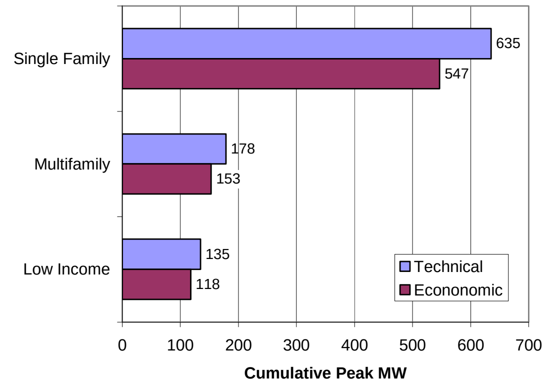


Figure 5-8 and Figure 5-9 show the building-type breakdown of commercial potential. Offices account for almost 40 percent of the economic potential, followed by retail, warehouses, and other commercial buildings.

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

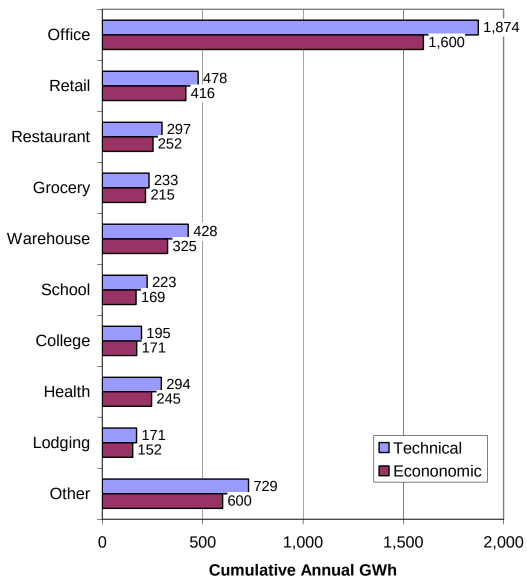



**Figure 5-9**
**Commercial Economic Demand-Savings Potential by Building Type (2014)**

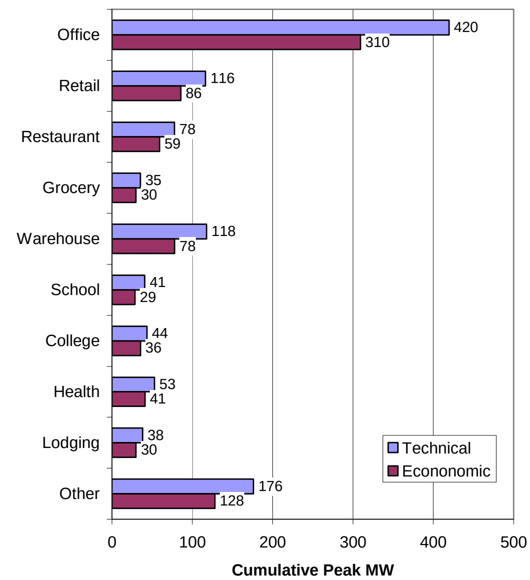



Figure 5-10 and Figure 5-11 show the business-type breakdown of industrial potential. Key industries in terms of economic potential include electronics, food processing, and petroleum refining. The electronics industry contributes a relatively higher amount to peak demand as the result of having more HVAC loads.

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

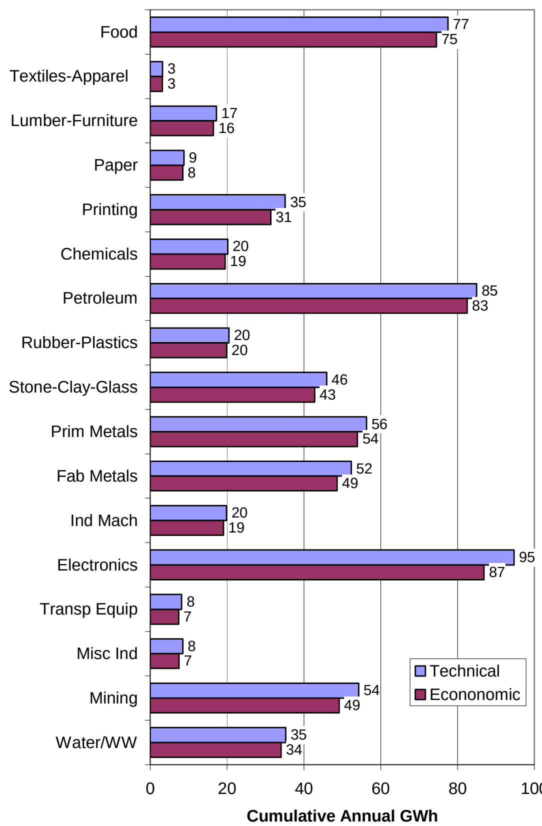
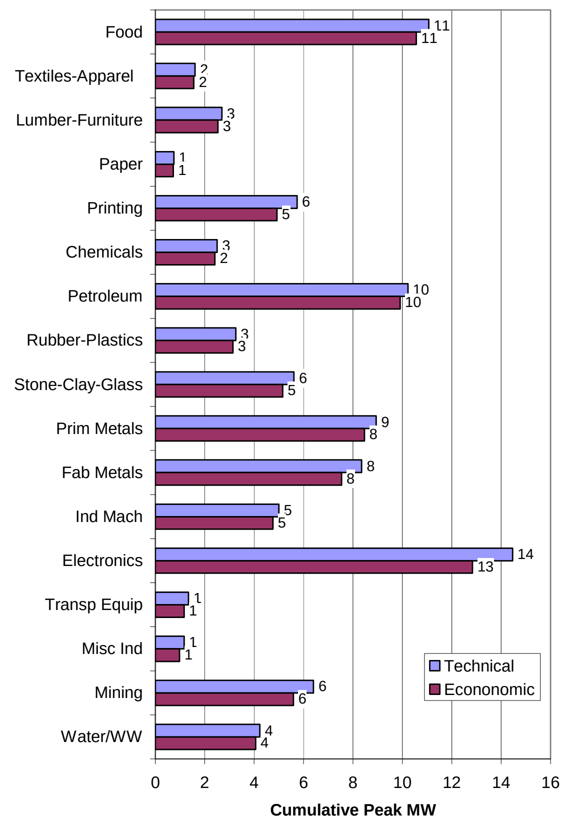



**Figure 5-11**
**Industrial Economic Demand-Savings Potential by Business Type (2020)**




### 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 is split fairly evenly among the lighting and cooling end uses, followed by refrigeration and plug loads (including entertainment and computers). 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 also account for significant amounts of both energy and peak-demand potential.

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

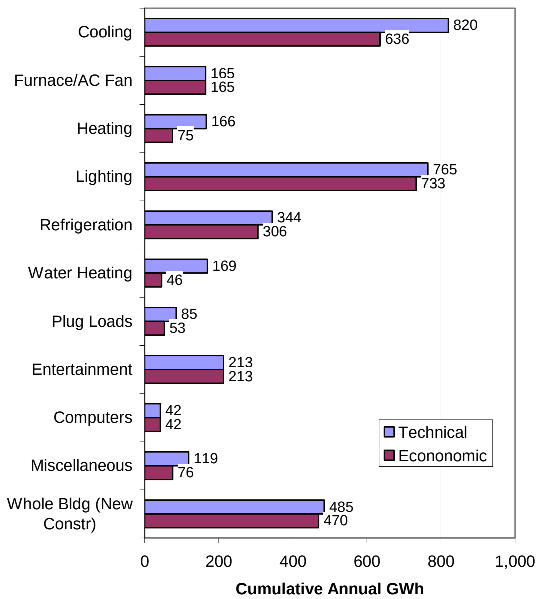



**Figure 5-13**
**Residential Economic Demand-Savings Potential by End Use (2020)**

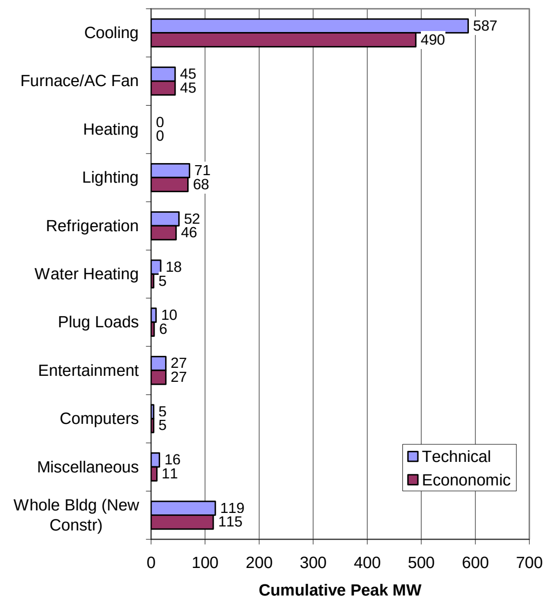



Figure 5-14 and Figure 5-15 show the end-use breakdown of commercial potential. Lighting's end use is the largest contributor to both energy and peak-demand economic-savings potential. CFLs and premium T8 lamps with electronic ballasts are key lighting measures.

**Figure 5-14**
**Commercial Economic Energy Savings Potential by End Use (2014)**

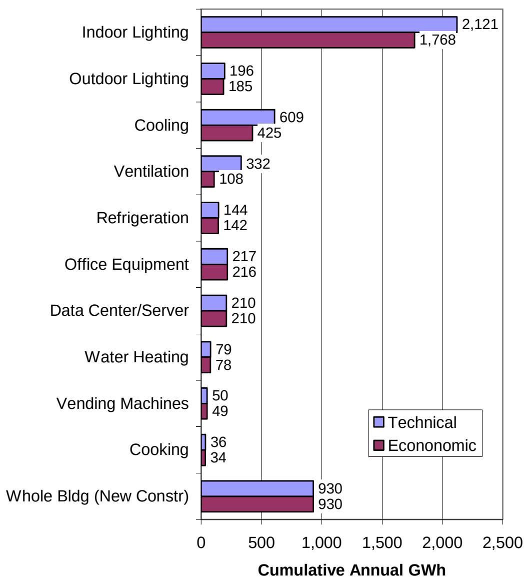



**Figure 5-15**
**Commercial Economic Demand Savings Potential by End Use (2014)**

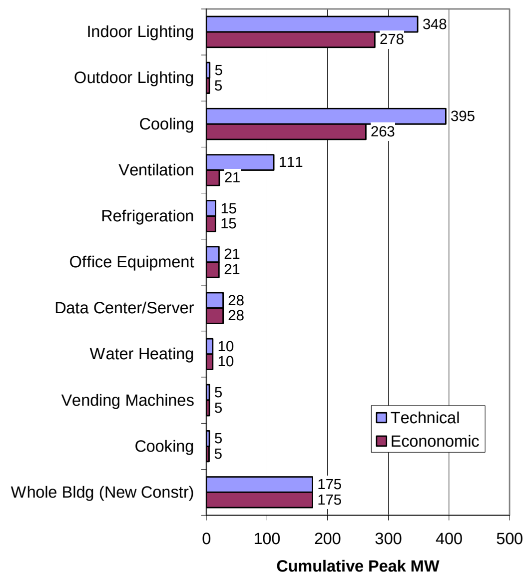



Figure 5-16 and Figure 5-17 show the end-use breakdown of industrial potential. Pumping-system measures provide the largest source of economic potential, followed by compressed-air systems and lighting.

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

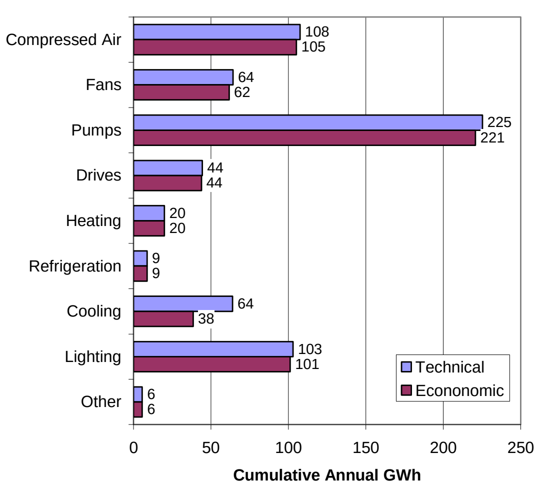
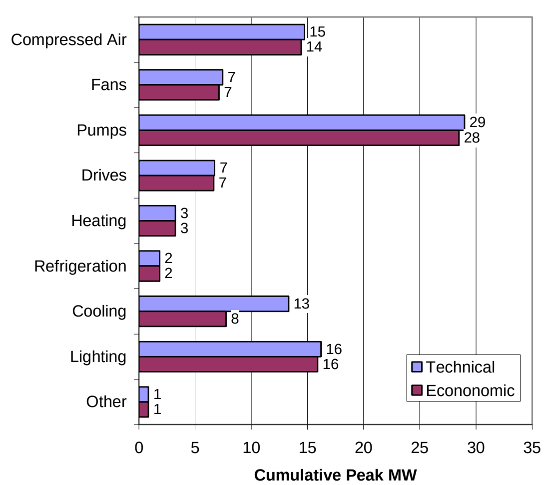



**Figure 5-17**
**Industrial Economic Demand-Savings Potential by End Use (2020)**

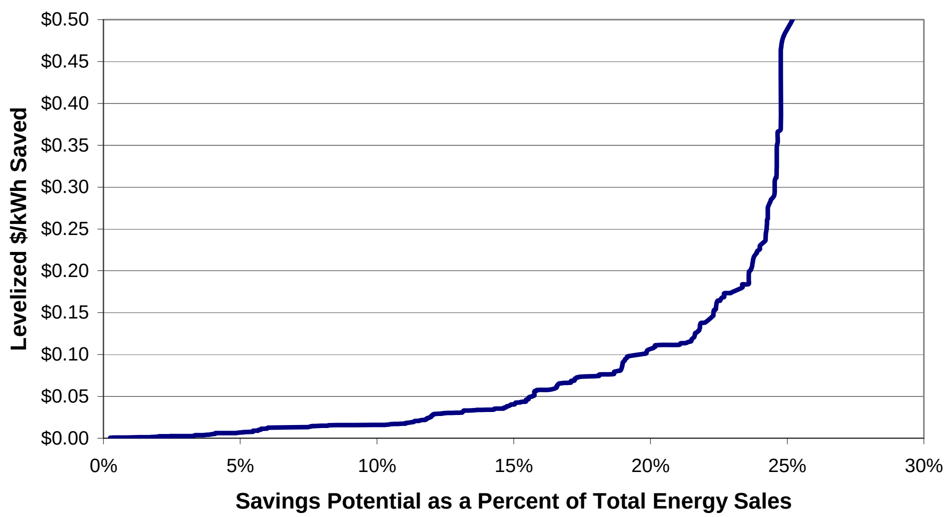


### 5.1.3 Energy-Efficiency Supply Curves

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.

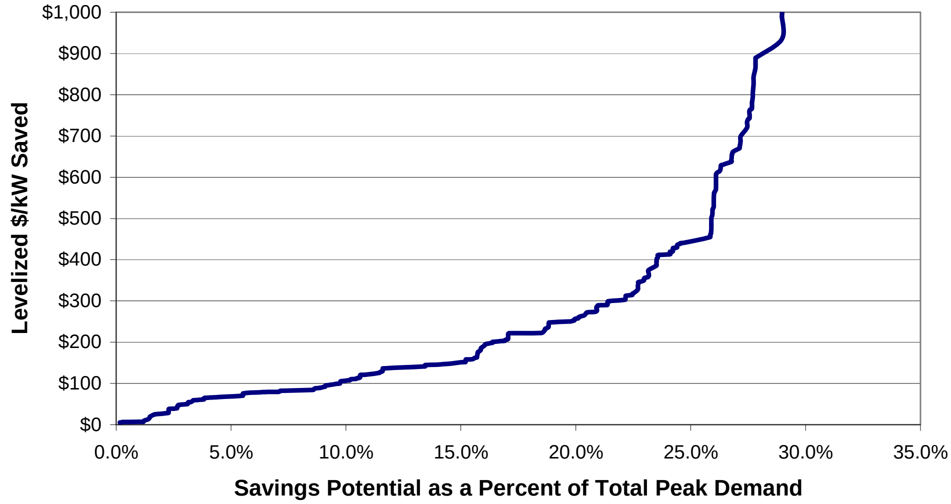
Figure 5-18 and Figure 5-19 present the supply curves constructed for this study for electric energy-efficiency and peak-demand efficiency, respectively. Each curve represents savings as a percentage of total energy or peak demand. These curves show that energy savings of about 16 percent are available at under $0.05 per kWh, and peak demand savings of about 9 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 5-18**
**Electric Energy Supply Curve***




*Levelized cost per kWh saved is calculated using a 7.9 percent nominal discount rate.

**Figure 5-19**
**Peak-Demand Supply Curve***




*Levelized cost per kW saved is calculated using a 7.9 percent nominal discount rate.

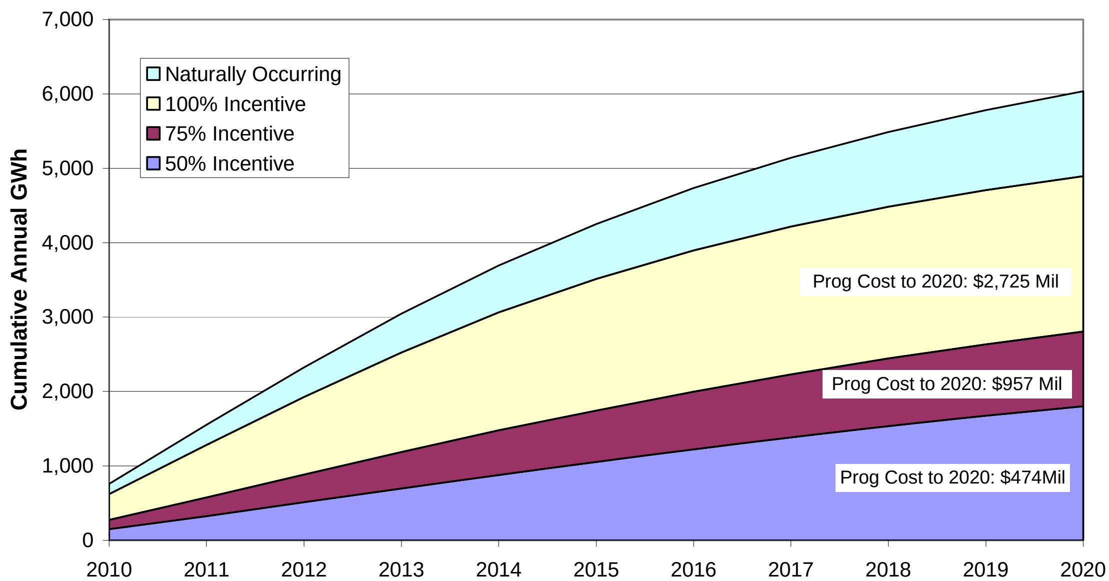
## 5.2 Achievable (Program) Potential

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 potential, first at the summary level and then by sector. More detail on achievable program potential is shown in Appendix H.

*Achievable potential* refers to the amount of savings that would occur in response to one or more specific program interventions. *Net* savings associated with program potential 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: 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. (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 2010-2020 period.

Figure 5-20 and Figure 5-21 show our estimates of achievable potential savings over time. As shown in Figure 5-20, by 2020, cumulative *net*[7] energy savings are projected to be 1,802 GWh under the 50-percent incentive scenario, 2,806 GWh under the 75-percent incentive scenario, and 4,892 GWh under the 100-percent incentive scenario. Figure 5-21 depicts projected net peak-demand savings of 328 MW under 50-percent incentives, 538 MW under 75-percent incentives, and 1,198 MW under 100-percent incentives.

**Figure 5-20**
**Achievable Electric Energy-Savings: All Sectors**




[7] Throughout this section, *net* refers to savings beyond those estimated to be naturally occurring; that is, from customer adoptions that would occur in the absence of any programs or standards.

**Figure 5-21**
**Achievable Peak-Demand Savings: All Sectors**

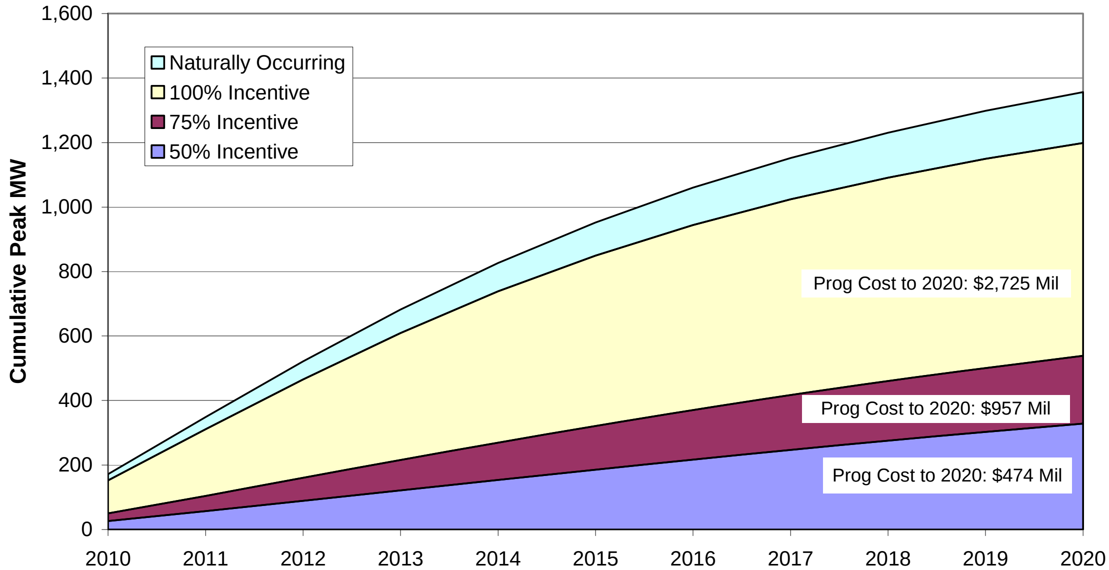
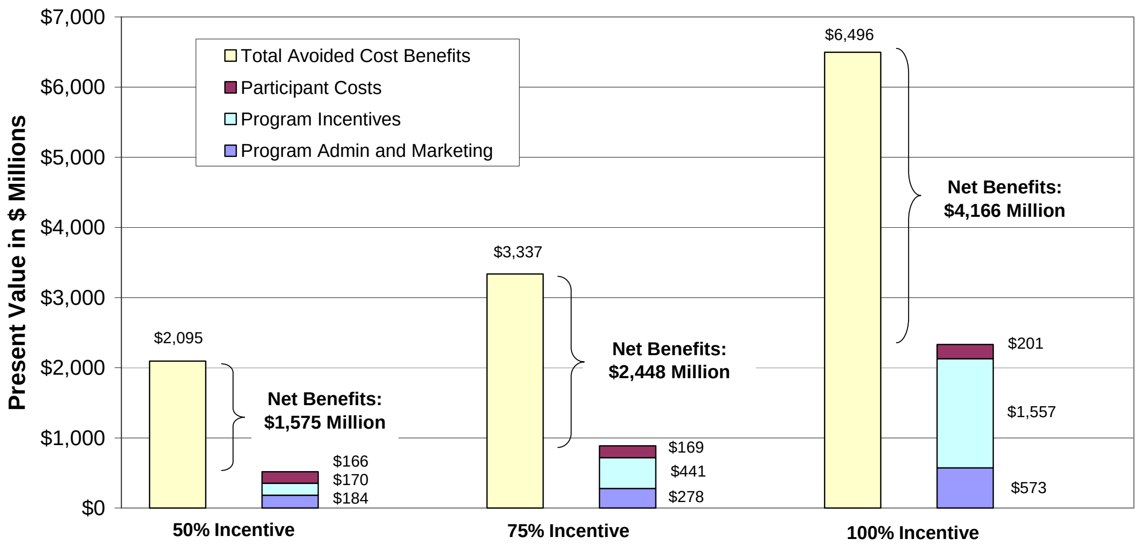



Figure 5-22 depicts costs and benefits under each funding scenario from 2010 to 2020. The present value of program costs (including administration, marketing, and incentives) is $354 million under the 50-percent incentive scenario, $719 million under the 75-percent incentive scenario, and $2,130 million under the 100-percent incentive scenario. The present value of total avoided-cost benefits is $2,095 million under 50-percent incentives, $3,337 million under 75-percent incentives, and $6,496 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 $1,575 million under 50-percent incentives, $2,448 million under 75-percent incentives, and $4,166 million under 100-percent incentives.

**Figure 5-22**
**Benefits and Costs of Energy-Efficiency Savings—2010-2020***




* Present value of benefits and costs over normalized 20-year measure lives; nominal discount rate is 7.9 percent, inflation rate is 1.5 percent.

All three 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 4.06 for the 50-percent incentive scenario, 3.8 for the 75-percent incentive scenario, and 2.8 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 5-1.

**Table 5-1**
**Summary of Achievable Potential Results—2010-2020**

| Result | Program Scenario | | |
|---|---|---|---|
| | 50% Incentive | 75% Incentive | 100% Incentive |
| **Gross Energy Savings - GWh** | 2,946 | 3,949 | 6,036 |
| **Gross Peak Demand Savings - MW** | 486 | 696 | 1,356 |
| **Net Energy Savings - GWh** | 1,802 | 2,806 | 4,892 |
| **Net Peak Demand Savings - MW** | 328 | 538 | 1,198 |
| **Program Costs - Real, $ Million** | | | |
| **Administration** | $179 | $303 | $682 |
| **Marketing** | $69 | $70 | $77 |
| **Incentives** | $227 | $584 | $1,966 |
| **Total** | $474 | $957 | $2,725 |
| **PV Avoided Costs Benefits** | $2,095 | $3,337 | $6,496 |
| **PV Annual Marketing and Admin Costs** | $184 | $278 | $573 |
| **PV Net Measure Costs** | $336 | $611 | $1,757 |
| **TRC Ratio** | 4.0 | 3.8 | 2.8 |

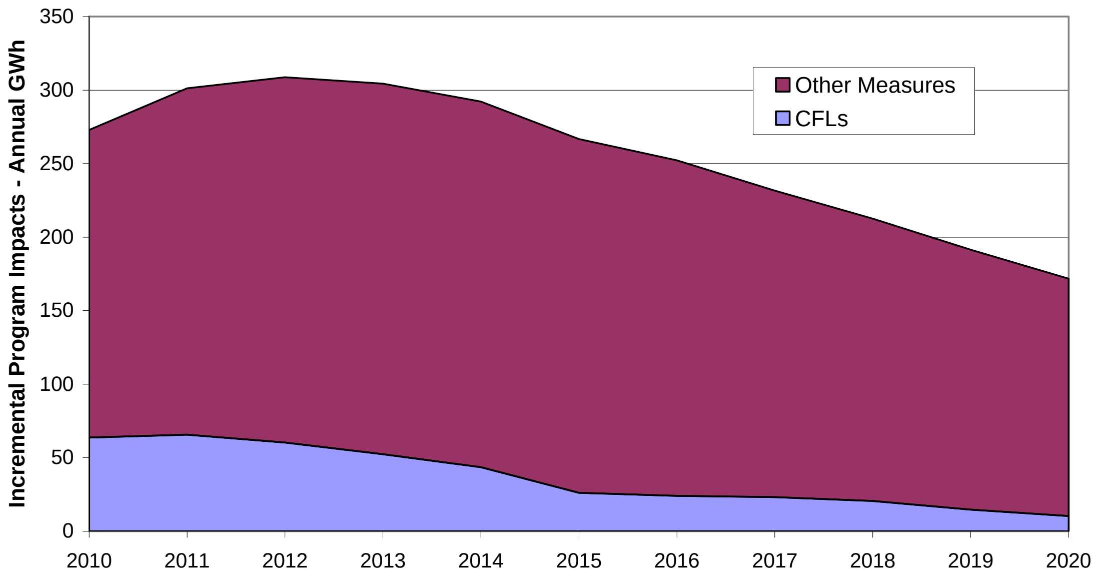
PV (present value) of benefits and costs is calculated over a 20-year normalized measure life for 2010-2020 program years, nominal discount rate = 7.9 percent, inflation rate = 1.5 percent; GWh and MW savings are cumulative through 2020.

## 5.2.1 CFL Potentials and Federal Lighting Standards

Federal lighting standards that are being introduced in 2012 and continue tightening through 2020 will reduce the allowed minimum energy consumption for incandescent bulbs. This, in turn, will lower impacts of program CFLs. While it is not entirely clear how markets will respond to the new standards, it appears that CFL impacts will be reduced in two ways: (1) CFL savings over a base incandescent bulb will be lower as the base incandescent usage drops; and (2) the more efficient incandescent bulbs will likely cost more, and this effect will increase a naturally occurring shift to CFLs due to price effects.

Figure 5-23 illustrates how the impacts of program CFLs are reduced over time in response to the federal standards. Overall, we expect some reduction in impacts between 2012 and 2014 and further reduction in CFL impacts after 2020. In addition to the effects of standards, continued penetration of CFLs into the market will also put a dampening effect on future program CFL impacts, as the measure reaches high saturation levels and it becomes more difficult to find customers who have not converted most of their lighting to CFLs.

**Figure 5-23**
**Incremental Impacts of Program CFLs versus Other Measures – 75% Incentive Case**




## 5.2.2 Breakdown of Achievable Potential

Cumulative net achievable potential estimates by customer class for the period of 2010-2020 are presented in Figure 5-24 and Figure 5-25. 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 highest for the commercial sector in the 50-percent and 75-percent incentive scenarios and are higher for the residential sector in the 100-percent incentive scenario.

**Figure 5-24**
**Net Achievable Energy Savings (2020) by Sector—GWh per Year**

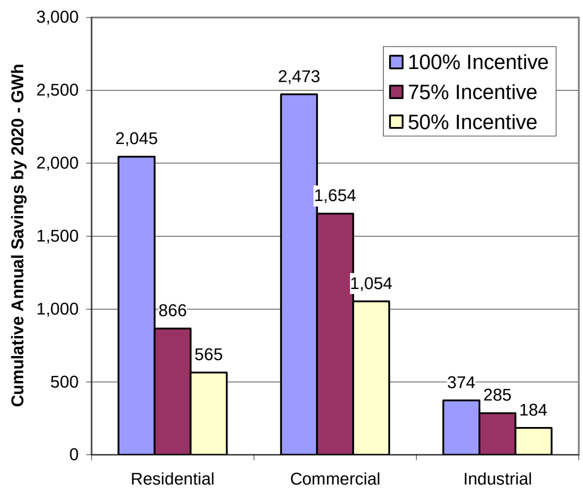
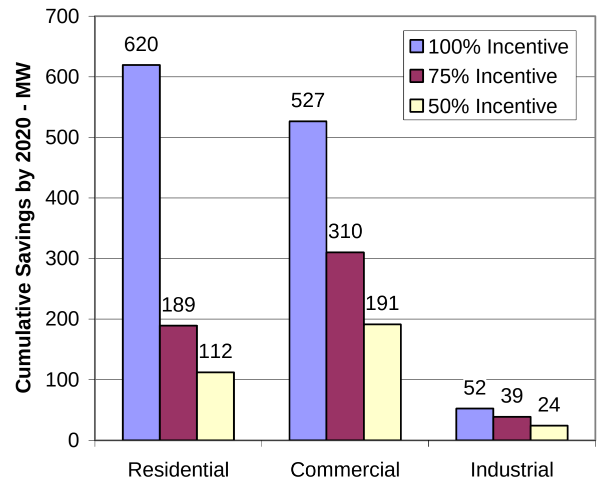



**Figure 5-25**
**Net Achievable Peak-Demand Savings (2020) by Sector—MW**




#### 5.2.2.1 Residential Sector

Figure 5-26 and Figure 5-27 show cumulative net achievable program savings by residential program scenario. By 2020, net energy savings reach 565 GWh under the 50-percent incentive scenario, 189 GWh under the 75-percent incentive scenario, and 620 GWh under the 100-percent incentive scenario. Energy savings are most sensitive to changes in incentives in the 75- to 100-percent range. For peak demand, net savings increase from 112 MW under 50-percent incentives to 189 MW under 75-percent incentives to 620 MW under 100-percent incentives.

**Figure 5-26**
**Achievable Energy Savings: Residential Sector**

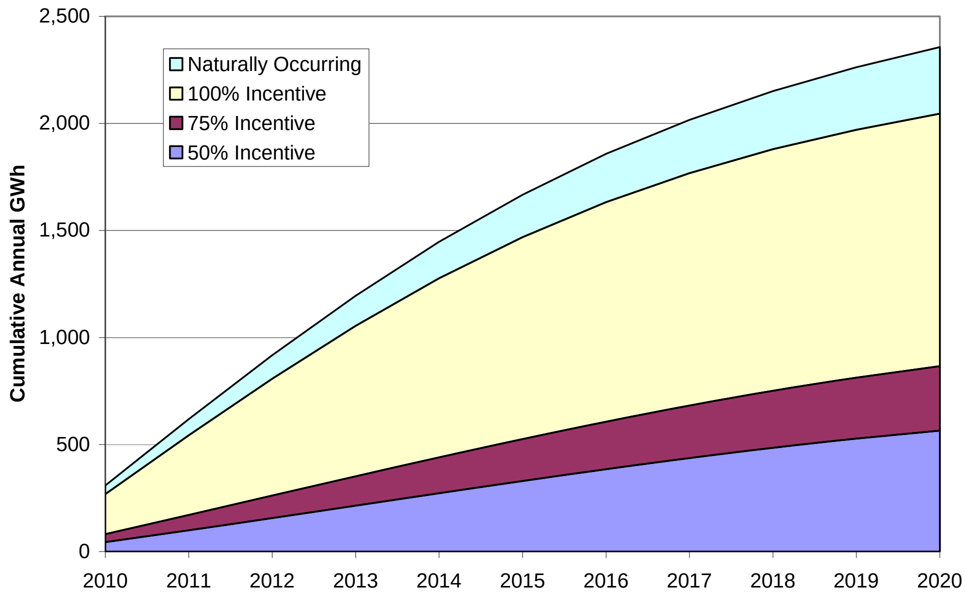



**Figure 5-27**
**Achievable Peak-Demand Savings: Residential Sector**

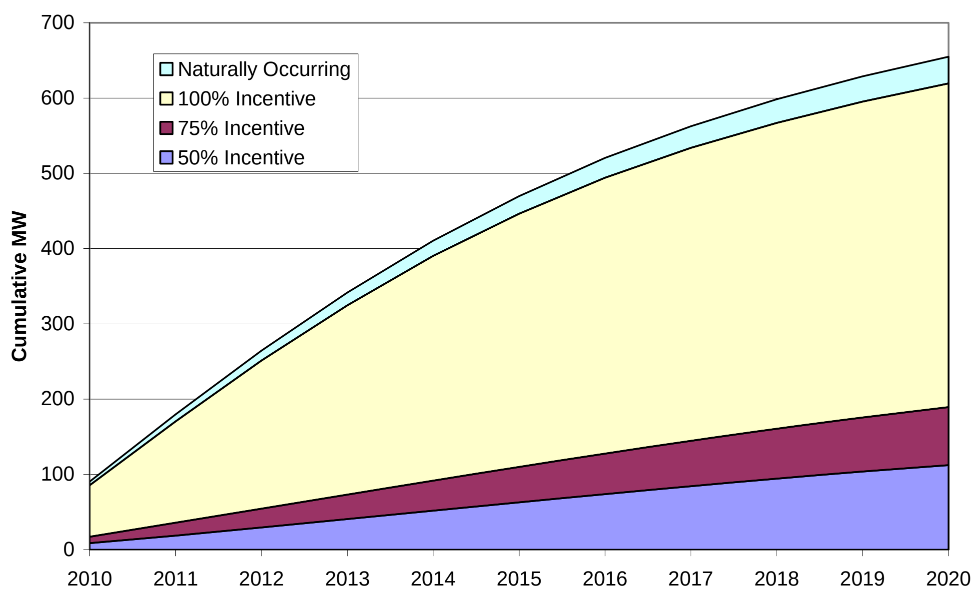



Figure 5-28 and Figure 5-29 show the end-use distribution of energy and peak-demand savings, cumulative to 2020. Key end uses for energy-savings potential include lighting, cooling, refrigeration, Energy Star entertainment systems, and new construction measures. Cooling and new construction measures provide much of the peak-demand savings potential. The figures also show that our models predict a large increase in savings when incentives are increased from 75 percent to 100 percent of incremental measure cost. This is especially true for 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.

**Figure 5-28**
**Residential Net Energy-Savings Potential by End Use (2020)**

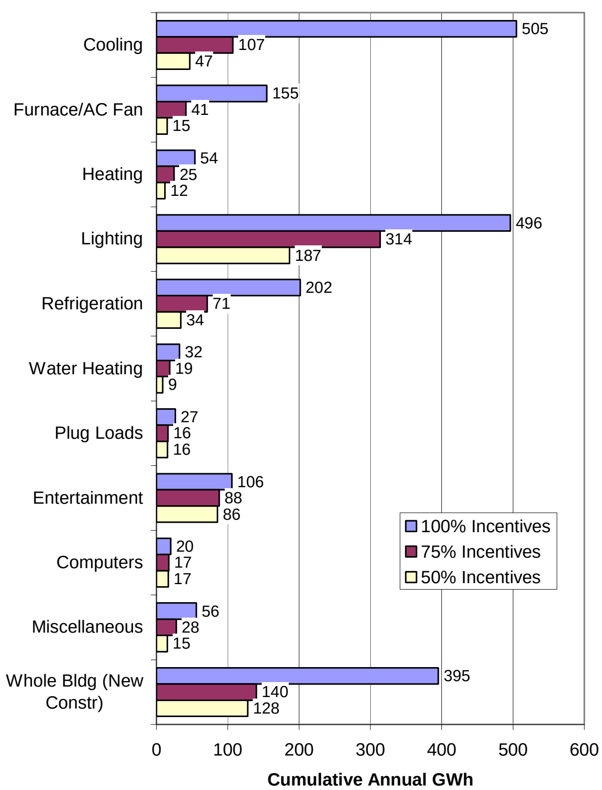



**Figure 5-29**
**Residential Net Peak-Savings Potential by End Use (2020)**

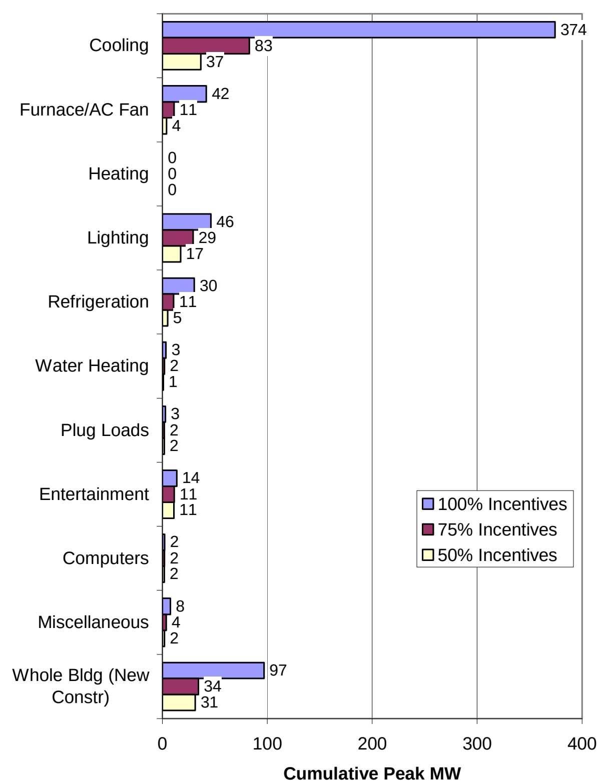



Table 5-2 shows how the low-income potentials compare to the overall residential potentials. The low-income segment accounts for about 13 percent of total residential economic potential and about 10 percent of total residential achievable potential. The primary reason for drop-off in low-income achievable potential relative to total residential potential is the exclusion of CFLs from the low-income totals. 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.

**Table 5-2**
**Low-Income Potentials Compared to Total Residential Potentials (2020)**

| | Economic Potential | Program Scenario 100% Incentive | 75% Incentive | 50% Incentive |
|---|---|---|---|---|
| Residential | 2,813 | 2,045 | 866 | 565 |
| Low Income | 366 | 185 | 92 | 55 |
| % of Residential | 13% | 9% | 11% | 10% |

Note: Low-income economic potentials include CFLs, but the low-income achievable potentials exclude CFLs.

Table 5-3 lists the various potentials for residential measures that passed cost-effectiveness screening. The list is sorted by economic potential.

## Table 5-3
## 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| CFL 13W | 35.4 | 477.6 | 477.6 | 259.6 | 255.7 | 99% | 226.9 | 87% | 164.1 | 63% |
| CFL 13W - Specialty | 2.7 | 245.5 | 245.5 | 243.8 | 239.9 | 98% | 86.8 | 36% | 22.6 | 9% |
| WINDOWS - Default With Sunscreen | 3.2 | 198.1 | 197.3 | 197.3 | 183.4 | 93% | 21.2 | 11% | 11.4 | 6% |
| ECM Furnace Fan (variable speed motor) | 5.4 | 164.5 | 164.5 | 164.1 | 154.8 | 94% | 41.3 | 25% | 15.1 | 9% |
| Refrigerator (Energy Star) | 2.2 | 152.8 | 152.8 | 151.7 | 62.7 | 41% | 25.6 | 17% | 15.9 | 11% |
| Evaporative Cooler - Direct | 1.6 | 132.2 | 126.0 | 125.1 | 118.3 | 95% | 34.5 | 28% | 13.5 | 11% |
| Refrigerator - Early Replacement (Energy Star) | 1.9 | 115.2 | 115.2 | 114.9 | 108.7 | 95% | 36.2 | 32% | 13.7 | 12% |
| Energy Star Big Screen TV | 150.1 | 91.7 | 91.7 | 65.1 | 48.9 | 75% | 41.0 | 63% | 39.7 | 61% |
| Energy Star Set-Top Box | 32.7 | 86.5 | 86.5 | 69.1 | 41.5 | 60% | 34.3 | 50% | 33.4 | 48% |
| WINDOWS - Double-Glazed Clear to Energy Star | 2.6 | 80.5 | 80.5 | 80.3 | 29.3 | 36% | 10.3 | 13% | 5.3 | 7% |
| 14 SEER (12.15 EER) Split-System Air Conditioner | 1.6 | 62.8 | 62.3 | 62.1 | 23.7 | 38% | 5.5 | 9% | 2.8 | 5% |
| Whole House Fans | 1.3 | 107.4 | 49.2 | 49.1 | 45.6 | 93% | 6.6 | 13% | 1.1 | 2% |
| Whole House Fans | 1.3 | 107.4 | 49.2 | 49.1 | 45.6 | 93% | 6.6 | 13% | 1.1 | 2% |
| High Efficiency CD (EF=3.01 w/moisture sensor) | 1.3 | 49.6 | 40.0 | 39.8 | 24.5 | 61% | 7.9 | 20% | 4.3 | 11% |
| Energy Star Desktop PC | 20.5 | 39.9 | 39.9 | 32.9 | 19.1 | 58% | 16.4 | 50% | 16.1 | 49% |
| Air Source Heat Pump | 2.9 | 38.8 | 38.8 | 38.1 | 19.2 | 50% | 12.3 | 32% | 7.5 | 20% |
| Crawlspace insulation | 5.7 | 35.8 | 35.8 | 35.7 | 33.4 | 94% | 8.3 | 23% | 3.0 | 8% |
| Proper Refrigerant Charging and Air Flow | 2.0 | 34.4 | 33.6 | 33.6 | 33.3 | 99% | 8.8 | 26% | 3.4 | 10% |
| Energy Star DVD Player | 17.7 | 21.0 | 21.0 | 17.8 | 10.1 | 56% | 8.2 | 46% | 8.0 | 45% |
| Programmable Thermostat | 2.8 | 19.8 | 19.7 | 19.6 | 19.6 | 100% | 5.5 | 28% | 2.1 | 11% |
| Freezer (Energy Star) | 1.3 | 19.5 | 19.5 | 19.3 | 13.1 | 68% | 4.4 | 23% | 2.6 | 13% |
| Energy Star Home Audio | 18.8 | 19.3 | 19.3 | 15.9 | 9.4 | 59% | 7.6 | 48% | 7.4 | 47% |
| Freezer - Early Replacement (Energy Star) | 1.5 | 18.2 | 18.2 | 18.2 | 17.2 | 95% | 5.0 | 28% | 2.0 | 11% |
| High Efficiency One Speed Pool Pump (1.5 hp) | 4.7 | 17.2 | 17.0 | 15.8 | 14.8 | 94% | 11.7 | 74% | 8.3 | 53% |
| Two Speed Pool Pump (1.5 hp) | 1.8 | 16.8 | 16.6 | 16.6 | 15.4 | 93% | 7.4 | 45% | 2.3 | 14% |
| HE Room Air Conditioner - CEE Tier 1 EER 11.3 | 1.7 | 15.4 | 15.2 | 15.2 | 8.9 | 59% | 2.8 | 18% | 1.3 | 9% |
| Energy Star TV | 8.8 | 13.8 | 13.8 | 12.6 | 5.4 | 43% | 4.6 | 36% | 4.5 | 36% |
| Proper Sizing and Quality Install | 4.0 | 12.1 | 12.1 | 12.0 | 4.7 | 39% | 1.6 | 14% | 0.6 | 5% |
| Ceiling R-0 to R-49 Insulation | 2.8 | 10.2 | 10.1 | 10.0 | 9.9 | 99% | 4.8 | 48% | 1.8 | 18% |
| ROB 2L4'T8, 1EB | 0.9 | 41.8 | 10.0 | 10.0 | 0.7 | 7% | 0.2 | 2% | 0.1 | 1% |
| Heat Pump Water Heater - Energy Star | 0.6 | 67.7 | 9.6 | 9.6 | 7.2 | 75% | 3.3 | 35% | 1.4 | 14% |
| Energy Star Cordless Phones | 8.5 | 8.7 | 8.7 | 7.8 | 3.5 | 45% | 2.9 | 37% | 2.8 | 37% |
| Energy Star CW CEE Tier 2 (MEF=2.0) | 1.2 | 14.1 | 8.3 | 8.3 | 4.4 | 53% | 2.0 | 24% | 0.8 | 10% |
| Pipe Wrap | 3.8 | 7.5 | 7.5 | 7.2 | 6.8 | 94% | 4.5 | 63% | 2.3 | 32% |
| Energy Star DTA (Digital to Analog Converter) | 7.6 | 7.8 | 7.5 | 6.8 | 3.0 | 44% | 2.5 | 37% | 2.5 | 36% |
| Duct Sealing - from 40% AHU to 12% | 2.8 | 7.9 | 7.5 | 7.4 | 7.4 | 99% | 2.7 | 36% | 1.0 | 14% |
| Plug Load Controls - Smart Power Strip | 0.6 | 21.2 | 7.3 | 7.3 | 7.3 | 99% | 0.1 | 1% | 0.0 | 0% |
| Low Flow Showerhead 1.5 Gal/Min | 3.8 | 7.0 | 7.0 | 6.7 | 6.3 | 94% | 4.7 | 70% | 2.4 | 35% |
| Duct Sealing - from 24% AHU to 12% | 1.1 | 11.7 | 6.4 | 6.4 | 6.3 | 99% | 1.7 | 27% | 1.1 | 17% |
| Wall Blow-in R-0 to R-13 Insulation | 1.3 | 12.7 | 6.3 | 6.3 | 6.3 | 99% | 2.1 | 33% | 1.1 | 18% |
| Energy Star Battery Chargers | 5.3 | 5.4 | 5.2 | 4.8 | 1.7 | 36% | 1.5 | 31% | 1.5 | 30% |
| Energy Star External Power Adapters | 5.3 | 5.4 | 5.2 | 4.8 | 1.7 | 36% | 1.5 | 31% | 1.5 | 30% |
| HE Water Heater (EF=0.93) | 1.2 | 8.6 | 4.8 | 4.8 | 2.4 | 50% | 1.1 | 23% | 0.5 | 10% |
| Faucent Aerators | 3.2 | 4.4 | 4.4 | 4.2 | 4.0 | 94% | 2.7 | 63% | 1.2 | 29% |
| Self Install Weatherization | 1.8 | 4.2 | 4.0 | 3.9 | 3.7 | 94% | 1.6 | 40% | 0.6 | 15% |
| Duct Insulation | 4.7 | 3.9 | 3.9 | 3.9 | 3.9 | 100% | 2.1 | 54% | 0.9 | 23% |
| Tankless Water Heater | 0.7 | 25.4 | 3.9 | 3.9 | 1.4 | 36% | 0.5 | 12% | 0.2 | 6% |
| Energy Star Laptop PC | 7.9 | 2.2 | 2.2 | 2.0 | 0.9 | 45% | 0.8 | 38% | 0.7 | 36% |
| Ceiling Fans | 0.8 | 8.9 | 2.0 | 2.0 | 1.8 | 91% | 0.1 | 5% | 0.0 | 1% |
| 10% better than Energy Star Dehumidifier | 8.5 | 2.0 | 2.0 | 1.9 | 1.3 | 66% | 0.7 | 36% | 0.4 | 21% |
| Ceiling R-11 to R-49 Insulation | 0.8 | 0.4 | 0.0 | 0.0 | 0.0 | 99% | 0.0 | 6% | 0.0 | 1% |
| New Construction Meausres | | | | | | | | | | |
| Best Practice Home | 1.4 | 279.3 | 263.9 | 253.4 | 221.4 | 87% | 70.5 | 28% | 63.2 | 25% |
| ENERGY STAR Home | 2.2 | 205.6 | 205.6 | 194.6 | 173.9 | 89% | 69.6 | 36% | 64.8 | 33% |

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.

### 5.2.2.2 Commercial Sector

Figure 5-30 and Figure 5-31 show cumulative net achievable program savings by commercial program scenario. By 2020, net energy savings reach 1,054 GWh under the 50-percent incentive scenario, 1,645 GWh under the 75-percent incentive scenario, and 2,473 GWh under the 100-percent incentive scenario. Peak-demand savings by 2020 range from 191 MW in the 50-percent incentive scenario to 310 MW in the 75-percent incentive scenario to 527 MW in the 100 percent incentive scenario. Savings increases begin to taper off in the more advanced scenarios as the lighting measures begin to reach high saturation levels and increased program penetration becomes more difficult.

**Figure 5-30**
**Achievable Energy Savings: Commercial Sector**

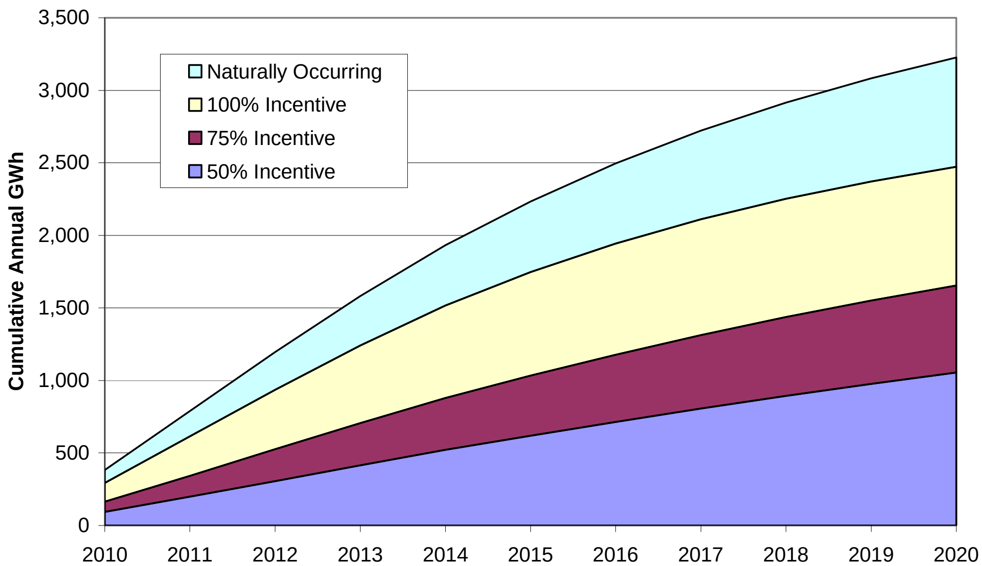


**Figure 5-31**
**Achievable Peak-Demand Savings: Commercial Sector**

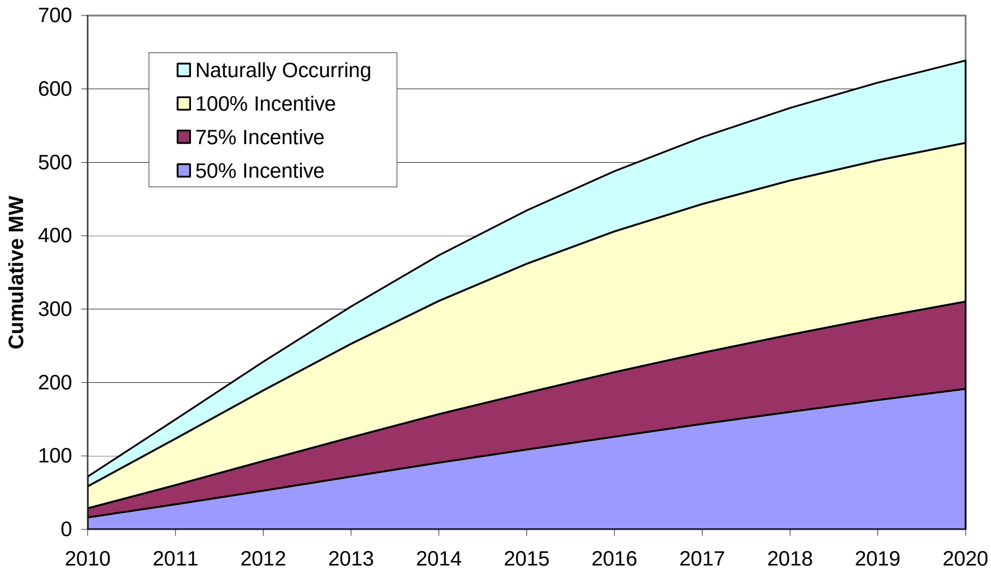



Figure 5-32 and Figure 5-33 show the end-use distribution of energy and peak-demand savings. Lighting contributes most to both the energy and peak-demand savings potential (except in the 100-percent incentive scenario), followed by cooling, data center, and outdoor lighting measures. As one would expect, HVAC contributes a higher share to peak-demand savings potential versus energy-savings potential. While office equipment measures are shown to be a contributor to net savings, no incentives are provided for measures affecting this end use. Rather, results show effects of program marketing and education efforts to make customers more aware of the benefits of implementing equipment power-management capabilities.

**Figure 5-32**
**Commercial Net Energy-Savings Potential by End Use (2020)**

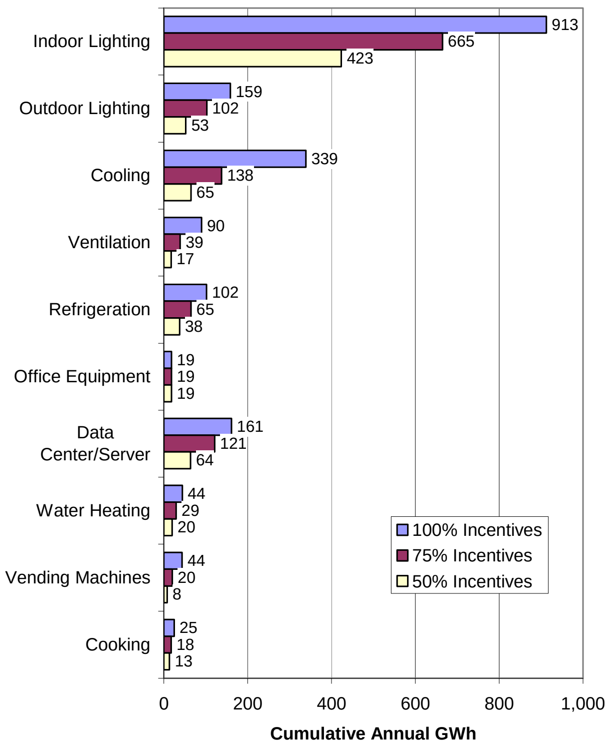



**Figure 5-33**
**Commercial Net Peak-Savings Potential by End-Use (2020)**

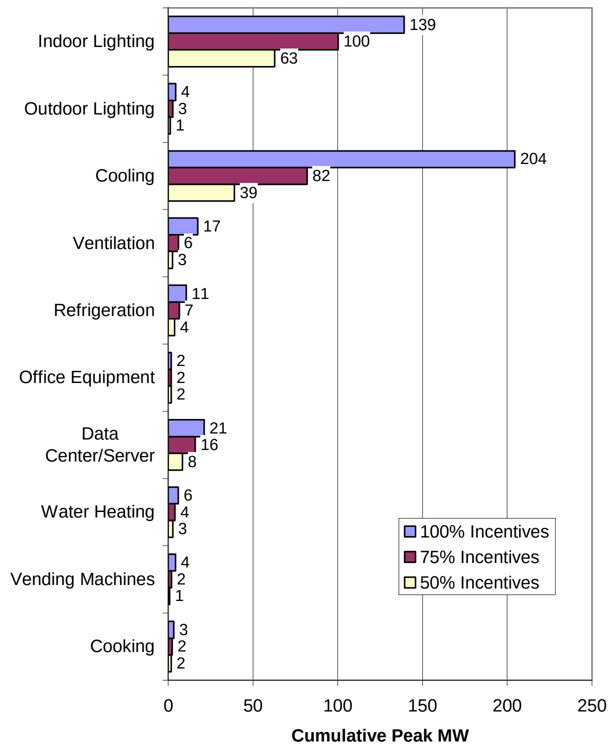



Table 5-4 lists the various potentials for commercial measures that passed cost-effectiveness screening. Lighting measures, especially the premium T8 lighting with electronic ballast and CFLs, account for much of the savings potential. Limited achievable program potential for office equipment measures reflect the fact that incentives are not being provided and that program savings are mainly from information-based efforts. 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 5-4
## Measure-Specific Commercial Results (Cumulative to 2020) – GWh

| Measure | Average TRC Ratio | Technical | Economic | Econ net of Nat Occ | Ach @100% Incentives | % of Net Economic | Ach @75% Incentives | % of Net Economic | Ach @50% Incentives | % of Net Economic |
|---|---|---|---|---|---|---|---|---|---|---|
| CFL Screw-in 18W | 126.2 | 369.1 | 369.1 | 64.7 | 58.7 | 91% | 54.5 | 84% | 44.2 | 68% |
| High Performance Lighting R/R - 25% Savings | 9.2 | 307.2 | 307.2 | 296.9 | 114.7 | 39% | 82.8 | 28% | 63.2 | 21% |
| RET 2L4' Premium T8, 1EB | 7.9 | 182.1 | 182.1 | 143.3 | 140.6 | 98% | 122.8 | 86% | 87.0 | 61% |
| High Pressure Sodium 250W Lamp | 1.1 | 177.0 | 166.1 | 157.5 | 145.5 | 92% | 89.9 | 57% | 42.9 | 27% |
| RET 4L4' Premium T8, 1EB | 19.8 | 147.3 | 147.3 | 54.7 | 52.7 | 96% | 49.3 | 90% | 42.9 | 78% |
| CFL Hardwired, Modular 18W | 4.4 | 123.0 | 123.0 | 112.4 | 65.7 | 58% | 36.0 | 32% | 14.6 | 13% |
| RET 2L4' Premium T8, 1EB, Reflector | 16.0 | 111.7 | 111.7 | 95.0 | 93.4 | 98% | 84.3 | 89% | 53.1 | 56% |
| PC Network Power Management Enabling | 37.2 | 95.3 | 95.3 | 38.7 | 11.0 | 29% | 11.0 | 29% | 11.0 | 29% |
| Data Center Best Practices | 68.3 | 93.1 | 93.1 | 88.5 | 82.5 | 93% | 65.2 | 74% | 25.1 | 28% |
| ROB 2L4' Premium T8, 1EB | 8.7 | 87.5 | 87.5 | 83.5 | 40.4 | 48% | 30.5 | 37% | 23.8 | 28% |
| Data Center Improved Operations | 167.7 | 81.3 | 81.3 | 50.9 | 45.6 | 90% | 44.2 | 87% | 36.7 | 72% |
| Occupancy Sensor, 8L4' Fluorescent Fixtures | 3.6 | 81.3 | 81.3 | 78.0 | 72.3 | 93% | 46.8 | 60% | 20.8 | 27% |
| Occupancy Sensor, 4L4' Fluorescent Fixtures | 2.8 | 79.4 | 79.4 | 77.6 | 71.7 | 92% | 37.0 | 48% | 13.5 | 17% |
| DX Packaged System, EER=10.9, 10 tons | 5.2 | 79.3 | 79.3 | 78.4 | 41.1 | 52% | 19.4 | 25% | 12.0 | 15% |
| Aerosol Duct Sealing - DX | 2.9 | 73.6 | 73.6 | 72.4 | 66.5 | 92% | 22.3 | 31% | 8.8 | 12% |
| ROB 4L4' Premium T8, 1EB | 6.6 | 71.2 | 71.2 | 69.3 | 26.2 | 38% | 18.5 | 27% | 13.8 | 20% |
| Vending Misers (cooled machines only) | 3.7 | 50.2 | 49.2 | 47.0 | 43.6 | 93% | 20.3 | 43% | 7.8 | 17% |
| Energy Star or Better PC | 53.5 | 45.8 | 45.8 | 8.8 | 3.9 | 44% | 3.9 | 44% | 3.9 | 44% |
| RET 1L4' Premium T8, 1EB, Reflector OEM | 7.2 | 45.6 | 45.6 | 44.8 | 44.2 | 98% | 25.0 | 56% | 7.2 | 16% |
| Economizer - DX | 2.0 | 48.0 | 41.8 | 40.4 | 37.3 | 92% | 17.4 | 43% | 8.2 | 20% |
| Heat Recovery Unit | 8.4 | 41.4 | 40.7 | 29.5 | 26.7 | 91% | 17.4 | 59% | 11.2 | 38% |
| Data Center State of the Art practices | 35.4 | 35.7 | 35.7 | 35.5 | 33.2 | 93% | 11.9 | 34% | 2.2 | 6% |
| Convection Oven | 7.7 | 33.4 | 33.4 | 31.1 | 23.9 | 77% | 17.2 | 55% | 13.2 | 43% |
| Freezer-Cooler Replacement Gaskets | 14.6 | 29.2 | 29.2 | 13.7 | 11.8 | 86% | 10.3 | 75% | 8.2 | 60% |
| DX Coil Cleaning | 6.2 | 27.3 | 27.3 | 25.8 | 24.0 | 93% | 14.7 | 57% | 7.4 | 29% |
| PSMH + electronic ballast | 2.3 | 25.3 | 25.3 | 24.8 | 22.4 | 90% | 9.9 | 40% | 3.5 | 14% |
| Cool Roof - DX | 4.2 | 32.6 | 24.8 | 23.1 | 21.1 | 91% | 7.0 | 30% | 3.5 | 15% |
| Centrifugal Chiller, 0.51 kW/ton, 500 tons | 6.6 | 24.4 | 24.4 | 24.2 | 9.5 | 39% | 5.1 | 21% | 3.3 | 14% |
| Window Film (Standard) - DX | 4.0 | 35.7 | 24.4 | 23.5 | 21.7 | 92% | 9.4 | 40% | 4.7 | 20% |
| High Bay T5 | 5.3 | 23.2 | 23.2 | 20.6 | 18.8 | 91% | 13.9 | 67% | 8.5 | 41% |
| PC Manual Power Management Enabling | 11.4 | 22.9 | 22.9 | 19.5 | 0.8 | 4% | 0.8 | 4% | 0.8 | 4% |
| Printer Power Management Enabling | 3.5 | 22.3 | 22.3 | 22.0 | 0.2 | 1% | 0.2 | 1% | 0.2 | 1% |
| Monitor Power Management Enabling | 30.8 | 22.3 | 22.3 | 13.8 | 2.2 | 16% | 2.2 | 16% | 2.2 | 16% |
| Variable Speed Drive Control, 40 HP | 2.5 | 21.8 | 21.7 | 20.1 | 18.6 | 92% | 11.1 | 55% | 6.1 | 31% |
| Heat Pump Water Heater (air source) | 7.9 | 21.4 | 21.4 | 20.5 | 10.7 | 52% | 7.5 | 36% | 5.7 | 28% |
| High-efficiency fan motors | 1.9 | 21.7 | 21.4 | 21.1 | 19.5 | 93% | 7.8 | 37% | 2.5 | 12% |
| LED Exit Sign | 2.5 | 20.2 | 20.2 | 19.9 | 19.6 | 98% | 9.8 | 49% | 2.9 | 15% |
| Prog. Thermostat - DX | 1.8 | 22.4 | 19.4 | 18.8 | 17.3 | 92% | 8.0 | 43% | 3.7 | 20% |
| Induction High Bay Lighting | 1.9 | 19.1 | 19.1 | 19.0 | 17.5 | 92% | 5.5 | 29% | 1.7 | 9% |
| Geothermal Heat Pump, EER=13, 10 tons - DX | 6.7 | 18.9 | 18.9 | 18.2 | 16.8 | 93% | 9.4 | 52% | 4.4 | 24% |
| RET 2 - 1L4' Premium T8, 1EB, Reflector OEM | 6.9 | 18.6 | 18.6 | 18.3 | 18.1 | 98% | 9.7 | 53% | 2.6 | 14% |
| Outdoor Lighting Controls (Photocell/Timeclock) | 4.3 | 18.6 | 18.6 | 13.4 | 13.1 | 98% | 12.4 | 93% | 9.7 | 73% |
| Oversized Air Cooled Condenser | 3.5 | 18.5 | 18.5 | 17.2 | 16.9 | 98% | 12.6 | 73% | 6.8 | 40% |
| Variable Speed Drive Control, 5 HP | 0.9 | 28.8 | 17.7 | 17.5 | 16.1 | 92% | 5.2 | 30% | 1.8 | 10% |
| Night covers for display cases | 2.8 | 16.9 | 16.8 | 14.9 | 13.8 | 92% | 10.4 | 69% | 6.4 | 43% |
| RET 2 - 2L4' Premium T8, 1EB | 7.2 | 15.1 | 15.1 | 12.4 | 12.1 | 98% | 10.4 | 84% | 7.2 | 58% |
| Variable Speed Drive Control, 15 HP | 1.5 | 17.6 | 14.7 | 14.2 | 13.1 | 92% | 6.3 | 44% | 2.9 | 21% |

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.

## Table 5-4 (Continued)
## Measure-Specific Commercial Results (Cumulative to 2020) – GWh

| Measure | Average TRC Ratio | Technical | Economic | Econ net of Nat Occ | Ach @100% Incentives | % of Net Econo mic | Ach @75% Incentives | % of Net Econo mic | Ach @50% Incentives | % of Net Econo mic |
|---|---|---|---|---|---|---|---|---|---|---|
| PSMH, magnetic ballast, 320 W | 32.5 | 14.1 | 14.1 | 4.5 | 3.5 | 80% | 3.2 | 73% | 2.8 | 63% |
| Energy Recovery Ventilation (ERV) | 1.9 | 17.6 | 14.1 | 14.0 | 12.8 | 92% | 3.2 | 23% | 1.0 | 7% |
| Fan Motor, 5hp, 1800rpm, 89.5% | 2.1 | 13.9 | 13.3 | 13.2 | 7.6 | 58% | 3.0 | 23% | 1.7 | 13% |
| Ceiling/roof Insulation  - DX | 2.3 | 13.8 | 12.8 | 12.6 | 11.6 | 92% | 3.1 | 24% | 1.0 | 8% |
| Economizer - Chiller | 1.2 | 17.3 | 12.1 | 12.0 | 11.8 | 98% | 2.3 | 19% | 0.5 | 4% |
| Air Handler Optimization, 15 HP | 2.6 | 11.5 | 11.4 | 11.3 | 10.5 | 93% | 4.7 | 42% | 1.4 | 13% |
| Refrigeration Commissioning | 1.5 | 11.7 | 11.4 | 11.2 | 10.4 | 93% | 4.3 | 39% | 1.4 | 13% |
| DX Tune Up/ Advanced Diagnostics | 1.4 | 14.1 | 11.3 | 11.3 | 10.3 | 92% | 2.5 | 22% | 0.7 | 7% |
| VSD for Chiller Pumps and Towers | 3.7 | 11.2 | 11.2 | 10.9 | 10.1 | 92% | 4.5 | 42% | 2.0 | 19% |
| Occupancy Sensor, High Bay T5 | 9.7 | 11.2 | 11.2 | 10.3 | 6.8 | 66% | 5.5 | 54% | 4.4 | 43% |
| Optimize Controls - DX | 1.4 | 13.0 | 10.5 | 10.2 | 9.4 | 92% | 4.2 | 41% | 1.9 | 18% |
| Lighting Control Tuneup | 7.5 | 10.0 | 10.0 | 8.5 | 8.2 | 97% | 7.0 | 82% | 4.7 | 55% |
| High Efficiency Chiller Motors | 2.7 | 9.5 | 9.5 | 9.5 | 9.3 | 98% | 2.3 | 24% | 0.5 | 5% |
| Anti-sweat (humidistat) controls | 4.4 | 9.4 | 9.4 | 8.1 | 7.5 | 92% | 5.7 | 71% | 3.7 | 45% |
| Chiller Tune Up/Diagnostics | 1.4 | 8.8 | 8.8 | 8.7 | 8.0 | 92% | 2.3 | 27% | 0.8 | 9% |
| Air Handler Optimization, 40 HP | 3.0 | 9.4 | 8.6 | 8.4 | 7.9 | 93% | 4.4 | 52% | 1.4 | 17% |
| Demand Defrost Electric | 36.3 | 8.5 | 8.5 | 2.3 | 1.8 | 77% | 1.6 | 70% | 1.4 | 61% |
| Solar Water Heater | 2.7 | 8.0 | 8.0 | 8.0 | 3.1 | 39% | 1.4 | 18% | 0.9 | 11% |
| EMS - Chiller | 1.6 | 7.6 | 7.6 | 7.4 | 6.8 | 91% | 2.0 | 27% | 0.9 | 12% |
| High R-Value Glass Doors | 1.7 | 7.1 | 7.1 | 7.0 | 6.5 | 93% | 2.6 | 37% | 0.8 | 11% |
| Strip curtains for walk-ins | 6.0 | 6.4 | 6.4 | 4.9 | 4.5 | 91% | 3.7 | 75% | 2.6 | 53% |
| Heat Trap | 14.0 | 5.4 | 5.4 | 3.1 | 2.7 | 89% | 2.3 | 75% | 1.7 | 56% |
| EMS Optimization - Chiller | 1.2 | 5.0 | 5.0 | 4.9 | 4.5 | 92% | 1.6 | 33% | 0.6 | 12% |
| Energy Star or Better Monitor | 104.1 | 4.7 | 4.7 | 0.8 | 0.4 | 46% | 0.4 | 46% | 0.4 | 46% |
| Compressor VSD retrofit | 1.7 | 4.7 | 4.5 | 4.4 | 4.1 | 93% | 1.9 | 44% | 0.7 | 16% |
| Efficient compressor motor | 9.6 | 4.3 | 4.3 | 3.9 | 3.0 | 76% | 2.3 | 58% | 1.8 | 46% |
| Occupancy Sensor, 4L8' Fluorescent Fixtures | 3.5 | 3.8 | 3.8 | 3.6 | 3.3 | 93% | 2.0 | 54% | 0.9 | 24% |
| Demand Hot Gas Defrost | 12.7 | 3.7 | 3.7 | 2.0 | 1.8 | 88% | 1.5 | 77% | 1.2 | 63% |
| Fan Motor, 15hp, 1800rpm, 92.4% | 2.3 | 3.1 | 3.0 | 2.9 | 1.7 | 58% | 0.7 | 24% | 0.4 | 14% |
| Copier Power Management Enabling | 0.9 | 3.2 | 2.4 | 2.4 | 0.0 | 0% | 0.0 | 0% | 0.0 | 0% |
| Continuous Dimming, 10L4' Fluorescent Fixtures | 0.9 | 74.8 | 2.2 | 2.2 | 2.0 | 91% | 0.4 | 18% | 0.1 | 4% |
| Fan Motor, 40hp, 1800rpm, 94.1% | 1.9 | 1.7 | 1.7 | 1.7 | 1.0 | 57% | 0.3 | 21% | 0.2 | 11% |
| ECM on an Air Handler Unit | 4.2 | 1.5 | 1.5 | 1.5 | 0.8 | 53% | 0.4 | 27% | 0.3 | 17% |
| Window Film (Standard) - Chiller | 1.3 | 4.0 | 1.4 | 1.4 | 1.3 | 92% | 0.2 | 17% | 0.1 | 4% |
| High Efficiency Water Heater (electric) | 4.7 | 1.3 | 1.3 | 1.3 | 0.7 | 53% | 0.4 | 32% | 0.3 | 23% |
| Efficient Fryer | 1.0 | 2.3 | 1.0 | 1.0 | 0.7 | 76% | 0.3 | 33% | 0.2 | 20% |
| Energy Star or Better Copier | 62.6 | 0.8 | 0.8 | 0.2 | 0.1 | 40% | 0.1 | 40% | 0.1 | 40% |
| Tankless Water Heater | 2.4 | 0.9 | 0.8 | 0.8 | 0.3 | 39% | 0.1 | 19% | 0.1 | 11% |
| Ceiling/roof Insulation - Chiller | 1.9 | 0.9 | 0.7 | 0.7 | 0.6 | 98% | 0.1 | 16% | 0.0 | 3% |
| Floating head pressure controls | 7.1 | 0.4 | 0.4 | 0.3 | 0.2 | 90% | 0.2 | 70% | 0.1 | 51% |
| Demand controlled circulating systems | 8.7 | 0.3 | 0.2 | 0.1 | 0.1 | 97% | 0.1 | 71% | 0.1 | 50% |
| Separate Makeup Air / Exhaust Hoods AC | 77.6 | 0.2 | 0.2 | 0.0 | 0.0 | 86% | 0.0 | 82% | 0.0 | 76% |
| Evaporator fan controller for MT walk-ins | 0.6 | 1.3 | 0.1 | 0.1 | 0.1 | 93% | 0.0 | 59% | 0.0 | 30% |
| Hot Water Pipe Insulation | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 98% | 0.0 | 48% | 0.0 | 18% |
| New Construction Meausres | | | | | | | | | | |
| High Performance Building/Int Design - Tier 2 50% | 10.3 | 489.5 | 489.5 | 476.5 | 305.9 | 64% | 227.1 | 48% | 170.2 | 36% |
| High Performance Building/Int Design - Tier 1 30% | 12.3 | 440.5 | 440.5 | 426.0 | 272.3 | 64% | 211.1 | 50% | 164.2 | 39% |

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.

### 5.2.2.3 Industrial Sector

Figure 5-34 and Figure 5-35 show cumulative net achievable program savings by industrial program scenario. By 2020, net energy savings reach 184 GWh under the 50-percent incentive scenario, 285 GWh under the 75-percent incentive scenario, and 374 GWh under the 100-percent incentive scenario. For peak demand, net savings increase from 24 MW under 50-percent incentives to 39 MW under 75-percent incentives to 52 MW under 100-percent incentives.

**Figure 5-34**
**Achievable Energy Savings: Industrial Sector**

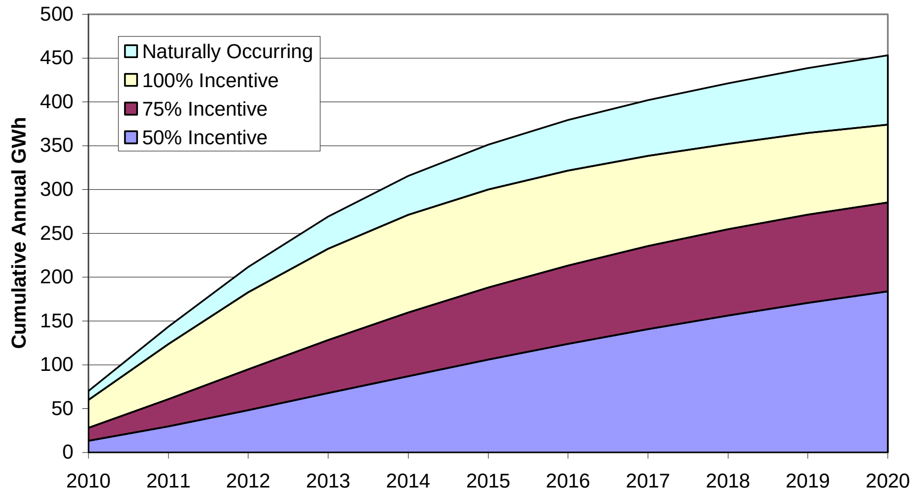



**Figure 5-35**
**Achievable Peak-Demand Savings: Industrial Sector**

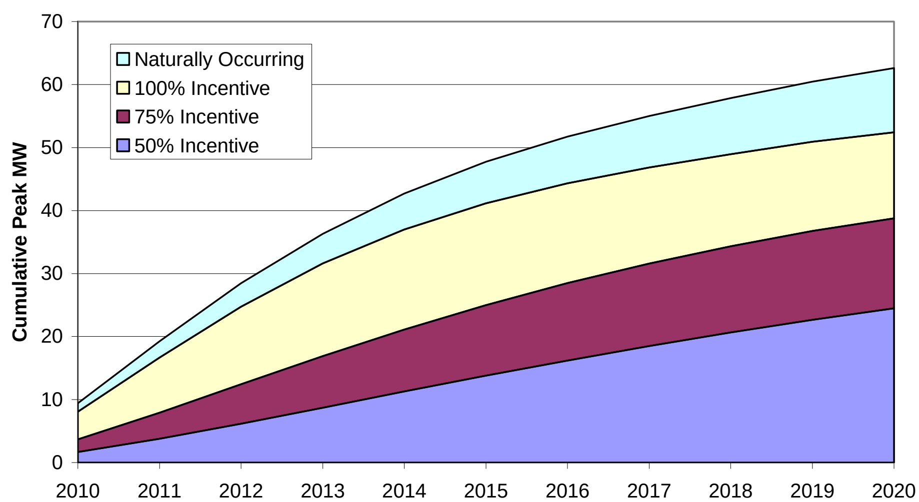



Figure 5-36 and Figure 5-37 show the end-use distribution of energy and peak-demand savings in the industrial sector. Pumping-system measures contribute most to both the energy and peak-demand savings potential, followed by lighting and compressed-air measures.

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

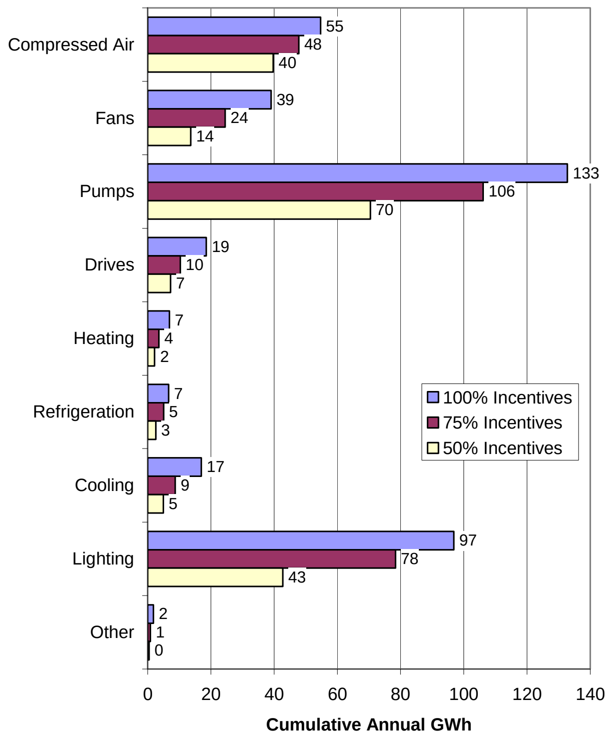



**Figure 5-37**
**Industrial Net Peak-Savings Potential by End-Use (2020)**

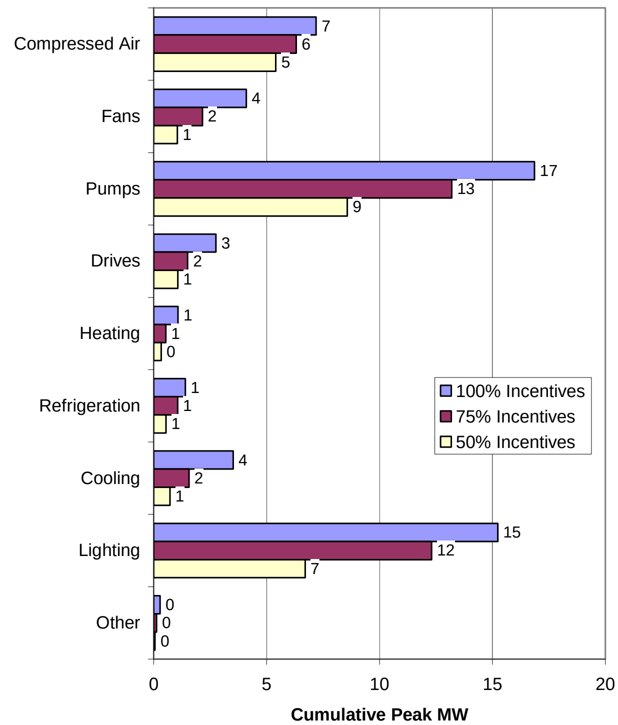



Table 5-5 lists the various potentials for industrial measures that passed cost-effectiveness screening. There are a large number of industrial measures that contribute to industrial savings potential. Limited penetration of some industrial measures is, in part, due equipment turnover cycles that limit energy-efficiency opportunities. In addition, some of the key process measures, such as installation of controls and process optimization, tend to have high market barriers, such as lack of customer knowledge about the measure and the need to take their plant out of operation to install measures.

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

| Measure | Average TRC Ratio | Technical | Economic | Econ net of Nat Occ | Ach @100% Incentives | % of Net Economic | Ach @75% Incentives | % of Net Economic | Ach @50% Incentives | % of Net Economic |
|---|---|---|---|---|---|---|---|---|---|---|
| RET 2L4' Premium T8, 1EB | 3.4 | 74.1 | 74.1 | 71.8 | 71.6 | 100% | 56.2 | 78% | 27.6 | 38% |
| Pumps - Controls | 10.3 | 73.2 | 73.2 | 69.9 | 30.4 | 44% | 20.7 | 30% | 13.5 | 19% |
| Pumps - System Optimization | 4.0 | 59.0 | 59.0 | 55.4 | 55.3 | 100% | 48.3 | 87% | 30.2 | 55% |
| Compressed Air-O&M | 13.4 | 38.1 | 38.1 | 20.0 | 12.8 | 64% | 12.8 | 64% | 12.8 | 64% |
| Compressed Air - System Optimization | 9.3 | 27.9 | 27.9 | 19.4 | 19.4 | 100% | 18.8 | 97% | 16.8 | 86% |
| Fans - Controls | 3.1 | 26.8 | 26.8 | 26.7 | 12.1 | 45% | 3.8 | 14% | 1.3 | 5% |
| Pumps - O&M | 17.0 | 25.3 | 25.3 | 10.3 | 7.4 | 72% | 7.4 | 72% | 7.4 | 72% |
| Pumps - Sizing | 7.7 | 23.2 | 23.2 | 22.6 | 10.1 | 45% | 6.1 | 27% | 3.6 | 16% |
| CFL Hardwired, Modular 36W | 4.0 | 20.2 | 20.2 | 18.6 | 18.5 | 100% | 18.3 | 99% | 13.9 | 75% |
| Pumps - ASD (100+ hp) | 2.9 | 15.2 | 15.2 | 14.0 | 14.0 | 100% | 12.5 | 89% | 8.4 | 60% |
| Centrifugal Chiller, 0.51 kW/ton, 500 tons | 5.5 | 13.4 | 13.4 | 13.2 | 3.0 | 23% | 1.3 | 10% | 0.8 | 6% |
| Pumps - ASD (6-100 hp) | 13.2 | 12.6 | 12.6 | 4.7 | 4.7 | 100% | 4.6 | 98% | 4.4 | 94% |
| Compressed Air- Sizing | 17.4 | 11.7 | 11.7 | 10.7 | 4.3 | 41% | 3.3 | 31% | 2.5 | 23% |
| Fans - System Optimization | 2.3 | 9.4 | 9.4 | 9.2 | 9.2 | 100% | 6.9 | 75% | 3.1 | 34% |
| DX Packaged System, EER=10.9, 10 tons | 1.5 | 9.2 | 9.2 | 9.2 | 2.7 | 29% | 0.5 | 6% | 0.2 | 2% |
| Fans - ASD (100+ hp) | 3.5 | 9.0 | 9.0 | 7.9 | 7.9 | 100% | 7.3 | 92% | 5.4 | 68% |
| Comp Air - ASD (100+ hp) | 2.9 | 7.8 | 7.8 | 7.2 | 7.2 | 100% | 6.4 | 89% | 4.3 | 60% |
| Compressed Air - Controls | 4.6 | 7.4 | 7.4 | 7.3 | 3.3 | 45% | 1.5 | 20% | 0.7 | 9% |
| Occupancy Sensor, 4L4' Fluorescent Fixtures | 2.1 | 6.8 | 6.8 | 6.7 | 6.7 | 100% | 3.8 | 57% | 1.2 | 18% |
| Comp Air - ASD (6-100 hp) | 13.2 | 6.4 | 6.4 | 5.8 | 2.3 | 40% | 1.8 | 31% | 1.4 | 24% |
| Efficient Curing ovens | 3.3 | 6.4 | 6.4 | 6.4 | 2.0 | 31% | 0.6 | 9% | 0.2 | 3% |
| Prog. Thermostat - DX | 13.7 | 6.1 | 6.1 | 2.5 | 2.5 | 100% | 2.5 | 98% | 2.4 | 93% |
| Optimization Refrigeration | 3.7 | 5.6 | 5.6 | 5.4 | 5.4 | 100% | 4.1 | 76% | 1.9 | 35% |
| Bakery - Process (Mixing) - O&M | 16.6 | 4.9 | 4.9 | 2.1 | 1.5 | 71% | 1.5 | 71% | 1.5 | 71% |
| Window Film - DX | 3.0 | 4.4 | 4.4 | 4.3 | 4.3 | 100% | 3.0 | 71% | 1.3 | 29% |
| Window Film - Chiller | 1.6 | 4.0 | 4.0 | 4.0 | 4.0 | 100% | 1.3 | 33% | 0.3 | 7% |
| Efficient processes (welding, etc.) | 6.3 | 4.0 | 4.0 | 3.9 | 1.2 | 31% | 0.6 | 16% | 0.3 | 8% |
| Heating - Process Control | 3.8 | 3.7 | 3.7 | 3.7 | 1.2 | 31% | 0.4 | 10% | 0.1 | 4% |
| Efficient electric melting | 4.3 | 3.6 | 3.6 | 3.6 | 0.8 | 23% | 0.3 | 8% | 0.1 | 3% |
| Pumps - Motor practices-1 (100+ HP) | 2.4 | 3.5 | 3.5 | 3.4 | 3.4 | 100% | 2.5 | 74% | 1.1 | 32% |
| Fans - ASD (6-100 hp) | 7.7 | 3.3 | 3.3 | 3.2 | 1.4 | 44% | 0.9 | 29% | 0.6 | 19% |
| Efficient practices printing press | 13.3 | 3.3 | 3.3 | 2.0 | 2.0 | 100% | 2.0 | 97% | 1.8 | 89% |
| Pumps - Motor practices-1 (6-100 HP) | 2.3 | 3.3 | 3.3 | 3.2 | 3.2 | 100% | 2.2 | 67% | 0.8 | 25% |
| Efficient Refrigeration - Operations | 16.7 | 3.2 | 3.2 | 3.0 | 1.2 | 42% | 0.9 | 31% | 0.7 | 22% |
| Fans- Improve components | 8.3 | 3.1 | 3.1 | 3.0 | 1.3 | 44% | 0.8 | 28% | 0.5 | 17% |
| Extruders/injection Moulding-multipump | 3.7 | 3.0 | 3.0 | 3.0 | 1.2 | 39% | 0.4 | 13% | 0.1 | 5% |
| Fans - O&M | 16.8 | 3.0 | 3.0 | 1.3 | 0.9 | 71% | 0.9 | 71% | 0.9 | 71% |
| Efficient grinding | 1.1 | 2.8 | 2.8 | 2.8 | 0.8 | 29% | 0.0 | 2% | 0.0 | 0% |
| Efficient Printing press (fewer cylinders) | 3.0 | 2.8 | 2.8 | 2.8 | 1.3 | 45% | 0.4 | 14% | 0.1 | 5% |
| Pumps - Replace 100+ HP motor | 1.2 | 2.7 | 2.7 | 2.7 | 1.7 | 62% | 0.2 | 7% | 0.0 | 1% |
| Fans - Motor practices-1 (6-100 HP) | 3.5 | 2.4 | 2.4 | 2.3 | 2.3 | 100% | 1.9 | 83% | 1.0 | 46% |
| Drives - Process Controls (batch + site) | 1.8 | 2.9 | 2.4 | 2.4 | 1.1 | 45% | 0.2 | 8% | 0.1 | 2% |
| Clean Room - Controls | 3.2 | 2.4 | 2.4 | 2.3 | 1.1 | 45% | 0.3 | 15% | 0.1 | 5% |
| Refinery Controls | 4.3 | 2.1 | 2.1 | 2.0 | 1.9 | 92% | 1.6 | 78% | 1.0 | 49% |
| O&M - Extruders/Injection Moulding | 20.6 | 2.1 | 2.1 | 2.0 | 0.2 | 11% | 0.2 | 11% | 0.2 | 11% |
| Drives - Optimization process (M&T) | 11.7 | 2.0 | 2.0 | 1.3 | 1.3 | 100% | 1.2 | 97% | 1.1 | 89% |
| Bakery - Process | 10.8 | 2.0 | 2.0 | 1.9 | 0.6 | 30% | 0.4 | 20% | 0.2 | 12% |
| Heating - Optimization process (M&T) | 11.3 | 1.9 | 1.9 | 1.2 | 1.2 | 100% | 1.2 | 97% | 1.1 | 89% |
| Air conveying systems | 11.9 | 1.9 | 1.9 | 1.8 | 0.5 | 30% | 0.4 | 22% | 0.3 | 16% |

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.

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

| Measure | Average TRC Ratio | Technical | Economic | Econ net of Nat Occ | Ach @100% Incentives | % of Net Economic | Ach @75% Incentives | % of Net Economic | Ach @50% Incentives | % of Net Economic |
|---|---|---|---|---|---|---|---|---|---|---|
| Comp Air - Motor practices-1 (100+ HP) | 2.6 | 1.8 | 1.8 | 1.8 | 1.8 | 100% | 1.4 | 75% | 0.6 | 34% |
| Efficient drives - rolling | 5.4 | 1.8 | 1.8 | 1.8 | 0.8 | 45% | 0.4 | 22% | 0.2 | 10% |
| Comp Air - Motor practices-1 (6-100 HP) | 2.5 | 1.8 | 1.8 | 1.7 | 1.7 | 100% | 1.2 | 69% | 0.5 | 27% |
| Fans - Replace 100+ HP motor | 1.6 | 1.7 | 1.7 | 1.7 | 1.1 | 63% | 0.2 | 10% | 0.0 | 2% |
| Direct drive Extruders | 2.4 | 1.6 | 1.6 | 1.6 | 0.6 | 38% | 0.1 | 8% | 0.0 | 2% |
| Drives - EE motor | 4.7 | 1.5 | 1.5 | 1.5 | 0.7 | 45% | 0.3 | 21% | 0.1 | 9% |
| Drives - Process Control | 3.9 | 1.5 | 1.5 | 1.5 | 0.5 | 31% | 0.1 | 10% | 0.1 | 4% |
| Comp Air - Replace 100+ HP motor | 1.3 | 1.5 | 1.5 | 1.4 | 0.9 | 62% | 0.1 | 7% | 0.0 | 1% |
| Light cylinders | 1.1 | 1.2 | 1.2 | 1.2 | 0.5 | 43% | 0.0 | 3% | 0.0 | 0% |
| Machinery | 5.0 | 1.2 | 1.2 | 1.2 | 0.5 | 45% | 0.2 | 20% | 0.1 | 9% |
| Fans - Motor practices-1 (100+ HP) | 2.2 | 1.2 | 1.2 | 1.2 | 1.2 | 100% | 0.6 | 53% | 0.2 | 16% |
| Injection Moulding - Impulse Cooling | 3.0 | 1.1 | 1.1 | 1.1 | 0.4 | 39% | 0.1 | 11% | 0.0 | 3% |
| Drives - Scheduling | 3.1 | 1.1 | 1.1 | 1.0 | 1.0 | 100% | 0.9 | 87% | 0.5 | 54% |
| Near Net Shape Casting | 12.7 | 1.0 | 1.0 | 1.0 | 0.3 | 29% | 0.2 | 20% | 0.1 | 13% |
| Optimize drying process | 3.6 | 1.0 | 1.0 | 0.9 | 0.9 | 100% | 0.8 | 82% | 0.4 | 43% |
| Chiller Tune Up/Diagnostics | 1.3 | 1.0 | 1.0 | 1.0 | 0.0 | 4% | 0.0 | 2% | 0.0 | 1% |
| Replace V-Belts | 5.7 | 1.0 | 1.0 | 0.9 | 0.4 | 46% | 0.3 | 27% | 0.2 | 16% |
| Injection Moulding - Direct drive | 1.9 | 1.0 | 1.0 | 1.0 | 0.4 | 38% | 0.1 | 6% | 0.0 | 1% |
| Pumps - Motor practices-1 (1-5 HP) | 1.5 | 0.9 | 0.9 | 0.9 | 0.9 | 100% | 0.3 | 35% | 0.1 | 8% |
| Other Process Controls (batch + site) | 2.7 | 0.8 | 0.8 | 0.8 | 0.3 | 45% | 0.1 | 13% | 0.0 | 4% |
| New transformers welding | 6.8 | 0.7 | 0.7 | 0.7 | 0.2 | 31% | 0.1 | 16% | 0.1 | 8% |
| Efficient drives | 4.9 | 0.6 | 0.6 | 0.6 | 0.3 | 45% | 0.1 | 21% | 0.1 | 10% |
| Clean Room - New Designs | 2.2 | 0.6 | 0.6 | 0.6 | 0.3 | 45% | 0.1 | 10% | 0.0 | 3% |
| Process control | 7.7 | 0.6 | 0.6 | 0.6 | 0.3 | 45% | 0.2 | 27% | 0.1 | 16% |
| Fans - Motor practices-1 (1-5 HP) | 1.9 | 0.6 | 0.6 | 0.5 | 0.5 | 100% | 0.3 | 49% | 0.1 | 14% |
| Heating - Scheduling | 3.2 | 0.6 | 0.6 | 0.5 | 0.5 | 100% | 0.5 | 88% | 0.3 | 56% |
| Comp Air - Motor practices-1 (1-5 HP) | 1.6 | 0.5 | 0.5 | 0.5 | 0.5 | 100% | 0.2 | 38% | 0.0 | 9% |
| Optimization control PM | 2.8 | 0.4 | 0.4 | 0.4 | 0.4 | 100% | 0.3 | 78% | 0.2 | 39% |
| Process optimization | 2.7 | 0.4 | 0.4 | 0.4 | 0.4 | 100% | 0.3 | 75% | 0.1 | 34% |
| Power recovery | 1.9 | 0.4 | 0.4 | 0.4 | 0.4 | 100% | 0.2 | 51% | 0.1 | 15% |
| O&M/drives spinning machines | 7.9 | 0.3 | 0.3 | 0.3 | 0.1 | 23% | 0.1 | 23% | 0.1 | 23% |
| Heat Pumps - Drying | 1.8 | 0.3 | 0.3 | 0.3 | 0.1 | 30% | 0.0 | 3% | 0.0 | 1% |
| Top-heating (glass) | 6.8 | 0.3 | 0.3 | 0.3 | 0.1 | 52% | 0.1 | 32% | 0.1 | 19% |
| EMS - Chiller | 0.9 | 6.1 | 0.2 | 0.2 | 0.2 | 100% | 0.0 | 13% | 0.0 | 2% |
| Cool Roof - DX | 0.9 | 4.8 | 0.2 | 0.2 | 0.2 | 100% | 0.0 | 12% | 0.0 | 2% |
| Gap Forming papermachine | 11.8 | 0.1 | 0.1 | 0.1 | 0.0 | 22% | 0.0 | 15% | 0.0 | 10% |
| High Consistency forming | 11.7 | 0.1 | 0.1 | 0.1 | 0.0 | 22% | 0.0 | 15% | 0.0 | 10% |
| Drying (UV/IR) | 3.7 | 0.1 | 0.1 | 0.1 | 0.1 | 53% | 0.0 | 19% | 0.0 | 7% |
| Process Drives - ASD | 2.3 | 0.1 | 0.1 | 0.1 | 0.1 | 100% | 0.1 | 69% | 0.0 | 27% |
| Intelligent extruder (DOE) | 1.0 | 0.1 | 0.1 | 0.1 | 0.0 | 42% | 0.0 | 2% | 0.0 | 0% |
| Efficient desalter | 4.2 | 0.1 | 0.1 | 0.1 | 0.0 | 45% | 0.0 | 20% | 0.0 | 9% |
| Cooling Circ. Pumps - VSD | 0.6 | 3.0 | 0.0 | 0.0 | 0.0 | 99% | 0.0 | 5% | 0.0 | 1% |
| Evaporative Pre-Cooler | 0.7 | 3.7 | 0.0 | 0.0 | 0.0 | 100% | 0.0 | 9% | 0.0 | 2% |
| Metal Halide, 50W | 0.5 | 1.9 | 0.0 | 0.0 | 0.0 | 100% | 0.0 | 10% | 0.0 | 2% |
| Pumps - Replace 6-100 HP motor | 0.6 | 3.0 | 0.0 | 0.0 | 0.0 | 41% | 0.0 | 1% | 0.0 | 0% |
| Fans - Replace 6-100 HP motor | 0.7 | 1.6 | 0.0 | 0.0 | 0.0 | 42% | 0.0 | 1% | 0.0 | 0% |
| Membranes for wastewater | 6.1 | 0.0 | 0.0 | 0.0 | 0.0 | 31% | 0.0 | 11% | 0.0 | 4% |
| Comp Air - Replace 6-100 HP motor | 0.6 | 1.6 | 0.0 | 0.0 | 0.0 | 41% | 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.

## 5.3 Behavioral Conservation and Emerging Technologies

In addition to the base potentials forecast that are 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

Two types of residential behavioral-conservation methods are addressed in the analysis: (1) indirect feedback approaches, which utilize energy information reports that motivate customers to use less, and (2) direct feedback interventions, such use of in-home energy use monitors. Both of these approaches 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.

For this analysis, we assumed that indirect feedback measures would save about two percent of household energy consumption at a cost of about $10 per customer per year (split between the electric and gas programs). These measures could be targeted to the entire residential population. Direct methods would save 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. These measure parameters are consistent with findings from recent pilot studies being conducted in various locales over the past several years.[8]

Figure 5-38 shows the effects on technical and economic potential from adding behavioral-conservation measures to the analysis. Behavioral conservation adds 218 GWh of technical potential and 216 GWh of economic potential to the base amounts. The behavioral-conservation potentials amount to an increase in total economic potential of about three percent and an increase to residential economic potential of about eight percent. The indirect feedback approaches account for 90 percent of the behavioral-conservation potentials since they are applicable to a much larger number of customers than the direct feedback measures.

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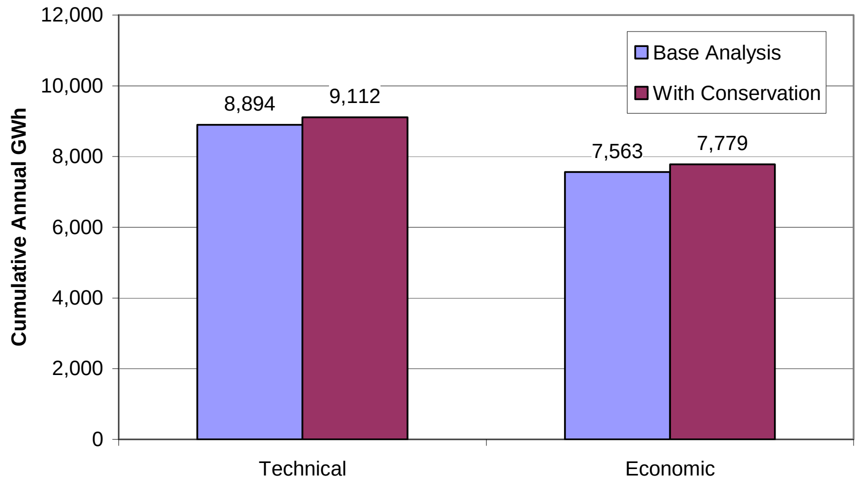
[8] For example see Franklyn Energy, *Research Study: Residential Energy Use Behavior Change Pilot*, Presented to the Minnesota Department of Commerce, Office of Energy Security, April 2009.

**Figure 5-38**
**Electric Technical and Economic Potentials with Behavioral-Conservation Activities**




For the achievable potential assessment of the behavioral-conservation measures, we focused on the indirect interventions and developed three scenarios:

- A low scenario that targets only the largest residential electricity users, about 0.15 million customers with average use of about 15,000 kWh per year
- A mid scenario that targets both large and medium residential electricity users, about 0.6 million customers with combined average electricity use of 9,500 kWh per year
- A high scenario that targets all residential customers, about 1.2 million customers with average electricity use of 7,600 kWh per year

In each case, program efforts were ramped up over a three-year period. Table 5-6 summarizes the results of the analysis over the 2010-2020 time period. As shown, behavioral-conservation potentials—if the assumptions outlined above hold up—could save between 44 and 176 GWh in annual program costs averaging between $9 million and $68 million dollars, 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 5-6**
**Achievable Potentials for Electric Behavioral Conservation**

| Result | Scenario | | |
|---|---|---|---|
| | Low<br>Large Users Only | Medium:<br>Lrg-Med Users | High:<br>All Customers |
| **Gross Energy Savings - GWh** | 43.7 | 107.4 | 175.8 |
| **Gross Peak Demand Savings - MW** | 10.7 | 26.3 | 43.1 |
| **Net Energy Savings - GWh** | 43.7 | 107.4 | 175.8 |
| **Net Peak Demand Savings - MW** | 10.7 | 26.3 | 43.1 |
| **Program Costs - Real, $ Million** | | | |
| **Administration** | $0.1 | $0.4 | $0.8 |
| **Marketing** | $8.4 | $32.6 | $67.0 |
| **Incentives** | $0.0 | $0.0 | $0.0 |
| **Total** | $8.6 | $33.0 | $67.8 |
| **PV Avoided Costs** | $35.1 | $86.2 | $141.0 |
| **PV Annual Marketing and Admin Costs** | $6.3 | $24.2 | $49.8 |
| **PV Net Measure Costs** | $0.0 | $0.0 | $0.0 |
| **TRC Ratio** | 5.6 | 3.6 | 2.8 |

PV (present value) of benefits and costs is calculated over a 20-year normalized measure life for 2010-2020 program years, nominal discount rate = 7.9 percent, inflation rate = 1.5 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, we focused our potential analysis on several of the more promising emerging technologies:

- LED lighting, including LED street lighting, LED replacements for incandescent/CFL lighting in the residential sector, and LED replacements for fluorescent tube lighting in the commercial sector;
- Induction street lighting, which is somewhat less efficient and also less costly than LED lighting;
- Fiber-optic refrigeration display lighting; and
- Indirect evaporative cooling in the residential sector.

For the analysis, we assumed that these measures were all commercially available and could provide claimed savings. We also assumed equipment costs that made these measures commercially viable. For the lighting measures, additional technology development will be required to make the equipment commercially viable for the majority of customers. For the indirect evaporative coolers, customer acceptance is the biggest source of uncertainty, since there is currently equipment available in the market, although market share is negligible. Measure costs and savings are presented in Appendix E, along with the other measures that comprise the base analysis.

We modeled the incremental effects of emerging technologies using the KEMA DSM Assyst model. Below, we present results for technical, economic, and achievable potentials. For the achievable potentials, we do not include firm program years, since it is unclear how long it might take before these technologies achieve any significant market penetration, if any at all.

Figure 5-39 and Figure 5-40 show the effects on economic potential (energy and peak demand, respectively) from the addition of emerging technologies. Overall, economic potential increases by 1,800 GWh (24 percent) and 628 MW (36 percent) when emerging technologies are considered. Economic potential for energy savings increases by about the same rate for the residential and commercial sectors, but economic peak-demand potential increases most in the residential sector (61 percent for the residential sector as compared to 15 percent in the commercial sector) as a result of the indirect evaporative cooler measure.

**Figure 5-39**
**Electric Energy Economic Potentials with Emerging Technologies (11 Years)**

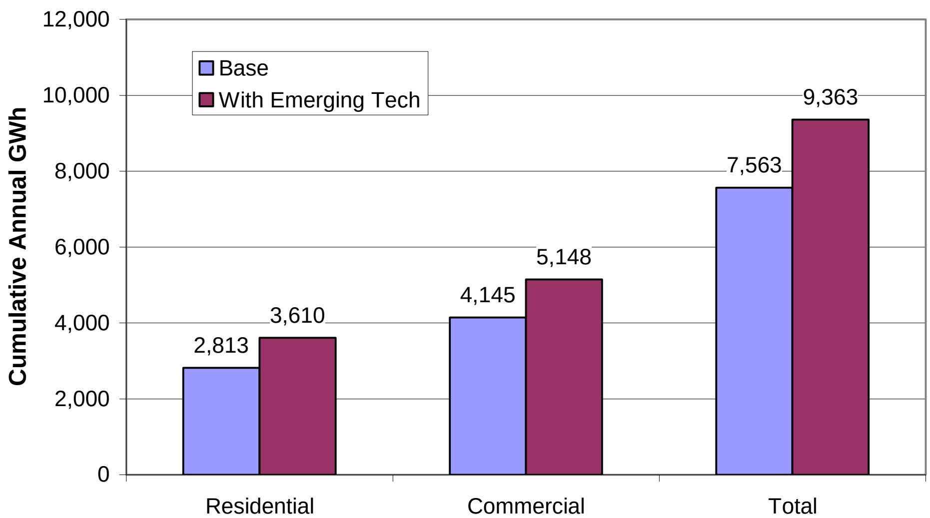


**Figure 5-40**
**Peak-Demand Economic Potentials with Emerging Technologies (11 Years)**

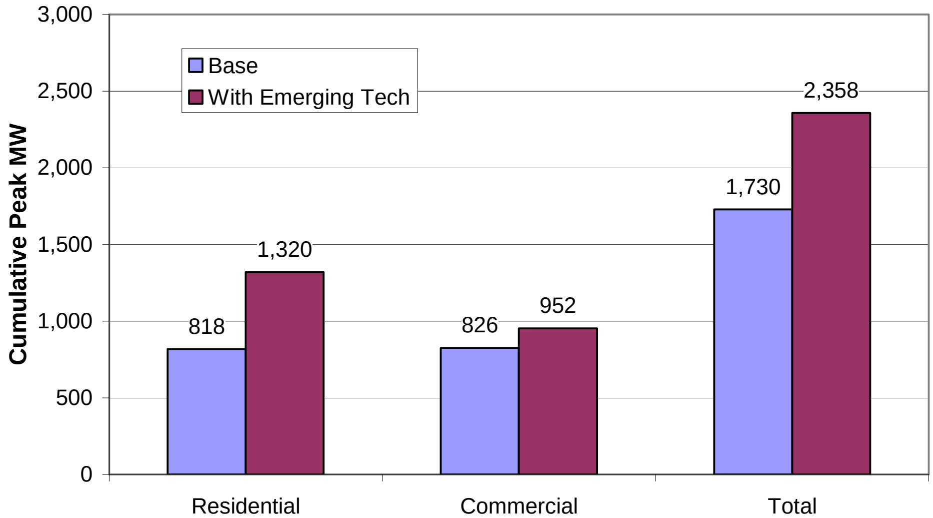



Figure 5-41 and Figure 5-42 show the end-use composition of residential economic potentials for energy and peak demand, respectively, with and without emerging technologies. These figures show that air conditioning (as a result of the indirect evaporative coolers) accounts for about 72 percent of the increase in energy potentials and about 96 percent of the increase in peak-demand potentials resulting from the emerging technologies.

Note that the analysis considers not only the effect of the emerging technologies but also the effects these technologies would have on other energy-efficiency measures. The indirect evaporative coolers would, by themselves, have even larger impacts, since they could save 80 percent on cooling compared to current air conditioners. However, if these units reach widespread penetration, many of the current base cooling measures would no longer be cost effective, so the net gain in economic potential is not as great as it would be if the emerging measure was considered in isolation. Also, it should be noted that savings from LED lighting in the residential sector is based off of a CFL base case, since it is most likely that CFLs will have captured much of the market by the time LED lighting becomes commercially feasible.

Figure 5-41
Residential Electric Economic Potentials with Emerging Technologies (11 Years)

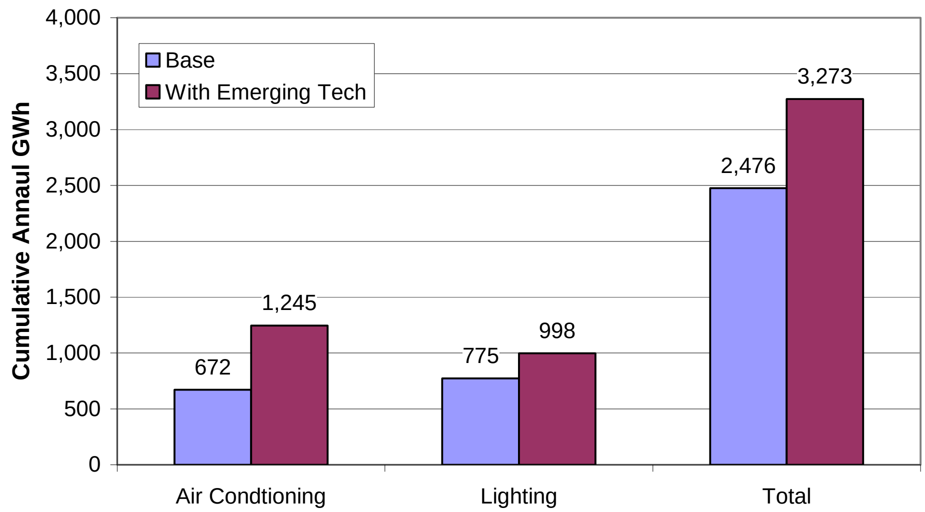



Figure 5-42
Residential Peak-Demand Economic Potentials with Emerging Technologies (11 Years)

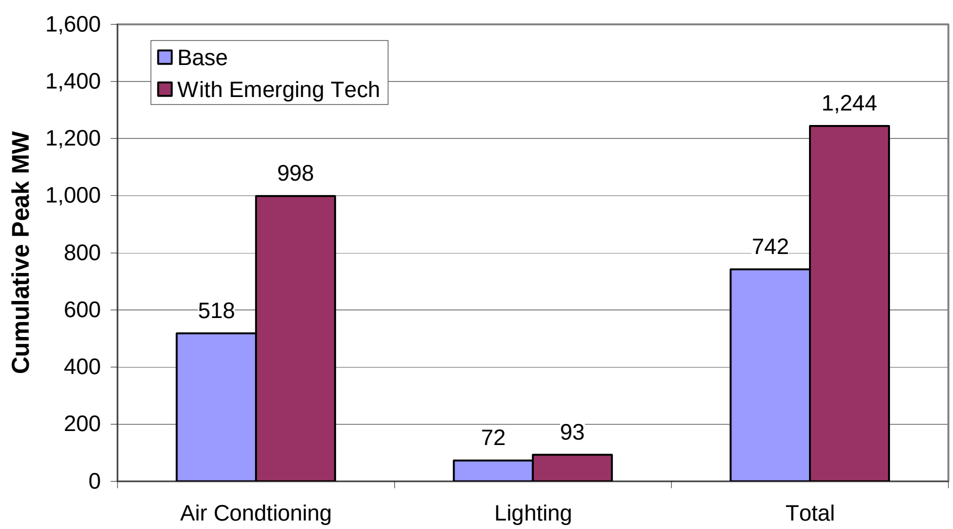



Figure 5-43 and Figure 5-44 show the end-use composition of commercial economic potentials for energy and peak demand, respectively, with and without emerging technologies. While LED streetlighting is likely to be more of a near-term measure (if current pilots prove successful), the application of LED lighting to indoor tube fixtures would provide a much larger source of energy savings.

**Figure 5-43**
**Commercial Electric Economic Potentials with Emerging Technologies (11 Years)**

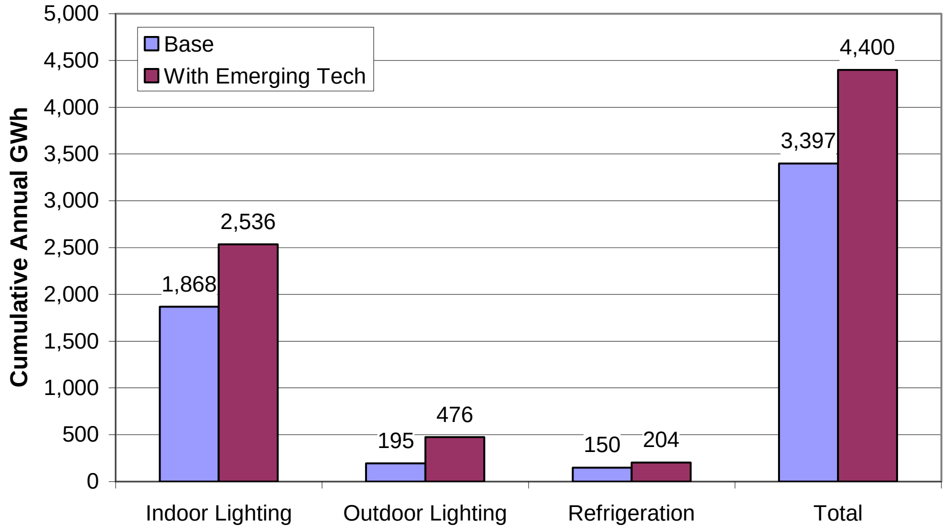



**Figure 5-44**
**Commercial Peak-Demand Economic Potentials with Emerging Technologies (11 Years)**

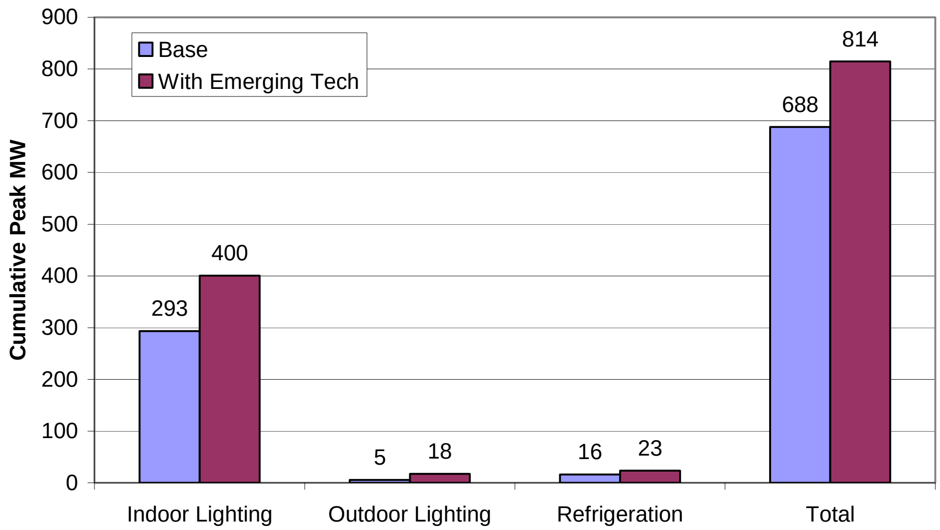



Figure 5-45 and Figure 5-46 show achievable potential estimates for residential and commercial emerging technologies, respectively. For residential, cumulative savings over an 11-year period range from 55 GWh for the 50-percent incentives case to 108 GWh for the 75-percent incentives case to 385 GWh for the 100 percent incentives case. About three-quarters of the residential potentials come from the indirect evaporative cooler measure. For commercial, cumulative savings over the 11-year period range from 64

GWh for the 50-percent incentives case to 227 GWh for the 75-percent incentives case to 606 GWh for the 100 percent incentives case. Most of the commercial savings are attributable to indoor LED lighting measures.

**Figure 5-45**
**Achievable Potentials for Residential Emerging Technologies**

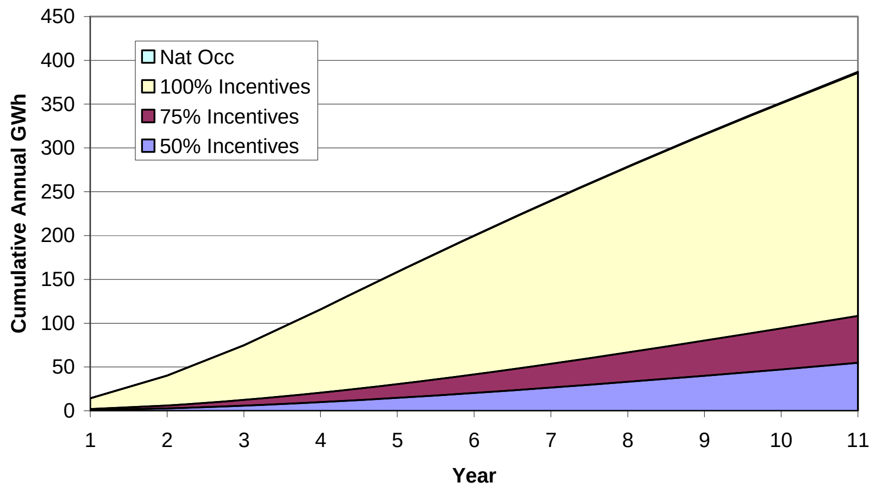
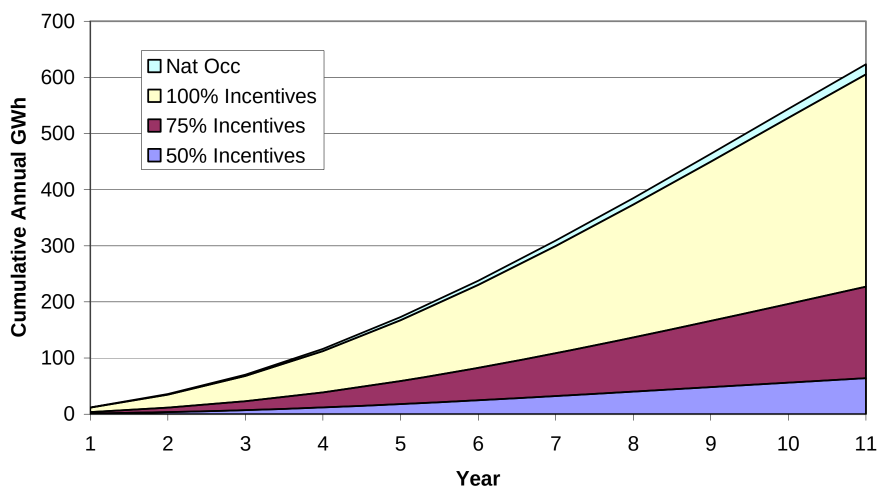



**Figure 5-46**
**Achievable Potentials for Commercial Emerging Technologies**




Note that the achievable potential estimates are highly uncertain since they are based on factors that are difficult to predict—technology improvement and customer adoption of new devices. Also note that we did not place dates on the annual projections, because it is still unclear if and when these technologies will be ready for full-scale implementation. We expect that Xcel Energy will want to run pilot programs to test measure performance and customer acceptance before expanding to large-scale investment in these measures. We expect that relatively high incentives may be required to effectively promote the emerging technologies. Hence, savings for the 50-percent and 75-percent incentive scenarios are relatively low compared to the 100-percent incentive scenario. Additionally, we expect that naturally occurring penetration of these measures will be low, at least at the onset.

## 5.4 Alternate High Avoided-Cost Scenario

As indicated in section 3 above, we tested the sensitivity of the energy-efficiency potential analysis to increases in avoided costs by running a high avoided-cost scenario where electric avoided costs are about 35 percent higher than for the base scenario. In this section, we present a comparison of potentials between the base-cost scenario and the high-cost scenario. Economic potentials are compared first, followed by a comparison of achievable potentials.

### 5.4.1 Economic Potentials

Figure 5-47 compares economic GWh and MW potentials for the high avoided cost scenario against the base scenario. As shown, potentials increase by about 3.5 percent in the high-cost scenario. Economic potentials don't change substantially because many of the measures studied were already cost effective in the base cost scenario.

**Figure 5-47**
**Economic Electric Potentials by Avoided-Cost Scenario (2020)**

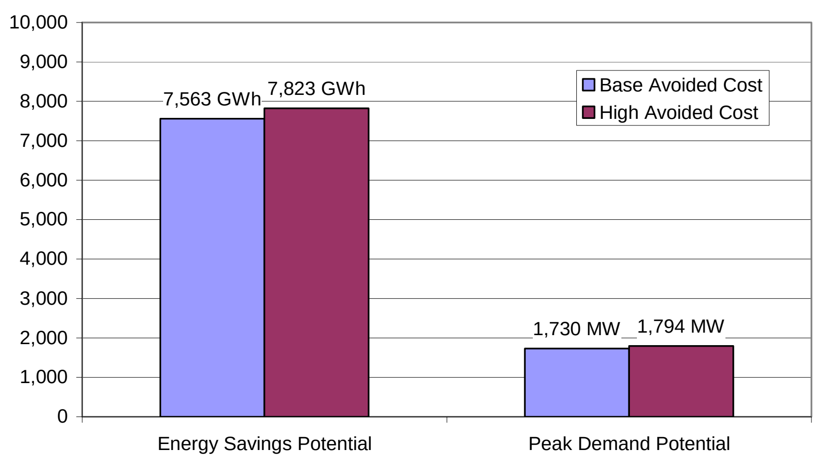


Figure 5-48 and Figure 5-49 show how economic potentials varied by sector for the two cost scenarios. The increase in economic potential with higher avoided costs is split fairly evenly between the residential and commercial sectors.

**Figure 5-48**
**Economic Potential Comparison (2020)**
**Energy Savings by Sector—GWh per Year**

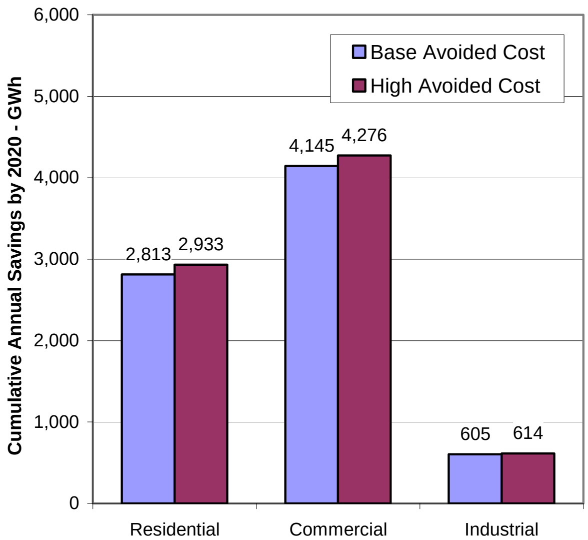



**Figure 5-49**
**Economic Potential Comparison (2020)**
**Demand Savings by Sector—MW**

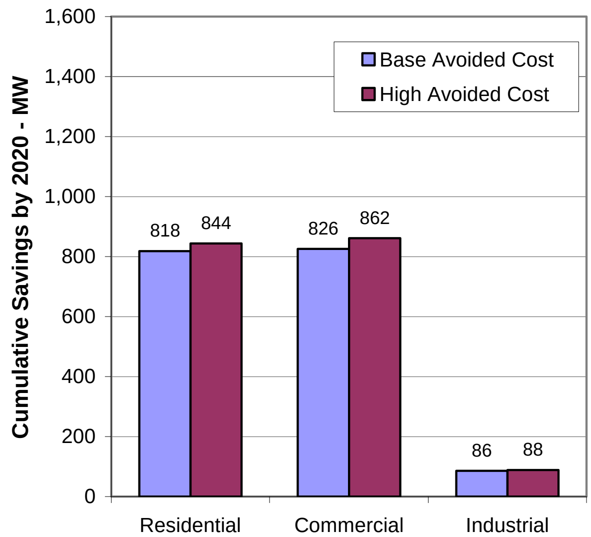


Figure 5-50 and Figure 5-51 show how residential economic potentials vary across the cost scenarios by end use. Most of the change in energy savings potential is in the cooling, lighting, heating, water heating, and miscellaneous end uses, while most of the change in peak demand potential is reflected in the cooling end use.

**Figure 5-50**
**Residential Economic Potential (2020)**
**Energy Savings by End Use—GWh per Year**

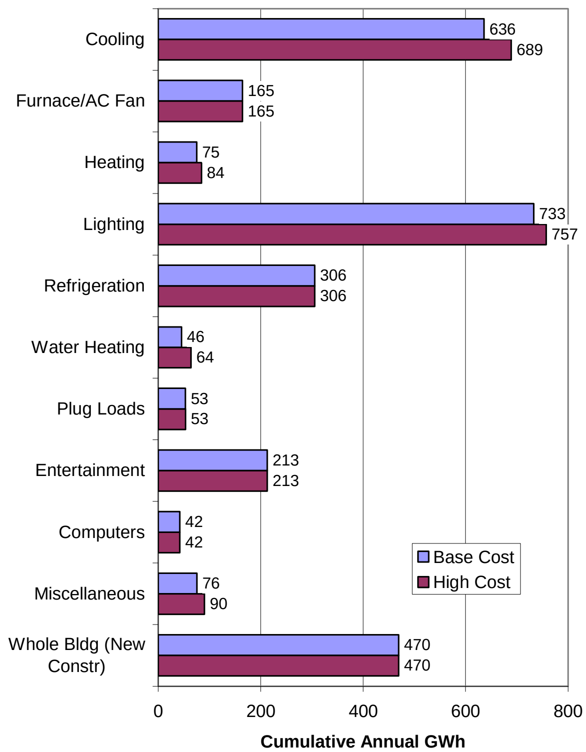



**Figure 5-51**
**Residential Economic Potential (2020)**
**Demand Savings by End Use—MW**

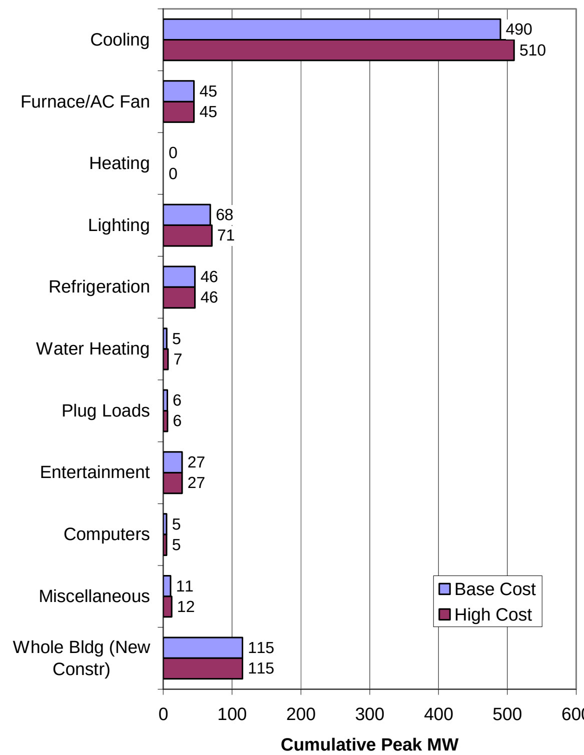


Figure 5-52 and Figure 5-53 show how commercial economic potentials vary across the cost scenarios by end use. Most of the increase in economic potential with the higher avoided costs is reflected in the indoor lighting and cooling end uses.

**Figure 5-52**
**Commercial Economic Potential (2020)**
**Energy Savings by End Use—GWh per Year**

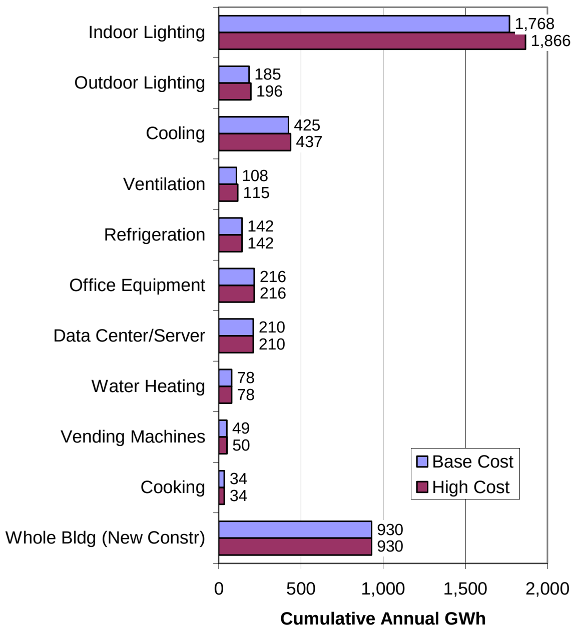
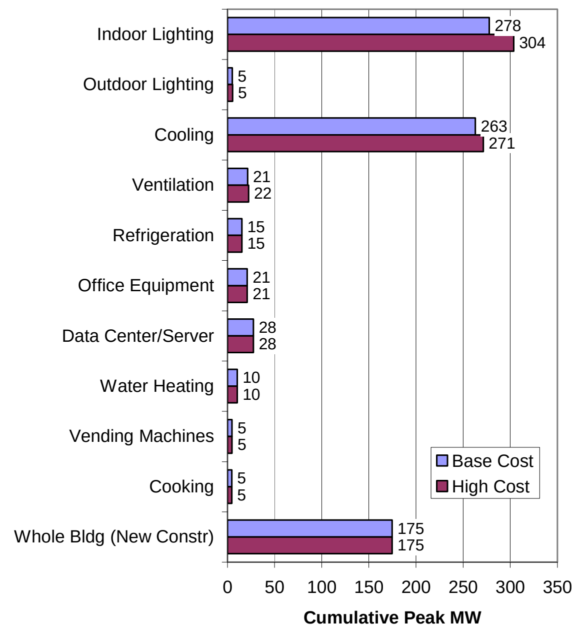



**Figure 5-53**
**Commercial Economic Potential (2020)**
**Demand Savings by End Use—MW**




## 5.4.2 Achievable Potentials

Increases in avoided energy costs (and rates) affect achievable program potentials in two key ways:

- The higher costs increase the likelihood that customers will participate in program as the economic incentive to do so increases; this can lead to higher achievable potentials; and
- The higher costs also increase the level of naturally occurring energy efficiency as more customers will install measures without program involvement because bill savings increase.

Our modeling results pick up the influences of these two effects.

Table 5-7 compares base and high-cost achievable potential estimates for the 2010-2020 time period by sector and program scenario. As the table shows, naturally occurring efficiency increases by about 25 percent with the higher energy costs as more customers would be willing to install energy efficiency measures and decrease their electric bill, even without Xcel Energy-provided incentives. Achievable potentials also increase for the 50-percent and 75-percent incentives scenarios, as it becomes easier for Xcel Energy to market and promote energy saving equipment with higher energy costs. Potentials decline in the 100-percent incentives scenario because after-program economics don't change much with higher energy costs (as all of the incremental measure cost is being paid in each cost scenario) but without-program economics are significantly affected by the higher energy rates. These non-program economics lead to higher naturally occurring savings that detract from program savings.

**Table 5-7**
**Comparison of Achievable Energy Potentials for Base and High Avoided Cost Scenarios Cumulative to 2020 - GWh**

| Sector | Program Scenario | Cost Scenario | | Percent Change |
|---|---|---|---|---|
| | | Base | High | |
| Residential | 50% Incentive | 565 | 616 | 9% |
| | 75% Incentive | 866 | 964 | 11% |
| | 100% Incentive | 2,045 | 2,056 | 1% |
| | Naturally Occurring | 311 | 390 | 25% |
| Commercial | 50% Incentive | 1,054 | 1,153 | 9% |
| | 75% Incentive | 1,654 | 1,715 | 4% |
| | 100% Incentive | 2,473 | 2,439 | -1% |
| | Naturally Occurring | 754 | 922 | 22% |
| Industrial | 50% Incentive | 184 | 211 | 15% |
| | 75% Incentive | 285 | 286 | 0% |
| | 100% Incentive | 374 | 349 | -7% |
| | Naturally Occurring | 79 | 119 | 50% |
| Total | 50% Incentive | 1,802 | 1,979 | 10% |
| | 75% Incentive | 2,806 | 2,965 | 6% |
| | 100% Incentive | 4,892 | 4,845 | -1% |
| | Naturally Occurring | 1,144 | 1,431 | 25% |

Table 5-8 shows similar results as in Table 5-7 but for peak demand potentials. Peak demand results are fairly similar to the energy results. The largest changes across the cost scenarios are reflected in the 50-percent and 75-percent program scenarios for the residential and commercial sectors. Potential peak demand savings for the 100-percent scenario also show slight increases in the high-cost scenario when compared to the base scenario.

**Table 5-8**

**Comparison of Achievable Energy Potentials for Base and High Avoided Cost Scenarios Cumulative to 2020 - MW**

| Sector | Program Scenario | Cost Scenario | | Percent Change |
|---|---|---|---|---|
| | | Base | High | |
| Residential | 50% Incentive | 112 | 130 | 16% |
| | 75% Incentive | 189 | 223 | 18% |
| | 100% Incentive | 620 | 635 | 3% |
| | Naturally Occurring | 36 | 44 | 25% |
| Commercial | 50% Incentive | 191 | 215 | 12% |
| | 75% Incentive | 310 | 332 | 7% |
| | 100% Incentive | 527 | 534 | 2% |
| | Naturally Occurring | 112 | 139 | 24% |
| Industrial | 50% Incentive | 24 | 29 | 17% |
| | 75% Incentive | 39 | 40 | 2% |
| | 100% Incentive | 52 | 50 | -4% |
| | Naturally Occurring | 10 | 15 | 51% |
| Total | 50% Incentive | 328 | 374 | 14% |
| | 75% Incentive | 538 | 594 | 10% |
| | 100% Incentive | 1,198 | 1,220 | 2% |
| | Naturally Occurring | 158 | 198 | 26% |

# 6. Natural-Gas Energy-Efficiency Potential Results

In this section, we present estimates of natural-gas 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 results exclude impacts from behavioral-conservation programs. This additional element is discussed separately since the lasting effects of behavioral-conservation programs are more uncertain than potentials from investing in energy-efficient technologies.

## 6.1 Technical and Economic Potential

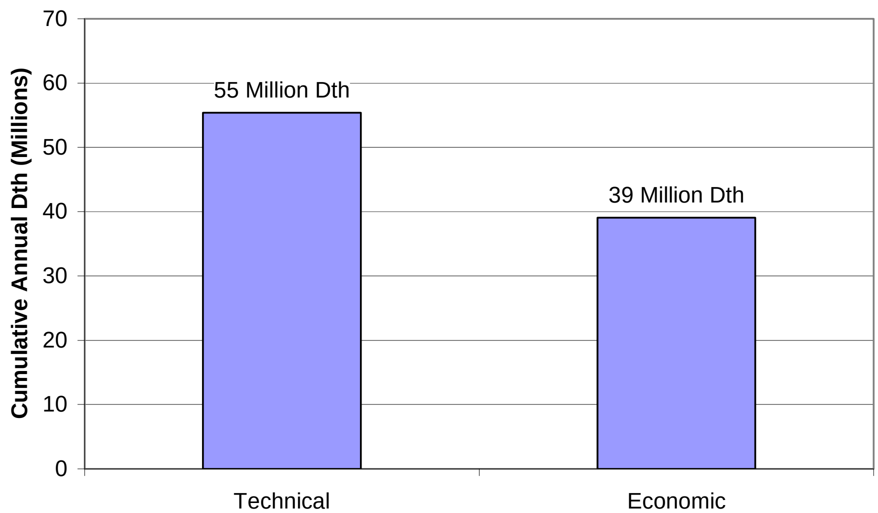
Estimates of overall energy-efficiency *technical* and *economic* potential are discussed in section 6.1.1. More detail on these potentials is presented in section 6.1.2. Energy-efficiency supply curves are shown in section 6.1.3.

### 6.1.1 Overall Technical and Economic Potential

Figure 6-1 presents our overall estimates of total technical and economic potential for electrical energy and peak-demand savings for the Xcel Energy Colorado 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 55 million Dth per year and economic potential at 39 million Dth per year by 2020 (about 40 and 28 percent of base 2020 usage, respectively).

**Figure 6-1**
**Estimated Natural-Gas Technical and Economic Potential, 2020**
**Xcel Energy Colorado Service Territory**




## 6.1.2 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.

### 6.1.2.1 Potentials by Sector

Figure 6-2 shows estimates of technical and economic energy-savings potential by sector. Figure 6-3 shows the same potentials as a percentage of 2020 base energy use.

The residential sector provides the largest contribution to both technical and economic potential for energy savings, accounting for about 80 percent of these potentials. The commercial sector contributes about 19 percent to the technical and economic potentials, while the industrial sector contributes only one percent. Note that transport-only customers are excluded from the analysis, and thus potentials for many of the large nonresidential customers are not included in these results.

As shown in Figure 6-3, the residential sector also has a higher savings potential in relation to base energy use than do the commercial or industrial sectors.

**Figure 6-2**
**Technical and Economic Potential (2020)**
**Energy Savings by Sector**
**Millions of Dth per Year**

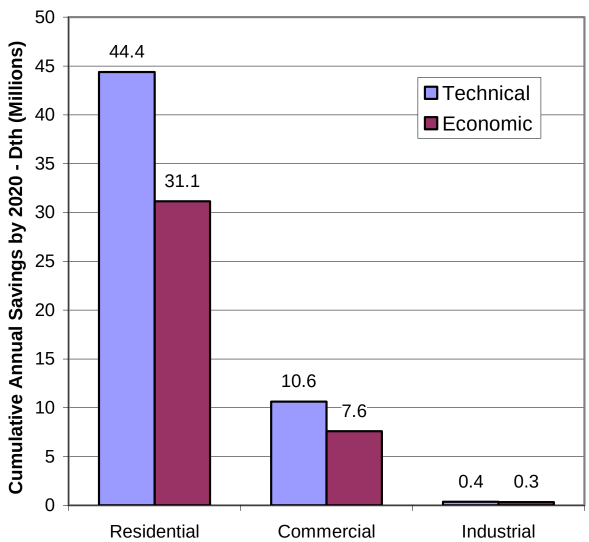
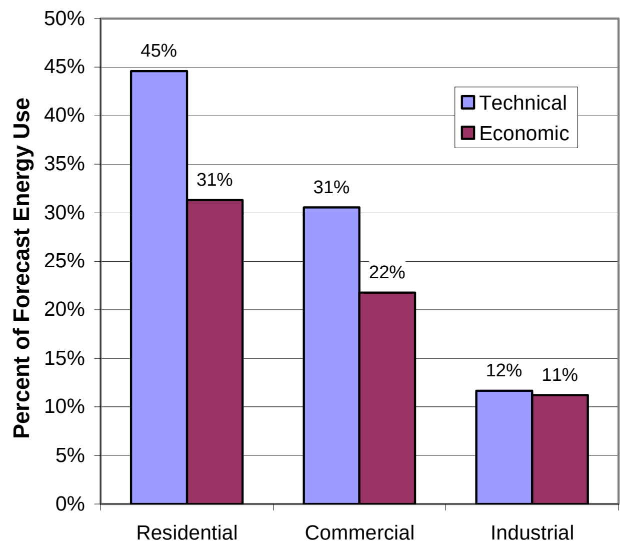



**Figure 6-3**
**Technical and Economic Potential (2020)**
**Percentage of Base Energy Use**




### 6.1.2.2 Potentials by Building Type

Figure 6-4 shows the technical and economic potentials in the residential sector by building type. Single-family homes account for about three-quarters of the potential, and low-income homes account for about 16 percent of the potential.

Figure 6-5 shows the building-type breakdown of commercial potential. Offices account for over half of the economic potential, followed by *other* commercial buildings.

**Figure 6-4**
**Residential Energy-Savings Potential by Building Type (2020)**

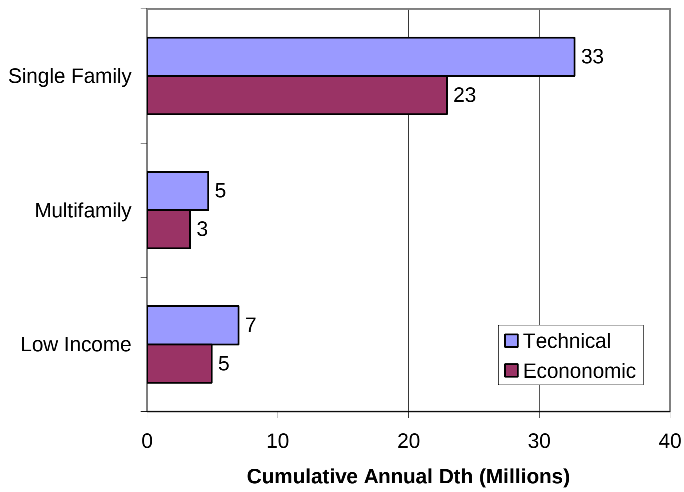



**Figure 6-5**
**Commercial Energy-Savings Potential by Building Type (2020)**

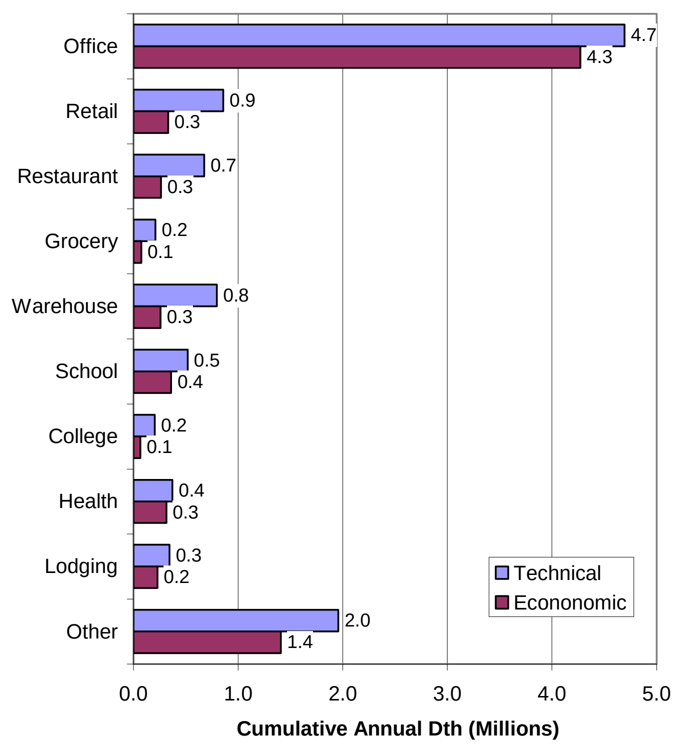
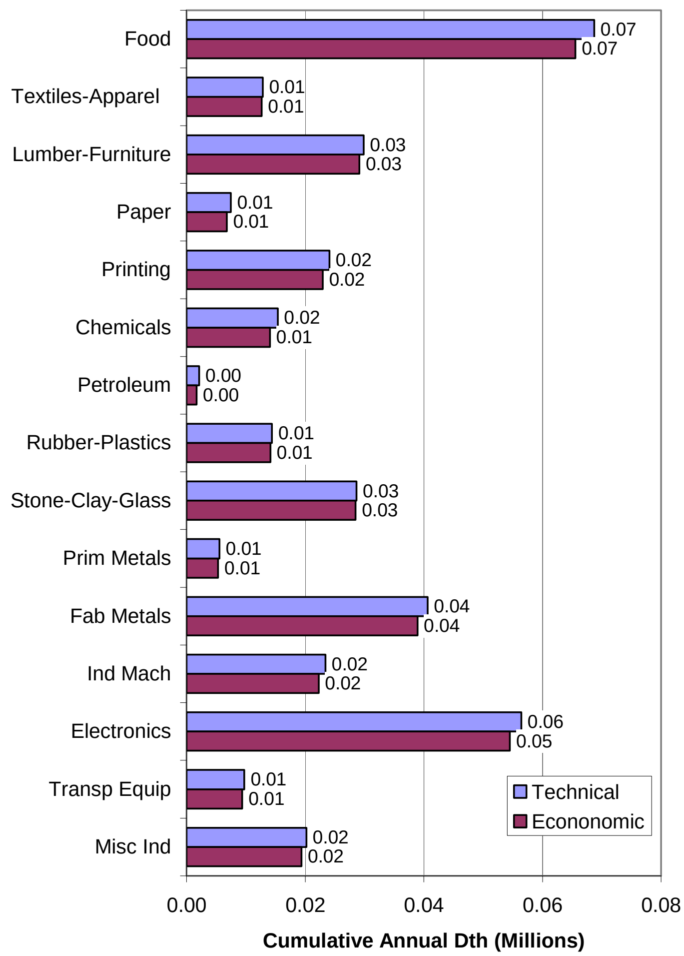


Figure 6-6 shows the business-type breakdown of industrial potential. Key industries in terms of economic potential include electronics, food processing, and fabricated metals. Note that many of the more energy-intensive industrial customers are excluded from the analysis since they are transport-only customers.

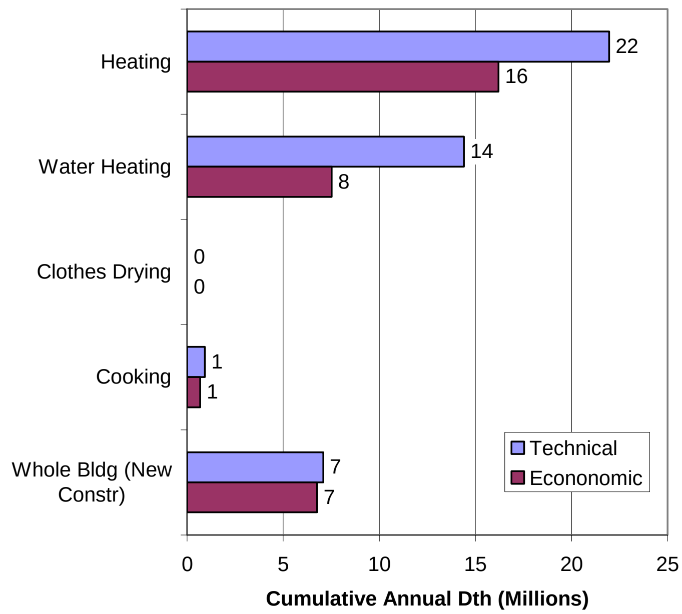
**Figure 6-6**
**Industrial Energy-Savings Potential by Business Type (2020)**




## 6.1.2.3 Potentials by End Use

Figure 6-7 shows the end-use breakdown of technical and economic potential in the residential sector. Energy-savings potential comes predominantly from space heating and water heating. The whole-building - new construction component also consists mainly of space-heating and water-heating measures.

**Figure 6-7**
**Residential Economic Energy-Savings Potential by End Use (2020)**




**Error! Not a valid bookmark self-reference.** shows the end-use breakdown of commercial potential. Similar to residential, space heating is the largest contributor to potentials, followed by water heating.

**Figure 6-8**
**Commercial Economic Energy-Savings Potential by End Use (2020)**

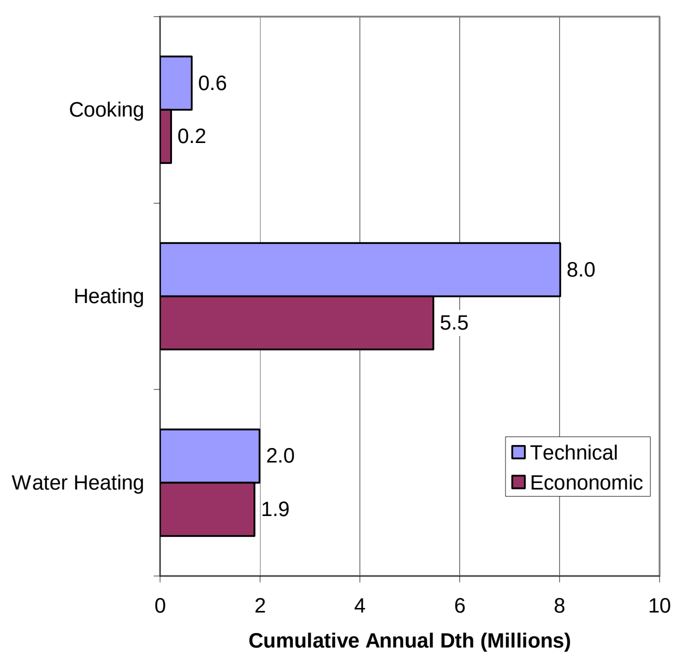
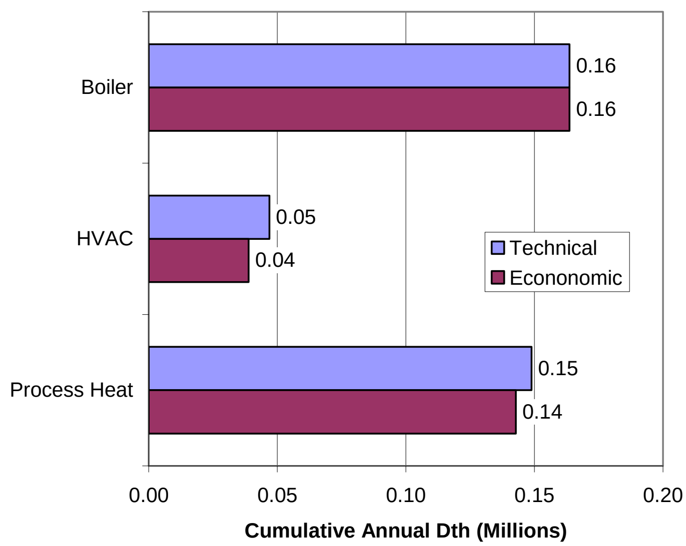


Figure 6-9 shows the end-use breakdown of industrial potential. Savings potentials are split fairly evenly between the boiler- and process-heating end uses, with the HVAC end use contributing a smaller share to the totals.

**Figure 6-9**
**Industrial Economic Energy-Savings Potential by End Use (2020)**

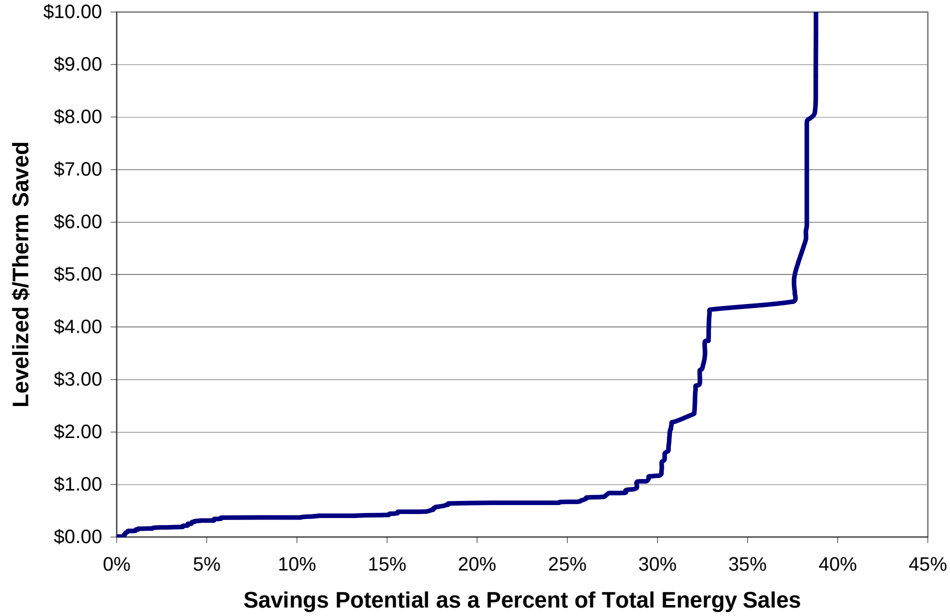



### 6.1.3 Energy-Efficiency Supply Curves

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 $/therm 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 preceded them. The costs of the measures are levelized over the life of the savings achieved.

Figure 6-10 presents the supply curves constructed for this study for natural gas. Each curve represents savings as a percentage of total energy or peak demand. These curves show that energy savings of almost 30 percent are available at under $1.00 per therm. Savings potentials and levelized costs for the individual measures that comprise the supply curve are provided in Appendix G.

**Figure 6-10**
**Natural-Gas Supply Curve***




*Levelized cost per kWh saved is calculated using a 7.7 percent nominal discount rate.

## 6.2 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. We estimate measure adoption while taking into account market barriers and actual consumer- and business-implicit discount rates. This section presents results for achievable potential, first at the summary level and then by sector. More detail on achievable program potential is shown in Appendix H.

*Achievable potential* refers to the amount of savings that would occur in response to one or more specific program interventions. *Net* savings associated with program potential 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, similar to the electric analysis, potential estimates under alternative funding scenarios: 50-percent incentives, 75-percent incentives, and 100-percent incentives. These scenarios reflect the percent of incremental measure cost that is assumed to be paid in customer incentives. (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 2010-2020 time period.

Figure 6-11 shows our estimates of achievable potential savings over time. As shown, by 2020 cumulative *net*[9] energy savings are projected to be 5 million Dth under the 50-percent incentive scenario, 9 million Dth under the 75-percent incentive scenario, and 24 million Dth under the 100-percent incentive scenario.

**Figure 6-11**
**Achievable Energy Savings: All Sectors**

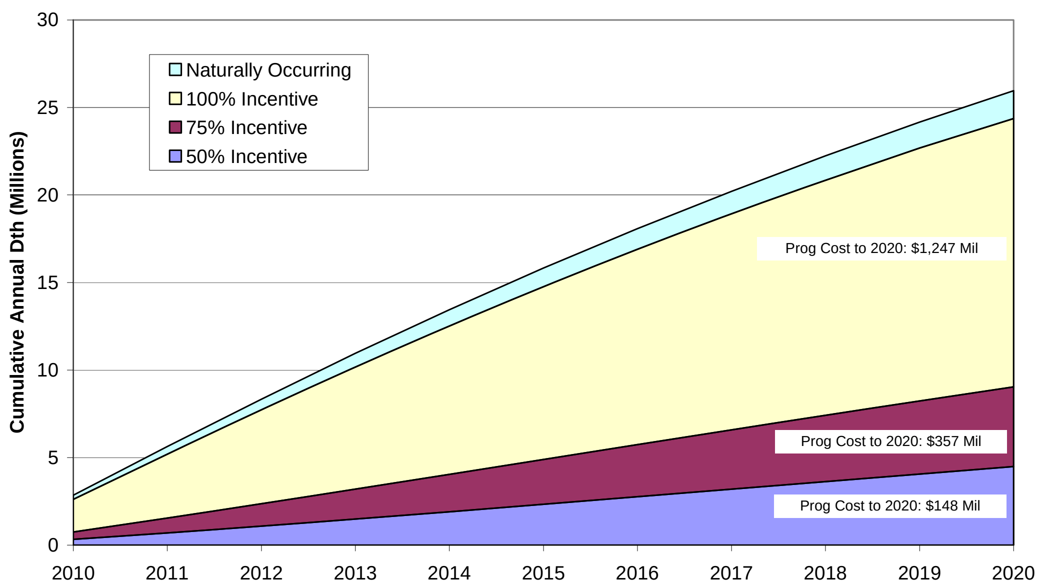
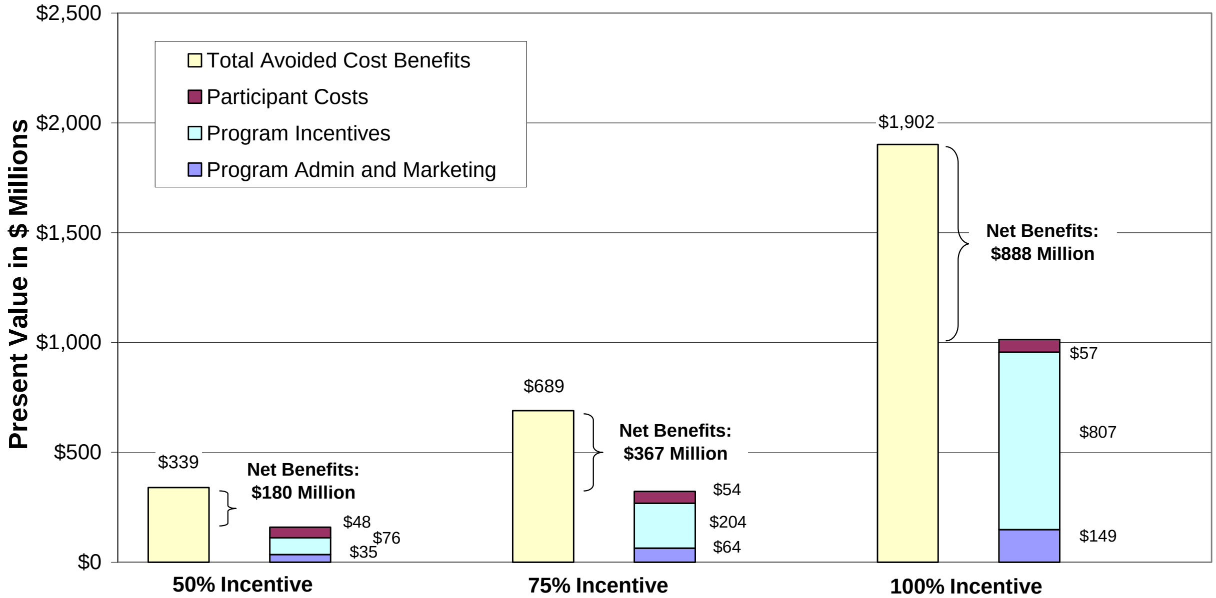



Figure 6-12 depicts costs and benefits under each funding scenario from 2010 to 2020. The present value of program costs (including administration, marketing, and incentives) is $111 million under the 50-percent incentive scenario, $268 million under the 75-percent incentive scenario, and $956 million under the 100-percent incentive scenario. The present value of total avoided-cost benefits is $339 million under 50-percent incentives, $689 million under 75-percent incentives, and $1,902 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 $180 million under 50-percent incentives, $367 million under 75-percent incentives, and $888 million under 100-percent incentives.

[9] Throughout this section, *net* refers to savings beyond those estimated to be naturally occurring; that is, from customer adoptions that would occur in the absence of any programs or standards.

**Figure 6-12**
**Benefits and Costs of Energy-Efficiency Savings—2010-2020***




* Present value of benefits and costs over normalized 20-year measure lives; nominal discount rate is 7.7 percent, inflation rate is 1.5 percent.

All three 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 50-percent incentive scenario and 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 6-1.

**Table 6-1**
**Summary of Achievable Potential Results—2010-2020**

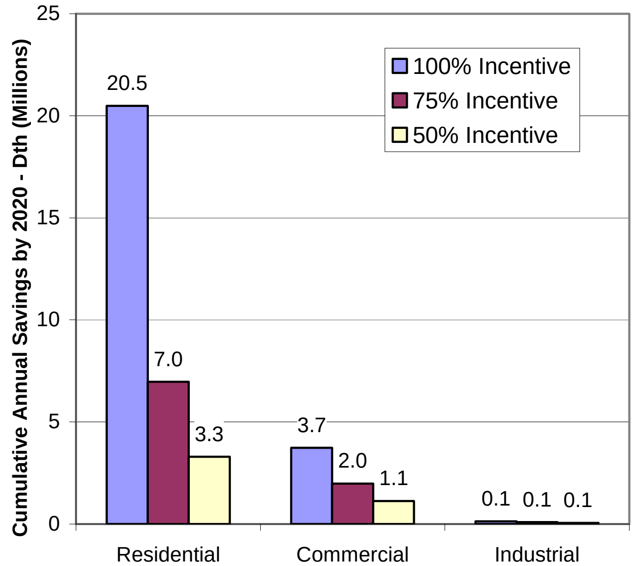
| Result | Program Scenario 50% Incentive | 75% Incentive | 100% Incentive |
|---|---|---|---|
| **Gross Energy Savings - Millions of Dth** | 6.1 | 10.6 | 26.0 |
| **Net Energy Savings - Millions of Dth** | 4.5 | 9.0 | 24.4 |
| **Program Costs - Real, $ Million** | | | |
| **Administration** | $33 | $71 | $181 |
| **Marketing** | $14 | $15 | $18 |
| **Incentives** | $101 | $271 | $1,047 |
| **Total** | $148 | $357 | $1,247 |
| **PV Net Avoided Cost Benefits** | $339 | $689 | $1,902 |
| **PV Annual Marketing and Admin Costs** | $35 | $64 | $149 |
| **PV Measure Costs** | $124 | $258 | $865 |
| **TRC Ratio** | 2.1 | 2.1 | 1.9 |

PV (present value) of benefits and costs is calculated over a 20-year normalized measure life for 2010-2020 program years, nominal discount rate = 7.7 percent, inflation rate = 1.5 percent; Dth savings are cumulative through 2020.

### 6.2.1 Breakdown of Achievable Potential

Cumulative net achievable potential estimates by customer class for the period of 2010-2020 are presented in Figure 6-13. This figure shows results for each funding scenario. Under the program assumptions developed for this study, achievable energy savings are highest for the residential sector, which is also the sector with the highest natural-gas demand and highest economic potential.

**Figure 6-13**
**Net Achievable Energy Savings**
**(2020) by Sector—Million Dth per Year**




### 6.2.1.1 Residential Sector

Figure 6-14 shows cumulative net achievable program savings by residential program scenario. By 2020, net energy savings reach 3 million Dth under the 50-percent incentive scenario, 7 million Dth under the 75-percent incentive scenario, and 20 million Dth under the 100-percent incentive scenario. Energy savings are most sensitive to changes in incentives in the 75- to 100-percent range.

**Figure 6-14**
**Achievable Energy Savings: Residential Sector**

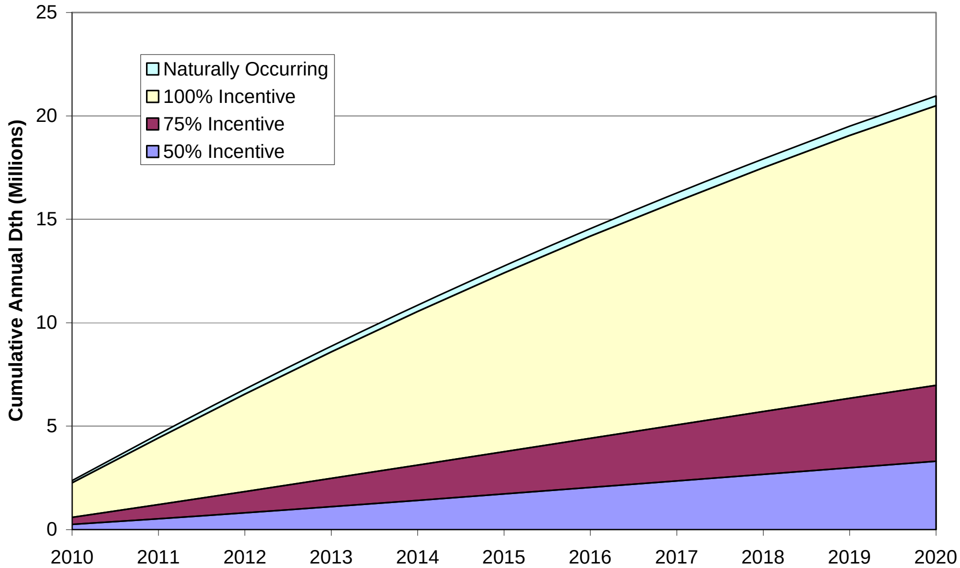



Figure 6-15 shows the end-use distribution of gas savings, cumulative to 2020. Key end uses for energy savings potential include heating, space heating, and new construction measures that mainly affect heating and space heating. The figure also shows that our models predict a large increase in savings when incentives are increased from 75 percent to 100 percent of incremental measure cost.

**Figure 6-15**
**Residential Net Energy-Savings Potential by End Use (2020)**

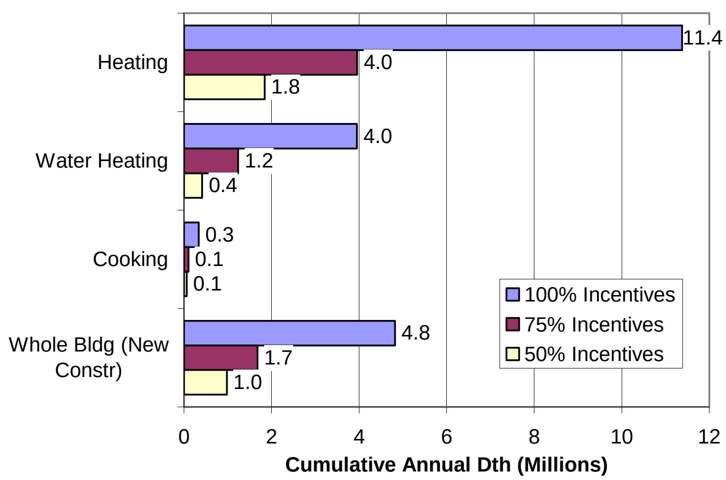


Table 6-2 shows how low-income potentials compare to the overall residential potentials. The low-income segment accounts for about 12 percent of total residential economic natural-gas potential and achievable potentials ranging from 12 percent to 26 percent. Note that the low-income segment was not modeled 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 roughly track other residential segments in terms of program achievements. Table 6-2 shows that the low-income estimates track the overall residential sector gas potentials fairly well—showing somewhat higher achievable savings in the lower incentive program scenarios.

**Table 6-2**
**Low-Income Potentials Compared to Total Residential Potentials (2020)**

| | Economic Potential | Program Scenario | | |
|---|---|---|---|---|
| | | 100% Incentive | 75% Incentive | 50% Incentive |
| Residential | 31,149,526 | 20,493,409 | 6,975,190 | 3,299,384 |
| Low Income | 3,833,848 | 2,547,731 | 1,147,502 | 847,798 |
| % of Residential | 12% | 12% | 16% | 26% |

Table 6-3 lists the various potentials for residential measures that passed cost-effectiveness screening. The list is sorted by economic potential.

**Table 6-3**
**Measure-Specific Residential Results (Cumulative to 2020) – Dth**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| HE Water Heater (EF=0.71) | 2.5 | 6,089,873 | 6,089,873 | 6,081,902 | 2,777,186 | 46% | 858,279 | 14% | 266,585 | 4% |
| Condensing Furnace - 94 AFUE (Tier 2) | 1.7 | 3,803,055 | 3,556,856 | 3,522,418 | 1,392,048 | 40% | 551,678 | 16% | 342,449 | 10% |
| Wall 2x4 R-0 to Blow-In R-13 Insulation | 2.5 | 3,448,552 | 3,442,224 | 3,409,368 | 2,960,407 | 87% | 990,957 | 29% | 391,667 | 11% |
| High Efficiency Condensing Boiler (AFUE = 90%) | 5.5 | 1,285,554 | 1,285,554 | 1,281,568 | 497,004 | 39% | 200,588 | 16% | 77,291 | 6% |
| Crawlspace insulation | 5.2 | 1,265,152 | 1,265,152 | 1,254,827 | 1,172,828 | 93% | 567,293 | 45% | 204,138 | 16% |
| Furnace Diagnostic Testing, Repair and Maintenanc | 1.4 | 1,325,779 | 1,215,802 | 1,214,914 | 1,008,940 | 83% | 129,692 | 11% | 57,751 | 5% |
| Windows - Double-Glazed to Energy Star | 2.4 | 1,213,789 | 1,213,789 | 1,188,335 | 801,000 | 67% | 358,668 | 30% | 230,920 | 19% |
| Basement insulation R-13 (Furnace) | 1.3 | 1,221,995 | 1,093,566 | 1,092,160 | 948,938 | 87% | 180,887 | 17% | 89,331 | 8% |
| Convection Oven | 1.0 | 876,132 | 682,128 | 676,985 | 339,403 | 50% | 103,826 | 15% | 61,537 | 9% |
| Low-Flow Showerheads | 1.5 | 653,247 | 653,247 | 651,700 | 534,770 | 82% | 121,545 | 19% | 43,225 | 7% |
| Self Install Weatherization | 8.7 | 622,026 | 622,026 | 562,738 | 488,096 | 87% | 363,730 | 65% | 200,679 | 36% |
| High efficiency gas room heater | 2.4 | 440,790 | 440,790 | 439,593 | 327,636 | 75% | 94,640 | 22% | 34,686 | 8% |
| Pipe Wrap | 1.8 | 432,203 | 400,116 | 397,599 | 337,915 | 85% | 125,812 | 32% | 48,320 | 12% |
| Duct Repair and Sealing | 1.3 | 403,670 | 365,050 | 364,620 | 317,395 | 87% | 59,978 | 16% | 30,704 | 8% |
| Ceiling R-0 to R-49 Insulation | 2.4 | 356,382 | 356,382 | 345,731 | 331,291 | 96% | 182,035 | 53% | 79,779 | 23% |
| Faucent Aerators | 4.9 | 248,891 | 248,891 | 238,726 | 195,779 | 82% | 128,382 | 54% | 55,581 | 23% |
| Boiler controls | 1.2 | 790,567 | 240,132 | 239,461 | 202,697 | 85% | 34,275 | 14% | 5,580 | 2% |
| Comprehensive Shell Air Sealing - Inf. Reduction | 0.9 | 940,086 | 230,685 | 230,255 | 175,931 | 76% | 23,307 | 10% | 3,617 | 2% |
| Boiler Diagnostic Testing, Repair and Maintenance | 1.6 | 225,703 | 223,702 | 223,216 | 195,868 | 88% | 48,157 | 22% | 21,308 | 10% |
| Basement insulation R-13 (Boiler) | 1.4 | 203,758 | 198,623 | 198,312 | 174,155 | 88% | 39,826 | 20% | 20,168 | 10% |
| Slab insulation R-0 to R-5 (4 ft) | 1.4 | 169,273 | 163,214 | 162,766 | 139,517 | 86% | 26,841 | 16% | 8,878 | 5% |
| Pipe Insulation (Boiler) | 4.9 | 132,353 | 132,353 | 130,005 | 112,297 | 86% | 57,335 | 44% | 21,410 | 16% |
| Drain Water Heat Recovery (GFX) | 0.8 | 563,405 | 127,779 | 127,767 | 106,656 | 83% | 853 | 1% | 107 | 0% |
| Basement insulation R-13 (Room Heater) | 1.1 | 157,397 | 83,624 | 83,543 | 75,649 | 91% | 22,207 | 27% | 13,842 | 17% |
| Heater Diagnostic Testing, Repair and Maintenance | 2.4 | 53,783 | 53,783 | 53,507 | 47,288 | 88% | 15,928 | 30% | 6,921 | 13% |
| Duct Insulation | 4.9 | 10,676 | 10,676 | 10,164 | 8,874 | 87% | 5,731 | 56% | 2,783 | 27% |
| New Construction Meausres | | | | | | | | | | |
| Best Practice Home | 1.5 | 4,643,174 | 4,310,829 | 4,180,440 | 3,096,725 | 74% | 956,497 | 23% | 513,558 | 12% |
| ENERGY STAR Home | 2.3 | 2,442,683 | 2,442,683 | 2,320,475 | 1,727,118 | 74% | 726,243 | 31% | 466,572 | 20% |

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.

#### 6.2.1.2 Commercial Sector

Figure 6-16 shows cumulative net achievable program savings by commercial program scenario. By 2020, net natural gas savings reach 1.1 million Dth under the 50-percent incentive scenario, 2.0 million Dth under the 75-percent incentive scenario, and 3.7 million Dth under the 100-percent incentive scenario. Similar to residential, energy savings are most sensitive to changes in incentives in the 50- to 75-percent range.

**Figure 6-16**
**Achievable Energy Savings: Commercial Sector**

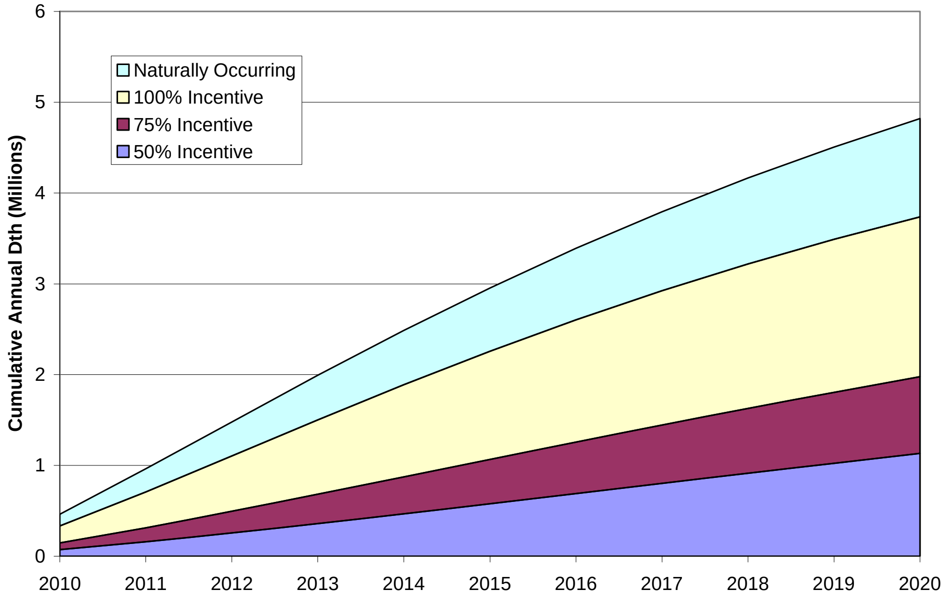



Figure 6-17 shows the end-use distribution of energy and peak-demand savings. Heating contributes most to the savings potential, followed by water heating. The heating end use also shows the largest difference between the 75-percent and 100-percent incentive scenarios, since a significant amount of heating potential is tied to replace-on-burnout measures. These measures would gain very high penetration levels if priced at the same cost as standard-efficiency equipment.

**Figure 6-17**
**Commercial Net Energy-Savings Potential by End Use (2020)**

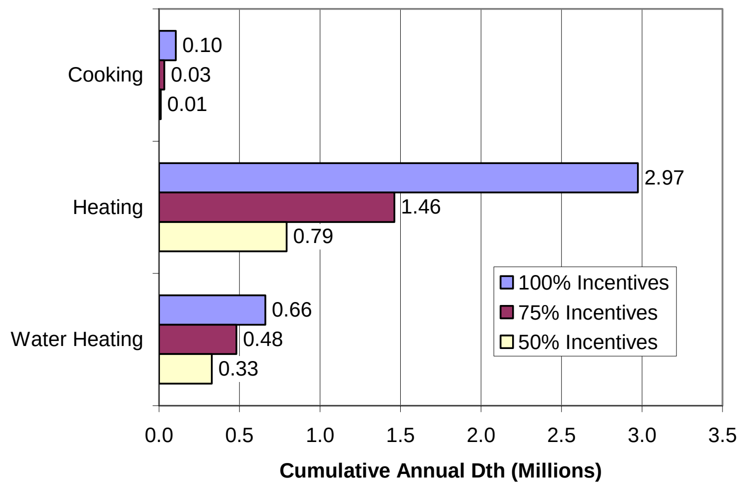



Table 6-4 (existing construction) and Table 6-5 (new construction) list the various potentials for commercial measures that passed cost-effectiveness screening.

**Table 6-4**
**Measure-Specific Commercial Results (Cumulative to 2020) – Dth**
**Existing Construction**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| High Efficiency (Power Burner/ Premium) Boiler | 3.2 | 2,145,403 | 1,960,609 | 1,915,242 | 590,149 | 31% | 338,222 | 18% | 224,269 | 12% |
| Insulation (wall) | 6.6 | 948,903 | 863,047 | 674,107 | 565,007 | 84% | 392,959 | 58% | 250,988 | 37% |
| Installation of Energy Management Systems (EMS) | 1.2 | 823,086 | 579,857 | 576,711 | 496,950 | 86% | 126,456 | 22% | 22,652 | 4% |
| Water Heater Tank Blanket/Insulation | 696.0 | 526,223 | 521,042 | 68,924 | 11,112 | 16% | 10,635 | 15% | 10,109 | 15% |
| Tankless Water Heater | 5.5 | 388,598 | 388,598 | 373,938 | 110,970 | 30% | 75,476 | 20% | 53,882 | 14% |
| Clock / Programmable Thermostat | 1.6 | 415,534 | 350,536 | 347,307 | 299,581 | 86% | 100,641 | 29% | 21,800 | 6% |
| Insulation (ceiling) | 9.3 | 353,651 | 349,822 | 245,472 | 201,283 | 82% | 114,878 | 47% | 57,588 | 23% |
| Condensing Water Heater | 9.3 | 383,060 | 313,545 | 286,177 | 105,947 | 37% | 81,955 | 29% | 61,411 | 21% |
| Demand controlled ventilation (DCV) | 0.6 | 1,400,805 | 258,397 | 257,276 | 221,525 | 86% | 48,804 | 19% | 8,205 | 3% |
| High Efficiency Windows | 1.7 | 238,159 | 207,844 | 205,570 | 64,898 | 32% | 28,320 | 14% | 16,854 | 8% |
| Stack Heat Exchanger | 8.5 | 202,598 | 198,090 | 140,175 | 115,431 | 82% | 81,819 | 58% | 51,792 | 37% |
| Thermally activated heat pump/chiller | 3.0 | 191,560 | 191,560 | 185,420 | 160,206 | 86% | 92,807 | 50% | 31,524 | 17% |
| Energy Star Steamer | 1.2 | 215,333 | 171,430 | 171,066 | 83,608 | 49% | 26,268 | 15% | 7,972 | 5% |
| EMS Optimization | 0.9 | 198,378 | 111,195 | 110,726 | 95,328 | 86% | 20,593 | 19% | 3,440 | 3% |
| Demand controlled circulating systems | 27.9 | 106,192 | 104,220 | 36,383 | 24,177 | 66% | 16,713 | 46% | 11,068 | 30% |
| Retrocommissioning | 2.2 | 40,924 | 34,629 | 33,682 | 29,099 | 86% | 15,694 | 47% | 5,084 | 15% |
| Pre-Rinse Spray Valve | 31.7 | 29,129 | 29,129 | 7,280 | 3,951 | 54% | 3,401 | 47% | 2,599 | 36% |
| Hot water temperature reset | 44.4 | 28,946 | 28,809 | 9,076 | 5,748 | 63% | 4,630 | 51% | 3,098 | 34% |
| Condensing unit heaters | 8.0 | 27,774 | 27,774 | 26,332 | 7,492 | 28% | 5,740 | 22% | 4,343 | 16% |
| Hot Water Pipe Insulation | 3.5 | 29,081 | 27,254 | 25,034 | 21,473 | 86% | 12,702 | 51% | 6,048 | 24% |
| Radiant heater | 10.7 | 26,506 | 26,506 | 24,729 | 6,681 | 27% | 5,424 | 22% | 4,304 | 17% |
| Energy Star Fryer | 0.6 | 216,306 | 20,204 | 20,184 | 8,386 | 42% | 1,968 | 10% | 505 | 3% |
| Boiler Tune-Up | 7.4 | 21,725 | 20,113 | 11,922 | 9,448 | 79% | 6,195 | 52% | 3,678 | 31% |

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.

**Table 6-5**
**Measure-Specific Commercial Results (Cumulative to 2020) – Dth**
**New Construction**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| Tankless Water Heater | 4.0 | 220,309 | 220,309 | 200,134 | 173,398 | 87% | 145,850 | 73% | 117,298 | 59% |
| High Efficiency Windows | 1.9 | 146,769 | 134,897 | 133,697 | 53,310 | 40% | 25,775 | 19% | 16,180 | 12% |
| High Efficiency Furnace/Boiler | 2.2 | 118,949 | 96,303 | 95,115 | 37,762 | 40% | 19,717 | 21% | 12,961 | 14% |
| Installation of Energy Management Systems (EMS) | 1.4 | 110,972 | 79,195 | 77,590 | 67,986 | 88% | 50,268 | 65% | 33,681 | 43% |
| Demand controlled ventilation (DCV) | 1.1 | 166,489 | 74,272 | 72,991 | 63,862 | 87% | 41,778 | 57% | 25,009 | 34% |
| Thermally activated heat pump/chiller | 3.1 | 34,728 | 34,728 | 32,480 | 28,291 | 87% | 23,868 | 73% | 19,035 | 59% |
| Condensing Water Heater | 8.0 | 48,284 | 33,971 | 32,055 | 11,686 | 36% | 9,136 | 29% | 7,075 | 22% |
| Stack Heat Exchanger | 8.8 | 26,795 | 26,274 | 20,142 | 16,873 | 84% | 14,906 | 74% | 12,870 | 64% |
| Water Heater Tank Blanket/Insulation | 94.2 | 25,007 | 23,757 | 13,416 | 7,457 | 56% | 6,764 | 50% | 6,219 | 46% |
| Energy Star Steamer | 1.2 | 29,422 | 23,436 | 23,350 | 10,013 | 43% | 4,338 | 19% | 2,170 | 9% |
| EMS Optimization | 1.1 | 29,440 | 17,408 | 17,092 | 14,979 | 88% | 10,910 | 64% | 7,161 | 42% |
| Condensing unit heaters | 7.8 | 8,701 | 8,701 | 8,323 | 3,133 | 38% | 2,455 | 29% | 1,921 | 23% |
| Radiant heater | 10.7 | 8,511 | 8,511 | 8,025 | 2,926 | 36% | 2,433 | 30% | 1,987 | 25% |
| Energy Star Fryer | 0.6 | 29,561 | 5,450 | 5,441 | 2,168 | 40% | 738 | 14% | 310 | 6% |
| Hot water temperature reset | 44.3 | 3,871 | 3,871 | 2,006 | 1,496 | 75% | 1,413 | 70% | 1,320 | 66% |
| Hot Water Pipe Insulation | 4.4 | 3,688 | 3,322 | 2,812 | 2,406 | 86% | 2,120 | 75% | 1,800 | 64% |
| Insulation of Pipes | 0.8 | 2,808 | 2,042 | 2,034 | 1,778 | 87% | 948 | 47% | 421 | 21% |
| Boiler Tune-Up | 4.0 | 2,020 | 1,593 | 1,286 | 1,089 | 85% | 975 | 76% | 848 | 66% |

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.

### 6.2.1.3 Industrial Sector

Figure 6-18 shows cumulative net achievable program savings by industrial program scenario. By 2020, net energy savings reach 0.05 million Dth under the 50-percent incentive scenario, 0.09 million Dth under the 75-percent incentive scenario, and 0.14 million Dth under the 100-percent incentive scenario.

**Figure 6-18**
**Achievable Energy Savings: Industrial Sector**

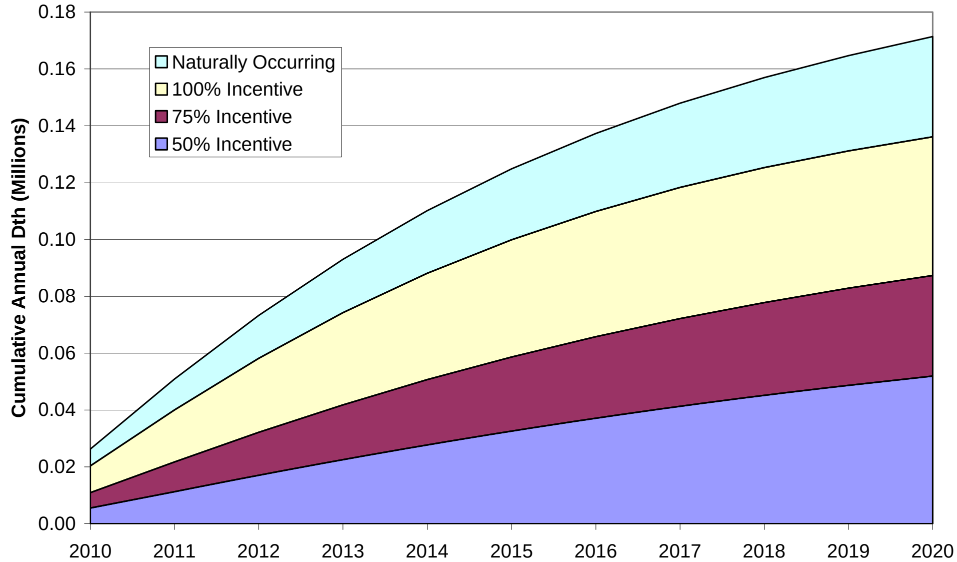



Figure 6-19 shows the end-use distribution of gas savings. Measures affecting the boiler and process-heat end uses contribute the most savings potential.

**Figure 6-19**
**Industrial Net Energy-Savings Potential by End-Use (2020)**

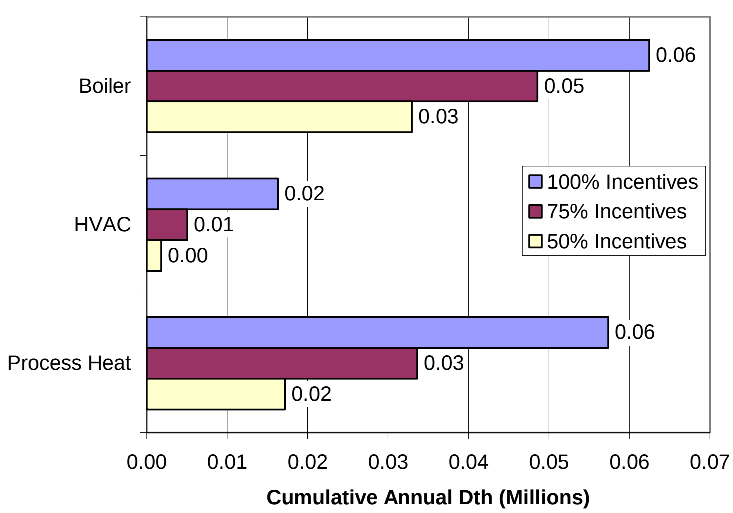



Table 6-6 lists the various potentials for industrial measures that passed cost-effectiveness screening.

**Table 6-6**
**Measure-Specific Industrial Results (Cumulative to 2020) – Dth**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| Improved insulation | 5.0 | 44,800 | 44,800 | 39,142 | 35,375 | 90% | 28,863 | 74% | 19,076 | 49% |
| Process Controls & Management | 3.3 | 34,437 | 34,437 | 31,902 | 29,785 | 93% | 22,698 | 71% | 12,513 | 39% |
| Heat Recovery | 1.5 | 37,164 | 34,159 | 34,002 | 10,655 | 31% | 3,133 | 9% | 1,173 | 3% |
| Steam trap maintenance | 2.0 | 31,188 | 31,188 | 30,367 | 961 | 3% | 961 | 3% | 961 | 3% |
| Efficient burners | 3.5 | 27,755 | 27,755 | 27,556 | 4,729 | 17% | 2,354 | 9% | 1,085 | 4% |
| Load control | 12.7 | 24,363 | 24,363 | 10,987 | 9,660 | 88% | 8,938 | 81% | 7,789 | 71% |
| Improve ceiling insulation | 1.8 | 20,433 | 20,433 | 20,332 | 13,257 | 65% | 3,274 | 16% | 976 | 5% |
| High efficiency (95%) condensing furnace/boiler | 3.2 | 15,566 | 15,566 | 15,545 | 793 | 5% | 309 | 2% | 129 | 1% |
| Automatic steam trap monitoring | 6.0 | 14,359 | 14,359 | 14,160 | 2,159 | 15% | 1,436 | 10% | 812 | 6% |
| Maintain boilers | 69.1 | 12,430 | 12,430 | 1,787 | 1,009 | 56% | 1,009 | 56% | 1,009 | 56% |
| Process integration | 1.3 | 13,225 | 11,089 | 11,044 | 4,104 | 37% | 1,055 | 10% | 365 | 3% |
| Improved process control | 10.2 | 10,349 | 10,349 | 9,956 | 1,352 | 14% | 1,054 | 11% | 746 | 7% |
| Efficient drying | 1.6 | 8,781 | 8,781 | 8,779 | 173 | 2% | 46 | 1% | 17 | 0% |
| Thermally activated heat pump/chiller | 1.8 | 7,552 | 7,552 | 7,495 | 7,097 | 95% | 3,092 | 41% | 749 | 10% |
| Combustion controls | 2.6 | 7,337 | 7,337 | 7,305 | 2,060 | 28% | 866 | 12% | 294 | 4% |
| Oxyfuel | 1.9 | 6,432 | 6,432 | 6,429 | 178 | 3% | 51 | 1% | 19 | 0% |
| Optimize furnace operations | 2.8 | 6,031 | 6,031 | 5,814 | 4,757 | 82% | 2,807 | 48% | 1,315 | 23% |
| Water treatment | 3.5 | 5,142 | 5,142 | 4,795 | 4,106 | 86% | 2,892 | 60% | 1,609 | 34% |
| Flue gas heat recovery/economizer | 2.2 | 5,041 | 5,041 | 5,036 | 312 | 6% | 97 | 2% | 36 | 1% |
| Upgrade burner efficiency | 2.6 | 2,545 | 2,545 | 2,543 | 108 | 4% | 38 | 1% | 15 | 1% |
| Blowdown steam heat recovery | 1.5 | 2,453 | 2,453 | 2,452 | 83 | 3% | 19 | 1% | 6 | 0% |
| Leak repair | 2.5 | 2,431 | 2,431 | 2,308 | 128 | 6% | 128 | 6% | 128 | 6% |
| Batch cullet preheating | 2.8 | 2,161 | 2,161 | 2,156 | 177 | 8% | 69 | 3% | 28 | 1% |
| Duct insulation | 3.6 | 1,735 | 1,735 | 1,669 | 1,428 | 86% | 881 | 53% | 412 | 25% |
| Thermal oxidizers | 2.3 | 1,594 | 1,594 | 1,592 | 104 | 7% | 33 | 2% | 12 | 1% |
| Improved separation processes | 2.5 | 1,317 | 1,317 | 1,316 | 53 | 4% | 18 | 1% | 7 | 1% |
| Condensate return | 4.1 | 1,030 | 1,030 | 1,025 | 109 | 11% | 57 | 6% | 28 | 3% |
| EMS optimization | 2.9 | 841 | 841 | 799 | 752 | 94% | 568 | 71% | 286 | 36% |
| Extended nip press | 1.1 | 629 | 629 | 629 | 6 | 1% | 1 | 0% | 0 | 0% |
| Preventative maintenance | 5.7 | 487 | 487 | 357 | 331 | 93% | 299 | 84% | 237 | 66% |
| Fouling control | 3.5 | 285 | 285 | 258 | 240 | 93% | 196 | 76% | 121 | 47% |
| Stack heat exchanger | 1.8 | 280 | 280 | 279 | 94 | 34% | 28 | 10% | 10 | 4% |
| Flare gas controls and recovery | 3.6 | 174 | 174 | 173 | 17 | 10% | 8 | 5% | 4 | 2% |
| Efficient furnaces | 2.6 | 89 | 89 | 89 | 4 | 4% | 1 | 1% | 1 | 1% |

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.

## 6.3 Behavioral Conservation

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

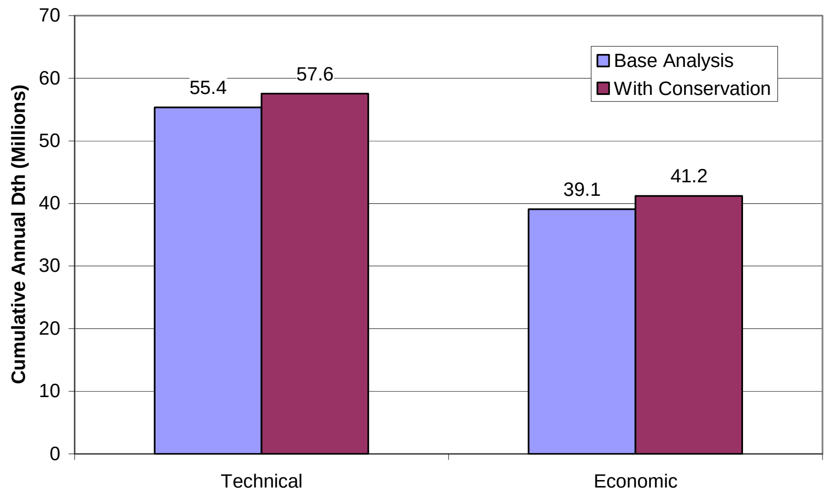
Two types of residential behavioral-conservation methods are addressed in the analysis: (1) indirect feedback approaches, which utilize energy information reports that motivate customers to use less, and (2) direct feedback interventions, such use of in-home energy use monitors. Both of these approaches 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.

For this analysis, we assumed that indirect feedback measures would save about two percent of household energy consumption at a cost of about $10 per customer per year (split between the electric and gas programs). These measures could be targeted to the entire residential population. Direct methods would save 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. These measure parameters are consistent with findings from recent pilot studies being conducted in various locales over the past several years.[10]

Figure 6-20 shows the effects on technical and economic potential from adding behavioral-conservation measures to the analysis. Behavioral conservation adds 2.19 million Dth of technical potential and 2.14 million Dth of economic potential to the base amounts. The behavioral-conservation potentials amount to an increase in total economic potential of about five percent and an increase to residential economic potential of about seven percent. The indirect feedback approaches account for 90 percent of the gas behavioral-conservation potentials since they are applicable to a much larger number of customers than the direct feedback measures.

[10] 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.

**Figure 6-20**
**Natural-Gas Technical and Economic Potentials with Behavioral-Conservation Activities**




Similar to the electric analysis, for the achievable potential assessment of the gas behavioral-conservation measures, we focused on the indirect interventions and developed three scenarios:

- A low scenario that targets only the largest residential electricity users,  about 0.15 million customers with average use of about 1,300 therms per year
- A mid scenario that targets both large and medium residential electricity users, about 0.6 million customers with combined average electricity use of 950 therms per year
- A high scenario that targets all residential customers,  about 1.2 million customers with average electricity use of 790 therms per year

In each case, program efforts were ramped up over a three-year period.  Table 6-7 summarizes the results of the analysis over the 2010-2020 time period.  As shown, behavioral-conservation potentials—if the assumptions outlined above hold up—could save between 0.46 and 1.90 million Dth in annual program costs averaging between $7.6 million and $51 million dollars, 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 6-7**
**Achievable Potentials for Natural-Gas Behavioral Conservation**

| Result | Scenario | | |
|---|---|---|---|
| | Low<br>Large Users Only | Medium<br>Lrg-Med Users | High<br>All Customers |
| **Gross Energy Savings - Millions of Dth** | 0.46 | 1.29 | 1.90 |
| **Net Energy Savings - Millions of Dth** | 0.46 | 1.29 | 1.90 |
| **Program Costs - Real, $ Million** | | | |
| **Administration** | $0.1 | $0.4 | $0.8 |
| **Marketing** | $7.4 | $28.6 | $50.5 |
| **Incentives** | $0.0 | $0.0 | $0.0 |
| **Total** | $7.6 | $29.0 | $51.0 |
| **PV Net Avoided Costs** | $25.0 | $70.5 | $104.1 |
| **PV Annual Marketing and Admin Costs** | $5.6 | $21.3 | $37.4 |
| **PV Measure Costs** | $0.0 | $0.0 | $0.0 |
| **TRC Ratio** | 4.4 | 3.3 | 2.8 |

PV (present value) of benefits and costs is calculated over a 20-year normalized measure life for 2010-2020 program years, nominal discount rate = 7.7 percent, inflation rate = 1.5 percent; Dth savings are cumulative through 2020.

## 6.4 Alternate High Avoided Cost Scenario

As indicated in section 3 above, we tested the sensitivity of the energy-efficiency potential analysis to increases in avoided costs by running a high avoided-cost scenario where natural gas avoided costs are about 40 percent higher than for the base scenario. In this section, we present a comparison of potentials between the base-cost scenario and the high-cost scenario. Economic potentials are compared first, followed by a comparison of achievable potentials.

### 6.4.1 Economic Potentials

Figure 6-21 compares economic potentials for the high avoided cost scenario against the base scenario. As shown, potentials increase by about 6 percent in the high-cost scenario, which is higher than the change in electric potentials but still fairly modest given the large assumed energy cost increases. Similar to the electric analysis, economic potentials don’t change substantially because many of the measures studied were already cost effective in the base cost scenario.

**Figure 6-21**
**Economic Gas Potentials by Avoided-Cost Scenario (2020)**

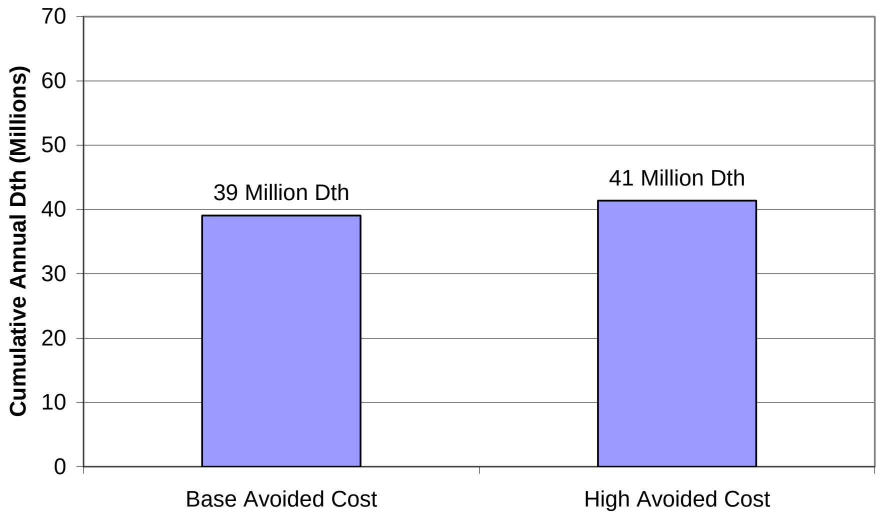



Figure 6-22 shows how economic potentials vary by sector for the two cost scenarios. The increase in economic potential with higher avoided costs is reflected mainly in the residential, which is the sector that accounts for most on the gas savings potentials in both scenarios.

**Figure 6-22**
**Economic Potential Comparison (2020)**
**Energy Savings by Sector—Million Dth per Year**

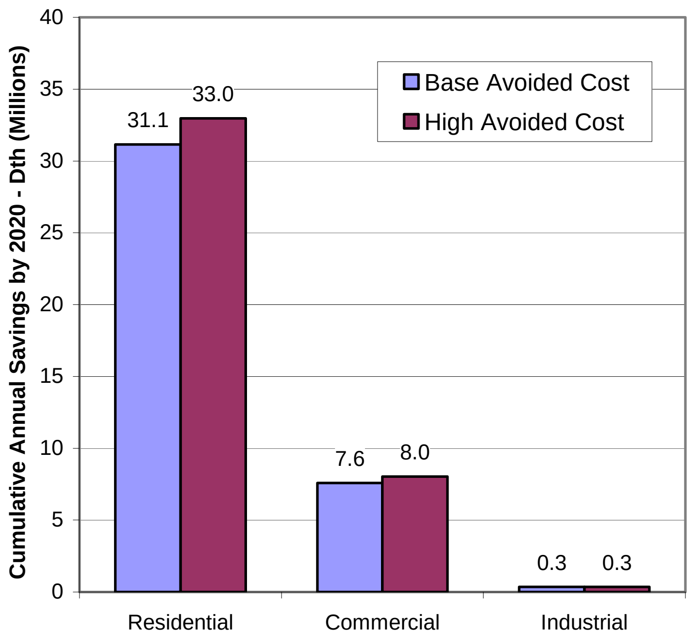



Figure 6-23 shows how residential economic potentials vary across the cost scenarios by end use. Most of the change in savings potential is reflected in the space heating end use and in the whole-building/new construction segment, with very modest changes in the water heating and cooking end uses.

For the commercial sector (see Figure 6-24) economic potential increases in the high-cost scenario for all end uses, but the increase is most pronounced in the space heating end use.

**Figure 6-23**
**Residential Economic Potential (2020)**
**Energy Savings by End Use—Millions of Dth per Year**

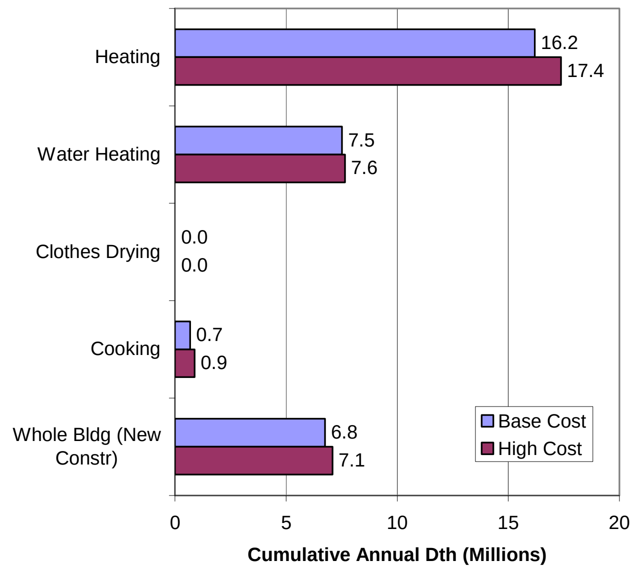
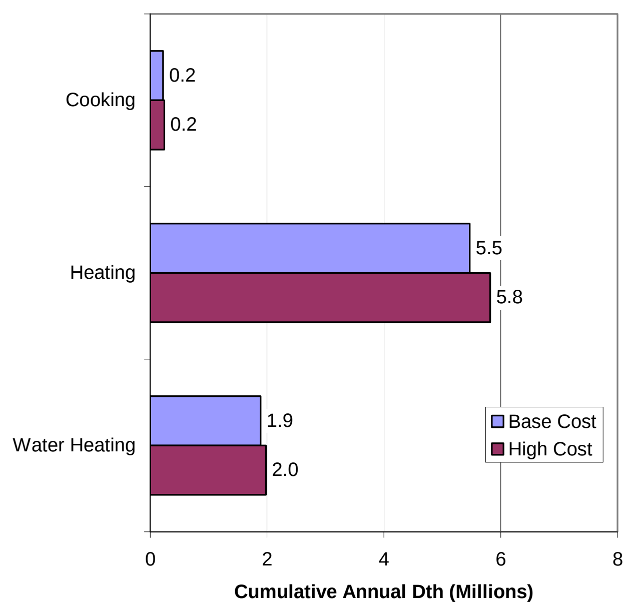



**Figure 6-24**
**Commercial Economic Potential (2020)**
**Energy Savings by End Use—Millions of Dth per Year**



## 6.4.2 Achievable Potentials

Table 6-8 compares base and high-cost achievable potential estimates for the 2010-2020 time period by sector and program scenario. As the table shows, naturally occurring efficiency increases by about 30 percent with the higher energy costs as more customers would be willing to install energy efficiency measures and decrease their electric bill, even without Xcel Energy-provided incentives. Achievable potentials also increase for all the program scenarios, as more measures are cost effective with higher avoided costs, and it becomes easier for Xcel Energy to market and promote energy saving equipment with when customers see higher rates.

**Table 6-8**
**Comparison of Achievable Energy Potentials for Base and High Avoided Cost Scenarios Cumulative to 2020 – Millions of Dth**

| Sector | Program Scenario | Cost Scenario | | Percent Change |
|---|---|---|---|---|
| | | Base | High | |
| Residential | 50% Incentive | 3.299 | 4.467 | 35% |
| | 75% Incentive | 6.975 | 8.934 | 28% |
| | 100% Incentive | 20.493 | 21.854 | 7% |
| | Naturally Occurring | 0.468 | 0.745 | 59% |
| Commercial | 50% Incentive | 1.131 | 1.253 | 11% |
| | 75% Incentive | 1.977 | 2.197 | 11% |
| | 100% Incentive | 3.739 | 3.831 | 2% |
| | Naturally Occurring | 1.082 | 1.277 | 18% |
| Industrial | 50% Incentive | 0.052 | 0.060 | 16% |
| | 75% Incentive | 0.087 | 0.094 | 8% |
| | 100% Incentive | 0.136 | 0.138 | 1% |
| | Naturally Occurring | 0.035 | 0.046 | 32% |
| Total | 50% Incentive | 4.483 | 5.781 | 29% |
| | 75% Incentive | 9.039 | 11.224 | 24% |
| | 100% Incentive | 24.369 | 25.823 | 6% |
| | Naturally Occurring | 1.585 | 2.068 | 30% |

# 7. Demand Response Potential Results

To estimate demand response (DR) impacts, we reviewed impacts from the Federal Energy Regulatory Commission's (FERC's) *2009 National Assessment of Demand Response Potential*[11] for the state of Colorado and customized the results to the Xcel Energy Colorado service territory, utilizing information on Xcel Energy's peak demand relative to the Colorado peak demand and information on current programs being run by Xcel Energy.

The national study utilized a model that implemented a bottom-up approach to estimate DR resources. This model utilized estimated 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 were 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.
- 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 Colorado analysis, we looked at only the business-as-usual and expanded-business-as-usual scenarios. Xcel Energy is still evaluating plans for full scale deployment of AMI. Without AMI, the dynamic pricing programs are not feasible, and dynamic pricing impacts are the key differences between the business-as-usual scenarios and the achievable and full participation scenarios. If at some future date, Xcel Energy decides to pursue AMI, then the establishment of a dynamic pricing program could lead to significant increases in demand response potential.

Xcel Energy currently runs 3 major DR programs: a residential direct load control program, a non-residential direct load control program, targeted to medium-sized customers, that is contracted out to a

[11] *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

third party implementer, and an interruptible tariff program that is targeted at large customers. The residential direct load control program is currently saving about 101 MW per year and could be expanded to about 211 MW per year if Xcel Energy can capture about 50 percent of the residential central air conditioning market. The nonresidential direct load control program is currently savings about 20 MW per year and is in the process of being expanded to 40 MW. Xcel Energy does not see much added potential for expanding the program further. The interruptible tariff program is currently savings about 179 MW per year, and Xcel Energy believes it can expand this program to about 227 MW per year.

Table 7-1 summarizes the DR potential estimates for the Xcel Energy service territory, as compared to the National Assessment of Demand Response Potentials for Colorado.

**Table 7-1**
**Comparison of National Assessment of Demand Response Potentials for Colorado with Estimates for Xcel Energy (Cumulative to 2020)**

| Customer Type | DR Type | Business as Usual (BAU) | | | Expanded BAU | | |
|---|---|---|---|---|---|---|---|
| | | Colorado* | Xcel Energy | % Xcel Energy | Colorado* | Xcel Energy | % Xcel Energy |
| Residential | Pricing With Enabling Technology | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Pricing Without Enabling Technology | 0.0 | 0.0 | - | 14.6 | 0.0 | 0% |
| | Automated or Direct Control DR | 113.9 | 101.0 | 89% | 144.6 | 211.0 | 146% |
| | Interruptible Tariffs | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Other DR | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Total Residential | 113.9 | 101.0 | 89% | 159.2 | 211.0 | 133% |
| Small C/I | Pricing With Enabling Technology | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Pricing Without Enabling Technology | 0.5 | 0.5 | 100% | 0.5 | 0.5 | 100% |
| | Automated or Direct Control DR | 1.0 | 0.0 | 0% | 6.6 | 0.0 | 0% |
| | Interruptible Tariffs | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Other DR | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Total Small C/I | 1.5 | 0.5 | 33% | 7.1 | 0.5 | 7% |
| Medium C/I | Pricing With Enabling Technology | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Pricing Without Enabling Technology | 0.0 | 0.0 | - | 8.0 | 0.0 | 0% |
| | Automated or Direct Control DR | 177.4 | 20.0 | 11% | 177.4 | 40.0 | 23% |
| | Interruptible Tariffs | 0.0 | 0.0 | - | 51.9 | 0.0 | 0% |
| | Other DR | 0.0 | 0.0 | - | 0.2 | 0.0 | 0% |
| | Total Medium C/I | 177.4 | 20.0 | 11% | 237.5 | 40.0 | 17% |
| Large C/I | Pricing With Enabling Technology | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Pricing Without Enabling Technology | 11.3 | 0.0 | 0% | 11.3 | 0.0 | 0% |
| | Automated or Direct Control DR | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Interruptible Tariffs | 103.6 | 179.0 | 173% | 103.6 | 229.0 | 221% |
| | Other DR | 20.0 | 0.0 | 0% | 140.2 | 0.0 | 0% |
| | Total Large C/I | 134.9 | 179.0 | 133% | 255.1 | 229.0 | 90% |
| Total | Pricing With Enabling Technology | 0.0 | 0.0 | - | 0.0 | 0.0 | - |
| | Pricing Without Enabling Technology | 11.8 | 0.5 | 4% | 34.4 | 0.5 | 1% |
| | Automated or Direct Control DR | 292.3 | 121.0 | 41% | 328.6 | 251.0 | 76% |
| | Interruptible Tariffs | 103.6 | 179.0 | 173% | 155.5 | 229.0 | 147% |
| | Other DR | 20.0 | 0.0 | 0% | 140.4 | 0.0 | 0% |
| | Total | 427.7 | 300.5 | 70% | 658.9 | 480.5 | 73% |
| Total | Base Peak Demand | 13,200.0 | 6,678.2 | 51% | 13,200.0 | 6,678.2 | 51% |

* Colorado estimates from the FERC study run through the year 2019, while the Xcel Energy estimates go to 2020.

Table 7-1shows that, overall, Xcel Energy could capture about 70 percent of the Colorado potential, as estimated in the FERC study, under the business-as-usual scenario (300.5 MW for Xcel Energy versus 427.7 MW for the state) and about 73 percent of the Colorado potential under the expanded business-as-usual scenario (480.5 MW for Xcel Energy versus 658.9 MW for the state). These Xcel Energy potentials are fairly aggressive, given that Xcel Energy's retail peak demand is expected to be about 51 percent of the state's peak demand in 2020. The table also points out some categorization issues associated with the National Assessment. In particular, the large potentials associated with the Medium C/I (commercial/industrial) Direct Control category may actually reflect savings for the Large C/I interruptible tariff category. Finally, the table shows about 0.5 MW of impacts in the Small C/I pricing category that is associated with a small Xcel Energy commercial pricing pilot study that is not expected to expand.

Table 7-2 summarizes the estimates of demand response potentials and associated program costs for the main Xcel Energy programs. Total savings are estimated at 300 MW for business-as-usual, increasing to 478 MW for the expanded scenario. Total program costs are estimated to be $343 million ($31 million per year) for the business-as-usual scenario and $535 million ($49 million per year) for the expanded scenario. Both scenarios are cost effective, based on the TRC test.

**Table 7-2**
**Summary of Demand Response Potentials for (2010-2020)**

| | Scenario | |
|---|---|---|
| **Result** | **Business-as-Usual (BAU)** | **Expanded BAU** |
| **Net Peak Demand Savings - MW** | 300 | 478 |
| | | |
| **Program Costs - Real, $ Million** | | |
| **Administration** | $14 | $20 |
| **Marketing** | $13 | $19 |
| **Third-Party** | $16 | $32 |
| **Incentives** | $300 | $464 |
| **Total** | $343 | $535 |
| | | |
| **PV Avoided Cost Benefits** | $494 | $646 |
| **PV Mkt, Admin, and 3rd Party Costs** | $30 | $49 |
| **PV Net Equipment Costs** | $44 | $65 |
| **TRC Ratio** | 6.7 | 5.7 |

PV (present value) of benefits and costs is calculated using a nominal discount rate = 7.9 percent, inflation rate = 1.5 percent; MW savings are cumulative through 2020.