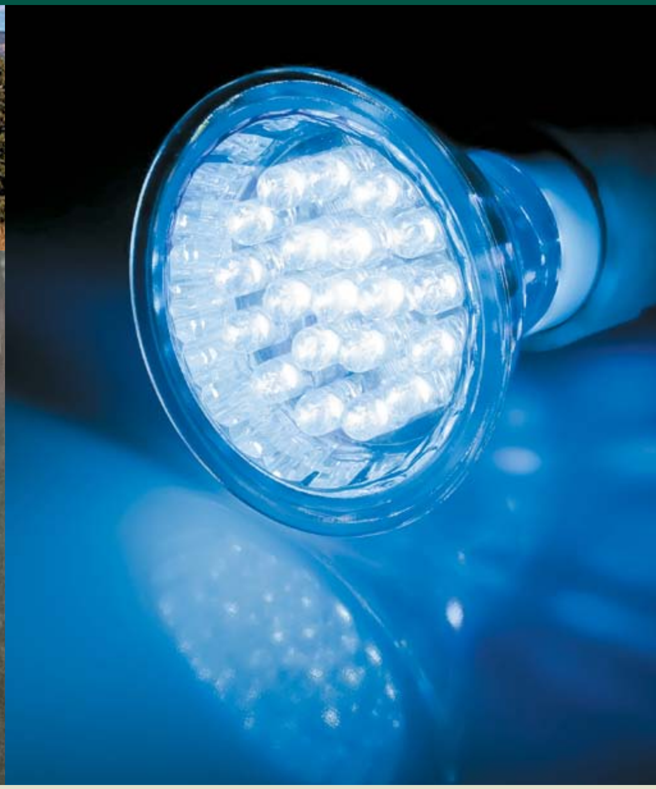
# THE $20 BILLION BONANZA

*Best Practice Electric Utility Energy Efficiency Programs and Their Benefits for the Southwest*




**HOWARD GELLER**

*With assistance from:*

*Bruce Biewald, Marshall Goldberg, Steven Nadel, Maggie Molina, Max Neubauer, Jeff Schlegel, Rachel Wilson and David White*



SWEEP

Southwest Energy Efficiency Project

*OCTOBER 2012*

*By investing a total of $17 billion in best practice utility energy efficiency programs, the Southwest region could realize $37 billion in utility system and public health benefits - meaning $20 billion in net benefits or $2,650 for every household in the region today.*

# The $20 Billion Bonanza:

## Best Practice Electric Utility Energy Efficiency Programs and Their Benefits for the Southwest

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## Acknowledgements

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SWEEP is solely responsible for the contents of the report.



The Southwest Energy Efficiency Project is a public interest organization dedicated to advancing energy efficiency in Arizona, Colorado, Nevada, New Mexico, Utah, Wyoming. For more information, visit www.swenergy.org.

SWEEP

2334 North Broadway, Suite A • Boulder, CO 80304 • 303-447-0078 • www.swenergy.org

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## Executive Summary

### A. Introduction

While significant progress has been made in ramping up utility energy efficiency programs in the Southwest region, much more could be done. The purpose of this study is to examine utility energy efficiency program "Best Practices" and the benefits that would result across the region from scaling up to Best Practice programs. We develop a comprehensive set of eighteen Best Practice utility energy efficiency programs based on experience in the region as well as elsewhere in the country. We analyze  how much it would cost and how much energy and peak demand savings would result by 2020 from scaling up to Best Practice programs in each state, compared to a Reference scenario without utility energy efficiency programs.

We then model utility systems and analyze the economic savings that would result from implementing Best Practice energy efficiency programs. We also analyze of the impact that Best Practice utility energy efficiency programs would have on jobs, personal income and economic output in each state and across the region. In addition, we estimate the water savings and reductions in pollutant emissions that would result from implementing Best Practice energy efficiency programs, along with the public health benefits that would occur as a result of the reduced pollutant emissions. Finally, we review the policy and program framework affecting utility energy efficiency programs in each state and recommend additional policies that would help to move each state towards Best Practice programs and their benefits.

The results of the analysis are impressive. By investing $17.3 billion in Best Practice energy efficiency programs and measured during 2010-2020, we estimate that the southwest region could realize $37.1 billion in utility system and public health benefits — nearly $20 billion in net benefits. In addition, we estimate that 10,100 jobs would be added in the region by 2015 and 28,000 jobs would be added by 2020, and that significant air quality improvements and water savings would result. By implementing Best Practice energy efficiency programs, utilities can share in these benefits while reducing the risks associated with higher load growth. It's a bonanza the Southwest cannot afford to ignore.

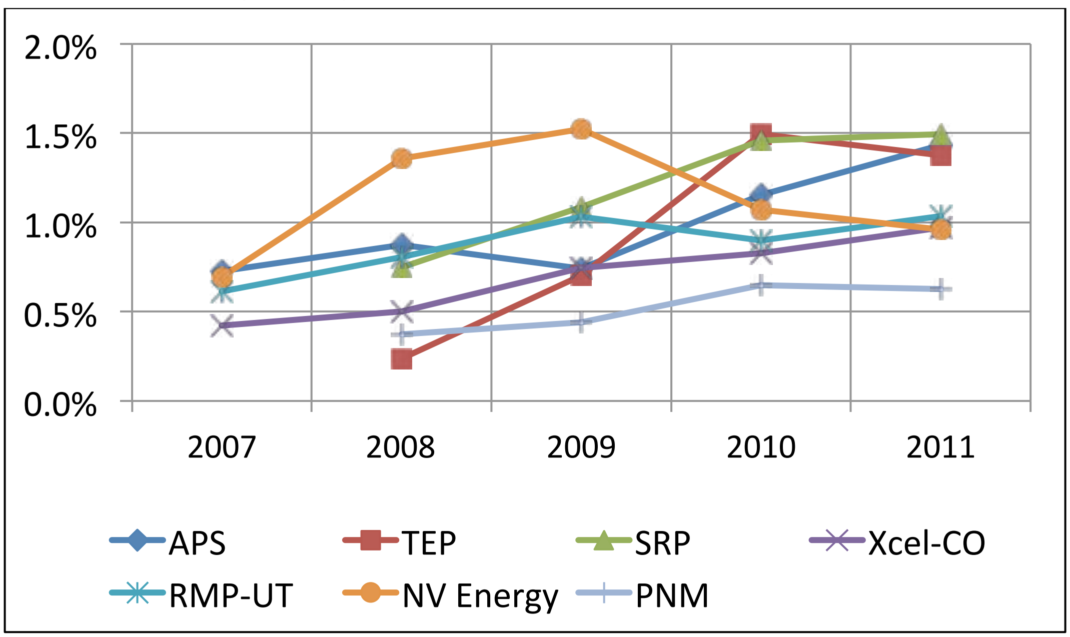
### B. Historical Review

Electric utilities in the Southwest (Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming) have greatly expanded their energy efficiency and other demand-side management (DSM) programs over the past decade. Total funding for these programs was only about $29 million in 2002, the first full year of activity for the Southwest Energy Efficiency Project (SWEEP). Funding steadily increased to approximately $318 million in 2011. In 2012, electric utilities in the region will spend about $370 million on DSM programs. Approximately 80% of the total amount spent on DSM goes to programs that have a primary goal of reducing electricity use; i.e., true energy efficiency programs. The remainder is spent on load management and demand response programs.

In conjunction with rising DSM budgets, there has been significant growth in the energy savings resulting from electric utility energy efficiency programs implemented in the Southwest in recent years. The seven major utilities in the region — Arizona Public Service Co. (APS), Tucson Electric Power Co. (TEP), Salt River Project (SRP), Xcel Energy in Colorado (Xcel-CO), Rocky Mountain Power in Utah (RMP-UT), NV Energy, and Public Service Company of New Mexico (PNM) — saved about 1,700 GWh per year from energy efficiency programs implemented in 2011. These seven utilities account for about 67% of total electricity sales and consumption in the region.

Figure ES-1 shows the energy savings by major utility as a fraction of retail electricity sales from programs implemented each year. As of 2011, the three Arizona utilities were achieving 1.4-1.5% savings as a fraction of sales; the main utilities in Colorado, Nevada and Utah were achieving around 1.0% savings; and PNM was lagging in achieving only about 0.6% savings. Saving 1.4-1.5% per year places the Arizona utilities in the top tier of utilities nationwide with respect to energy efficiency program performance.

**Figure ES-1. First Year Energy Savings as a Fraction of Retail Electricity Sales**




Utilities in the Southwest are realizing substantial benefits for their customers and for their systems by implementing effective energy efficiency programs. For example, Xcel Energy, the principal electric utility in Colorado, estimates that households and businesses it serves will save $638 million net as a result of DSM programs implemented in 2009-2011. (Net means the value energy savings minus the cost of efficiency measures and programs.) Likewise, NV Energy, the parent company of Nevada Power and Sierra Pacific Power Companies, estimates that its customers will realize $470 million in net economic benefits as a result of DSM programs implemented during 2007-2011. The programs also help utilities to reduce water consumption and cut emissions.

## C. Best Practice Energy Efficiency Programs

Each state analysis includes a Reference scenario for electricity sales and peak demand through 2020. The Reference scenario excludes the impacts of all utility energy efficiency programs, even those programs underway or planned by utilities. The analysis was structured in this manner in order to avoid double counting of savings in the High Efficiency scenario and to evaluate the full costs and benefits of utility energy efficiency programs — both existing and expanded programs — through 2020.

Our portfolio of model energy efficiency programs includes a comprehensive set of strategies for residential, commercial and industrial customers based on Best Practice program offerings from leading utilities and other program administrators in the Southwest and elsewhere. The programs were selected to maximize cost-effective energy savings by 2020. We develop ten residential programs and eight business programs, briefly described below and discussed in much greater detail in Chapter 2. For the purposes of this study, we do not include load management or demand response programs which are aimed primarily at peak demand reduction.

### Residential Programs

#### *1. Low-Income Weatherization*

This program provides weatherization services, efficient appliance upgrades, and energy savings kits to income-qualified households on a no-cost basis. The program is administered by local community action agencies or state agencies and leverages funds from the federal government. Utilities pay 10-20% of the cost for home retrofits; the remainder is paid for through the funding that states receive from the federal Weatherization Assistance Program.

#### *2. Multi-Family Retrofit*

This program provides retrofit services for multifamily buildings. Services include initial energy assessments, education on energy savings opportunities, direct installation of low-cost measures, and the opportunity to install major measures at a reduced cost.

#### *3. Residential New Construction and Code Support*

This program offers training and financial incentives to builders who construct energy-efficient new homes. The program emphasizes the whole building approach to improving energy efficiency and includes field testing of homes to ensure high performance. Builders and contractors receive training on building science and energy-efficient construction techniques, while prospective homebuyers are educated about the benefits of an energy-efficient home. Additionally, the program trains builders, contractors and local code officials on building energy codes in order to improve code enforcement and compliance.

#### *4. Home Retrofit*

This program provides incentives and high quality retrofit services to owners of single family houses or manufactured houses, promoting both "light" and "comprehensive" retrofits. A light retrofit includes lighting measures, low-flow devices, and home-envelope air sealing. A comprehensive retrofit includes replacing appliances (clothes washers, dishwashers, water heaters, and refrigerators/freezers), shell measures (insulation, home-envelope air sealing, and window replacement), and HVAC measures (AC tune-up, replacement, duct sealing and insulation).

***5. Retail Products***

This program provides midstream and upstream incentives to retailers and manufacturers for increasing sales of qualifying ENERGY STAR products including televisions, personal computers, laptops, computer monitors, clothes washers, dishwashers, refrigerators, room air conditioners, and high-efficiency pool pumps and timers. Other electronic products such as set-top boxes and game consoles may be included in the future.

***6. Residential Lighting***

This program provides education and financial incentives to encourage customers to purchase energy-efficient light bulbs, including standard and specialty CFLs and LED lamps, as well as services to assist consumers to dispose of CFLs in an environmentally friendly manner. Customers purchase energy-efficient lamps at a discount at local retailers or through mail-order sales.

***7. Refrigerator and Freezer Recycling***

This program takes less-efficient refrigerators and freezers out of use and recycles materials to the maximum degree feasible. The program is implemented on a turn-key basis by a qualified contractor.

***8. Residential Cooling***

This program provides incentives for the purchase, installation, and proper sizing of evaporative cooling equipment and high-efficiency compressor-based air conditioning equipment. Incentives are provided to both end-use customers and the contractors who install the equipment. The program also includes a tune-up component for existing central air conditioners.

***9. Water Heating***

This program encourages customers to purchase ENERGY STAR-qualified electric heat-pump water heaters and promotes greater adoption of low-flow showerheads and faucet aerators by households with electric water heating.

***10. Home Energy Reports and Information Feedback***

This program helps customers cut electricity waste by providing comparative reports through the mail and/or internet as well as suggested actions that each household can take to reduce its electricity use. The program also includes promotion of, and incentives for, in-home information feedback devices, particularly in the latter part of the decade when smart meters are likely to be commonplace.

**Commercial and Industrial Programs**

***1. Commercial New Construction and Code Support***

This program includes design assistance and incentives for energy-saving measures that exceed building code requirements for new commercial buildings. The program also promotes upgrades to state or local building energy codes and training to strengthen code enforcement and compliance.

***2. Small Business Direct Install***

This program hires contractors to audit smaller commercial buildings and then install cost-effective measures at a modest cost to the customer. The utility would pay about 70% of the installed cost for qualifying efficiency measures. Customers would pay the remainder, and would also be given a financing option for their share of the installed cost.

***3. Prescriptive Rebates and Upstream Incentives***

This program provides rebates to medium-size and larger businesses that purchase and install high efficiency lighting, air conditioning, motors, and other commonplace energy efficiency measures. Both new and existing buildings would be eligible. The program also provides upstream incentives to equipment distributors who increase their stock of high efficiency motors and AC equipment.

***4. Custom Retrofits, Process Efficiency, and Self-Direct***

This program provides technical assistance and incentives to large businesses for specialized projects requiring project-specific energy savings analysis. The program also promotes continuous energy improvement in order to promote deep and ongoing energy savings. In addition, large customers would be given a "self-direct" option involving utility bill credits against the company's energy efficiency programs surcharge rather than rebates. In this option, the customer is responsible for providing engineering work as well as documenting energy savings.

***5. Computer Efficiency and Other Plug Loads***

This program provides upstream incentives to computer and server manufacturers that produce and sell higher efficiency personal computers, monitors and servers to businesses. It also provides direct rebates to businesses that implement virtualization of their desktop computers.

***6. Commercial Lighting Redesign***

This program provides financial incentives to either building owners, property managers or tenants based on the amount of electricity saved from redesigning lighting systems at the time commercial space is remodeled and/or taken over by a new tenant. The redesign can include use of better light fixtures, appropriate lighting levels, use of task lighting, and better lighting controls.

***7. Retrocommissioning***

This program provides a free analysis of what can be done to increase the energy efficiency of existing equipment and systems through low-cost adjustments, followed by implementation of measures with relatively short payback periods. In effect, this program helps building owners and managers "tune-up" existing buildings.

### *8. Combined Heat and Power*

This program provides incentives to customers who install on-site combined heat and power (CHP) systems that generate electricity and utilize waste heat for space and/or water heating or industrial process needs. Eligible CHP systems could run on natural gas or waste materials, waste heat, or excess pressure.

## D. Program Analysis

For each program, we develop forecasts for the number of eligible customers statewide and then estimate participation rates based on Best Practice programs in the Southwest and elsewhere. Energy savings and peak demand impacts per participant are similarly estimated from Best Practice utility-specific programs as well as studies regarding different types of utility efficiency programs. Program costs and customer costs are estimated per participant or per first-year kWh saved, again based on specific programs in the region or Best Practice programs elsewhere in the country. Sources for all of these assumptions are provided in Chapter 2 and Appendix A.

Using the energy savings and cost estimates, we then analyze the cost-effectiveness of each program over the program time horizon. Estimates of gross program savings are based on a wide variety of sources from regional and national Best Practice programs. The net savings are calculated based on an assumed net-to-gross ratio for each program, which we estimate based on typical program assumptions and hold constant across all states. Like the energy savings estimates, cost estimates are drawn from a wide variety of regional and national Best Practice programs. For determining cost of saved energy and net present values of costs and benefits, we assume a 5% real discount rate. All costs and benefits are expressed in 2010 dollars.

Based on these detailed assumptions, we calculate an average cost of saved energy for each program. The cost of saved energy for residential programs ranges from $0.02 - $0.09 per kWh, with an overall average (weighted by energy saved) of $0.036/kWh. The cost of saved energy for commercial and industrial programs ranges from $0.01 - $0.05 per kWh, with an overall average of $0.022/kWh. These values are from the utility perspective; i.e., they do not include participant costs. Consistent with experience nationwide, we find that energy efficiency programs are the lowest cost utility resource by far.

Tables ES-1 and ES-2 provide the estimated electricity and peak demand impacts of implementing the Best Practice programs in each state. The savings are a result of programs implemented during 2010-2020, with savings in 2010 and 2011 based on actual utility efforts in those years. After 2011, we assume programs are expanded over time at a relatively rapid pace. Based on our assumptions, the total electricity savings in the High Efficiency scenario reach about 49,800 GWh per year in 2020. This is equivalent to the electricity use of 4.6 million typical households in the region.

The energy savings in 2020 equal or exceed 20% of sales that year in the High Efficiency scenario in all states other than Wyoming. For the region as a whole, the Best Practice programs result in 21% electricity savings and an 18% peak demand reduction by 2020, relative to projected electricity sales and peak demand that year in the High Efficiency scenario. Savings are lower on a percentage basis in Wyoming in large part because utility energy efficiency programs in Wyoming were further behind those in other states as of 2010-12.

Achieving 20% or greater savings by 2020 is consistent with the energy savings requirements adopted by the Arizona Corporation Commission for investor-owned electric utilities in the state. It is also consistent with savings standards or targets adopted in Delaware, Maryland, Massachusetts, New Jersey, New York, Rhode Island and Vermont.

For the region as a whole, commercial and industrial programs provide 64% of the total energy savings in 2020, while residential programs provide 36% of savings. In the residential sector, lighting and home energy reports/information feedback are the single largest sources of energy savings in 2020. In the commercial and industrial sectors, prescriptive and custom rebate programs provide the most energy savings in 2020. However, all of the programs are needed to achieve the substantial energy savings represented by the High Efficiency scenario.

**Table ES-1. Total Annual Electricity Savings by State in the High Efficiency Scenario (GWh)**

| State | Electricity Savings in 2010 | Electricity Savings in 2015 | Electricity Savings in 2020 | Projected Electricity Sales in 2020 | Savings in 2020 as % of 2020 Sales |
|---|---|---|---|---|---|
| Arizona | 695 | 6,059 | 16,713 | 78,111 | 21% |
| Colorado | 285 | 4,373 | 11,495 | 51,538 | 22% |
| Nevada | 304 | 2,722 | 7,040 | 31,321 | 22% |
| New Mexico | 87 | 1,863 | 5,110 | 21,370 | 24% |
| Utah | 194 | 2,455 | 6,234 | 30,757 | 20% |
| Wyoming | 17 | 1,143 | 3,238 | 20,771 | 15% |
| **Total Regional Savings** | **1,582** | **18,615** | **49,828** | **234,469** | **21%** |
| Reference scenario electricity use* | 227,109 | 254,642 | 284,298 | 284,298 | NA |
| High Efficiency scenario electricity use* | 227,109 | 236,027 | 234,469 | 234,469 | NA |

**2010 sales are adjusted for savings generated by programs in the 2010 program year, so the sales in the Reference and High Efficiency scenarios are the same for 2010.*

Table ES-2. Total Annual Peak Demand Reduction by State in the High Efficiency Scenario (MW)

| State | Peak Demand Savings in 2010 | Peak Demand Savings in 2015 | Peak Demand Savings in 2020 | Peak Demand in 2020 | Savings in 2020 as % of Demand |
|---|---|---|---|---|---|
| Arizona | 111 | 1,183 | 3,239 | 21,486 | 15% |
| Colorado | 52 | 861 | 2,213 | 11,020 | 20% |
| Nevada | 53 | 645 | 1,745 | 8,096 | 21% |
| New Mexico | 10 | 351 | 973 | 4,719 | 20% |
| Utah | 29 | 450 | 1,144 | 6,312 | 18% |
| Wyoming | 1 | 132 | 367 | 2,561 | 14% |
| **Total Regional Savings** | **257** | **3,622** | **9,681** | **54,194** | **18%** |
| Reference scenario peak demand* | 52,009 | 57,651 | 63,875 | 63,875 | NA |
| High Efficiency scenario peak demand* | 52,009 | 54,029 | 54,194 | 54,194 | NA |
| **2010 peak load requirements are adjusted for savings generated by efficiency programs in the 2010 program year, so the peak load requirements in the Reference and High Efficiency scenarios are the same for 2010.* | | | | | |

Table ES-3 shows the estimated utility program costs by state in the High Efficiency scenario. A rapid and large increase in program funding is required to achieve 21% energy savings region wide by 2020. Annual utility program costs increase to about $1.1 billion in 2015 and nearly $1.8 billion in 2020 in the High Efficiency scenario. These are large values but not impossible to envision given that electric utilities in the region had $20 billion in revenues from retail electricity sales as of 2010, and revenues are rising due to rate increases and other factors. Also, it is worth noting that southwest states demonstrated the ability to rapidly expand certain types of energy efficiency programs when funding was provided through the American Recovery and Reinvestment Act of 2009 (ARRA).

Table ES-3. Program Costs by State (Million dollars)

| State | Annual Cost 2010 | Annual Cost 2015 | Annual Cost 2020 | Net Present Value through 2020 |
|---|---|---|---|---|
| Arizona | 54 | 377 | 623 | 2,767 |
| Colorado | 43 | 257 | 404 | 1,918 |
| Nevada | 29 | 152 | 248 | 1,137 |
| New Mexico | 15 | 121 | 191 | 877 |
| Utah | 40 | 138 | 214 | 1,052 |
| Wyoming | 4 | 71 | 101 | 480 |
| **Total Regional Costs** | **185** | **1,116** | **1,780** | **8,230** |

Table ES-4. Program Plus Participant Costs by State (million dollars)

| State | Annual Cost 2010 | Annual Cost 2015 | Annual Cost 2020 | Annual Cost 2025 | Annual Cost 2030 | Net Present Value through 2030 |
|---|---|---|---|---|---|---|
| Arizona | 77 | 642 | 1,077 | 142 | 301 | 5,459 |
| Colorado | 89 | 464 | 749 | 80 | 215 | 4,104 |
| Nevada | 81 | 274 | 464 | 351 | 123 | 2,590 |
| New Mexico | 25 | 221 | 361 | 26 | 103 | 1,854 |
| Utah | 65 | 250 | 402 | 49 | 122 | 2,241 |
| Wyoming | 6 | 143 | 211 | 11 | 78 | 1,107 |
| **Total Regional Costs** | **343** | **1,994** | **3,264** | **625** | **945** | **17,343** |

It should be recognized that utility energy efficiency programs are evolving and that "Best Practices" change over time. This means that there is likely to be additional cost-effective savings potential later in the decade that has not been accounted for in this analysis.

## E. Utility System Impacts, Net Economic Benefits and Avoided Emissions

**Methodology**

We created a model for calculating avoided electricity costs at the state level in moving from the Reference Scenario to the High Efficiency Scenario. The model begins with an analysis of actual electricity generation and cost data for a base year, and then develops a plan for meeting projected electricity demand each year in the two scenarios. The difference in costs between the plans represents the avoided costs (i.e., the utility system benefits) for the High Efficiency scenario. The utility system modeling extends through 2030 in order to capture the full benefits of utility efficiency programs implemented during 2010-2020.

Detailed assumptions regarding capital costs for different types of power plants, fuel cost assumptions, operating cost assumptions, avoided transmission and distribution costs, and other key values are provided in Chapter 3. Fuel costs for electric generation are based on the Annual Energy Outlook 2012 Early Release forecast prepared by the U.S. DOE Energy Information Administration.

The U.S. Environmental Protection Agency (EPA) has promulgated, or is in the process of promulgating, new pollution standards that are affecting utilities nationwide. Utilities are determining whether to retrofit older coal-fired power plants with necessary pollution control technologies, or to retire these units. Numerous coal plant retirements have already been announced by utilities in the Southwest, and those retirements are included in both the Reference and High Efficiency scenarios. Announced coal plant retirements in the region total approximately 1,911 MW.

In addition to these retirements, other coal-fired power plant retirements are likely, particularly in a scenario that combines higher levels of energy efficiency with proposed EPA regulations. We assume an additional 4,407 MW of coal capacity would be plausible to retire by 2020 in the High Efficiency scenario and provide a list of the specific units in Chapter 3. The avoided investment in pollution control equipment for these units is quantified and included as one of the benefits in the High Efficiency scenario.

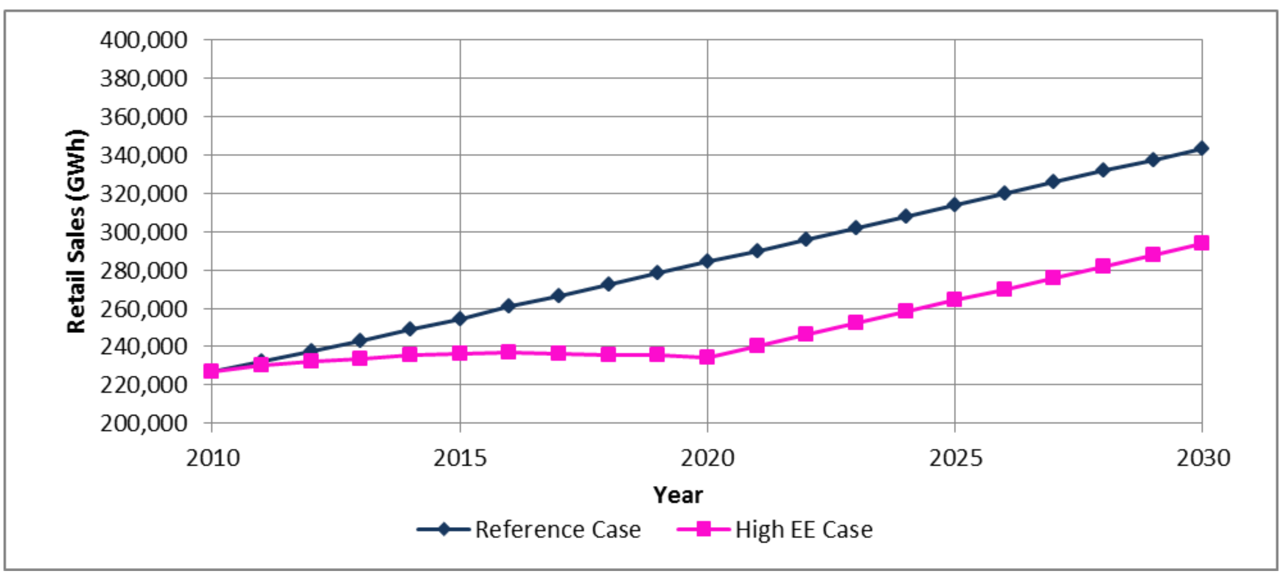
A number of southwest states have adopted renewable energy standards for electric utilities. These standards could be strengthened in the future. However, in this study we assume that existing renewable energy requirements are met but not increased since our objective is to analyze the costs and benefits of higher levels of energy efficiency.

The southwest states presently are net exporters of electricity to other regions. Overall 25% of the electricity that is generated in the Southwest is exported, with most of these exports going to California. In this study, we assume that state electricity imports and exports remain constant at the actual values in 2010.

**Results**

Figure ES-2 shows electricity consumption in the two scenarios through 2030 (excluding out-of-state sales). As noted previously, utility efficiency programs are only considered through 2020, when in reality they will continue beyond this year. Energy savings occurring in 2020 are maintained through customer investment in measure replacement as necessary during 2021-2030.

Figure ES-2. Electricity Sales in the Southwest Region



The generation mix for the Southwest region is currently dominated by coal, which accounted for 58% of the generation mix as of 2010. Natural gas made up 25%, nuclear 10%, and hydro and other renewable technologies accounted for the remaining 7% of generation. Figure ES-3 shows how the generation mix changes over time in the High Efficiency scenario for the region as a whole. The amount of generation and new capacity required is significantly reduced compared to the Reference scenario.

Figure ES-3. Generation Mix in the Region in the High Efficiency Scenario.

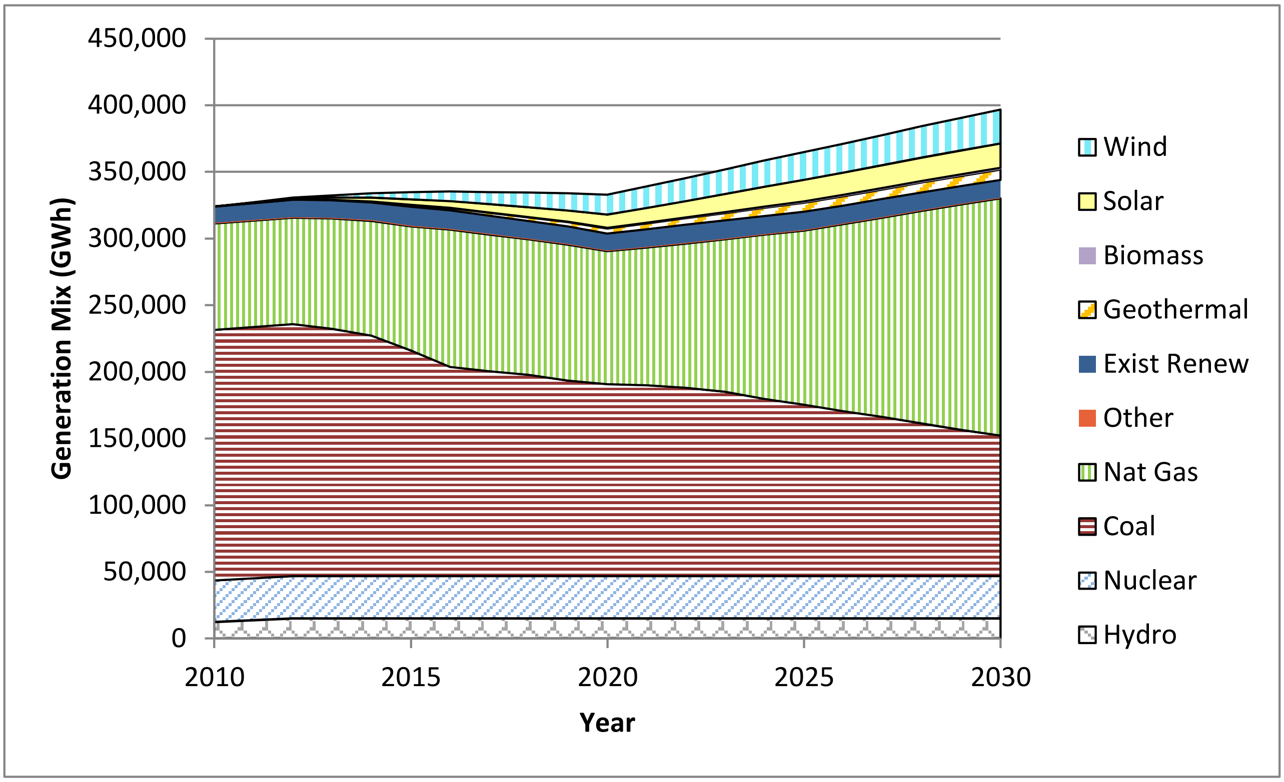



Figure ES-4 shows the avoided capacity in the region associated with the High Efficiency scenario as compared to the Reference scenario. The coal portion represents the retirement of older, dirty power plants described above. Most of the avoided new capacity is natural gas-fired, with almost 8,000 MW of capacity avoided in the High Efficiency scenario. In addition, there is a small amount avoided renewable power development in High Efficiency scenario, relative to the Reference scenario, due to the reduction in electricity demand. However, there is still substantial expansion of renewable energy generation in the High Efficiency scenario as shown in Figure ES-3. Of course renewable energy generation could be expanded further if renewable energy requirements are in fact strengthened. In total, the region could avoid or retire about 32 large (400) MW power plants if the High Efficiency scenario is pursued.

Figure ES-4. Avoided Capacity in the Region in the High Efficiency Scenario

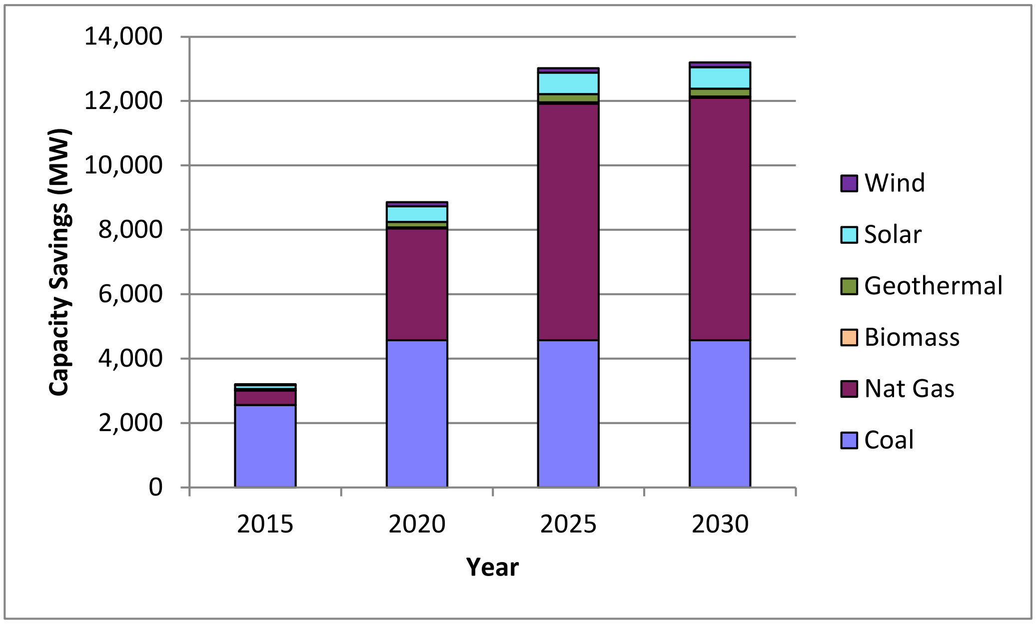



Figure ES-5 shows the avoided utility costs for the region in the High Efficiency scenario, relative to the Reference scenario, on an annual basis. The avoided costs reach about $4 billion per year (in 2010 dollars) in the early part of the next decade. The largest savings are avoided fuel costs and avoided investments in new power plants.

Figure ES-5. Avoided Utility Costs in the Region in the High Efficiency Scenario

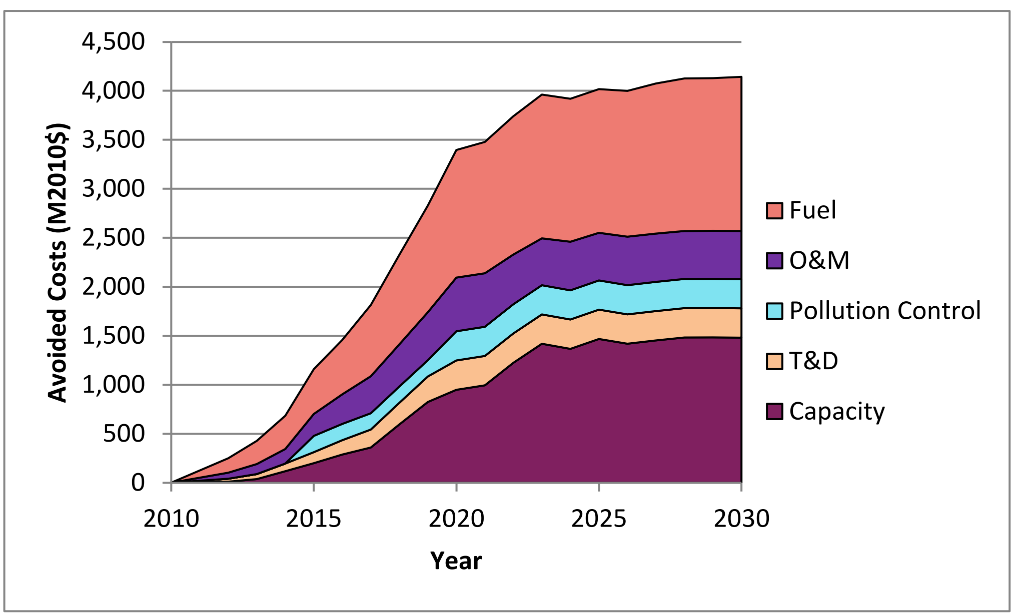


Table ES-5 shows the utility avoided costs and consumer benefits, in net present value terms, for each state and for the region as a whole. The consumer benefits include estimates of the avoided administrative costs, system maintenance costs, and taxes, in addition to the avoided costs shown in Figure ES-5. The consumer benefits also include valuation of public health benefits from reduced air pollutant emissions, as described in the next section. For the region as a whole, we estimate total consumer benefits of $37.2 billion on a net present value basis, compared to energy efficiency program and measure costs of $17.4 billion. This leads to the projected overall benefit-cost ratio of 2.14 and net economic benefits of about $19.8 billion. The benefit-cost ratio across the states rages from about 1.75 in Utah to 2.3 in Arizona and Nevada. The net economic benefits from pursuing the High Efficiency scenario equal about $7.3 billion for Arizona, $4.8 billion for Colorado, $3.4 billion for Nevada, $1.7 billion for New Mexico, $1.7 billion for Utah, and $0.9 billion for Wyoming.

**Table ES-5. Benefit-Cost Comparison by State**

| | **Net Present Value During 2010-2030** (Million 2010 $) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **AZ** | **CO** | **NV** | **NM** | **UT** | **WY** | **Region** |
| ***Utility Avoided Costs*** | | | | | | | |
| Capacity | 3,571 | 2,570 | 944 | 486 | 597 | 153 | 8,320 |
| T&D | 782 | 551 | 417 | 243 | 293 | 95 | 2,380 |
| Pollution Control | 447 | 86 | 417 | 392 | 244 | 497 | 2,084 |
| O&M | 1,112 | 786 | 625 | 567 | 691 | 290 | 4,070 |
| Fuel | 3,717 | 2,718 | 1,960 | 667 | 966 | 538 | 10,566 |
| | | | | | | | |
| ***Consumer Benefits*** | | | | | | | |
| Utility Bill Savings | 12,583 | 8,857 | 5,957 | 3,406 | 3,879 | 1,929 | 36,611 |
| Public Health Benefits | 175 | 51 | 54 | 112 | 52 | 100 | 544 |
| Total | 12,758 | 8,908 | 6,011 | 3,518 | 3,931 | 2,029 | 37,155 |
| | | | | | | | |
| ***Energy Efficiency Costs*** | | | | | | | |
| Utility | 2,767 | 1,918 | 1,137 | 877 | 1,052 | 480 | 8,230 |
| Participant | 2,692 | 2,186 | 1,452 | 977 | 1,189 | 627 | 9,124 |
| Total | 5,459 | 4,104 | 2,590 | 1,854 | 2.241 | 1,107 | 17,354 |
| | | | | | | | |
| ***Net Economic Benefits*** | 7,299 | 4,804 | 3,421 | 1,664 | 1,690 | 922 | 19,801 |
| ***Benefit-Cost Ratio*** | 2.33 | 2.17 | 2.32 | 1.90 | 1.75 | 1.83 | 2.14 |

Table ES-6 shows the avoided $CO_2$, $NO_x$ and $SO_2$ emissions in the High Efficiency scenario in 2020. For the region as a whole, $CO_2$ emissions decline by 15.5%, $NO_x$ emissions by12%, and $SO_2$ emissions by 17% (reductions from projected utility sector emissions in the Reference scenario). The avoided $CO_2$ emissions in the High Efficiency scenario, 31.6 million metric tons per year in 2020, are equivalent to taking over six million passenger vehicles off the road. Clearly, pursuing the High Efficiency scenario would help states meet air quality and greenhouse gas emissions reduction goals. However, the percentage reductions vary considerably among the states depending on the types of power generation avoided, the emissions rates of specific plants, and whether states are net electricity exporters or importers.

Table ES-6 also shows the water savings in 2020 due to reduced operation of power plant cooling systems. In total, the region would save about 18.5 billion gallons of water per year by 2020 through implementing the High Efficiency scenario. Additional water savings would result if utilities promote use of energy and water-saving devices such as resource-efficient clothes washers, dishwashers and low-flow showerheads as part of their efficiency programs.

**Table ES-6. Avoided Pollutant Emissions and Reduced Water Consumption in 2020 in the High Efficiency Scenario**

| | AZ | CO | NV | NM | UT | WY | Region |
|---|---|---|---|---|---|---|---|
| ***Avoided Emissions*** | | | | | | | |
| CO2 (Million metric tons) | 9.6 | 5.4 | 4.4 | 6.2 | 2.4 | 3.5 | 31.6 |
| NOx (thousand metric tons) | 0.85 | 0.70 | 1.76 | 0.98 | 0.83 | 0.34 | 5.46 |
| SO2 (thousand metric tons) | 6.1 | 0.8 | 1.1 | 3.9 | 2.0 | 2.4 | 16.3 |
| CO2 (%) | 17 | 15 | 26 | 22 | 14 | 7 | 15.5 |
| NOx (%) | 10 | 9 | 15 | 18 | 18 | 5 | 12 |
| SO2 (%) | 22.5 | 9 | 43 | 31 | 18 | 7 | 17 |
| ***Reduced Water Consumption*** | | | | | | | |
| Water (billion gallons) | 4.1 | 2.5 | 2.4 | 4.6 | 3.2 | 1.8 | 18.5 |
| Water (%) | 8.0 | 11.7 | 27.5 | 25.4 | 16.4 | 7.2 | 12.9 |

### Public Health Effects

Because higher amounts of energy efficiency result in decreased power generation and decreased air pollutant emissions, there are resulting public health benefits. These health benefits include less chronic bronchitis and asthma, fewer emergency hospital admissions for respiratory and cardiovascular diseases, and reduced premature mortality. The health benefits are quantified in this study based on coefficients (dollar value per unit of avoided pollutant emissions) and other factors in a 2009 report by the National Research Council, a part of the U.S. National Academy of Sciences (NRC 2009). It should be noted that we only consider the public health benefits from reduced operation of fossil fuel-based power plants. There are additional health benefits from reduced pollutant emissions in other parts of the fuel cycle, such as reduced emissions during coal and natural gas production and transportation.

Most of the health benefits in the High Efficiency scenario are from reduced $SO_2$ emissions with a smaller amount from reduced $NO_x$ emissions. We were not able to estimate avoided particulate or mercury emissions in the study; therefore we could not quantify the health benefits associated with lowering these emissions. Nor did we assign any monetary value to reduced $CO_2$ emissions. Thus our estimates of avoided health damages are conservative.

With these caveats, the estimated net present value of the health benefits during 2010-2030 are $544 million for the region as a whole. This is equivalent to about 2.8% of the utility system net economic benefits. Table ES-7 shows the estimated health benefits by state. The health benefits compared to utility system benefits are larger in New Mexico and Wyoming, and are smaller in Colorado and Nevada. The relatively high values for New Mexico and Wyoming are due to large amounts of older, dirty coal-fired power plants that are retired in those states in the High Efficiency scenario as well as the lower value of utility system benefits in the case of Wyoming.

Table ES-7. Comparison of Public Health Benefits to Utility System Net Economic Benefits

| State | Net Present Value (NPV) of Public Health Benefits (million $) | Ratio of NPV of Health Benefits To NPV of Utility System Benefits (%) |
|---|---|---|
| AZ | 175.1 | 2.5 |
| CO | 50.6 | 1.1 |
| NV | 53.9 | 1.6 |
| NM | 112.2 | 7.2 |
| UT | 51.8 | 3.2 |
| WY | 100.4 | 12.2 |
| **Southwest** | **544.0** | **2.8** |

In general, the southwest region tends to have a lower population density than in other parts of the United States, and power plants in the Southwest tend to be further away from population centers. These factors lead to lower public health benefits than might be seen in other parts of the country.

**Other Benefits**

Utility energy efficiency programs result in important non-energy benefits in addition to those analyzed in this study. For example, home retrofit programs can increase occupant comfort, health and safety, increase property value, and increase the capability of low-income households to pay their energy bills thereby reducing service terminations and reconnects. Commercial and industrial retrofit and new construction programs can increase worker comfort, enhance productivity, reduce waste in the production process, and/or lower environmental control costs. While valuing these non-energy benefits can be difficult, doing so even if approximate can significantly increase the cost-effectiveness of energy efficiency programs. In fact, some studies have found that the value of non-energy benefits can exceed the energy benefits by a factor of two or more, although the magnitude of the non-energy benefits varies with the type of program and the efficiency measures implemented.

Utility risk reduction is another benefit of vigorous utility energy efficiency programs. Utilities face a variety of risks from load growth and pursuit of new generation resources to meet that growth including possible construction cost overruns and delays, fuel and operating cost risks, risks associated with potential new environmental regulations, water constraint risks, and load forecasting and other planning risks. A recent study regarding these risks and mitigation strategies indicated that energy efficiency is not only a utility's lowest cost resource; it is also the lowest risk resource. Because the non-energy benefits and risk reduction potential of utility energy efficiency programs were not analyzed or included in this study, we believe our results are conservative.

## F. Macroeconomic Impacts

This study does analyze the macroeconomic impacts — the impacts on employment, wage and salary compensation, and gross state product — that result from pursuing the High Efficiency scenario rather than the Reference scenario. To analyze the macroeconomic impacts, we used the IMPLAN model, an input-output model that accounts for interactions between all sectors of the economy as described in Chapter 4. The input-output analysis captures the full economic impacts of the investments in energy efficiency including:

- The *direct effect*: the on-site or immediate effects of installing energy efficiency measures in homes or businesses.

- The *indirect effect*: the increase in economic activity that occurs when a contractor or vendor receives payment for goods or services delivered; e.g., the effect on equipment manufacturer or wholesaler who provides energy-efficient technologies.

- The *induced effect*: the changes in spending that occur when households and businesses lower their electricity use and consequently are able to increase purchases of other goods and services such as food, clothing, appliances, or entertainment (in the case of households), and equipment, product development or marketing (in the case of businesses).

The sum of these three effects yields the total macroeconomic impact resulting from investment in utility energy efficiency programs designed to reduce electricity consumption in homes and businesses.

Table ES-8 shows the estimated macroeconomic impacts of the High Efficiency scenario for each state and the region as a whole in 2020. We estimate that pursuing the High Efficiency scenario rather than the Reference scenario would result in a net increase of 28,080 jobs in the region by 2020, and a net increase in wage and salary compensation of just over $1.0 billion (in 2010 dollars). The study also estimates that pursuing the High Efficiency scenario would result in a net increase of 10,120 jobs and an increase in wages and salaries of $317 million by 2015.

Gross State Product (GSP) rises $294 million region wide by 2020 in the High Efficiency scenario. However, GSP declines in three states in the High Efficiency scenario, relative to the Reference scenario, because the positive GSP impacts from the investments in efficiency are not sufficient to offset GSP losses in the utility, coal, natural gas and related industries.

Table ES-8. Macroeconomic Impacts in 2020 by State in the High Efficiency Scenario

| State | Net Jobs Gain | Change in Wage and Salary Compensation (million $) | Change in Gross State Product (million $) |
|---|---|---|---|
| Arizona | 10,400 | 382 | 44 |
| Colorado | 6,960 | 334 | 277 |
| Nevada | 4,680 | 246 | 284 |
| New Mexico | 2,330 | 32 | (88) |
| Utah | 3,100 | 89 | (16) |
| Wyoming | 610 | (47) | (206) |
| **Region** | **28,080** | **1,036** | **294** |

According to the U.S. Bureau of Labor Statistics, just over 8.9 million workers were employed in the region in May 2012, and about 787,000 workers in the region were unemployed. Given reasonable assumptions about employment growth, adding 10,120 jobs by 2015 will result in approximately a 0.1% increase in projected regional employment that year. Adding 28,080 jobs by 2020 will result in approximately a 0.3% increase in projected regional employment.

The construction and service sectors are the industries that benefit most directly as contractors are hired to install the new technologies and make the requisite efficiency upgrades. The retail trade and the service sectors benefit from the actual investments in energy efficiency programs and technologies. They also benefit from the higher level of goods and services sold as households and businesses spend their energy bill savings elsewhere in the economy.

## G. Policy and Program Review and Recommendations

The growth of utility energy efficiency programs in the Southwest has been heavily influenced by policies adopted either through state legislation or state utility commission action. Table ES-9 summarizes the key policies affecting utility energy efficiency efforts in each state. All states have adopted a favorable cost-effectiveness test for determining whether energy efficiency programs are cost-effective as well as a convenient and timely cost recovery mechanism. Integrated resource planning requirements are in place in all states except Wyoming, and four states have adopted some form of energy savings goals or standards for investor-owned utilities. In addition, three states have adopted performance-based shareholder incentives and two states have adopted lost revenue recovery mechanisms to remove financial disincentives that utilities face. However, no state in the region has adopted decoupling of electricity sales and revenues.

Table ES-9. Key Policies Influencing Electric Utility Efficiency Programs in the Southwest

| Policy | AZ | CO | NM | NV | UT | WY |
|---|---|---|---|---|---|---|
| Energy efficiency goals or standards (1) | ✓ | ✓ | ✓ | ✓ | | |
| Integrated Resource Planning | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Use of Total Resource Cost, Societal Cost, or Utility Cost test as sole/primary cost-effectiveness test | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Public benefits funds supporting energy efficiency programs | | | | | | |
| Convenient DSM cost recovery mechanism | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Financial incentive for utility shareholders | ✓ | ✓ | ✓ | | | |
| Decoupling or lost revenue recovery mechanism (2) | ✓ | | | ✓ | | |
| Collaboration in DSM program design/analysis | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Industrial self-direction option | Partial | ✓ | ✓ | | ✓ | ✓ |
| *Notes: (1) Energy savings are allowed to count towards clean energy standards in Nevada. (2) Lost revenue recovery mechanism approved for Arizona Public Service Company; pending for Tucson Electric Power Company.* | | | | | | |

Funding for utility energy efficiency programs will need to rise substantially in order to achieve at least 20% energy savings by 2020 (15% savings in Wyoming). The policy recommendations presented in Chapter 5, and summarized below, are intended to help each state scale up its utility energy efficiency programs and achieve the energy savings identified in the High Efficiency scenario.

**Arizona Policy and Program Recommendations**

Arizona is currently the leading state in the region with respect to utility energy efficiency policies as well as the level of energy savings being achieved. For the most part, Arizona is on track towards achieving the full energy savings and the $7.1 billion in net benefits indicated in the High Efficiency scenario in this study. SWEEP recommends adoption of the following policies to ensure that all utilities in Arizona stay on track and actually do reach 20% or greater energy savings by 2020:

1) The Arizona Corporation Commission (ACC) should adopt decoupling or a lost revenue recovery mechanism along with performance-based incentives for all investor-owned utilities, not just Arizona Public Service Company.

2) Electric utilities and the ACC should commit to fully fund cost-effective efficiency programs and to strive for maximum customer participation along with as maximum cost-effective energy savings. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3) The ACC should commit to approve energy efficiency implementation plans submitted by utilities in a timely manner.

4) Salt River Project (SRP), the state's large publicly-owned and unregulated utility, should continue to expand and fully fund cost-effective energy efficiency programs without arbitrary spending caps.

5) Other publicly-owned utilities and rural cooperatives should commit to implement strong energy efficiency programs.

**Colorado Policy and Program Recommendations**

Colorado is moving in the direction of comprehensive, well-funded utility energy efficiency programs, at least on the part of investor-owned electric utilities and a couple of publicly-owned utilities. In order to achieve the full energy savings and the $4.8 billion in net benefits indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1) The Colorado Public Utilities Commission (PUC) should strengthen energy savings goals for the investor-owned utilities it regulates while ensuring that utilities are rewarded financially when they implement effective efficiency programs for their customers.

2) Electric utilities and the Colorado PUC should commit to fully fund cost-effective efficiency programs and to strive for maximum customer participation along with maximum cost-effective energy savings. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3) The Colorado legislature should adopt energy efficiency program requirements for all utilities in Colorado so that households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by Xcel Energy and Black Hills Energy.

4) Many rural electric cooperatives in Colorado receive power from and are members of Tri-State Generation and Transmission Association. Tri-State should help its cooperative members implement well-funded, effective energy efficiency programs. Funding permitting, the Colorado Energy Office could offer assistance to the smallest utilities, say those with 10,000 customers or less.

**Nevada Policy and Program Recommendations**

Nevada's investor-owned utilities, which implemented some of the most effective energy efficiency programs in the nation as recently as 2009, have backtracked since then due to decisions made by the Public Utilities Commission of Nevada (PUCN) in response to the deep recession in the state and other factors. In order to get back on track and achieve the $3.4 billion in benefits for households and businesses and addition of 4,700 jobs in Nevada by 2020 as indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1) The legislature should remove energy savings from the Portfolio Standards and adopt separate energy savings requirements so that NV Energy resumes implementing comprehensive, well-funded energy efficiency programs.

2) The legislature should direct the utilities and the PUCN to fully fund cost-effective efficiency programs, strive for maximum customer participation, and maximize cost-effective energy savings.

3) The legislature should replace the unpopular lost revenue recovery policy with decoupling — a policy that assures that utilities receive their authorized fixed cost recovery per customer, and no more or no less. In addition, the PUCN should adopt performance-based incentives that allow utility shareholders to earn a reasonable profit when utilities implement effective energy efficiency programs for their customers.

4) All utilities in Nevada should implement efficiency programs so that households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by NV Energy. Funding permitting, the Nevada State Office of Energy could offer assistance to the smallest utilities, say those with 10,000 customers or less.

**New Mexico Policy and Program Recommendations**

The funding for and effectiveness of energy efficiency programs varies considerably across utilities in New Mexico. In order to ramp up savings and achieve the $1.6 billion in benefits for households and businesses as well as addition of 2,300 jobs in New Mexico by 2020, as indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1) The energy efficiency requirements for electric utilities are relatively weak. The legislature should increase the requirements to at least 15% savings by 2020, counting savings from programs implemented starting in 2010.

2) The New Mexico Public Regulation Commission (PRC) and utilities should fully fund cost-effective efficiency programs, strive for maximum customer participation, and maximize cost-effective energy savings. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3) The PRC should decouple electricity sales and fixed cost recovery per customer as has been proposed. In addition, the PRC should adopt performance-based incentives that allow utility shareholders to earn a reasonable profit when utilities implement effective energy efficiency programs for their customers.

4) All utilities in New Mexico should implement efficiency programs so that households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by Public Service Company of New Mexico (PNM), Southwestern Public Service (SPS), and El Paso Electric (EPE). Tri-State should help its members in New Mexico implement well-funded, effective energy efficiency programs. Funding permitting, the New Mexico Energy, Minerals and Natural Resources Department could offer assistance to the smallest utilities, say those with 10,000 customers or less.

**Utah Policy and Program Recommendations**

PacifiCorp, the only investor-owned electric utility operating in Utah through its Rocky Mountain Power (RMP) subsidiary, has significantly increased its energy efficiency and load management programs over the past eight years. In order to ramp up savings and achieve the $1.6 billion in benefits for households and businesses and addition of 3,100 jobs in Utah by 2020, as indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1) The Utah Public Service Commission (PSC) should act upon the 2009 legislative resolution and adopt energy savings goals for PacifiCorp. The goals should increase over time reaching 2% savings per year by the latter part of the decade.

2) PacifiCorp and the PSC should strive for maximum customer participation, and maximize cost-effective energy savings. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3) The PSC should decouple electricity sales and fixed cost recovery as has been done for Questar Gas Company. In addition, the PSC should adopt performance-based incentives that allow PacifiCorp's shareholders to earn a reasonable profit when the utility implements effective energy efficiency programs for its customers.

4) All utilities in Utah should implement efficiency programs so that households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by PacifiCorp. The Utah Associated Municipal Power Systems (UAMPS) should help its members implement well-funded, effective energy efficiency programs. Funding permitting, the Utah Office of Energy Development could offer assistance to the smallest utilities, say those with 10,000 customers or less.

**Wyoming Policy and Program Recommendations**

Wyoming has not enacted any legislation related to utility energy efficiency programs. PacificCorp, the largest investor-owned utility in the state, began implementing six programs in 2009 although the results have been quite modest so far. In order to ramp up savings and achieve significant benefits for households and businesses in Wyoming by 2020, as indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1) The Wyoming Public Service Commission (PSC) should adopt energy savings goals that reach 1.0% savings as a fraction of retail sales per year by 2015 and 1.5% per year by the latter part of the decade for the utilities it regulates.

2) Utilities and the PSC should strive for maximum customer participation, and maximize cost-effective energy savings. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3) The PSC should decouple electricity sales and authorized fixed cost recovery as has been done for Questar Gas Company in Wyoming. In addition, the PSC should adopt performance-

based incentives that allow utility shareholders to earn a reasonable profit when the utility implements effective energy efficiency programs for its customers.

4) All utilities in Wyoming should implement efficiency programs so that households and businesses throughout the state receive the same (or better) energy efficiency services as those provided by PacifiCorp.

Electric utilities in the Southwest have made considerable progress in helping their customers save electricity and money through implementation of cost-effective energy efficiency programs. This progress has been driven in large part by the adoption of state policies including integrated resource planning, minimum energy savings goals or requirements, convenient cost recovery mechanisms, removal of disincentives and/or providing a financial incentive to shareholders for implementing well-performing efficiency programs. However, the adoption of these policies throughout the region is incomplete, and in some cases states have adopted weak versions of the policies.

Achieving 20% energy savings (15% in Wyoming) by 2020 presents a number of challenges including the need for rapid and large increases in energy efficiency program funding during the remainder of the decade. We believe these challenges can be overcome if adequate and comprehensive policies are put in place. We recommend adopting strong energy savings goals or requirements and policies to ensure that utility shareholders can earn a reasonable profit when they implement effective energy efficiency programs. Furthermore, we recommend extending these policies to all utilities, not just the large investor-owned utilities, and enhancing energy efficiency program portfolios to include the full set of Best Practice programs identified in this report. Doing so would provide tremendous economic, environmental and other non-energy benefits throughout the southwest region.

# I. Introduction

Electric utilities in the Southwest (Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming) have greatly expanded their energy efficiency and other demand-side management (DSM) programs over the past decade. As shown in Table 1-1, total funding for these programs was only about $29 million in 2002, SWEEP's first full year of activity. Funding steadily increased to $284 million in 2010 and reached approximately $320 million in 2011. In 2012, we expect that electric utilities in the region will spend about $368 million on DSM programs. It should be noted that these funding values include some load management and demand response programs for utilities that implement load management and/or demand response programs jointly with energy efficiency programs. Approximately 80% of the total DSM funding shown in Table 1-1 goes to programs that have a primary goal of reducing electricity use; i.e., true energy efficiency programs.

**Table I-1. Electric Utility DSM Spending in the Southwest, 2002-2011**

| | **DSM program budget** (million $ per year) | | | | | |
|---|---|---|---|---|---|---|
| **State** | **2002** | **2004** | **2006** | **2008** | **2010** | **2011** |
| AZ | 4 | 4 | 19 | 45 | 94 | 111 |
| CO | 11 | 21 | 18 | 28 | 66 | 85 |
| NV | 3 | 11 | 30 | 55 | 46 | 45 |
| NM | 1 | 1 | 1 | 10 | 24 | 28 |
| UT | 9 | 16 | 27 | 36 | 51 | 47 |
| WY | ~0 | ~0 | ~0 | ~0 | 3 | 4 |
| **Region** | **29** | **54** | **95** | **174** | **284** | **318** |
| *Source: Southwest Energy Efficiency Project* | | | | | | |

In conjunction with rising DSM budgets, there has been significant growth in the energy savings resulting from electric utility energy efficiency programs implemented in the Southwest in recent years. Figure 1-1 shows the growth in first year savings from programs implemented during 2007-2011 for the seven major utilities in the region: Arizona Public Service Co., Tucson Electric Power Co., Salt River Project, Xcel Energy (CO), Rocky Mountain Power (UT), NV Energy, and Public Service Company of New Mexico. The total energy savings achieved by these seven companies reached 1,710 GWh per year from energy efficiency programs implemented in 2011, 2.5 times the savings achieved from program five years prior to this. These seven utilities account for about 67% of total electricity sales and consumption in the region.

Figure I-1. First Year Energy Savings by Major Utility (GWh/yr)

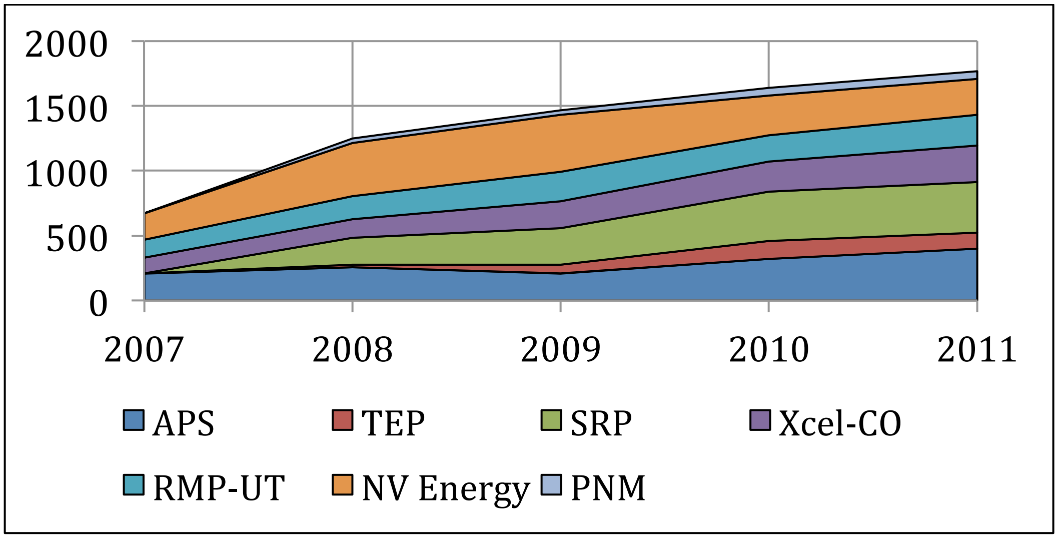
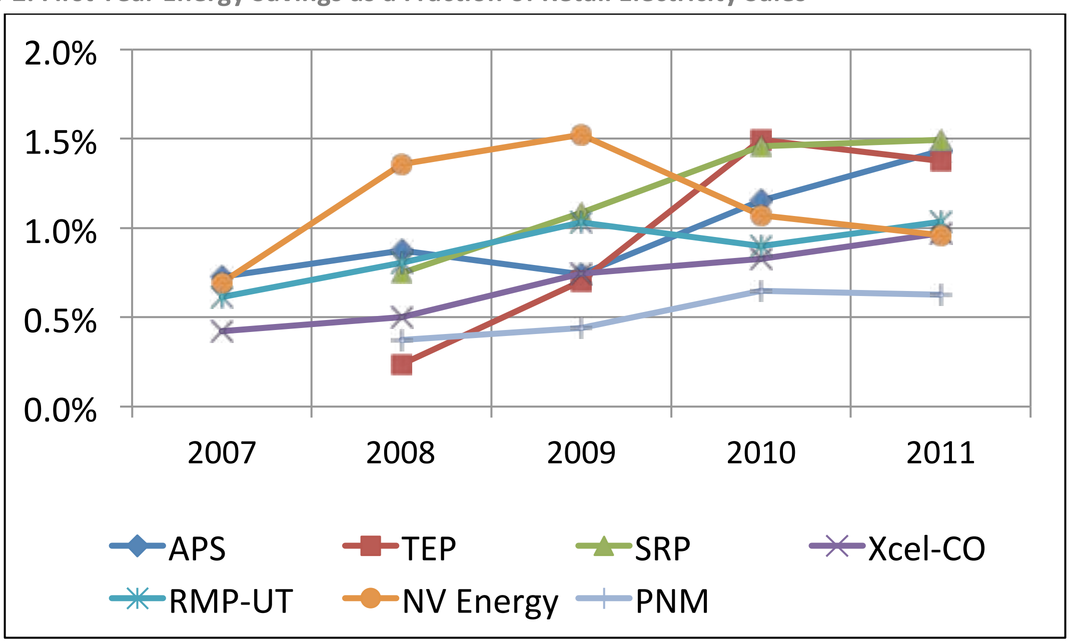



Figure 1-2 shows the energy savings trends by major utility based on the metric first year energy savings as a fraction of retail electricity sales from programs implemented each year. As of 2011, the three Arizona utilities were achieving 1.4-1.5% savings as a fraction of sales; the main utilities in Colorado, Nevada and Utah were achieving around 1.0% savings; and PNM was lagging in achieving only about 0.6% savings. Saving 1.4-1.5% per year places the Arizona utilities in the top tier of utilities nationwide with respect to energy efficiency program performance (MJBA 2011).

Figure I-2. First Year Energy Savings as a Fraction of Retail Electricity Sales



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A review of the energy savings achievement of 50 electric utilities across the nation found that 12 utilities achieved energy savings of at least 1.0% per year as a fraction of retail electricity sales, and only three achieved savings of 1.5% per year as of 2009 (MJBA 2011). One of the three utilities was Nevada Power Company, the subsidiary of NV Energy operating in southern Nevada. Considering that energy savings of at least 1% per year is considered good performance and savings of 1.5% per year or greater is very strong performance, most major electric utilities in the Southwest are now performing well with respect to energy savings achievement. This stands in contrast to 5-10 years ago when utilities in the Southwest were lagging far behind leading utilities (and third party program administrators) with respect to energy efficiency performance.

Utilities in the Southwest are realizing substantial benefits for their customers and for their systems through implementing comprehensive, effective energy efficiency programs. For example, Xcel Energy, the principal electric utility in Colorado, estimates that households and businesses it serves will save $638 million net as a result of DSM programs implemented in 2009-2011. (Net means the value energy savings minus the cost of efficiency measures and programs.) Likewise, NV Energy, the parent company of Nevada Power and Sierra Pacific Power Companies, estimates that its customers will realize $470 million in net economic benefits as a result of DSM programs implemented during 2007-2011.[1] The programs help utilities to defer costly investment in new power plants and transmission and distribution (T&D) facilities, and reduce fuel purchases. The programs also help utilities to reduce water consumption and pollutant emissions.

Most electric utilities in the Southwest are still expanding their energy efficiency programs and are attempting to increase cost-effective energy savings. In Arizona, Colorado and New Mexico, this is partly due to energy savings requirements or goals adopted either through legislation or public utility commission (PUC) action. In other cases, such as in Utah and Wyoming, utilities are subject to Integrated Resource Planning (IRP) requirements that lead to consideration of energy savings opportunities as an alternative to energy supply investments. The upshot is that utilities across the region are considering a wide array of technologies and program strategies for helping their customers save electricity in a cost-effective manner, and are interested in tracking and replicating "best practices" in the utility DSM industry.

At the same time that most utility energy efficiency programs in the Southwest are still expanding, there is some pressure to cut program funding (or to stop funding growth), particularly in Arizona and Nevada, the two southwest states hardest hit by the economic recession. Major utilities in both states experienced a drop in total electricity sales between 2008 and 2011, leading to less need for

[1] The net economic benefits values for both Colorado and Nevada were derived from DSM annual reports prepared and filed by utilities in each state.

energy savings in the short run and lower avoided costs from energy savings. Utilities in these states are under pressure to get more "bang per buck" or just spend fewer dollars on energy efficiency programs in this difficult economic environment. This is challenging the utilities to develop more effective programs, drop programs that are no longer cost-effective, and develop a stronger justification for continuing programs that are marginal.

The purpose of this study is to examine utility energy efficiency program "best practices" and the benefits that would result across the region from scaling up to best practice programs. Chapter 2 of the study develops a comprehensive set of eighteen "Best Practice" utility energy efficiency programs, based on experience in the region as well as elsewhere in the country as of 2011-12. We then analyze how much it would cost and how much energy and peak demand savings would result by 2020 from scaling up to Best Practice programs in each state and across the region, compared to a Reference scenario without utility energy efficiency programs. For the sake of the analysis, we assume that Best Practice programs are implemented by all electric utilities in each state, not just by the large investor-owned utilities. We only consider Best Practice energy efficiency programs, not load management or demand response programs. Also, we do not take into account potential growth in electricity use from adoption of electric vehicles or plug-in hybrid vehicles in this study.

Chapter 3 models utility systems and analyzes the avoided costs that would result from implementing Best Practice energy efficiency programs in each state and across the region. These costs include avoided investment in new power plants and T&D facilities, avoided fuel purchases and operation and maintenance (O&M) costs, and avoided investment in pollution control equipment if some of the energy savings is used to facilitate shutdown of older, highly polluting power plants. The analysis extends to 2030 in order to more fully capture the impacts of utility efficiency programs implemented through 2020. Chapter 3 also estimates that water savings and reductions in pollutant emissions that would result from Best Practice energy efficiency programs, and the public health benefits that would occur (and their value) as a result of the reduced pollutant emissions.

Chapter 4 contains macroeconomic modeling of the impact that Best Practice utility energy efficiency programs would have on jobs, personal income and economic output in each state and across the region through 2020. Once again the analysis compares a High Efficiency scenario with the Best Practice efficiency programs to a Reference scenario without any programs in order to estimate the net changes resulting from vigorous efficiency programs.

The final chapter reviews the policy and program framework affecting utility energy efficiency programs in each state and the barriers to more comprehensive and effective energy efficiency programs. We then recommend a series of additional policies that if adopted would help each state to realize the levels of energy savings and the substantial economic and environmental benefits offered by Best Practice programs.

In summary, we hope this study will help utilities and energy policymakers better understand what is possible with respect to Best Practice utility energy efficiency programs and what benefits would result from taking full advantage of cost-effective energy efficiency resources. In turn, we hope that this will motivate stronger, more effective utility energy efficiency programs in the years ahead.

# II. Best Practice Energy Efficiency Programs

## A. Methodology

We start by developing a comprehensive portfolio of "best practice" utility energy efficiency programs for the southwest states. We then examine how this set of programs could ramp up to achieve aggressive but realistic levels of electricity savings through 2020, which we call our High Efficiency scenario. We provide a separate analysis for each state in the Southwest — Arizona, Colorado, New Mexico, Nevada, Utah, and Wyoming — as well as an analysis for the region as a whole. In our High Efficiency scenario, we begin program expansion in 2012 and gradually expand program implementation through the year 2020. In addition, we analyze the consumer investment necessary to maintain the energy savings realized in 2020 through 2030; i.e., the cost for replacing any efficiency measures that wear out during 2021-2030.

**Reference Scenario Assumptions**

Each state analysis includes a Reference scenario for electricity sales (GWh) and peak demand (MW) through 2020. The Reference scenario excludes the impacts of any utility energy efficiency programs, not even programs underway or planned by utilities in each state. In other words, current utility resource plans and load forecasts were adjusted upwards to remove the effects of ongoing or planned energy efficiency programs. The analysis was structured in this manner to avoid double counting of savings in the High Efficiency Scenario and to evaluate the full costs and benefits of utility energy efficiency programs — both existing and expanded programs — through 2020.

For each state, we start with 2010 baseline electricity sales data from the U.S. Energy Information Administration (EIA 2012b). We then analyze recent Integrated Resource Plans (IRP) for utilities in each state and collect data on electricity sales and peak demand forecasts. We adjust these resource plans and forecasts to exclude energy efficiency program impacts. We then develop statewide annual growth rates for sales and peak demand using a weighted average of the available forecasts within each state.[2]

**Choosing Model Programs**

Our portfolio of model energy efficiency programs includes a comprehensive set of strategies for residential (including low-income), commercial, and industrial customers based on best practice program offerings from leading utilities and other program administrators in the U.S. including the southwest region. The programs were selected to maximize cost-effective energy savings by 2020. We develop ten residential programs and eight business programs for commercial and industrial

[2] We use data from several utility IRPs: *Arizona* – Arizona Public Service Company (APS 2011b) and Salt River Project (SRP 2010); *Nevada* – Nevada Power Company (NPC 2011) and Sierra Pacific Power Company (SPPC 2011); *Utah and Wyoming* – Rocky Mountain Power (PacifiCorp 2011a); *Colorado* – Tri-State Generation & Transmission (Tri-State 2010); Xcel Energy (Xcel 2011a); *New Mexico* – Public Service Company of New Mexico (PNM 2011). Full citations are provided in the list of references.

customers, as shown in Table 2-1. Our portfolio of best practice programs does not include load management or demand response programs, which are aimed entirely or primarily at peak demand reduction.

Table 2-1. Residential and Business Program List

| Residential | Commercial and Industrial |
|---|---|
| 1. Low-Income Weatherization | 1. Commercial New Construction and Code Support |
| 2. Multi-Family Retrofit | 2. Small Business Direct Install |
| 3. Residential New Construction and Code Support | 3. Custom Retrofits, Process Efficiency and Self-Direct |
| 4. Home Retrofit | 4. Computer Efficiency and other Plug Loads |
| 5. Retail Products | 5. Prescriptive Rebates and Upstream Incentives |
| 6. Residential Lighting | 6. Commercial Lighting Redesign |
| 7. Refrigerator/Freezer Recycling | 7. Retrocommissioning |
| 8. Residential Cooling | 8. Combined Heat and Power (CHP) |
| 9. Water Heating | |
| 10. Home Energy Reports and Information Feedback | |

**Treatment of Existing Utility Program Portfolios and Plans**

Most electric utilities in the Southwest are currently administering energy efficiency programs. We accounted for these program impacts in 2010 and 2011 based on reported program costs, energy savings, and peak demand reductions on a net impacts basis (i.e., adjusting for free ridership and spillover effects as reported by utilities). We also collected utility-specific information on future energy efficiency program plans. In some cases, we used 2012 program plans if available to inform our assumptions about 2012 program costs and impacts.

Some utilities implement programs that do not fit the same general definitions of our model programs. In these cases we had to re-categorize programs such as combining several existing utility programs into one model program category. For example, one utility has separate business lighting program, motor replacement, and heating and cooling programs. In our model program portfolio, we include one prescriptive equipment replacement program that bundles all types of equipment eligible for prescriptive incentives. In this example, we combined the results from these separate programs into one "Prescriptive Rebates and Upstream Incentives" program.

When a state did not already have some form of the model program in place, we assumed that in 2012 the program would start statewide at very modest levels and ramp up in subsequent years. When 2012 utility program plans were available, we used these plans to inform our analysis (e.g., average savings per participant; program cost data). However, we scaled up the model programs to the state level rather than to the individual utility level.

It is important to note that our programs analysis and results represent statewide values, and not just analysis and results for major investor-owned utilities (IOUs). Readers should be careful not to directly compare our analysis to individual utility plans.

**Participation, Energy and Peak Savings, and Cost Estimates**

For each program, we first developed forecasts for the number of eligible customers statewide, and then estimated reasonable participation rates (%) based on best practice programs in the Southwest and elsewhere in the U.S.

Energy savings (kWh) and peak impacts (kW) per participant were similarly estimated from best practice utility-specific programs as well as studies regarding different types of utility efficiency programs. Program costs and customer costs were estimated per participant or per first-year kWh saved, again based on specific programs in the region or best practice programs elsewhere in the country.

In the presentation of the program analysis, *incremental annual savings* are the new savings impacts from one program year only. *Total annual savings* include savings from programs and measures implemented in previous years as well as in the year of interest. For programs in which the savings are largely operational, e.g. commercial building retrocommissioning, savings degrade gradually over time.

We assume, for the purposes of this study, that utilities cease to invest in programs beyond 2020, which means that no new measures are installed by customers leveraging utility rebates or incentives after 2020. This construct is simply for the purpose of performing this study; we fully expect that utility energy efficiency programs will continue after 2020. However, we assume that households and businesses continue to invest in some energy efficiency upgrades on their own, independent of utility programs and incentives. We assume that the level of customer investments and the resulting savings are sufficient to maintain the 2020 total annual energy savings levels through 2030. This is important because the utility system analysis, presented in the next chapter, considers avoided utility system investments as well as fuel and operating cost savings through 2030. Thus to provide a fair comparison of costs and benefits, we maintain energy savings through 2030 but without considering utility program expenditures or new efficiency measures implemented beyond 2020.

**Benefit-Cost Analysis**

Using the energy savings and cost estimates, we then examine the cost-effectiveness of each program over the program time horizon. Estimates of gross program savings are based on a wide variety of sources from regional and national best practice programs. The net savings were calculated based on an assumed net-to-gross ratio for each program, which we estimate based on typical program assumptions and hold constant across all states. The net-to-gross ratio adjusts savings to account for freerider and spillover effects. Like the energy savings estimates, cost estimates are drawn from a wide variety of regional and national best practice programs. For determining cost of saved energy and net present values of costs and benefits, we assume a 5% real discount rate.[3] All costs are expressed in 2010 dollars. Measure lifetime assumptions are held constant across all states, but informed from several program examples.

Table 2-2. Summary of Program Net-to-Gross Ratios, Measure Lifetimes, and Levelized Costs

| Program | Net-to-Gross Ratio | Average Measure Lifetime (Years) | Levelized Cost of Saved Energy ($/kWh)** |
|---|---|---|---|
| ***Residential*** | | | |
| Low-Income Weatherization | 100% | 10 | $0.09 |
| Multi-Family Retrofit | 80% | 13 | $0.04 |
| New Construction and Code Support | 80% | 20 | $0.03 |
| Home Retrofit | 80% | 13 | $0.02 |
| Retail Products | 80% | 10 | $0.02 |
| Residential Lighting | Varies over time | 10 | $0.02 |
| Refrigerator/Freezer Recycling | 60% | 9 | $0.05 |
| Residential Cooling | Varies over time | 15 | $0.06 |
| Water Heating | 80% | 13 | $0.05 |
| Home Energy Reports and Information Feedback | 100% | 1 and 5* | $0.04 |
| ***Commercial and Industrial*** | | | |
| New Construction and Code Support | 80% | 14.7 | $0.01 |
| Small Business Direct Install | 98.5% | 12.7 | $0.05 |
| Custom Retrofits, Process Efficiency, and Self-Direct | 80% | 15 | $0.02 |
| Computer Efficiency and Other Plug Loads | 90% | 7 | $0.02 |
| Prescriptive Rebates and Upstream Incentives | 80% | 16 | $0.04 |
| Commercial Lighting Redesign | 80% | 13 | $0.02 |
| Retrocomissioning | 100% | 7 | $0.03 |
| Combined Heat and Power | 100% | 19.6 | $0.01 |
| *Notes: *1 year for home energy reports; 5 years for in-home displays; **Levelized costs of saved energy are calculated assuming total program costs only through 2020, a real discount rate of 5%, average measure life, and total annual savings in 2020. These levelized costs do not include customer investments or operating costs.* | | | |

[3] We assume a 5% real discount rate, which includes the cost of capital but excludes the impact of inflation. This rate has been commonly used in efficiency program analysis, for example the California Energy Commission (CEC) has used real discount rates ranging from 3-5% since the 1980s (CEC 2005). Also, the U.S. Department of Energy uses a real discount rate of approximately 5% in its analyses of the cost effectiveness of potential appliance efficiency standards. A 5% discount rate is higher than a social discount rate which is closer to 3% real. For example, see http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/74fr34080.pdf.

Table 2-2 presents the key assumptions regarding measure lifetime and net-to-gross energy savings ratios for each model program. Table 2-2 also includes the levelized cost of saved energy for each type of program, which is a function of program costs and energy savings, average measure lifetime, and the discount rate. The cost of saved energy for residential programs ranges from $0.02 - $0.09 per kWh, with an overall average of $0.036/kWh. The cost of saved energy for commercial and industrial programs ranges from $0.01 - $0.05 per kWh, with an overall average of $0.022/kWh. Consistent with experience nationwide, we find that utility investment in energy efficiency is the lowest cost utility resource by far (Freidrich et al. 2009; MJBA 2011; Eckman 2012).

## B. Program Descriptions

In this section we describe each of the 18 model programs included in the analysis and the key assumptions for each program. Further details regarding the model programs are provided in Appendix A.

**Residential Energy Efficiency Programs**

***1. Low-Income Weatherization***

Program Design: This program provides weatherization services, efficient appliance upgrades, and energy savings kits to income-qualified households on a no-cost basis. The program is administered by local community action agencies or state agencies and leverages funds from the federal government.

Once customers are deemed eligible, they will receive an in-home energy assessment from their local weatherization provider. Eligible customers are households which are at or below 150% of the federal poverty income threshold. The agency then arranges for weatherization and other services, including distribution of energy savings kits, to be installed by a qualified contractor. Savings are increased by installing additional efficiency measures. As a final step, the agency performs a quality assurance inspection to ensure that all work is performed to program guidelines. Educational materials are also provided, which include: customer education packages; materials for outreach workers; web link on unemployment website; other outreach opportunities.

Target Market: This program is for residential customers living in 1-4 unit dwellings (both single family and manufactured homes) who are at or below 150% of the federal poverty income threshold. In the case of multi-unit dwellings, 50% of the occupants must qualify as low-income in order to be served by the low-income program.

Marketing Approach: Marketing will consist of contacting (by mail and/or by telephone) customers subscribing to the low-income rates who have not received prior energy efficiency services. Direct mail, bill inserts, and literature distributed through social service agencies, government offices, and other networks are also used to market the program. Outreach and marketing efforts could be expanded to include building relationships with unemployment centers, medical service providers, places of religious worship, and other venues that would reach potential income-eligible customers.

Efficiency Measures: The measures include insulation (attic, wall, pipe, and duct), air sealing, water heating measures, compact fluorescent lamps (CFLs), heating system repair and replacement, major weatherization work (electrical, roofs, etc.), ENERGY STAR refrigerators and freezers, high efficiency air conditioning (AC) units, and "smart" power strips. Energy kits include a high efficiency showerhead, faucet aerators (kitchen and bath), and CFLs or light-emitting diode (LED) lamps.

Financial Incentives and Other Services: Efficiency measures and services are directly installed and delivered with no co-payment from participating low-income customers. Utilities pay for 10-20% of home retrofit costs; the remainder is paid for through the funding that states receive from the federal Weatherization Assistance Program.

Program References and Methodology: This program analysis is based largely on Xcel Colorado's (Xcel CO) low-income program (Xcel 2011b and 2011c). We first determined the number of eligible households, defined as those households living at or below 150% of federal income poverty guidelines, which was taken from the U.S. Census (Census 2011). We then determined participation levels for weatherization services, both single and multifamily, and for energy savings kits, which are based upon participation in Xcel CO's low-income program. Annual participation rates in the weatherization program for 2010 are taken from utility DSM reports. Otherwise, participation is assumed to start at 1.5% of eligible households starting in 2011 and grows to 6% of eligible households by 2020. Participation rates for the distribution of energy savings kits in 2010 and 2011 are taken from utility DSM reports and plans, when available. Otherwise, participation grows from 8% of eligible households in 2012 and grows to 14% of households by 2020. Savings per participant for weatherization services and energy savings kits were taken from Xcel CO's low-income program (Xcel 2011b). Costs were taken both from Xcel CO's low-income program and from the Massachusetts Joint Statewide Three-Year Electric Energy Efficiency Plan (NSTAR 2011). We assume no participant costs, so measure installations are 100% subsidized by utilities.

### *2. Multi-Family Retrofit*

Program Design: This program provides retrofit services for multifamily buildings and units including initial energy assessments, education on energy savings opportunities, direct installation of low-cost measures, and the opportunity to install major measures at a reduced cost.

Target Market: Residential buildings with five or more dwelling units.

Marketing Approach: The program is assumed to be supported by the statewide energy efficiency marketing effort; however, direct outreach to building owners and/or property managers occurs via trade associations as well as program contractors. The contractor will develop a marketing plan to educate building owners and property managers on the program services.

Efficiency Measures: The measures in this program include energy-efficient lighting upgrades and controls, occupancy sensors, LED exit signs, water heating measures (low-flow showerheads, aerators, pipe wrap), programmable thermostats, insulation, air sealing, high-efficiency HVAC equipment, ENERGY STAR-rated refrigerators and other appliances, high-efficiency motors and motor speed controls, energy management systems, high efficiency water heating equipment including solar hot water heating systems, combined heat and power (CHP) systems, and heat or energy recovery ventilators.

Financial Incentives and Other Services: The program offers property owners free direct installation of low-cost energy efficient products as well as information on rebate opportunities for more capital-intensive measures. The program also provides funding for "soft costs" such as building operator training and technical assistance for those projects requiring an engineering study. Utilities also provide training for building/facility managers.

Program References and Methodology: This program analysis is based on programs run by Southern California Edison (SCE) and the Massachusetts Joint Statewide program. We first determined the number of multifamily households in each state through data from Moody's Analytics (www.economy.com). Only two states, Colorado and Arizona, have efficiency programs explicitly directed at multifamily housing, though Xcel Colorado's program is aimed at low-income customers (so we account for those savings in our low-income program). Arizona Public Service's program was only approved in January 2011, so the program had not yet begun to deliver energy savings in the 2011 program year. Therefore, we assume that the program begins in 2012 for all states. Participation is assumed to start at 1.5% of multifamily households, ramping up to 6% of households by 2017 and remaining at that level through 2020. The savings per participant assumption comes from the Massachusetts statewide program (NSTAR 2011). Costs are taken from SCE and the Massachusetts statewide program (SCE 2009 and NSTAR 2011, 2009a and 2009b).

### *3. Residential New Construction and Code Support*

Program Design: This program features training and financial incentives to builders who meet the program's energy-efficiency standards. The program emphasizes the whole building approach to improving energy efficiency and includes field testing of homes to ensure high performance. Builders and contractors receive training on building science and energy-efficient construction techniques, while prospective homebuyers are educated about the benefits of an energy-efficient home. The program takes advantage of the national ENERGY STAR brand name and promotes ENERGY STAR homes to prospective buyers. Additionally, the program works with contractors and builders to provide training on building energy code compliance as a means of supporting code enforcement and compliance for new homes not participating in the above code program.

Target Market: New single- and multi-family residential construction.

Marketing Approach: The program will educate homebuilders, consumers, and trade partners regarding the energy-savings benefits of ENERGY STAR-qualified homes. Marketing efforts will focus on: homebuilder recruitment, continued training and support, public relations, and the implementation of large scale multi-media advertising campaigns geared toward homebuilders, consumers, and trade ally groups. The program will support development of leads through building permit lists in cities and towns throughout the state.

The multi-media campaign will include vehicles such as: strategic television partnerships with local affiliate or cable programming providers, radio live reads and on-air interviews, print advertising in builder and trade publications, direct marketing via email/fax lists, and online advertising and social media. There will be heavy emphasis on "earned media" and editorial public relations involvement to ensure market penetration and an increased program capture rate.

Efficiency Measures: The measures for this program include building shell measures such as energy-efficient windows and higher levels of insulation, duct and envelope air sealing, installation of efficient HVAC equipment, efficient lighting, and appliance upgrades (ENERGY STAR clothes washers, dishwashers and refrigerators).

Financial Incentives and Other Services: This program offers builders first-tier incentives of $400 per home to meet basic energy efficiency standards, equivalent to standard ENERGY STAR homes. ENERGY STAR standards change over time, so we assume the program is modified accordingly. Second-tier incentives of $1000 per home are offered to encourage builders to meet savings levels of at least 30% above the model energy code or about 15% better than ENERGY STAR. Third-tier incentives of $1500 per home are offered to encourage builders to meet savings levels of 50% or more relative to the model energy code.

Program References and Methodology: This program analysis is based largely on Arizona Public Service's (APS) new construction program. This program applies to single, multifamily, and mobile home new construction, for which data on annual housing completions is taken from Moody's Analytics (www.economy.com).

There are three tiers: first-tier measures generate savings 15% above code; second-tier measures generate savings 30% above code; third-tier measures generate savings 30% above code. We also assume that utilities are given credit for 50% of the savings generated by utility support for compliance with building energy codes. Participation rates in each tier in 2010 and 2011 are taken from utility DSM reports and plans when available. Starting in 2012, participation rates are assumed to be 37% and are assumed to increase 3% annually for the first and second tiers and 0.1% annually for the third tier, until a new code is introduced. We assume new building codes become effective in 2014 and 2019. When a new code becomes effective, participation drops to levels from the beginning of the previous code iteration. Participation in the third-tier measures starts in 2014.

Participation for utility code support begins at 50% in 2014 and increases to 98% by 2018, falling back to 50% in 2019 when a new code becomes effective. Savings are based on the average electricity consumption per single and multifamily household, which is estimated using data from utility IRPs and existing potential studies that disaggregate data by housing type. Average household consumption values are then adjusted to reflect consumption in new homes using the ratio of average household consumption of new and existing homes in the APS service territory. Savings per participant is the product of the percent savings by tier and the average household electricity consumption, which is adjusted downward when a new code is introduced. Costs are based on the APS new construction program (APS 2010 and 2011a).

### 4. *Home Retrofit*

Program Design: This program provides a broad framework to deliver incentives and high quality retrofit services to owners of single family houses or manufactured houses.

Target Market: Residential customers in existing single family and manufactured homes.

Marketing Approach: The program will rely to some degree upon HVAC and insulation contractor-generated marketing to drive customer enrollment, along with utility bill inserts, radio/print media campaigns, direct mail, special-interest publications, presence at consumer and home shows, and links from utility websites to approved vendor/contractor websites. There will also be a residential education and support campaign to help maximize benefits of the program and encourage favorable behavioral changes.

Efficiency Measures: The program promotes both "light" and "comprehensive" retrofits. A light retrofit includes blower door test, direct installation of lighting measures (CFLs, fixtures and ceiling fans), low-flow measures, and home-envelope air sealing. A comprehensive retrofit includes replacing appliances (clothes washers, dishwashers, water heaters, and refrigerators/freezers), shell measures (insulation, home-envelope air sealing, and window replacement), and HVAC (AC tune-up, replacement, duct sealing and insulation).

Financial Incentives and Other Services: Incentives are provided to customers through a post-purchase application process with incentives paid directly to participating customers.

Program References and Methodology: This program design is based on programs run by APS (APS 2010a) and Connecticut Light and Power (CL&P). Eligible households include both single family and manufactured homes. Participation, savings and costs are broken out between "light" and "comprehensive" retrofits. The number of households, by type, is taken from Moody's Analytics (www.economy.com). Participation rates are taken from CL&P and start at 1.2% in 2012 (regardless of whether the state has an existing program or not) and increase to 5% by 2020. We allocate the annual participation rates across retrofit type (light vs. comprehensive) based on the ratio of measures installed, by retrofit type, to all measures installed in Rocky Mountain Power's (RMP) home retrofit program (RMP 2010a). On average, we assume that 75% of retrofits are "light" type and that 25% are "comprehensive." We allocate participation by housing type by taking the product of the total number of eligible households by the total participation rate, and disaggregating it by the ratio of eligible households by type to the total number of eligible households. Savings are represented as a percentage of average household energy consumption, taken from CL&P 2010; we assume 10% savings for light retrofits and 25% savings for comprehensive retrofits. Costs are taken from APS 2010a and RMP 2010a.

### *5. Retail Products*

Program Design: The program pursues the objective of building awareness, customer acceptance and market share of ENERGY STAR customer electronics and appliances. It provides midstream and upstream incentives to retailers and manufacturers for increasing sales of qualifying ENERGY STAR products, and requires retailers to develop a marketing and merchandising plan, implement sales training for employees, display point of purchase signage, and submit sales data on a monthly basis. Utilities will partner with both manufacturers and retailers to offer education and training regarding the benefits of energy-efficient products to local retail sales staff and customers.

Target Market: The program targets residential customers who purchase electronic products (televisions, PCs and monitors) and appliances (clothes washers, dishwashers, refrigerators, and room AC units) as well as commercial retailers of these products.

Marketing Approach: The program focuses on building awareness of the benefits of energy-efficient products within the utility service territory. Other strategies include providing retail point-of-purchase materials; seeking out special retail placement opportunities; print, radio and online ads to promote eligible products; bill inserts to promote the program; articles on the benefits of ENERGY STAR products; and leveraging cooperative advertising opportunities with retailers and manufacturers to create general awareness of the ENERGY STAR brand.

Efficiency Measures: Measures include ENERGY STAR qualified televisions, desktop personal computers (PCs), laptops, computer monitors, clothes washers, dishwashers, refrigerators, room air conditioners, and high-efficiency pool pumps and timers. For some products, incentives are provided for products that exceed the ENERGY STAR criteria by a specified amount. Other electronic products such as set-top boxes and game consoles may be included in the future (Frank et al. 2012).

Financial Incentives and Other Services: Incentives are paid out to retailers on a per-unit-sold basis. Per-unit incentives for consumer electronics average $17.50. Per-unit incentives for appliances average $44.

Program References and Methodology: This program is based largely the retail products programs implemented by Nevada Power Company and Xcel Colorado (NPC 2009 and Xcel 2011b). Savings are based on the number of efficient retail products sold annually, which is a percentage of the total number of retail products sold annually (both efficient and standard). Participation rates vary across measure types; we include televisions, PCs, monitors and appliances for all states, and add high-efficiency pool pumps and pump timers for Arizona and Nevada, which already have existing programs for those measures. Participation rates for the first four measure types are based on NPC 2009: annual participation starts at 5.4%, 6.7%, and 3.3% for TVs, PCs, and monitors, respectively, growing to 70%, 50%, and 50% by 2020. We assume participation rates for appliances remains static at 5% throughout the entire analysis. Participation rates for pool pumps and timers are based on actual results from programs in AZ and NV, and then increased by 0.5% and 0.1% annually for pool pumps and timers, respectively. Estimates of statewide sales for each product are calculated using product saturation data from state-specific potential studies, when available, and the EIA's residential electricity consumption survey (RECS) when state-specific data are not available. Annual sales of efficient products are the product of participation in the program (ability of retailers to sell efficient products) and the total number of product sales in the state. Per unit savings are taken from ASAP 2012. Costs are taken from NPC 2009 and Xcel 2011b.

### *6. Residential Lighting*

Program Design: This program provides outreach, education and financial incentives to encourage customers to purchase energy-efficient light bulbs, including standard and specialty CFLs and LED lamps, as well as services to assist consumers to dispose of CFLs in an environmentally friendly manner. Customers may purchase energy-efficient lamps at a discount through either mail-order sales or local retailers.

Target Market: All residential customers in utility service territory.

Marketing Approach: The program will be marketed through two primary channels: mail order sales and retail discounts. Mail order sales will focus on CFLs and be used to help customers locate specialty and hard-to-find bulbs; it also offers the benefit of home delivery. Mail order will likely account for less than 1% of overall CFL sales, but it is important to encourage customers to go beyond purchasing typical twist CFLs, and thus the program markets a variety of models and styles

Retail discounts will drive 99% of lighting sales and will be the only way customers can receive rebates for LEDs. This channel offers the lowest prices and will reach more customers than the mail order channel, offering more participation and savings potential. Utilities will implement a minimum of two retail promotions per year and will work with many different retailers. The peak sales period for lighting is in the fall and winter, so promotions are focused during these peak time periods. Utilities will also market this program through bill inserts, mass media advertising, cooperative advertising with retailers, and community events.

Efficiency Measures: Standard and specialty CFLs and LED lamps.

Financial Incentives and Other Services: The upstream markdown (incentive) accounts for 30% to 70% of the incremental cost, depending on the bulb. The savings are ultimately passed on to the customer as an instant rebate at the point of purchase. There are no rebates for the mail order sales channel; the utility passes the wholesale price on to the customer.

The retail price of a 60-watt equivalent LED bulb is approximately $30, but is decreasing rapidly. The utility will offer instant in-store rebates at major retailers. The rebate will be approximately $10 each but may vary depending on the type and manufacturer of the bulb. The market price of LEDs will decline over time as acceptance grows and the technology improves. The utility will negotiate the rebate with the manufacturers in order to make the final cost of an LED bulb $20 or less for the customer in the initial program years and less than $5 by 2020.

Program References and Methodology: This program analysis is based largely on programs run by Nevada Power Company and Xcel Colorado (NPC 2009; Xcel 2011b and 2011c). In addition, we took note of the experience of Efficiency Vermont which has had very good success promoting the adoption of specialty CFLs recently (Bonn 2012). We use data on CFL installations from state-specific DSM status reports and plans for 2010 and 2011. In 2012, we assume the installation of one CFL per household, and that LEDs are offered starting in 2012. We assume CFLs are installed at a rate of one per household until 2015, when installations drop by 50%. CFL installations drop by 50% again in 2017 and 2019. We believe these assumptions are conservative based on experience in the region as well as in other leading states such as Vermont.

LED installations are a product of the assumed annual participation rate and the number of households in the state. Annual LED participation (installation) rates are taken from NPC 2009 for 2012 and 2013, starting at 2.8% in 2012, 32% in 2013, ramping up to 100% in 2017 (equivalent to one LED per household) and 200% in 2019 (equivalent to two LEDs per household). Per unit savings are based on RMP 2010a and NPC 2009, which fall in 2015 when the market begins to adjust after federal lighting standards become effective in 2014. We assume that per-unit savings of LEDs increase slightly over time as the technology improves. Program costs are estimated from Xcel's program (Xcel 2011c). Participant costs for CFLs are also based on Xcel 2011c. Participant costs for LEDs are derived from Lowe's 2011 and RAP 2011.

### *7. Refrigerator and Freezer Recycling*

Program Design: Less-efficient refrigerators and freezers are taken out of use permanently and recycled in an environmentally responsible manner. To participate, customers call a toll-free number to schedule a pick-up. The program is implemented on a turn-key basis by a qualified contractor.

Target Market: All residential customers with older primary and/or secondary refrigerators and freezers.

Marketing Approach: Mass media advertising channels as well as utility communication channels such as the program's website, bill stuffers, and customer newsletters.

Efficiency Measures: Older refrigerators and freezers are removed from the housing stock. Participants also receive an energy efficiency kit consisting of ENERGY STAR-certified CFLs, a refrigerator/freezer thermometer, and energy education materials.

Financial Incentives and Other Services: Free pick-up and a cash incentive for recycling an older refrigerator or freezer.

Program References and Methodology: Most utilities in the Southwest region implement a refrigerator/freezer recycling program, so data were largely state-specific with the exception of participation rates and per unit savings. Data on the number of units recycled in 2010 and 2011 were taken from utility-specific DSM status reports and plans. The number of units recycled in 2012 and beyond is a product of the number of households in the state, from Moody's Analytics (www.economy.com), and the annual participation rate. The participation rate, which is based on experience by RMP in Utah, begins at 2.2% in 2010 and falls to 2% in 2015 after federal standards for refrigerators become effective in 2014. Participation remains at 2% for the remainder of the decade. Per unit savings are taken from APS 2011a and RMP 2010a, and adjusted annually to account for the increasing efficiency of the existing appliance stock. Savings are adjusted based on AHAM 2010. Costs are based on RMP 2010a, although program administrative costs are state-specific given the ubiquity of recycling programs in the Southwest. The range of per participant program administrative costs is $119-$169.

### *8. Residential Cooling*

Program Design: This program provides incentives for the purchase, best-practice installation, and proper sizing of evaporative cooling equipment and high-efficiency compressor-based air conditioning equipment. Incentives are provided to both end-use customers and the contractors who install the equipment. In addition, the program includes a tune-up component for existing air conditioners.

This program provides incentives to homeowners, residential homebuilders, and HVAC contractors to influence the choice and installation of high-efficiency air conditioning equipment. There is a focus on training equipment dealers and installers to influence the purchasing decisions of end-use customers who are considering adding or replacing cooling equipment, as well as to ensure that cooling equipment is sized and installed properly. Given the hot, arid climate typical of the Southwest, the program also helps customers understand the increasing availability of alternatives to compressor-based cooling equipment, specifically evaporative cooling technology. In addition, the program promotes and offers an air conditioner tune-up and duct testing and sealing service, with discounts provided for such services. The quality installation process is based upon standards developed by the Air Conditioning Contractors of America, which dictate the steps a contractor must take to ensure that the total energy savings potential of newly installed AC equipment is realized.

Target Market: All residential customers with central air conditioning.

Marketing Approach: Marketing channels include local newspaper advertising, internet advertising, monthly customer email updates, bill inserts in the spring and mid-summer, contractor outreach, and builder kits. Utilities partner with contractors and builders in the state to help promote the program. Contractors and builders are an essential part of customer awareness and will receive information on program changes regularly.

Efficiency Measures: Direct, indirect, or two-stage evaporative cooling units and high-efficiency central air conditioning (CAC) systems with SEER ratings of 15 or greater; duct testing and sealing; and tune-up of older CAC systems.

Financial Incentives and Other Services: The program provides tiered incentives to encourage homeowners to invest in more efficient CAC systems. Three rebate levels for evaporative cooling are offered, which are based on Xcel Energy's program:

- **Tier 1:** Qualifying evaporative cooling units have a minimum ISR airflow of 2,500 CFM. The rebate amount is the lesser of $200 or the purchase price of the unit.

- **Tier 2:** Qualifying evaporative cooling units have minimum media saturation effectiveness of 85%. The units must be manufactured with a remote thermostat and a periodic purge water control. First time installation rebate is the lesser of $600 or the purchase price of the unit; replacement rebate is $500.

- **Tier 3:** To qualify for the whole house rebate, the whole house cooler must be indirect/directly cooling and fully ducted in the home with a minimum four down ducts installed. Tier 2 eligibility requirements also apply to Tier 3. The rebate amount is $1,000 paid directly to the builder.

We assume an average customer incentive of $350, equivalent to upgrading from SEER 13 or 14 to SEER 15 in Xcel CO's program. Incentives also include $100 for contractors to ensure quality installation. For tune-up of existing CAC systems, the incentive is around $150.

<u>Program References and Methodology:</u> This program analysis is based largely on the residential cooling programs implemented Rocky Mountain Power and Xcel Colorado (RMP 2010a; Xcel 2011c). For all states except Wyoming and Colorado, the measures include high-efficiency CAC systems, CAC tune-ups, and evaporative cooler installations. The cooling load in Wyoming was not large enough to justify incentives except for high-efficiency and ductless heat pumps. In order to estimate savings and costs, estimates of unit installations, eligible customers, statewide CAC sales and participation rates first had to be made. The number of cooling unit installations is the product of either all eligible customers (for tune-ups) or statewide CAC sales, and the respective participation rate for that measure. Participation rates for the cooling measures are static across states beginning in 2012 and are based on Xcel 2011c, with the exception of tune-ups, which is based on RMP 2010a.

For heat pumps in Wyoming, eligible customers are equivalent to the number of households in the state that heat with electricity. We assume that participation rates for heat pumps are split evenly between high-efficiency and ductless heat pumps, of which the total participation rate is equivalent to the participation rate for CAC upgrades. There is no heating program currently offered in Wyoming, so the program begins in 2012. Savings are then determined by taking the product of the unit installations and the per-unit savings. Per-unit savings for cooling measures are taken from RMP 2010a; per-unit savings for heating measures are taken from PacifiCorp 2011b and NEEA 2011. Costs are taken from RMP 2010a and Xcel 2011c.

### *9. Water Heating*

<u>Program Design:</u> This program encourages customers to purchase ENERGY STAR-qualified electric heat-pump water heaters (minimum Energy Factor = 2.0), and promotes greater adoption of low-flow showerheads and faucet aerators by households with electric water heating.

Target Market: Residential customers with electric resistance water heating.

Marketing Approach: The program provides bill inserts and information via a website; works with retailers, contractors and distributors; participates in tradeshows; and offers point-of-purchase materials that will be made available at larger retailers.

Efficiency Measures: ENERGY-STAR qualified heat-pump water heaters, low-flow showerheads and faucet aerators.

Financial Incentives and Other Services: The program offers a $450 rebate for ENERGY-STAR qualified electric heat-pump water heaters, a free 1.5 gallon-per-minute (gpm) showerhead, and a free 1.5 gpm faucet aerator.

Program References and Methodology: This program is modeled on Xcel Colorado's water heating program (Xcel 2010 and 2011c). The number of installations is a function of the number of homes that heat water with electricity and the existing saturation of heat-pump water heaters, showerheads, and faucet aerators. Measure saturation data is taken from state-specific energy efficiency potential studies when available, and RECS when state-specific data are unavailable. Participation is based on data from Xcel 2010 and 2011c. We assume one participation rate for all three measures because of the ease of installing showerheads and faucet aerators concurrently during water heater replacement. Colorado is the only state in the Southwest region with an existing water heater replacement program, so the program begins in 2012 for all other states. Participation in 2012 starts at 0.1% and increases to 4% by 2020. Per unit energy savings are state-specific when data are available. Arizona and Nevada are the only two states for which state-specific data were not available, so we use savings data from other states with similar climates to fill this gap. Costs are from Xcel 2010 and PacifiCorp 2011b.

***10. Home Energy Reports and Information Feedback***

Program Design: This program helps customers manage their energy use by providing comparative reports through the mail and/or internet as well as suggesting tailored actions that each household can take to reduce its electricity use. The program also includes promotion of, and incentives for, in-home information feedback devices, particularly in the latter part of the decade when smart meters are likely to be commonplace.

Target Market: All residential customers.

Marketing Approach: The program is marketed through mass media advertising as well as utility communications channels such as the program website, bill stuffers, and customer newsletters.

Efficiency Measures: Home Energy Reports include recommendations that vary depending on a household's energy consumption patterns and other characteristics. The information feedback portion of the program involves in-home displays, which may be linked to a smart meter.

Financial Incentives and Other Services: Home Energy Reports are provided to households free of charge, with all costs paid by the utility efficiency program. Customers participating in the information feedback/in-home display portion of the program receive a $100 rebate toward the purchase and installation of this equipment.

Program References and Methodology: There is growing experience with Home Energy Reports demonstrating that it is a cost-effective addition to utility efficiency programs. For energy savings estimates, we make use of a number of assessments of behavioral programs around the country. We assume that by 2017, 100% of households are either receiving Home Energy Reports or have installed an in-home display. For Home Energy Reports, participation begins at 5% in 2012 and ramps up to 92% by 2017, but falls to 80% by 2020 as more consumers shift towards the real-time information feedback part of the program. For information feedback, participation begins at 0% in 2012 and gradually ramps up to 20% by 2020. Savings vary across the two program areas and are a function of the average electricity consumption per household across all housing types. We assume Home Energy Reports result in energy savings of 1.9% of total household electricity consumption on average and that in-home displays result in 8% savings on average (EPRI 2010a and Faruqui et. al 2011). We believe these savings estimates are conservative given recent evaluations of successful Home Energy Reports and real-time information feedback programs (Agnew et al. 2012; MacLaury et al. 2012). Costs are derived from EPRI 2010a. Participant costs apply only to the in-home display portion of the program, and only for the first-time buyers of the in-home display device.

**Commercial and Industrial Energy Efficiency Programs**

***1. Commercial New Construction and Code Support***

Program Design: This program includes two sub-programs that interact. The first element is a new-construction design assistance and incentive program that provides incentives for energy-saving measures that exceed building code requirements for commercial buildings. The second element is a program to promote upgrades to state or local building energy codes and training to strengthen code enforcement and compliance. More specifically, we propose that utilities provide analysis, networking and political advocacy in support of code upgrades as well as training of builders, contractors, and code officials to help increase code compliance. This helps support code updates that take effect in 2014 and 2019. The two programs interact in that the design assistance and incentive program helps lay the groundwork for code upgrades, and the code upgrades result in long-term market transformation.

Target Market: New commercial building construction.

Marketing Approach: The new construction component will be promoted through outreach to property developers, architects and engineers. This might include breakfast meetings and one-on-one visits as each developer and architecture/engineering firm is typically involved in multiple projects.

Code support marketing will involve outreach to public officials as well as promotion of training targeted to builders, contractors, and local code officials.

Efficiency Measures: Measures include improved lighting; high efficiency HVAC systems; building envelope improvements such as high efficiency windows and cool roofs; energy management and control systems; and other energy-efficient equipment. In addition, energy savings can be increased significantly and costs can be reduced through improved building design that integrates the various components together in optimal ways.

Financial Incentives and Other Services: Utilities pay building owners per unit of energy savings, typically about half to two-thirds of the incremental cost of upgrading the building envelope and equipment to achieve energy savings. Design assistance is also provided free of charge (up to some limit) to the architect or building design team. Code support activities are paid by utilities.

Program References and Methodology: For the new construction incentive component, the program assumptions are based on programs implemented by Connecticut Light & Power (CL&P) and United Illuminating (UI) in Connecticut, National Grid in Massachusetts, and Southern California Edison (SCE) (CEEF 2011, Massachusetts Energy Efficiency Advisory Council 2011, Hawkins 2011). We first estimate eligible participants by developing a new construction forecast using national projections for new and existing commercial building floorspace from EIA's *Annual Energy Outlook* and estimating state-specific shares using commercial-sector employment projections from Moody's Analytics (www.economy.com). Future participation rates are estimated from national best practices, including National Grid and Northeast Utilities (NU) which are achieving over 50% participation in Massachusetts, Rhode Island and Connecticut (McAteer 2008). We assume that utilities in the southwest states can ramp up to this participation level over 5 years. For the incentive portion of the program, we estimate an average of 20% savings until a new energy code takes effect in 2014 (Hawkins 2011). After the new code takes effect, all new buildings improve in energy efficiency. We estimate an average 25% savings relative to buildings built to meet the previous model energy code, in line with the savings for the ASHRAE 90.1-2010 code (Thornton et al. 2011). We estimate another round of code changes five years later (i.e., in 2019) with the new code saving an additional 25%. For example, ASHRAE is targeting 20% savings from the 2013 version of their standard; savings targets have not yet been set for the 2016 standard. We estimate program costs, including both incentives and marketing/administrative costs, for the incentive program based on data from SCE and CL&P (CEEF 2011, SCE 2011).

### 2. *Small Business Direct Install*

Program Design: This program involves utilities hiring contractors to audit facilities consuming less than 250,000 kWh/year (i.e., around 200 kW in peak demand) and to then install cost-effective measures at a modest cost to customer. This is a direct-installation program, which means that the contractors do the audit and installation work, while the customers simply have to enroll in the program and approve specific measures.

Target Market: Small commercial buildings and industrial facilities.

Marketing Approach: Contractors reach out to eligible customers, typically going neighborhood by neighborhood so that costs can be minimized for marketing and audits. Utility bill inserts and other communications can be used to notify customers when contractors will be in their areas.

Efficiency Measures: Mostly lighting measures (e.g. CFLs, "super T8" lamps and ballasts, and pulse metal-halide fixtures) but also control measures such as for refrigeration and HVAC equipment.

Financial Incentives and Other Services: The program pays audit costs and approximately 70% of measure and installation cost, and the building owner (or tenant) pays the remainder of the cost. This gives the customer some buy-in, but the incentive is large enough so that the payback is relatively short. In addition, we recommend that utilities offer to finance the customer share of the cost either directly or through a third party financing entity. In most cases, the monthly loan payment will be less than the monthly energy savings, thereby making the efficiency upgrades cash flow-positive to the small business.

Program References and Methodology: The program assumptions are based on best practice programs implemented by Southern California Edison (SCE), as well as the Massachusetts and Connecticut utilities (CEEF 2011; Massachusetts Energy Efficiency Advisory Council 2011; Hawkins 2011). Small commercial and industrial customers using less than 250,000 kWh per year are eligible for this program. We start with data on total number of existing C&I customers by state for 2009 (EIA 2011b), and we estimate that 83% of these are eligible for the program based on data for the U.S. Mountain region (EIA 2008b). To project total eligible customers through 2020, we include some new construction but assume that most is already relatively energy-efficient due to building energy codes or utility new construction incentive programs. We start with existing participation rates if a program is currently offered in a state; based on participation results from best practice programs (cites above), we estimate that utilities can reasonably ramp up to about 3% participation per year by 2014. Participant savings and costs are based on the same best practice programs referenced above.

### *3. Custom Retrofits, Process Efficiency, and Self-Direct*

Program Design: This program provides energy engineering technical assistance and incentives to large business customers for specialized projects requiring project-specific energy savings analysis. The program provides custom rebates on a wide variety of equipment, retrofits, and process improvements that do not fall within the prescriptive rebates, and therefore operates as a complement to the more streamlined prescriptive rebate program. Custom efficiency projects require pre-approval before installation to ensure that projects are cost-effective and meet other program requirements.

The program promotes continuous energy improvement in order to promote deep and ongoing energy savings by large customers. Model programs include the Process Efficiency program implemented by Xcel Energy in Colorado, the FinAnswer program implemented by Rocky Mountain Power in Utah, and the Energy Leadership Challenge program implemented by Efficiency Vermont. The latter is ramping up its large customer technical support and custom incentive program to achieve 7.5% savings over two years from its largest customers. To emphasize continuous improvement, programs use tools like Strategic Energy Management principles and the new ISO Standard 50001, both of which help companies establish the systems and processes to achieve ongoing and deep improvements in energy performance.

Under this program large customers also can have the option to "self-direct" their cost-effective equipment replacements and custom efficiency opportunities in their facilities, obtaining credits that can be used to offset the company's utility bill surcharge for energy efficiency programs rather than rebates. In this option, however, the customer is responsible for providing the energy engineering work as well as documenting the energy savings.

Target Market: Large commercial and industrial (C&I) customers are eligible for this program. The size threshold will vary depending on the utility. The definition for large customers varies in the region from a peak demand greater than 500 kW (e.g. Xcel Energy in Colorado) to a peak load of at least 1,000 kW (e.g. Rocky Mountain Power in Utah).

Marketing Approach: One-on-one account management and support with large C&I customers.

Efficiency Measures: The program includes a wide variety of equipment and process efficiency improvements.

Financial Incentives and Other Services: The program provides energy engineering assistance and custom rebates. For the self-direct option, incentives can be provided in the form of credits used to offset the customer energy efficiency services charge.

Program References and Methodology: We examined regional and national best practice programs such as the Rocky Mountain Power FinAnswer Program (RMP 2010a; 2010b), Xcel Colorado Process Efficiency (Xcel 2011b; 2011c), and programs offered by Energy Trust of Oregon and Efficiency Vermont. We start with data for total number of existing statewide C&I customers (EIA 2009), and we assume that all industrial customers are eligible and all large commercial customers that do not qualify for the small business program are eligible (i.e. about 17% of customers). To project total eligible customers through 2020, we develop a customer growth rate as described above under new commercial building construction. We start with existing participation rates if a program is currently offered. Based on participation results from best practice programs, we estimate that states in the Southwest can ramp up to participation levels of about 1% to 1.5% of eligible customers per year. Participant savings and costs are based on the same best practice programs as above. Program savings per participant were based on existing programs if offered in the state, and when those savings estimates are not available we scaled the savings estimate from the Rocky Mountain Power program in Utah to the average size customer in the state (RMP 2010a; 2010b). Large C&I customer size can vary substantially, and our estimates for savings per participant represent an average savings.

### *4. Computer Efficiency and Other Plug Loads*

Program Design: The "plug load" end use in commercial buildings has increased in recent years and is projected to continue increasing faster than other end-uses. This program targets computers, which represent the largest category of plug loads in commercial buildings (Ecos Consulting 2011). Furthermore, business computers are replaced on average every four years, which presents a unique opportunity to capture ongoing program participation and energy efficiency upgrades.

This program takes two primary strategies to improve computer efficiency for business customers: (1) upstream incentives to computer and server manufacturers that produce and sell higher efficiency PCs, monitors and servers to business customers; and (2) desktop virtualization with direct rebates to business customers.

The first component would be administered by a third-party contractor that has developed a relationship with the computer industry. The contractor would provide incentives to manufacturers that sell qualified products in participating utilities' service territories, and the utilities then reimburse the contractor. Manufacturers use the incentives to promote efficient computers, monitors and servers, and to increase the number of products offered with high-efficiency power supplies.

The second component provides rebates to customers to implement a Virtualization Desktop Infrastructure (VDI), which uses less energy than traditional desktop computers and stores data on a server rather than local hard drives.

A third component involves utilities educating businesses about other low- and no-cost measures to improve the efficiency of existing plug load equipment. For example, power management settings for computer and imaging equipment, which are routinely disabled accidentally or intentionally, can be enabled manually or optimized through network-based power management software packages. Likewise, smart power strips can be employed to fully disconnect electronic devices when not in use.

Target Market: Business customers with desktop computers and servers.

Marketing Approach: For the upstream incentives, the program is administered through a third party contractor. Marketing efforts involve participating manufacturers promoting and supplying a greater number of efficient products in the service areas of utilities. Regarding the virtualization component, utilities market the programs through channels such as newsletters, business solution centers, websites, and direct contacts with customers.

Efficiency Measures: Measures include high-efficiency computers, monitors and servers, and Virtualization Desktop Infrastructure (VDI).

Financial Incentives and Other Services: The program provides rebates to manufacturers and direct customer rebates for VDI.

Program References and Methodology: We base this program on Xcel Energy's Computer Efficiency Program (Xcel 2011c). Savings per participant, participation rates, and costs per participant are based on Xcel's program (Xcel 2011c). We assume that the program also promotes no-cost and low-cost approaches to reducing plug load consumption, which could save 20-40% of electricity usage by plug loads in office buildings (ECOS Consulting 2011).

### *5. Prescriptive Rebates and Upstream Incentives*

Program Design: The program helps business customers improve the efficiency of their new or replacement lighting, motors, refrigeration and other equipment by providing prescriptive rebates on commonplace efficiency measures. Both new construction and retrofit customers would be eligible in the program. The program also administers upstream incentives to equipment distributors for selected products.

This type of utility energy efficiency program is well-established in the Southwest and throughout the U.S. Examples in the region include RMP's FinAnswer Express Program, NV Energy's Commercial Retrofit Incentives program, APS's Large Existing Facilities program, and Xcel Energy's various prescriptive rebate programs. These programs include a wide range of efficiency measures, but typically find that lighting measures provide 80% or more of the total energy savings. Other measures include efficiency improvements to food service, refrigeration, building shell, and motors.

In addition to direct rebates to consumers, this program includes upstream incentives for products such as high efficiency motors and rooftop AC units. Upstream rebates help to change stocking practices by distributors, and are used effectively by utilities such as NV Energy.

Over the next several years, utilities will need to take into account changes in federal energy efficiency standards for commercial and industrial equipment including lighting, motors, HVAC and refrigeration measures. For example, new federal standards for linear fluorescent lamps became effective on July 14, 2012. Most types of T12 linear fluorescent lamps, and some T8s, do not meet the new standards and can no longer be manufactured or imported to the U.S. Utilities and their customers will shift to other energy efficiency measures such as lighting controls and LED lamps and fixtures in order to continue achieving significant savings through utility programs (Rosenberg 2012). In addition, utilities and businesses will place greater emphasis on lighting design and systems-based approaches once the standards affect products at the retail level.

Target Market: This program mainly targets medium-sized commercial and industrial customers who do not participate in the custom program; however, customers could participate in both programs. The program also targets retrocommissioning program participants that might also be able to make equipment efficiency upgrades.

Marketing Approach: This includes rebates to customers, upstream market incentives, marketing through lighting and other contractors, as well as direct contacts between utilities and their business customers.

Efficiency Measures: High efficiency lighting devices, air conditioning equipment, motors, motor speed controls, refrigeration equipment, energy management and control systems, and more.

Financial Incentives and Other Services: Both prescriptive and system rebates are offered to end users (downstream) and trade allies such as retailers (upstream).

Program References and Methodology: Program references include Rocky Mountain Power, Xcel Energy and Vermont Energy Investment Corporation. All C&I customers are eligible for this program. We start with data for total number of existing C&I customers statewide (EIA 2009). To project total eligible customers through 2020, we develop a customer growth rate as described previously under new commercial building construction. We start with existing participation rates if a program is currently offered, then based on participation results from best practice programs we estimate that states in the Southwest can ramp up to 2-3% of customers participating per year from 2014 through 2020. Participant savings and costs are based on the same best practice programs as above (RMP 2010a; RMP 2010b; Xcel 2011b; Xcel 2011c; VEIC 2011).

### *6. Commercial Lighting Redesign*

Program Design: Customers (either building owners, property managers or tenants) will earn financial incentives based on the amount of electricity saved through redesigning lighting systems at the time commercial space is remodeled and/or taken over by a new tenant. The redesign reduces lighting power density and electricity consumption through use of better fixtures, appropriate lighting levels, use of task lighting, and better lighting controls. Through this systems approach, large amounts of energy savings are possible.

Target Market: Both existing and new buildings would be eligible to participate. However, for this analysis we include only existing buildings in order to avoid double counting savings with the Commercial New Construction program. In addition, we assume specific building types are targeted, and estimate savings based on the square feet of total commercial space comprised of lodging, office, mercantile/service, warehouse, and education building types.

Marketing Approach: Program promotion is focused upstream from commercial tenants by targeting building property managers, lighting designers and some equipment contractors to accelerate the design and installation high-efficiency, integrative design elements into newly built-out or remodeled commercial building space. Outreach is done before the lease terms are up, which reduces the need for re-design and helps building owners market their leased spaces.

Efficiency Measures: High efficiency lighting and controls (e.g., super T8 lamps, LEDs, and occupancy sensors) and harvesting sunlight through additional daylighting.

Financial Incentives and Other Services: The program offers incentives to building property managers and some equipment contractors to motivate them to collaborate with tenants to design and install high-efficiency lighting systems when commercial space is remodeled.

Program References and Methodology: Program references include the Energy Trust of Oregon (ETO 2011) and the New Buildings Institute's Office of the Future Consortium (NBI 2011). We first estimate eligible commercial building square footage in each state by starting with total commercial floor space estimates for the Mountain census region from the *2011 Annual Energy Outlook (AEO)* by EIA and apportion statewide estimates using employment data from Moody's Analytics (www.economy.com) as a proxy for commercial buildings. We assume that buildings are eligible at the time of occupancy change, which we estimate is every 8 years, and assumed that 82% of floorspace is applicable (accounting for office, education, mercantile/service, and warehouse buildings per data from AEO). We estimate that annual participation increases from 2% of eligible participants in 2012 to 30% by 2020. We estimate savings by starting with a baseline lighting power density (LPD) of 1.0 W/sf and multiply by 10.3 typical hours of operation per day (for office buildings per ASHRAE 90.1). We estimate 35% savings from a lighting upgrade in 2012 and 2013, but that savings drop to 25% in 2014 after the state adopts a new building code that is 10% tighter. Cost estimates are derived from California Title 24 incremental cost estimates for comprehensive lighting projects (CUSCST 2011).

### *7. Retrocommissioning*

Program Design: This program promotes the hiring of retrocommissioning contractors, with subsidies from the utility, to help building owners and managers "tune-up" their building systems. Retrocommissioning involves a study of what can be done to increase the energy efficiency of existing equipment and systems through low-cost adjustments, followed by implementing those measures with relatively short paybacks.

Target Market: This program targets owners and managers of large commercial buildings and industrial facilities. Most participants are owners and managers of commercial buildings but there has been increasing participation from the industrial sector (specifically for compressed air leak reduction and process controls optimization).

Marketing Approach: The utility pays 50-75% of the cost of retrocommissioning services. The program is marketed in conjunction with the Prescriptive Rebates and Upstream Incentives program and the Custom Retrofit program, so that if a project requires a capital equipment investment it is referred to another program. Retrocommissioning contractors help market the program, as do local peer-to-peer networks such as local hospitality, hospital and office building owner and manager associations.

Efficiency Measures: The program provides systematic tune-ups of energy management systems, air dampers, chilled water systems, and other building systems to restore building operations to their original design intent. The program trains and uses Retrocommissioning Service Providers (RSPs) to assist customers with their projects, delivering savings through no or low-cost improvements.

Financial Incentives and Other Services: Utilities pay 50-75% of the cost for retrocommissioning services. In addition, contractors may refer customers to other utility programs when capital measures are recommended.

Program References and Methodology: We first estimate a reference forecast of total business customers in the state using the forecast as described previously (under new commercial building construction), and then we estimate eligibility based on the proportion of commercial buildings over 100,000 square feet in the Mountain states (EIA 2008b). For participation rates, we start with actual program experience in states with utilities that are currently operating a program. If no program exists, we estimate a slow but steady ramp-up until two-thirds of customers are reached, then the rate of increase slows down with participation capped at 90%. Savings and costs per customer are based on Rocky Mountain Power's Retrocommissioning Program (RMP 2010a; 2010b).

### *8. Combined Heat and Power (CHP)*

Program Design: This program provides incentives to customers who install on-site combined heat and power (CHP) units, which generate electricity and utilize waste heat for space and/or water heating or industrial process needs. CHP units can be used in buildings or industries that have a fairly coincident thermal and electric load, where combustible biomass or biogas is produced, or where waste heat or pressure is available. CHP units have been traditionally installed in hospitals, schools, and manufacturing facilities, but they can be used across nearly all segments with an average annual energy load greater than about 30 kW.

This program provides a financial incentive for CHP systems that run on natural gas as well as waste fuels, waste heat, or excess pressure. Both commercial and industrial customers are eligible.

Target Market: The program targets large industrial customers and large commercial buildings, as well as institutional customers such as hospitals and universities.

Marketing Approach: The program is promoted through one-on-one account management with large C&I customers. Another option is for a utility to hire an energy engineer who would assist customers to evaluate CHP opportunities.

Efficiency Measures: Typically a natural gas-fired CHP system or systems that make use of waste materials, waste heat or excess pressure.

Financial Incentives and Other Services: Financial incentives (e.g., $500/kW installed) are provided to customers installing a CHP system.

Program References and Methodology: Estimated potential for achievable installed CHP capacity by 2020 and estimated costs are provided by SWEEP, based on PacifiCorp's energy efficiency potential study (PacifiCorp 2011b) and estimating that 10% of technical potential is achievable.

**Additional Programs**
The energy efficiency programs analyzed in this report are by no means an exhaustive list, but rather represent a robust set of best practice program strategies. There are a number of innovative programs not included in our list that are currently offered as either full or pilot programs by at least one utility in the region or nation. In some cases, the experience with these programs is still relatively limited and thus there remain uncertainties regarding energy savings and cost effectiveness. However, these innovative programs could be implemented to generate additional energy savings in southwest states during at some point during the decade. In addition, it should be recognized that utility energy efficiency programs are evolving and "Best Practices" improve over time (Bell et al. 2011). This means that there is likely to be additional cost-effective savings potential later in the decade not accounted for in this analysis.

***1. Community or Neighborhood Initiatives***
Direct interaction with communities can help boost participation in utility energy efficiency programs. For this reason, some utilities have started to go beyond traditional education programs, investing more funds in community initiatives that use trained community volunteers to provide energy efficiency education, promote utility efficiency programs, conduct walk-through assessments of home energy savings, and provide direct installation of energy saving products, such as efficient lighting and showerheads. A community-based energy efficiency program could take a number of different approaches, and could either stand alone as a separate program or be used to market participation in other programs.

As an example, the Vermont Community Energy Mobilization program implemented by Efficiency Vermont relies on community volunteers to conduct home energy visits in order to: 1) achieve quantifiable reductions in home energy use; and 2) increase customer awareness of home energy savings opportunities and resources, as well as other energy efficiency programs offered by the utility/agency (Efficiency Vermont 2009).

***2. Shade Trees***
Shade trees lower solar heat gain and therefore reduce energy usage for cooling. Placing shade trees in appropriate locations – whether on a residential property or an urban setting – can significantly reduce air conditioning loads in homes and commercial buildings, and some utilities are starting to promote greater use of shade trees through their efficiency programs. For example, Arizona Public Service Company (APS) offers a residential shade tree program that provides free shade trees to customers who have attended an APS Shade Tree workshop. The workshop is designed to educate customers on successful tree planting and care techniques and provides a customer-specific site map indicating the ideal tree planting location(s) for energy efficiency. Customers can qualify to receive between two and three free shade trees per residence.

***3. Conservation Resource Manager and Continuous Energy Improvement***
Utilities in the Pacific Northwest and elsewhere have had success funding or co-funding energy managers who work on energy savings initiatives in commercial or industrial facilities. The utilities also provide training and assist the energy managers in establishing energy savings goals and plans, and implementing a Continuous Energy Improvement strategy. For example, the Northwest Energy

Efficiency Alliance (NEEA) implemented a very successful Continuous Energy Improvement program with industries in the northwest region during 2006-2010, with energy savings of nearly 100 GWh per year as a result of this five-year effort (Smith, Siong and Sandin 2011). The program has since been adopted by the other program administrators including the Bonneville Power Administration (BPA), Puget Sound Energy, and Energy Trust of Oregon.

#### *4. Pre-pay Metering*

The Salt River Project (SRP) in Arizona offers a prepay program called M-Power that uses an in-home display monitor, a smart card and a payment kiosk network. Over 100,000 customers voluntarily participate in the program, thereby gaining greater control over many aspects of their electric service. The program allows customers to monitor electricity usage and costs with real-time information. The in-home display provides immediate feedback about home energy usage.

Energy can be purchased in any amount at nearly 100 kiosks in various locations. Customers pay an $87.50 equipment deposit for an in-home display unit that shows how minor changes in behavior can produce visible energy savings. According to SRP and Energy Policy Research Institute (EPRI), the program reduces customer energy use by an average of 12% annually (EPRI 2010b). However, it is unclear to what degree the program stimulates true reduction of energy waste and inefficiency, versus encouraging the typically low-income households that participate to forego electricity service for brief periods.

## C. Program Analysis

Total annual electricity consumption in the Reference and High Efficiency scenarios, and thus the resulting energy savings, are shown by state in Table 2-3 and Figure 2-1. In our High Efficiency scenario, we estimate that by 2020 the Southwest region would save nearly 50,000 GWh or 21% relative to projected electricity sales that year in the High Efficiency scenario. The savings in 2020 is equivalent to the electricity use of 4.6 million typical households in the region. In the High Efficiency scenario, there is minimal load growth during 2010-20 for the region as a whole. Although we examined impacts of programs implemented through 2020 only, savings would continue to occur through 2030 as described previously in the Methodology section (see Figure 2-1).

Considering state contributions to total energy savings, Arizona and Colorado contribute the largest portion of savings, together comprising about 57% of total annual savings in 2020. We estimate that Nevada, Utah and New Mexico would each contribute 10-14% of the total energy savings, and that Wyoming would contribute about 6.5% of the total.

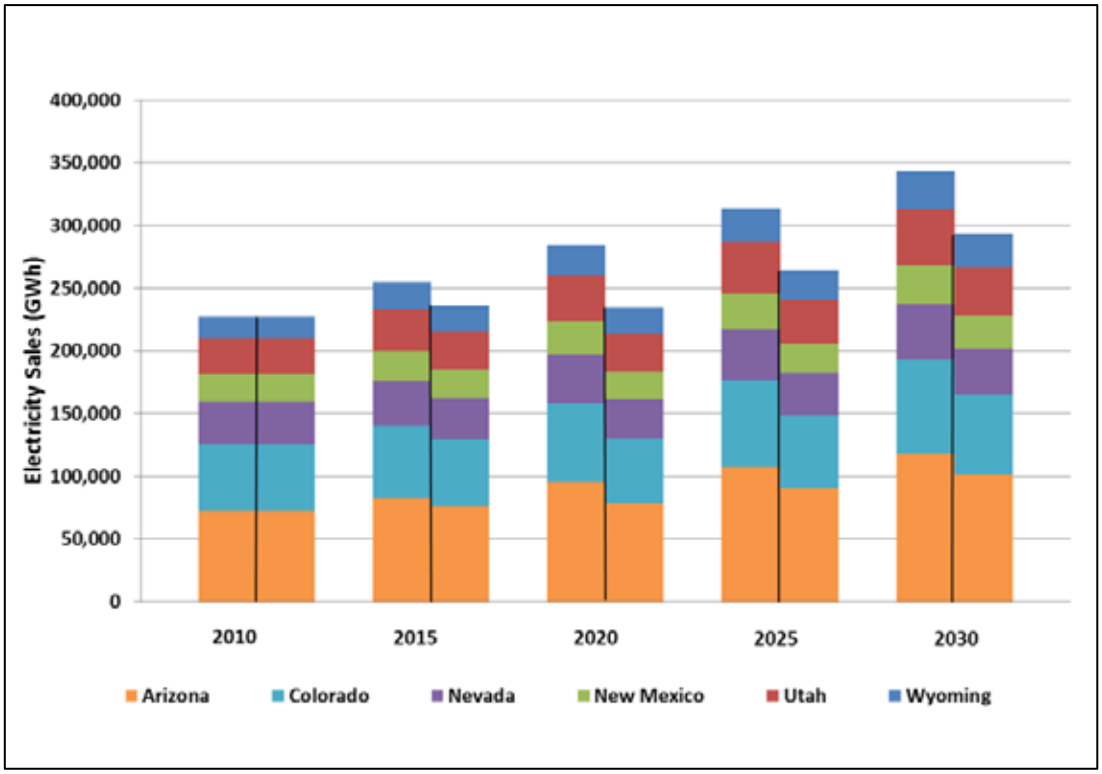
### Regional Results

Table 2-3. Total Annual Electricity Savings by State in the High Efficiency Scenario (GWh)

| State | Electricity Savings in 2010 | Electricity Savings in 2015 | Electricity Savings in 2020 | Projected Electricity Sales in 2020 | Savings in 2020 as % of 2020 Sales |
|---|---|---|---|---|---|
| Arizona | 695 | 6,059 | 16,713 | 78,111 | 21% |
| Colorado | 285 | 4,373 | 11,495 | 51,538 | 22% |
| Nevada | 304 | 2,722 | 7,040 | 31,321 | 22% |
| New Mexico | 87 | 1,863 | 5,110 | 21,370 | 24% |
| Utah | 194 | 2,455 | 6,234 | 30,757 | 20% |
| Wyoming | 17 | 1,143 | 3,238 | 20,771 | 15% |
| **Total Regional Savings** | **1,582** | **18,615** | **49,828** | **234,469** | **21%** |
| Reference scenario electricity use* | 227,109 | 254,642 | 284,298 | 284,298 | NA |
| High Efficiency scenario electricity use* | 227,109 | 236,027 | 234,469 | 234,469 | NA |

**2010 sales are adjusted for savings generated by programs in the 2010 program year, so the sales in the Reference and High Efficiency scenarios are the same for 2010.*

Figure 2-1. Electricity Use by State in the Reference and High Efficiency Scenarios




*Notes: Column on the left for each year shows the Reference scenario while the column on the right for each year shows the High Efficiency scenario. 2010 shows actual electricity sales data.*

Table 2-4. Total Annual Peak Demand Reduction by State in the High Efficiency Scenario (MW)

| State | Peak Demand Savings in 2010 | Peak Demand Savings in 2015 | Peak Demand Savings in 2020 | Peak Demand in 2020 | Savings in 2020 as % of Demand |
|---|---|---|---|---|---|
| Arizona | 111 | 1,183 | 3,239 | 21,486 | 15% |
| Colorado | 52 | 861 | 2,213 | 11,020 | 20% |
| Nevada | 53 | 645 | 1,745 | 8,096 | 21% |
| New Mexico | 10 | 351 | 973 | 4,719 | 20% |
| Utah | 29 | 450 | 1,144 | 6,312 | 18% |
| Wyoming | 1 | 132 | 367 | 2,561 | 14% |
| **Total Regional Savings** | **257** | **3,622** | **9,681** | **54,194** | **18%** |
| Reference scenario peak demand* | 52,009 | 57,651 | 63,875 | 63,875 | NA |
| High Efficiency scenario peak demand* | 52,009 | 54,029 | 54,194 | 54,194 | NA |
| **2010 peak load requirements are adjusted for savings generated by efficiency programs in the 2010 program year, so the peak load requirements in the Reference and High Efficiency scenarios are the same for 2010.* | | | | | |

Achieving 20% or greater savings by 2020 is consistent with the energy savings requirements adopted by the Arizona Corporation Commission for investor-owned electric utilities in the state. It is also consistent with savings standards or targets adopted in Delaware, Maryland, Massachusetts, New Jersey, New York, Rhode Island and Vermont (Sciortino et al. 2011; Prindle et al. 2011).

Figure 2-2 shows the relative contribution of each customer sector to total energy savings in 2020. We estimate that the majority of electricity savings (64%) would result from commercial and industrial programs, while residential programs would provide the remainder (36%). This result is related to the fact that commercial and industrial customers account for the majority of electricity use in the region. Figures 2-3 and 2-4 provide further detail about the savings contribution from each of the programs. Regarding residential programs, lighting and home energy reports/ information feedback are the single largest sources of energy savings in 2020, together accounting for 39% of total savings in the sector. Regarding commercial and industrial programs, prescriptive and custom rebate programs provide the most energy savings in 2020, together accounting for 49% of total savings in the sectors. However, all programs are needed to achieve the substantial energy savings represented by the High Efficiency scenario.

Table 2-5 shows the estimated utility program costs by state and year, while Table 2-6 shows the combination of utility and participant costs. As noted previously, programs are analyzed through 2020 but participant investments are assumed post-2020 in order to maintain the energy savings occurring in 2020 for the following decade; i.e., replacing energy efficiency measures when they wear out. Table 2-5 shows that a significant increase in energy efficiency investment is required on the part of utilities in order to achieve 20% or greater energy savings in 2020 (in all states except Wyoming). Expressed in 2010 dollars, utility program costs for the region as a whole increase to about $1.1 billion in 2015 and nearly $1.8 billion in 2020 in the High Efficiency scenario. For comparison, electric utilities in the region spent about $185 million on efficiency programs in 2010 and SWEEP estimates they will spend about $300 million on such programs in 2012. Clearly, large and rapid increases in energy efficiency program funding are required to implement the High Efficiency scenario. But such levels of energy efficiency funding are not impossible to envision given that electric utilities in the region had revenues of $20 billion from retail electricity sales as of 2010, and revenues have risen since then due to rate increases and load growth in some states.[4] Also, it is worth noting that southwest states demonstrated the ability to rapidly expand certain types of energy efficiency programs when funding to do so was provided through the American Recovery and Reinvestment Act of 2009 (ARRA).

[4] For data on utility sales revenues by state, see http://www.eia.gov/electricity/sales_revenue_price/pdf/table3.pdf.

Considering the combination of program and participant costs, the total investment in energy efficiency measures reaches nearly $2.0 billion in 2015 and $3.3 billion in 2020, while the amount that households and businesses need to spend to maintain energy savings after 2020 averages about $480 million per year (2010 dollars). On a net present value basis assuming a 5% real discount rate, we estimate that utilities in the region would need to invest about $8.2 billion in energy efficiency programs during 2010-2020 in order to realize the net energy savings in the High Efficiency scenario. Households and businesses would need to invest about $9.1 billion during 2010-2030 (participant costs after utility rebates are taken into account), meaning a total investment of $17.3 billion on a net present value basis.

**Figure 2-2. Region: Total Annual Electricity Savings in 2020 by Sector (GWh)**

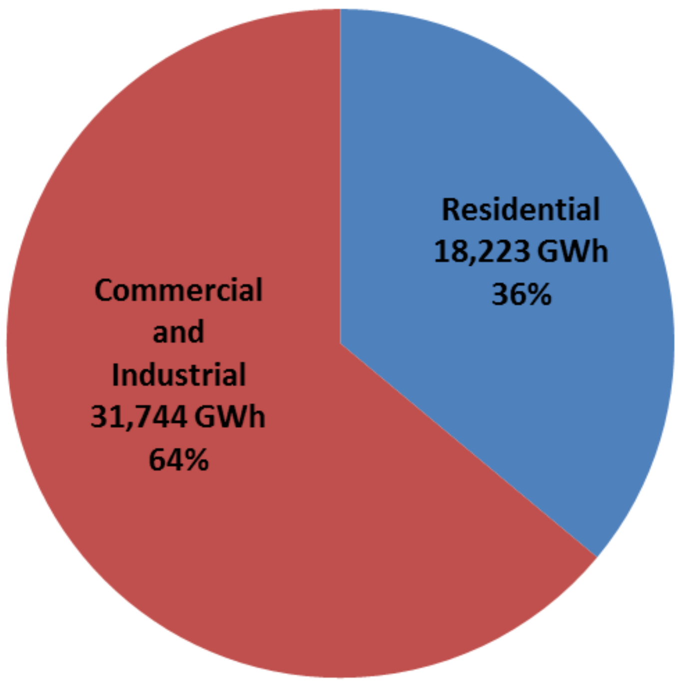


**Figure 2-3. Region: Total Annual Residential Electricity Savings in 2020 by Program (GWh)**

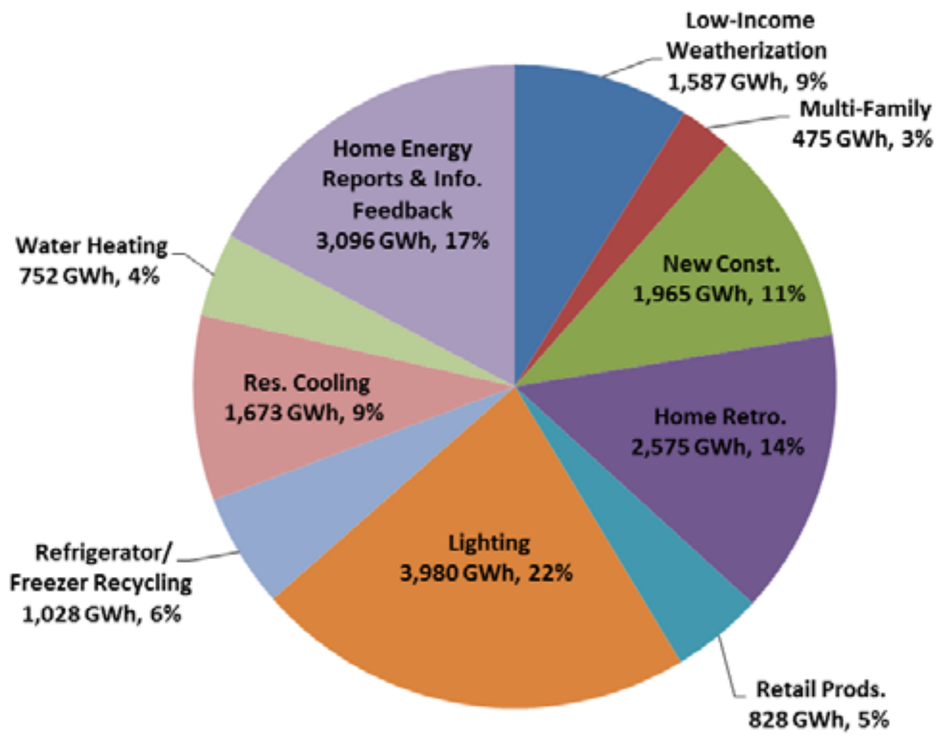



**Figure 2-4. Region: Total Annual Business Electricity Savings in 2020 by Program (GWh)**

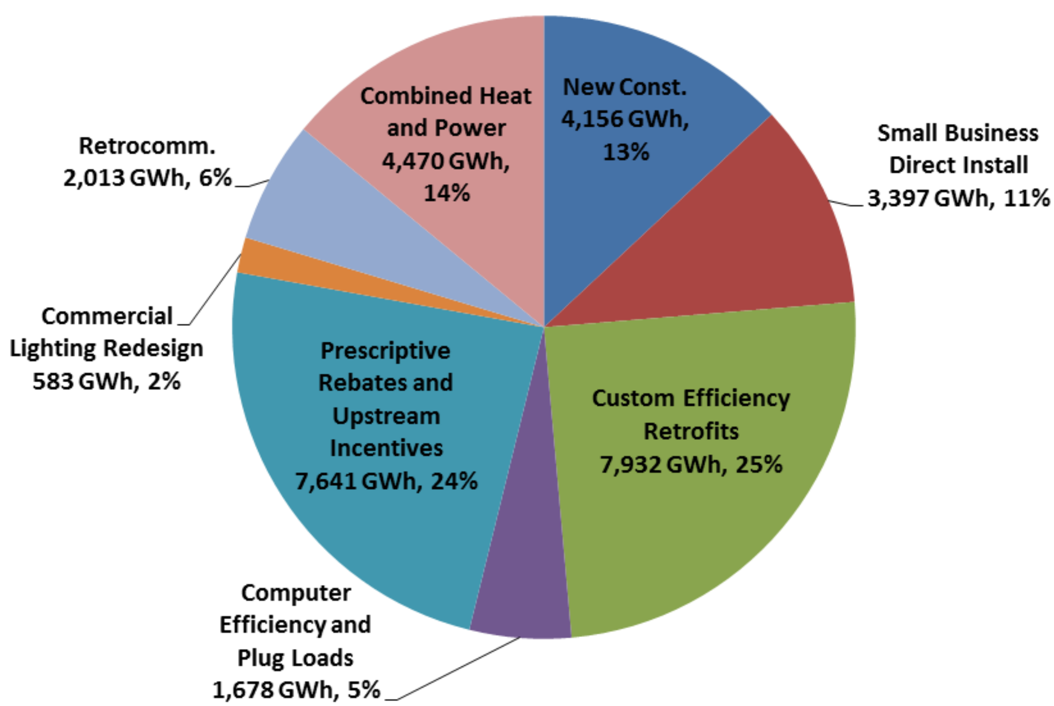


Table 2-5. Program Costs by State (Million dollars)

| State | Annual Cost 2010 | Annual Cost 2015 | Annual Cost 2020 | Net Present Value through 2020 |
|---|---|---|---|---|
| Arizona | 54 | 377 | 623 | 2,767 |
| Colorado | 43 | 257 | 404 | 1,918 |
| Nevada | 29 | 152 | 248 | 1,137 |
| New Mexico | 15 | 121 | 191 | 877 |
| Utah | 40 | 138 | 214 | 1,052 |
| Wyoming | 4 | 71 | 101 | 480 |
| **Total Regional Costs** | **185** | **1,116** | **1,780** | **8,230** |

Table 2-6. Program Plus Participant Costs by State (Million dollars)

| State | Annual Cost 2010 | Annual Cost 2015 | Annual Cost 2020 | Annual Cost 2025 | Annual Cost 2030 | Net Present Value through 2030 |
|---|---|---|---|---|---|---|
| Arizona | 77 | 642 | 1,077 | 142 | 301 | 5,459 |
| Colorado | 89 | 464 | 749 | 80 | 215 | 4,104 |
| Nevada | 81 | 274 | 464 | 351 | 123 | 2,590 |
| New Mexico | 25 | 221 | 361 | 26 | 103 | 1,854 |
| Utah | 65 | 250 | 402 | 49 | 122 | 2,241 |
| Wyoming | 6 | 143 | 211 | 11 | 78 | 1,107 |
| **Total Regional Costs** | **343** | **1,994** | **3,264** | **625** | **945** | **17,343** |

**Arizona**

Tables 2-7 and 2-8 show the overall energy savings and peak demand reduction results for Arizona. The energy savings, about 16,700 GWh/yr in 2020, are equivalent to about 21% of projected statewide electricity consumption in the High Efficiency scenario that year. The savings in 2020 are also equivalent to the electricity use of 1.4 million typical households in Arizona. The energy savings are sufficient to meet Arizona's energy efficiency resource standards for investor-owned utilities, and the savings are also extended to other utilities not subject to the standards. The peak demand reduction in the High Efficiency scenario, 3,239 MW in 2020, is equivalent to about 15% of projected statewide peak demand in the High Efficiency scenario that year. There remains some growth in electricity consumption and peak demand in Arizona in the High Efficiency scenario, but far less than that in the Reference scenario.

Figure 2-5 shows the breakdown of energy savings in Arizona in 2020 by sector from programs implemented during 2010-2020. Figure 2-6 shows the breakdown by program for residential programs, and Figure 2-7 shows the breakdown for commercial and industrial programs. Lighting and home energy reports plus information feedback are the most important residential programs, followed by home retrofit, new construction and cooling programs. Prescriptive rebates and custom incentives are the most important C&I programs, followed by commercial new construction. Table 2-9 shows the energy savings levels for each program per year, for selected years, as well as the total savings in 2020.

**Table 2-7. Arizona: Total Annual Electricity Savings by Year (GWh)**

| Electricity Savings (GWh) | 2010 | 2015 | 2020 | Savings in 2020 as % of Sales |
|---|---|---|---|---|
| Residential | 397 | 2,689 | 7,369 | 21.0% |
| Commercial and Industrial | 297 | 3,370 | 9,344 | 21.6% |
| **Total Savings** | **695** | **6,059** | **16,713** | **21.3%** |
| Reference scenario electricity use* | 72,833 | 82,308 | 95,424 | NA |
| High Efficiency scenario electricity use* | 72,833 | 76,249 | 78,711 | NA |

**2010 sales are adjusted for savings generated by programs in the 2010 program year, so the sales in the Reference and High-EE cases are the same for 2010.*

Table 2-8. Arizona: Total Annual Peak Demand Savings by Year (MW)

| Peak Demand Savings (MW) | 2010 | 2015 | 2020 | Savings in 2020 as % of Peak |
|---|---|---|---|---|
| Residential | 91 | 610 | 1,681 | NA |
| Commercial and Industrial | 20 | 573 | 1,558 | NA |
| **Total Savings** | **111** | **1,183** | **3,239** | **15.2** |
| Reference scenario peak demand* | 18,872 | 21,327 | 24,725 | NA |
| High Efficiency scenario peak demand* | 18,872 | 20,144 | 21,486 | NA |
| **2010 peak load requirements are adjusted for savings generated by efficiency programs in the 2010 program year, so the peak load requirements in the Reference and High-EE cases are the same for 2010.* | | | | |

Figure 2-5. Arizona: Cumulative Electricity Savings in 2020 by Sector (GWh)

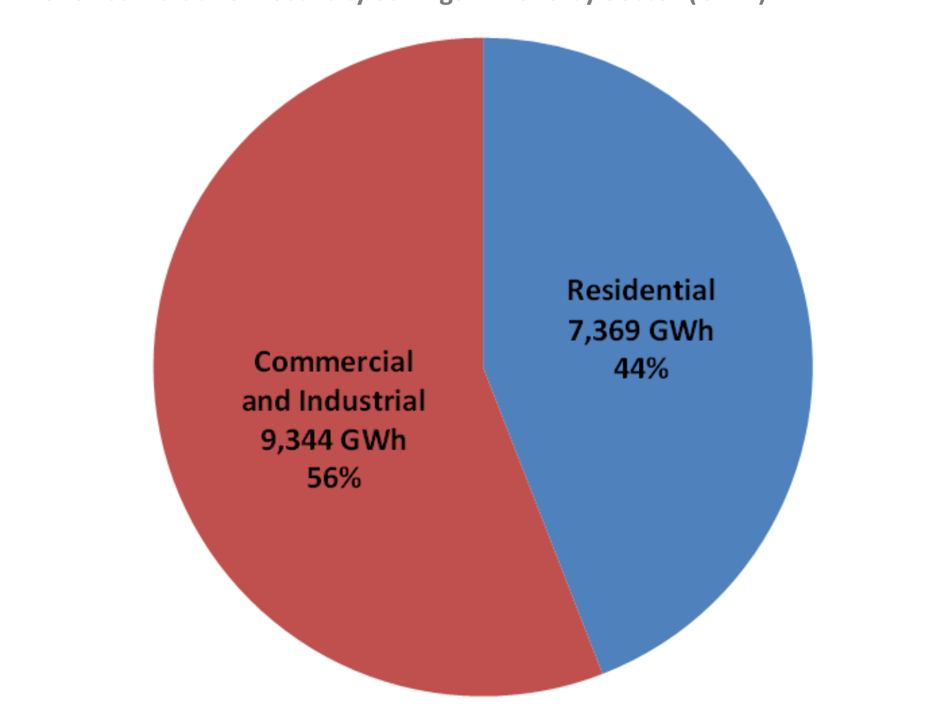


Figure 2-6. Arizona: Total Annual Residential Electricity Savings in 2020 by Program (GWh)

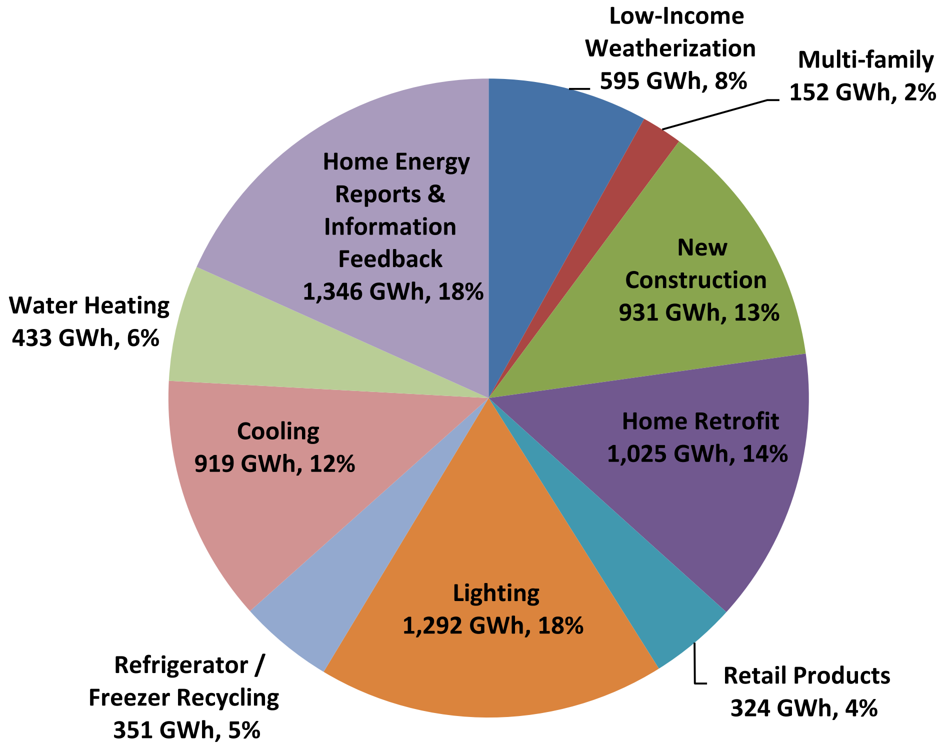



Figure 2-7. Arizona: Total Annual C&I Electricity Savings in 2020 by Program (GWh)

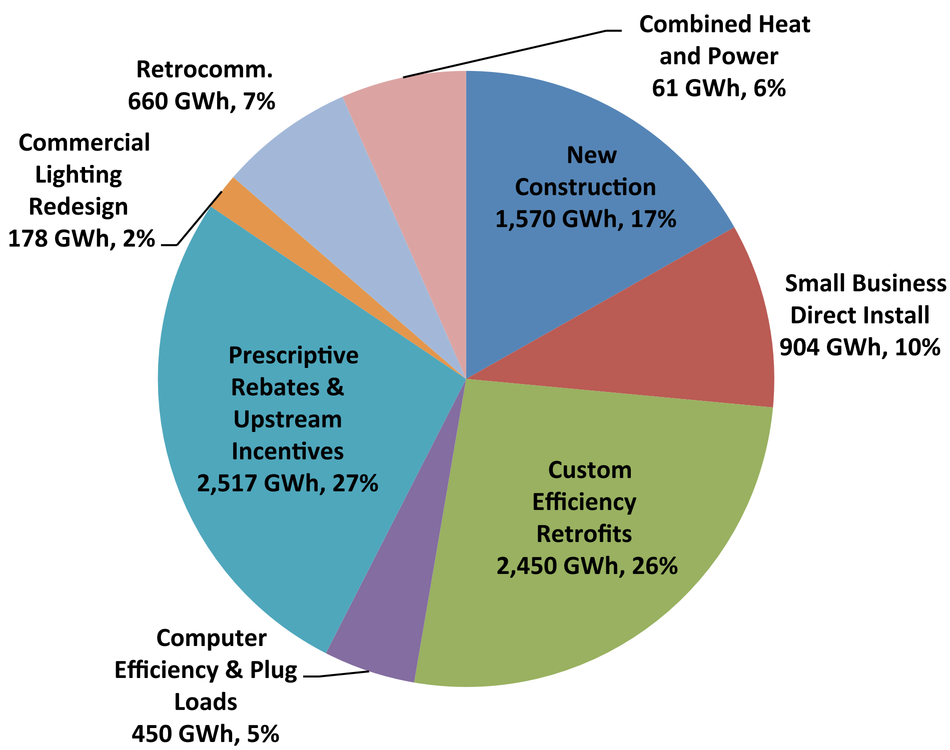


Table 2-9. Arizona: Incremental Annual Electricity Savings by Program (GWh)

| Sector and Program | 2010 | 2015 | 2020 | Total Annual Savings in 2020 |
|---|---|---|---|---|
| ***Residential Programs*** | | | | |
| Low-Income Weatherization | 1 | 58 | 108 | 595 |
| Multi-family | - | 15 | 25 | 152 |
| New Construction | 9 | 109 | 116 | 931 |
| Home Retrofit | 12 | 86 | 198 | 1,025 |
| Retail Products | 2 | 35 | 62 | 324 |
| Lighting | 176 | 69 | 203 | 1,292 |
| Refrigerator / Freezer Recycling | 16 | 33 | 33 | 351 |
| Cooling | 3 | 102 | 154 | 919 |
| Water Heating | - | 33 | 102 | 433 |
| Home Energy Reports & Information Feedback | 178 | 682 | 1,346 | 1,346 |
| ***Residential Subtotal*** | ***397*** | ***1,224*** | ***2,347*** | ***7,369*** |
| ***Commercial and Industrial Programs*** | | | | |
| New Construction | 15 | 163 | 315 | 1,570 |
| Small Business Direct Install | 21 | 106 | 114 | 904 |
| Custom Efficiency Retrofits | 140 | 231 | 350 | 2,450 |
| Computer Efficiency & Plug Loads | - | 18 | 112 | 450 |
| Prescriptive Rebates & Upstream Incentives | 120 | 249 | 298 | 2,517 |
| Commercial Lighting Redesign | - | 11 | 38 | 178 |
| Retrocommissioning | 3 | 128 | 49 | 660 |
| Combined Heat and Power | - | 68 | 68 | 614 |
| ***Commercial and Industrial Subtotal*** | ***297*** | ***975*** | ***1,345*** | ***9,344*** |
| **Total** | **695** | **2,199** | **3,692** | **16,713** |

Table 2-10 shows the estimated utility program costs in Arizona in 2010, 2015 and 2020. Total program costs reach $377 million in 2015 and $623 million in 2020, in 2010 dollars. Table 2-11 shows the combination of program and participant costs, which are about 70-75% greater than the program costs alone. A large ramp-up in programs statewide is required to achieve the substantial energy savings in the High Efficiency scenario.

**Table 2-10. Arizona: Annual Program Costs (Million dollars)**

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 2.3 | 40.8 | 79.3 |
| Multi-family | - | 6.4 | 10.7 |
| New Construction | 2.1 | 24.9 | 18.3 |
| Home Retrofit | 10.4 | 11.3 | 25.9 |
| Retail Products | 0.7 | 3.8 | 12.0 |
| Lighting | 6.1 | 11.5 | 18.5 |
| Refrigerator / Freezer Recycling | 3.7 | 12.1 | 13.8 |
| Cooling | 3.0 | 37.1 | 71.9 |
| Water Heating | - | 15.6 | 47.4 |
| Home Energy Reports & Information Feedback | 0.5 | 25.5 | 44.8 |
| ***Residential Subtotal*** | ***28.7*** | ***189.0*** | ***342.6*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | 3.4 | 18.8 | 28.1 |
| Small Business Direct Install | 2.4 | 45.6 | 49.0 |
| Custom Efficiency Retrofits | - | 40.5 | 70.1 |
| Computer Efficiency & Plug Loads | - | 1.3 | 14.9 |
| Prescriptive Rebates & Upstream Incentives | 19.4 | 56.1 | 89.5 |
| Commercial Lighting Redesign | - | 4.9 | 16.9 |
| Retrocommissioning | - | 13.9 | 5.3 |
| Combined Heat and Power | - | 6.7 | 6.7 |
| ***Commercial and Industrial Subtotal*** | ***25.3*** | ***187.7*** | ***280.4*** |
| **Total** | **54.0** | **376.7** | **623.0** |

Table 2-11. Arizona: Annual Costs, Program plus Participants (Million dollars)

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 2.3 | 40.8 | 79.3 |
| Multi-family | - | 6.7 | 11.2 |
| New Construction | 3.3 | 44.2 | 30.8 |
| Home Retrofit | 10.4 | 15.9 | 36.4 |
| Retail Products | 0.7 | 7.7 | 24.6 |
| Lighting | 6.1 | 25.5 | 40.8 |
| Refrigerator / Freezer Recycling | 3.7 | 12.1 | 13.8 |
| Cooling | 3.6 | 44.1 | 88.1 |
| Water Heating | - | 30.8 | 90.1 |
| Home Energy Reports & Information Feedback | 0.5 | 28.4 | 51.8 |
| ***Residential Subtotal*** | ***30.5*** | ***256.1*** | ***467.0*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | 5.0 | 57.1 | 107.2 |
| Small Business Direct Install | 2.4 | 65.1 | 69.9 |
| Custom Efficiency Retrofits | - | 80.9 | 140.2 |
| Computer Efficiency & Plug Loads | - | 2.2 | 20.7 |
| Prescriptive Rebates & Upstream Incentives | 39.5 | 112.2 | 179.0 |
| Commercial Lighting Redesign | - | 10.1 | 34.6 |
| Retrocommissioning | - | 27.8 | 10.6 |
| Combined Heat and Power | - | 30.8 | 47.9 |
| ***Commercial and Industrial Subtotal*** | ***47.0*** | ***386.2*** | ***610.1*** |
| **Total** | **77.5** | **642.3** | **1,077.1** |

**Colorado**

Tables 2-12 and 2-13 show the overall energy savings and peak demand reduction results for Colorado. The energy savings in the High Efficiency scenario, about 11,500 GWh/yr in 2020, are equivalent to about 22% of projected statewide electricity consumption in the High Efficiency scenario that year. The savings in 2020 are also equivalent to the electricity use of 1.3 million typical households in Colorado. The peak demand reduction in the High Efficiency scenario, 2,213 MW in 2020, is equivalent to about 20% of projected statewide peak demand in the High Efficiency scenario that year. In addition, both electricity consumption and peak demand in 2020 are slightly below the levels in 2010 in the High Efficiency scenario, thereby facilitating retirement of older, dirtier power plants.

Figure 2-8 shows the breakdown of energy savings in Colorado in 2020 by sector from programs implemented during 2010-2020. Figure 2-9 shows the breakdown by program for residential programs, and Figure 2-10 shows the breakdown for commercial and industrial programs. Lighting is the most important residential program, followed by home energy reports plus information feedback and home retrofit. Prescriptive rebates are the most important C&I program, followed by custom rebates, small business direct installation, and combined heat and power programs. Table 2-14 shows the energy savings levels for each program per year, for selected years, as well as the total savings in 2020.

Table 2-12. Colorado: Total Annual Electricity Savings by Year (GWh)

| Electricity Savings (GWh) | 2010 | 2015 | 2020 | Savings in 2020 as % of Sales |
|---|---|---|---|---|
| Residential | 102 | 1,454 | 3,650 | 20.0% |
| Commercial and Industrial | 183 | 2,918 | 7,845 | 23.4% |
| **Total Savings** | **285** | **4,373** | **11,495** | **22.2%** |
| Reference scenario electricity use* | 52,918 | 57,634 | 63,033 | NA |
| High Efficiency scenario electricity use* | 52,918 | 53,261 | 51,538 | NA |
| **2010 sales are adjusted for savings generated by programs in the 2010 program year, so the sales in the Reference and High-EE cases are the same for 2010.* | | | | |

Table 2-13. Colorado: Total Annual Peak Demand Savings by Year (MW)

| Peak Demand Savings (MW) | 2010 | 2015 | 2020 | Savings in 2020 as % of Peak |
|---|---|---|---|---|
| Residential | 16 | 301 | 777 | NA |
| Commercial and Industrial | 35 | 560 | 1,436 | NA |
| **Total Savings** | **52** | **861** | **2,213** | **19.8%** |
| Reference scenario peak demand* | 11,906 | 12,569 | 13,233 | NA |
| High Efficiency scenario peak demand* | 11,906 | 11,708 | 11,020 | NA |
| **2010 peak load requirements are adjusted for savings generated by efficiency programs in the 2010 program year, so the peak load requirements in the Reference and High-EE cases are the same for 2010.* | | | | |

Figure 2-8. Colorado: Cumulative Electricity Savings in 2020 by Sector (GWh)

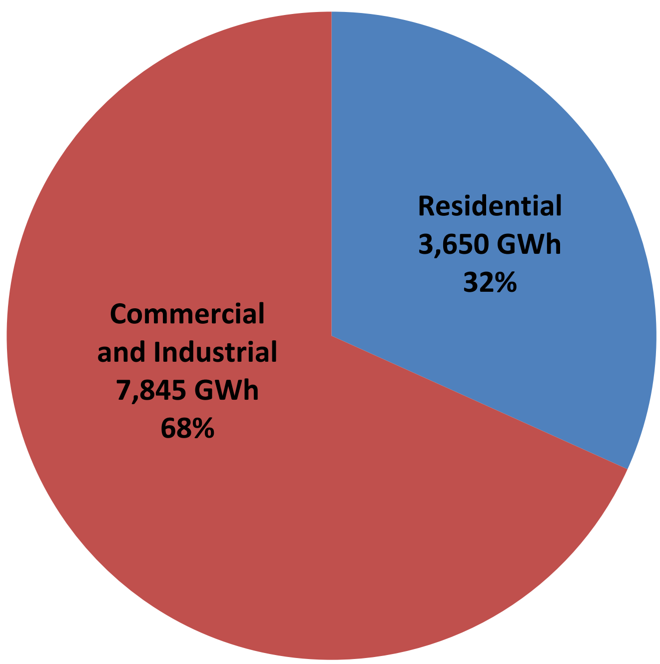


Figure 2-9. Colorado: Total Annual Residential Electricity Savings in 2020 by Program (GWh)

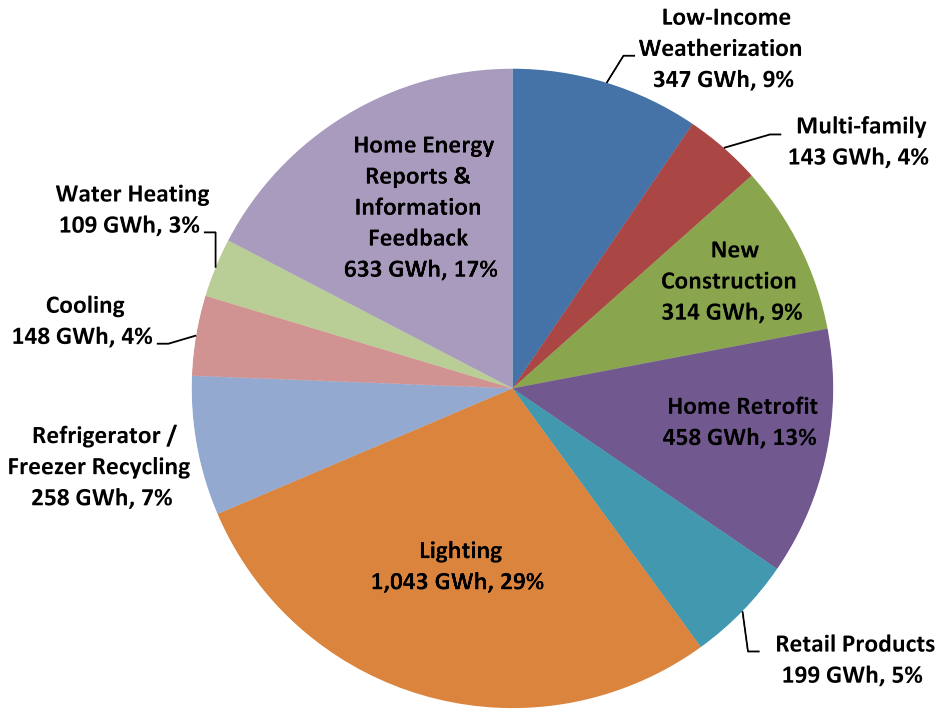



Figure 2-10. Colorado: Total Annual Commercial and Industrial Electricity Savings in 2020 by Program

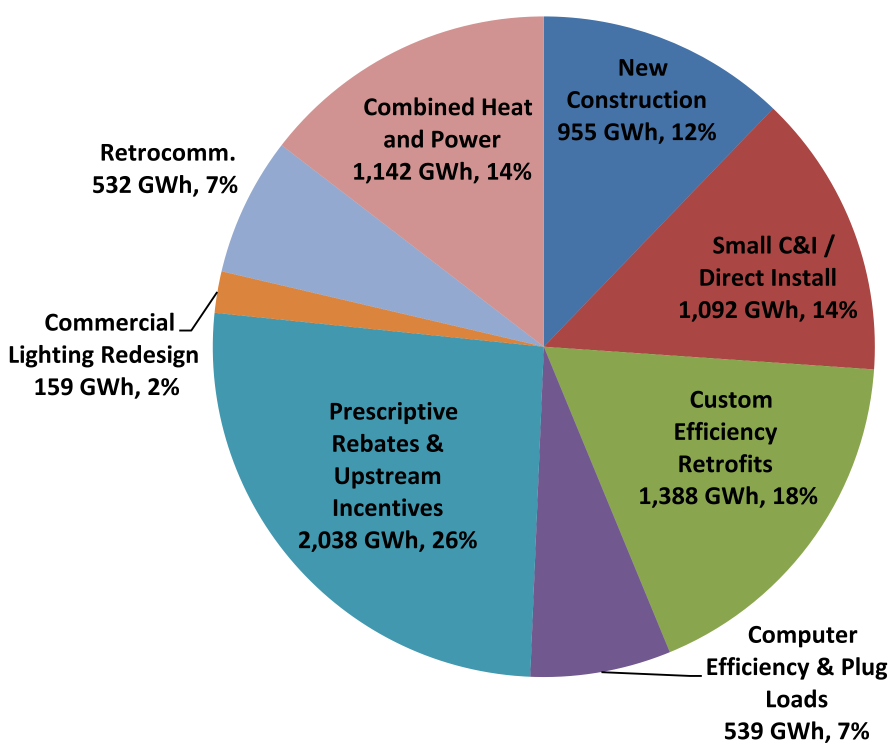


Table 2-14. Colorado: Incremental Annual Electricity Savings by Program (GWh)

| Sector and Program | 2010 | 2015 | 2020 | Total Annual Savings in 2020 |
|---|---|---|---|---|
| ***Residential Programs*** | | | | |
| Low-Income Weatherization | 15 | 32 | 40 | 347 |
| Multi-family | 0 | 14 | 22 | 143 |
| New Construction | 1 | 36 | 31 | 314 |
| Home Retrofit | 0.1 | 41 | 88 | 458 |
| Retail Products | 5 | 20 | 40 | 199 |
| Lighting | 74 | 60 | 88 | 1,043 |
| Refrigerator / Freezer Recycling | 2 | 27 | 25 | 258 |
| Cooling | 2 | 15 | 25 | 148 |
| Water Heating | 2 | 8 | 24 | 109 |
| Home Energy Reports & Information Feedback | - | 342 | 633 | 633 |
| ***Residential Subtotal*** | ***102*** | ***595*** | ***1,016*** | ***3,650*** |
| ***Commercial and Industrial Programs*** | | | | |
| New Construction | 19 | 122 | 182 | 955 |
| Small Business Direct Install | 8 | 133 | 138 | 1,092 |
| Custom Efficiency Retrofits | 22 | 134 | 209 | 1,388 |
| Computer Efficiency & Plug Loads | - | 68 | 116 | 539 |
| Prescriptive Rebates & Upstream Incentives | 126 | 213 | 221 | 2,038 |
| Commercial Lighting Redesign | - | 16 | 33 | 159 |
| Retrocommissioning | 7 | 97 | 3 | 532 |
| Combined Heat and Power | - | 127 | 127 | 1,142 |
| ***Commercial and Industrial Subtotal*** | ***183*** | ***909*** | ***1,029*** | ***7,845*** |
| **Total** | **285** | **1,504** | **2,046** | **11,495** |

Table 2-15 shows the estimated utility program costs in Colorado in 2010, 2015 and 2020. Total program costs reach $257 million in 2015 and $404 million in 2020, in 2010 dollars. Table 2-16 shows the combination of program and participant costs, which are 80-85% greater than the program costs alone. A large ramp-up in programs statewide is required to achieve the substantial energy savings in the High Efficiency scenario.

**Table 2-15. Colorado: Annual Program Costs by Program (Million dollars)**

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 2.0 | 22.3 | 40.6 |
| Multi-family | - | 6.1 | 9.7 |
| New Construction | 0.4 | 15.2 | 10.3 |
| Home Retrofit | 0.1 | 8.3 | 12.1 |
| Retail Products | 1.0 | 2.6 | 9.6 |
| Lighting | 3.5 | 9.9 | 14.7 |
| Refrigerator / Freezer Recycling | 0.7 | 9.3 | 10.0 |
| Cooling | 3.0 | 11.7 | 22.6 |
| Water Heating | 0.3 | 3.7 | 10.5 |
| Home Energy Reports & Information Feedback | - | 10.6 | 31.2 |
| ***Residential Subtotal*** | ***11.0*** | ***99.6*** | ***171.3*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | 3.8 | 11.2 | 16.6 |
| Small Business Direct Install | 3.5 | 56.4 | 59.6 |
| Custom Efficiency Retrofits | 5.9 | 23.1 | 41.9 |
| Computer Efficiency & Plug Loads | - | 1.6 | 17.6 |
| Prescriptive Rebates & Upstream Incentives | 17.8 | 39.3 | 66.4 |
| Commercial Lighting Redesign | - | 4.5 | 14.7 |
| Retrocommissioning | 1.3 | 8.7 | 3.2 |
| Combined Heat and Power | - | 12.4 | 12.4 |
| ***Commercial and Industrial Subtotal*** | ***32.3*** | ***157.3*** | ***232.4*** |
| **Total** | **43.3** | **257.0** | **403.8** |

Table 2-16. Colorado: Annual Costs, Program Plus Participants (Million dollars)

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 2.0 | 22.3 | 40.6 |
| Multi-family | - | 6.4 | 10.2 |
| New Construction | 2.0 | 27.0 | 17.4 |
| Home Retrofit | 0.1 | 11.6 | 19.3 |
| Retail Products | 1.0 | 5.6 | 20.6 |
| Lighting | 3.5 | 21.6 | 32.4 |
| Refrigerator / Freezer Recycling | 0.7 | 9.3 | 10.0 |
| Cooling | 3.9 | 14.1 | 28.1 |
| Water Heating | 0.3 | 7.4 | 20.1 |
| Home Energy Reports & Information Feedback | - | 12.8 | 36.1 |
| ***Residential Subtotal*** | ***13.4*** | ***138.1*** | ***234.8*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | 5.7 | 33.3 | 62.2 |
| Small Business Direct Install | 4.3 | 80.6 | 85.1 |
| Custom Efficiency Retrofits | 11.7 | 46.3 | 83.7 |
| Computer Efficiency & Plug Loads | - | 2.7 | 24.4 |
| Prescriptive Rebates & Upstream Incentives | 60.9 | 78.7 | 132.9 |
| Commercial Lighting Redesign | - | 9.3 | 30.1 |
| Retrocommissioning | 2.6 | 17.3 | 6.5 |
| Combined Heat and Power | - | 57.3 | 89.0 |
| ***Commercial and Industrial Subtotal*** | ***85.2*** | ***325.5*** | ***513.9*** |
| **Total** | **98.6** | **463.6** | **748.7** |

**Nevada**

Tables 2-17 and 2-18 show the overall energy savings and peak demand reduction results for Nevada. The energy savings in the High Efficiency scenario, about 7,040 GWh/yr in 2020, are equivalent to about 22% of projected statewide electricity consumption in the High Efficiency scenario that year. The savings in 2020 are also equivalent to the electricity use of 550,000 typical households in Nevada. The peak demand reduction in the High Efficiency scenario, 1,745 MW in 2020, is equivalent to about 21% of projected statewide peak demand in the High Efficiency scenario that year. In addition, both electricity consumption and peak demand in 2020 are significantly below the levels in 2010 in the High Efficiency scenario, thereby facilitating retirement of older, dirtier power plants.

Figure 2-11 shows the breakdown of energy savings in Nevada in 2020 by sector from programs implemented during 2010-2020. Figure 2-12 shows the breakdown by program for residential programs, and Figure 2-13 shows the breakdown for commercial and industrial programs. Lighting is the most important residential program, followed by home energy reports plus information feedback, cooling and home retrofit. Combined heat and power and prescriptive rebates are the most important C&I programs, followed by custom rebates, new construction, and small business direct installation programs. Table 2-19 shows the energy savings levels for each program per year, for selected years, as well as the total savings in 2020.

Table 2-17. Nevada: Total Annual Electricity Savings by Year (GWh)

| Electricity Savings (GWh) | 2010 | 2015 | 2020 | Savings in 2020 as % of Sales |
|---|---|---|---|---|
| Residential | 134 | 1,147 | 2,820 | 27.6% |
| Commercial and Industrial | 169 | 1,575 | 4,220 | 19.7% |
| **Total Savings** | **304** | **2,722** | **7,040** | **22.2%** |
| Reference scenario electricity use* | 33,773 | 35,644 | 38,361 | NA |
| High Efficiency scenario electricity use* | 33,773 | 32,922 | 31,321 | NA |

**2010 sales are adjusted for savings generated by programs in the 2010 program year, so the sales in the Reference and High-EE cases are the same for 2010.*

Table 2-18. Nevada: Total Annual Peak Demand Savings by Year (MW)

| Peak Demand Savings (MW) | 2010 | 2015 | 2020 | Savings in 2020 as % of Peak |
|---|---|---|---|---|
| Residential | 18 | 347 | 984 | NA |
| Commercial and Industrial | 35 | 298 | 761 | NA |
| **Total Savings** | **53** | **645** | **1,745** | **21.3%** |
| Reference scenario peak demand* | 8,620 | 9,167 | 9,842 | NA |
| High Efficiency scenario peak demand* | 8,620 | 8,522 | 8,096 | NA |

**2010 peak load requirements are adjusted for savings generated by efficiency programs in the 2010 program year, so the peak load requirements in the Reference and High-EE cases are the same for 2010.*

Figure 2-11. Nevada: Cumulative Electricity Savings in 2020 by Sector (GWh)

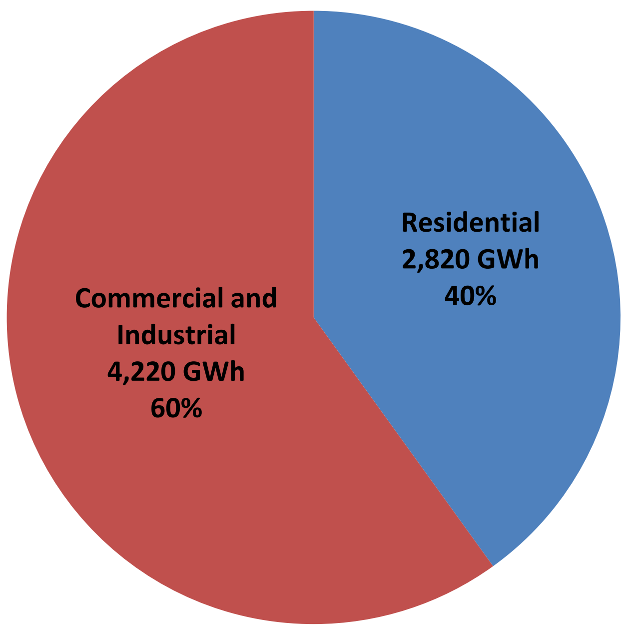


Figure 2-12. Nevada: Total Annual Residential Electricity Savings in 2020 by Program (GWh)

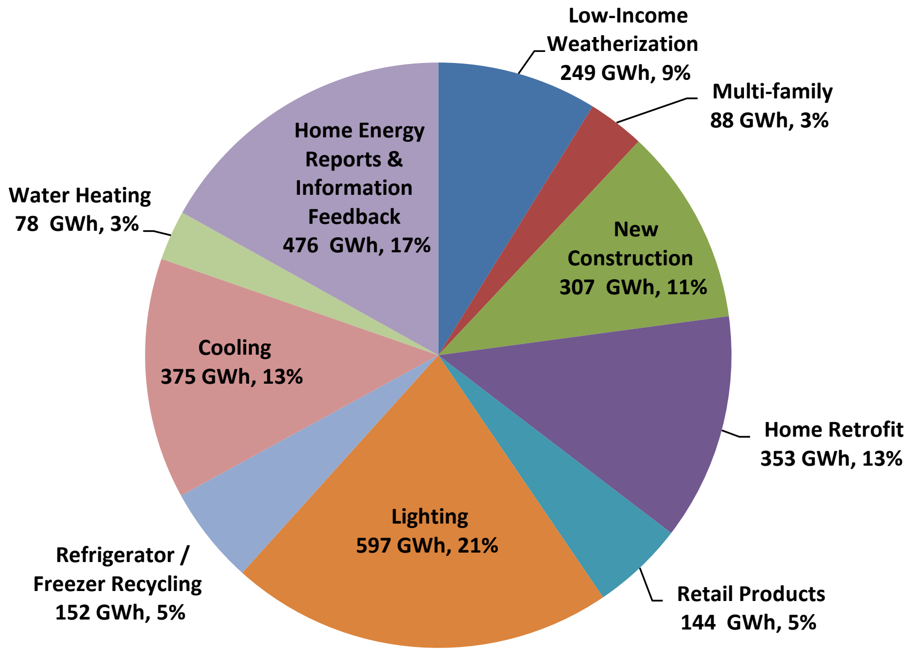



Figure 2-13. Nevada: Total Annual C&I Electricity Savings in 2020 by Program (GWh)

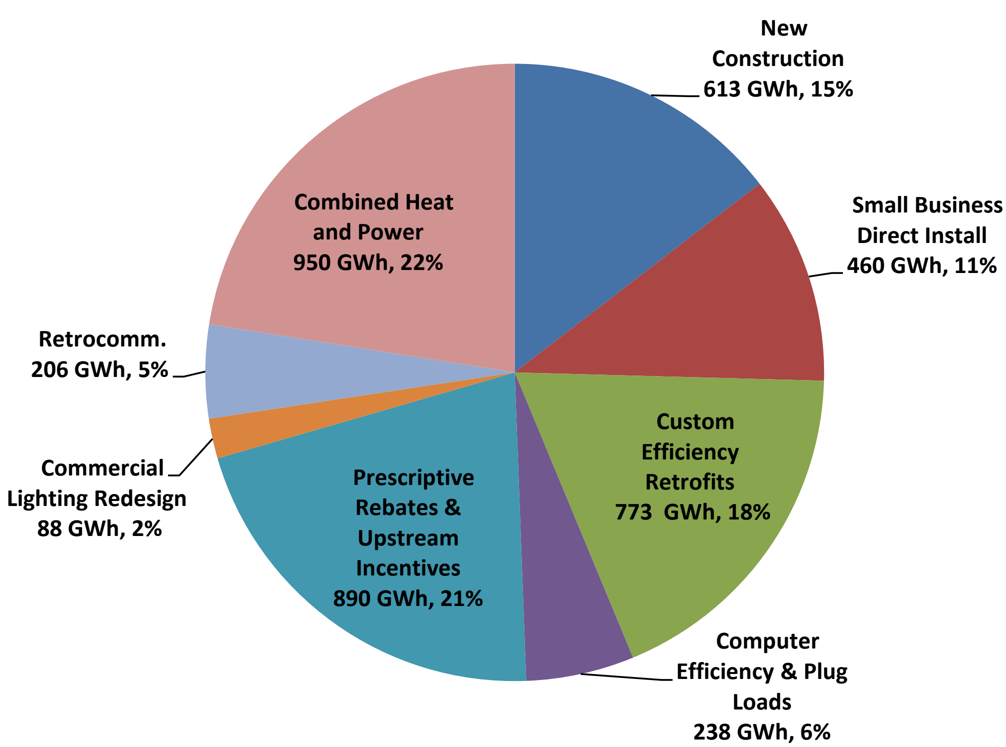


Table 2-19. Nevada: Incremental Annual Electricity Savings by Program (GWh)

| Sector and Program | 2010 | 2015 | 2020 | Total Annual Savings in 2020 |
|---|---|---|---|---|
| ***Residential Programs*** | | | | |
| Low-Income Weatherization | 2 | 23 | 43 | 249 |
| Multi-family | - | 9 | 14 | 88 |
| New Construction | 4 | 34 | 40 | 307 |
| Home Retrofit | 1 | 30 | 71 | 353 |
| Retail Products | 9 | 13 | 21 | 144 |
| Lighting | 105 | 30 | 88 | 597 |
| Refrigerator / Freezer Recycling | 10 | 13 | 13 | 152 |
| Cooling | - | 42 | 55 | 375 |
| Water Heating | - | 6 | 18 | 78 |
| Home Energy Reports & Information Feedback | - | 236 | 476 | 76 |
| ***Residential Subtotal*** | ***130*** | ***435*** | ***841*** | ***2,820*** |
| ***Commercial and Industrial Programs*** | | | | |
| New Construction | 26 | 77 | 115 | 613 |
| Small Business Direct Install | 5 | 56 | 60 | 460 |
| Custom Efficiency Retrofits | - | 81 | 123 | 773 |
| Computer Efficiency & Plug Loads | - | 30 | 53 | 238 |
| Prescriptive Rebates & Upstream Incentives | 139 | 73 | 98 | 890 |
| Commercial Lighting Redesign | - | 8 | 26 | 88 |
| Retrocommissioning | - | 36 | 1 | 206 |
| Combined Heat and Power | - | 106 | 106 | 950 |
| ***Commercial and Industrial Subtotal*** | ***169*** | ***466*** | ***581*** | ***4,220*** |
| **Total** | **300** | **901** | **1,422** | **7,040** |

Table 2-20 shows the estimated utility program costs in Nevada in 2010, 2015 and 2020. Total program costs reach $152 million in 2015 and $248 million in 2020, in 2010 dollars. Table 2-21 shows the combination of program and participant costs, which are 80-85% greater than the program costs alone. A large ramp-up in programs statewide is required to achieve the substantial energy savings in the High Efficiency scenario.

**Table 2-20. Nevada: Annual Program Costs (Million dollars)**

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 3.4 | 15.9 | 31.5 |
| Multi-family | - | 3.7 | 6.2 |
| New Construction | 1.8 | 9.8 | 8.6 |
| Home Retrofit | 0.4 | 4.1 | 9.7 |
| Retail Products | 0.5 | 1.0 | 3.7 |
| Lighting | 7.3 | 4.9 | 8.0 |
| Refrigerator / Freezer Recycling | 1.3 | 4.1 | 4.8 |
| Cooling | 0.02 | 16.6 | 28.4 |
| Water Heating | - | 2.8 | 8.9 |
| Home Energy Reports & Information Feedback | - | 10.4 | 18.7 |
| ***Residential Subtotal*** | ***14.8*** | ***73.3*** | ***128.5*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | 3.2 | 7.5 | 10.8 |
| Small Business Direct Install | 0.6 | 23.6 | 25.6 |
| Custom Efficiency Retrofits | - | 13.9 | 24.7 |
| Computer Efficiency & Plug Loads | - | 0.7 | 8.0 |
| Prescriptive Rebates & Upstream Incentives | 10.6 | 15.6 | 29.4 |
| Commercial Lighting Redesign | - | 2.4 | 8.5 |
| Retrocommissioning | - | 4.8 | 1.9 |
| Combined Heat and Power | - | 10.3 | 10.3 |
| ***Commercial and Industrial Subtotal*** | ***14.4*** | ***78.8*** | ***119.2*** |
| **Total** | **29.2** | **152.1** | **247.7** |

Table 2-21. Nevada: Annual Costs, Program Plus Participants (Million dollars)

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 3.4 | 15.9 | 31.5 |
| Multi-family | - | 3.9 | 6.6 |
| New Construction | 2.8 | 17.5 | 14.5 |
| Home Retrofit | 0.4 | 5.8 | 13.7 |
| Retail Products | 1.3 | 2.4 | 8.2 |
| Lighting | 7.3 | 10.8 | 17.7 |
| Refrigerator / Freezer Recycling | 1.3 | 4.1 | 4.8 |
| Cooling | 0.02 | 18.8 | 33.5 |
| Water Heating | - | 5.7 | 16.9 |
| Home Energy Reports & Information Feedback | - | 11.6 | 21.6 |
| ***Residential Subtotal*** | ***16.6*** | ***96.4*** | ***169.0*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | 6.4 | $ 21.4 | $ 39.6 |
| Small Business Direct Install | 0.6 | $ 33.7 | $ 36.6 |
| Custom Efficiency Retrofits | - | $ 27.8 | $ 49.4 |
| Computer Efficiency & Plug Loads | - | $ 1.4 | $ 15.9 |
| Prescriptive Rebates & Upstream Incentives | 57.4 | $ 31.2 | $ 58.8 |
| Commercial Lighting Redesign | - | $ 4.8 | $ 16.9 |
| Retrocommissioning | - | $ 9.7 | $ 3.7 |
| Combined Heat and Power | - | $ 47.7 | $ 74.0 |
| ***Commercial and Industrial Subtotal*** | ***64.4*** | ***$ 177.7*** | ***$ 295.1*** |
| **Total** | **80.9** | **$ 274.0** | **$ 464.1** |

**New Mexico**

Tables 2-22 and 2-23 show the overall energy savings and peak demand reduction results for New Mexico. The energy savings in the High Efficiency scenario, about 5,100 GWh/yr in 2020, are equivalent to nearly 24% of projected statewide electricity consumption in the High Efficiency scenario that year. The savings in 2020 are also equivalent to the electricity use of 580,000 typical households in New Mexico. The peak demand reduction in the High Efficiency scenario, 973 MW in 2020, is equivalent to 20.5% of projected statewide peak demand in the High Efficiency scenario that year. In addition, both electricity consumption and peak demand in 2020 are slightly below the levels in 2010 in the High Efficiency scenario, thereby facilitating retirement of older, dirtier power plants.

Figure 2-14 shows the breakdown of energy savings in New Mexico in 2020 by sector from programs implemented during 2010-2020. Figure 2-15 shows the breakdown by program for residential programs, and Figure 2-16 shows the breakdown for commercial and industrial programs. Lighting is the most important residential program, followed by home retrofit, low-income weatherization, and home energy reports plus information feedback. Custom incentives and prescriptive rebates are the most important C&I programs, followed by combined heat and power, new construction, and small business direct installation programs. Table 2-24 shows the energy savings levels for each program per year, for selected years, as well as the total savings in 2020.

**Table 2-22. New Mexico: Total Annual Electricity Savings by Year (GWh)**

| Electricity Savings (GWh) | 2010 | 2015 | 2020 | Savings in 2020 as % of Sales |
|---|---|---|---|---|
| Residential | 47 | 588 | 1,513 | 21.1% |
| Commercial and Industrial | 40 | 1,275 | 3,597 | 24.9% |
| **Total Savings** | **87** | **1,863** | **5,110** | **23.6%** |
| Reference scenario electricity use* | 22,428 | 24,344 | 26,480 | NA |
| High Efficiency scenario electricity use* | 22,428 | 22,480 | 21,370 | NA |

**2010 sales are adjusted for savings generated by programs in the 2010 program year, so the sales in the Reference and High-EE cases are the same for 2010.*

Table 2-23. New Mexico: Total Annual Peak Demand Savings (MW) by Year

| Peak Demand Savings (MW) | 2010 | 2015 | 2020 | Savings in 2020 as % of Peak |
|---|---|---|---|---|
| Residential | 7 | 116 | 304 | NA |
| Commercial and Industrial | 3 | 235 | 669 | NA |
| **Total Savings** | **10** | **351** | **973** | **20.5%** |
| Reference scenario peak demand* | 4,823 | 5,240 | 5,692 | NA |
| High Efficiency scenario peak demand* | 4,823 | 4,889 | 4,719 | NA |
| **2010 peak load requirements are adjusted for savings generated by efficiency programs in the 2010 program year, so the peak load requirements in the Reference and High-EE cases are the same for 2010.* | | | | |

Figure 2-14. New Mexico: Cumulative Electricity Savings in 2020 by Sector (GWh)

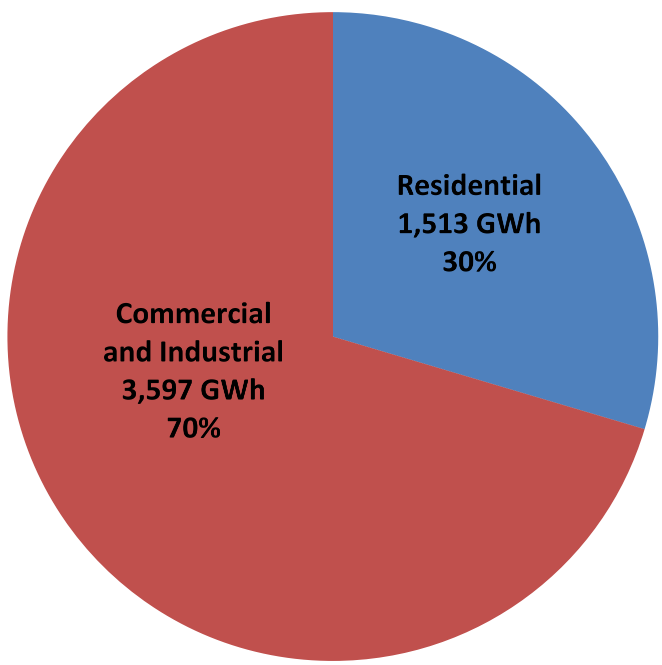


**Figure 2-15. New Mexico: Total Annual Residential Electricity Savings in 2020 by Program (GWh)**

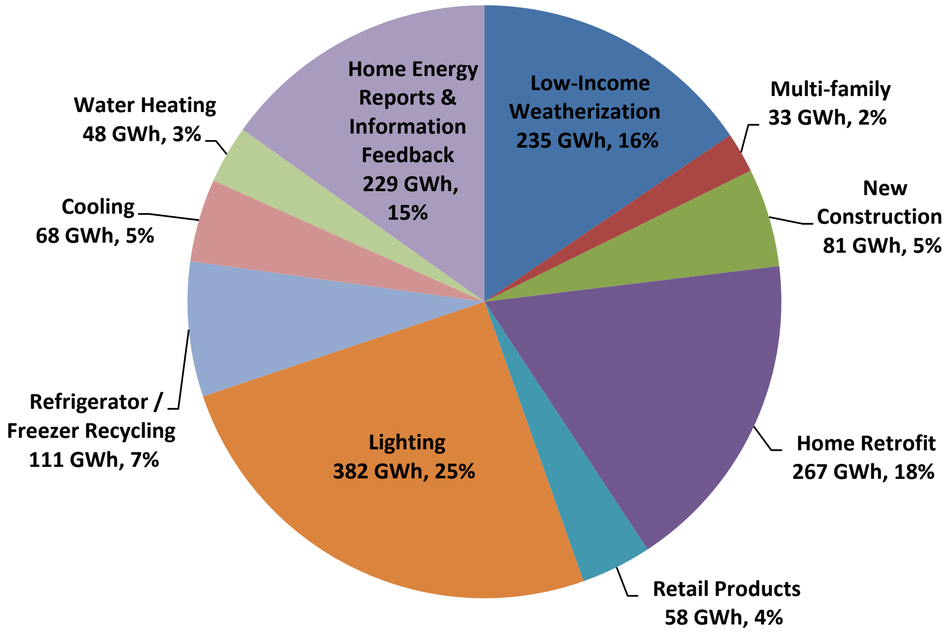



**Figure 2-16. New Mexico: Total Annual C&I Electricity Savings in 2020 by Program (GWh)**

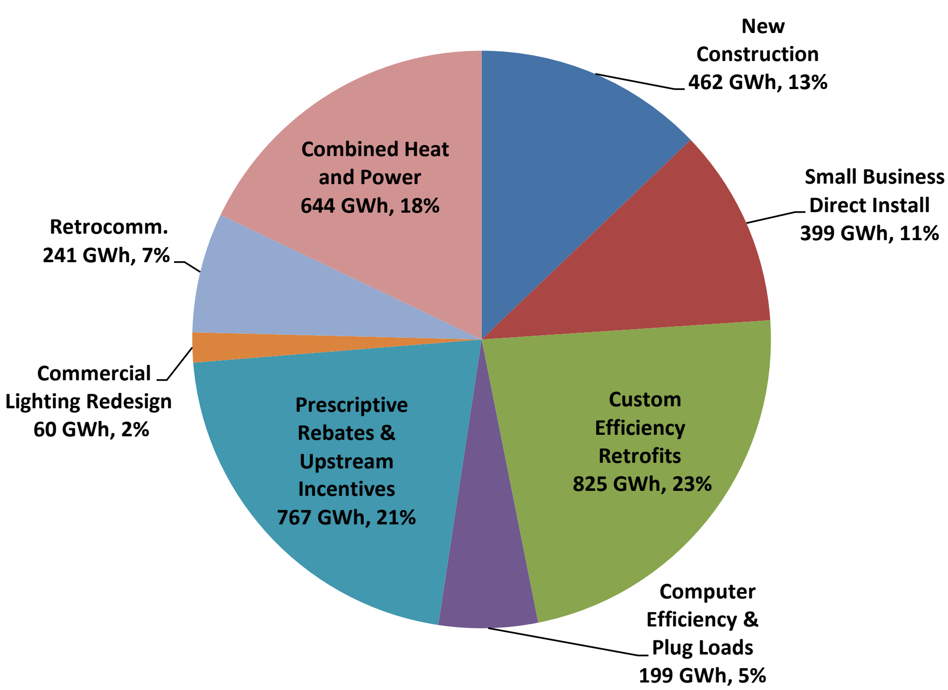


Table 2-24. New Mexico: Incremental Annual Electricity Savings by Program (GWh)

| Sector and Program | 2010 | 2015 | 2020 | Total Annual Savings in 2020 |
|---|---|---|---|---|
| ***Residential Programs*** | | | | |
| Low-Income Weatherization | 4 | 22 | 38 | 235 |
| Multi-family | - | 3 | 5 | 33 |
| New Construction | 1 | 9 | 8 | 81 |
| Home Retrofit | 5 | 23 | 49 | 267 |
| Retail Products | - | 6 | 12 | 58 |
| Lighting | 28 | 23 | 62 | 382 |
| Refrigerator / Freezer Recycling | 8 | 10 | 10 | 111 |
| Cooling | 1 | 8 | 11 | 68 |
| Water Heating | - | 4 | 11 | 48 |
| Home Energy Reports & Information Feedback | - | 124 | 229 | 229 |
| ***Residential Subtotal*** | ***47*** | ***233*** | ***435*** | ***1,513*** |
| ***Commercial and Industrial Programs*** | | | | |
| New Construction | - | 50 | 96 | 462 |
| Small Business Direct Install | 1 | 49 | 52 | 399 |
| Custom Efficiency Retrofits | 18 | 78 | 112 | 825 |
| Computer Efficiency & Plug Loads | - | 8 | 43 | 199 |
| Prescriptive Rebates & Upstream Incentives | 21 | 75 | 106 | 767 |
| Commercial Lighting Redesign | - | 4 | 13 | 60 |
| Retrocommissioning | - | 38 | 4 | 241 |
| Combined Heat and Power | - | 73 | 70 | 644 |
| ***Commercial and Industrial Subtotal*** | ***40*** | ***374*** | ***494*** | ***3,597*** |
| **Total** | **87** | **607** | **928** | **5,110** |

Table 2-25 shows the estimated utility program costs in New Mexico in 2010, 2015 and 2020. Total program costs reach $121 million in 2015 and $191 million in 2020, in 2010 dollars. Table 2-26 shows the combination of program and participant costs, which are 80-90% greater than the program costs alone. A large ramp-up in programs statewide is required to achieve the substantial energy savings in the High Efficiency scenario.

Table 2-25. New Mexico: Annual Program Costs (Million dollars)

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 1.2 | 15.4 | 28.0 |
| Multi-family | - | 1.4 | 2.2 |
| New Construction | 0.5 | 4.7 | 3.3 |
| Home Retrofit | 1.6 | 4.9 | 10.6 |
| Retail Products | - | 0.8 | 2.9 |
| Lighting | 2.5 | 3.8 | 5.7 |
| Refrigerator / Freezer Recycling | 1.4 | 3.4 | 3.7 |
| Cooling | 0.1 | 5.0 | 9.5 |
| Water Heating | - | 1.7 | 4.9 |
| Home Energy Reports & Information Feedback | - | 7.7 | 12.5 |
| ***Residential Subtotal*** | ***7.4*** | ***48.9*** | ***83.3*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | - | 6.4 | 9.2 |
| Small Business Direct Install | 0.6 | 21.1 | 22.3 |
| Custom Efficiency Retrofits | 4.3 | 13.6 | 22.4 |
| Computer Efficiency & Plug Loads | - | 0.6 | 6.5 |
| Prescriptive Rebates & Upstream Incentives | 2.6 | 16.8 | 31.7 |
| Commercial Lighting Redesign | - | 1.7 | 5.6 |
| Retrocommissioning | - | 5.3 | 2.5 |
| Combined Heat and Power | - | 7.2 | 7.2 |
| ***Commercial and Industrial Subtotal*** | ***7.6*** | ***72.5*** | ***107.4*** |
| **Total** | **15.0** | **121.4** | **190.6** |

Table 2-26. New Mexico: Annual Costs, Program Plus Participants (Million dollars)

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 1.2 | 15.4 | 28.0 |
| Multi-family | - | 1.5 | 2.4 |
| New Construction | 0.8 | 8.4 | 5.6 |
| Home Retrofit | 1.6 | 7.0 | 14.9 |
| Retail Products | - | 1.7 | 6.2 |
| Lighting | 2.5 | 8.4 | 12.5 |
| Refrigerator / Freezer Recycling | 1.4 | 3.4 | 3.7 |
| Cooling | 0.1 | 5.9 | 11.7 |
| Water Heating | - | 3.4 | 9.4 |
| Home Energy Reports & Information Feedback | - | 8.5 | 14.4 |
| ***Residential Subtotal*** | ***7.7*** | ***63.6*** | ***108.6*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | - | 18.0 | 33.2 |
| Small Business Direct Install | 0.9 | 30.1 | 31.8 |
| Custom Efficiency Retrofits | 8.6 | 27.2 | 44.9 |
| Computer Efficiency & Plug Loads | - | 1.2 | 13.0 |
| Prescriptive Rebates & Upstream Incentives | 7.5 | 33.5 | 63.4 |
| Commercial Lighting Redesign | - | 3.5 | 11.6 |
| Retrocommissioning | - | 10.5 | 4.9 |
| Combined Heat and Power | - | 33.0 | 49.7 |
| ***Commercial and Industrial Subtotal*** | ***17.0*** | ***157.1*** | ***252.5*** |
| **Total** | **24.7** | **220.7** | **361.1** |

**Utah**

Tables 2-27 and 2-28 show the overall energy savings and peak demand reduction results for Utah. The energy savings in the High Efficiency scenario, about 6,200 GWh/yr in 2020, are equivalent to about 20% of projected statewide electricity consumption in the High Efficiency scenario that year. The savings in 2020 are also equivalent to the electricity use of 590,000 typical households in Utah. The peak demand reduction in the High Efficiency scenario, 1,144 MW in 2020, is equivalent to about 18% of projected statewide peak demand in the High Efficiency scenario that year. There remains some growth in electricity consumption and peak demand in Utah in the High Efficiency case, but far less than that in the Reference scenario.

Figure 2-17 shows the breakdown of energy savings in Utah in 2020 by sector, Figure 2-18 shows the breakdown by program for residential programs, and Figure 2-19 shows the breakdown for commercial and industrial programs. Lighting is the most important residential program, followed by home retrofit, home energy reports plus information feedback, and new construction. Custom incentives and prescriptive rebates are the most important C&I programs, followed by the combined heat and power program. Table 2-29 shows the energy savings levels for each program per year, for selected years, as well as the total savings in 2020.

**Table 2-27. Utah: Total Annual Electricity Savings by Year (GWh)**

| Electricity Savings (GWh) | 2010 | 2015 | 2020 | Savings in 2020 as % of Sales |
|---|---|---|---|---|
| Residential | 104 | 931 | 2,153 | 24.2% |
| Commercial and Industrial | 90 | 1,523 | 4,081 | 18.7% |
| **Total Savings** | **194** | **2,455** | **6,234** | **20.3%** |
| Reference scenario electricity use* | 28,044 | 33,095 | 36,990 | NA |
| High Efficiency scenario electricity use* | 28,044 | 30,641 | 30,757 | NA |
| **2010 sales are adjusted for savings generated by programs in the 2010 program year, so the sales in the Reference and High-EE cases are the same for 2010.* | | | | |

Table 2-28. Utah: Total Annual Peak Demand Savings by Year (MW)

| Peak Demand Savings (MW) | 2010 | 2015 | 2020 | Savings in 2020 as % of Peak |
|---|---|---|---|---|
| Residential | 19 | 213 | 508 | NA |
| Commercial and Industrial | 10 | 238 | 636 | NA |
| **Total Savings** | **29** | **450** | **1,144** | **18.2%** |
| Reference scenario peak demand* | 5,645 | 6,679 | 7,455 | NA |
| High Efficiency scenario peak demand* | 5,645 | 6,228 | 6,312 | NA |
| **2010 peak load requirements are adjusted for savings generated by efficiency programs in the 2010 program year, so the peak load requirements in the Reference and High-EE cases are the same for 2010.* | | | | |

Figure 2-17. Utah: Cumulative Electricity Savings in 2020 by Sector (GWh)

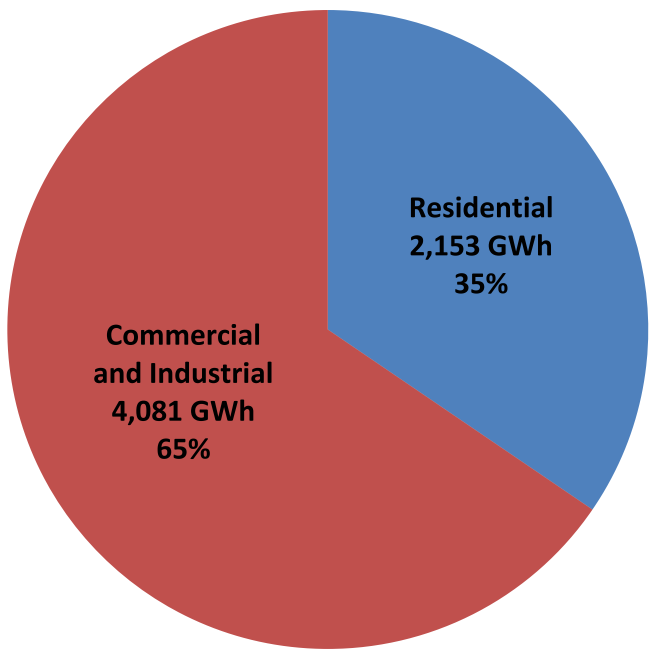


Figure 2-18. Utah: Total Annual Residential Electricity Savings in 2020 by Program (GWh)

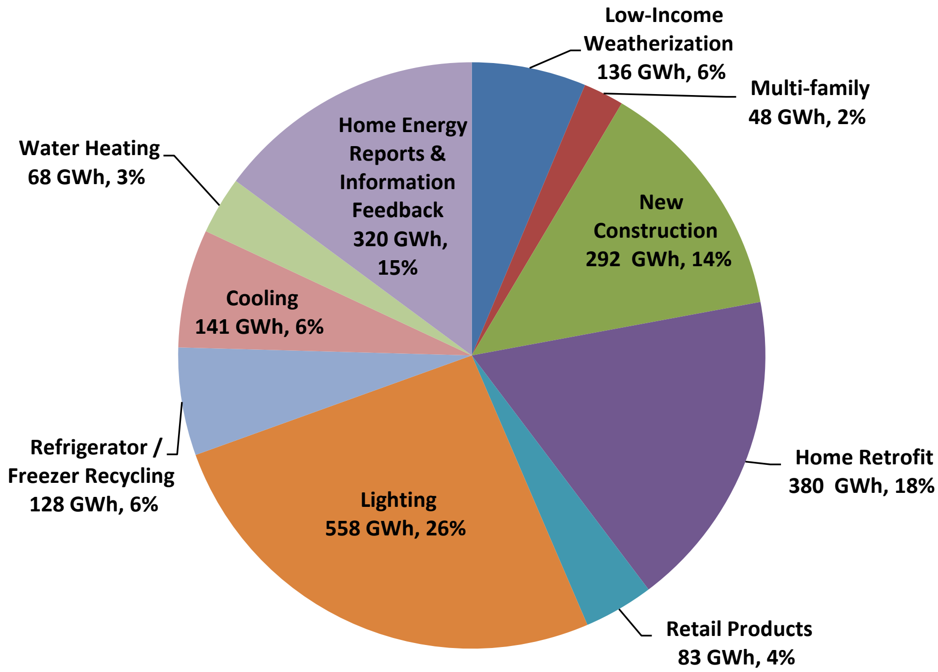



Figure 2-19. Utah: Total Annual C&I Electricity Savings in 2020 by Program (GWh)

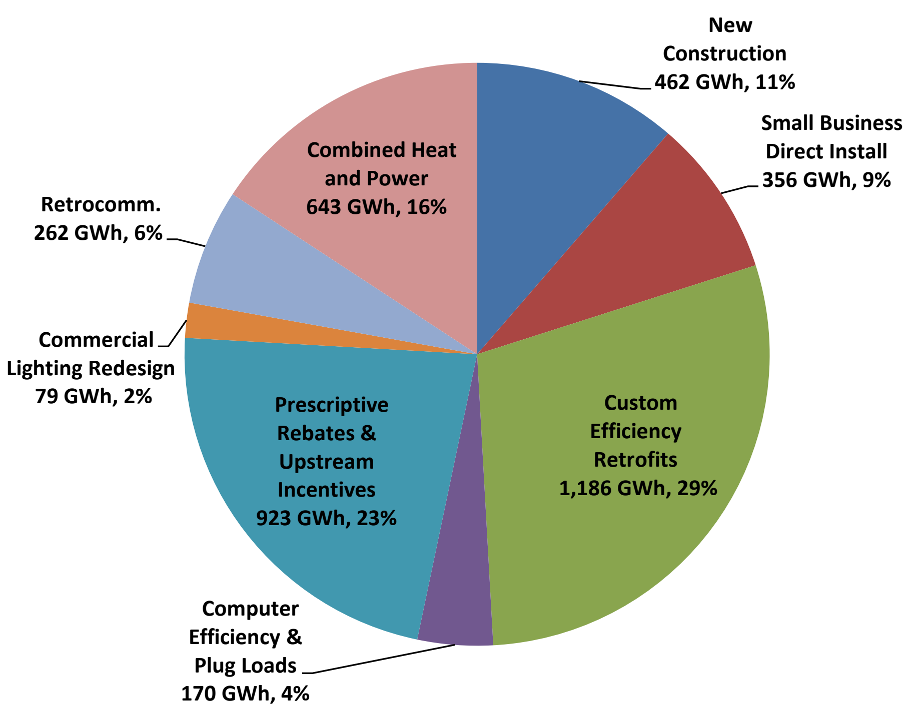


Table 2-29. Utah: Incremental Annual Electricity Savings by Program (GWh)

| Sector and Program | 2010 | 2015 | 2020 | Total Annual Savings in 2020 |
|---|---|---|---|---|
| ***Residential Programs*** | | | | |
| Low-Income Weatherization | 2 | 13 | 22 | 136 |
| Multi-family | 0 | 5 | 7 | 48 |
| New Construction | 5 | 31 | 32 | 292 |
| Home Retrofit | 48 | 25 | 55 | 380 |
| Retail Products | - | 7 | 19 | 83 |
| Lighting | 37 | 34 | 75 | 558 |
| Refrigerator / Freezer Recycling | 11 | 11 | 11 | 128 |
| Cooling | 1 | 15 | 22 | 141 |
| Water Heating | - | 5 | 16 | 68 |
| Home Energy Reports & Information Feedback | - | 172 | 320 | 320 |
| ***Residential Subtotal*** | ***104*** | ***234*** | ***296*** | ***2,153*** |
| ***Commercial and Industrial Programs*** | | | | |
| New Construction | - | 50 | 96 | 462 |
| Small Business Direct Install | - | 44 | 46 | 356 |
| Custom Efficiency Retrofits | 54 | 108 | 143 | 1,186 |
| Computer Efficiency & Plug Loads | - | 7 | 41 | 170 |
| Prescriptive Rebates & Upstream Incentives | 29 | 81 | 118 | 923 |
| Commercial Lighting Redesign | - | 5 | 16 | 79 |
| Retrocommissioning | 7 | 49 | 18 | 262 |
| Combined Heat and Power | - | 71 | 71 | 643 |
| ***Commercial and Industrial Subtotal*** | ***90*** | ***416*** | ***550*** | ***4,081*** |
| **Total** | **194** | **650** | **846** | **6,234** |

Table 2-30 shows the estimated utility program costs in Utah in 2010, 2015 and 2020. Total program costs reach $138 million in 2015 and $214 million in 2020, in 2010 dollars. Table 2-31 shows the combination of program and participant costs, which are 80-90% greater than the program costs alone. A large ramp-up in programs statewide is required to achieve the substantial energy savings in the High Efficiency scenario.

**Table 2-30. Utah: Annual Program Costs (Million dollars)**

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 0.3 | 8.8 | 16.2 |
| Multi-family | - | 2.1 | 3.1 |
| New Construction | 2.6 | 9.8 | 7.8 |
| Home Retrofit | 16.9 | 4.0 | 8.8 |
| Retail Products | - | 1.1 | 4.4 |
| Lighting | - | 5.4 | 6.9 |
| Refrigerator / Freezer Recycling | 2.4 | 3.0 | 3.2 |
| Cooling | 1.5 | 13.5 | 26.0 |
| Water Heating | - | 2.6 | 7.5 |
| Home Energy Reports & Information Feedback | - | 8.9 | 14.7 |
| ***Residential Subtotal*** | ***23.6*** | ***59.3*** | ***98.8*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | - | 6.4 | 9.2 |
| Small Business Direct Install | - | 19.0 | 19.8 |
| Custom Efficiency Retrofits | 10.9 | 19.0 | 28.7 |
| Computer Efficiency & Plug Loads | - | 0.5 | 5.5 |
| Prescriptive Rebates & Upstream Incentives | 4.8 | 18.2 | 35.3 |
| Commercial Lighting Redesign | - | 2.2 | 7.3 |
| Retrocommissioning | 1.0 | 5.9 | 2.2 |
| Combined Heat and Power | - | 7.0 | 7.0 |
| ***Commercial and Industrial Subtotal*** | ***16.7*** | ***78.2*** | ***115.0*** |
| **Total** | **40.3** | **137.5** | **213.8** |

Table 2-31. Utah: Annual Costs, Program Plus Participants (Million dollars)

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 0.3 | 8.8 | 16.2 |
| Multi-family | - | 2.2 | 3.3 |
| New Construction | 4.5 | 17.4 | 13.2 |
| Home Retrofit | 16.9 | 5.6 | 12.4 |
| Retail Products | - | 2.3 | 9.4 |
| Lighting | - | 10.7 | 14.9 |
| Refrigerator / Freezer Recycling | 2.4 | 3.0 | 3.2 |
| Cooling | 2.1 | 16.1 | 31.9 |
| Water Heating | - | 5.2 | 14.3 |
| Home Energy Reports & Information Feedback | - | 9.9 | 17.0 |
| ***Residential Subtotal*** | ***26.1*** | ***81.3*** | ***136.0*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | - | 18.0 | 33.2 |
| Small Business Direct Install | - | 27.1 | 28.3 |
| Custom Efficiency Retrofits | 21.8 | 38.0 | 57.4 |
| Computer Efficiency & Plug Loads | - | 0.9 | 7.6 |
| Prescriptive Rebates & Upstream Incentives | 14.7 | 36.4 | 70.6 |
| Commercial Lighting Redesign | - | 4.5 | 14.6 |
| Retrocommissioning | 2.0 | 11.9 | 4.4 |
| Combined Heat and Power | - | 32.2 | 50.1 |
| ***Commercial and Industrial Subtotal*** | ***38.5*** | ***169.0*** | ***266.2*** |
| **Total** | **64.5** | **250.3** | **402.1** |

**Wyoming**

Tables 2-32 and 2-33 show the overall energy savings and peak demand reduction results for Wyoming. The energy savings in the High Efficiency scenario, about 3,200 GWh/yr in 2020, are equivalent to about 15% of projected statewide electricity consumption in the High Efficiency scenario that year. The savings in 2020 are also equivalent to the electricity use of 245,000 typical households in Wyoming. The peak demand reduction in the High Efficiency scenario, 354 MW in 2020, is equivalent to about 14% of projected statewide peak demand in the High Efficiency scenario that year. The energy savings and peak reductions do not reach 20% by 2020 in Wyoming because of the very limited energy efficiency program activity in the state as of 2011-12, the time required to ramp up efforts, and the high growth rates in the state in the Reference scenario. Nonetheless, the High Efficiency scenario eliminates almost half of the load growth projected in the Reference scenario through 2020.

Figure 2-20 shows the breakdown of energy savings in Wyoming in 2020 by sector from programs implemented during 2010-2020. Figure 2-21 shows the breakdown by program for residential programs, and Figure 2-22 shows the breakdown for commercial and industrial programs. Lighting, home retrofit, and home energy reports plus information feedback are the most important residential programs. Custom efficiency retrofits are by far the most important C&I program in Wyoming. Table 2-34 shows the energy savings levels for each program per year, for selected years, as well as the total savings in 2020.

**Table 2-32. Wyoming: Total Annual Electricity Savings by Year (GWh)**

| Electricity Savings (GWh) | 2010 | 2015 | 2020 | Savings in 2020 as % of Sales |
|---|---|---|---|---|
| Residential | 6 | 170 | 455 | 14.3% |
| Commercial and Industrial | 12 | 973 | 2,783 | 15.6% |
| **Total Savings** | **17** | **1,143** | **3,238** | **15.4%** |
| Reference scenario electricity use* | 17,113 | 21,618 | 24,009 | NA |
| High Efficiency scenario electricity use* | 17,113 | 20,475 | 20,771 | NA |

**2010 sales are adjusted for savings generated by programs in the 2010 program year, so the sales in the Reference and High-EE cases are the same for 2010.*

Table 2-33. Wyoming: Total Annual Peak Demand Savings (MW) by Year

| Peak Demand Savings (MW) | 2010 | 2015 | 2020 | Savings in 2020 as % of Peak |
|---|---|---|---|---|
| Residential | 1 | 23 | 64 | NA |
| Commercial and Industrial | 1 | 109 | 290 | NA |
| **Total Savings** | **1** | **132** | **354** | **14.1%** |
| Reference scenario peak demand* | 2,143 | 2,669 | 2,927 | NA |
| High Efficiency scenario peak demand* | 2,143 | 2,538 | 2,561 | NA |

**2010 peak load requirements are adjusted for savings generated by efficiency programs in the 2010 program year, so the peak load requirements in the Reference and High-EE cases are the same for 2010.*

Figure 2-20. Wyoming: Cumulative Electricity Savings in 2020 by Sector (GWh)

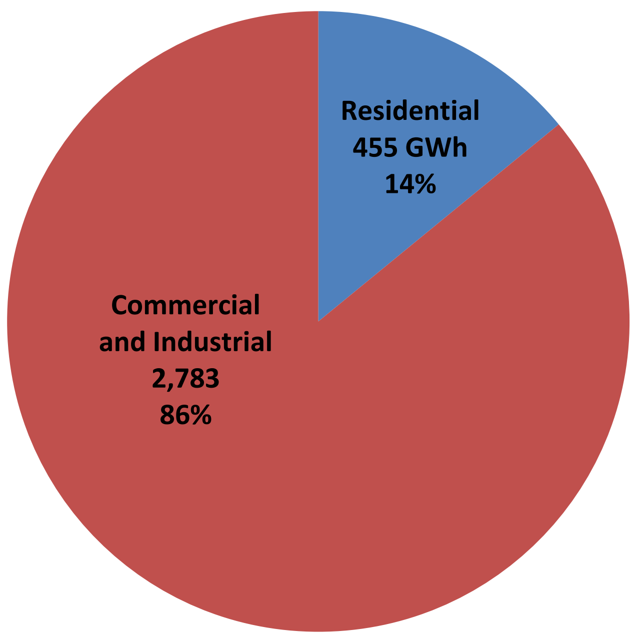


**Figure 2-21. Wyoming: Total Annual Residential Electricity Savings in 2020 by Program (GWh)**

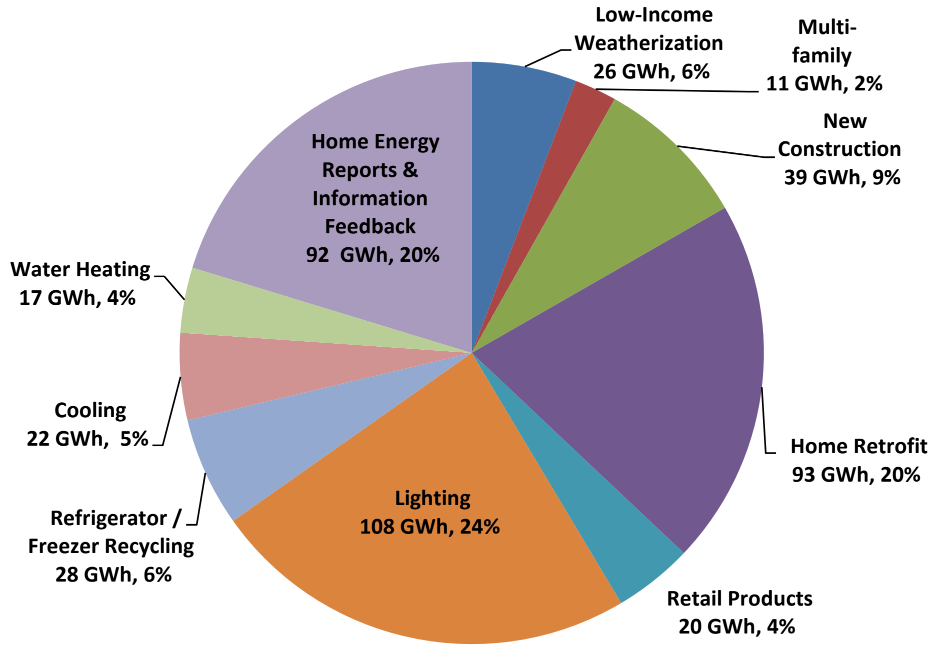



**Figure 2-22. Wyoming: Total Annual C&I Electricity Savings in 2020 by Program**

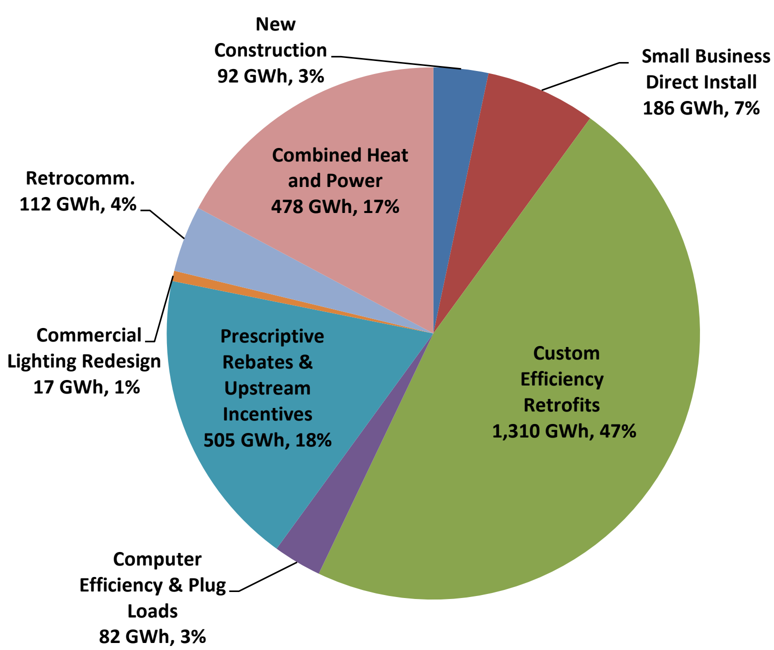


Table 2-34. Wyoming: Incremental Annual Electricity Savings by Program (GWh)

| Sector and Program | 2010 | 2015 | 2020 | Total Annual Savings in 2020 |
|---|---|---|---|---|
| ***Residential Programs*** | | | | |
| Low-Income Weatherization | 1 | 3 | 4 | 26 |
| Multi-family | - | 1 | 2 | 11 |
| New Construction | - | 4 | 4 | 39 |
| Home Retrofit | 4 | 8 | 16 | 93 |
| Retail Products | - | 2 | 4 | 20 |
| Lighting | - | 7 | 18 | 108 |
| Refrigerator / Freezer Recycling | 1 | 3 | 3 | 28 |
| Cooling | - | 2 | 4 | 22 |
| Water Heating | - | 1 | 4 | 17 |
| Home Energy Reports & Information Feedback | - | 47 | 92 | 92 |
| ***Residential Subtotal*** | ***6*** | ***77*** | ***141*** | ***455*** |
| ***Commercial and Industrial Programs*** | | | | |
| New Construction | - | 10 | 19 | 92 |
| Small Business Direct Install | - | 23 | 24 | 186 |
| Custom Efficiency Retrofits | 9 | 156 | 174 | 1,310 |
| Computer Efficiency & Plug Loads | - | 3 | 20 | 82 |
| Prescriptive Rebates & Upstream Incentives | 3 | 49 | 73 | 505 |
| Commercial Lighting Redesign | - | 1 | 4 | 17 |
| Retrocommissioning | - | 22 | 8 | 112 |
| Combined Heat and Power | - | 53 | 53 | 478 |
| ***Commercial and Industrial Subtotal*** | ***12*** | ***318*** | ***374*** | ***2,783*** |
| **Total** | **17** | **395** | **514** | **3,238** |

Table 2-35 shows the estimated utility program costs in Wyoming in 2010, 2015 and 2020. Total program costs reach $71 million in 2015 and $101 million in 2020, in 2010 dollars. Table 2-36 shows the combination of program and participant costs, which are about 100% greater than the program costs alone. We estimate that the large ramp up in program costs statewide is required to achieve the substantial energy savings in the High Efficiency scenario.

**Table 2-35. Wyoming: Annual Program Costs (Million dollars)**

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 0.05 | 1.9 | 3.3 |
| Multi-family | - | 0.5 | 0.7 |
| New Construction | - | 1.3 | 0.9 |
| Home Retrofit | 0.7 | 0.9 | 1.9 |
| Retail Products | - | 0.3 | 1.0 |
| Lighting | - | 1.2 | 1.7 |
| Refrigerator / Freezer Recycling | 0.2 | 0.7 | 0.8 |
| Cooling | - | 2.8 | 5.5 |
| Water Heating | - | 0.6 | 1.8 |
| Home Energy Reports & Information Feedback | - | 2.2 | 3.5 |
| ***Residential Subtotal*** | ***1.0*** | ***12.3*** | ***21.0*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | - | 2.1 | 2.6 |
| Small Business Direct Install | - | 10.0 | 10.2 |
| Custom Efficiency Retrofits | 1.8 | 27.4 | 34.8 |
| Computer Efficiency & Plug Loads | - | 0.3 | 2.6 |
| Prescriptive Rebates & Upstream Incentives | 0.8 | 11.0 | 21.9 |
| Commercial Lighting Redesign | - | 0.5 | 1.6 |
| Retrocommissioning | - | 2.7 | 1.0 |
| Combined Heat and Power | - | 5.2 | 5.2 |
| ***Commercial and Industrial Subtotal*** | ***2.6*** | ***59.1*** | ***79.8*** |
| **Total** | **3.5** | **71.3** | **100.8** |

**Table 2-36. Wyoming: Annual Costs, Program Plus Participants (Million dollars)**

| Sector and Program | 2010 | 2015 | 2020 |
|---|---|---|---|
| ***Residential Programs*** | | | |
| Low-Income Weatherization | 0.05 | 1.9 | 3.3 |
| Multi-family | - | 0.5 | 0.8 |
| New Construction | - | 2.3 | 1.5 |
| Home Retrofit | 0.7 | 1.2 | 2.6 |
| Retail Products | - | 0.6 | 2.2 |
| Lighting | - | 2.5 | 3.7 |
| Refrigerator / Freezer Recycling | 0.2 | 0.7 | 0.8 |
| Cooling | - | 3.5 | 7.1 |
| Water Heating | - | 1.3 | 3.4 |
| Home Energy Reports & Information Feedback | - | 2.4 | 4.0 |
| ***Residential Subtotal*** | ***1.0*** | ***16.9*** | ***29.3*** |
| ***Commercial and Industrial Programs*** | | | |
| New Construction | - | 4.4 | 7.4 |
| Small Business Direct Install | - | 14.3 | 14.5 |
| Custom Efficiency Retrofits | 3.6 | 54.7 | 69.6 |
| Computer Efficiency & Plug Loads | - | 0.4 | 3.6 |
| Prescriptive Rebates & Upstream Incentives | 1.5 | 22.0 | 43.7 |
| Commercial Lighting Redesign | - | 1.0 | 3.2 |
| Retrocommissioning | - | 5.3 | 1.9 |
| Combined Heat and Power | - | 24.0 | 37.3 |
| ***Commercial and Industrial Subtotal*** | ***5.2*** | ***126.2*** | ***181.3*** |
| **Total** | **6.1** | **143.1** | **210.6** |

# III. Utility System Impacts and Public Health Effects

## A. Methodology and Assumptions

We developed a methodology and created a model for calculating avoided electricity costs at the state level using a number of public data sources, including load and fuel price forecasts. The model begins with an analysis of actual electricity generation and cost data for a base year, develops a plan for meeting projected physical requirements in each future year of the study period, and calculates the incremental wholesale electricity costs associated with that plan (incremental to electricity supply costs being recovered in current retail rates). This model has been used and refined by Synapse Energy Economics, Inc. since 2009 in a number of avoided cost studies. More details about the model used and the methodology can be found in Appendix B.

#### Loads and Energy Efficiency Savings

The details of the electricity sales forecast and the proposed energy efficiency programs are discussed in detail in the previous chapter. In the Reference scenario (which includes no utility energy efficiency programs) electricity sales grow 51% from 2010 to 2030 for the region as a whole, representing an annual growth rate of 2.1%. Peak load growth in the Reference scenario is a little less at 1.9% per annum. For the region as a whole, the proposed energy efficiency programs in the High Efficiency scenario essentially offset load growth from 2010 to 2020, but after 2020 the energy efficiency efforts are continued only at maintenance levels and load growth resumes. The overall energy growth in the High Efficiency scenario from 2010 to 2030 is reduced to 1.3% and the peak load growth to 1.2% per annum.[5] Load growth in the Southwest region and in the individual states is discussed further below. The differences between the two scenarios result in avoided electricity generation and construction costs, reduced fuel costs, and operation & maintenance (O&M) costs, as well as lower pollutant emissions in the High Efficiency scenario. The difference in costs represents the avoided costs (i.e., utility system benefits) in the High Efficiency Scenario.

#### Capital and O&M costs

Capital and operating costs, and other key performance parameters, for new generating resources are based on values obtained by Synapse Energy Economics, as shown in Tables 3-1 and 3-2. These values were designed to be a reasonable, comparable set of costs and operating parameters, although costs and performance for specific projects may vary from the values. Not included here are fuel costs, production tax credits, renewable energy credits and proxy carbon dioxide emissions costs. All data sources that were used are publicly available. The Annual Energy Outlook 2011 (EIA 2011a) is the primary data source, supplemented by an Electric Power Research Institute report (EPRI 2011).

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[5] For comparison the aggregate Southwest electricity sales growth rate during the 1990-2010 period was 2.84% per annum. Nevada had the highest growth rate of 3.69%, while Wyoming had the lowest growth rate of 1.89%.

**Table 3-1. Key Financial Parameters for New Resources**

| Generation Type | Standard Size (MW) | Total Cost in 2015 (2010 $/ kW) | Total Cost in 2025 (2010 $/ kW) | Lead Time (years) | Book Life (years) |
|---|---|---|---|---|---|
| Coal Steam | 650 | 4,300 | 4,300 | 4 | 30 |
| NG CC | 400 | 1,100 | 1,100 | 3 | 30 |
| NG CT | 85 | 900 | 900 | 1 | 20 |
| Hydro | 500 | 5,000 | 5,000 | 4 | 50 |
| Biomass | 50 | 4,000 | 4,000 | 3 | 30 |
| Geothermal | 50 | 4,500 | 4,500 | 4 | 30 |
| Solar PV | 150 | 3,400 | 2,300 | 1 | 20 |
| Solar Thermal | 100 | 5,500 | 4,700 | 3 | 30 |
| Wind | 100 | 1,900 | 1,800 | 1 | 20 |

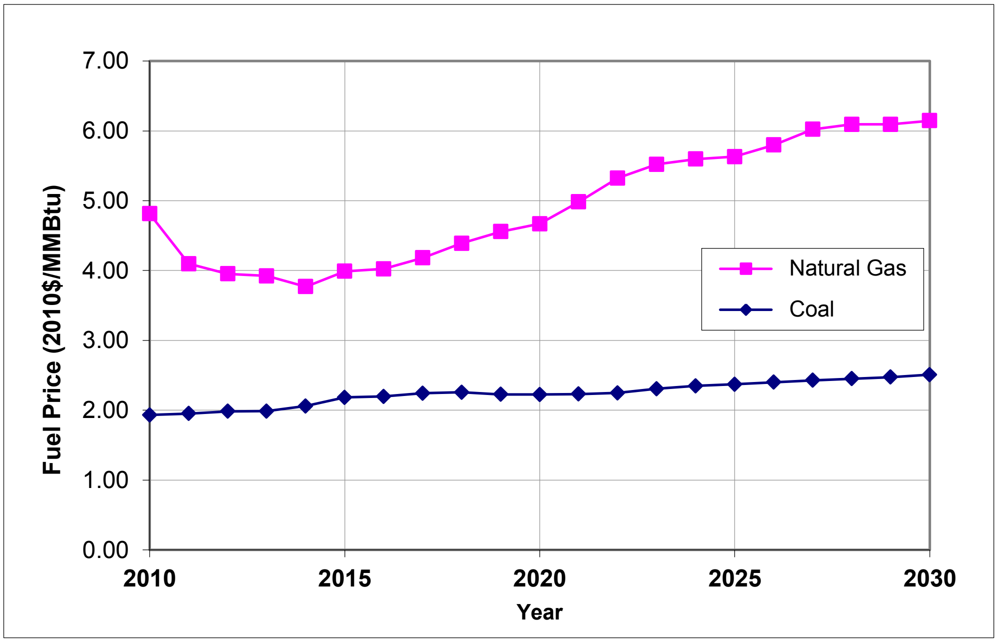
**Table 3-2. Key Operating Parameters for New Resources**

| Generation Type | Energy Source | Heatrate (Btu/ kWh) | Variable O&M (2010 $/ MWh) | Fixed O&M (2010$/ kW) | Typical Capacity Factor | Capacity Value for Load |
|---|---|---|---|---|---|---|
| Coal Steam | Coal | 8,800 | 4.28 | 29.9 | 80% | 100% |
| NG CC | Nat Gas | 7,050 | 3.44 | 14.5 | 80% | 100% |
| NG CT | Nat Gas | 10,745 | 8.31 | 9.95 | 10% | 100% |
| Hydro | Water | 9,854 | 2.47 | 13.82 | 50% | 100% |
| Biomass | Biomass | 13,500 | 7.08 | 101.29 | 70% | 100% |
| Geothermal | Geothermal | NA | 9.71 | 109.42 | 70% | 100% |
| Solar PV | Solar | NA | 0 | 34.38 | 19% - 31% | 58% |
| Solar Thermal | Solar | NA | 0 | 64.49 | 37% | 60% |
| Wind | Wind | NA | 0 | 28.28 | 30% - 40% | 15% |

***Fuel Costs***

Fuel costs for electric generation are based on the Annual Energy Outlook (AEO) 2012 Early Release forecast for the Western Electricity Coordinating Council (WECC) Southwest, published by the Energy Information Administration (EIA 2012a). However, the prices for each state have been calibrated to the actual 2010 values to reflect the differences in fuel prices between states. Figure 3-1, below, shows the base AEO prices that are used for this study. Coal prices show a slight increase over the study period, and while natural gas prices are forecast to decline in the near term, by 2030 gas prices increase by about 50%. For historic comparison, during the 1990-2010 period natural gas prices ranged from a low of about $2.50/MMBtu in 1990 to a high of $7.50/MMBtu in 2008. All prices are presented in 2010 dollars.

Figure 3-1. Base Fuel Prices for Electric Generation




***Emission Control Impacts for Existing Plants***

The Environmental Protection Agency (EPA) has recently proposed a number of regulations, in various stages of promulgation, which may have a significant impact on coal-fired generation in the southwestern states. Utilities are currently in the process of determining whether to retrofit older coal-fired units with necessary pollution control technologies, or to retire uneconomic coal units. In this analysis, coal retirements in the Southwest were estimated under both the Reference and High Efficiency scenarios. There are some instances in which coal units that receive pollution control retrofits in the Reference case are retired in the High Efficiency case. In these cases, the retirement of these units causes those costs for emission controls in the Reference scenario to be avoided. These avoided emission control costs are quantified and included in the calculation of total avoided costs. The sections below describe the relevant EPA regulations, the methodology used to determine which coal units are candidates for retirement, and the methodology used to estimate the avoided costs of emission control retrofits. In addition to the specific regulations discussed below, the EPA Regional Haze program, which is aimed at improving visibility in national parks and wilderness areas, is also pressuring utilities to retire older, dirty coal-fired power plants.

***Mercury and Air Toxics Standards***

The Mercury and Air Toxics Standards (MATS) rule is currently the only "new" rule that applies to the southwestern states that is in final form. The final rule was announced by EPA on December 21, 2011, and limits the emissions of mercury, total metals, particulate matter, hydrogen chloride, and sulfur dioxide from new and existing power plants. When examining the impacts of these standards, EPA suggested that many power plants would need to install widely available pollution control technologies in order to reduce emissions. These control technologies include wet scrubbers (flue gas desulfurization systems), selective catalytic reduction systems, activated carbon injection systems, and baghouses. Existing generators would have three years after the standards become effective to comply with the MATS rule, and may ask for a one-year extension to install controls. Coal-fired power plants, unless retired, are expected to comply with the standards in 2015.

***Coal Combustion Residuals***

Following the 2008 accidental release of fly ash, bottom ash, and coal combustion byproducts from the ash pond at the Tennessee Valley Authority's Kingston power plant, federal and state officials began to call for greater regulation of these coal combustion residuals (CCRs). On May 4, 2010, EPA released a proposal that offered two approaches for the disposal and management of CCRs under the Resource Conservation and Recovery Act (RCRA), the first approach under Subtitle C of the Act and the second approach under Subtitle D.

Under the Subtitle C approach, regulations establish location restrictions, standards for ash pond liners, leachate collection and removal systems, groundwater monitoring for landfill disposal units, fugitive dust control, closure and post-closure care requirements, storage requirements, collective action, financial assurance, waste characterization, and permitting requirements.

Under the Subtitle D approach, EPA would establish minimum nationwide standards for the disposal of CCRs, akin to the standards for municipal solid waste (non-hazardous waste). These standards would restrict placement of CCR landfills and surface impoundments in certain areas, and would require new landfills and surface impoundments to install a composite liner and leachate collection and removal system. Existing landfills and surface impoundments in certain areas would have to be closed until they could meet more stringent safety requirements.

Requirements of each proposal would take effect at different times. For Subtitle C, the CCR requirements would go into effect when individual states adopt the rule; timing would therefore vary from state to state. For Subtitle D, the rule would become effective six months after promulgation.

***Clean Water Act § 316(b)***

Section 316(b) of the Clean Water Act requires that new power plants use the best available cooling water intake technologies for minimizing adverse environmental impacts.[6] Adverse environmental impacts include the intake of aquatic organisms with cooling water when using once-through systems.

The EPA promulgated a §316(b) rule in 2004 that covered large existing power plants with water intake in excess of 50 million gallons per day. In 2007, the Second Circuit Court of Appeals remanded this rule to the EPA. Absent federal regulations, states have begun to consider and adopt rules governing the retrofit of existing power plants with closed-loop cooling systems. EPA is

[6] Thermal power plants using water for cooling purposes use one of three types of cooling systems: once-through, recirculating, and dry cooling. Once-through systems withdraw water in large volumes and then discharge it back into the same water body at elevated temperatures. Recirculating systems withdraw water in smaller volumes, and continuously circulate the cooling water through a plant's heat exchangers with the aid of cooling towers. Dry cooling systems are closed-loop systems that do not rely on cooling water, but instead on forced draft air flow.

developing revised national regulatory standards implementing §316(b) for existing power plants and manufacturing facilities, and published the draft rule in April 2011.

The proposed §316(b) rule has three components: 1) Existing facilities that withdraw more than 2 million gallons of water per day, and withdraw 25% of water from an adjacent water body for cooling purposes, would be subject to an impingement limit, which restricts the number of fish that can be killed by being pinned against intake screens. The facility could also reduce water intake velocity to 0.5 feet per second or less; 2) Existing facilities withdrawing 125 million gallons of water per day or more would be required to conduct studies to determine if controls would be required to reduce entrainment of aquatic organisms in cooling water systems; and 3) New units would be required to add technology that is equivalent to recirculating cooling technology.

EPA estimates that this rule covers approximately 1,260 existing facilities, of which 670 are power plants. Compliance dates will not be relevant until EPA has issued the final rule, but power plants are expected to have to comply by no later than 2020.

***Waste Water Rule***

Following a multi-year study of steam generating units across the country, EPA found that coal-fired power plants are currently discharging higher-than-expected levels of toxic-weighted pollutants. Current effluent regulations were last updated in 1982 and do not reflect the changes that have occurred in the electric power industry over the last thirty years. Unfortunately, they do not adequately manage the pollutants being discharged from coal-fired generating units. Coal ash ponds and flue gas desulfurization (FGD) systems used by such power plants are the source of a large portion of these pollutants, which are likely to increase in the future as environmental regulations are promulgated and as pollution controls are installed. No new rule has yet been proposed, but EPA intends to issue the proposed waste water rule in November 2012, and a final rule in April 2014.

***Impacts of Regulations on Existing Coal Plants in the Southwest***

In order to comply with the regulations described above, power plant owners and operators will likely be required to make investments in pollution control retrofit technologies or to retire coal-fired units, depending on utility calculations of the costs and benefits of the alternatives. Several coal plant retirements have already been announced by utilities, and those retirements are included here in both the Reference and High Efficiency scenarios. Announced retirements are shown in Table 3-3, below. Announced retirements were determined through a review of utility press releases and proceedings before state public utility commissions. Total announced coal plant retirements in the region are approximately 1,911 MW.

In addition to those retirements listed above, other coal-fired retirements are likely, particularly in a scenario that combines higher levels of energy efficiency with proposed EPA regulations. The High Efficiency scenario includes the announced coal unit retirements shown in Table 3-1, and also includes the retirements of the units listed in Table 3-4.

Table 3-3. Announced Coal Retirements Included in the Reference and High Efficiency Scenarios

| State | Plant | Operator | Boiler or Unit | Year Built | Capacity (MW) |
|---|---|---|---|---|---|
| CO | Cameo Station | Public Service Company of Colorado | 1 | 1957 | 25 |
| CO | Cameo Station | Public Service Company of Colorado | 2 | 1960 | 50 |
| CO | Arapahoe Station | Public Service Company of Colorado | 3 | 1951 | 45 |
| CO | Arapahoe Station | Public Service Company of Colorado | 4 | 1955 | 111 |
| CO | Cherokee Station | Public Service Company of Colorado | 1 | 1957 | 107 |
| CO | Cherokee Station | Public Service Company of Colorado | 2 | 1959 | 106 |
| CO | Cherokee Station | Public Service Company of Colorado | 3 | 1962 | 152 |
| CO | Cherokee Station | Public Service Company of Colorado | 4 | 1968 | 352 |
| CO | Valmont Station | Public Service Company of Colorado | 5 | 1964 | 186 |
| CO | Clark Station | Black Hills Energy | 1 | 1955 | 18.7 |
| CO | Clark Station | Black Hills Energy | 2 | 1959 | 25 |
| NM | Four Corners Steam Plant | Arizona Public Service Company | 1 | 1963 | 190 |
| NM | Four Corners Steam Plant | Arizona Public Service Company | 2 | 1963 | 190 |
| NM | Four Corners Steam Plant | Arizona Public Service Company | 3 | 1964 | 253 |
| UT | Utah Smelter Power Plant | Rio Tinto | 1 | 1943 | 25 |
| UT | Utah Smelter Power Plant | Rio Tinto | 2 | 1943 | 50 |
| UT | Utah Smelter Power Plant | Rio Tinto | 3 | 1946 | 25 |
| | | | | **Total MW Retired** | **1,911** |

As shown in Table 3-4, an additional 4,407 MW of coal capacity may be economic to retire under the High Efficiency scenario. Some of these units may be retired even if utility energy efficiency programs are not expanded; however expanding utility efficiency programs and reducing or eliminating utility load growth at least for the remainder of the decade will facilitate retirement decisions. The economic cost of each generator in the fleet is estimated as the current running cost of the unit (fuel and O&M costs) plus the capital and O&M costs of any new environmental controls.

Table 3-4. Coal retirements Included in the High Efficiency Scenario Only

| State | Plant | Operator | Boiler or Unit | Year Built | Capacity (MW) |
|---|---|---|---|---|---|
| AZ | Apache Station | Arizona Electric Power Cooperative | ST2 | 1979 | 204 |
| AZ | Apache Station | Arizona Electric Power Cooperative | ST3 | 1979 | 204 |
| AZ | Cholla | Arizona Public Service Company | 3 | 1980 | 312 |
| AZ | H. Wilson Sundt Generating Station | UniSource Energy | 4 | 1967 | 173 |
| CO | Martin Drake | City of Colorado Springs | 5 | 1962 | 50 |
| CO | Martin Drake | City of Colorado Springs | 6 | 1968 | 75 |
| CO | Martin Drake | City of Colorado Springs | 7 | 1974 | 132 |
| CO | Nucla | Tri-State Generation and Transmission | 1 | 1959 | 11.5 |
| CO | Nucla | Tri-State Generation and Transmission | 2 | 1959 | 11.5 |
| CO | Nucla | Tri-State Generation and Transmission | 3 | 1959 | 11.5 |
| CO | Nucla | Tri-State Generation and Transmission | ST4 | 1991 | 79 |
| NM | San Juan | PNM Resources | 3 | 1979 | 555 |
| NM | San Juan | PNM Resources | 4 | 1982 | 555 |
| NV | North Valmy | Sierra Pacific Resources | 1 | 1981 | 277 |
| NV | Reid Gardner | NV Energy | 1 | 1965 | 114 |
| NV | Reid Gardner | NV Energy | 2 | 1968 | 114 |
| NV | Reid Gardner | NV Energy | 3 | 1976 | 114 |
| UT | Bonanza | Deseret Power Electric Cooperative | 1 | 1986 | 500 |
| UT | Carbon | PacifiCorp | 1 | 1954 | 75 |
| UT | Carbon | PacifiCorp | 2 | 1957 | 114 |
| UT | Sunnyside Cogen | Sunnyside Cogen Associates | 1 | 1993 | 58 |
| WY | Dave Johnston | PacifiCorp | 1 | 1959 | 114 |
| WY | Dave Johnston | PacifiCorp | 2 | 1961 | 114 |
| WY | Naughton | PacifiCorp | 1 | 1963 | 163 |
| WY | Naughton | PacifiCorp | 2 | 1968 | 218 |
| WY | Neil Simpson | Black Hills Corporation | 5 | 1969 | 22 |
| WY | Osage | Black Hills Corporation | 1 | 1948 | 12 |
| WY | Osage | Black Hills Corporation | 2 | 1949 | 12 |
| WY | Osage | Black Hills Corporation | 3 | 1952 | 12 |
| | | | | **Total MW Retired** | **4,407** |

Operating characteristics (including generation, capacity factor and heat rate), fuel costs, and the presence and status of existing environmental controls are all extracted from publicly available data from the U.S. EIA. O&M costs are estimated from public data sources and federal assumptions. Forward-going costs of coal units after retrofits were compared with the estimated cost of a new natural gas combined-cycle unit. In cases where the plant costs with pollution control retrofits exceed the costs of a new combined-cycle natural gas-fired unit, existing units were considered candidates for retirement.

This analysis does not assume a particular regulatory framework for the requirement of environmental control technologies. Some of the control technologies here may be required under MATS rules or under rules regulating water withdrawals (under the CWA, section 316(b)). The default assumptions in this analysis are that every generator will be required to:

- Scrub sulfur dioxide ($SO_2$) using a wet-process flue gas desulfurization unit (FGD);
- Remove excess oxides of nitrogen ($NO_x$) using selective catalytic reduction (SCR);
- Capture mercury (Hg) with activated carbon injection (ACI);
- Remove primary particulate matter (PM) with a baghouse structure; and
- Use, at a minimum, a wet cooling tower to reduce water withdrawals.

Generators are only assumed to require new environmental controls if the generator is not equipped with operational controls (or was not as of the data collection in 2009), or the controls are inadequate to sufficiently reduce emissions or water withdrawals.

The per-kilowatt capital cost of these controls was amortized based on a 12.7% capital recovery factor and uses the average of the unit's 2008-2010 annual capacity factors. Note that forward going costs for a control are calculated for all coal units greater than 100 MW that currently do not have that control. Note also that some coal units may require multiple controls.

When coal-fired units (which would have received environmental retrofits in the Reference scenario) are retired in the High Efficiency scenario, the costs of the environmental controls are saved. Those costs represent the avoided cost of emission controls, and are included in the calculations of total avoided cost in moving from the Reference to High Efficiency scenario.

In order to determine the avoided emissions between the Reference and High Efficiency scenarios, emission rates from 2010 were taken from EPA's Air Markets Program Dataset. Total annual emissions of a plant (as reported by EPA) were divided by the annual plant generation (as reported by EPA) to find an emissions rate. This rate was then multiplied by the unit's average annual generation to find total yearly emissions for each unit. Emission rates for $SO_2$ and $NO_x$ were each reduced by 90% for all units projected to require emissions controls.

**Water Use**

Water use (withdrawal and consumption) for thermal generating units is calculated in both the Reference and High Efficiency scenarios. Withdrawals are defined as quantities of water taken from a source for use in power plant cooling. Generating units that utilize once-through cooling technologies typically withdraw larger quantities of water, but return the bulk of withdrawn water to its source. Consumption values are defined as the quantities of water that are taken but not returned (i.e., water which is typically lost as a result of evaporation). Some water is consumed in power plants with once-through cooling systems. Plants that utilize recirculating cooling systems typically withdraw smaller volumes of water, but the majority of the water that is withdrawn is consumed during cooling. Average (median) rates of withdrawal and consumption for the various generation resource types were used to capture the relative water use impacts.

Water savings between the Reference and High Efficiency scenarios was calculated using water withdrawal and consumption rates from EIA. These rates, shown in Table 3-5, were multiplied by a unit's 2008-2010 total generation to determine total water withdrawals and consumption. Units requiring compliance with the §316(b) water regulation had their withdrawal and consumption rates changed to the median withdrawal and consumption rates of all units currently having appropriate controls.

**Table 3-5. Coal Plant Water Usage Rates**[7]

| State | 2012 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| ***Withdrawn*** *(Million gallons/GWh)* | | | | | |
| AZ | 2.213 | 1.141 | 0.628 | 0.628 | 0.628 |
| CO | 0.867 | 0.866 | 0.842 | 0.842 | 0.842 |
| NM | 12.115 | 0.771 | 0.771 | 0.771 | 0.771 |
| NV | 0.641 | 0.641 | 0.641 | 0.641 | 0.641 |
| UT | 0.655 | 0.655 | 0.655 | 0.655 | 0.655 |
| WY | 3.126 | 1.434 | 0.597 | 0.597 | 0.597 |
| **Total** | **3.298** | **1.000** | **0.677** | **0.677** | **0.677** |
| ***Consumed*** *(Million gallons/GWh)* | | | | | |
| AZ | 0.519 | 0.543 | 0.544 | 0.544 | 0.544 |
| CO | 0.702 | 0.689 | 0.693 | 0.693 | 0.693 |
| NM | 0.744 | 0.673 | 0.673 | 0.673 | 0.673 |
| NV | 0.592 | 0.592 | 0.592 | 0.592 | 0.592 |
| UT | 0.579 | 0.579 | 0.579 | 0.579 | 0.579 |
| WY | 0.538 | 0.552 | 0.566 | 0.566 | 0.566 |
| **Total** | **0.602** | **0.595** | **0.600** | **0.600** | **0.600** |

Water withdrawal rates first decline from 2012 to 2015 as a result of the retirement of coal units (some of which are equipped with once-through cooling systems) in 2015. Withdrawal rates continue to decline between 2015 and 2020, this time as a result of the implementation of the §316(b) rule, which requires that units with once-through cooling systems be retrofit to utilize recirculating cooling technologies. Conversely, water consumption rates may increase slightly as a result of retirements and retrofits. Recirculating cooling systems, while withdrawing significantly smaller volumes of water, consume slightly more water than once-through systems. This is the reason total consumption rates for the southwest region rise from 2015 to 2020.

For other types of existing fossil units we use the median values for recirculating (or cooling tower) technologies (0.253 MGal/GWh for withdrawal and 0.198 MGal/GWh for consumption). For new

[7] The high rates for NM represent estimates of water use at Four Corners 3, 4 & 5 which currently use cooling ponds.

natural gas combined cycle (NGCC) plants we assume a 50/50 mix of recirculating and dry cooling.[8] This represents a withdrawal rate of 0.128 MGal/GWh and a consumption rate of 0.100 MGal/GWh (NREL 2011). For the existing nuclear plants we use the median cooling tower values of 1.101 MGal/GWh for withdrawal and 0.672 MGal/GWh for consumption.

The dominant users of water in the Southwest for electric generation are coal and nuclear plants. In Arizona, for example, coal plants represent about 45% of water use, nuclear plants another 45%, and natural gas plants the remaining 10%. Therefore, the major water savings that we see in the analysis are associated with cooling system changes at existing coal plants, along with the retirement of some older coal-fired plants.

**Transmission and Distribution Avoided Costs**

The cost of upgrading and maintaining transmission and distribution (T&D) infrastructure to relieve congested loads at lines and substations represents a significant portion of utility capital investment. However, such T&D investments are always lumpy investments, and the majority of new T&D capacity is under-utilized in virtually all years. While the monetary benefit of avoiding or delaying new T&D upgrades is often overlooked because it is challenging to accurately relate energy savings from efficiency measures with associated investments in T&D infrastructure, energy efficiency can have a significant impact on avoiding or delaying costly new T&D investment in the long-term by more precisely matching growing energy demand locally and incrementally.

To develop a single representative T&D avoided cost for the Southwest, we reviewed T&D avoided cost estimates applied in various analyses of the Southwest and Western regions. One of the most comprehensive estimates we found is a comparative review of T&D avoided costs by the Northwest Power and Conservation Council (NPCC) in its Sixth Power Plan.[9] The Sixth Plan adopted the T&D avoided cost estimates recommended by the Regional Technical Forum (RTF), which is an advisory committee that develops standards to verify and evaluate energy efficiency programs in the Pacific Northwest. The RTF gathered and reviewed comprehensive T&D avoided costs data from a dozen utilities across the Pacific Northwest region and recommended a value of $23/kW-year in 2006 dollars ($24.6/kW-year in 2010 dollars) for transmission system avoided cost and $25/kW-year in 2006 dollars ($26.7/kW-year in 2010 dollars) for distribution system avoided cost. The total T&D avoided cost recommended by the RTF and adopted by NPCC is $48/kW-year in 2006 dollars (or about $51/kW-year in 2010 dollars).

We also reviewed several avoided T&D cost estimates for utilities in the Southwest. These are shown in Table 3-6. Based on all of the above, we have adopted a value of $30/kW-year (2010 dollars) for the T&D avoided costs in this study.

[8] In some areas, particularly in arid regions, new power plants may be required to utilize dry cooling systems, which consume almost no water.

[9] NPCC 2010. Sixth Northwest Conservation and Electric Power Plan, available at http://www.nwcouncil.org/energy/powerplan/6/default.htm

Table 3-6. A Review of T&D Avoided Cost in the Southwest

| Utility | Region/ State | Avoided T&D ($/kW-yr) | Source |
|---|---|---|---|
| Xcel Energy | CO | 29 | Public Service Company of Colorado 2012/2013 Demand-Side Management Plan |
| Rocky Mountain Power | UT | 23 | Rocky Mountain Power 2010 Annual Energy Efficiency and Peak Reduction Report |
| Nevada Power | NV | 75/12 | Data obtained from NV Energy. The higher number is the company's estimated marginal T&D cost; the lower number is used by the company in its 2012 DSM plan. |

**Renewable Performance Standards Requirements**

The renewable performance standards (RPS) vary considerably by state within the Southwest. The target levels vary from zero to 30% of loads, and the attainment years are either 2020 or 2025. Some states set aside some of these requirements by specific resource type: solar, wind, or distributed generation, for example. Eligible resources commonly need to be installed after a given date and in Nevada include energy efficiency up to a limit. The Utah requirement is further qualified as "only if cost effective," which is somewhat ambiguous. However, we assume that the Utah RPS requirement is met.

Table 3-7 below summarizes the existing state requirements with information obtained from the DSIRE database (DSIRE 2012) where full details of the state policies are available. We also note in this table the reported 2010 renewable and hydro generation for each state (EIA 2012b), which in some cases fulfills part of the RPS requirements. Moreover, in this study we assume that existing RPS requirements are met but not increased.[10]

[10] It is certainly possible if not likely that some RPS requirements will be increased in the future. However, the focus of this study is to examine the costs and benefits of implementing best practice utility energy efficiency programs.

Table 3-7. RPS Requirements in the Southwest

| State | Requirement Level | Requirement Year | Sectors | Carve Outs | Eligible Resources | Non-hydro Renewable generation in 2010 | Hydro generation in 2010 |
|---|---|---|---|---|---|---|---|
| AZ | 15% | 2025 | All | Distributed generation 4.5% of sales in 2025 | Installed after 1/1/97 | 0.30% | 5.90% |
| CO | 30% | 2020 | IOU 30% COOPS 10% | IOU Dist. Gen. 3% of sales by 2020. | | 7.00% | 3.10% |
| NV | 25% | 2025 | All | 6% of requirements from solar | Includes Efficiency | 6.50% | 6.10% |
| NM | 20% | 2020 | IOU 20% REC 10% | Solar 20%, Wind 20%, Geoth+biomass+other 10%, Distributed 3% | On-line after 7/1/2007 | 5.10% | 0.60% |
| UT | 20% | 2025 | All | | Only if cost-effective | 1.80% | 1.60% |
| WY | None | | None | | | 6.70% | 2.10% |

In the utility system modeling we attempt to replicate these requirements as much as possible. We may not capture all of the details, but are most concerned about the differences between the Reference and High Efficiency scenarios. We also attempt to model "real world" conditions, e.g., adding wind generation in Wyoming based on current trends, even though additional wind is not driven by an RPS. One thing to note is that most of the new resource additions included in the model are associated with the RPS requirements. These increase faster than actual electricity sales, particularly in the High Efficiency scenario.

**Additions and Retirements**

As well as being driven by RPS requirements, most of the new generation resources in SWEEP will be driven by relative economics. There will also be some new conventional generation additions, which are based on currently available information. This conventional generation will be natural gas fired, with a mix of combined cycle and combustion turbine units.

We have reviewed public materials, including utility resource plans, regarding planned additions and retirements and have included those for the individual states through 2020. After 2020 we also assume a gradual retirement of existing fossil fuel-based generation as plants reach the end of their useful lives.

For the new renewable generation mix in the Southwest, we have relied on the recent Western Grid study (Western Grid 2011). Tables 12 and 13 of that report present projections of renewable capacity and generation for 2020. While we do not use those precise generation numbers, we do use the relative renewable resource mix by state in our modeling. Those percentages are specified in Table 3-8. Note that the renewable mix is state specific; wind is the greatest resource in three of the states, solar is very high in Arizona, and geothermal is greater in Nevada and Utah. In practice, actual renewable energy development will likely differ from these fractions, but we expect them to be roughly similar.

Table 3-8. Renewable Mix in 2020 by State

| State | Wind | Solar | Biomass | Geothermal | Small Hydro |
|---|---|---|---|---|---|
| AZ | 8% | 85% | 5% | 0% | 0% |
| CO | 81% | 19% | 0% | 0% | 0% |
| NV | 4% | 31% | 3% | 63% | 0% |
| NM | 64% | 23% | 9% | 2% | 0% |
| UT | 38% | 0% | 0% | 63% | 0% |
| WY | 99% | 0% | 0% | 0% | 1% |
| **Total** | **52%** | **28%** | **2%** | **17%** | **0%** |

**Other Costs**

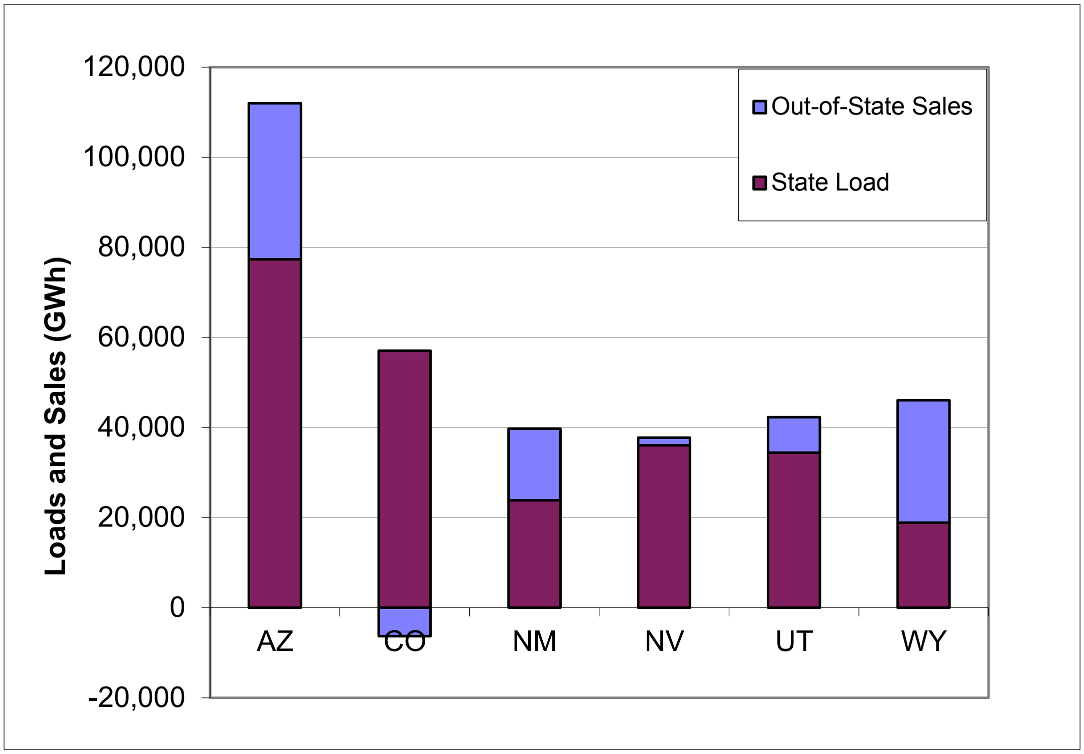
In addition to the types of costs described above there are a variety of other costs that are somewhat fixed and not much influenced by changes in load associated with EE programs. These include management, administrative and customer service costs. Also included in this category are costs associated with the existing infrastructure. This includes both ongoing maintenance which is only modestly much affected by changes in load as well as depreciation and capital recovery for existing investments. Also, if a power plant is retired with a positive book value, many utilities can still recover that "sunk" cost from their customers. The exact magnitude of such "fixed" costs varies by utility and circumstances, but could reasonably account for as much as a quarter of what the customers pay in their bills. To be conservative in our analysis, we do not treat such costs as avoidable and include them based on historic levels in the calculation of the customer retail prices.

**Inter-Regional Considerations**

On a regional basis, the southwest states presently are net exporters of electricity to other regions. Overall 25% of the electricity that is generated in the Southwest is exported, with most of those exports going to California. Colorado is the exception, as the state imports some electricity to meet its loads. Wyoming is at the opposite end of the spectrum as it exports more power than it uses. To provide some perspective on the relative magnitudes of electricity use in the West, the total electricity use of the six southwest states combined is 85% of the total electricity consumption in California.

Electricity consumption and sales in 2010 in the southwest states are shown in Figure 3-2 (data from EIA 2012b). Exports and imports will likely change in the future, but the precise nature of those changes is unknown. In this study, we assume that state electricity imports and exports remain constant at the actual values in 2010.

Figure 3-2. Net State Electric Export/Import Position




**Financial Parameters**

Although financial costs vary among the many participants who might build new resources in the Southwest region, we have chosen to use common values for consistency between the various states. The values that we use are typical for investor-owned utilities (IOU), although financing costs might be higher for independent power producers, or lower for public entities. We use an equity rate of 10%, a debt rate of 6%, and a 50/50 debt/equity mix. We also assume an overall (federal and state) income tax rate of 40%, along with a property tax rate of 0.5%. Capital recovery factors are calculated based on the book life of the specific resources. To be consistent with the valuation of the energy efficiency program costs, we use a 5% real discount rate for the net present value (NPV) calculations.

Also consistent with the energy efficiency programs analysis, all costs and savings are represented in constant 2010 dollars.

## B. Results

In the High Efficiency scenario, we expect that some marginally economic coal plants will retire rather than retrofit emission controls. These retirements have a major impact on emission reductions and reduced water use (discussed in the next section). The retirements are summarized in Table 3-9. In total, an additional 4,407 MW of coal-fired generating capacity is retired in the High Efficiency scenario in addition to the 1,911 MW assumed to be retired in the Reference scenario, based on announced coal plant retirements. We estimate that the region as a whole will avoid nearly $3 billion in investment in pollution control technologies as a result of these additional coal plant retirements.

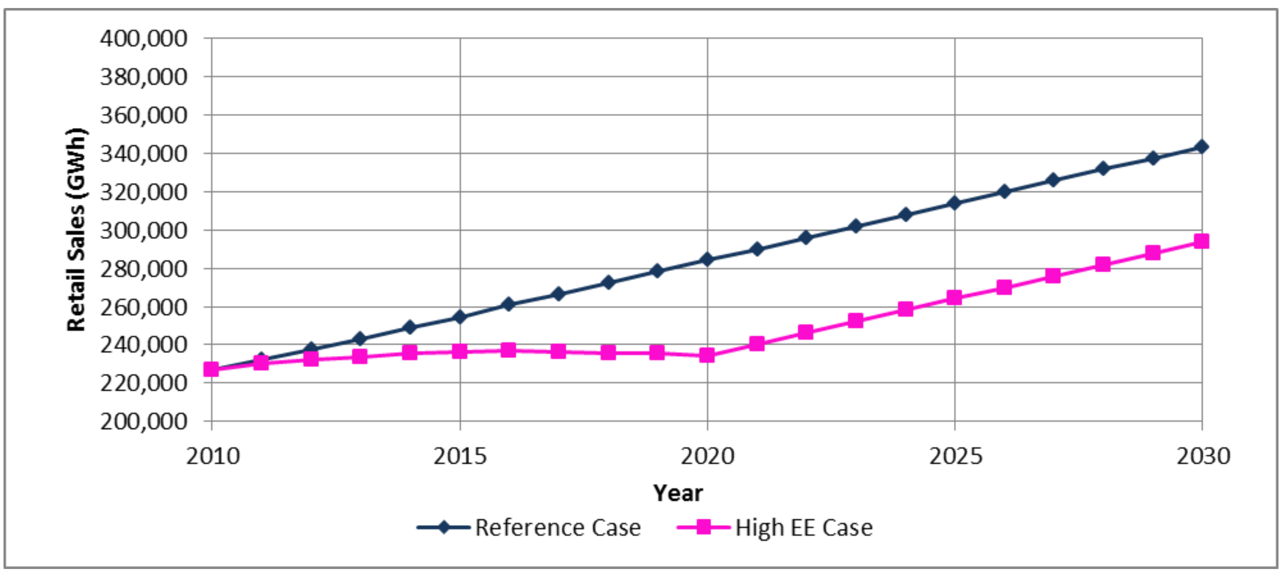
**Table 3-9. Aggregate Differences in the High Efficiency Scenario**

| State | Coal Retirements (MW) | Emission Control Savings (M$) |
|---|---|---|
| AZ | 893 | 605 |
| CO | 371 | 165 |
| NM | 1,110 | 452 |
| NV | 619 | 556 |
| UT | 747 | 352 |
| WY | 667 | 805 |
| **Total** | **4,407** | **2,936** |

**Regional Results**

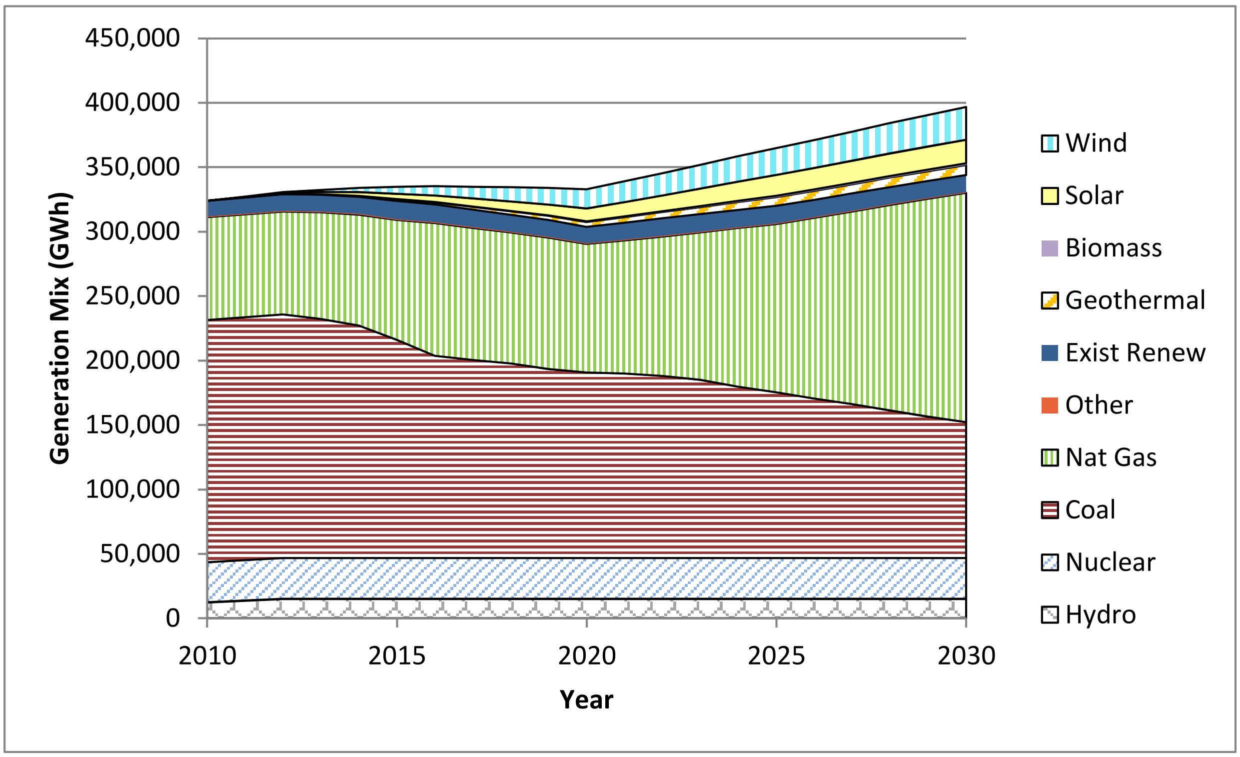
For the region as a whole, the High Efficiency scenario reduces electricity sales in 2020 by 17.5% relative to those in the Reference scenario, and the savings still remain at 14.5% by 2030. The average growth rate in the Reference case is 2.09% per year, which is lowered to 1.29% per year in the High Efficiency scenario. As noted in the previous chapter, the savings by 2020 are equal to about 21% of projected electricity consumption that year in the High Efficiency scenario. Figure 3-3 shows electricity consumption in the two scenarios through 2030 (excluding out-of-state sales).

**Figure 3-3. Electricity Sales in the Southwest**



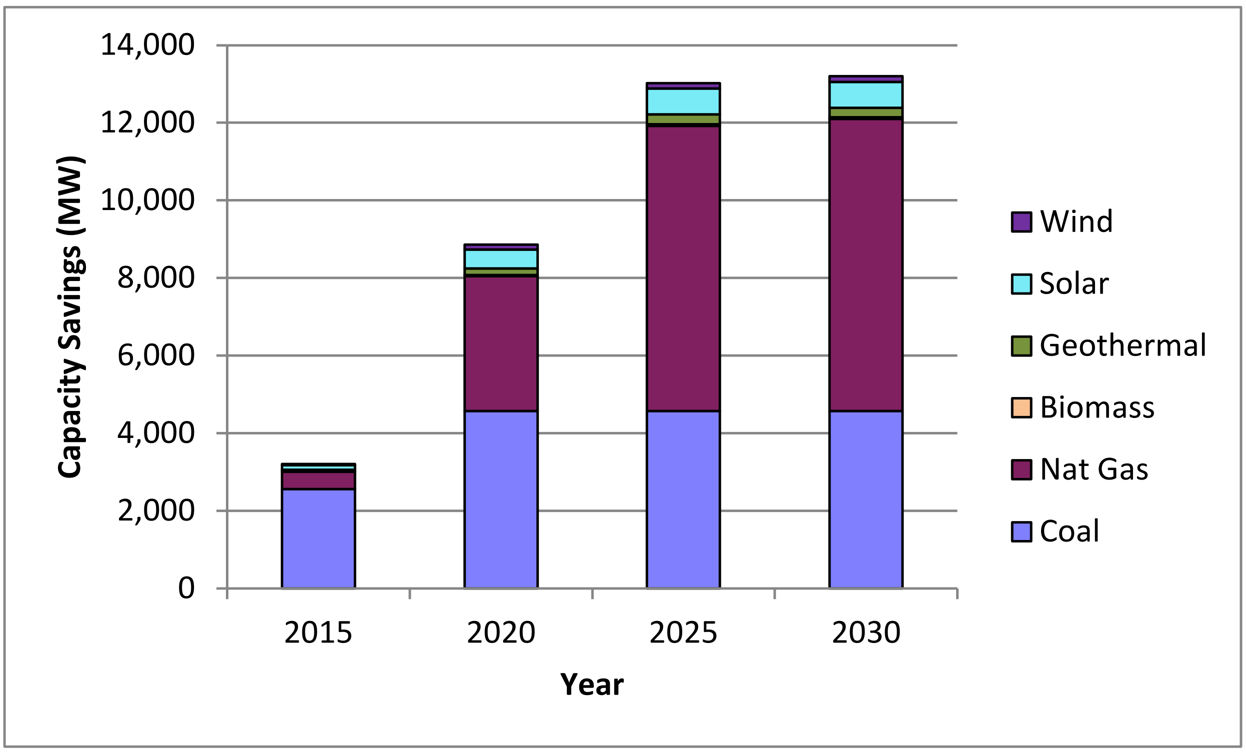
The generation mix for the Southwest region is currently dominated by coal, which accounted for 58% of the generation mix as of 2010. Natural gas makes up 25%, nuclear makes up 10%, and hydro and other renewable technologies account for the remaining 7% of generation. Figure 3-4 shows how the generation mix changes over time in the High Efficiency scenario. Generation from hydroelectric and nuclear generating resources stays constant over time. Coal generation declines significantly, and natural gas and renewables not only make up the difference but also increase to meet higher loads. However, the amount of generation and new capacity required is significantly reduced compared to the Reference scenario.

Figure 3-4. Generation Mix in the Region in the High Efficiency Scenario.



Reduced loads mean reduced generation costs and the delay and avoidance of new plant construction. Figure 3-5 shows the capacity savings in the Southwest associated with the High Efficiency scenario as compared to the Reference scenario. The coal portion reflects the retirement of 4,407 MW of existing coal generation to avoid about $2.9 billion for new emission control equipment. The majority of avoided new capacity is natural gas-fired, with almost 8,000 MW of capacity avoided in the High Efficiency scenario. In addition, fewer renewables are needed due to renewables standards applying to reduced loads, and more than 1,000 MW of a combination of wind, solar, geothermal and biomass capacity is avoided. However, as Fig. 3-4 shows, there is still substantial expansion of renewable capacity in the High Efficiency scenario. Of course renewable energy generation could be expanded further if renewable energy requirements are strengthened. In total, the region could avoid or retire about 32 large (400) MW power plants if the High Efficiency scenario is pursued. These results are consistent with recent utility resource plans in the region which project that new generation capacity will be either natural gas-fired power plants or renewable resources (PacifiCorp 2011a; APS 2012b; Xcel Energy 2011a).

Figure 3-5. Avoided Capacity in the Region in the High Efficiency Scenario

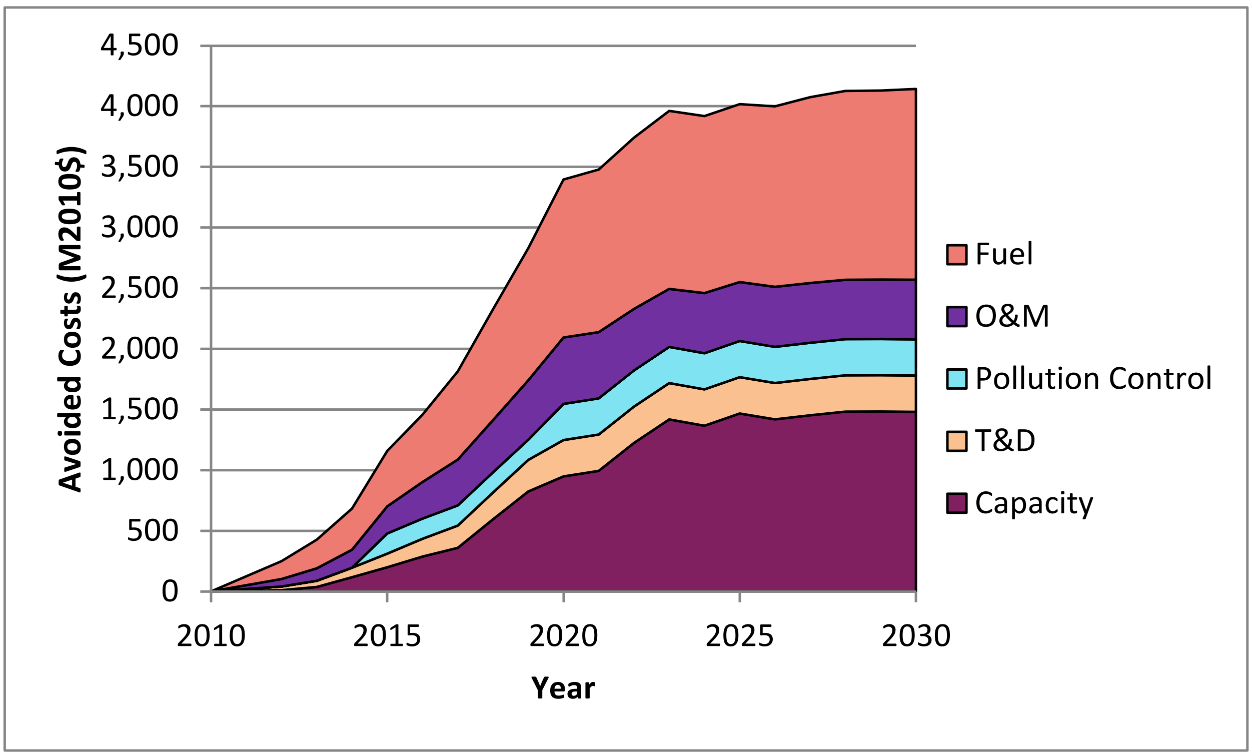


There are five major categories of avoided costs associated with reduced electricity:

1. Investment in new power plants;
2. Investment in Transmission and Distribution (T&D) system expansion;
3. Avoided pollution control costs from retirement of existing coal plants;
4. Operating and Maintenance (O&M) cost reductions because of decreased generation; and
5. Reduced fuel consumption.

Figure 3-6 shows these results for the Southwest in the High Efficiency scenario, relative to the Reference scenario, on an annual basis. The avoided costs reach $4 billion per year (in 2010 dollars) in the early part of the next decade. The largest savings are avoided fuel costs and avoided investments in new power plants. As load growth returns after 2020 more capital investment is needed so that the avoided costs level off.

**Figure 3-6. Avoided Costs in the Region in the High Efficiency Scenario**



For comparison with the cost of the energy efficiency programs, Table 3-10 shows the utility avoided costs and consumer benefits in net present value terms. The utility avoided cost categories do not reflect labor and material costs, nor do they reflect taxes. The consumer benefits represent a more complete representation of the total avoided costs; i.e., they include estimates of the avoided administrative costs, system maintenance costs, and taxes. The consumer benefits also include valuation of public health benefits from reduced air pollutant emissions, as described in the next section. For the region as a whole, we estimate total consumer benefits of $37.2 billion on a net present value basis, compared to energy efficiency measure and program costs of $17.4 billion. This leads to the projected overall benefit-cost ratio of 2.14 and net economic benefits of about $19.8 billion for the region as a whole. Note that this benefit-cost ratio does not value any of the other non-energy benefits of energy efficiency improvements, which can be significant.

**Table 3-10. Southwest Region Benefit-Cost Comparison**

| | **Net Present Value 2010-2030** (Million 2010 $) |
|---|---|
| ***Utility Avoided Costs*** | |
| Capacity | 8,320 |
| T&D | 2,380 |
| Pollution Control | 2,084 |
| O&M | 4,070 |
| Fuel | 10,566 |
| **Total** | **27,421** |
| | |
| ***Consumer Benefits*** | |
| Utility Bill Savings | 36,611 |
| Public Health Benefits | 544 |
| **Total** | **37,155** |
| | |
| ***Energy Efficiency Costs*** | |
| Program Costs | 8,230 |
| Participant Costs | 9,123 |
| **Total** | **17,354** |
| | |
| **Net Economic Benefits** | **19,801** |
| **Benefit-Cost Ratio** | **2.14** |

Natural gas prices represent a key uncertainty in this analysis. A sensitivity analysis indicates that a 30% increase in future natural gas prices, compared to EIA projections, would increase total fuel cost savings for the High Efficiency scenario by 17% and increase overall consumer benefits by 5%. The benefit-cost ratio would also increase by 5% from 2.14 to 2.25. A 30% decrease in future natural gas prices, compared to EIA projections, would reduce the savings and benefit-cost ratio by the same amounts. Thus, the overall economic results are not highly sensitive to assumptions about future natural gas prices.

Table 3-11 shows the avoided pollutant emissions and the water savings in the High Efficiency scenario. By 2020, $CO_2$ emissions decline by about 15.5%, $NO_x$ emission decline by 12%, and SO2 emissions decline by 17% (reductions from projected utility sector emissions in the Reference scenario). The avoided $CO_2$ emissions in the High Efficiency scenario, 31.6 million metric tons per year in 2020, are equivalent to taking over six million passenger vehicles off the road. The absolute amount of $CO_2$ and $SO_2$ emissions reduction falls somewhat but the absolute amount of $NO_x$ emissions reduction increases during 2020-2030 given the assumptions about power plant operation and emissions rates over time.

Table 3-11 also shows that water use for power generation in the region would drop by about 18.5 billion gallons in 2020 in the High Efficiency scenario, nearly a 13% reduction relative to water use that year in the Reference scenario. Additional water savings would result if utilities promote energy and water-saving devices such as low-flow showerheads and resource-efficient clothes washers and dishwashers as part of their efficiency programs.

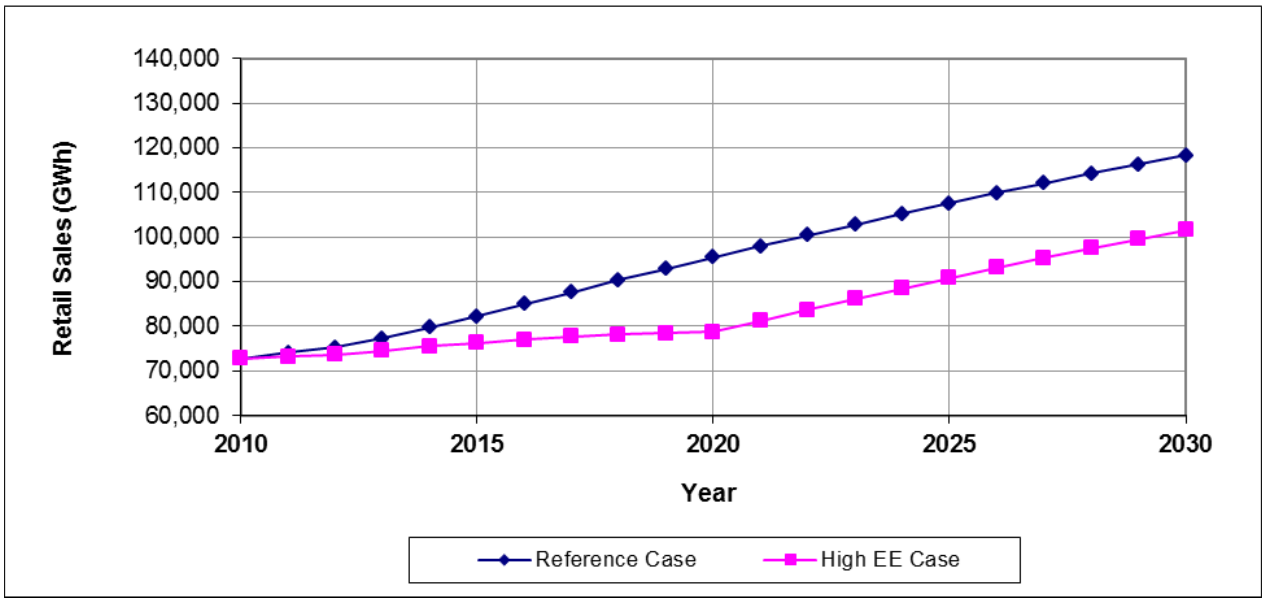
**Table 3-11. Avoided Pollutant Emissions and Water Savings in the Region in the High Efficiency Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| | **Reduction** | | | | |
| $CO_2$ Emissions | (1000 metric tons) | 14,872 | 31,588 | 27,206 | 28,350 |
| $NO_x$ Emissions | (metric tons) | 7,938 | 5,459 | 7,882 | 7,730 |
| $SO_2$ Emissions | (metric tons) | 8,103 | 16,274 | 13,071 | 13,300 |
| Water Consumption | (million gallons) | 9,515 | 18,512 | 14,397 | 15,163 |
| | **% Reduction** | | | | |
| $CO_2$ Emissions | | 7.2 | 15.5 | 13.9 | 14.8 |
| $NO_x$ Emissions | | 12.3 | 12.0 | 16.5 | 13.9 |
| $SO_2$ Emissions | | 6.6 | 17.0 | 15.6 | 18.6 |
| Water Consumption | | 6.4 | 12.9 | 10.8 | 12.3 |

**Arizona Results**

Arizona uses the most electricity of all the Southwest states, representing 32% of the total regional sales. Figure 3-7 shows electricity consumption in the two scenarios through 2030.The High Efficiency scenario reduces electricity sales in 2020 by 17.5% relative to those in the Reference scenario, and the savings still remain at 14.1% in 2030. The average growth rate in the Reference case is 2.46% per year, which is lowered to 1.68% per year in the High Efficiency case. As noted in the previous chapter, the savings by 2020 are equal to about 21% of projected electricity consumption that year in the High Efficiency scenario.

Figure 3-7. Arizona Electricity Sales



Arizona exports about 31% of its electricity production, and the total generation requirements reflect that as well as transmission and distribution losses. The generation mix for Arizona is currently dominated by coal, natural gas and nuclear resources. Figure 3-8 below shows how the generation mix changes over time in the High Efficiency scenario. Coal generation declines significantly, and natural gas and renewables not only make up the difference but also increase to meet higher loads. By 2030, natural gas accounts for 43% of generation, nuclear for 23%, coal for 17%, and renewables for 15% in the High Efficiency scenario.

**Figure 3-8. Arizona Generation Mix in the High Efficiency Scenario**

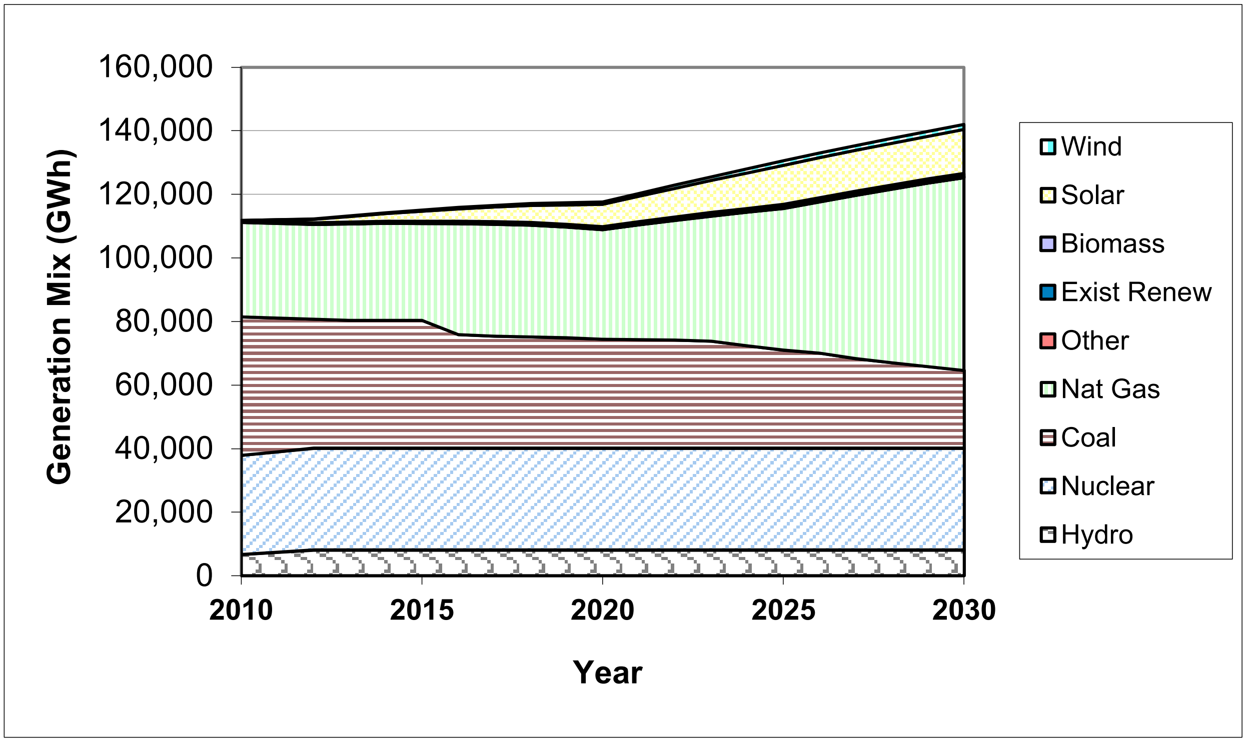


Figure 3-9 shows the capacity savings associated with the High Efficiency scenario compared to the Reference scenario. The maximum level of savings represents about 10% of the base case capacity. The coal portion reflects the retirement of almost 900 MW of existing coal generation to avoid about $600M for new emission control equipment. Most of the avoided new capacity is natural gas generation (approximately 3,000 MW), but because of reduced loads renewable capacity is also reduced by about 500 MW. However, as Figure 3-8 shows, there is still major expansion of renewable capacity in the High Efficiency scenario. Of course renewable energy generation could be expanded further if the renewable energy requirements are strengthened. In total, Arizona could avoid or retire about 10.5 large (400) MW power plants if the High Efficiency scenario is pursued.

Figure 3-9. Arizona Avoided Capacity

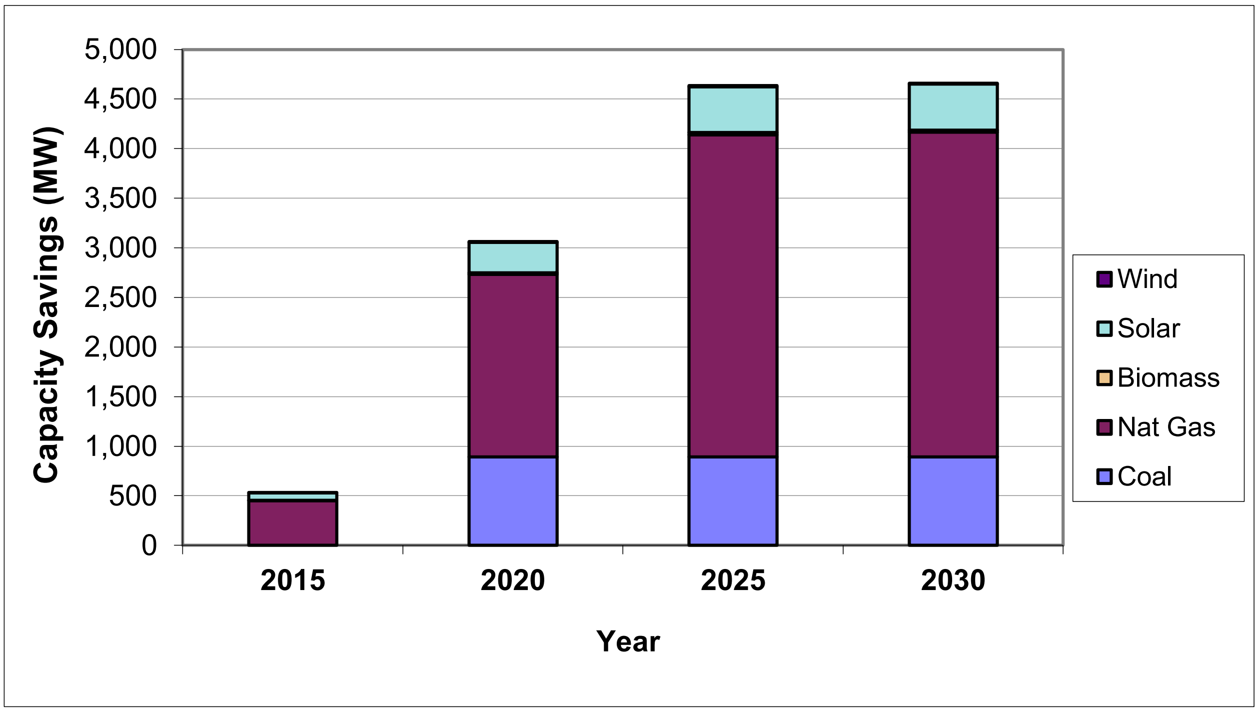


Figure 3-10 shows the avoided costs for Arizona. The avoided costs reach $1.4 billion per year (in 2010 dollars) in the early part of the next decade. Most of the savings are avoided fuel costs and avoided investments in new power plants.

**Figure 3-10. Arizona Avoided Costs**

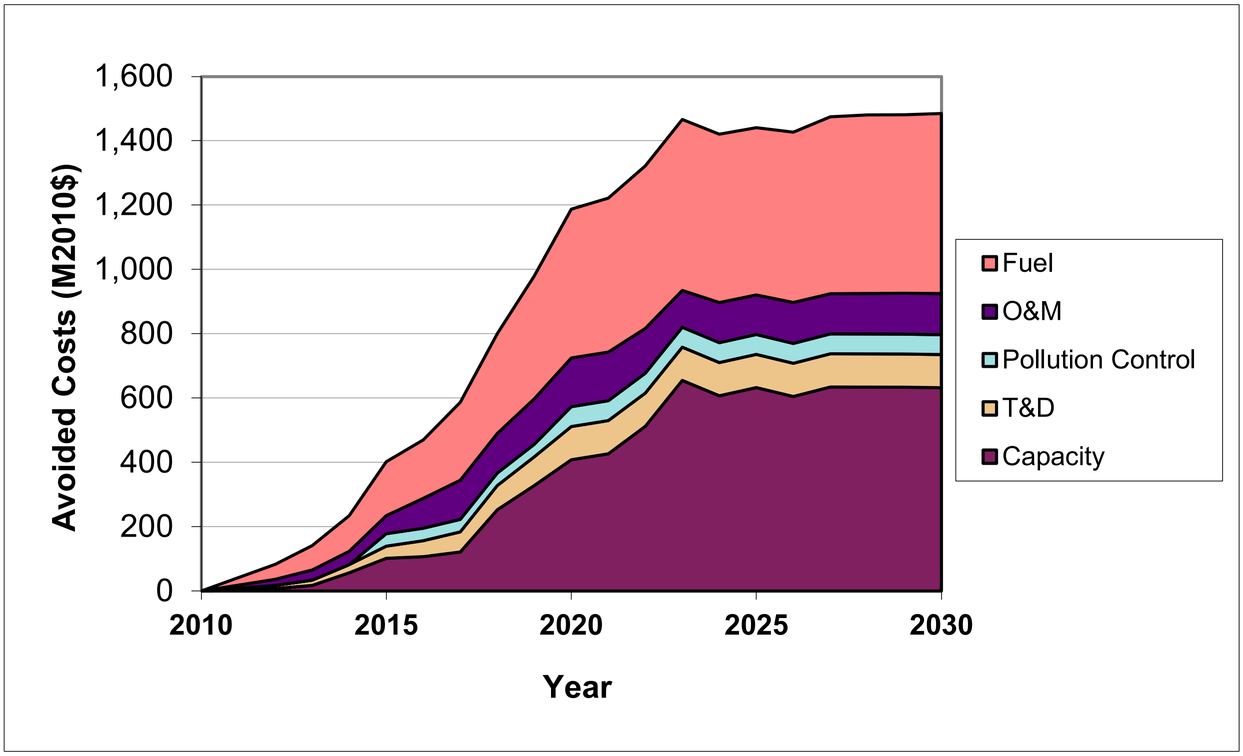


Table 3-12 presents utility avoided costs and consumer benefits, in net present value terms. Total economic benefits in Arizona in the High EE scenario are approximately $12.8 billion, while the total cost of energy efficiency programs and measures is about $5.5 billion. This leads to a benefit-cost ratio of 2.33 and net economic benefits of about $7.3 billion.

**Table 3-12. Arizona Benefit-Cost Comparison**

| | **Net Present Value 2010-2030** (Million 2010 $) |
|---|---|
| ***Utility Avoided Costs*** | |
| Capacity | 3,571 |
| T&D | 782 |
| Pollution Control | 447 |
| O&M | 1,112 |
| Fuel | 3,717 |
| **Total** | **9,629** |
| | |
| ***Consumer Benefits*** | |
| Utility Bill Savings | 12,583 |
| Public Health Benefits | 175 |
| **Total** | **12,758** |
| | |
| ***Energy Efficiency Costs*** | |
| Program Costs | 2,767.41 |
| Participant Costs | 2,691.58 |
| **Total** | **5,459** |
| | |
| **Net Economic Benefits** | **7,299** |
| **Benefit-Cost Ratio** | **2.33** |

Natural gas prices represent a key uncertainty in this analysis. A sensitivity analysis indicates that a 30% increase in future natural gas prices, compared to EIA projections, would increase total fuel cost savings for the High Efficiency scenario by 22% and increase overall consumer benefits by 6%. The benefit-cost ratio would also increase by 6% from 2.33 to 2.47. A 30% decrease in future natural gas prices, compared to EIA projections, would reduce the savings and benefit-cost ratio by the same amounts. Thus, the Arizona results are not highly sensitive to assumptions about future natural gas prices.

Table 3-13 shows the avoided pollutant emissions and the water savings in the High Efficiency scenario, relative to the Reference scenario for Arizona. By 2020, $CO_2$ emissions decline by about 17%, $NO_x$ emission decline by 10%, and $SO_2$ emissions decline by 22.5%. The avoided $CO_2$ emissions in the High Efficiency scenario, 9.6 million metric tons per year in 2020, are equivalent to taking about 1.9 million passenger vehicles off the road. The absolute amount of $CO_2$ and $SO_2$ emissions reduction falls somewhat but the absolute amount of $NO_x$ emissions reduction falls substantially during 2020-2030 given the assumptions about power plant operation and emissions rates over time. In addition, Table 3-13 shows that water use for power generation in Arizona would drop by about 4.1 billion gallons in 2020 in the High Efficiency scenario, an 8% reduction relative to water use that year in the Reference scenario.

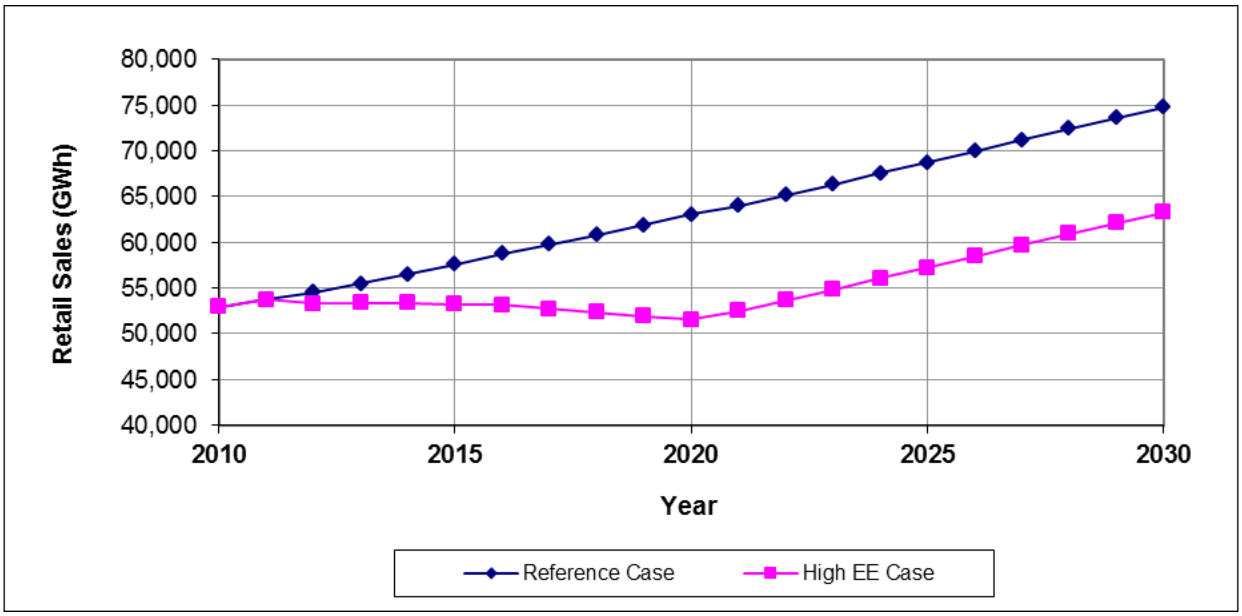
**Table 3-13. Avoided Pollutant Emissions and Water Savings in Arizona in the High Efficiency Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| | **Reduction** | | | | |
| $CO_2$ Emissions | (1000 metric tons) | 2,994 | 9,585 | 7,806 | 8,064 |
| $NO_x$ Emissions | (metric tons) | 411 | 847 | 48 | 204 |
| $SO_2$ Emissions | (metric tons) | 745 | 6,078 | 4,454 | 4,308 |
| Water Consumption | (million gallons) | 1,285 | 4,075 | 2,570 | 2,907 |
| | **% Reduction** | | | | |
| $CO_2$ Emissions | | 5.4 | 16.6 | 13.8 | 14.3 |
| $NO_x$ Emissions | | 4.0 | 10.3 | 0.7 | 3.5 |
| $SO_2$ Emissions | | 2.6 | 22.5 | 19.1 | 22.4 |
| Water Consumption | | 2.5 | 8.0 | 5.3 | 6.3 |

**Colorado Results**

After Arizona, Colorado has the second highest amount of electricity consumption within the Southwest region. In contrast to Arizona, though, Colorado has to import some electricity from other states in order to meet its loads. Figure 3-11 shows the electricity consumption in the two scenarios through 2030. Energy efficiency measures reduce sales by 18.2% from those in the Reference scenario in 2020 and by 15.4% in 2030. In the Reference scenario, retail electricity sales grow at an average rate of 1.74% per year from 2010 to 2030. In the High Efficiency scenario, the growth in retail sales drops to a rate of 0.90% per year. As noted in the previous chapter, the savings by 2020 are equal to about 22% of projected electricity consumption that year in the High Efficiency scenario.

Figure 3-11. Colorado Electricity Sales



As shown in Figure 3-12, Colorado's resource mix is currently dominated by coal-fired generation, which accounted for 68% of the electricity generation in the state in 2010. By 2030, natural gas is the dominant source of energy in Colorado in the High Efficiency scenario, making up 48% of generation that year. Coal-fired power plants drop to approximately 26% of total generation, and renewables (hydroelectric, wind, and solar) make up the remaining 26% of generation in 2030 in the High Efficiency scenario.

**Figure 3-12. Colorado Generation Mix in the High Efficiency Scenario**

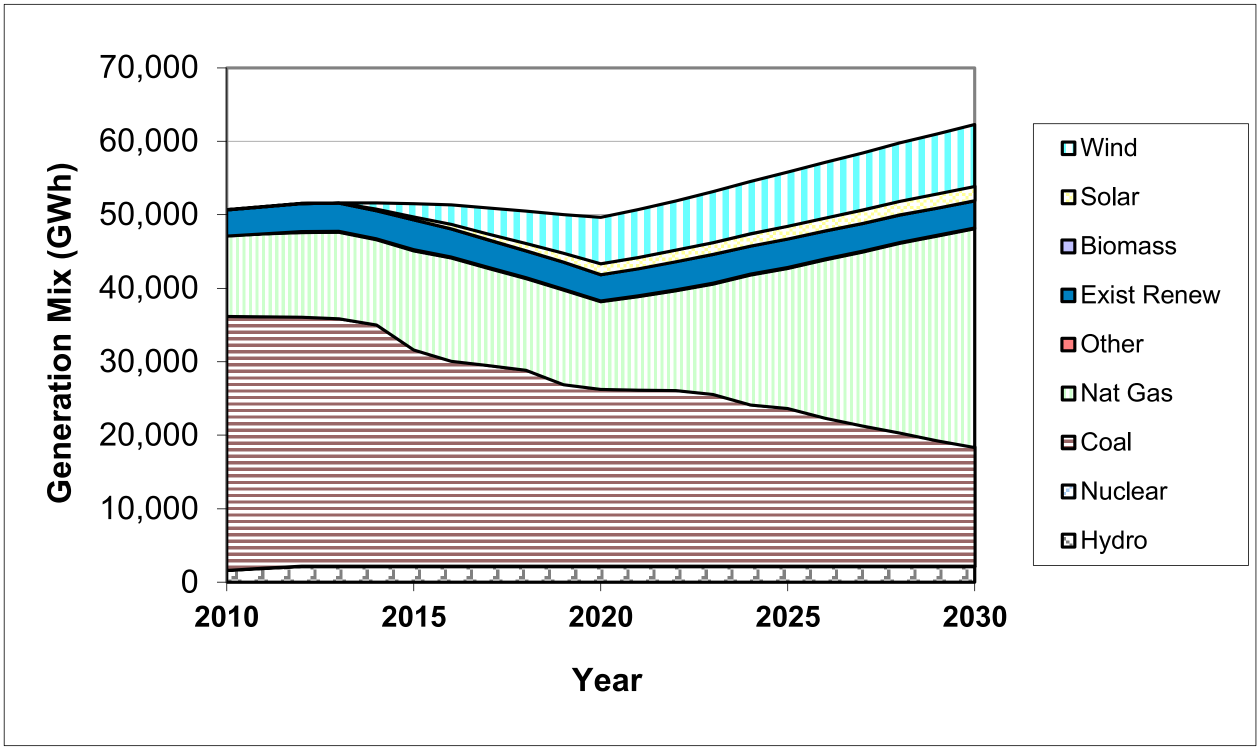


Figure 3-13 shows the avoided capacity associated with the High Efficiency scenario compared to the Reference case. The coal portion reflects the retirement of an additional 371 MW of existing coal capacity to avoid about $165M for new emission control equipment. The bulk of the avoided new capacity is natural gas generation at more than 2,000 MW, with about 150 MW consisting of avoided renewable capacity. Of course, renewable energy generation could be expanded further if the renewable energy requirements are strengthened. In total, Colorado could avoid or retire about 7.5 large (400) MW power plants if the High Efficiency scenario is pursued.

**Figure 3-13. Colorado Avoided Capacity**

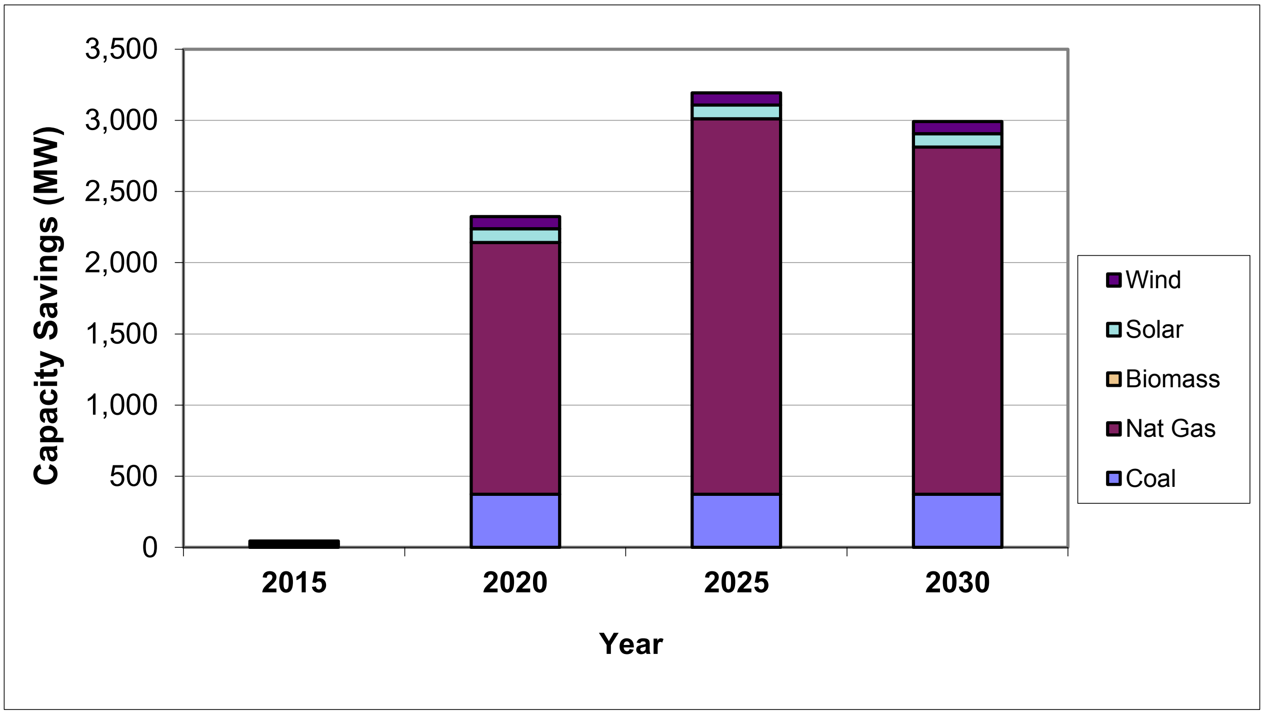


Figure 3-14 shows the avoided costs in the High Efficiency scenario in Colorado. The avoided costs reach $1 billion per year (in 2010 dollars) by the middle of the next decade. As in other states, avoided fuel costs and avoided investment in new power plants account for most of the avoided costs.

**Figure 3-14. Colorado Avoided Costs**

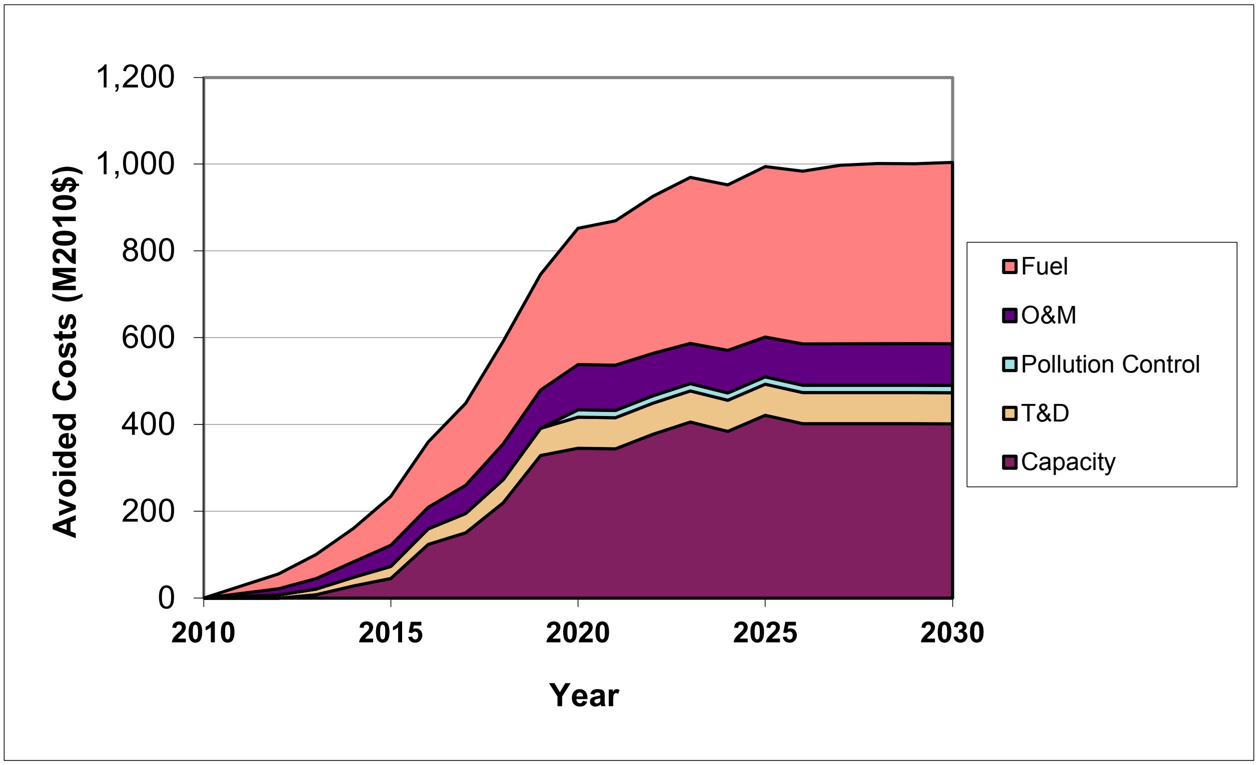


Table 3-14 presents utility avoided costs and consumer benefits in net present value terms. Total economic benefits in Colorado in the High Efficiency scenario are approximately $8.9 billion, while the total cost of energy efficiency programs and measures is about $4.1 billion. This leads to a benefit-cost ratio of 2.17 and net economic benefits of about $4.8 billion.

**Table 3-14. Colorado Benefit-Cost Comparison**

| | **Net Present Value 2010-2030** (Million 2010 $) |
|---|---|
| ***Utility Avoided Costs*** | |
| Capacity | 2,570 |
| T&D | 551 |
| Pollution Control | 86 |
| O&M | 786 |
| Fuel | 2,718 |
| **Total** | **6,710** |
| ***Consumer Benefits*** | |
| Utility Bill Savings | 8,857 |
| Public Health Benefits | 51 |
| **Total** | **8,908** |
| ***Energy Efficiency Costs*** | |
| Program Costs | 1,918 |
| Participant Costs | 2,186 |
| **Total** | **4,104** |
| | |
| **Net Economic Benefits** | **4,804** |
| **Benefit-Cost Ratio** | **2.17** |

The natural gas sensitivity analysis for Colorado indicates that a 30% increase in future natural gas prices, compared to EIA projections, would increase total fuel cost savings for the High Efficiency scenario by 26% and increase overall consumer benefits by 8%. The benefit-cost ratio would also increase by 8% from 2.17 to 2.35. A 30% decrease in future natural gas prices compared to projections would reduce the savings and benefit-cost ratio by the same amounts. Thus, the Colorado results are not highly sensitive to assumptions about future natural gas prices.

Table 3-15 shows the avoided pollutant emissions and the water savings in the High Efficiency scenario, relative to the Reference scenario for Colorado. By 2020, $CO_2$ emissions decline by about 15%, $NO_x$ emission decline by 9%, and $SO_2$ emissions decline by 9%. The avoided $CO_2$ emissions in the High Efficiency scenario, 5.4 million metric tons per year in 2020, are equivalent to taking about 1.1 million passenger vehicles off the road. The absolute amount of $CO_2$ and $SO_2$ emissions reduction falls somewhat but the absolute amount of NOx emissions reduction falls substantially during 2020-2030 given the assumptions about power plant operation and emissions rates over time. In addition, Table 3-15 shows that water use for power generation in Colorado would drop by about 2.5 billion gallons in 2020 in the High Efficiency scenario, nearly a 12% reduction relative to water use that year in the Reference scenario.

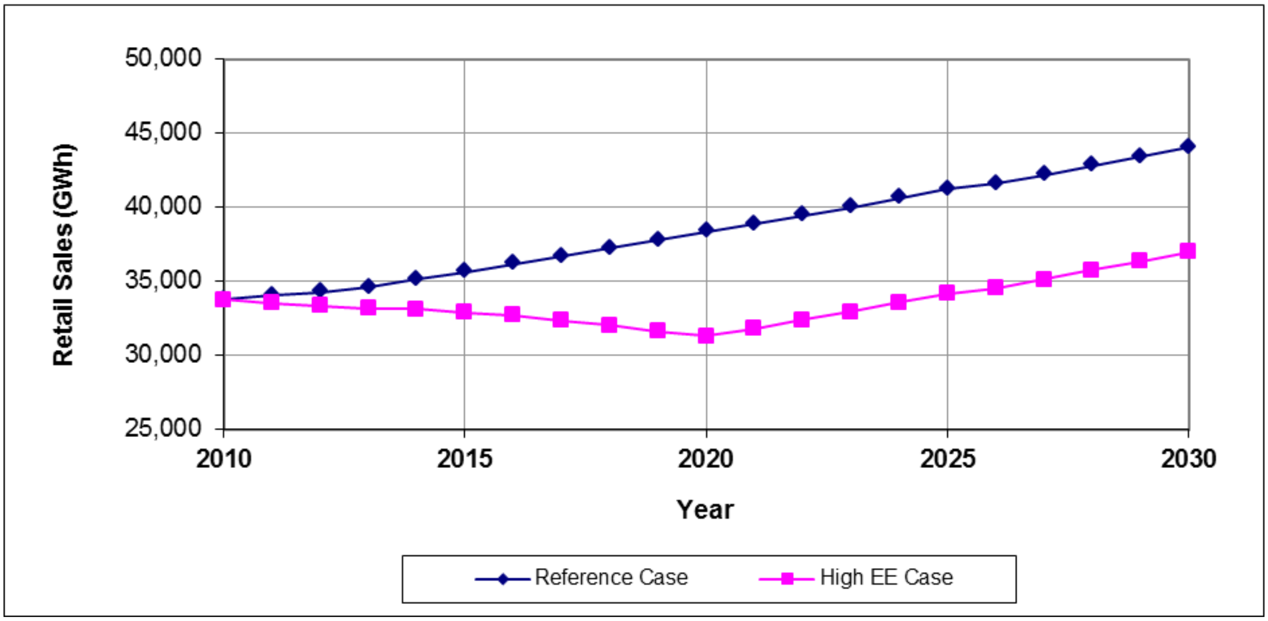
**Table 3-15. Avoided Pollutant Emissions and Water Savings in Colorado in the High Efficiency Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| | **Reduction** | | | | |
| $CO_2$ Emissions | (1000 metric tons) | 2,759 | 5,450 | 4,576 | 4,934 |
| $NO_x$ Emissions | (metric tons) | 1,560 | 700 | -181 | 158 |
| $SO_2$ Emissions | (metric tons) | 843 | 827 | 389 | 569 |
| Water Consumption | (million gallons) | 1,618 | 2,500 | 1,566 | 1,953 |
| | **% Reduction** | | | | |
| $CO_2$ Emissions | | 7.0 | 15.4 | 13.2 | 14.7 |
| $NO_x$ Emissions | | 8.6 | 8.8 | -2.5 | 2.6 |
| $SO_2$ Emissions | | 5.6 | 9.4 | 5.2 | 9.6 |
| Water Consumption | | 6.6 | 11.7 | 8.1 | 11.5 |

**Nevada Results**

In Nevada, energy efficiency measures reduce electricity sales by 18.4% from those in the Reference scenario in 2020 and by 16.0% in 2030. Figure 3-15 shows the electricity consumption in the two scenarios through 2030. In the Reference case, retail electricity sales grow at an average rate of 1.33% per year from 2010 to 2030. In the High Efficiency scenario, the growth in retail sales drops to a rate of 0.46% per year. As noted in the previous chapter, the savings by 2020 are equal to about 22% of projected electricity consumption that year in the High Efficiency scenario.

Figure 3-15. Nevada Electricity Sales



As shown in Figure 3-16, Nevada's resource mix is currently dominated by natural gas-fired generation, which accounted for 67% of the electricity generation in the state as of 2010. Natural gas generation remains the dominant fuel for electricity generation over the course of the study period in the High Efficiency scenario, making up 69% of generation in 2030. Over the course of the study period, coal generation drops from approximately 20% of generation as of 2010 to slightly less than 7% by 2030. All types of renewable resources account for about 26% of generation in 2030 in the High Efficiency scenario.

**Figure 3-16. Nevada Generation Mix in the High Efficiency Scenario**

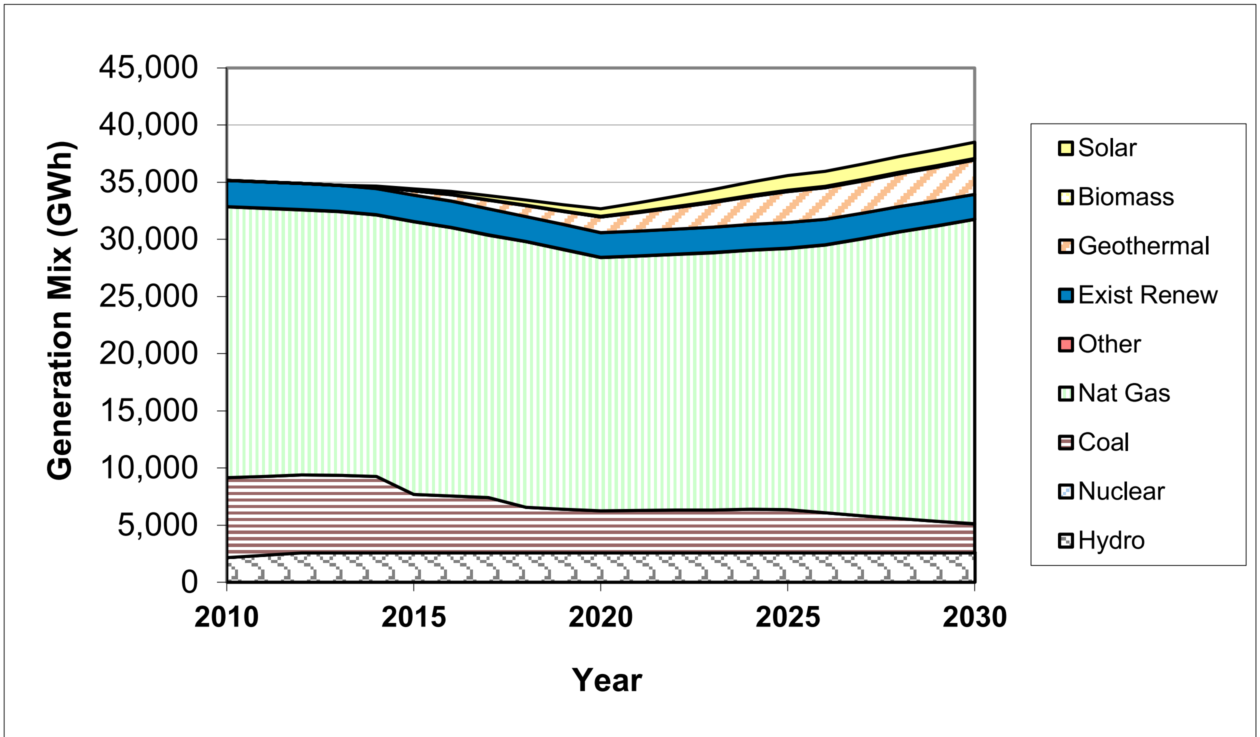


Figure 3-17 shows the capacity savings associated with the High Efficiency scenario compared to the Reference case. The coal portion reflects the retirement of 805 MW of existing coal capacity in order to avoid about $556M for new emission control equipment. The avoided new capacity is mostly natural gas fired, totaling about 900 MW by 2025. Just over 100 MW of new geothermal generation is avoided in 2025, and more than 50 MW of solar is avoided. In total, Nevada could avoid or retire four large (400) MW power plants if the High Efficiency scenario is pursued.

Figure 3-17. Nevada Avoided Capacity

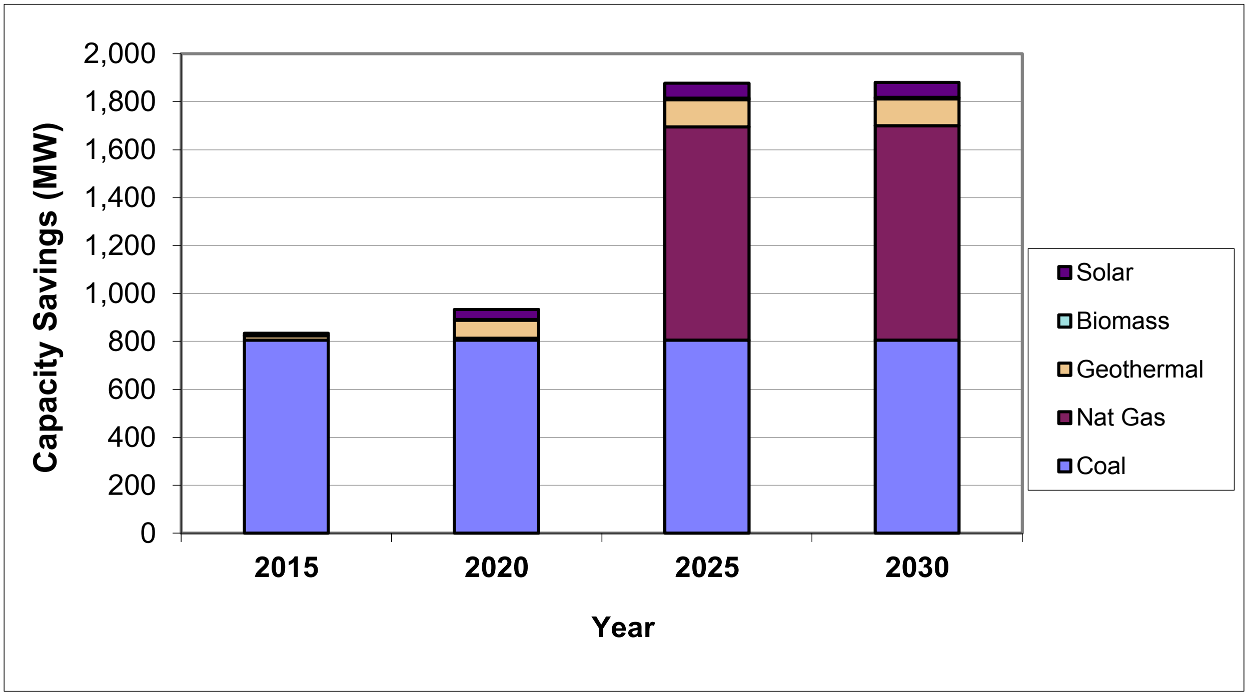


Figure 3-18 shows the avoided costs in the High Efficiency scenario in Nevada. The avoided costs reach $500 million per year by 2020 and nearly $700 million per year (in 2010 dollars) by 2030. Fuel costs make up the largest category of avoided costs in Nevada, with avoided investment in new power plants the second largest portion.

**Figure 3-18. Nevada Avoided Costs**

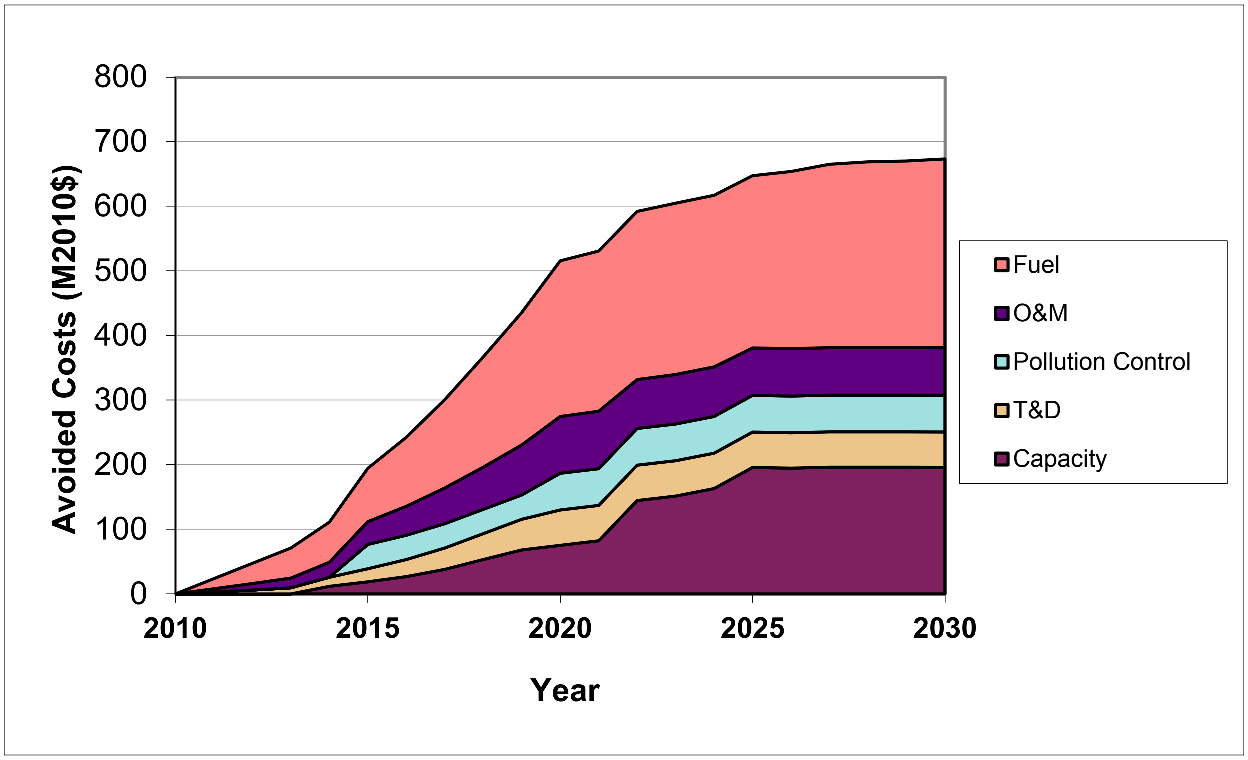


Table 3-16 presents utility avoided costs and consumer benefits in net present value terms. Total consumer benefits in Nevada in the High Efficiency scenario are approximately $6.0 billion, while the total cost of energy efficiency programs and measures is about $2.6 billion. This leads to a benefit-cost ratio of 2.32 and net economic benefits of about $3.4 billion.

**Table 3-16. Nevada Benefit-Cost Comparison**

| | **Net Present Value 2010-2030** (Million 2010 $) |
|---|---|
| ***Utility Avoided Costs*** | |
| Capacity | 944 |
| T&D | 417 |
| Pollution Control | 417 |
| O&M | 625 |
| Fuel | 1,960 |
| **Total** | **4,363** |
| ***Consumer Benefits*** | |
| Utility Bill Savings | 5,957 |
| Public Health Benefits | 54 |
| **Total** | **6,011** |
| ***Energy Efficiency Costs*** | |
| Program Costs | 1,137 |
| Participant Costs | 1,452 |
| **Total** | **2,590** |
| | |
| **Net Economic Benefits** | **3,421** |
| **Benefit-Cost Ratio** | **2.32** |

The natural gas sensitivity analysis for Nevada indicates that a 30% increase in future natural gas prices, compared to EIA projections, would increase total fuel cost savings for the High Efficiency scenario by 20% and increase overall consumer benefits by 7%. The benefit-cost ratio would also increase by 7% from 2.32 to 2.48. A 30% decrease in future natural gas prices, compared to EIA projections, would reduce the savings and benefit-cost ratio by the same amounts. Thus, the Nevada results are not highly sensitive to assumptions about future natural gas prices.

Table 3-17 shows the avoided pollutant emissions and the water savings in the High Efficiency scenario, relative to the Reference scenario for Nevada. By 2020, $CO_2$ emissions decline by about 26%, $NO_x$ emission decline by 15%, and $SO_2$ emissions decline by 43%. The avoided $CO_2$ emissions in the High Efficiency scenario, 4.4 million metric tons per year in 2020, are equivalent to taking about 867,000 passenger vehicles off the road. The absolute amount of $CO_2$ and $SO_2$ emissions reduction falls somewhat but the absolute amount of $NO_x$ emissions reduction increases dramatically during 2020-2030 given the assumptions about power plant operation and emissions rates over time. In addition, Table 3-17 shows that water use for power generation in Nevada would drop by about 2.4 billion gallons in 2020 in the High Efficiency scenario, a 27.5% reduction relative to water use that year in the Reference scenario.

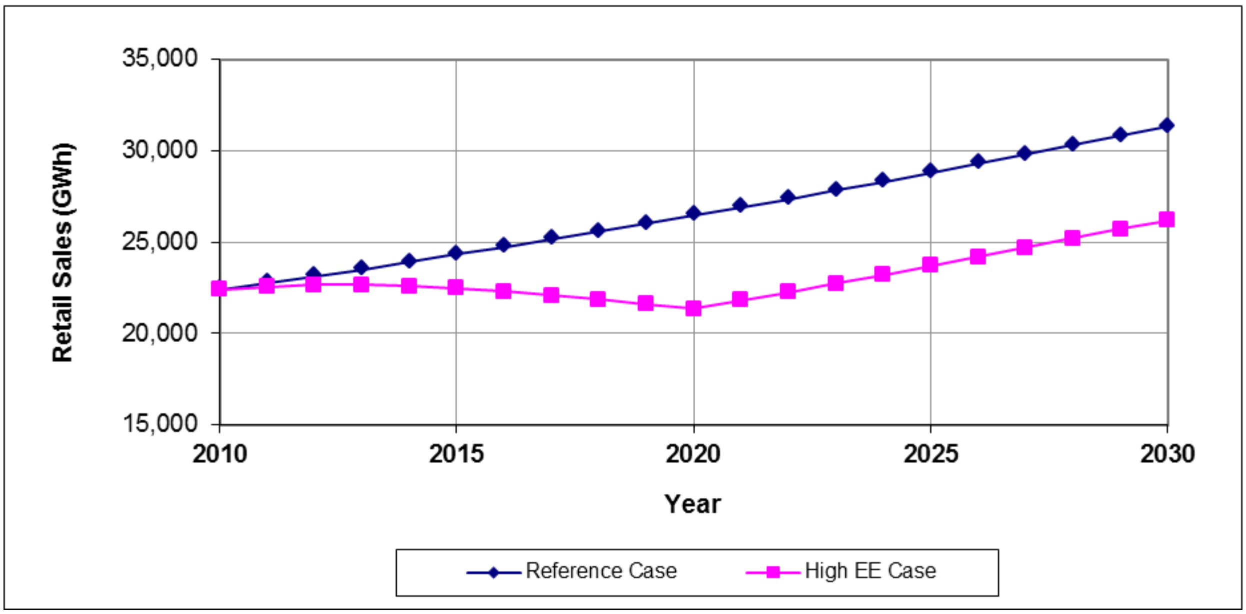
**Table 3-17. Avoided Pollutant Emissions and Water Savings in Nevada in the High Efficiency Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| | **Reduction** | | | | |
| $CO_2$ Emissions | (1000 metric tons) | 2,437 | 4,425 | 3,469 | 3,377 |
| $NO_x$ Emissions | (metric tons) | 1,053 | 1,759 | 6,272 | 6,159 |
| $SO_2$ Emissions | (metric tons) | 881 | 1,085 | 641 | 585 |
| Water Consumption | (million gallons) | 1,382 | 2,378 | 1,433 | 1,387 |
| | **% Reduction** | | | | |
| $CO_2$ Emissions | | 13.9 | 25.7 | 20.8 | 20.3 |
| $NO_x$ Emissions | | 10.3 | 14.7 | 36.6 | 23.9 |
| $SO_2$ Emissions | | 29.7 | 43.3 | 30.6 | 37.4 |
| Water Consumption | | 15.1 | 27.5 | 18.3 | 19.8 |

**New Mexico Results**

In New Mexico, energy efficiency measures reduce electricity sales by 19.3% from those in the Reference scenario in 2020 and by 16.3% in 2030. Figure 3-19 shows the electricity consumption in the two scenarios through 2030. In the Reference scenario, retail electricity sales grow at an average rate of 1.68% per year from 2010 to 2030. In the High Efficiency scenario, the growth in retail sales drops to a rate of 0.78% per year. As noted in the previous chapter, the savings by 2020 are equal to 23.6% of projected electricity consumption that year in the High Efficiency scenario.

Figure 3-19. New Mexico Electricity Sales



As shown in Figure 3-20, New Mexico's resource mix is currently dominated by coal-fired generation, which accounted for nearly 71% of the electricity generation in the state as of 2010. Over the course of the study period, coal generation declines as units are retired in the High Efficiency scenario, with coal-fired power plants providing approximately 23% of generation in 2030. Natural gas-fired generation grows from just over 23% as of 2010 to about 61% in 2030. All types of renewable resources account for the remaining 16% of power generation in 2030 in the High Efficiency scenario.

Figure 3-20. New Mexico Generation Mix in the High Efficiency Scenario

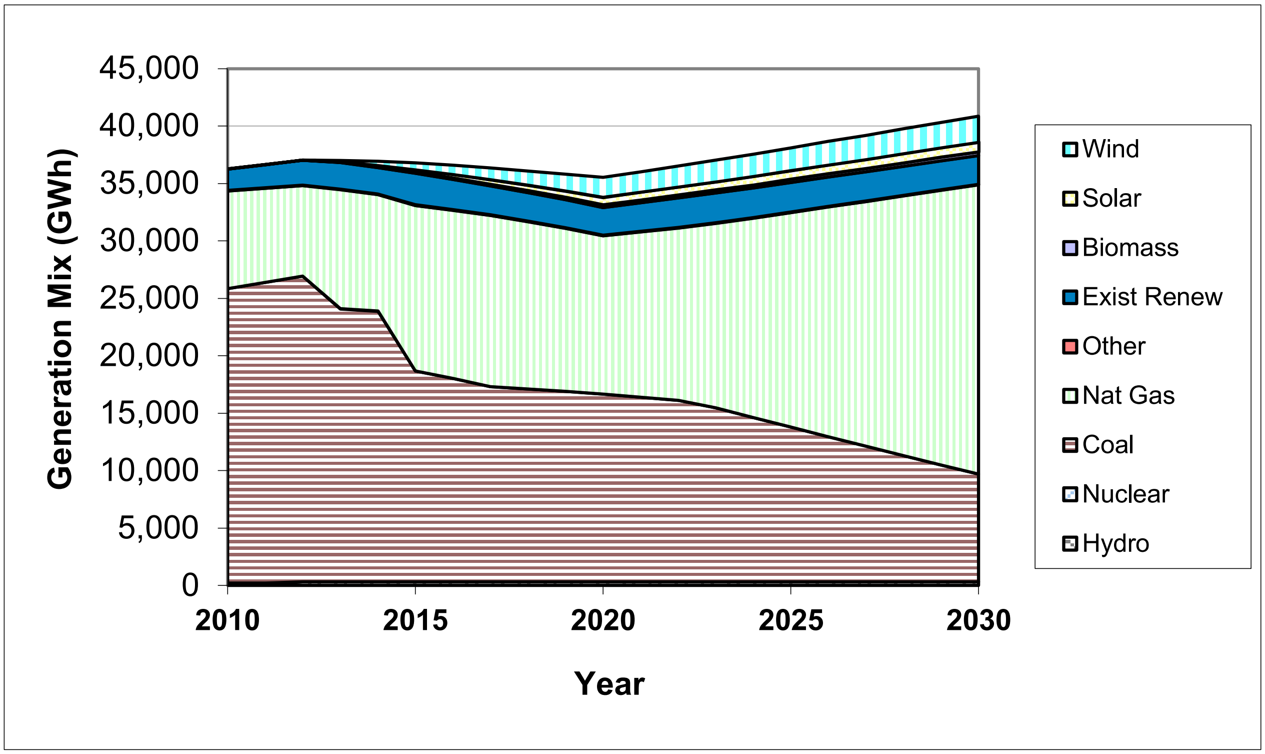


Figure 3-21 shows the avoided capacity associated with the High Efficiency scenario compared to the Reference case. The coal portion reflects the retirement of 1,110 MW of existing coal generation to avoid about $452M for new emission control equipment. Some natural gas is added in 2020 to make up for a small portion of the retired coal generation, leading to the negative capacity savings shown in Figure 3-18. With reduced loads, about 300 MW of natural gas and 80 MW of wind and solar capacity are avoided thereafter. In total, New Mexico could avoid or retire about 3.5 large (400) MW power plants if the High Efficiency scenario is pursued.

Figure 3-21. New Mexico Avoided Capacity

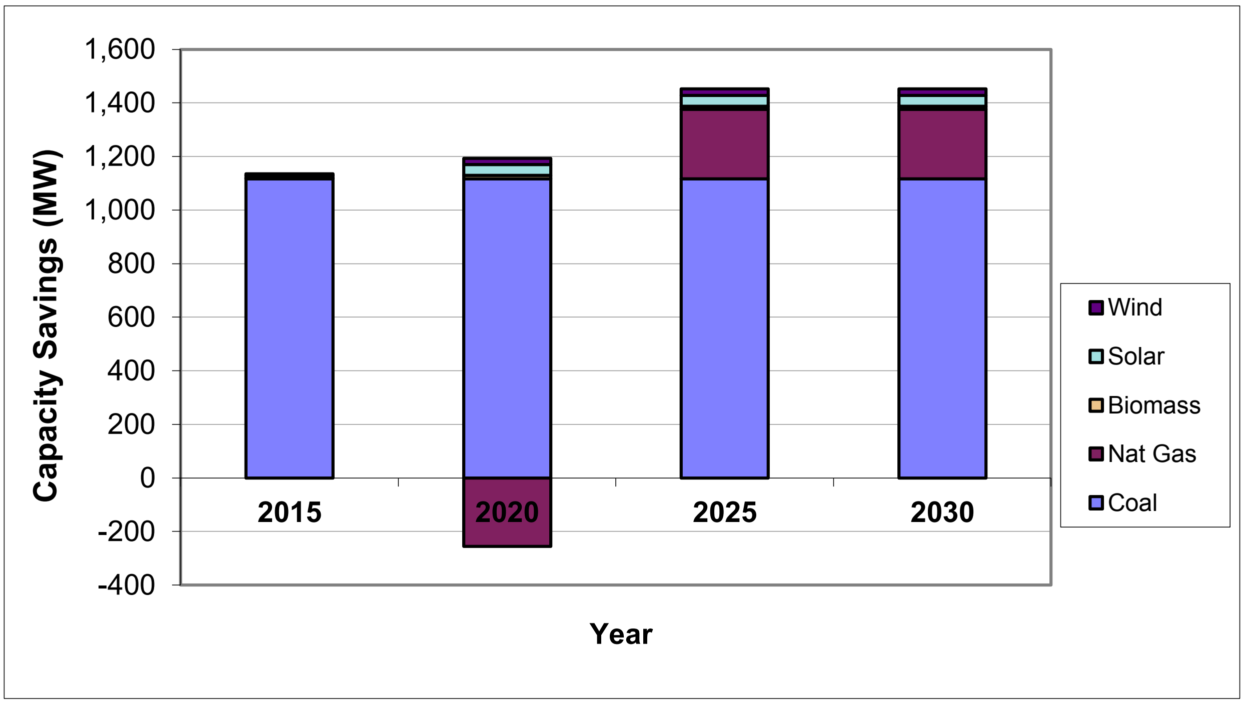


Figure 3-22 shows the avoided costs in the High Efficiency scenario in New Mexico. The avoided costs reach nearly $350 million per year by (in 2010 dollars) early in the next decade.  The avoided costs are more evenly split among the five categories in New Mexico, compared to other states in the region.

**Figure 3-22. New Mexico Avoided Costs**

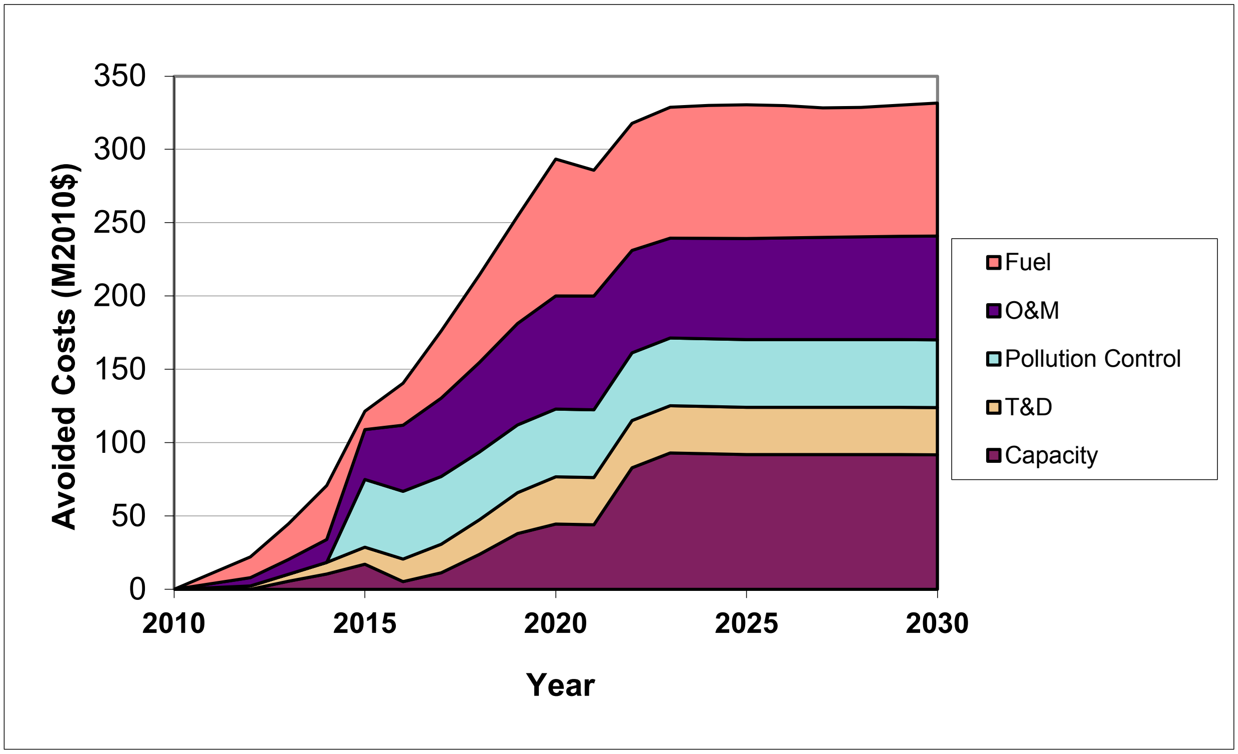


Table 3-18 presents utility avoided costs and consumer benefits in net present value terms. Total consumer benefits in New Mexico in the High Efficiency scenario are approximately $3.5 billion, while the total cost of energy efficiency programs and measures is about $1.85 billion. This leads to a benefit-cost ratio of 1.90 and net economic benefits of about $1.66 billion.

**Table 3-18. New Mexico Benefit-Cost Comparison**

| | **Net Present Value 2010-2030** (Million 2010 $) |
|---|---|
| ***Utility Avoided Costs*** | |
| Capacity | 486 |
| T&D | 243 |
| Pollution Control | 392 |
| O&M | 567 |
| Fuel | 667 |
| **Total** | **2,355** |
| ***Consumer Benefits*** | |
| Utility Bill Savings | 3,406 |
| Public Health Benefits | 112 |
| **Total** | **3,518** |
| ***Energy Efficiency Costs*** | |
| Program Costs | 877 |
| Participant Costs | 977 |
| **Total** | **1,854** |
| | |
| **Net Economic Benefits** | **1,664** |
| **Benefit-Cost Ratio** | **1.90** |

The natural gas sensitivity analysis for New Mexico indicates that a 30% increase in future natural gas prices would decrease total fuel cost savings for the High Efficiency scenario by 37% and decrease overall consumer benefits. The benefit-cost ratio would also decrease by 4% from 1.90 to 1.82. This counterintuitive result is due to the fact that because of the additional coal plant retirements, more natural gas is burned in the High Efficiency scenario than in the Reference case in 2020. A decrease in future natural gas prices would increase the consumer benefits and benefit-cost ratio by the same amounts. In any event, the New Mexico results are not highly sensitive to assumptions about future natural gas prices.

Table 3-19 shows the avoided pollutant emissions and the water savings in the High Efficiency scenario, relative to the Reference scenario for New Mexico. By 2020, $CO_2$ emissions decline by about 22%, $NO_x$ emission decline by 18%, and $SO_2$ emissions decline by 31%. The avoided $CO_2$ emissions in the High Efficiency scenario, 6.2 million metric tons per year in 2020, are equivalent to taking about 1.2 million passenger vehicles off the road. The absolute amount of $CO_2$, $SO_2$ and $NO_x$ emissions reduction falls somewhat during 2020-2030 given the assumptions about power plant operation and emissions rates over time. In addition, Table 3-19 shows that water use for power generation in New Mexico would drop by about 4.6 billion gallons in 2020 in the High Efficiency scenario, more than a 25% reduction relative to water use that year in the Reference scenario.

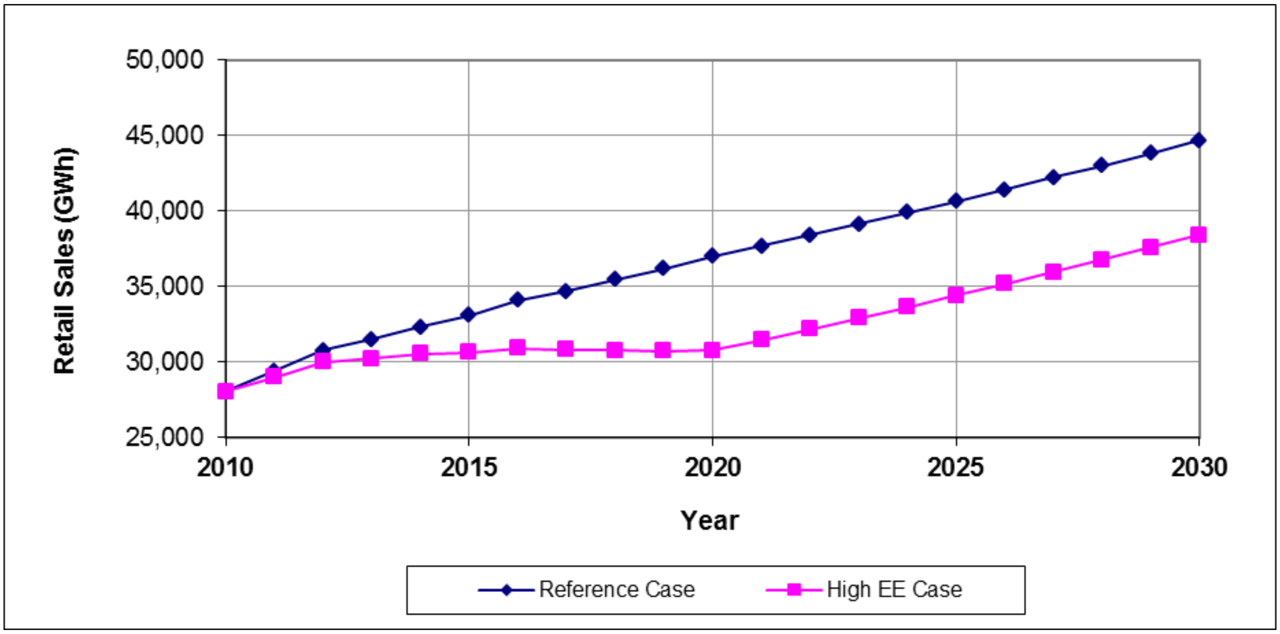
**Table 3-19. Avoided Pollutant Emissions and Water Savings in New Mexico in the High Efficiency Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| | **Reduction** | | | | |
| $CO_2$ Emissions | (1000 metric tons) | 4,135 | 6,229 | 5,829 | 6,010 |
| $NO_x$ Emissions | (metric tons) | 364 | 983 | 706 | 779 |
| $SO_2$ Emissions | (metric tons) | 3,099 | 3,872 | 3,551 | 3,700 |
| Water Consumption | (million gallons) | 3,223 | 4,559 | 4,117 | 4,317 |
| | **% Reduction** | | | | |
| $CO_2$ Emissions | | 14.3 | 21.8 | 21.4 | 23.4 |
| $NO_x$ Emissions | | 6.6 | 18.4 | 14.8 | 19.2 |
| $SO_2$ Emissions | | 24.0 | 30.7 | 33.0 | 42.5 |
| Water Consumption | | 17.6 | 25.4 | 25.7 | 30.9 |

**Utah Results**

In Utah, energy efficiency measures reduce electricity sales by 16.9% from those in the Reference scenario in 2020 and by 14.0% in 2030. Figure 3-23 shows the electricity consumption in the two scenarios through 2030. In the Reference scenario, retail electricity sales grow at an average rate of 2.35% per year from 2010 to 2030. In the High Efficiency scenario, the growth in retail sales drops to a rate of 1.59% per year. As noted in the previous chapter, the savings by 2020 are equal to about 20% of projected electricity consumption that year in the High Efficiency scenario.

**Figure 3-23. Utah Electricity Sales**



As shown in Figure 3-24, Utah's generation mix is dominated by coal-fired generation, which accounted for about 81% of the electricity generation in the state as of 2010. Coal generation declines by half as units are retired in the High Efficiency scenario, dropping to approximately 41% of generation in 2030. Natural gas-fired generation grows from about 15% of generation as of 2010 to about 41% in 2030. All types of renewable resources account for the remaining 18% of power generation in 2030 in the High Efficiency scenario.

Figure 3-24. Utah Generation Mix in the High Efficiency Scenario

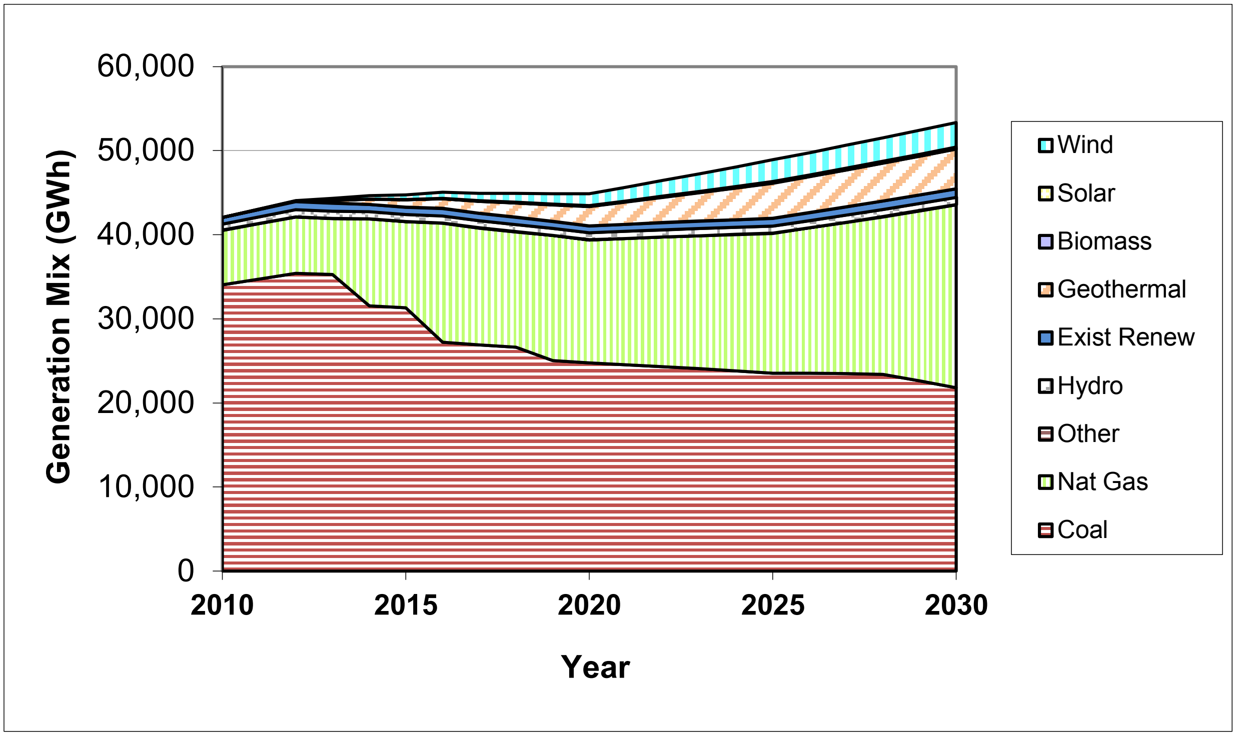


Figure 3-25 shows the capacity savings associated with the High Efficiency scenario compared to the Reference scenario. The coal portion reflects the retirement of 747 MW of existing coal generation to avoid about $352M for new emission control equipment which represents the bulk of the avoided capacity. In addition, 250 MW of new natural gas capacity is avoided by 2030 under the High Efficiency scenario. Some geothermal capacity is avoided beginning in 2015, as lower loads decrease the capacity that must be added under the RPS. However, as Figure 3-24 shows, there is still major expansion of renewable capacity in the High Efficiency scenario. Of course renewable energy generation could be expanded further if the renewable energy requirements are strengthened. In total, Utah could avoid or retire nearly 3 large (400) MW power plants if the High Efficiency scenario is pursued.

Figure 3-25. Utah Avoided Capacity

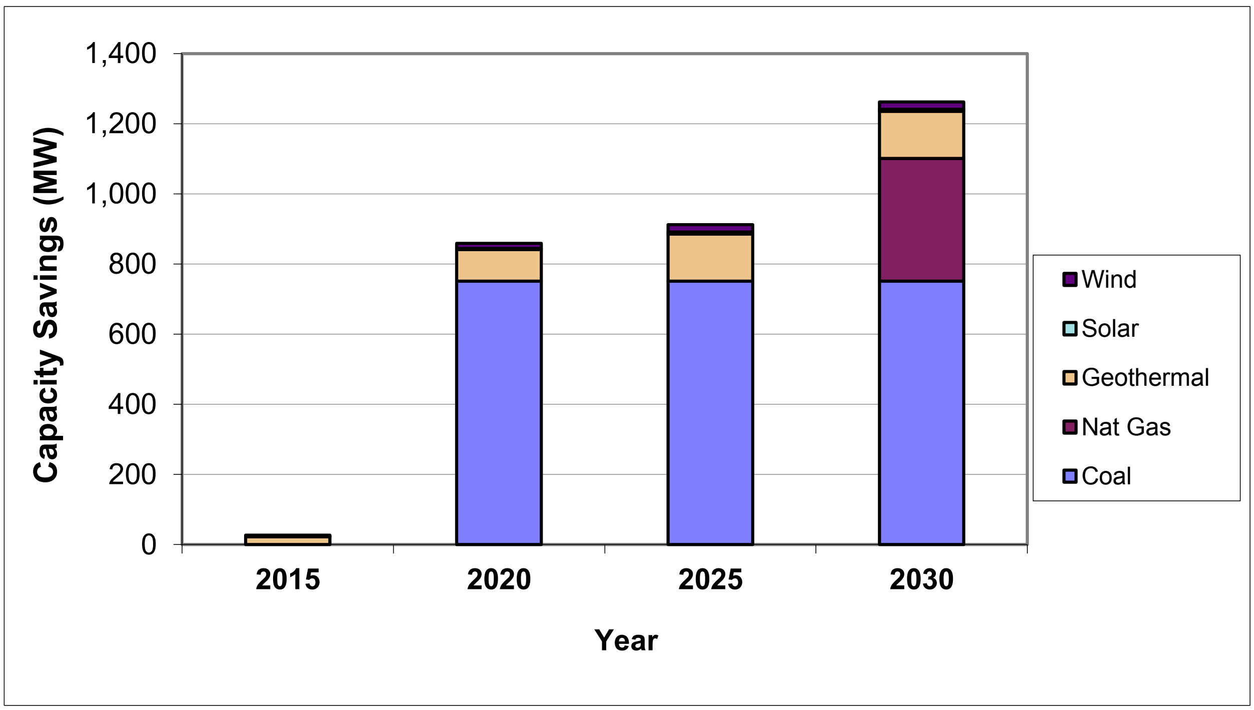


Figure 3-26 shows the avoided costs in the High Efficiency case in Utah. The avoided costs reach $350 million per year by 2020 and $425 million per year (in 2010 dollars) by 2030. As in New Mexico, avoided costs are more equally distributed between categories than in other states.

Figure 3-26. Utah Avoided Costs

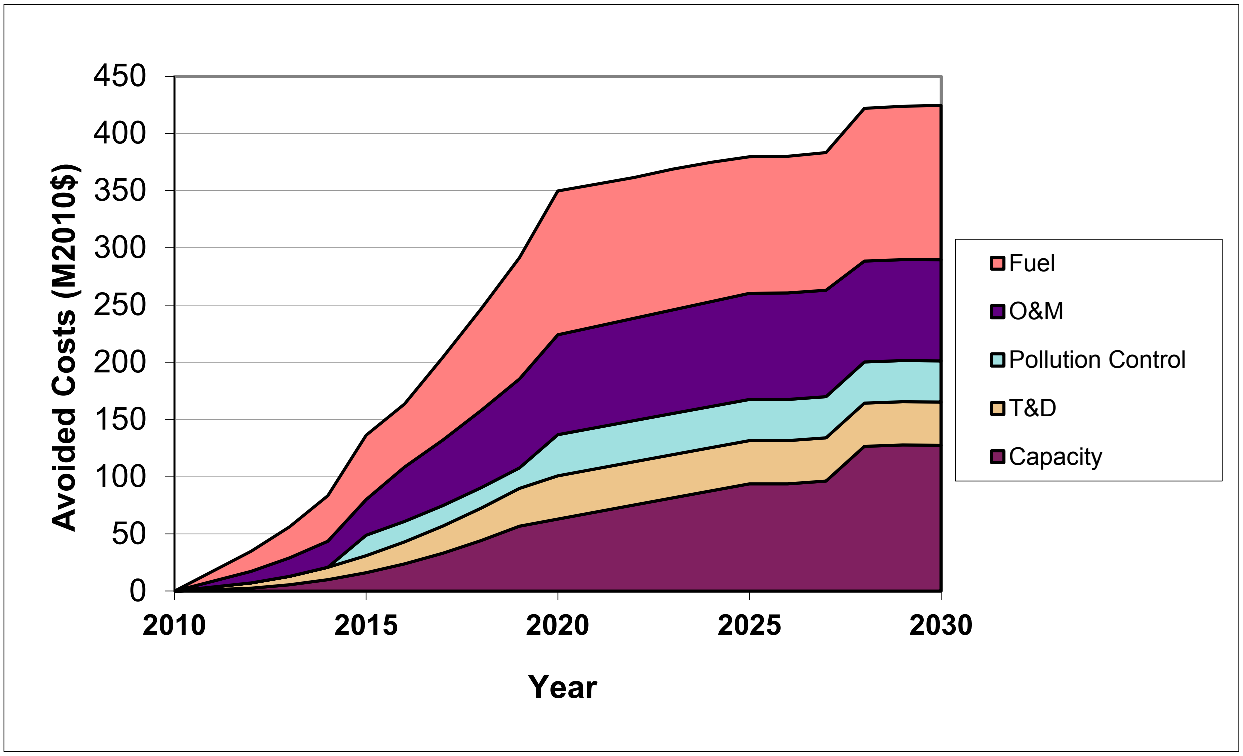


Table 3-20 presents utility avoided costs and consumer benefits in net present value terms. Total consumer benefits in Utah in the High Efficiency scenario are approximately $3.9 billion, while the total cost of energy efficiency programs and measures is about $2.2 billion. This leads to a benefit-cost ratio of 1.75 and net economic benefits of about $1.69 billion.

**Table 3-20. Utah Benefit-Cost Comparison**

| | **Net Present Value 2010-2030** (Million 2010 $) |
|---|---|
| ***Utility Avoided Costs*** | |
| Capacity | 597 |
| T&D | 293 |
| Pollution Control | 244 |
| O&M | 691 |
| Fuel | 966 |
| **Total** | **2,790** |
| ***Consumer Benefits*** | |
| Utility Bill Savings | 3,879 |
| Public Health Benefits | 52 |
| **Total** | **3,931** |
| ***Energy Efficiency Costs*** | |
| Program Costs | 1,052 |
| Participant Costs | 1,189 |
| **Total** | **2,241** |
| | |
| **Net Economic Benefits** | **1,690** |
| **Benefit-Cost Ratio** | **1.75** |

The natural gas sensitivity analysis for Utah indicates that a 30% increase in future natural gas prices, relative to EIA projections, would increase total fuel cost savings for the High Efficiency scenario by 3% and increase overall consumer benefits by 2%. The benefit-cost ratio would also increase by 2% from 1.75 to 1.78. A 30% decrease in future natural gas prices relative to projections would reduce the savings by the same amounts. Thus, the Utah results are not highly sensitive to assumptions about future natural gas prices.

Table 3-21 shows the avoided pollutant emissions and the water savings in the High Efficiency scenario, relative to the Reference scenario for Utah. By 2020, $CO_2$ emissions decline by about 14%, $NO_x$ emission decline by 18%, and $SO_2$ emissions decline by 18%. The avoided $CO_2$ emissions in the High Efficiency scenario, 2.4 million metric tons per year in 2020, are equivalent to taking about 473,000 passenger vehicles off the road. The absolute amount of $NO_x$ and $SO_2$ emissions reduction falls somewhat by 2030 but the absolute amount of $CO_2$ emissions reduction remains relatively constant during 2020-2030 given the assumptions about power plant operation and emissions rates over time. In addition, Table 3-21 shows that water use for power generation in Utah would drop by about 3.2 billion gallons in 2020 in the High Efficiency scenario, more than a 16% reduction relative to water use that year in the Reference scenario.

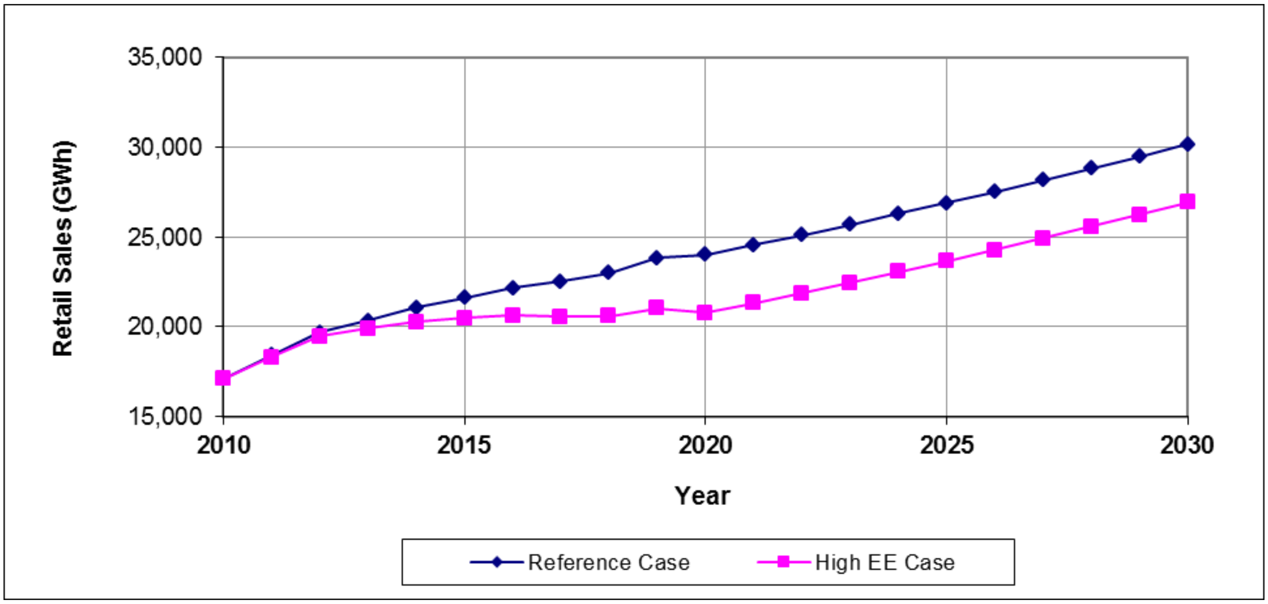
**Table 3-21. Avoided Pollutant Emissions and Water Savings in Utah in the High Efficiency Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| | **Reduction** | | | | |
| $CO_2$ Emissions | (1000 metric tons) | 747 | 2,389 | 2,313 | 2,509 |
| $NO_x$ Emissions | (metric tons) | 309 | 833 | 831 | 748 |
| $SO_2$ Emissions | (metric tons) | 732 | 2,051 | 2,046 | 1,841 |
| Water Consumption | (million gallons) | 1,041 | 3,184 | 3,110 | 2,810 |
| | **% Reduction** | | | | |
| $CO_2$ Emissions | | 4.7 | 14.2 | 13.8 | 14.0 |
| $NO_x$ Emissions | | 4.7 | 17.8 | 18.5 | 18.0 |
| $SO_2$ Emissions | | 4.7 | 17.8 | 18.5 | 18.0 |
| Water Consumption | | 5.0 | 16.4 | 16.4 | 15.5 |

**Wyoming Results**

In Wyoming, energy efficiency measures reduce electricity sales by 13.5% in 2020 relative to the Reference scenario, and by 10.7% in 2030. Figure 3-27 shows the electricity consumption in the two scenarios through 2030. In the Reference scenario, retail electricity sales grow at an average rate of 2.87% per year from 2010 to 2030. In the High Efficiency scenario, the growth in retail sales over this period drops to a rate of 2.29% per year. As noted in the previous chapter, the electricity savings by 2020 are equal to 15.4% of projected electricity consumption that year in the High Efficiency scenario.

Figure 3-27. Wyoming Electricity Sales



As shown in Figure 3-28, coal-fired power plants provided almost 90% of the electricity generation in Wyoming as of 2010. Coal-fired generation declines to 52% of the state's generation in 2030 as older units are retired in the High Efficiency scenario. Natural gas generation rises to just over 23% of Wyoming's generation by 2030. Wyoming also has a high wind potential, and generation from wind rises to almost 17% of the state's electricity generation in 2030 in the High Efficiency scenario.

Figure 3-28. Wyoming Generation Mix in the High Efficiency Scenario

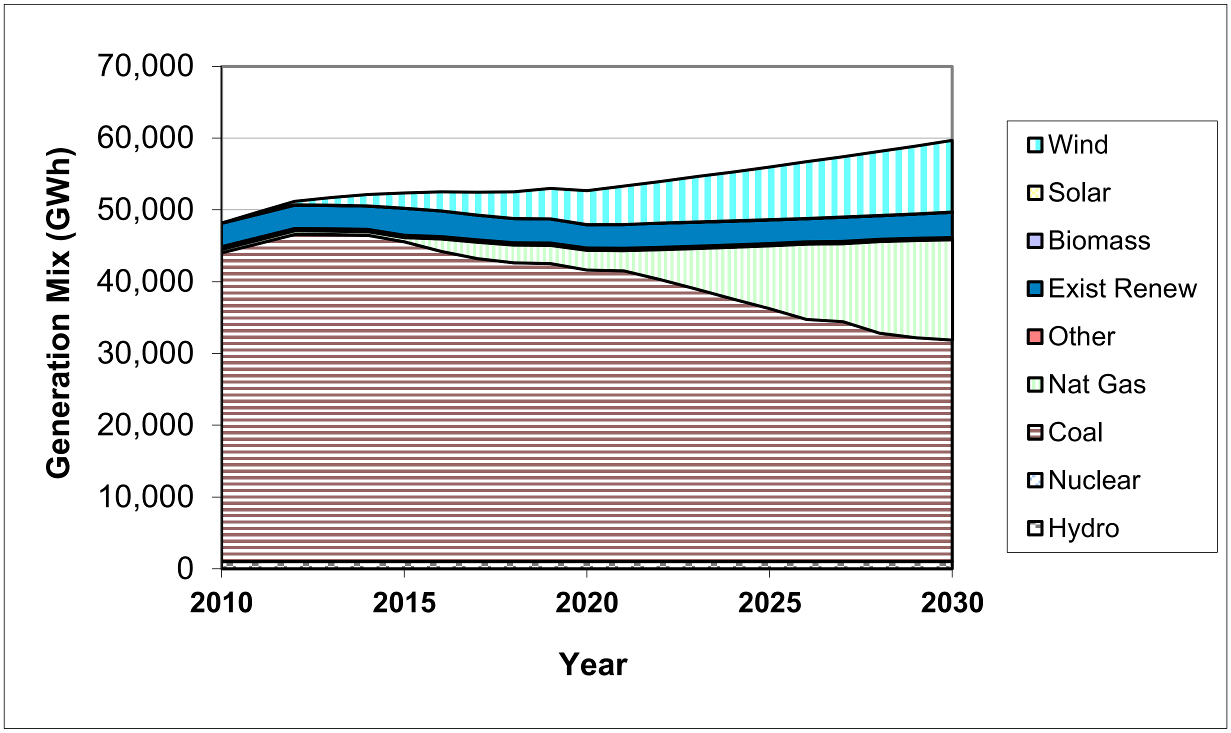


Figure 3-29 shows the capacity savings associated with the High Efficiency scenario compared to the Reference case. The coal portion reflects the retirement of 631 MW of existing coal generation to avoid about $805M for new emission control equipment. In addition, more than 300 MW of new natural gas capacity can be avoided in Wyoming as a result of the energy savings in the High Efficiency scenario. In total, Wyoming could avoid or retire about 2.4 large (400) MW power plants if the High Efficiency scenario is pursued.

**Figure 3-29. Wyoming Avoided Capacity**

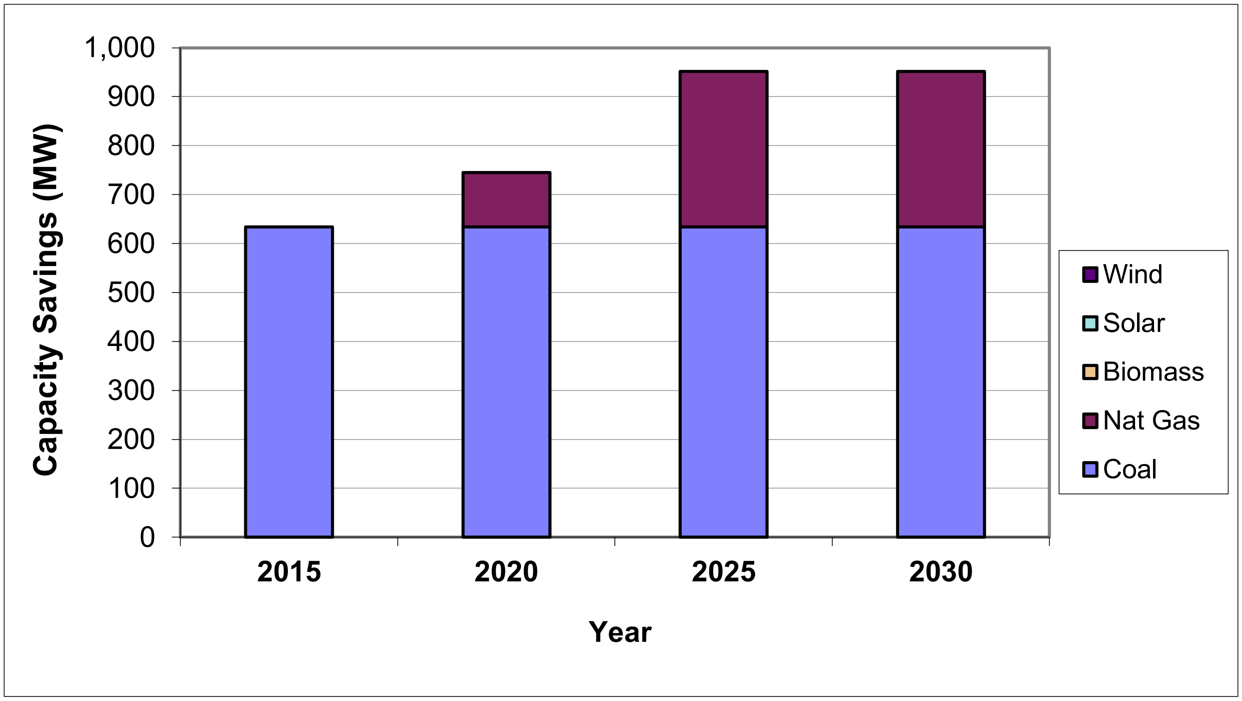


Figure 3-30 shows the avoided costs in the High Efficiency scenario in Wyoming. The avoided costs reach $225 million per year (in 2010 dollars) early in the next decade. Unlike the other states, pollution control equipment represents the largest component of avoided costs. This is followed closely by avoided fuel costs.

**Figure 3-30. Wyoming Avoided Costs**

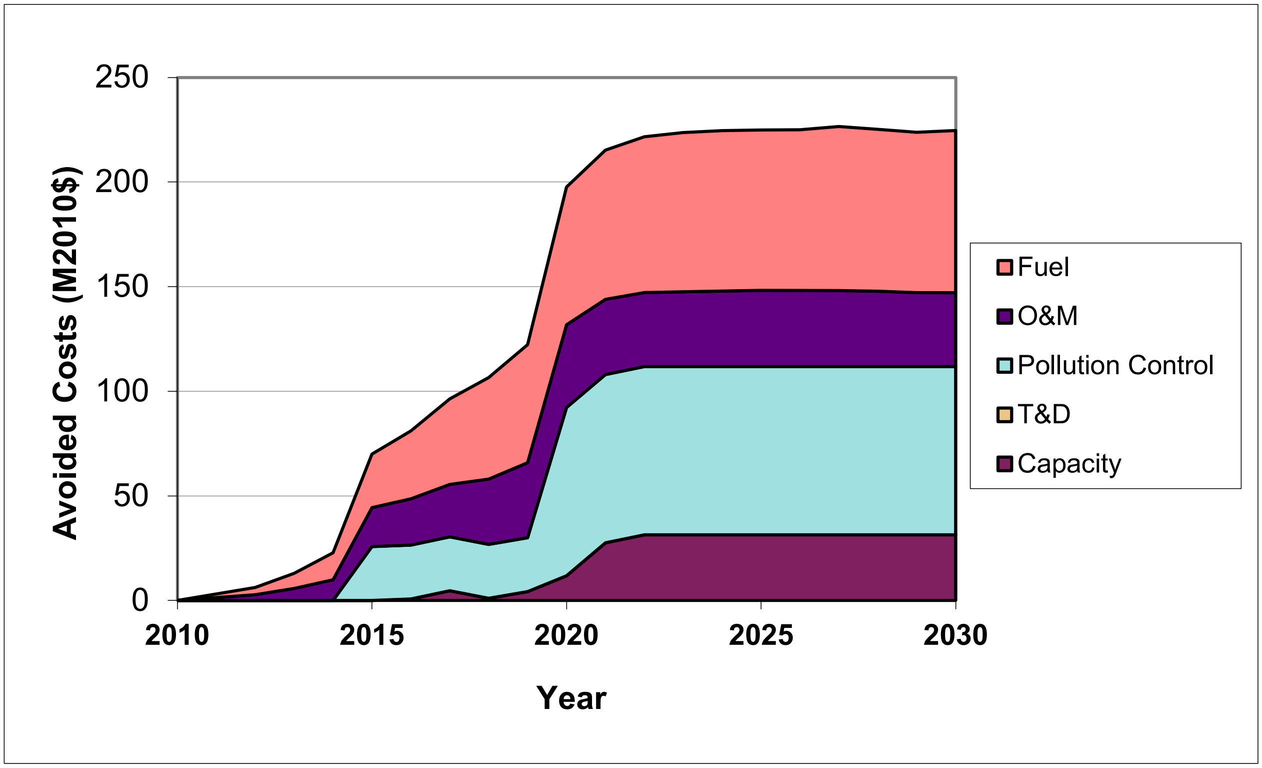


Table 3-22 presents utility avoided costs and consumer benefits in net present value terms. Total consumer benefits in Wyoming in the High Efficiency scenario are approximately $2.03 billion, while the total cost of energy efficiency programs and measures is about $1.11 billion. This leads to a benefit-cost ratio of 1.83 and net economic benefits of about $920 million.

**Table 3-22. Wyoming Benefit-Cost Comparison**

| | **Net Present Value 2010-2030** (Million 2010 $) |
|---|---|
| ***Utility Avoided Costs*** | |
| Capacity | 153 |
| T&D | 95 |
| Pollution Control | 497 |
| O&M | 290 |
| Fuel | 538 |
| **Total** | **1,573** |
| ***Consumer Benefits*** | |
| Utility Bill Savings | 1,929 |
| Public Health Benefits | 100 |
| **Total** | **2,029** |
| ***Energy Efficiency Costs*** | |
| Program Costs | 480 |
| Participant Costs | 627 |
| **Total** | **1,107** |
| | |
| **Net Economic Benefits** | **922** |
| **Benefit-Cost Ratio** | **1.83** |

The natural gas sensitivity analysis for Wyoming indicates that a 30% increase in future natural gas prices, relative to EIA projections, would increase total fuel cost savings for the High Efficiency scenario by 8% and increase overall customer savings by 2%. The benefit-cost ratio would also increase by 2% from 1.83 to 1.86. A 30% decrease in future natural gas prices relative to projections would reduce the savings by the same amounts. Thus, the Wyoming results are not highly sensitive to assumptions about future natural gas prices.

Table 3-23 shows the avoided pollutant emissions and the water savings in the High Efficiency scenario, relative to the Reference scenario for Wyoming. By 2020, $CO_2$ emissions decline by about 7%, $NO_x$ emission decline by 5%, and $SO_2$ emissions decline by 7%. The avoided $CO_2$ emissions in the High Efficiency scenario, 3.5 million metric tons per year in 2020, are equivalent to taking about 690,000 passenger vehicles off the road. The absolute amount of $CO_2$, $SO_2$ and $NO_x$ emissions reduction falls somewhat during 2020-2030 given the assumptions about power plant operation and emissions rates over time. In addition, Table 3-23 shows that water use for power generation in Wyoming would drop by about 1.8 billion gallons in 2020 in the High Efficiency scenario, a 7% reduction relative to water use that year in the Reference scenario.

**Table 3-23. Avoided Pollutant Emissions and Water Savings in Wyoming in the High Efficiency Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| | **Reduction** | | | | |
| $CO_2$ Emissions | (1000 metric tons) | 1,800 | 3,510 | 3,214 | 3,456 |
| $NO_x$ Emissions | (metric tons) | 4,239 | 337 | 206 | -318 |
| $SO_2$ Emissions | (metric tons) | 1,802 | 2,360 | 1,990 | 2,297 |
| Water Consumption | (million gallons) | 967 | 1,817 | 1,601 | 1,790 |
| | **% Reduction** | | | | |
| $CO_2$ Emissions | | 3.7 | 7.4 | 7.3 | 8.3 |
| $NO_x$ Emissions | | 31.5 | 4.7 | 2.9 | -3.3 |
| $SO_2$ Emissions | | 3.8 | 7.1 | 6.9 | 8.9 |
| Water Consumption | | 3.8 | 7.2 | 7.1 | 8.7 |

## C. Health Effects Analysis

When the externalities associated with electric power generation are monetized, health effects make up the vast majority of damages. Because higher amounts of energy efficiency result in decreased power generation and decreased air pollutant emissions, there are resulting benefits to human health. These health benefits (or avoided health damages) are quantified in this section. It should be noted, however, that we only consider the public health benefits from reduced operation of fossil fuel-based power plants. There are additional public health benefits from reduced pollutant emissions in other parts of the fuel cycle, such as reduced emissions during coal and natural gas production and transportation (Keith et al. 2012). These benefits are not considered here.

**Methodology**

Avoided health damages resulting from avoided emissions of $SO_2$ and $NO_x$ were calculated using the National Research Council study entitled *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use* (NRC 2009). Health damages include premature mortality and morbidity (e.g., chronic bronchitis, asthma, and emergency hospital admissions for respiratory and cardiovascular diseases). Premature mortality is the single largest health damage category (NRC 2009). Using emissions data from 2005, the NRC used the Air Pollution Emissions Experiments and Policy (APEEP) model to link emissions of $SO_2$, $NO_x$, $PM_{2.5}$, $PM_{10}$, ammonia and volatile organic compounds (VOCs) from individual power plants to ambient levels of $SO_2$, $NO_x$, PM, and ozone. The APEEP model then calculates the effect of the change in ambient air quality on population-weighted exposures to $SO_2$, $NO_x$, PM and ozone, which is a function of the county in which each pollutant is emitted and the stack height of the emissions. The resulting health damages were then monetized using the Value of a Statistical Life (VSL) estimates from the economic literature. Damages at each power plant were calculated by multiplying the damages associated with each pollutant by the emissions at each plant in 2005.

In order to calculate the health damages avoided under the High Efficiency scenario, we began by taking an average of the monetary damages associated with $SO_2$ and $NO_x$ emissions at the power plants in each state. Averages for $SO_2$ were taken using the damages associated with the coal plants in each state, while averages for $NO_x$ were taken using the damages associated with the natural gas plants in each state. As noted above, the coefficients we used were taken directly from the recent NRC report. These average values were multiplied by the resulting emissions in each state under the Reference scenario and the High Efficiency scenario. Avoided damages for each pollutant were calculated by subtracting the damages under the High Efficiency scenario from the damages under the Reference scenario. The number of statistical deaths avoided in each state was calculated by dividing the total avoided damages by the VSL used in the NRC study.[11]

We did not estimate avoided $PM_{2.5}$ and $PM_{10}$ emissions in this study, therefore we were not able to quantify reduced health damages associated with lower emissions of particulate matter in the High

[11] The NRC used a VSL of $6 million (2000 dollars).

Efficiency scenario. Nor did we assign any monetary value to reduced $CO_2$ emissions. Thus our estimates of avoided health damages are conservative. To put our estimates in context, public health damages from $SO_2$ and $NO_x$ emissions represent 92% of all health damages associated with electricity generation in the U.S. according to the NRC study (NRC 2009).

**Results**

Avoided damages from $SO_2$ and $NO_x$ under the High Efficiency scenario are estimated be just over $34 million in the Southwest states in 2015. Two-thirds of the avoided damages result from reduced $SO_2$ emissions in that year. Avoided damages grow to $53.5 million in 2020 before declining somewhat in 2025 and 2030. As shown in Table 3-24, avoided damages from reduced $SO_2$ emissions make up more than 80% of the total after 2015. For the entire period 2010-2030, the estimated avoided health damages in the High Efficiency scenario for the region as a whole are about $544 million (net present value in 2010 dollars). For comparison, this is equivalent to about 2.8% of the utility system net economic benefits shown in Table 3-10 above.

**Table 3-24. Southwest Region Avoided Damage Estimates (Million 2010 $)**

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| $NO_x$ Damages | 11.32 | 8.04 | 7.45 | 8.02 |
| $SO_2$ Damages | 23.01 | 45.48 | 36.31 | 37.28 |
| **Total Avoided Damages** | **34.34** | **53.53** | **43.76** | **45.30** |

Due to differences in population densities between the states, distances from population centers to power plants, differences in number and type of power plants, and effective stack heights of the emissions at power plants, avoided damages from $SO_2$ and $NO_x$ vary considerably from state to state. Results for each state are shown below in Tables 3-25 to 3-30.

The total net present value of the avoided damages during 2010-2030 are approximately $175 million for Arizona, $51 million for Colorado, $54 million for Nevada, $112 million for New Mexico, $52 million for Utah, and $100 million for Wyoming. Table 3-31 below shows the avoided health damages compared to the utility system net economic benefits for each state and for the Southwest region as a whole. The avoided health damages are higher relative to utility net benefits for New Mexico and Wyoming, and are smaller relative to utility net benefits for Colorado and Nevada. The relatively high values for New Mexico and Wyoming are due to the large amounts of older, dirty coal-fired power plants that are retired in those states in the High Efficiency scenario as well as the lower value of utility system benefits in the case of Wyoming.

Table 3-25. Arizona Avoided Damage Estimates (Million 2010 $)

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| $NO_x$ Damages | 0.90 | 1.86 | 0.11 | 0.45 |
| $SO_2$ Damages | 2.14 | 17.48 | 12.80 | 12.39 |
| **Total Avoided Damages** | **3.04** | **19.33** | **12.91** | **12.83** |

Table 3-26. Colorado Avoided Damage Estimates (Million 2010 $)

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| $NO_x$ Damages | 4.04 | 1.82 | -0.47 | 0.41 |
| $SO_2$ Damages | 2.39 | 2.34 | 1.10 | 1.61 |
| **Total Avoided Damages** | **6.43** | **4.16** | **0.63** | **2.02** |

Table 3-27. Nevada Avoided Damage Estimates (Million 2010 $)

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| $NO_x$ Damages | 0.93 | 1.56 | 5.56 | 5.46 |
| $SO_2$ Damages | 2.23 | 2.74 | 1.62 | 1.48 |
| **Total Avoided Damages** | **3.16** | **4.30** | **7.18** | **6.93** |

Table 3-28. New Mexico Avoided Damage Estimates (Million 2010 $)

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| $NO_x$ Damages | 0.54 | 1.45 | 1.04 | 1.15 |
| $SO_2$ Damages | 8.93 | 11.16 | 10.23 | 10.66 |
| **Total Avoided Damages** | **9.47** | **12.61** | **11.28** | **11.81** |

Table 3-29. Utah Avoided Damage Estimates (Million 2010 $)

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| $NO_x$ Damages | 0.37 | 1.00 | 0.99 | 0.90 |
| $SO_2$ Damages | 1.46 | 4.08 | 4.07 | 3.66 |
| **Total Avoided Damages** | **1.83** | **5.08** | **5.07** | **4.56** |

Table 3-30. Wyoming Avoided Damage Estimates (Million 2010 $)

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| $NO_x$ Damages | 4.53 | 0.36 | 0.22 | -0.34 |
| $SO_2$ Damages | 5.87 | 7.69 | 6.48 | 7.48 |
| **Total Avoided Damages** | **10.40** | **8.05** | **6.70** | **7.14** |

Table 3-31. Comparison of Public Health Benefits to Utility System Net Economic Benefits

| State | Net Present Value (NPV) of Public Health Benefits (Million $) | Ratio of NPV of Health Benefits to NPV of Utility System Benefits (%) |
|---|---|---|
| AZ | 175.1 | 2.5 |
| CO | 50.6 | 1.1 |
| NV | 53.9 | 1.6 |
| NM | 112.2 | 7.2 |
| UT | 51.8 | 3.2 |
| WY | 100.4 | 12.2 |
| **Southwest** | **544.0** | **2.8** |

In general, the southwest region tends to have a lower population density than in other parts of the United States, and power plants in the Southwest tend to be further away from population centers. These factors lead to lower amounts of avoided health damages than might be seen in other parts of the country.

The NRC found that there was a significant amount of variation in the value of the damages from each power plant, primarily due to variation in pollution intensity among plants. Variation in pollution intensity is due to sulfur content of the coal burned, adoption and use of emissions control technologies, and the vintage of the power plant (as newer plants are subject to more stringent control technologies). Control technologies and plant vintage are especially important in this analysis. Total avoided damages are often greatest in 2015 and 2020 when many of the power plants in the Southwest are still uncontrolled for $SO_2$ and/or $NO_x$. Under the High Efficiency scenario, more of these uncontrolled plants are retired, leading to a decrease in emissions and a higher amount of avoided damage from emissions. In 2025 and 2030, on the other hand, the remaining coal and gas units have been retrofitted with emissions control technologies in the Reference scenario, and new power plants coming online already have emission controls installed. This results in the drop in avoided damages when comparing the Reference and High Efficiency scenarios in the post-2020 period for the region and most of the states.

## D. Other Benefits

Utility energy efficiency programs result in important non-energy benefits in addition to those analyzed in this study. For example, home retrofit programs can increase occupant comfort, health and safety, increase property value, and increase the capability of low-income households to pay their energy bills thereby reducing service terminations and reconnects. Commercial and industrial retrofit and new construction programs can increase worker comfort, enhance productivity, reduce waste in the production process, and/or lower environmental control costs. While valuing these non-energy benefits can be difficult, doing so even if approximate can significantly increase the cost-effectiveness of energy efficiency programs (Skumatz, Dickerson and Coates 2000; Amann 2006). In fact, some studies have found that the value of non-energy benefits can exceed the energy benefits by a factor of two or more, although the magnitude of the non-energy benefits varies with the type of program and the efficiency measures implemented (Fuchs, Skumatz and Ellefsen 2004; Skumatz, Khawaja and Colby 2009).

For example, Skumatz and Dickerson (1998) analyzed the non-energy benefits of a low-income housing weatherization and education program implemented by Pacific Gas & Electric Company in California. This study estimated that the non-energy benefits were worth $305 per year, 2.4 times the value of the direct energy savings. The main non-energy benefits were reduced water and wastewater costs, fewer utility service terminations, improved quality of the housing stock, and fewer occupant illnesses. Likewise, a study of the non-energy impacts of a low-income home weatherization program funded by utilities and other sources in the metropolitan Cincinnati area estimated that homes receiving comprehensive weatherization services sold for about $7,000 (10.6%) more than homes not receiving energy efficiency upgrades, correcting for other differences among homes sold in the same neighborhoods (Drakos, Khawaja and Pitzer 2011).

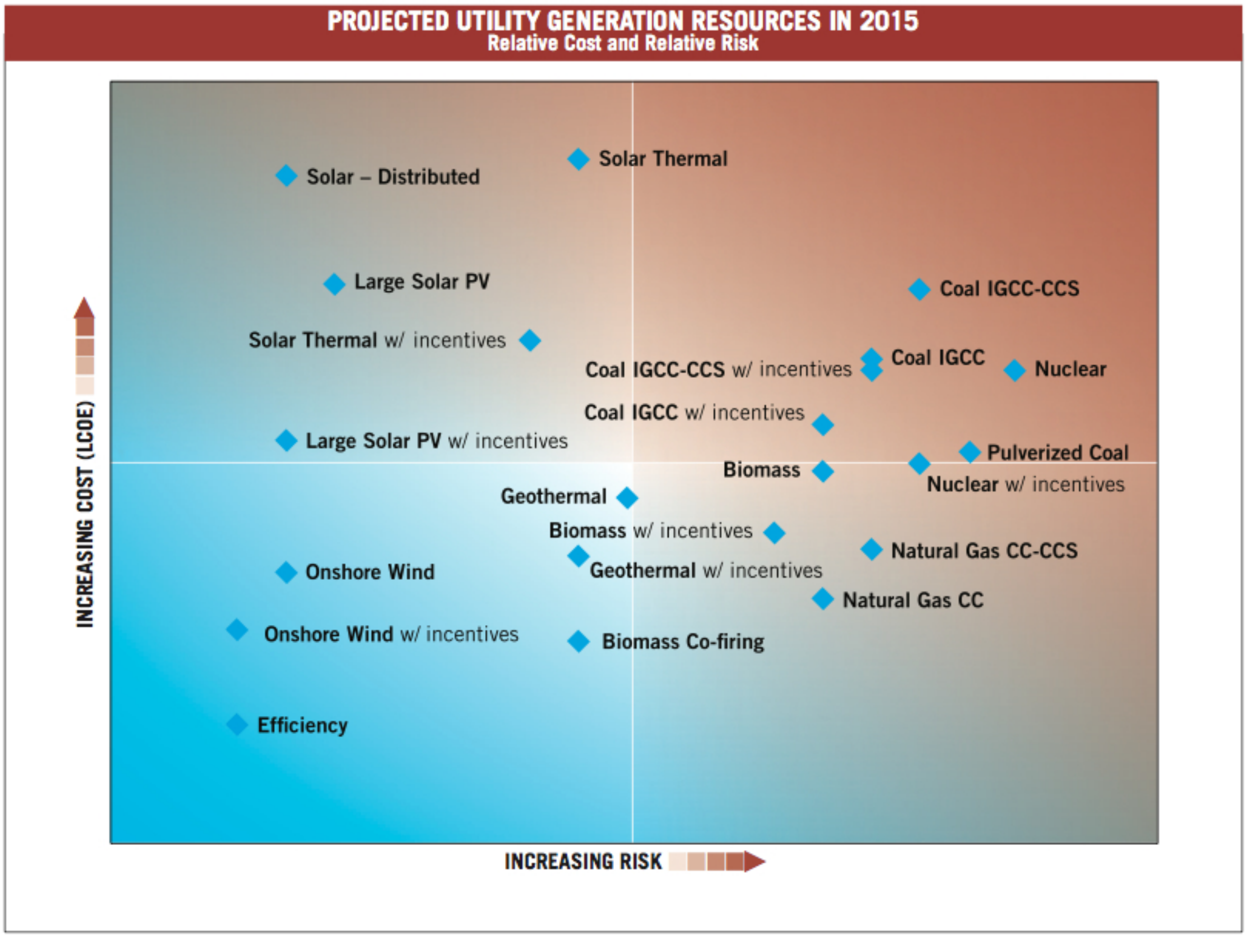
The non-energy benefits from increasing the energy efficiency of new homes — better comfort, noise reduction, better indoor air quality, higher resale or rental value, etc. — can also outweigh the direct energy savings benefits. For example, a study of the ENERGY STAR new homes program in Massachusetts estimated that these non-energy benefits have a total value of $1,445 per year on average, 3.6 times the value of the energy bill savings (Tolkin et al. 2009).

In another example, Hall and Roth (2003) analyzed the non-energy benefits of an energy efficiency incentives program for businesses in Wisconsin through interviews with 74 program participants. Over 70% of participants reported that the installation of energy efficiency measures reduced maintenance costs and improved employee morale. And 30-50% of participants reported that the measures improved productivity, increased equipment life, or reduced waste generation. The researchers estimated that the overall non-energy benefits resulting from the installation of energy efficiency measures were worth $17,300 per year on average, 2.5 times the value of the direct energy savings. This analysis included estimates by companies of both increased and decreased non-energy costs.

Given that non-energy benefits are well-established but difficult to measure, a number of states have adopted non-energy benefit "adders" that are included in the cost effectiveness evaluation of utility energy efficiency programs (Skumatz, Khawaja and Colby 2009). The adder is a multiplier to the direct utility system and/or customer benefits. For example, the Colorado Public Utility Commission has adopted non-energy benefits adders of 10% for non-low-income programs and 25% for low-income programs, in addition to separate valuation of avoided pollutant emissions (Colorado PUC 2011).

Utility risk reduction is another benefit of vigorous utility energy efficiency programs. Utilities face a variety of risks from load growth and pursuit of new generation resources to meet that growth, including construction cost overruns and delays, fuel and operating cost risks, risks associated with potential new environmental regulations, water constraint risks, and load forecasting and other planning risks (Binz et al. 2012). A recent study regarding these risks and strategies for mitigating them indicated that energy efficiency is not only a utility's lowest cost resource, it is also the lowest risk resource (see Figure 3-31). Keith et al. (2012) discuss the risks associated with each type of new power generation resource.

Figure 3-31. Ranking of Electric Utility Resource Options by Cost and Risk (Binz et al. 2012)




Because the non-energy benefits and risk reduction potential of utility energy efficiency programs were not analyzed or included in this study, we believe the results are conservative. In the next chapter we analyze one class of non-energy benefits not discussed above, namely net job creation and income generation potential from vigorous utility energy efficiency programs.

# IV. Macroeconomic Impacts Analysis

This chapter examines the macroeconomic impacts — the impacts on employment, wage and salary compensation, and gross state product — from pursuing the High Efficiency scenario rather than the Reference scenario. The analysis of the macroeconomic impacts of energy efficiency improvements is based on the assumptions regarding energy efficiency programs described previously, and their associated costs and benefits.

## A. Methodology

To analyze the employment and other economic impacts of the energy efficiency policies, we used an input-output model that accounts for interactions between all sectors of the economy. Input-output (I-O) models were initially developed to trace supply linkages in the economy. For example, I-O models can show how states that produce fabricated metal products will likely benefit from expanded sales of locally manufactured high-efficiency light fixtures; states without such production will not benefit in the same way.

To capture the full economic impacts of the investments in energy efficiency, three separate effects (direct, indirect, and induced) are examined for each change in expenditure:

- The *direct effect* refers to the on-site or immediate effects produced by expenditures. In the case of installing energy efficiency upgrades in a home or business, the direct effects are the on-site expenditures and jobs of the construction or trade contractors hired to carry out the work.

- The *indirect effect* refers to the increase in economic activity that occurs when a contractor or vendor receives payment for goods or services delivered and he or she is able to pay others who support their businesses. This includes payments to equipment manufacturers or wholesalers who provide energy-efficient technologies. It also includes the bank that provides financing to the contractor, the vendor's accountant, and the building owner where the contractor maintains its local offices.

- The *induced effect* derives from changes in spending that occur from wages paid to workers in every phase of the energy efficiency investment and installation (direct and indirect) process. In addition, businesses and households are able to meet their refrigeration, cooling, ventilation, lighting, and other energy-related needs at a lower cost, due to energy efficiency upgrades. This lowers the cost of doing business and operating households, thereby making more money available for businesses and families to spend on other goods and services such as food, clothing, appliances, or entertainment in the case of households, and equipment, product development, or marketing in the case of businesses.

The sum of these three effects yields the total macroeconomic effect resulting from certain expenditures; in this case, increasing investment in utility programs which results in more efficient use of electricity in homes and businesses.

To analyze the High Efficiency scenario, we matched the net changes in expenditures in each of the states, and the region as a whole, with the appropriate state- and region-specific industry multipliers. In this study we utilized industry multipliers from the 2010 IMPLAN model for the analysis (IMPLAN 2012). The IMPLAN (IMpact analysis for PLANning) model is widely used by state and local governments, federal government agencies, colleges and universities, and other organizations to analyze the potential macroeconomic impacts of policy or investment options. The analysis considers all changes in business and consumer expenditures — both positive and negative — and accounts for displacement of traditional electricity generating plants and the associated operating and fuel costs, as well as avoided pollution control equipment costs and avoided transmission and distribution (T&D) costs.

The analysis included several modifications to this technique of matching expenditures with their appropriate multipliers. First, it was assumed that only 90% of the efficiency investments are spent within each of the states and the region as a whole. While local contractors and suppliers complete most efficiency improvements, out-of-state or out-of-region firms can also complete improvements.

Second, an adjustment was made in the employment impacts to account for sector-specific changes in labor productivity that are projected to occur. As indicated in the Bureau of Labor Statistics' *Employment and Output by Industry, 2000, 2010, and Projected 2020,* future productivity rates are expected to vary widely among sectors, ranging from a 1.1% annual productivity gain in the construction sectors to just over 4.3% annual productivity gain in the oil refining sectors.[12]

Third, it was assumed that approximately 80% of the participant's investment for the efficiency measures will be financed by bank loans carrying an average interest rate of 4% over a five-year period. To limit the scope of the analysis, however, no parameters were established to account for any changes in interest rates as less capital-intensive technologies (i.e., efficiency measures) are substituted for conventional supply strategies, or in labor participation rates — all of which might affect overall spending patterns.

Finally, it should be noted that the full effects of the efficiency investments are not accounted for since the energy bill savings beyond 2020 are not incorporated in the macroeconomic analysis. Nor does the analysis include other productivity benefits that are likely to come about from energy efficiency investments. These can be substantial, especially in the commercial and industrial sectors. Energy efficiency investments by businesses often result in improved product quality, lower capital and operating costs, reduced waste generation, and increased employee productivity (Romm 1999; Hall and Roth 2003). To the extent these benefits are realized in addition to the energy savings, the positive macroeconomic impacts will be greater than those reported here.

[12]The productivity trends were calculated by MRG & Associates using data from the Bureau of Labor Statistics (BLS) Output and Employment Projections (BLS 2012a).

## B. Data and Results

Table 4-1 shows the cumulative energy efficiency investments and energy bill savings achieved as a result of these investments for each of the states examined in this study and for the region as a whole. The investment values shown in Table 4-1 are for the period 2010-2020. The investment values in Table 4-1 differ from those in the previous chapter because the values in Table 4-1 are not discounted, and they exclude program administration costs; i.e., they are the total amounts invested in energy efficiency measures. The energy savings are the annual savings in each of the years analyzed, 2015 and 2020. We note again that the energy efficiency investments will result in energy savings well beyond 2020; however, these savings were not considered in this part of the macroeconomic analysis.

**Table 4-1. Energy Efficiency Investments and Energy Bill Savings in the High Efficiency Scenario**

| **Cumulative Investment** (Million 2010 dollars) | **2015** | **2020** |
|---|---|---|
| Arizona | 1,539 | 5,247 |
| Colorado | 1,294 | 3,973 |
| Nevada | 760 | 2,381 |
| New Mexico | 563 | 1,832 |
| Utah | 709 | 2,178 |
| Wyoming | 346 | 1,142 |
| **Region Total** | **5,211** | **16,752** |
| **Annual Energy Bill Savings** (Million 2010 dollars) | | |
| Arizona | 613 | 1,759 |
| Colorado | 427 | 1,139 |
| Nevada | 269 | 732 |
| New Mexico | 172 | 492 |
| Utah | 193 | 511 |
| Wyoming | 83 | 239 |
| **Region Total** | **1,757** | **4,873** |

*Notes: Investments occur each year during the 2010-2020 period of analysis. Investments shown in the table represent cumulative investments through the year noted. Energy bill saving increase each year; annual energy bill savings represent the savings that occur in the year noted.*

As shown in Table 4-1, we assume a total regional investment of just under $21.5 billion (in 2010 dollars) in energy efficiency measures during 2010-2020. We estimate that these investments result in just under $1.8 billion in annual energy bill savings in 2015 and increase each year to just under $4.9 billion in annual energy bill savings in 2020.

Using the input-output model, the investment and savings assumptions were used to estimate three sets of impacts. The first is the net contribution to the region and each state's employment base as measured by full-time equivalent jobs. The second is the net gain to wage and salary compensation, measured in millions of 2010 dollars. The final impact is the net contribution to Gross State

Product (GSP), also measured in millions of 2010 dollars. In other words, once the gains and losses are sorted out for each sector of the economy, the analysis provides the net impact on each state and the region's economy.

Tables 4-2 through 4-15 show the economic impacts of the High Efficiency scenario for the region as a whole and for each of the individual states in 2020. They provide the estimated macroeconomic benefits of the accelerated use of energy efficiency technologies in all end-use sectors. (See Appendix D for tables showing the macroeconomic impacts in 2015.)

**Regional Macroeconomic Impacts**

Table 4-2 shows the macroeconomic impacts of the High Efficiency scenario for the six-state region, relative to pursuing the Reference scenario. There are several aspects of Table 4-2 worth noting. The first is that wage and salary compensation as well as employment rise throughout the period of analysis. The impacts increase over time as greater investment in energy efficiency and more energy savings occur. We estimate a net increase of 28,080 jobs in the region by 2020, and a net increase in wage and salary compensation of just over $1.0 billion (in 2010 dollars) if the High Efficiency scenario is followed rather than the Reference scenario. Gross State Product (GSP) also rises $294 million by 2020 (in 2010 dollars).

**Table 4-2. Macroeconomic Impacts in the Region in the High Efficiency Scenario**

| Year | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in Gross State Product (Million $) |
|---|---|---|---|
| 2015 | 10,120 | 317 | (39) |
| 2020 | 28,080 | 1,036 | 294 |

The small decline in GSP in 2015 shown in Table 4-2 is the result of the transition from the capital-intensive nature of the electric utility industries combined with the reduction in use of fossil fuels, which are produced predominately in the region. Electric utilities have traditionally required greater total capital investment for each dollar of revenue generated by the utility, relative to other industries. As the revenues of the utilities decrease under the High Efficiency scenario, the amount of capital investment also decreases (i.e., fewer new power plants are built); this in turn lowers the overall value-added and GSP for the state as a whole. This impact is tempered somewhat by the investments in energy efficiency and increased spending of energy bill savings. However, the full impact of these investments and savings in more labor intensive industries, rather than capital intensive industries, is not realized until several years later; at that point, GSP turns positive.

According to the U.S. Bureau of Labor Statistics, just over 8.9 million workers were employed in the region in May 2012, and about 787,000 workers in the region were unemployed (BLS 2012b). Given reasonable assumptions about employment growth, adding 10,120 jobs by 2015 will result in approximately a 0.1% increase in projected regional employment that year. Adding 28,080 jobs by 2020 will result in approximately a 0.3% increase in projected regional employment.

According to the U.S. Bureau of Economic Analysis, personal income for the region was approximately $75.6 billion in 2011 (BEA 2012). Adding $317 million in 2015 will result in approximately a 0.4% increase in projected income. Adding $1,036 million in 2020 will result in approximately a 1.2% increase in projected income. These contributions are not large relative to the region's overall economy, but they would certainly help the region as it tries to expand employment, increase personal income, and recover from the economic recession that has hit some southwest states particularly hard.

Table 4-3 provides additional insight into the projections. It shows how each of the major economic sectors is affected in 2020 as a result of the energy efficiency investments in the High Energy Efficiency scenario. The sectors are listed according to the anticipated job impacts, beginning with those sectors that have the largest employment gains.

The construction and service sectors are the sectors that benefit most directly as contractors are hired to install the new technologies and make the requisite efficiency upgrades. The retail trade and the service sectors benefit from the actual investments in energy efficiency programs and technologies. They also benefit from the higher level of goods and services sold as households and businesses spend their energy bill savings elsewhere in the economy.

As might be expected, the energy industries incur overall losses in jobs and wage compensation, which lowers GSP. But this result can be tempered somewhat as the industries themselves undergo internal restructuring. For example, as the electric utilities engage in more energy efficiency services and other alternative energy investment activities, they will undoubtedly employ more people from the business services sectors. Explained differently, while the electric utilities may lose an estimated 3,010 jobs in 2020 (primarily due to selling less energy), they can gain some of those jobs back if they move aggressively into the energy efficiency business, thereby absorbing some of the job gains realized in other sectors, such as the construction and service sectors. In effect, if they expand their participation in the energy efficiency market, their job totals can increase relative to the estimates based on a more conventional definition of an electric utility as solely an energy supplier.

Given the large reliance on fossil fuels for electricity generation in the region, and the fact that most of the coal and natural gas used in the region is produced within the region, it is not surprising that these industries also incur losses in jobs, compensation, and GSP as energy efficiency increases and the use of fossil fuels declines.

It should also be remembered that these estimates are not job losses in the strict sense of the word. Rather, they reflect differences between a Reference scenario absent utility energy efficiency programs and a future with vigorous implementation of "Best Practice" utility energy efficiency programs.

Table 4-3. Regional Impacts by Sector in 2020 in the High Efficiency Scenario

| Sectors | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in GSP (Million $) |
|---|---|---|---|
| Services | 14,500 | 745 | 962 |
| Construction | 10,350 | 598 | 744 |
| Retail Trade | 4,070 | 184 | 263 |
| Finance | 1,360 | 76 | 120 |
| Government | 1,210 | 102 | 120 |
| Insurance/Real Estate | 1,120 | 34 | 277 |
| Other Manufacturing | 970 | 91 | 166 |
| Wholesale Trade | 230 | 21 | 37 |
| Primary Metals | 220 | 16 | 27 |
| Food | 80 | 5 | 10 |
| Oil Refining | 0 | (2) | (8) |
| Agriculture | (10) | 0 | 0 |
| Other Mining | (30) | (3) | (10) |
| Transportation, Communication & Utilities | (50) | (4) | (8) |
| Natural Gas Utilities | (60) | (9) | (28) |
| Coal Mining | (1,310) | (194) | (406) |
| Oil and Gas Mining | (1,560) | (122) | (211) |
| Electric Utilities | (3,010) | (500) | (1,761) |
| **TOTAL** | **28,080** | **1,036** | **294** |
| *Notes: The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the High Efficiency scenario. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.* | | | |

As elsewhere it should be noted that the results in these tables are not intended to be precise forecasts but rather approximate estimates of overall impact. While the aggregate totals offer reasonable insights into the benefits of the energy efficiency investments and savings, some of the individual sectors show impacts that are very small, meaning that the results may swing one way or the other depending upon even modest changes in the assumptions.

**Macroeconomic Impacts for Arizona**

The overall results in Table 4-4 for Arizona are generally very positive. Net jobs increase by 3,810 in 2015 and 10,400 in 2020 in the High Efficiency scenario. Net wage and salary compensation increases by $128 million in 2015 and $382 million in 2020, again in 2010 dollars. The small drop in GSP in 2015, similar to the regional impacts discussed earlier, reflects the lower electric utility industry revenues and the capital-intensive nature of the industry. The positive impacts from the investments in efficiency and spending of energy bill savings (again in more labor intensive industries, rather than capital intensive industries) are not yet sufficient to offset the utility related GSP losses. By 2020, the impacts from energy bill savings are sufficient to show an overall increase in GSP of $44 million.

Table 4-4. Arizona Macroeconomic Impacts in the High Efficiency Scenario

| Year | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in Gross State Product (Million $) |
|---|---|---|---|
| 2015 | 3,810 | 128 | (9) |
| 2020 | 10,400 | 382 | 44 |

On the other hand, the wage and salary compensation share of GSP actually increases in both periods evaluated here. This is for two reasons. First, new electric plants are displaced by more cost-effective efficiency investments that are more labor rather than capital intensive. Second, the spending of electricity bill savings, for consumer and business purchases, generally redirects dollars to more labor intensive industries rather than capital intensive industries. The change in the economic mix results in a net increase in wages and employment.

According to the U.S. Bureau of Labor Statistics, in May 2012 just under 2.8 million workers were employed in Arizona and about 247,000 workers in the state were unemployed (BLS 2012b). Given reasonable assumptions about employment growth, adding 3,810 jobs by 2015 will result in approximately a 0.1% increase in projected statewide employment that year. Adding 10,400 jobs by 2020 will result in approximately a 0.3% increase in projected statewide employment.

According to the U.S. Bureau of Economic Analysis, in 2011 personal income for Arizona was approximately $23.3 billion (BEA 2012). Adding $128 million in 2015 will result in approximately a 0.6% increase in projected income. Adding $382 million in 2020 will result in approximately a 1.4% increase in projected income. The contributions are not large relative to the state's overall economy, but would certainly help the state as it tries to recover from a deep economic recession.

Table 4-5 shows the same three big sectoral "winners" in Arizona as for the region as a whole. These are the service sectors, construction industry, and retail trade. The service sectors benefit from the actual investments in energy efficiency programs and technologies as well as from the higher level of services purchased as households and businesses spend their energy bill savings throughout the economy. The construction industries benefit as contractors are hired to make the energy efficiency upgrades. The retail trade benefits from purchases of energy efficient technologies as well as the higher level of goods purchased as households and businesses spend their energy bill savings throughout the economy.

Table 4-5 also shows that the traditional electric utilities and associated fuel supply sectors lose the most jobs, similar to the results for the region as a whole. The loss of jobs assumes a traditional economic structure for electric utilities in 2020. Thus, as fewer conventional power plants are needed as a result of energy efficiency gains, fewer traditional utility jobs and fossil fuel related jobs are sustained.

Once again, this points to an important opportunity for utilities: if utilities become more proactive in the area of energy efficiency services, they can employ more workers to carry out these new responsibilities. One might assume, therefore, that utilities in Arizona can incorporate at least some of the jobs gained in the construction and service sectors if they implement well-funded and comprehensive energy efficiency programs for their customers.

**Table 4-5. Arizona Impacts by Sector in 2020 in the High Efficiency Scenario**

| **Sectors** | **Change in Jobs** | **Change in Wage and Salary Compensation** (Million $) | **Change in GSP** (Million $) |
|---|---|---|---|
| Services | 5,680 | 292 | 384 |
| Construction | 3,120 | 181 | 222 |
| Retail Trade | 1,520 | 73 | 104 |
| Government | 670 | 55 | 64 |
| Finance | 470 | 31 | 47 |
| Insurance/Real Estate | 440 | 15 | 115 |
| Other Manufacturing | 290 | 28 | 52 |
| Primary Metals | 40 | 3 | 6 |
| Wholesale Trade | 40 | 4 | 7 |
| Food | 20 | 1 | 3 |
| Oil and Gas Mining | 0 | 0 | 0 |
| Oil Refining | 0 | 0 | 0 |
| Other Mining | (10) | (1) | (4) |
| Agriculture | (20) | 0 | (1) |
| Natural Gas Utilities | (30) | (4) | (14) |
| Coal Mining | (100) | (15) | (32) |
| Transportation, Communication & Utilities | (210) | (19) | (49) |
| Electric Utilities | (1,520) | (260) | (860) |
| **TOTAL** | **10,400** | **382** | **44** |

*Notes: The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the High Efficiency scenario. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

**Macroeconomic Impacts for Colorado**

The overall results in Table 4-6 for Colorado are very positive. Net jobs increase by 2,380 in 2015 and 6,960 in 2020 in the High Efficiency scenario. Net wage and salary compensation increases by $98 million in 2015 and $334 million in 2020 (in 2010 dollars). GSP increases by $54 million in 2015 and $277 million in 2020.

Unlike the region as a whole, and some of the other states in the region, the in-state electric utility sector does not sustain large losses. This is due in large part to some of the state's electricity needs being generated outside of the state. As a result, the positive impacts from the investments in efficiency and spending of energy bill savings (in more labor intensive industries, rather than capital intensive industries) are sufficient to offset the in-state utility-related GSP losses.

Table 4-6. Colorado Macroeconomic Impacts in the High Efficiency Scenario

| Year | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in Gross State Product (Million $) |
|---|---|---|---|
| 2015 | 2,380 | 98 | 54 |
| 2020 | 6,960 | 334 | 277 |

According to the U.S. Bureau of Labor Statistics, in May 2012 just over 2.5 million workers were employed in Colorado, and about 222,000 workers in the state were unemployed (BLS 2012b). Given reasonable assumptions about employment growth, adding 2,380 jobs by 2015 will result in approximately a 0.1% increase in projected statewide employment that year. Adding 6,960 jobs by 2020 will result in approximately a 0.3% increase in projected statewide employment.

According to the U.S. Bureau of Economic Analysis, in 2011 personal income for Colorado was approximately $22.6 billion (BEA 2012). Adding $98 million in 2015 will result in approximately a 0.4% increase in projected income. Adding $334 million in 2020 will result in approximately a 1.3% increase in projected income. As noted previously, the contributions are not large relative to the state's overall economy, but would certainly help the state as it tries to recover economically.

Table 4-7 shows the same three big sectoral "winners" in 2020 in Colorado as for the region. These are the service sectors, construction industry, and retail trade. The construction industries benefit as contractors are hired to make the energy efficiency upgrades. The service sectors benefit from the actual investments in energy efficiency programs and technologies as well as the higher level of services purchased as households and businesses spend their energy bill savings throughout the economy. The retail trade sectors also benefit from purchases of energy efficient technologies and the higher level of goods purchased as households and businesses spend their energy bill savings throughout the economy.

Table 4-7. Colorado Impacts by Sector in 2020 in the High Efficiency Scenario

| Sectors | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in GSP (Million $) |
|---|---|---|---|
| Services | 3,030 | 173 | 217 |
| Construction | 2,560 | 150 | 184 |
| Retail Trade | 1,020 | 44 | 63 |
| Government | 310 | 27 | 33 |
| Finance | 300 | 19 | 30 |
| Insurance/Real Estate | 230 | 8 | 63 |
| Other Manufacturing | 220 | 23 | 44 |
| Primary Metals | 80 | 6 | 10 |
| Wholesale Trade | 70 | 7 | 12 |
| Transportation, Communication & Utilities | 70 | 8 | 27 |
| Food | 20 | 1 | 4 |
| Agriculture | 10 | 0 | 1 |
| Oil Refining | 0 | 0 | (1) |
| Natural Gas Utilities | (10) | (2) | (6) |
| Other Mining | (20) | (2) | (6) |
| Coal Mining | (150) | (23) | (48) |
| Oil and Gas Mining | (240) | (19) | (33) |
| Electric Utilities | (540) | (87) | (316) |
| **TOTAL** | **6,960** | **334** | **277** |

*Notes: The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the High Efficiency scenario. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

Table 4-7 also shows that the traditional electric utilities sector and fuel supply sectors lose the most jobs, similar to the results for the region as a whole. The loss of jobs assumes a traditional economic structure for electric utilities in 2020. Thus, as fewer conventional power plants are needed as a result of energy efficiency gains, fewer traditional utility jobs and fossil fuel related jobs are sustained.

Once again, this points to an important opportunity for utilities: if utilities become more proactive in the area of energy efficiency services, they can employ more workers to carry out these new responsibilities. One might assume, therefore, that utilities in Colorado can incorporate at least some of the jobs gained in the construction and service sectors if they implement well-funded and comprehensive energy efficiency programs for their customers.

**Macroeconomic Impacts for Nevada**

The overall results in Table 4-8 for Nevada are also very positive. Net jobs increase by 1,820 in 2015 and 4,680 in 2020 in the High Efficiency scenario. Net wage and salary compensation increases by $92 million in 2015 and $246 million in 2020, again in 2010 dollars. GSP increases by $54 million in 2015 and $277 million in 2020.

Unlike the region as a whole, and some of the other states in the region, the in-state electric utility sector and fossil fuel-related industries do not sustain large losses. This is due in large part to the very limited production of fossil fuels within the state. As a result, the positive impacts from the investments in efficiency and spending of energy bill savings (again in more labor intensive industries, rather than capital intensive industries) are sufficient to offset the in-state utility related GSP losses.

**Table 4-8. Nevada Macroeconomic Impacts in the High Efficiency Scenario**

| **Year** | **Change in Jobs** | **Change in Wage and Salary Compensation** (million $) | **Change in Gross State Product** (million $) |
|---|---|---|---|
| 2015 | 1,820 | 92 | 91 |
| 2020 | 4,680 | 246 | 284 |

According to the U.S. Bureau of Labor Statistics, in May 2012 just over 1.2 million workers were employed in Nevada, and about 158,000 workers in the state were unemployed (BLS 2012b). Given reasonable assumptions about employment growth, adding 1,820 jobs by 2015 will result in approximately a 0.1% increase in projected statewide employment that year. Adding 4,680 jobs by 2020 will result in approximately a 0.3% increase in projected statewide employment.

According to the U.S. Bureau of Economic Analysis, in 2011 personal income for Nevada was approximately $10.4 billion (BEA 2012). Adding $92 million in 2015 will result in approximately a 0.8% increase in projected income. Adding $246 million in 2020 will result in approximately a 2.0% increase in projected income. As noted previously for the other states, the contributions are not large relative to the state's overall economy, but would certainly help Nevada as it tries to recover from a very deep economic recession.

Table 4-9. Nevada Impacts by Sector in 2020 in the High Efficiency Scenario

| Sectors | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in GSP (Million $) |
|---|---|---|---|
| Services | 2,130 | 110 | 149 |
| Construction | 1,230 | 90 | 112 |
| Retail Trade | 580 | 27 | 39 |
| Finance | 240 | 10 | 17 |
| Insurance/Real Estate | 220 | 6 | 50 |
| Other Manufacturing | 150 | 14 | 24 |
| Transportation, Communication & Utilities | 130 | 11 | 26 |
| Government | 110 | 11 | 13 |
| Wholesale Trade | 60 | 6 | 10 |
| Primary Metals | 50 | 3 | 5 |
| Food | 20 | 1 | 2 |
| Agriculture | 0 | 0 | 0 |
| Oil and Gas Mining | 0 | 0 | 0 |
| Coal Mining | 0 | 0 | 0 |
| Natural Gas Utilities | 0 | (1) | (2) |
| Oil Refining | 0 | 0 | 0 |
| Other Mining | (20) | (2) | (5) |
| Electric Utilities | (230) | (40) | (156) |
| **TOTAL** | **4,680** | **246** | **284** |

*Notes: The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the High Efficiency scenario. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

Table 4-9 shows two big sectoral "winners" in Nevada in 2020: the service sectors and the construction industry. The retail trade sectors benefit as well, but not as significantly. The service sectors benefit from the actual investments in energy efficiency programs and technologies, as well as the higher level of services purchased as households and businesses spend their energy bill savings throughout the economy. The construction industries benefit as contractors are hired to make the energy efficiency upgrades. The retail trade sectors also benefit from purchases of energy efficient technologies and the higher level of goods purchased as households and businesses spend their energy bill savings throughout the economy.

Table 4-9 also shows that the traditional electric utilities sector loses the most jobs, similar to the results for the region as a whole. The loss of jobs assumes a traditional economic structure for electric utilities in 2020. Thus, as fewer conventional power plants are needed as a result of energy efficiency gains, fewer traditional utility jobs are sustained. Once again, this points to an important opportunity for utilities: if utilities become more proactive in the area of energy efficiency services, they can employ more workers to carry out these new responsibilities. One might assume, therefore, that utilities in Nevada can incorporate at least some of the jobs gained in the construction and service sectors if they implement well-funded and comprehensive energy efficiency programs for their customers.

**Macroeconomic Impacts for New Mexico**

The overall results in Table 4-10 for New Mexico are positive. Net jobs increase by 890 in 2015 and 2,330 in 2020 in the High Efficiency scenario. Net wage and salary compensation increases by $2 million in 2015 and $32 million in 2020, again in 2010 dollars. Despite the increases in jobs and compensation, GSP decreases by $58 million in 2015 and $88 million in 2020. This is due in large part to the presence of large coal, natural gas and related industries that serve New Mexico and other states in the region. The positive GSP impacts from the investments in efficiency are not sufficient to offset the GSP losses in the fossil fuel and related industries.

Table 4-10. New Mexico Macroeconomic Impacts in the High Efficiency Scenario

| **Year** | **Change in Jobs** | **Change in Wage and Salary Compensation** (Million $) | **Change in Gross State Product** (Million $) |
|---|---|---|---|
| 2015 | 890 | 2 | (58) |
| 2020 | 2,330 | 32 | (88) |

According to the U.S. Bureau of Labor Statistics, in May 2012 just under 900,000 workers were employed in New Mexico, and about 62,000 workers in the state were unemployed (BLS 2012b). Given reasonable assumptions about employment growth, adding 890 jobs by 2015 will result in approximately a 0.1% increase in projected statewide employment that year. Adding 2,330 jobs by 2020 will result in approximately a 0.2% increase in projected statewide employment.

According to the U.S. Bureau of Economic Analysis, in 2011 personal income for New Mexico was approximately $7.2 billion (BEA 2012). Adding $2 million in 2015 will result in less than a 0.1% increase in projected income. Adding $32 million in 2020 will result in approximately a 0.4% increase in projected income. The contributions are not large relative to the state's overall economy, but would certainly help in a relatively poor state such as New Mexico.

Table 4-11 shows two big sectoral "winners" in 2020: the service sectors and the construction industry. The retail trade sectors benefit as well, but not as significantly. The service sectors benefit from the actual investments in energy efficiency programs and technologies as well as the higher level of services purchased as households and businesses spend their energy bill savings throughout the economy. The construction industries benefit as contractors are hired to make the energy efficiency upgrades. The retail trade sectors also benefit from purchases of energy efficient technologies and the higher level of goods purchased as households and businesses spend their energy bill savings throughout the economy.

Table 4-11 also shows that the oil, gas and coal mining industries and the electric utilities lose the most jobs, similar to the results for the region as a whole. The loss of jobs assumes a traditional economic structure for electric utilities in 2020, and that the fossil fuel mining industries in New Mexico supply other states in the region. Thus, as fewer conventional power plants are needed, along with the associated reductions in fuel use as a result of energy efficiency gains, fewer of these mining and traditional utility jobs are sustained. Again, this points to an important opportunity for utilities: if utilities become more proactive in the area of energy efficiency services, they can employ more workers to carry out these new responsibilities. One might assume, therefore, that utilities in New Mexico can incorporate at least some of the jobs gained in the construction and service sectors if they implement well-funded and comprehensive energy efficiency programs for their customers.

**Table 4-11. New Mexico Impacts by Sector in 2020 in the High Efficiency Scenario**

| **Sectors** | **Change in Jobs** | **Change in Wage and Salary Compensation** (Million $) | **Change in GSP** (Million $) |
|---|---|---|---|
| Services | 1,500 | 71 | 89 |
| Construction | 1,260 | 59 | 80 |
| Retail Trade | 430 | 18 | 26 |
| Other Manufacturing | 140 | 9 | 18 |
| Finance | 120 | 6 | 11 |
| Government | 100 | 8 | 9 |
| Insurance/Real Estate | 80 | 2 | 21 |
| Wholesale Trade | 30 | 2 | 4 |
| Food | 10 | 0 | 1 |
| Primary Metals | 10 | 1 | 2 |
| Other Mining | 10 | 1 | 2 |
| Agriculture | 0 | 0 | 0 |
| Oil Refining | 0 | (1) | (4) |
| Natural Gas Utilities | (10) | (1) | (3) |
| Transportation, Communication & Utilities | (20) | (1) | (4) |
| Electric Utilities | (260) | (39) | (146) |
| Coal Mining | (290) | (43) | (89) |
| Oil and Gas Mining | (770) | (60) | (104) |
| **TOTAL** | **2,330** | **32** | **(88)** |

***Notes:*** *The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the High Efficiency scenario. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

**Macroeconomic Impacts for Utah**

The overall results in Table 4-12 for Utah are positive. Net jobs increase by 1,190 in 2015 and 3,000 in 2020 in the High Efficiency scenario. Net wage and salary compensation increases by $30 million in 2015 and $89 million in 2020, again in 2010 dollars. Similar to the other states in the region with large coal and natural gas resources, although there are increases in jobs and compensation, GSP decreases by a small amount: $12 million in 2015 and $16 million in 2020. The positive GSP impacts from the investments in efficiency are not sufficient to offset GSP losses in the utility, coal, natural gas and related industries.

**Table 4-12. Utah Macroeconomic Impacts in the High Efficiency Scenario**

| **Year** | **Change in Jobs** | **Change in Wage and Salary Compensation** (Million $) | **Change in Gross State Product** (Million $) |
|---|---|---|---|
| 2015 | 1,190 | 30 | (12) |
| 2020 | 3,100 | 89 | (16) |

According to the U.S. Bureau of Labor Statistics, in May 2012 just under 1.3 million workers were employed in Utah, and about 81,000 workers in the state were unemployed (BLS 2012b). Given reasonable assumptions about employment growth, adding 1,190 jobs by 2015 will result in approximately a 0.1% increase in projected statewide employment that year. Adding 3,100 jobs by 2020 will result in approximately a 0.2% increase in projected statewide employment.

According to the U.S. Bureau of Economic Analysis, in 2011 personal income for Utah was approximately $9.5 billion (BEA 2012). Adding $30 million in 2015 will result in approximately a 0.3% increase in projected income. Adding $89 million in 2020 will result in approximately a 0.8% increase in projected income. As noted previously for the other states, the contributions are not large relative to the state's overall economy, but would certainly help the state as it tries to recover economically.

Table 4-13 shows two big sectoral "winners" in Utah in 2020: the service sectors and construction industry. The retail trade sectors show gains, but not as significant as these other sectors. The service sectors benefit from the actual investments in energy efficiency programs and technologies as well as the higher level of services purchased as households and businesses spend their energy bill savings throughout the economy. The construction industries benefit as contractors are hired to make the energy efficiency upgrades. The retail trade sectors benefit from purchases of energy efficient technologies and the higher level of goods purchased as households and businesses spend their energy bill savings throughout the economy.

Table 4-13. Utah Impacts by Sector in 2020 in the High Efficiency Scenario

| Sectors | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in GSP (Million $) |
|---|---|---|---|
| Services | 1,660 | 77 | 93 |
| Construction | 1,510 | 79 | 97 |
| Retail Trade | 390 | 17 | 24 |
| Finance | 180 | 8 | 13 |
| Insurance/Real Estate | 130 | 3 | 24 |
| Other Manufacturing | 120 | 12 | 19 |
| Wholesale Trade | 30 | 3 | 5 |
| Government | 30 | 2 | 3 |
| Primary Metals | 20 | 2 | 3 |
| Transportation, Communication & Utilities | 20 | 1 | 3 |
| Food | 10 | 1 | 1 |
| Other Mining | 10 | 1 | 3 |
| Agriculture | 0 | 0 | 0 |
| Oil Refining | 0 | (1) | (3) |
| Natural Gas Utilities | (10) | (1) | (3) |
| Coal Mining | (190) | (28) | (58) |
| Electric Utilities | (270) | (44) | (166) |
| Oil and Gas Mining | (550) | (43) | (74) |
| **TOTAL** | **3,100** | **89** | **(16)** |
| *Notes: The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the High Efficiency scenario. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.* | | | |

Table 4-13 also shows that the oil, gas and coal mining industries and electric utilities lose the most jobs, similar to the results for the region as a whole. The loss of jobs assumes a traditional economic structure for electric utilities in 2020, and that the fossil fuel mining industries in Utah supply other states in the region. Thus, as fewer conventional power plants are needed, along with the associated reductions in fuel use as a result of energy efficiency gains, fewer of these mining and traditional utility jobs are sustained. Once again, this points to an important opportunity for utilities: if utilities become more proactive in the area of energy efficiency services, they can employ more workers to carry out these new responsibilities. One might assume, therefore, that utilities in Utah can incorporate at least some of the jobs gained in the construction and service sectors if they implement well-funded and comprehensive energy efficiency programs for their customers.

**Macroeconomic Impacts for Wyoming**

The overall results in Table 4-14 for Wyoming are positive with respect to impact on jobs. Net jobs increase by 30 in 2015 and 610 in 2020 in the High Efficiency scenario. Despite the net gain in jobs, net wage and salary compensation decreases by $32 million in 2015 and $47 million in 2020, and GSP decreases by $105 million in 2015 and $206 million in 2020, all in 2010 dollars. This is largely the result of the coal and fossil fuel-related industries being such a significant sector in the Wyoming economy. The increases in income and GSP from the investments in energy efficiency are not sufficient to offset the losses in the coal mining and electric utility sectors.

Table 4-14. Wyoming Macroeconomic Impacts in the High Efficiency Scenario

| Year | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in Gross State Product (Million $) |
|---|---|---|---|
| 2015 | 30 | (32) | (105) |
| 2020 | 610 | (47) | (206) |

According to the U.S. Bureau of Labor Statistics, in May 2012 just under 300,000 workers were employed in Wyoming, and about 16,000 workers in the state were unemployed (BLS 2012b). Adding 30 jobs by 2015 will have a minimal effect on statewide employment. Given reasonable assumptions about employment growth, adding 610 jobs by 2020 will result in approximately a 0.2% increase in projected statewide employment. The contributions are not large relative to the state's overall economy, but would help the state diversify economically.

Table 4-15 shows that the two big sectoral "winners" in Wyoming in 2020 are the service sectors and the construction industries. The retail trade sector benefits as well, but significantly less. The construction industries benefit as contractors are hired to make the energy efficiency upgrades. The service sectors benefit from the actual investments in energy efficiency programs and technologies as well as the higher level of services purchased as households and businesses spend their energy bill savings throughout the economy. The retail trade sectors also benefit from purchases of energy-efficient technologies and the higher level of goods purchased as households and businesses spend their energy bill savings throughout the economy.

Table 4-15 also shows that the most jobs are lost in the electric utilities, coal mining and related industries, similar to the results for the region as a whole. The loss of jobs assumes a traditional economic structure for electric utilities in 2020, and that the coal mining industries in Wyoming supply other states in the region. Thus, as fewer conventional power plants are needed throughout the region, along with the associated reductions in coal use as a result of energy efficiency gains, fewer jobs are sustained in traditional utilities, coal mining and related industries. Once again, this points to an important opportunity for utilities: if utilities become more proactive in the area of energy efficiency services, they can employ more workers to carry out these new responsibilities.

One might assume, therefore, that utilities in Wyoming can incorporate at least some of the jobs gained in the construction and service sectors if they implement well-funded and comprehensive energy efficiency programs for their customers.

**Table 4-15. Wyoming Impacts by Sector in 2020 in the High Efficiency Scenario**

| Sectors | Change in Jobs | Change in Wage and Salary Compensation (Million $) | Change in GSP (Million $) |
|---|---|---|---|
| Construction | 670 | 40 | 49 |
| Services | 500 | 22 | 29 |
| Retail Trade | 130 | 5 | 8 |
| Other Manufacturing | 50 | 5 | 9 |
| Finance | 50 | 2 | 3 |
| Primary Metals | 20 | 1 | 2 |
| Insurance/Real Estate | 20 | 0 | 5 |
| Agriculture | 0 | 0 | 0 |
| Oil and Gas Mining | 0 | (0) | (0) |
| Natural Gas Utilities | 0 | (1) | (2) |
| Food | 0 | 0 | 0 |
| Oil Refining | 0 | 0 | 0 |
| Other Mining | 0 | (0) | (0) |
| Wholesale Trade | 0 | (0) | (1) |
| Government | (10) | (1) | (1) |
| Transportation, Communication & Utilities | (40) | (4) | (10) |
| Electric Utilities | (190) | (30) | (118) |
| Coal Mining | (580) | (86) | (179) |
| **TOTAL** | **610** | **(47)** | **(206)** |

*Notes: The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the High Efficiency scenario. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

## C. Summary

Increasing energy efficiency will have a positive impact on overall employment and salary and wage compensation in this six state region. We estimate that if $16.75 billion is invested in energy efficiency measures during 2010-2020, it will result in a net increase of about 10,120 jobs in the region by 2015 and 28,080 jobs by 2020. Likewise, aggregate salaries and wages in the region as a whole will rise by about $317 million in 2015 and just over $1.0 billion in 2020 if all states in the region pursue the High Efficiency scenario.

GSP will not change significantly by 2015, due to a variety of effects, including reduced the need for capital investment in conventional energy production and reduced use of the coal and natural gas resources. However, GSP in the region as a whole will increase by $294 million by 2020.

The analysis shows that the largest impacts are realized in the construction and service industries. Furthermore, the job impacts grow over time as more energy efficiency investments are made and the energy savings increase.

Adding 28,080 jobs to the region by 2020 will mean roughly a 0.3% increase in the number of people employed (i.e., a 0.3% reduction in the unemployment rate) in the region. The increase in jobs ranges from 0.2% in Wyoming to over 0.3% in Arizona and Nevada. These jobs will be widely distributed throughout the region's economy with most of the job growth occurring in the services, construction and retail trade sectors. Electric utilities, coal mining, and the oil and gas production sectors lose jobs, although some of this loss can be mitigated if utilities provide comprehensive energy efficiency services to their customers.

## V. Policy and Program Review and Recommendations

The growth of utility energy efficiency programs in the Southwest has been heavily influenced by policies either through state legislation or state utility commission action during the past decade. Table 5-1 summarizes the key policies affecting utility energy efficiency efforts in each state. In short, there are many more positive entries in the chart today compared to five or six years ago (Geller and Schlegel 2012). All states have adopted a favorable cost-effectiveness test (i.e., the Societal Cost test, Total Resource Cost test or Utility Cost test) for determining if energy efficiency programs are cost-effective. All states have adopted a convenient and timely cost recovery mechanism, in most cases allowing cost recovery for approved energy efficiency programs in the same year that expenditures occur.

Integrated resource planning requirements are in place in all states except Wyoming, and four states have adopted some form of energy savings goals or standards for investor-owned utilities (IOUs). In addition, three states have adopted performance-based incentives to provide a positive financial incentive and/or mitigate any adverse financial impact that operating DSM programs has on the company's bottom line. Two states have adopted lost revenue recovery mechanisms to remove financial disincentives that utilities face. However, so far no state in the region has adopted decoupling of electricity sales and revenues for electric utilities. The status of policies and programs in each state is discussed in greater detail below.

**Table 5-1. Key Policies Influencing Electric Utility Efficiency Programs in the Southwest**

| Policy | AZ | CO | NM | NV | UT | WY |
|---|---|---|---|---|---|---|
| Energy efficiency goals or standards (1) | ✓ | ✓ | ✓ | ✓ | | |
| Integrated Resource Planning | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Use of Total Resource Cost, Societal, or Utility Cost test as sole/primary cost-effectiveness test | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Public benefits funds supporting energy efficiency programs | | | | | | |
| Convenient DSM cost recovery mechanism | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Financial incentive for utility shareholders | ✓ | ✓ | ✓ | | | |
| Decoupling or lost revenue recovery mechanism (2) | ✓ | | | ✓ | | |
| Collaboration in DSM program design/analysis | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Industrial self-direction option | Partial | ✓ | ✓ | | ✓ | ✓ |
| *Notes: (1) Energy savings are allowed to count towards clean energy standards in Nevada. (2) Lost revenue recovery mechanism approved for Arizona Public Service Company; pending for Tucson Electric Power Company.* | | | | | | |

As noted in Chapter 1, funding for and energy savings from utility energy efficiency programs is on the rise in the region with the exception of recent trends in Nevada. Funding will need to rise substantially, however, in all states in order to achieve the target of 20% energy savings by 2020 (15% savings in Wyoming). Energy efficiency analysts have pointed out based on empirical evidence that energy savings tend to increase with program spending and with the adoption of policies such as aggressive energy savings goals or requirements (Kushler, Witte and York 2009; Chandler 2012). The policy recommendations presented below are intended to help each state scale up its utility energy efficiency programs and achieve the energy savings and broad benefits identified in the High Efficiency scenario.

## A. Arizona Policy and Program Review and Recommendations

In 2010, the Arizona Corporation Commission (ACC) approved three landmark policies: 1) an electric energy efficiency standard (EEES); 2) a decoupling policy statement, and 3) new integrated resource planning rules. Together these policies established strong regulatory support for the growth of utility energy efficiency programs. The first policy requires regulated electric utilities to achieve 22% energy savings by 2020, with 2% of the total possible through a credit for demand response and/or load management efforts (ACC 2010a). Utilities are required to file annual or biennial energy efficiency implementation plans for review and approval by the ACC. The second policy enables investor-owned electric utilities to file specific decoupling proposals in general rate cases in order to align company financial interests with energy efficiency objectives (ACC 2010b). The third policy allows for meaningful opportunities for energy efficiency to compete on a level playing field with conventional energy supply resources.

Following the adoption of these policies, both Arizona Public Service (APS) and Tucson Electric Power (TEP) expanded their energy efficiency programs and achieved first-year savings of about 1.4% of retail sales from programs implemented in 2011 (APS 2012a; TEP 2012). Furthermore, the two regulated utilities proposed further program enhancements in 2012 aimed at achieving around 1.75% first year savings. APS received approval of its 2012 energy efficiency implementation plan which as proposed would deliver annual energy savings that exceed 480 GWh and about $195 million in net benefits for customers.[13] APS will provide customers with new and enhanced programs including a revamped Home Performance with ENERGY STAR® program; a revamped multi-family program; an energy codes and standards support program; and new options for large businesses, small businesses, and schools.

Unfortunately the approval of TEP's 2011-12 DSM implementation plan has been delayed. As a result, many existing residential and business energy efficiency programs were suspended during the first half of 2012. The delay in the approval TEP's plan was due to an array of outstanding issues including adoption of a lost fixed cost recovery mechanism outside of a rate case which the ACC elected to address through evidentiary hearings. The hearings took place during summer 2012, and DSM programs could be approved and resumed by fall 2012.

[13] The ACC made some changes to APS's plan as filed that will result in slight modifications to these figures.

In May 2012, instead of adopting decoupling, the ACC approved a lost revenue recovery mechanism that allows APS to recover approved fixed costs that are not collected because of energy savings from the utility's energy efficiency programs. The ACC previously approved a performance-based shareholder incentive mechanism for APS, which was slightly modified in a 2012 rate case decision. The incentive amount is tied to the level of energy savings achieved relative to the goal each year and is expressed as a percentage of the net economic benefits, ranging from 6% of net benefits once APS achieves 85% of its annual savings goal to 8% of net benefits when the utility exceeds 105% of the savings goal. The incentive is also capped as a percentage of program expenditures. In 2011, APS spent $55 million on its energy efficiency programs and saved 397 GWh/yr, about 115% of the EEES standard that year. As a result the utility earned an incentive of $8.8 million (APS 2012a). The recent APS rate case decision requires the company to work with stakeholders to develop a new performance incentive structure by the end of 2012.

Integrated Resource Planning (IRP) requirements are also helping to build support for strong utility energy efficiency programs in Arizona. APS prepared a new IRP in 2012 showing energy efficiency as the utility's fastest growing resource in the remainder of the decade with energy efficiency providing 16% of the company's total resources by 2020 (Zuckerman and Schlegel 2012).

The Salt River Project (SRP) is a large unregulated utility operating in Arizona. In 2006, SRP's Board of Directors adopted a Sustainable Portfolio Standard which guides the utility's pursuit of energy efficiency and renewable energy resources. In May 2011, the SRP Board unanimously approved several revisions to the Sustainable Portfolio Standard (SRP 2011) including:

- An increased and accelerated goal for the company to achieve 20% of its expected retail energy requirements through the implementation of energy efficiency and renewable energy resources by FY 2020.
- Energy savings targets of 1.5 percent per year in FY 2012-2014, 1.75 percent per year in FY 2015-2017, and 2.0 percent per year in FY 2018-2020.
- A commitment to support building energy codes and standards, for which the company can count up to 50 percent of the energy savings as a credit towards achievement of the Sustainable Portfolio Standard.
- Approval of a FY 2012 energy efficiency budget of $49.1 million, a significant increase over the previous year's $39.3 million budget. For FY 2013, the budget increases to $55 million.

Another noteworthy policy in Arizona is the fact that the EEES applies to rural electric cooperatives as well as investor-owned utilities. Rural cooperatives must achieve 75% of the energy savings that is required of the IOUs, meaning an overall savings requirement of 16.5% of sales by 2020 (with up to 1.5% credit from demand response and load management programs). The EEES does not apply to SRP or municipal utilities, as they are not regulated by the ACC.

APS, TEP and SRP all implement relatively comprehensive energy efficiency programs, including programs promoting deep retrofits as well as individual efficiency measures, along with codes and standards support (aside from the fact that TEP's programs were suspended as of mid-2012). Information feedback and behavior change-oriented programs are implemented to some degree as well. However, other publicly-owned utilities and rural cooperatives in Arizona are not yet implementing comprehensive efficiency programs.

Arizona is currently the leading state in the region with respect to utility energy efficiency policies as well as the level of energy savings being achieved. For the most part, Arizona is on track towards achieving the full energy savings and the $7.1 billion in net benefits indicated in the High Efficiency scenario in this study. SWEEP recommends adoption of the following policies to ensure that all utilities in Arizona stay on track and actually do reach 20% or greater energy savings by 2020:

1) The ACC should adopt decoupling or a lost revenue recovery mechanism along with performance-based incentives for all investor-owned utilities, not just APS. Doing so would enable utility shareholders as well as customers to benefit from implementation of cost-effective, comprehensive and high-performing energy efficiency programs.

2) Electric utilities and the ACC should strive for maximum customer participation and maximum cost-effective energy savings. Arbitrary caps on funding for cost-effective programs should be avoided. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3) The ACC should commit to approve energy efficiency implementation plans submitted by utilities in a timely manner.

4) SRP, the state's large publicly-owned and unregulated utility, should continue to expand and fully fund cost-effective energy efficiency programs without arbitrary spending caps.

5) Other publicly-owned utilities and rural cooperatives should commit to implement strong energy efficiency programs. Funding permitting, the Governor's Office of Energy Policy could offer assistance to the smallest utilities, say those with 10,000 customers or less. This assistance could provide help with program planning and/or some co-funding for program implementation. Smaller utilities should focus on the most influential and effective programs given their customer base.

## B. Colorado Policy and Program Review and Recommendations

Legislation enacted in 2007 directed the Colorado Public Utilities Commission (PUC) to establish energy savings goals and a performance-based incentive mechanism for regulated electric utilities. It also established the Total Resource Cost (TRC) test as the basis for determining if energy efficiency programs are cost-effective, and directed utilities and the PUC to include valuation of avoided emissions and other non-energy benefits in TRC calculations. In 2008, the PUC established energy savings goals through 2020 for Xcel Energy along with a shareholder incentive mechanism (Colorado PUC 2008). The performance-based incentive mechanism allows the utility to receive a small fraction of the net economic benefits resulting from programs implemented each year, with the fraction dependent on the level of energy savings achieved relative to the savings goal each year.

In 2011, the Colorado PUC adopted more ambitious energy savings goals and a revised shareholder incentive mechanism for Xcel Energy (Colorado PUC 2011). The PUC's new goals call for energy savings reaching 1.2% of sales in 2013, 1.4% of sales by 2016, and 1.7% of sales by 2020. The new goals are 30% higher than the goals adopted by the PUC in 2008. The new shareholder incentive mechanism, structured in the same manner as the previous incentive mechanism, is meant to both remove any disincentive to energy efficiency investment and provide Xcel a bonus, assuming the energy savings goals are met or exceeded.

In 2011, Xcel Energy spent $63.8 million on DSM programs and achieved about 290 GWh per year of annual energy savings, 130% of the goal set by the PUC (Xcel Energy 2012). Based on the TRC cost-effectiveness test used in Colorado, the portfolio of DSM programs had a benefit-cost ratio of 2.85. The utility received a bonus of $18.7 million in addition to program cost recovery, equivalent to about 9.5% of the estimated total net economic benefits resulting from DSM programs implemented in 2011. Programs will continue to expand in 2012 and beyond as the company strives to meet energy savings goals that increase each year.

Other utilities in Colorado implementing relatively comprehensive energy efficiency programs for customers include Black Hills Energy (a smaller IOU) and the municipal utilities serving Fort Collins and Colorado Springs. The PUC adopted the same energy savings goals in percentage terms for Black Hills as it did for Xcel Energy in 2008. Black Hills estimates it saved about 0.9% of sales per year from programs implemented in 2011. In early 2012, Black Hills submitted a new three and a half year DSM program plan to the Colorado PUC. The new plan, along with a settlement agreement supported by most parties in the docket, expands programs and ramps up energy savings to about 1.2% of projected sales in 2015. Approval of the plan is expected by the fall of 2012.

Fort Collins Utilities (FCU) estimated that its 2010 programs resulted in gross energy savings of 20.5 GWh/yr, equivalent to about 1.4% of retail electricity sales, with net savings equivalent to about 1.2% of sales (FCU 2011). In 2011, the utility reports its programs saved 20.4 GWh/yr (1.4% of sales) considering gross savings and 15.3 GWh/yr (1.0% of sales) on a net basis; i.e., adjusted for estimated savings that would have occurred in the absence of utility programs (FCU 2012). (See box next page for more details.)

The Colorado Springs municipal utility offers a wide range of efficiency programs to its customers and reports saving 22.7 GWh/yr from program implemented in 2011 (James 2012). This is equivalent to about 0.5% of the utility's retail sales.  Municipal utilities and rural electric cooperatives are not subject to PUC regulation in Colorado; nor do they operate under any legislative mandates with respect to energy efficiency efforts.

Colorado is moving in the direction of comprehensive, well-funded utility energy efficiency programs, at least on the part of investor-owned electric utilities and a couple of publicly-owned utilities. In order to achieve the full energy savings and the $4.8 billion in net benefits indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies to ensure that all utilities in Colorado maximize cost-effective energy savings by their customers and to achieve 20% or greater energy savings by 2020:

1. The Colorado PUC should strengthen energy savings goals for the investor-owned utilities it regulates while ensuring that utilities are rewarded financially when they implement effective efficiency programs for their customers. The current incentive policy adopted for Xcel Energy and Black Hills Energy appears to be working well, providing the utilities with a significant bonus when they meet or exceed the savings goals while ensuring that customers retain the large majority of the net economic benefits from the utilities' programs.

2. Electric utilities and the Colorado PUC should strive for maximum customer participation and maximum cost-effective energy savings. Arbitrary caps on funding for cost-effective programs should be avoided. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3. Municipal utilities and rural electric cooperative supply about 40% of the electricity consumed in Colorado. The state legislature should adopt energy efficiency program requirements for all utilities in Colorado so that households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by Xcel Energy and Black Hills Energy. All utilities can and should implement cost-effective energy efficiency programs that save at least 1% of sales each year.

4. Many rural electric cooperatives in Colorado receive power from and are members of Tri-State Generation and Transmission Association. Tri-State should help its members implement well-funded, effective energy efficiency programs, as do wholesale power providers in other states such as Iowa, Indiana, Minnesota and Oregon (Freischlag 2011).

5. Funding permitting, the Colorado Energy Office could offer assistance to the smallest utilities, say those with 10,000 customers or less. This assistance could provide help with program planning and/or some co-funding for program implementation. Smaller utilities should focus on the most influential and effective programs given their customer base.

## Fort Collins Utilities: A Public Utility Success Story

Fort Collins Utilities, in northern Colorado, is a leader in energy efficiency among municipal utilities. With 65,000 residential and business customers, the utility has achieved savings at an average cost of 2-4 cents per kWh, thereby taking advantage of the lowest cost and cleanest resource available to utilities big and small. Fort Collins Utilities serves as a successful model for smaller public utilities throughout the region.

Fort Collins Utilities began efficiency efforts in 1982 with educational programs and load management. Its first official DSM budget was approved for 2004 after the City Council adopted an energy policy that included explicit energy efficiency goals. In 2009, the City Council adopted a revised Energy Policy that includes a goal of achieving 1.5% savings from energy efficiency and conservation programs implemented each year (FCU 2009).

Fort Collins Utilities now implements a comprehensive set of programs to serve its residential, commercial and industrial sectors. Programs include incentives for home, commercial building, and industrial facility retrofits, technical assistance and incentives for highly efficient new construction, discounts on energy-efficient light bulbs, and a Home Energy Reports program. The utility's net savings from programs implemented during 2002-2011 totaled more than 83,000 MWh, nearly 6% of sales in 2011. As of 2011, the utility was helping its customers lower their electricity use by 1.4% per year based on gross energy savings and 1.0% per year on a net basis including adjustments for estimated program free ridership (FCU 2012).

According to John Phelan, Energy Services Manager, leadership is provided at many levels: an involved and supportive city council, a history of progressive public policies, and a well-educated and environmentally conscious community.

In addition to its existing programs, Fort Collins Utilities was developing several new or expanded initiatives in mid-2012, including:

- On-bill financing for residential customers investing in efficiency upgrades up to $15,000.
- Home Energy Reports provided to all 55,000 residential customers.
- Direct installation of low-cost energy and water efficiency measures along with incentives for more costly measures such as insulation, energy-efficient windows and HVAC equipment in multi-family housing.
- Enhanced design assistance and performance incentives for new commercial buildings.
- A streamlined consumer product incentive program in collaboration with other public utilities and major retailers.
- New tools for customers to manage their home energy use via real-time feedback made possible by advanced "smart" electric meters.

## C. Nevada Policy and Program Review and Recommendations

In 2005, legislation was enacted in Nevada that added energy savings from utility DSM programs to the state's Renewable Portfolio Standard. Utilities are allowed to comply with the Standard in part with verified energy savings from DSM programs, up to a limit of 25% of the total requirement in any particular year. With the addition of energy savings, the Standard was renamed the Portfolio Standard. The total Standard equals 12% of electricity supply in 2009-2010, 15% in 2011-2012, 18% in 2013-14, 20% in 2015 and then 25% in 2025.

In response to this policy, Nevada Power Company (NPC) and Sierra Pacific Power Company (SPPC), now jointly owned and operated by NV Energy, greatly expanded their energy efficiency programs starting in 2006. In 2009, the two utilities achieved net energy savings of about 440 GWh per year, equivalent to 1.5% of retail electricity sales that year. This placed NV Energy among the leading utilities in the nation with respect to energy savings achievement (MJBA 2009). The programs providing the most energy savings were residential lighting and commercial building retrofit incentives. Furthermore, the utilities have built up a large surplus of energy savings credits that can be used toward compliance with the Portfolio Standards in the future (albeit with the 25% limit each year).

Due to delays in approval of NPC's 2010-2012 DSM plan and other factors including the state being hit very hard by the recession, DSM program expenditures declined in 2010 and energy savings achievement by NV Energy fell to about 305 GWh per year or about 1.1% of retail sales. Further reductions in energy efficiency program savings occurred in 2011 as Nevada was stuck in a deep economic recession, negative load growth continued, avoided costs declined, and the Public Utilities Commission of Nevada (PUCN) increasingly questioned the desirability of robust utility energy efficiency programs. Energy savings from NV Energy's programs fell to 278 GWh per year from programs implemented in 2011, slightly less than 1.0% of sales that year.

During 2004-2010, DSM program expenditures in Nevada were rate-based and utilities were allowed to earn their approved rate of return plus 5% on the equity portion of DSM program expenditures. This was considered an adequate financial incentive by the utilities, at least when energy savings were relatively modest. However, as budgets and savings increased, the utilities became increasingly concerned about delays in cost recovery and the lost revenues that occur between rate cases. In 2009, the utilities advocated and the Nevada legislature approved expensing of program costs and lost revenue recovery policies, replacing the previous rate base and bonus rate of return policies.

The first docket to determine the amount of lost revenue that the utilities were entitled to recover was held in 2010-11 and was highly contentious. NV Energy proposed lost revenue recovery from energy savings that were ongoing at the time of the rule change but were due to DSM programs implemented prior to it as well as lost revenues based on gross rather than net energy savings. Commission staff and the consumer advocate strongly objected to these proposals because of their potential rate impact, leading the PUCN to allow the utilities to recover only a portion of the lost revenue that they had requested (PUCN 2011). The utilities started collecting lost revenues in July

2011. In addition, the PUCN directed the utilities to make some programmatic cuts and modify measurement and verification (M&V) procedures as part of the lost revenue recovery docket.

Due to the factors mentioned above, the utilities along with Commission staff and the state's consumer advocate proposed further cuts in energy efficiency programs as part of a new docket that reviewed the 2012 DSM budgets. Energy efficiency advocates challenged the proposed cuts in programs that continue to be cost-effective in spite of lower avoided costs. In March 2012, the PUCN approved significant funding cuts for 2012 relative to previously approved levels, and eliminated the residential lighting and low-income weatherization programs (PUCN 2012).

The prevailing attitude at the PUCN at this time appears to be to ratchet back DSM programs and thereby reduce the short-term rate impacts, even if it means higher utility bills in the long run. The fact that the utilities are allowed to collect lost revenue in addition to recover program costs has contributed to this negative outlook. Due to the controversy over lost revenue recovery, there appears to be some interest in replacing this policy with decoupling and/or a performance-based shareholder incentive mechanism.

Nevada's investor-owned utilities, which implemented some of the most effective energy efficiency programs in the nation as recently as 2009, have backtracked since then due to decisions made by the PUCN acting in response to positions advocated by some stakeholders. In order to get back on track and achieve the $3.4 billion in net benefits for households and businesses and net addition of 4,700 jobs in Nevada by 2020 as indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1. The inclusion of energy savings towards meeting the Portfolio Standards is no longer an effective or desirable policy due to the large surplus of credits generated by efficiency programs implemented in the past. We recommend that the legislature remove energy savings from the Portfolio Standards and adopt separate energy savings requirements so that NV Energy helps its customers achieve as much cost-effective energy savings as possible, with energy savings and net economic benefits growing over time.

2. The legislature should also direct the utilities and the PUCN to strive for maximum customer participation and maximum cost-effective energy savings. Arbitrary caps on funding for cost-effective programs should be avoided. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3. The legislature should replace the unpopular lost revenue recovery policy with decoupling—a policy that assures that utilities receive their authorized fixed cost recovery per customer, and no more or no less. This symmetrical policy removes the "throughput incentive" and any financial disincentive the utility has for implementing strong, well-performing energy efficiency programs.

4. In addition to decoupling, the PUCN should adopt performance-based incentives that allow utility shareholders to earn a reasonable profit when utilities implement effective energy efficiency programs for their customers.

5. NV Energy is responsible for providing about 85% of the electricity consumed in Nevada. While the share provided by publicly-owned and cooperative utilities is relatively small, all utilities should implement efficiency programs so that households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by NV Energy. All utilities can and should implement cost-effective energy efficiency programs that save at least 1% of sales each year.

6. Funding permitting, the Nevada State Energy Office could offer assistance to the smallest utilities, say those with 10,000 customers or less. This assistance could provide help with program planning and/or some co-funding for program implementation. Smaller utilities should focus on the most influential and effective programs given their customer base.

## D. New Mexico Policy and Program Review and Recommendations

The Efficient Use of Energy Act (EUEA), enacted in 2005, directs utilities in New Mexico to implement cost-effective DSM programs, indicates use of the Total Resource Cost test for evaluating cost-effectiveness, establishes a convenient cost recovery mechanism, and directs the Public Regulation Commission (PRC) to establish rules for integrated resource planning. In 2008, the Act was amended to add energy savings requirements as well as a directive to the PRC to remove disincentives and allow utilities an opportunity to earn a profit on investment in cost-effective energy efficiency and load management program (New Mexico State Legislature 2008). Investor-owned electric utilities are required to achieve 5% electricity savings by 2014 and 10% savings by 2020, from programs implemented starting in 2007. The 2008 EUEA amendments also directed utilities to acquire as much cost-effective energy efficiency and load management resources as possible.

As a result of these policies, electric utility DSM program funding in New Mexico nearly tripled from about $10 million in 2008 to around $28 million in 2011. Funding is expected to reach about $33 million in 2012. Two smaller utilities, Southwestern Public Service Company (SPS), a subsidiary of Xcel Energy, and El Paso Electric Company (EPE) saved 0.8-0.9% of retail sales from programs implemented in 2011 and are expected to exceed 1.0% savings in 2012, based on net energy savings. In fact El Paso Electric's new DSM plan that was approved in February 2012 calls for ramping up energy savings to about 30 GWh per year or about 1.8% of sales from programs implemented starting in 2012 (EPE 2011).

Public Service Company of New Mexico (PNM), the main investor-owned utility in the state, saved only about 0.6% of retail sales from programs implemented in 2011 (PNM 2012). This means that PNM is lagging other large IOUs in the region as well as the two smaller IOUs in New Mexico with respect to energy savings achievement. PNM will be submitting a new two-year DSM plan to the PRC in fall 2012 that is expected to increase energy savings to nearly 1% savings per year from programs implemented in 2013 and 2014 (Bean 2012).

Regarding disincentive removal and providing utilities the opportunity to profit from energy efficiency investments, the PRC adopted a relatively simple interim "adder" approach in 2010, following lengthy stakeholder discussions that resulted in a proposal along these lines. The interim adder provides utilities a fixed amount per kWh and peak kW saved each year, in addition to program cost recovery. However, the Attorney General and industrial consumers opposed this policy and challenged it in court. In 2011, the New Mexico Supreme Court ruled that any adder must be cost-based rather than based on arbitrary values. The PRC responded that the interim adders adopted for PNM and other utilities do comply with the Supreme Court ruling, and the PRC approved specific adders based on a showing that such adders were equal to or less than lost revenues due to DSM programs for all three utilities.

Due to the controversy over the adder approach, two members of the PRC proposed adoption of revenue per customer decoupling in mid-2012 as a policy for permanently removing disincentives to strong utility energy efficiency programs. The full PRC should reach a decision in this rulemaking by the end of 2012.

The two smaller IOUs in New Mexico are implementing relatively comprehensive energy efficiency programs, including an information feedback pilot program initiated by SPS. PNM's programs have been somewhat limited although the utility is planning to seek approval for a number of new programs as part of its 2013-14 DSM plan (Bean 2012). In order to ramp up savings and achieve the $1.6 billion in net benefits for households and businesses as well as net addition of 2,300 jobs in New Mexico by 2020, as indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1. The energy efficiency requirements for electric utilities are relatively weak, requiring just 5% savings by 2014 and 10% savings by 2020 measured as a fraction of sales in 2005, and counting savings from programs starting in 2007. The utilities are on track to meet the 2014 target even though in the case of PNM efficiency programs have been relatively limited in recent years. We recommend that the legislature increase the requirements to at least 15% savings by 2020, counting savings as a fraction of sales in the year the standards take effect and counting savings starting with programs implemented in 2010.

2. The PRC and utilities should fully fund cost-effective efficiency programs, striving for maximum customer participation and maximum cost-effective energy savings. Arbitrary caps on funding for cost-effective programs should be avoided. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3. As a substitute for the interim adders currently in place, the PRC should decouple electricity sales and authorized fixed cost recovery per customer as has been proposed. In addition, the PRC should adopt performance-based incentives that allow utility shareholders to earn a reasonable profit when utilities implement effective energy efficiency programs for their customers.

4. The IOUs are responsible for providing about 67% of the electricity consumed in New Mexico. All utilities should implement efficiency programs so that households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by PNM, SPS, and EPE. All utilities can and should implement cost-effective energy efficiency programs that save at least 1% of sales each year.

5. A number of rural electric cooperatives in New Mexico receive power from and are members of Tri-State Generation and Transmission Association. Tri-State should help its members in New Mexico implement well-funded, effective energy efficiency programs, as do wholesale power providers in other states such as Iowa, Indiana, Minnesota and Oregon (Freischlag 2011).

6. Funding permitting, the New Mexico Energy, Minerals and Natural Resources Department could offer assistance to the smallest utilities, say those with 10,000 customers or less. This assistance could provide help with program planning and/or some co-funding for program implementation. Smaller utilities should focus on the most influential and effective programs given their customer base.

## E. Utah Policy and Program Review and Recommendations

The Utah Public Service Commission (PSC) first adopted Integrated Resource Plan (IRP) requirements and rules for electric utilities in the early 1990s. These rules require biennial resource plans, direct the utilities to include cost-effective demand-side resources in the plans, and state that the Total Resource Cost test be used as the primary test for determining if DSM programs are cost-effective. The rules were changed in 2009 to indicate that the Utility Cost test be used instead of the TRC as the primary test for determining DSM program cost effectiveness. Utility DSM programs are individually approved by the PSC and may be continued indefinitely once they are approved, as long as they continue to be cost-effective. The PSC has generally supported implementation of all cost-effective DSM programs.

PacifiCorp, the only investor-owned electric utility operating in Utah through its Rocky Mountain Power (RMP) subsidiary, has significantly increased its energy efficiency and load management programs over the past eight years. Funding rose from $27 million in 2006 to $49 million in 2010 — approximately 3.4% of retail sales revenue. The utility achieved net energy savings of 202 GWh per year from programs implemented in 2010, equal to about 0.9 percent of retail electricity sales (RMP 2011a). DSM program spending declined to about $45 million in 2011 but savings increased to 244 GWh per year, about 1.1% of electricity sales (RMP 2012a). Programs delivering the most energy savings include residential lighting incentives, custom incentives and a self-direction option for industries, and prescriptive incentives for commercial customers. RMP also implements relatively successful residential retrofit and ENERGY STAR new homes programs (RMP 2012a).

The Utah legislature approved a non-binding joint resolution in 2009 that supports the goal of saving at least 1.0% of retail electricity sales through DSM programs each year (Utah Legislature

2009). The non-binding resolution also encourages adoption of decoupling as well as performance-based incentives for utility shareholders. The PSC approved decoupling for the state's investor-owned gas utility (Questar Gas Company) but not for PacifiCorp. In addition, PacifiCorp has not requested, nor has the PSC approved, any form of shareholder incentive mechanism. The utility does obtain program cost recovery on a contemporaneous basis through a tariff rider mechanism.

PacifiCorp ramped up DSM programs in the past decade due to IRP requirements, adoption of an assured and convenient cost recovery mechanism, and the fact that the programs helped the utility avoid capital-intensive investment in new power plants. Utah is a relatively high-growth state and PacifiCorp is in a resource-deficit position. The company's 2011 IRP included a greater level of energy efficiency resources than its previous IRP with energy efficiency and load management programs projected to provide about 13% of system capacity and 11% of energy within the company's total resource mix by 2020. Energy efficiency is projected to be the largest new resource added during 2012-2030 according to the IRP (PacifiCorp 2011a).

Due to PacifiCorp's capital structure, the company has had a financial interest in reducing or deferring costly capital investment in order to limit new debt. This motivated the company to expand DSM programs during the past decade even though it only receives program cost recovery. However, PacifiCorp is increasingly concerned about the short-term impact of its energy efficiency programs on revenues and has asked the PSC to ensure the company is not penalized financially when it implements cost-effective DSM programs for its customers. The PSC rejected a partial decoupling mechanism that was proposed in a PacifiCorp rate case in 2010, a proposal that the state's consumer advocate opposed. There were no formal discussions of disincentive removal or shareholder incentives for PacifiCorp underway as of fall 2012.

In order to ramp up savings and achieve the $1.6 billion in net benefits for households and businesses and net addition of 3,100 jobs in Utah by 2020, as indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1. The Utah PSC should act upon the 2009 legislative resolution and adopt energy savings goals as well as policies to remove financial disincentives and provide a positive incentive to PacifiCorp for implementation of well-performing energy efficiency programs. Regarding energy savings goals, we recommend goals that increase over time starting at 1.2% savings as a fraction of retail sales per year (slightly more than what was achieved in 2011) and increasing to 2% savings per year by the latter part of the decade.

2. PacifiCorp and the PSC should strive for maximum customer participation and maximum cost-effective energy savings. Arbitrary caps on funding for cost-effective programs should be avoided. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3. The PSC should decouple electricity sales and authorized fixed cost recovery as has been done for Questar Gas Company. In addition, the PSC should adopt performance-based

incentives that allow Pacificorp's shareholders to earn a reasonable profit when the utility implements effective energy efficiency programs for its customers. The level of incentive should be tied to program performance including achieving any energy savings goals that are established.

4. PacifiCorp is responsible for providing about 80% of the electricity consumed in Utah. Over 40 municipal utilities and rural electric cooperatives provide the remaining 20%. All utilities should implement efficiency programs so that households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by PacifiCorp. All utilities can and should implement cost-effective energy efficiency programs that save at least 1% of sales each year.

5. A number of municipal utilities in Utah receive power from and are members of UAMPS – the Utah Associated Municipal Power Systems. UAMPS should help its members implement well-funded, effective energy efficiency programs, as do wholesale power providers in other states such as Iowa, Indiana, Minnesota and Oregon (Freischlag 2011).

6. Funding permitting, the Utah Office of Energy Development could offer assistance to the smallest utilities, say those with 10,000 customers or less. This assistance could provide help with program planning and/or some co-funding for program implementation. Smaller utilities should focus on the most influential and effective programs given their customer base.

## F. Wyoming Policy and Program Review and Recommendations

Wyoming has not enacted any legislation related to utility DSM programs. PacificCorp (RMP) is the largest investor-owned utility in Wyoming and is responsible for about 55% of retail electricity sales in the state. As part of a settlement agreement in the sale of PacifiCorp to MidAmerican Energy Holdings, PacifiCorp agreed to conduct a DSM market potential study and file an application "to implement prudent and cost-effective DSM programs in Wyoming that can be shown to be in the public interest and to propose in the application an appropriate cost recovery mechanism."

In 2008, PacifiCorp proposed and received approval from the Wyoming PSC to implement six DSM programs with an estimated total budget of $34 million during 2009-2013 (1.7 percent of 2008 revenues on average). The programs are modeled on the utility's successful DSM programs in Utah and include incentives for a wide range of residential efficiency measures, refrigerator recycling, incentives for all types of efficiency measures adopted by businesses, and an industrial self-direction option. A tariff rider mechanism was established to allow the utility to obtain timely cost recovery for approved programs.

Due to a number of factors including the time required to set up new DSM programs, lack of customer awareness initially, and the economic recession, programs ramped up more slowly than expected. RMP reported achieving about 22 GWh per year of net energy savings in 2010, representing just 0.23% of retail sales that year (RMP 2011b). In spite of relatively low energy savings, the portfolio of programs implemented in 2010 had benefit-cost ratios of 3.6 under the Utility Cost test and 2.2 under the TRC test. In addition, the industrial sector provided about 43% of total energy savings in 2010, more than was provided by either the residential or commercial sectors.

In 2010, PacifiCorp proposed a number of revisions to its initial DSM plan including program enhancements, increased rebate levels, and expanded marketing and customer education efforts. The utility also revised its budget and energy savings projections for 2010-2013, and proposed suspending the DSM tariff rider temporarily due to a significant surplus in the DSM balancing account. The Wyoming PSC approved these changes in mid-2011, but total electricity savings declined to only 13.9 GWh per year in 2011 (RMP 2012b). Savings were increasing in early 2012 however as the new and revised programs gained momentum (RMP 2012b). There is timely program cost recovery but no disincentive removal or shareholder incentive mechanism in Wyoming.

In order to ramp up savings and achieve significant net benefits for households and businesses and net addition of 610 jobs in Wyoming by 2020, as indicated in the High Efficiency scenario in this study, SWEEP recommends adoption of the following policies:

1. The Wyoming PSC should adopt energy savings goals as well as policies to remove financial disincentives and provide a positive incentive to investor-owned utilities for implementation of well-performing energy efficiency programs. Regarding energy savings goals, we recommend goals that increase over time reaching 1.0% savings as a fraction of retail sales per year by 2015 and 1.5% per year by the latter part of the decade. Given that utility energy efficiency programs are relatively new and not yet very effective in Wyoming, we suggest goals that are challenging but not as ambitious as those recommended for other states.

2. Utilities and the PSC should strive for maximum customer participation and maximum cost-effective energy savings. Arbitrary caps on funding for cost-effective programs should be avoided. Energy efficiency program portfolios should be expanded to be as comprehensive and effective as possible.

3. The PSC should decouple electricity sales and authorized fixed cost recovery as has been done for Questar Gas Company in Wyoming. In addition, the PSC should adopt performance-based incentives that allow utility shareholders to earn a reasonable profit when the utility implements effective energy efficiency programs for its customers. The level of incentive should be tied to program performance including achieving any energy savings goals that are established.

4. Investor-owned utilities are responsible for providing about 65% of the electricity consumed in Wyoming. All utilities should implement efficiency programs so that

households and businesses throughout the state receive the same (or similar) energy efficiency services as those provided by PacifiCorp. Smaller utilities should focus on the most influential and effective programs given their customer base.

## G. Conclusion

Electric utilities in the Southwest have made considerable progress in implementing well-funded, comprehensive energy efficiency programs for their customers. This progress has been driven in large part by the adoption of state policies including integrated resource planning, minimum energy savings goals or requirements, convenient and timely cost recovery mechanisms, removal of disincentives and/or providing a financial incentive to shareholders for implementing well-performing energy efficiency programs. However, the adoption of these policies throughout the region is incomplete, and in some cases states have adopted weak versions of the policies. This has resulted in utility energy efficiency programs that are not reaching their full cost-effective savings potential.

Achieving 20% energy savings (15% in Wyoming) by 2020 statewide presents a number of challenges, including the need for rapid and large increases in energy efficiency program funding during the remainder of the decade. We believe these challenges can be overcome if adequate and comprehensive policies are put in place. We recommend adopting strong energy savings goals or requirements and policies to ensure that utility shareholders can earn a reasonable profit when they implement effective energy efficiency programs. Furthermore, we recommend extending these policies to all utilities in the state, not just the large investor-owned utilities, and enhancing DSM program portfolios to include the full set of Best Practice programs identified in this report. Doing so will enable all households and businesses in the region to participate in energy efficiency programs, increase services offered and energy savings achieved, and provide the full magnitude of benefits indicated in Chapters 3 and 4.

By implementing Best Practice utility energy efficiency programs throughout the region, we can save households and businesses in the Southwest tens of billions of dollars, make our air cleaner and thereby improve public health, and support over 25,0000 additional jobs in the region by 2020. Utilities can share in these benefits while reducing the risks associated with higher load growth. It's a bonanza the Southwest cannot afford to ignore.

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# Appendix A: Detailed Program Methodologies

## A. Residential Programs

### 1. Low-Income Weatherization

Program savings come from the weatherization of single- and multi-family homes (the former includes manufactured housing) and the distribution of energy savings kits to these residences.

***Participation***

The first step was to estimate the number of eligible homes for the program. Eligible customers are households which are at or below 125% of the federal poverty income threshold for all states except Arizona; in Arizona we assume 150% of the federal poverty income threshold per existing program design in the state. We then estimate the number of homes that could be weatherized over the program period as well as the number of energy savings kits that will be distributed. The baseline data for these variables come from Xcel Colorado's 2010 DSM Annual Status Report (Xcel 2011), which we calculate to be about 2.1% of eligible customers in Xcel's service territory. We then assume that there is a 10% increase in participation in these services every year throughout the analysis period. As a result, the number of homes weatherized increases by a factor of about 2.6 between 2010 and 2020. The number of energy savings kits increases by the same amount.

***Savings per Participant***

The per-participant savings that we assume can be achieved through this program is taken from the performance data reported in Xcel 2011 and is static across the program period. We assume: low-income single-family homes weatherized through this program will save 1,090 kWh annually; low-income multi-family buildings will save 127,167 kWh annually; and distributed energy savings kits will save 359 kWh annually. Peak demand savings are also taken from Xcel 2011. We assume: single-family homes will save 0.09 kW annually; multi-family buildings will save 11.62 kW annually; and that distributed energy savings kits will save 0.02 kW annually.

***Program Costs per Participant***

The utility program management and administrative costs that we assume for this program are taken from Xcel 2011 and are static across the program period. We assume: single-family homes cost $89 per participant; multi-family buildings cost $16,672 per participant; and energy savings kits cost $12 per participant.

The volume of incentives given to participants by utilities is taken from Xcel 2011 and is static across the program period. We assume: incentives for single-family homes are $399 per participant; incentives for multi-family buildings are $7,885 per participant; and incentives for energy savings kits are $21 per participant.

***Participant Costs***

We assume no participant costs for the low-income weatherization program because the vast majority of low-income programs subsidize 100% of the costs of energy efficiency improvements for participants.

### *Net-to-Gross Ratio*

The net-to-gross (NTG) ratio we assume for this program is taken from Rocky Mountain Power's (RMP) 2009 DSM Status Report (RMP 2010). We assume an NTG ratio of 100%.

## 2. Multi-family Retrofit

Program savings come from retrofit of multi-family buildings (other than buildings primarily occupied by low-income families) for which services include initial energy assessment, education on energy savings opportunities, direct installation of low-cost measures, and the opportunity to install major measures at a reduced cost.

### *Participation*

The first step was to determine the number of eligible multi-family households/units in each state (as opposed to buildings) in the state. This data was downloaded from Moody's Economy.com. We then determine the rate, or percentage, of households that would participate in this program. No utilities in the Southwest region currently offer a multi-family retrofit program (any rebates offered for multi-family measures in the region are bundled into programs with single-family measures), so we reference NSTAR's multi-family program in Massachusetts for assumptions on best-practice. We scale NSTAR's participant numbers to their service territory size by multiplying the number of NSTAR residential customers by the percentage of multi-family households in the state, equivalent to a participation rate of 1.5% of multi-family households in 2012. We then ramp up program participation over the next several years, reaching 6% by 2017, which we assume remains static through 2020. In 2012 we estimate the number of participants at around 2,800 multi-family households, which increases to almost 11,000 in 2020. This is equivalent to almost 73,000 multi-family units retrofitted over the time period, or 40% of projected multi-family units in 2020.

### *Savings per Participant*

Participant savings estimates for this program are taken from the performance of NSTAR's multi-family retrofit program for 2010, which average around 290 kW and 800 kWh in savings per participant.

### *Program Costs per Participant*

Program costs are taken from NSTAR's multi-family retrofit program for 2010, which estimated an average of $170 per unit (as opposed to per building). Participant costs per unit are also taken from NSTAR's multi-family retrofit program for 2010, which estimated an average of $15 per unit. Incentive costs per unit are taken from Southern California Edison's (SCE) program in 2006 and adjusted to 2010 dollars using the consumer price index (CPI) deflator.

### *Participant Costs*

We assume participant costs of $15 per participant, which are estimated from NSTAR's 2010 program report for its low-income weatherization program.

***Net-to-Gross Ratio***

The NTG ratio of 80% we assume for this program is taken from the Home Retrofit program, which itself is taken from Rocky Mountain Power's (RMP) 2009 DSM Status Report (RMP 2010). The majority of measures in the Home Retrofit program are similar to those incented in the Multi-family Retrofit program, so we assume the same NTG ratio.

### 3. Residential New Construction and Code Support

This program features training and financial incentives to builders who meet the program's energy-efficiency standards. The program is divided into three tiers: 1) 15% above code; 2) 30% above code; and 3) 50% above code. Participation and savings are also driven in part by utility support for building code compliance and enforcement. In addition, the program supports higher levels of code compliance for new homes not participating in the above code program.

***Baseline Electricity Consumption per Household by Housing Type for New Construction (kWh/HH)***

Our assumptions for average electricity consumption per household by housing type for new construction are based upon the same metric for existing homes, and are specific to each state.[14] For new construction, we increase the estimates for existing homes by the ratio of electricity consumption between new and existing homes in the state of Arizona (19,000/14,000 kWh), the only state for which we were able to obtain data on average household electricity consumption for new construction. This ratio is applied to both single- and multi-family estimates of average household electricity consumption.

***Participation***

First we identified the number of eligible participants, which are the number of annual housing completions by housing type (single and multifamily). This data was downloaded from Economy.com.

Participation rates for Tier 1 and 2 participants in 2009 and 2010 were estimated by dividing actual program results from RMP's Energy Star New Homes program as reported in its 2009 and 2010 DSM status reports by estimated housing statewide completions from Economy.com. Tier 1 participation rates in RMP's program in 2009 and 2010 were 27% and 31% of housing completions statewide. Tier 1 participation is assumed to increase by 3% annually until the introduction of a new building energy code, which we assume occurs in 2014 and 2020. In 2014 and 2020, participation reverts back to 2009 levels, or 27%.

Tier 2 participation rate in RMP's program in 2010 was 2%. Tier 2 participation is also assumed to increase by 3% annually until the introduction of new building energy codes in 2014 and 2020. In 2014 and 2020, participation reverts back to 2010 levels, or 2%.

Tier 3 measures are then introduced in 2014, providing 50% savings above the new code. Since only a small segment will reach this very high performance level, we assume participation starts at

[14] See the methodology for our Home Retrofit program for details on estimates for average electricity consumption in existing homes.

0.5% and increases by 0.5% annually. We do not assume that participation reverts to 2014 levels in 2020.

Utility participation in code support also begins in 2014. We assume that utility efforts lead to 50% compliance in the first year, 75% in the second, and 90% in the third and thereafter, until 2020 when a new code is introduced and participation reverts back to 2014 levels, or 50%.

***Savings per Participant***

Participant savings (kWh) are based upon average household electricity consumption by housing type and the average percent savings above code realized through the installation of measures specific to each Tier. Tier 1 measures are designed to achieve 15% savings above code; Tier 2 measures, 30% above code; and Tier 3 measures, 50% above code. Electricity savings per participant are estimated by multiplying the percent savings by the average household electricity consumption by housing type. The percent savings for Tier 1 and Tier 2 are based on the U.S. Environmental Protection Agency's (EPA) ENERGY STAR New Homes program (15% or more savings) and ENERGY STAR Plus program (30% or more savings). Tier 3 savings are based on tax credits that were available for ENERGY STAR homes that achieved 50% savings above code.

For savings from utility code support, we assume that utilities are given 50% credit for the savings that they generate from code compliance. So when new codes are introduced in 2014 and 2019 that achieve savings of 25% and 50% for end uses covered by building energy codes, utilities get credit for 50% of the those savings for each participant.

***Program Costs per Participant***

We assume that program costs cover the administration of measure installations in all Tiers as well as costs associated with utility code support, such as for training. Administrative costs are assumed to be $452 per participant, which is estimated from data reported for Arizona Public Service's (APS) new construction program in 2010 and is assumed to remain constant over the course of the analysis.

Incentive costs per participant vary by Tier and increase between Tier 1 and Tier 3. Tier 1 and 2 costs are taken from APS's new construction program reported in its 2010 DSM status report, which are $400 and $1000 per participant, respectively. No utilities currently offer incentives for measure installations equivalent to our assumptions for Tier 3 measures, so we assume a similarly scaled increase between Tier 2 and 3 as between Tier 1 and 2, so that Tier 3 incentives are $1,500 per participant. We assume no incentives for utility code support.

***Participant Costs***

We estimate participant costs by taking the difference between the incremental cost of the measure installations and the incentives, by tier. The incremental costs for Tier 1 and 2 are taken from a personal communication with Tom Hines, the program manager for APS's new construction program. He noted that Tier 1 incremental costs are $700 per participant, so that Tier 1 participant costs are $700 less the $400 incentive, or $300. Tier 2 incremental costs are $3,700 per participant, so that Tier 2 participant costs are $3,700 less the $1,000 incentive, or $2,700. There is no utility data upon which to base Tier 3 participant costs, so we assumed a $5,000 incremental cost for Tier

3 measures, so that Tier 3 participant costs are $5,000 less the $1,500 incentive, or $3,500. We assume no participant costs for utility code support.

***Net-to-Gross Ratio***

We assume a NTG ratio of 80%, which is taken from RMP's 2009 DSM status report for its ENERGY STAR New Homes program.

***Average Measure Life***

We assume an average measure life of 20 years, which is taken from APS's 2010 DSM status report for its Residential New Home Construction program.

### 4. Home Retrofit

This program provides a broad framework to deliver incentives for more efficient products and services installed in existing homes (single-family and manufactured housing), bifurcated into "light" and "comprehensive" retrofits. The former focuses on lighting and some home envelope measures, while the latter focuses on deeper retrofits like insulation, window replacement, and HVAC and appliance upgrades.

*Baseline Electricity Consumption per Household by Housing Type for Existing Homes (kWh/HH)*

Our estimates for the average electricity consumption per household by housing type are based on data reported in utility or state energy efficiency potential studies from the Southwest region. All utilities or states, with the exception of Arizona and Nevada, reported data on average electricity consumption by housing type. To determine average consumption by housing type for these two states, we used the average consumption by housing type in New Mexico and Utah, as a fraction of the average consumption of all housing in those states.

***Participation***

At least one utility in each state currently offers a home retrofit program, so our assumptions for participation in this program begin in 2012. We assume participation of 1.2% of eligible households in 2012, which is based on data from Connecticut Light and Power's (CL&P) Home Energy Solutions program in its 2011 DSM plan. We assume participation increases to 1.5% in 2013 and 0.5% annually thereafter, growing to 5% total participation in 2020.

Participation is divided between participants in the "light" and "comprehensive" portions of the program, which we disaggregate by assuming that 75% of participants invest in "light" retrofit measures and 25% invest in "comprehensive" measures. The breakdown between "light" and "comprehensive" is taken from RMP's Home Energy Savings program, based on the number and type of measure installations completed in its 2009 DSM status report.

Participants are also broken out by housing type, either single-family or manufactured homes. In each year, estimates of the total number of participants across the two housing types are determined by first multiplying the total number of households in the state for these two housing types by the participation rate (in 2012, 1.2%). These participants are then allocated across the two housing types by multiplying the total number of participants by the ratio of the number of households by housing type to the total number of households statewide across both housing types.

***Savings per Participant***

We do not estimate savings per participant for the home retrofit program; rather, we assume a percent savings for "light" and "comprehensive" measure installations and apply the percent savings to the product of the number of participants by housing type for each tier and the average electricity consumption per household by housing type. We assume installations of "light" retrofit measures save 10% and installations of "comprehensive" retrofit measures save 25%, which we base off data from CL&P's Home Energy Solutions program as reported in its 2011 DSM plan.

***Program Costs per Retrofit***

Due to data availability, we assumed program administrative and incentive costs from a few different sources. Program administrative and incentive costs for "light" retrofit measures are taken from APS's Residential Existing Homes program, as reported in its 2010 DSM status report. We assume $92 per participant for administrative costs and $87 per participant for incentive costs. Both are averages of program costs per participant for "light" retrofit measures in APS's program, weighted by achieved savings for each measure.

Program administrative and incentive costs for "comprehensive" retrofit measures are taken from RMP's Home Energy Savings program in its 2009 DSM status report. RMP breaks out program costs and savings between appliances, shell measures, HVAC, and lighting. We assume costs associated with the first three are associated with "comprehensive" retrofit measures while costs for lighting measures reflect "light" retrofit measures. We assume $34 per participant for administrative costs and $238 for incentive costs. Both are the quotient of the program and incentive costs for all "comprehensive" retrofit measures from RMP's program and the number of participants that installed these measures.

***Participant Costs***

Participant costs for "light" and "comprehensive" retrofit measures are taken from RMP's 2009 DSM status report. We assume per participant costs of $28 for "light" retrofit measures and $244 for "comprehensive" retrofit measures. Both are the quotient of the participant costs for each category of measures and the number of participants that installed these measures.

***Net-to-Gross Ratio***

We assume an NTG ratio of 80%, which is taken from RMP's 2009 DSM status report.

***Average Measure Life***

We assume a weighted average of measure lives based on the contribution to overall savings from each end-use measure, from RMP's 2009 DSM status report.

### 5. Retail Products

The program pursues the objective of continuing to build awareness, customer acceptance and market share of ENERGY STAR consumer electronics (televisions, PCs and monitors) and appliances (refrigerators, clothes washers, dishwashers and room AC units). For Arizona and Nevada we also add pool pumps and timers to the list of eligible products. The program provides upstream incentives to retailers for increasing sales of qualifying ENERGY STAR customer electronics and appliances.

Arizona, Colorado and Nevada are the only states in the Southwest with utilities that currently partner with retailers to increase upstream sales of efficiency electronics, appliances and pool products. So program costs and savings for 2010 and 2011 for these three states are taken from utility DSM status reports and plans. For the remaining three states, estimates of costs and savings begin in 2012.

***Participation***

For this program, we define participation as the number of units sold through a program divided by the volume of statewide sales for a particular product, except for appliances (see methodology for estimating statewide product sales below). Participation in 2010 and 2011 for these three states is derived from data reported in their 2010 DSM status reports and DSM plans. For the remaining three states, we assume that the program, and savings, begins in 2012.

Participation rates between 2012 and 2014 are estimated from sales projections reported in Nevada Power's 2010-2012 DSM plan for its Consumer Electronics and Plug Loads program, so that sales projections for 2010-2012 are assumed for 2012-2014. Sales projections from Nevada Power are then divided by the volume of statewide sales for a particular product, based on statewide sales of these products in Utah. For televisions, participation begins at 5% in 2012, ramps up to 18% in 2013 and 2014, 20% in 2015, and climbs steadily to 70% by 2020. For PCs, participation begins at 7% in 2012, 7.9% in 2013 and 2014, 10% in 2015, and climbs steadily to 50% by 2020. For monitors, participation begins at 3%, ramps up to 8% in 2013 and 2014, 10% in 2015, and climbs steadily to 50% by 2020.

For appliances, participation is based on the number of appliances sold through RMP's Home Energy Savings program, which is scaled to statewide by dividing by the number of RMP customers, which yields 5% in 2012 and we assume remains static through 2020. We assume that theses participation rates for consumer electronics and appliances also remain static through 2012 across all states.

***Annual Statewide Sales of Eligible Products***

Estimates of annual product sales were made using saturation data from the EIA's Residential Energy Consumption Survey (RECS) for the Mountain Census Division, with the exception of Utah and Wyoming, for which PacifiCorp conducted a residential measure saturation survey to determine state-specific saturation of products in its energy efficiency potential study.

For Utah and Wyoming, PacifiCorp reported data on product saturation, as a percentage, by state and by housing type. To estimate annual products sales, we first assume that products are replaced on burnout (at the end of the measure life). Annual sales are then equal to the product of the number of households by housing type and the respective saturation of a specific measure, which is then multiplied by the inverse of the measure life to determine how many units of that measure are being sold (replaced) annually.

For the remaining states, the methodology is the same, except that product saturation was calculated using data from RECS, which is not necessarily state-specific (RECS reports state-specific data for AZ and CO, but not for the remaining states in the Mountain region) and does not disaggregate by housing type. RECS reports product saturation data in absolute terms, so percentages were estimated by dividing the number of households in a region by the number of existing products in that region. We then multiply that percentage by the number of households in the state and the inverse of the measure life, as we did above.

***Number of Efficient Retail Products Sold***

To estimate the number of efficient retail products sold through the program, we multiply the participation rate by the respective annual product sales.

***Savings per Unit***

Product savings per unit were estimated using a variety of sources. For those products subject to federal appliance and equipment standards (televisions, refrigerators, clothes washers, dishwashers and room AC units), per unit savings were adjusted to take into account future updates to federal standards as issued by the U.S. DOE.

Per unit savings for televisions is an average calculated from the current ENERGY STAR standard, which varies as a function of screen size. We assume savings of 168 kWh per television. Per unit savings for appliances are estimated by taking the difference between existing ENERGY STAR appliance standards and the existing federal standards as reported by the U.S. DOE in its technical support documents. We assume savings of 130 kWh per refrigerator; 244 kWh per clothes washer (includes savings from machine and water heating); 24 kWh per dishwasher (machine savings only); and 110 kWh per room air conditioning unit.

Per unit savings for personal computers and computer monitors were taken from Nevada Power's 2010-2012 DSM plan, referencing its consumer electronics program, and estimated by dividing the total projected savings of the program for a particular measure and dividing by the number of units projected to be sold through the program.

For Arizona and Nevada, we added pool pumps and timers as eligible measures, though our assumption for the efficient upgrade is different between Arizona and Nevada because Arizona has passed its own efficiency standard for pool pumps, which will require dual-speed motors as the baseline product beginning in 2012 (the baseline is currently single-speed motors). So we assume the efficient upgrade in Nevada is a dual-speed motor while the upgrade in Arizona, beginning in 2012, is a variable speed motor. Per unit savings for pool pumps was taken from a CEE report on its residential swimming pool initiative (CEE 2011). In Arizona, pool pump savings will drop from 1,400 kWh per unit prior to 2012 to 450 kWh per unit when the state standard becomes effective in 2012. In Nevada we assume the savings remain static at 1,400 kWh per unit over the analysis period. Per unit savings for timers was taken from APS market potential study (ICF 2007), which we assume are 873 kWh per unit.

***Program Costs***

Program administrative and incentive costs for consumer electronics (televisions, PCs and monitors) were taken from Nevada Power's 2010-2012 DSM plan for its Consumer Electronics and Plug Loads program. We assume per unit administrative costs of $7 and incentives of $6.50 per unit. Program administrative and incentives costs for appliances were taken from Xcel Colorado's 2010 DSM status report for its ENERGY STAR Retailer Incentive program. We assume per unit administrative costs of $21 and incentives of $7.50 per unit.

For pool pumps and timers, we do not estimate administrative and incentives costs as this data was not available. Rather, total program costs (administrative plus incentives) are a function of the estimated energy savings and the total program cost per kWh as reported by utilities in the two states. For Arizona, we calculated the total program cost per kWh using cost and savings data reported by APS in its 2010 DSM status report for its Consumer Products program, which provides rebates for CFLs, pool pumps (motors) and timers. For Nevada, we calculated the total program cost per kWh using cost and savings data reported by Nevada Power Company in its 2010 DSM status report for its Pool Pumps program. To calculate total program costs for these products, we multiply the estimated cost per kWh by the estimated program savings.

***Participant Costs***

Participant costs for appliances are taken from the Massachusetts Joint Statewide Three-Year Electric Efficiency Plan, which includes plans for NSTAR, NGRID, and Unitil. We derived participant costs for appliances from the Massachusetts plan, which we assume are $32 per unit. We estimate participant costs for the consumer electronics component of the program by multiplying the costs for the appliances component by the ratio of incentive costs for consumer electronics to appliances, which is about 46%, or about $15.

Participant costs for pool pumps and timers vary between Arizona and Nevada because Arizona has set its own standards for pool pumps/motors. For both states, we assume an incremental cost of $182 for an upgrade from a single to a dual-speed motor, which, less a $100 rebate (as featured in CEE's initiative), amounts to $82 per unit in participant costs (incentives for pool pumps and timers are rolled into the estimated cost per kWh we discussed above). For Arizona, this is only applicable in 2010 and 2011. In 2012, the Arizona standard will require dual-speed motors as the baseline, for which the upgrade to a variable-speed motor entails a higher incremental cost. In Arizona, beginning in 2012, the incremental cost of the upgrade increases to $400, less a $270 rebate, as reported by APS in its 2010 DSM status report, for a participant cost per unit of $130.

***Net-to-Gross Ratio***

We assume an NTG ratio of 80%, taken from RMP's 2009 DSM status report for the appliance measures in its Home Energy Savings program.

***Average Measure Life***

We assume an average measure life of 14 years, taken from RMP's 2009 DSM status report for the appliance measures in its Home Energy Savings program.

### 6. Residential Lighting

This program provides resources for customers to purchase energy-efficient light bulbs, including rebates for standard and next-generation CFLs and LEDs, and to dispose of them in an environmentally friendly manner.

All six states in the Southwest region currently offer rebates for lighting upgrades, either as an autonomous lighting program or as part of a home retrofit program. We therefore report program costs and savings in 2010 and 2011 as reported in utility DSM status reports and DSM plans. For 2012 on, we assume that utilities offer an autonomous residential lighting program. Nevada is currently the only state whose utilities offer rebates for LEDs.

Despite Nevada having passed legislation allowing it to adopt its own lighting standard, the prevailing notion in the state is that it will not follow through with its commitment. Therefore our assumptions for this program are predominantly the same for all six states in the region.

***Units Installed***

Unit installations of CFLs and LEDs for 2010 and 2011 are taken from utility DSM status reports and DSM plans. For CFLs, in 2012 we assume that utilities issue one CFL per household in the state. This volume remains static until 2015, when the last round of standards lowering the maximum allowable wattage of general service incandescent lamps becomes effective, which will impact sales of certain wattages of CFLs. Starting in 2015 we assume sales of CFLs drop by 50% biennially through 2020, albeit not to zero, as sales shift towards LEDs and more next-generation CFLs.

For LEDs, unit installations are determined by multiplying the participation rate (see methodology discussion next) by the number of households in the state, which ultimately ramps up to 2 LEDs per household by 2019.

***Participation***

For the residential lighting program, the number of unit installations is a function of participation only for LEDs. For CFLs we simply assume an arbitrary decrease in sales of 50% biennially.

Participation is defined as the number of units (LEDs) installed divided by the total number of residential customers. Our assumptions for participation come from projections for Nevada Power's LED program plan for 2011 and 2012, as reported in its 2010-2012 DSM plan. From its DSM plan, we estimate participation of 2.5% in 2010, 2.8% in 2011, and 32% in 2012. We assume these rates apply in the years for which they are reported only for Nevada. In the other five states that do no currently offer rebates for LEDs, we assume the program begins in 2012 with 2.8% participation, ramping up to 32% in 2013 and ultimately to 200% in 2019 and 2020, where we assume the installation of 2 LEDs per household.

***Savings per Unit***

Per unit savings for CFLs are taken from the lighting portion of RMP's Home Energy Savings program as reported in its 2010 DSM status report, by dividing the annual savings by the number of bulbs sold in that year, which we calculated as 35 kWh per bulb. In 2015 we assume savings decrease by 7% to account for halogen incandescent lamps becoming the new baseline, which lowers per unit savings to 32 kWh.[15]

Per unit savings for LEDs are calculated using a number of assumptions. Through 2014, we assume the baseline technology is a 60-W incandescent bulb that is replaced by a 10-W LED. We then assume average usage of 3 hours per day per bulb. Per unit savings is then equivalent to the difference between the kWh consumption of the two bulbs given the usage assumptions. From 2012 to 2014, we assume per unit savings for LEDs of 55 kWh. In 2015 we update the baseline to a 43 W compliant bulb and assume that technological advancements allow the wattage of an equivalent LED to ultimately fall from 10 W in 2015 to 7 W in 2021, dropping 0.5 W annually. As a result, savings drop in 2015 from 55 kWh to 36 kWh, but increase about 0.5 kWh annually for the remainder of the analysis as LED technology improves.

***Program Costs***

Administrative and incentive costs are taken from Xcel CO's Home Lighting program, except for incentive costs assumed for LEDs. Administrative costs are based on cost per kWh of $0.03/kWh calculated from Xcel CO's 2012-2013 DSM plan, which includes only administrative costs and not incentive costs. Administrative costs are calculated by multiplying this cost per kWh, which remains static throughout the analysis, but the estimated program savings in a given year. We assume administrative costs cover both CFLs and LEDs.

Per unit incentive costs for CFLs are also based on Xcel CO's Home Lighting program, using data reported in its 2012-2013 DSM plan. From this data we calculated a per unit incentive of $1.15.

Per unit incentive costs for LEDs are based on market research on Lowe's website (www.lowes.com). We assume a product price of $30, which we use as an incremental cost. We estimate lamp costs drop to $5 by 2020. According to the Regulatory Assistance Project (RAP), incentive costs for LEDs are usually 70% of the incremental cost (RAP 2011), so we multiply the product price by 70% to determine the per unit incentive. We decrease the incentives over time, from 70% in 2012 to 30% in 2019, to take into account wider adoption as a result of technological advancement and customer acceptance. Per unit incentive costs begin at $21 in 2012 and fall to $2 by 2018.

***Participant Costs***

Per unit participant costs for CFLs are also taken from Xcel CO's Home Lighting program. Xcel reports per unit incremental costs for CFLs of $2.73 in its 2012-2013 DSM plan. Assuming a per unit rebate of $1.15, the participant cost is the difference between the incremental cost and the rebate, or $1.58.

[15] Despite the effective date for the last round of federal standards in 2014, experts say it will take a couple of years before inefficient bulbs are phased-out of the market

***Net-to-Gross Ratio***

Our estimates of the NTG ratios differ between CFLs and LEDs. For CFLs, we assume 100% NTG until federal lighting standards take effect in 2012, which lowers NTG to 80%. We assume the NTG continues to fall until 2015, when next-generation CFLs begin to drive up CFL sales.

***Average Measure Life***

We assume an average measure life of 10 years, which is the low-end range for CFLs, taken from the ENERGY STAR calculator for CFLs and based on EPA assumptions about wattage and usage. Over time we increase the average life to reflect a movement away from CFLs and toward greater LED adoption, which has a longer life. By 2020 we assume the average life increases to 19 years.

### 7. Refrigerator and Freezer Recycling

Less-efficient refrigerators and freezers are taken out of use permanently and recycled in an environmentally-responsible manner.

At least one utility in all six states in the Southwest region is currently offering rebates for refrigerator/freezer recycling. Program costs and savings for 2010 and 2011 are therefore taken from utility DSM status reports and DSM plans. For utilities without DSM plans detailing their projections for 2011, we assume 2010 program costs and savings in 2011.

***Units Recycled***

For 2010 and 2011, the number of units recycled is taken from completions and projections reported in utility DSM status reports and DSM plans. From 2012 onward, the number of units recycled is calculated by multiplying the participation rate by the number of households in the state, which is then disaggregated into the number of refrigerators and freezers recycled using the methodologies below.

Utilities in all states but two report the number of refrigerators and/or freezers recycled through the program. Utilities in Nevada and New Mexico only report the total number of units recycled, though Nevada disaggregates program savings between refrigerators and freezers. Xcel CO is the only utility where the program focuses on refrigerators alone. We assume that utilities in Colorado begin offering rebates for freezers in 2012.

For Colorado and New Mexico, we assume that, beginning in 2012, the total number of units recycled is split between refrigerators and freezers using the ratio of recycled units from the Utah analysis, or 80% refrigerators and 20% freezers. For Nevada, we use the ratio of savings between refrigerators and freezers in order to disaggregate the total number of units recycled. For the remaining three states, we assume the same split between refrigerators and freezers from 2012 onward as was reported for 2010.

***Participation Rate***

For 2010-2011, the participation rate is calculated by dividing the total number of units recycled by the number of customers in the utility service territory. In Utah, we calculated a participation rate of 2.2% in 2010 and 2011. For 2012-2020, we assume the same participation rate across all six states, which we take from our Utah analysis. We assume that participation stays static at 2.2% from 2012-2014, but new federal refrigeration standards that become effective in 2015 lower the participation rate by 10%, to around 2.0% annually, which remains static through 2020.

***Savings per Unit***

Per unit savings for refrigerators and freezers come from RMP Utah's 2009 DSM status report, which reported savings of 1,149 kWh per unit for refrigerators and 1,590 kWh per unit for freezers. However, over time, as older, less-efficient units are recycled, per unit savings drop, reflecting the increase in efficiency of the existing stock of refrigerators and freezers. We utilize research from the Association of Home Appliance Manufacturers (AHAM), which has tracked the decline in average consumption (or increase in efficiency) of refrigerators and freezers over the last two decades, to adjust per unit savings over time. Given a measure life of 19 years, we assume that savings drop by the annual percentage change in energy consumption of the units installed 19 years prior, according to the AHAM research. By 2020, we assume that per unit savings for refrigerators and freezers drops to 758 kWh and 1,161 kWh, respectively.

***Program Costs***

Program administrative and incentive costs are taken from utility DSM status reports and DSM plans and, as such, are specific to each state. Program administrative costs per unit range from $119 to $169. Program incentive costs per unit range from $27 to $35. We assume that these costs remain static for the entire analysis.

***Participant Costs***

We assume no participant costs for this program because it is a recycling program and does not incent the purchase of new equipment.

***Net-to-Gross Ratio***

We assume different net-to-gross ratios for refrigerators and freezers. Both are taken from RMP Utah's 2009 DSM status report. We assume an NTG of 60% for refrigerators and 58% for freezers.

***Average Measure Life***

We assume an average measure life of 19 years, which is taken from research conducted by the Appliance Standards Awareness Project. Although refrigerators are rated with much lower lifetimes, this average measure life reflects the fact that households are likely to continue to use their refrigerators long after their rated lifetime.

### 8. Residential Cooling

This program provides incentives for the purchase, best-practice installation, tune-ups and proper sizing of high-efficiency central air conditioning (CAC) equipment and evaporative coolers. We analyze costs and savings from three measures: central air conditioning equipment upgrades, tune-ups and proper sizing, and evaporative cooling upgrades.

All states in the Southwest region, with the exception of Wyoming, have utilities that currently offer rebates for residential cooling upgrades. Program costs and savings for 2010 and 2011 are therefore taken from utility DSM status reports and DSM plans. For utilities without DSM plans detailing their cost and savings projections for 2011, we assume 2010 program costs and savings for 2011.

Wyoming's heating load is considerably larger than its cooling load, so we added electric heat pumps (high-efficiency and ductless) to the list of eligible measures for the program in Wyoming. We assume a baseline of a SEER 13 heat pump for high-efficiency heat-pump upgrades, and a baseline of electric resistance (furnace) for ductless heat-pump upgrades.

***Unit Installations***

Unit installations for 2010-2011 come from utility DSM status reports and DSM plans. For 2012-2020, unit installations are the product of the respective participation rate for a measure and the statewide estimate of central air conditioning sales.

For Wyoming, the calculation is the same for heat pumps: unit installations are the product of the respective participation rate for either high-efficiency or ductless heat pumps and the statewide estimate of heat-pump sales. We assume that 50% of homes purchase a high-efficiency central HP system and 50% purchase ductless heat pumps. This is consistent with data reported by RECS on the saturation of central and ductless heat pumps in the Mountain region, which shows saturation in the region of each measure to be about 50%.

***Eligible Customers***

For 2010-2011, the number of eligible customers is equivalent to the product of the total number of customers in the utility service territory and the percent of households that have central air conditioning, either for the utility service territory or across the state, depending on data availability.

Starting in 2012, the number of eligible customers is scaled to statewide, so that it is equivalent to the product of the total number of households in the state and the percent of households statewide that have central air conditioning. Statewide saturation of CAC equipment is from RECS unless there is an existing statewide potential study that reports this data. We used RECS data to estimate statewide saturation of CAC equipment for Arizona, Colorado and Nevada as their potential studies are limited to their service territories. Recent statewide potential studies have been published for New Mexico, Utah and Wyoming.[16]

For our heating measures in Wyoming, the number of eligible customers for 2010-2011 is specific to the RMP service territory only, and is the product of the total number of customers in the RMP service territory and the percent of households that heat with electricity. PacifiCorp's DSM potential study did not include state-specific data on the saturation of electric heating, so we used regional data from RECS for the Mountain North Sub-Division as a measure of this value, which was reported as 20%.

[16] KEMA conducted a potential study for the Xcel CO service territory only. ICF conducted a potential study for Arizona Public Service utility.

Starting in 2012, the number of eligible customers for Wyoming is scaled to statewide, so that it is equivalent to the product of the total number of households in the state and the percent of households statewide that heat with electricity, or 20%, as reported by RECS for the Mountain North Sub-Division.

***Estimate of Statewide Annual Equipment Sales***

We estimate annual equipment sales by assuming that households replace their CAC and heating equipment upon burnout at the end of the average measure life, so that units are being replaced annually at a rate of 1/x, where "x" is the average measure life.

***Participation Rate***

For 2010-2011, participation is defined as the number of measure installations divided by the volume of equipment sales, except for the tune-ups/proper sizing measure where the number of installations is divided by the total number of customers with CAC in the service territory. The measures for which rebates for cooling equipment are offered through an autonomous cooling program differ across states. Utah and Wyoming are the only states that provide rebates for the three cooling measures we include. Arizona and Nevada only provide rebates for CAC upgrades and tune-ups/proper sizing. Colorado provides rebates for CAC and evaporative cooling upgrades, but terminated its tune-up measure for an indefinite period starting in 2010, focusing instead on quality installation. New Mexico only provides rebates for evaporative cooling equipment.[17]

For 2012-2020, we assume that the annual participation rates for each measure are the same across all six states. Rates for CAC and evaporative equipment upgrades in 2012-2013 are taken from Xcel CO's 2012-2013 DSM plan for its High-Efficiency Air Conditioning program and its Evaporative Cooling program, which we estimate by dividing the number of unit installations by the number of households in Xcel CO's service territory that have CAC. We then assume an annual increase in participation of 4% for CAC upgrades and 2% for evaporative cooling upgrades, which grow to 35% and 30% of annual sales in 2020, respectively. Rates for tune-ups/proper sizing were derived from program installations in RMP Utah's Cool Cash program, which we estimated at 0.2% in 2010. We assume an annual increase in participation of 0.1% so that participation reaches 1.2% of all customers with CAC in 2020.

For the two heating measures in Wyoming, we assume the same annual rates as our CAC upgrade measure, but split in half between high-efficiency and ductless heat pumps. Therefore, participation in each of the two measures reaches about 18% of electric heating equipment sales per year in 2020.

***Savings per Unit***

Per unit savings for the three cooling measures varies widely across the six states because of differences in climate. First, we assume a baseline of a SEER 13 CAC unit for the two equipment measures and a baseline of no tune-up for the tune-up/proper sizing measure. The efficient

[17] Southwestern Public Service Company provides rebates for CAC upgrades through its Home Energy Services program.

upgrade for the CAC upgrade is a SEER 15 CAC unit and a central evaporative cooling system for the evaporative cooling upgrade.

The vast majority of assumptions for per unit savings are state-specific, taken either from utility DSM status reports, DSM plans, or efficiency potential studies. We were unable to determine state-specific per unit savings in New Mexico for the CAC upgrade and tune-up/proper sizing measures, so we adjusted the per unit savings for these measures in Arizona by the ratio of per unit savings for evaporative coolers between the two states. We were also unable to determine state-specific per unit savings in Nevada for the evaporative cooling measure, so we adjusted the per unit savings for this measure in Arizona by the ratio of cooling degree days between the two states, as reported by the National Climatic Data Center at the National Oceanographic and Atmospheric Association.

Per unit savings for the two heating measures in Wyoming come from different sources. First, for high-efficiency heat pumps, we assume a baseline of a SEER 13 heat pump. Per unit savings are taken from PacifiCorp's DSM potential study and are state-specific. PacifiCorp did not report per unit savings for upgrading from a SEER 13 to a SEER 15, so we took the average per unit savings between a SEER 13 to SEER 14 upgrade and a SEER 13 to SEER 16 upgrade, which we estimate at 1,279 kWh. For ductless heat pumps, we first assume a baseline of electric resistance heating (furnace). Per unit savings are taken from the Northwest Energy Efficiency Alliance's (NEEA) Northwest Ductless Heat Pump Initiative, which reports per unit savings for various climate regions. We assume per unit savings for regions with greater than 7,000 heating degree days, which NEEA reports as 4,796 kWh.

***Program Costs***

Program administrative and incentive costs for CAC and evaporative cooling upgrades are taken from Xcel CO's 2012-2013 DSM plan, using data projected for its 2012 program year. For CAC upgrades, we assume administrative costs of $359 per unit and incentive costs of $450 per unit, which includes a $350 rebate for SEER 15 replacement and $100 rebate to contractors for quality installation. For evaporative cooling upgrades, we assume administrative costs of $173 per unit and incentive costs of $358 per unit. Program administrative and incentive costs for the tune-ups/proper sizing measure are taken from RMP Utah's 2009 DSM status report. We assume administrative costs of $12 per unit and incentive costs of $144 per unit. We assume these costs are static throughout the entire analysis period.

For the two heating measures in Wyoming, we assume that program administrative costs are the same as for the CAC upgrades. Incentive costs for the high-efficiency heat pump measure are also assumed to be the same as the CAC upgrade. Incentive costs for ductless heat pumps differ, however, which we take from NEEA's ductless heat pump initiative. According to NEEE's heat pump program evaluation, rebates are set at 38% of the incremental costs. Market research on Home Depot's website (www.homedepot.com) revealed a range of prices for ductless heat pump systems, so we take the average, which works out to be about $1,100. 38% of this incremental cost is $434, which we assume as the incentive cost.

### *Participant Costs*

We assume that participants only incur costs for the CAC upgrade. Participant costs for tune-ups/proper sizing are negligible and assumed to be rolled into the participant cost for CAC upgrades. For the CAC upgrade, the participant costs is the difference between the incremental cost of the upgrade from SEER 13 to SEER 15, or about $660 as reported in the U.S. DOE technical support document for HVAC, and the $350 customer rebate from above; we do not include the $100 contractor rebate. We estimate participant costs for CAC upgrade of $309 per unit. For evaporative cooling, the incremental cost of an upgrade is less than the incremental cost of the baseline unit, which we base on costs reported in RMP Utah's 2009 DSM status report, so we assume no participant costs for evaporative cooling.

Our assumptions for participant costs for the two heating measures in Wyoming come from different sources. For the high-efficiency heat pump measure, the participant cost is the difference between the average incremental cost from upgrading from a SEER 13 to SEER 14 and SEER 16, as reported in PacifiCorp's DSM potential study, and the customer rebate, which we assume is the same as the CAC upgrade ($350). For the ductless heat pump measure, the participant cost is the difference between the incremental cost from above ($1,100) and the customer rebate ($434), which we estimate at $708 per unit.

### *Net-to-Gross*

Our assumptions for NTG ratios vary between CAC upgrades and evaporative cooling upgrades, and they also change over time to reflect new federal standards for HVAC equipment that become effective in 2015. First, we assume the same NTG ratio for CAC upgrades and tune-ups/proper sizing. We estimate the NTG ratios by taking a weighted average of NTG ratios for CAC measures from RMP Utah's 2009 DSM status report for its Cool Cash program. For evaporative cooling, we again take a weighted average, but here it is a weighted average of evaporative cooling measures as reported in RMP Utah's 2009 DSM status report for its Cool Cash program. NTG ratios for CAC and evaporative cooling upgrades begin at 50% and 52%, respectively, increase to 85% and 87% when the new federal HVAC standards become effective, and then gradually decline over time, falling to 75% and 77% by 2020.

We assume the same NTG ratio for both of the heating measures in Wyoming. The saturation of heat pumps is very low in Wyoming, so we assume an NTG of 90%. In 2015 we assume the NTG begins to fall as program awareness increases, falling to 77% by 2020.

### *Average Measure Life*

We assume an average measure life of 15 years for all cooling and heating measures, taken from RMP Utah's 2009 DSM status report.

## 9. Water Heating

This program provides incentives for the purchase of ENERGY STAR qualified electric heat pump water heaters (minimum EF = 2.0), as well as the installation of water savings measures such as faucet aerators and low-flow showerheads.

Currently, only Xcel CO is offering autonomous programs focusing on rebates for efficient water heaters and related products. Therefore, 2010 & 2011 program costs and savings for Colorado are taken from its 2010 DSM status report and 2011 DSM plan. We assume this program begins in 2012 for the remaining five states.

***Potential Number of Participating Households / Measure Replacements***

To determine the potential number of participating households for the three measures, first we had to estimate the percentage of households in the state that use electricity for water heating. State-specific data was not available from state/utility potential studies, IRPs, etc., so we used regional data from RECS to estimate the saturation of electric water heating. Saturation for five of the six states fell in the range of 16%-25%, while 52% of households in Arizona use electricity for their water heating. So the total number of households that use electricity for water heating is the product of the total number of households in the state and the percentage of households that use electricity for water heating.

Next we had to determine the percentage of households that have already installed the energy efficiency measures. We found state-specific data on saturation of showerheads and faucet aerators for only three states: Colorado, Utah and Wyoming. For the three remaining states, we assume the same saturation of these measures as in Utah (35%). Review of DSM potential studies and interviews with residential program managers revealed that the saturation of heat pump water heaters in the Southwest region is close to zero in all six states. Therefore, we assume that there is 0% saturation of heat pumps for all six states in the Southwest region.

Finally, we calculate the potential number of participating households, which can also be thought of as the potential number of equipment replacements. To calculate this for showerheads and faucet aerators, we first multiply the total number of households in the state that use electricity for water heating by the percentage of incomplete installations of the two efficient measures (or 1 minus the percent saturation). This is the number of households in which we can replace the measures. Then we have to calculate the total number of showerheads and faucet aerators that can be replaced, which is dependent upon the number of bathrooms and kitchens in each home. We use housing characteristics data from RECS that report the percent of homes with 1, 2, and 3+ full and half bathrooms and assume one kitchen per household. For showerheads, we multiply the number of participating households by the percent of homes that have 1, 2, and 3+ full bathrooms and sum those numbers. For faucet aerators, we again multiply the number of participating households by the percent of homes that have 1, 2, and 3+ full and half bathrooms, add in the number of kitchens (which is equivalent to the number of participating households) and sum those numbers.[18]

For heat pump water heaters, this is the product of the total number of households in the state that use electricity for water heating and the percent of incomplete installations of heat pump water heaters (or 1 minus the saturation of heat pump water heaters). Since we assume 0% saturation of heat pump water heaters, this is equivalent to the number of households in the state that heat with electricity.

[18] We assume that only full bathrooms have a showerhead, while faucet aerators can be replaced in full and half bathrooms, and kitchens.

### *Participation Rate*

We use installation projections from Xcel CO's Water Heating program to determine annual participation rates, which we assume are the same for all six states. Xcel CO reported projections on water heater installations for 2012 and 2013 in its 2012-2013 DSM plan. We divide those projections by the number of households that use electricity for water heating in the Xcel service territory to get program participation, which we estimate at 0.1% and 0.4% in 2012 and 2013, respectively. We then assume 1% participation in 2014 and increase participation annually by 0.5% so that participation ramps up to 4% by 2020. We assume the same annual participation rates for all three measures.

### *Number of Units Replaced*

The number of water heating products replaced is equivalent to the product of the participation rate and the potential number of participating households (HPs) / measure replacements (showerheads and faucet aerators) and the participation rate.

### *Savings per Unit*

State-specific per unit savings data for the three water heating measures was available for four states – Colorado, New Mexico, Utah and Wyoming – which we took from their respective DSM potential studies. For Arizona and Nevada, we utilized per unit savings data from New Mexico and Utah, respectively.

### *Program Costs*

Program administrative and incentive costs for heat pump water heaters and showerheads are taken from Xcel CO's 2011 DSM plan. We assume $249 per unit administrative costs and $450 per unit incentive costs for heat pump water heaters, and $3 per unit administrative costs and $5.50 per unit incentive costs for showerhead, the latter of which represents the incremental cost of the measure, so we assume that the utility subsidizes the full cost. Program incentive costs for faucet aerators are taken from PacifiCorp's DSM potential study, which reports incremental costs of around $0.50 per unit. We assume that the utility subsidizes the full cost of the aerator because of the low cost.

### *Participant Costs*

Because of the low incremental costs of the showerhead and faucet aerator measures, we assume participant costs only for heat pump water heaters. The participant cost is the difference between the incremental cost of the product and the rebate. Xcel CO reports incremental costs for heat pump water heaters of $1,150 in its 2012-2013 DSM plan. With a $450 rebate, participant costs amount to $700 per unit.

### *Net-to-Gross*

We assume a net-to-gross ratio of 80%, as reported in RMP's 2009 DSM status report for its Home Energy Savings program for appliances, which includes water heaters.

### *Average Measure Life*

We assume an average measure life of 13 years for heat pump water heaters, which is from the U.S. DOE technical support document for water heaters, specifically electric storage water heaters.

### 10. Home Energy Reports and Information Feedback

There are two components/measures in this program: enhanced billing and information feedback/in-home displays. An enhanced billing program helps customers manage their energy use by providing detailed paper reports on end-use consumption, with comparisons to consumption patterns of similar households, as well as suggesting actions households can take to reduce energy use. The program evolves to include rebates for in-home displays/real-time feedback, where utilities subsidize the installation of home energy monitors/displays.

Currently there are no utilities in any of the six Southwestern states that are offering this type of a program to their customers. We assume that the program begins in 2012 and that utilities target all residential households.

***Participation Rate***

Because there were no program results in the Southwest to reference, our annual participation rates and ramp-up rates are loosely based on program results from elsewhere, but designed so that participants slowly transfer from enhanced billing so that total participation in 2018-2020 is 100%. We assume the enhanced billing measure begins in 2012 starting at 5% annual participation and ramping up to 90% participation in 2018, after which it gradually falls to 80% in 2020. We assume that the information feedback measure begins in 2013, starting at 1% annual participation and ramping up to 10% in 2018 and 20% participation in 2020.

***Total Number of Participants***

The total number of participants in the enhanced billing measure is the product of the total number of households in the state and the participation rate. The total number of participants in the information feedback measure is also the product of the total number of households in the state and the participation rate. However, for the purposes of estimating program and participant costs, we also have to calculate the number of *incremental* participants in the information feedback measure, which is the difference in the number of participants between two given years. We discuss the need for this additional estimate in our program cost methodology discussion below.

***Average Electricity Consumption per Household***

Savings for this program is based on the statewide average electricity consumption per household, which is an average of consumption in all housing types.

***Savings per Unit***

Per unit savings is calculated by assuming a percent savings for the two components/measures and multiplying that percent savings by the average electricity consumption per household. As a result, per unit savings varies across the six states. We assume that enhanced billing generates 1.9% savings per household, while information feedback/in-home displays generates 8% per household. Savings for enhanced billing is based on an Environmental Defense Fund analysis of OPOWER program evaluations. Savings for information feedback/in-home displays is based on a 2010 study by the Electric Power Research Institute (EPRI 2010a) on a number of information feedback pilots, which found a range of savings from 5%-10%.

***Program Costs***

For enhanced billing, there are no incentive costs. Program administrative costs are taken from an ACEEE review of OPOWER programs. We assume $10 per participant, which declines over time as participation increases due to economies of scale and more use of information feedback through electronic media (i.e., internet and smart phones), reaching $7 per participant in 2018.

For information feedback/in-home displays, program administrative and incentive costs are taken from the 2010 EPRI study. EPRI reports a $75-$200 program cost over two years, the majority of which is for equipment purchases. We assume a total program cost of $125 per participant: $25 for administrative costs and $100 for incentive costs. The administrative costs are incurred for all participants in this component of the program because we assume that a utility needs to consistently engage the customer in order to ensure their use of the technology so as to maintain the assumed savings rates. Incentive costs, however, are only incurred for new, or incremental, participants, since the incentive is intended to buy down the cost of the in-home display.

***Participant Costs***

We assume that there are no participant costs for the enhanced billing component of this program. For information feedback/in-home displays, we assume $50 cost per participant, which goes towards the purchase of an in-home display. This is taken from the EPRI study, which noted that at least a $25 participant cost would be needed to ensure customer "buy-in" (EPRI 2010a). Because of the average equipment cost of $150, we assume that the participant share of the cost should be higher because utilities will be reluctant to bear a higher portion of the equipment costs.

***Net-to-Gross***

We assume a net-to-gross ratio of 100%. For enhanced billing, customers are unlikely to incorporate behavior changes without persistent engagement on the part of the utility. For information feedback/in-home displays, the high up-front cost of purchasing, installing, and operating the equipment is a considerable barrier such that only a very small percentage of customers will invest in this measure independently.

***Average Measure Life***

For enhanced billing, we assume an average measure life of one year because of the perpetual need for utilities to engage their customers in order to ensure that behavior changes inspired by the program are sustained. The consequence of this assumption is that energy savings do not accumulate: customers will not routinely incorporate these changes without persistent engagement on the part of the utility. For information feedback/in-home displays, we assume a five-year measure life, which represents the life of the in-home display equipment.

## B. Commercial and Industrial Programs

### 1. Commercial New Construction and Building Code Support

***Eligibility and Participation***
To determine eligible customers for this program, we first use projections for new commercial building floorspace in the U.S. through 2020 from EIA's Annual Energy Outlook. We then estimate each state-specific share of projected new construction using state commercial sector employment projections from Moody's economy.com, relative to the same data for the U.S. For participation rates for the incentive program, we examine best practice national programs. National Grid and Northeast Utilities are achieving over 50% participation in Massachusetts, Rhode Island and Connecticut. We assume that utilities in the southwest states can ramp up to this participation level over 5 years. For the code support portion of this program, we estimate that 50% of new buildings are in compliance the first year, 75% the second year, and 90% the third year and thereafter. The latter recognizes that not all buildings will be in compliance and also the fact that a few buildings being built today will meet the new codes. The years before a new code takes effect we estimate 10% of buildings comply with new code voluntarily due to new code and utility technical assistance efforts.

***Participant Savings***
To estimate electricity savings, we first assume a baseline electricity intensity of 12.7 kWh per square foot (sf) for new buildings, which is based on EIA's CBECS data for the most recently built new buildings. For the incentive portion of the program, we estimate an average of 20% savings until the new code takes effect in 2014. After the new code takes effect, all new buildings improve energy efficiency. We estimate an average 25% savings relative to buildings built to meet the previous model energy code, in line with the savings for the ASHRAE 90.1-2010 code. We estimate another round of code changes five years later (i.e., in 2019) with the new code saving an additional 25% and the incentive program targeting 30% savings relative to the lower base. Still, as the code gets more stringent, savings per square foot from the incentive program go down. For the code support portion of the program, we estimate 25% savings from adoption of ASHRAE 90.1-2010, effective 2014 (Liu 2011). We estimate another 25% average savings from ASHRAE 2016 code which we assume each state will adopt effective 2019. We estimate peak demand impacts for the overall program using the ratio of peak (W) savings to electricity (kWh) savings in Southern California Edison's (SCE) 2010 commercial new construction program.

***Costs***
We estimate program costs, including both incentives and marketing/administrative costs, for the incentive program based on data from SCE and Connecticut. For Connecticut we only have total utility cost and assume the SCE ratio of 71% incentives, 29% administration and marketing applies. We estimate that costs increase on the order of 25% by 2015. For the code support portion, there are no incentives for meeting code. Code compliance efforts will emphasize training and technical assistance. For these costs, we estimate $1 million/year in the years immediately before and after new codes take effect. This is in line with what California utilities have spent in

past years, but since states in the Southwest are smaller, this allows more extensive training and support. We assume $500,000/yr in years between code updates to help maintain compliance rates. To estimate customer costs, we use SCE's estimates that in their program the utility pays 60% of total costs and the customer 40%.

***Net-to-Gross (NTG) Ratio and Measure Lifetime***
Finally, we assume a net-to-gross (NTG) ratio of 80% from SCE and a weighted average lifetime of 14.7 years from National Grid Massachusetts Design 2000 Plus program in 2006.

## 2. Small Business Direct Install

***Eligibility and Participation***
Small commercial and industrial customers are eligible for this program, and we use consumption of 250,000 kWh/yr (i.e., around 200 kW in peak demand) as a ceiling for eligibility. The average commercial building in the Mountain states uses 15.4 kWh/sf based on the 2003 CBECS data (EIA 2008b), which means an average building size of approximately 16,200 sf. About 83% of Mountain state buildings are below this threshold (EIA 2008b). Data for total number of existing statewide C&I customers are from EIA Electricity Annual for 2009, and we assume that 83% of these are eligible for the program. To project eligible customers through 2020, we develop a customer growth rate per Moody's economy.com employment forecast; however we assume only 50% of the growth rate because we estimate that half of new construction customers will be affected by the new construction/code support program. We start with existing participation rates if a program is currently offered in a state, and based on participation results from best practice programs we estimate that utilities can reasonably ramp up to about 3% participation per year by 2014.

In 2010, for example, SCE completed 24,642 jobs, Massachusetts utilities completed 5,000 jobs and Connecticut utilities completed 1,816 jobs. Based on these results we estimate that states in the Southwest ramping up to about 3% participation or 3000 jobs/year by 2014 is reasonable. Also, Arizona Public Service (APS) is achieving savings of 32 GWh in its first year of the program, which is consistent with our estimates for participation in 2013 and a more modest effort in 2012.

***Participant Savings***
For electricity savings per participant, we estimate 14,297 kWh per participant by taking the average of results for 2010 from SCE, Massachusetts and Connecticut utilities. SCE emphasizes smaller customers while the New England utilities serve larger customers. We estimate peak demand impacts of 2.8 kW per participant by multiplying the electricity savings by the SCE program's ratio of summer peak savings to kWh savings in 2010.

***Costs***
We estimate program costs (including incentives and administrative costs) of $5,539 per participant by taking the average of costs for 2010 from SCE, Massachusetts and Connecticut utilities. For SCE in 2010, administrative costs accounted for 8% of total costs, with the remainder for direct material and installation costs. This is largely a contractor-run program, so installation

costs include contractor administration. We estimate customer costs using estimates that Massachusetts and Connecticut utilities pay about 70% of the costs and customers pay about 30%.

***Net-to-Gross (NTG) Ratio and Measure Lifetime***

We assume a net-to-gross ratio of 98.5% from the 2008 evaluation of the Connecticut program by PA Consulting Group. SCE estimates 85% based on CPUC estimates. We assume an average measure lifetime of 12.7 years, which is the average for the SCE, Massachusetts and Connecticut programs.

### 3. Custom Retrofits, Process Efficiency, and Self-Direct

***Eligibility and Participation***

Large C&I customers are eligible for this program, and the size threshold can vary depending on the utility. We start with data for total number of existing statewide C&I customers from EIA Electricity Annual for 2009, and we assume that all industrial customers are eligible and all large commercial customers that do not qualify for the small business program are eligible (i.e. 17% of customers). To project eligible customers through 2020, we develop a customer growth rate per Moody's economy.com employment forecast. However, we assume only 50% of the growth rate because we estimate that half of new construction customers will be affected by the new construction/code support program. We assume current participation rates for utilities in the Southwest that are already administering similar programs. For example, we use data from the Rocky Mountain Power (RMP) FinAnswer custom program in Utah and also include self-direct C&I participants. In 2010, 115 customers participated in those programs, which is equivalent to about 0.5% of all eligible customers. We estimate the program can ramp up to levels of about 1% to 1.5% of eligible customers per year. This is similar to Xcel CO's program plans for process efficiency and self-direct, which together reach about 3.7% of their industrial customers alone. Efficiency Vermont plans to reach 300 key customer accounts over two years, which is equivalent to about 0.6% of total C&I customers in the state. This would be equivalent to Utah, for example, reaching nearly 800 key customer accounts over two years.

***Participant Savings***

For electricity savings estimates, we use actual results if a utility in the state is currently running a program. In 2010, the RMP FinAnswer custom program in Utah achieved about 415,000 kWh per commercial customer and about 700,000 per industrial customer. These participant savings are a weighted average of regular customers and self-direct customers. For 2012 and beyond, we adjust savings downward to account for pending federal efficiency savings. The adjusted savings are consistent with savings per participant that Xcel Colorado expects to achieve in 2012-2013 from its large C&I programs (including process, custom, and self-direct). To estimate peak demand savings we assume a peak savings factor of 0.17 W/kWh based on Xcel Colorado's large industrial and self-direct programs.

***Costs***

We estimate program costs based on current costs from the RMP programs ($0.16 per first-year kWh), which includes both incentives and administrative costs. We estimate that the program's costs can drop somewhat (to $0.14 per first-year kWh) in the near-term to the levels that APS is achieving in Arizona for its Large Existing Facilities program (APS is spending $0.12 per kWh, but that includes prescriptive rebates which are a bit less expensive, so we estimate $0.14 per kWh). We assume that costs then ramp up a bit (to $0.16 per kWh) as the program goes after more customers and federal standards make up for some of the more cost-effective savings. These costs are consistent with levels of Xcel Colorado's Custom, Process and Self-direct programs which are estimated to cost $0.16 per net kWh in 2012. We assume that customer costs are equivalent to program costs for this program.

***Net-to-Gross (NTG) Ratio and Measure Lifetime***

Finally, we assume a net-to-gross ratio of 80% and an average measure lifetime of 15 years based on PacifiCorp programs in Utah.

### 4. Computer Efficiency and other Plug Loads

***Eligibility and Participation***

This program provides upstream incentives to computer and server manufacturers that produce and sell higher efficiency PCs, monitors and servers to business customers, and it also includes desktop virtualization with direct rebates to business customers. All commercial customers are eligible for this program, and we estimate number of commercial customers based on statewide data from EIA Electricity Annual for 2009. To project eligible customers through 2020, we develop a customer growth rate per Moody's economy.com employment forecast. Participation rates are based on Xcel Energy's 2012-2013 plan for its Computer Efficiency program, which plans to reach 2700-2800 participants (1.7-1.8% of commercial customers) each year over the first 2 years of the program. We estimate that the participation rate increases to 3% by 2020.

***Participant Savings***

Electricity savings per participant are based on Xcel Energy's 2012-2013 plan for its Computer Efficiency program, and adjusted to gross savings of 2,880 kWh per participant (Xcel 2011c). By 2016, we assume that the program also goes after no-cost and low-cost behavioral solutions to reducing plug load consumption, which can save 20-40% of electricity usage by plug loads according to a study by ECOS (ECOS Consulting 2011). We estimate savings per participant of 7,000 kWh. Peak demand participant savings are also based on the Xcel Energy program plan, and adjusted to gross savings of 450 Watts per participant.

***Costs***

We estimate program costs of $180 per participant, or $0.07 per first-year kWh, based on Xcel Colorado's plan for 2012-2013. This includes both incentives and administrative costs. We estimate participant costs ($132 per participant or $0.05 per first-year kWh) based on Xcel's 2012-2013 plan for its Computer Efficiency program, which assumes that rebates to customers/manufacturers are on average 54% of incremental costs and the customer pays the remaining 46%.

***Net-to-Gross (NTG) Ratio and Measure Lifetime***
We assume a net-to-gross ratio of 90%, which is an average of two values used by Xcel Energy for its Computer Efficiency program: 88% is used for its upstream manufacturer incentives and 92% is used for its desktop virtualization program. Xcel notes, however, that other utilities around the country are using a NTG ratio of 100% for their upstream manufacturer incentive program. Finally, we assume an average measure lifetime of 7 years based on estimates by Xcel Energy.

### 5. Prescriptive Rebates and Upstream Incentives

***Eligibility and Participation***
All commercial and industrial customers are eligible for this program, which offers incentives to replace or install new high-efficiency equipment and also includes upstream incentives to equipment distributors for selected products. We start with data for the total number of existing statewide C&I customers from EIA Electricity Annual for 2009. To project eligible customers through 2020, we develop a customer growth rate per Moody's economy.com employment forecast; however, we assume only 50% of the growth rate because we estimate that half of new construction customers will be affected by the new construction/code support program. For participation rates, we use current program results if a utility is operating a program in the state. The Rocky Mountain Power (RMP) FinAnswer Express Program reached 577 and 846 customers in 2009 and 2010, respectively. This is equivalent to about 0.5% of commercial customers alone and 1% of industrial customers on average, or 0.6% of total eligible customers. We estimate that participation rates can ramp up to 2-3% of customers per year from 2014 through 2020. Efficiency Vermont (EVT), for example, reached about 2-3% of all electric C&I customers in Vermont from 2009-2010 for its C&I equipment replacement program.

***Participant Savings***
For electricity savings, we use kWh saved per customer from RMP's prescriptive rebate programs for commercial and industrial customers. In 2010, savings were on average 38,000 kWh for commercial customers and 68,000 kWh for industrial customers. We assume that average savings decrease by 10% in 2012 due to pending federal efficiency standards for commercial equipment. For peak demand impacts, we assume savings are coincident with peak demand (peak demand factor assumed is 0.21 from Pacificorp IRP).

***Costs***
Program cost estimates include both incentives and administrative/operating costs, based on 2009 and 2010 costs from RMP's program in Utah. For 2011-2013 we assume $0.12 per first-year kWh, which is the average of RMP's 2009 and 2010 commercial programs, and also consistent with APS' 2012 plan. We then assume a ramp-up of 1st-year kWh as utilities go after harder savings and higher participation (e.g. in 2010 EVT equipment replacement programs were about $0.24/first year kWh and Xcel Energy plans for 2012 and 2013 programs are $0.18-$0.19/kWh, but these

programs may pursue different levels of customer costs). Customer cost estimates of $0.27 per first-year kWh are based on actual customer costs incurred in the RMP program, based on project close-out documentation (invoices), less any adjustments if necessary for baseline equipment.

***Net-to-Gross (NTG) Ratio and Measure Lifetime***

Finally, we assume a net-to-gross ratio of 80% from the RMP program and an average measure life of 13 years, which is the assumption of the RMP and Efficiency Vermont C&I equipment replacement programs.

### 6. Commercial Lighting Redesign

***Eligibility and Participation***

Commercial customers in existing buildings are eligible for this program, which provides incentives to building property managers and some equipment contractors to design and install high-efficiency, integrative design elements into newly built-out commercial space. We estimate eligible commercial building square footage in each state by starting with total commercial floor space estimates by census region from the *2011 Annual Energy Outlook* by EIA. We apportion statewide estimates from the Mountain region estimates using employment data from Moody's Economy.com as a proxy for commercial building floor space. We then assume that buildings are eligible at change of occupancy, which is estimated as every 6 years for offices (NBI 2012) and 10 years for other types. We used 8 years as an average change-over, and assumed that 82% of floorspace is applicable (accounting for office, education, mercantile/service, and warehouse buildings), which is based on data from AEO. For participation rates, we estimate that annual participation ramps from 2% of eligible participants in 2012 to 30% by 2020.

***Participant Savings***

To estimate electricity savings, we estimate typical lighting savings from a tenant lighting redesign. We first develop a baseline usage for lighting by assuming a lighting power density (LPD) of 1.0 W/sf and multiply by 10.3 typical hours of operation per day (for office buildings per ASHRAE 90.1). We then estimate 35% savings from a lighting upgrade in 2012 and 2013; in 2014 and after the state adopts a new building code that is 10% tighter, we estimate that savings drop to 25%. Savings are estimated at 1.32 kWh per sf, and dropping to 0.94 kWh per sf in 2014 and thereafter.

***Costs***

Direct program operator costs are assumed at $0.47 per sf, which is derived from California Title 24 incremental cost estimates of $0.70 per sf for comprehensive lighting projects. We assume that 50% goes toward incentives ($0.35 per sf) and that incentives represent 75% of total program costs (i.e. that additional costs for program administration are $0.12 per sf) We assume that the customer pays for the other 50% of incremental costs of $0.35 per sf.

***Net-to-Gross (NTG) Ratio and Measure Lifetime***

Finally, we estimate a net-to-gross of 80% ratio and an average measure lifetime of 16 years, which is our estimate assuming that the lighting upgrades last for 2 tenancies of 8 years each.

## 7. Retrocommissioning

***Eligibility and Participation***

We assume that large buildings over 100,000 sf are eligible for this program; however, some utilities in the region offer this program to buildings of at least 50,000 sf To estimate the number of eligible customers and participation rates, we start with data for total number of existing statewide C&I customers from EIA Electricity Annual for 2009. To project eligible customers through 2020, we develop a customer growth rate per Moody's economy.com employment forecast by state, however we assume only 50% of the growth rate because we estimate that half of new construction customers will be affected by the new construction/code support program. We then estimate eligibility based on the proportion of commercial buildings over 100,000 sf in the Mountain states per CBECs 2003 (1.3%).For participation rates, we start with actual program experience in states with utilities that are currently operating a program. For example, Rocky Mountain Power (RMP) in Utah had 31 and 14 participants in 2009 and 2010 for its Retrocommissioning program, respectively, which is equivalent to 1.9% and 0.8% of total statewide eligible customers. We estimate a slow but steady ramp-up until two-thirds of customers are reached, then participation slows down with participation capped at 90%.

***Participant Savings***

We estimate electricity savings using actual program results from the RMP program, which achieved savings of about 417,000 kWh per participant over 2009-2010. This is equivalent to about 10% savings in a 300,000 sf building (according to CBECS data that large buildings in the Mountain region use 14.5 kWh/sf We assume that absolute savings gradually decrease 10% per year to reflect smaller buildings gradually entering the program, until actual savings reach 179,700 kWh per participant in 2020. We then estimate peak demand savings by dividing the kWh savings by 3890, which is the ratio of kWh/kW savings in the EIA 2009 database on savings from energy-efficiency programs.

***Costs***

The program costs per participant are estimated at $50,500 per customer, which is the average of RMP programs from 2009-2010. Similar to savings estimates, we that assume that costs gradually decrease 10% per year. We assume that the customer pays the same amount as the utility pays, although some utilities pay 75% of costs and the customer pays 25%.

***Net-to-Gross (NTG) Ratio and Measure Lifetime***

We assume a net-to-gross ratio of 100% per the PacifiCorp/RMP program in Utah. As a comparison, SCE uses 86% NTG for retrocommissioning. We assume an average measure lifetime of 7 years, which is the value now used for Utah and Connecticut programs and is the same as ACEEE's estimate in Thorne and Nadel 2003.

## 8. Combined Heat and Power (CHP)

***Participant Savings***

Estimates for total achievable potential by 2020 were provided by SWEEP, and were derived from technical potential estimates in Pacificorp's DSM potential study by The Cadmus Group. We estimate that 10% of technical potential is achievable. This is based on the mid-range of technical versus achievable estimates prepared in an in-depth study by ICF International for New Jersey. That study found achievable potential was 6.4% of technical in a base case scenario, and 19% with very high incentives of $900/kW. We assume $500/kW incentives. The Cadmus Group study assumes all achievable potential would be installed by 2020, so we assume the savings are reasonable to achieve by 2020. The Cadmus Group study does not include waste-heat-to-power, so we added this separately. We assume an average capacity factor of 70% to calculate electricity output of the achievable potential capacity values. And we estimate incremental annual additions by assuming a linear ramp-up to achieve the achievable potential by 2020. To estimate savings by sector, we assume that 16% of the potential occurs in the commercial sector and 84% in the industrial sector, which is the estimated break-down by sector from the Cadmus Group study. To estimate peak savings, we assume that 95% of the savings are going to be on-peak savings.

***Costs***

For cost estimates, the installed costs assumed to be $1608/kW or $0.24 per first-year kWh, assuming average operating hours of 6833 per year (per data from SWEEP). Additional operating costs (fuel and operations) are assumed to be $0.05 per kWh generated (per data from SWEEP). Program incentives are assumed to be $500 per kW installed, and additional administrative costs are estimated at 20% of the incentives. Finally, we assume a net-to-gross ratio of 100% and an average measure lifetime of 19.6 years, based on weighted averages from the Pacificorp DSM potential study by The Cadmus Group.

# Appendix B: Utility System Modeling: Detailed Results

## A. Southwest Region

**Table B-1. Southwest Region Customer Sales (GWh)**

| | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| Reference Scenario | 227,109 | 254,642 | 284,298 | 313,890 | 343,254 | 2.09% |
| High Efficiency Scenario | 227,109 | 236,027 | 234,469 | 264,062 | 293,426 | 1.29% |
| Difference | 0 | -18,615 | -49,828 | -49,828 | -49,828 | |

**Table B-2. Southwest Region Generation Mix Including Exports (GWh)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| **Reference Scenario** | | | | | | |
| Hydro | 12,294 | 14,898 | 14,898 | 14,898 | 14,898 | 1.02% |
| Nuclear | 31,200 | 32,070 | 32,070 | 32,070 | 32,070 | 0.14% |
| Coal | 187,862 | 183,138 | 170,913 | 149,808 | 127,498 | -2.02% |
| Nat Gas | 79,853 | 97,740 | 119,609 | 155,167 | 201,693 | 5.00% |
| Other | 687 | 707 | 609 | 587 | 540 | -1.26% |
| Exist Renew | 12,043 | 13,632 | 12,452 | 12,514 | 12,566 | 0.22% |
| Biomass | 0 | 350 | 957 | 1,458 | 1,608 | #N/A |
| Solar | 0 | 4,626 | 12,343 | 19,529 | 21,563 | #N/A |
| Wind | 0 | 6,147 | 18,107 | 24,071 | 28,.556 | #N/A |
| **Grand Total** | **323,938** | **353,307** | **381,959** | **410,102** | **440,992** | **1.64%** |
| **High Efficiency Scenario** | | | | | | |
| Hydro | 12,294 | 14,898 | 14,898 | 14,898 | 14,898 | 1.02% |
| Nuclear | 31,200 | 32,070 | 32,070 | 32,070 | 32,070 | 0.14% |
| Coal | 187,862 | 169,035 | 143,779 | 128,379 | 105,207 | -3.01% |
| Nat Gas | 79,853 | 93,003 | 99,716 | 130,536 | 177,974 | 4.31% |
| Other | 687 | 691 | 600 | 634 | 576 | -0.92% |
| Exist Renew | 12,043 | 14,069 | 12,525 | 13,277 | 13,263 | 0.51% |
| Biomass | 0 | 303 | 761 | 1,202 | 1,353 | #N/A |
| Solar | 0 | 4,043 | 9,920 | 16,232 | 18,278 | #N/A |
| Wind | 0 | 5,394 | 15,031 | 20,737 | 25,232 | #N/A |
| **Grand Total** | **323,938** | **333,507** | **329,301** | **357,965** | **388,852** | **0.97%** |

**Table B-3. Southwest Region Capacity Savings – High Efficiency vs. Reference Scenario (MW)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Hydro | 0 | 0 | 0 | 0 | 0 |
| Nuclear | 0 | 0 | 0 | 0 | 0 |
| Coal | 0 | 2,556 | 4,573 | 4,573 | 4,573 |
| Nat Gas | 0 | 450 | 3,472 | 7,351 | 7,351 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Exist Renew | 0 | 0 | 0 | 0 | 0 |
| Biomass | 0 | 8 | 32 | 42 | 42 |
| Solar | 0 | 118 | 491 | 668 | 666 |
| Wind | 0 | 32 | 132 | 143 | 142 |
| **Grand Total** | **0** | **3,164** | **8,700** | **12,776** | **12,953** |

**Table B-4. Southwest Region Emissions Impacts – High Efficiency vs. Reference Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Savings** | | | | | |
| $CO_2$ Emissions | 1000 mT | 14,872 | 31,588 | 27,206 | 28,350 |
| $NO_x$ Emissions | mTons | 7,938 | 5,459 | 7,882 | 7,730 |
| $SO_2$ Emissions | mTons | 8,103 | 16,274 | 13,071 | 13,300 |
| Water Withdrawal | M Gal | 13,002 | 21,516 | 16,707 | 17,573 |
| Water Consumption | M Gal | 9,515 | 18,512 | 14,397 | 15,163 |
| **Savings Percent** | | | | | |
| $CO_2$ Emissions | 1000 mT | 7.2% | 15.5% | 13.9% | 14.8% |
| $NO_x$ Emissions | mTons | 12.3% | 12.0% | 16.5% | 13.9% |
| $SO_2$ Emissions | mTons | 6.6% | 17.0% | 15.6% | 18.6% |
| Water Withdrawal | M Gal | 5.3% | 12.2% | 10.1% | 11.5% |
| Water Consumption | M Gal | 6.4% | 12.9% | 10.8% | 12.3% |

## B. Arizona

**Table B-5. Arizona Customer Sales (GWh)**

| | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| Reference Scenario | 72,833 | 82,308 | 95,424 | 107,566 | 118,323 | 2.59% |
| High Efficiency Scenario | 72,833 | 76,249 | 78,711 | 90,854 | 101,610 | 1.77% |
| Difference | 0 | 6,059 | 16,713 | 16,713 | 16,713 | |

**Table B-6. Arizona Generation Mix Including Exports (GWh)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| **Reference Scenario** | | | | | | |
| Hydro | 6,622 | 7,970 | 7,970 | 7,970 | 7,970 | 0.98% |
| Nuclear | 31,200 | 32,070 | 32,070 | 32,070 | 32,070 | 0.14% |
| Coal | 43,644 | 41,378 | 40,113 | 34,557 | 28,566 | -2.21% |
| Nat Gas | 29,676 | 35,383 | 44,722 | 56,097 | 71,763 | 4.76% |
| Other | 275 | 71 | 64 | 52 | 38 | -9.86% |
| Exist Renew | 319 | 394 | 376 | 367 | 346 | 0.44% |
| Biomass | 0 | 210 | 504 | 860 | 949 | #N/A |
| Solar | 0 | 3,567 | 8,574 | 14,612 | 16,132 | #N/A |
| Wind | 0 | 420 | 1,009 | 1,719 | 1,898 | #N/A |
| **Grand Total** | **111,736** | **121,463** | **135,401** | **148,303** | **159,733** | **1.90%** |
| **High Efficiency Scenario** | | | | | | |
| Hydro | 6,622 | 7,970 | 7,970 | 7,970 | 7,970 | 0.98% |
| Nuclear | 31,200 | 32,070 | 32,070 | 32,070 | 32,070 | 0.14% |
| Coal | 43,644 | 40,321 | 34,389 | 30,912 | 24,524 | -2.99% |
| Nat Gas | 29,676 | 30,446 | 34,461 | 44,591 | 60,653 | 3.83% |
| Other | 275 | 65 | 64 | 67 | 49 | -8.67% |
| Exist Renew | 319 | 379 | 376 | 407 | 380 | 0.93% |
| Biomass | 0 | 189 | 416 | 726 | 816 | #N/A |
| Solar | 0 | 3,208 | 7,065 | 12,348 | 13,878 | #N/A |
| Wind | 0 | 377 | 831 | 1,453 | 1,633 | #N/A |
| **Grand Total** | **111,736** | **115,024** | **117,641** | **130,543** | **141,973** | **1.27%** |

**Table B-7. Arizona Capacity Savings – High Efficiency vs. Reference Scenario (MW)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Hydro | 0 | 0 | 0 | 0 | 0 |
| Nuclear | 0 | 0 | 0 | 0 | 0 |
| Coal | 0 | 0 | 893 | 893 | 893 |
| Nat Gas | 0 | 450 | 1,840 | 3,247 | 3,273 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Exist Renew | 0 | 0 | 0 | 0 | 0 |
| Biomass | 0 | 3 | 14 | 22 | 22 |
| Solar | 0 | 74 | 309 | 464 | 462 |
| Wind | 0 | 2 | 8 | 11 | 11 |
| **Grand Total** | **0** | **529** | **3,064** | **4,637** | **4,661** |

**Table B-8. Arizona Emissions Impacts – High Efficiency vs. Reference Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Savings** | | | | | |
| $CO_2$ Emissions | 1000 mT | 2,994 | 9,585 | 7,806 | 8,064 |
| $NO_x$ Emissions | mTons | 411 | 847 | 48 | 204 |
| $SO_2$ Emissions | mTons | 745 | 6,078 | 4,454 | 4,308 |
| Water Withdrawal | M Gal | 2,115 | 4,991 | 3,210 | 3,565 |
| Water Consumption | M Gal | 1,285 | 4,075 | 2,570 | 2,907 |
| **Savings Percent** | | | | | |
| $CO_2$ Emissions | 1000 mT | 5.4% | 16.6% | 13.8% | 14.3% |
| $NO_x$ Emissions | mTons | 4.0% | 10.3% | 0.7% | 3.5% |
| $SO_2$ Emissions | mTons | 2.6% | 22.5% | 19.1% | 22.4% |
| Water Withdrawal | M Gal | 2.3% | 7.2% | 4.8% | 5.5% |
| Water Consumption | M Gal | 2.5% | 8.0% | 5.3% | 6.3% |

## C. Colorado

Table B-9. Colorado Customer Sales (GWh)

| | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| Reference Scenario | 52,918 | 57,634 | 63,033 | 68,735 | 74,757 | 1.84% |
| High Efficiency Scenario | 52,918 | 53,261 | 51,538 | 57,241 | 63,262 | 0.94% |
| Difference | 0 | 4,373 | 11,495 | 11,495 | 11,495 | |

Table B-10. Colorado Generation Mix Including Exports (GWh)

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| **Reference Scenario** | | | | | | |
| Hydro | 1,578 | 2,117 | 2,117 | 2,117 | 2,117 | 1.56% |
| Nuclear | 0 | 0 | 0 | 0 | 0 | #N/A |
| Coal | 34,559 | 31,246 | 26,588 | 22,686 | 17,925 | -3.40% |
| Nat Gas | 11,062 | 15,552 | 19,332 | 28,051 | 38,113 | 6.73% |
| Other | -103 | 185 | 113 | 111 | 94 | -199.49% |
| Exist Renew | 3,555 | 4,315 | 3,618 | 3,673 | 3,565 | 0.02% |
| Biomass | 0 | 0 | 0 | 0 | 0 | #N/A |
| Solar | 0 | 530 | 1,950 | 2,194 | 2,446 | #N/A |
| Wind | 0 | 2,260 | 8,315 | 9,355 | 10,426 | #N/A |
| **Grand Total** | **50,651** | **56,205** | **62,032** | **68,187** | **74,686** | **2.06%** |
| **High Efficiency Scenario** | | | | | | |
| Hydro | 1,578 | 2,117 | 2,117 | 2,117 | 2,117 | 1.56% |
| Nuclear | 0 | 0 | 0 | 0 | 0 | #N/A |
| Coal | 34,559 | 29,496 | 24,100 | 21,515 | 16,213 | -3.91% |
| Nat Gas | 11,062 | 13,481 | 11,947 | 19,066 | 29,767 | 5.35% |
| Other | -103 | 158 | 108 | 131 | 104 | -200.03% |
| Exist Renew | 3,555 | 4,053 | 3,571 | 3,883 | 3,681 | 0.18% |
| Biomass | 0 | 0 | 0 | 0 | 0 | #N/A |
| Solar | 0 | 414 | 1,479 | 1,723 | 1,976 | #N/A |
| Wind | 0 | 1,766 | 6,305 | 7,345 | 8,422 | #N/A |
| **Grand Total** | **50,651** | **51,485** | **49,626** | **55,781** | **62,280** | **1.09%** |

**Table B-11. Colorado Capacity Savings – High Efficiency vs. Reference Scenario (MW)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Hydro | 0 | 0 | 0 | 0 | 0 |
| Nuclear | 0 | 0 | 0 | 0 | 0 |
| Coal | 0 | 0 | 373 | 373 | 373 |
| Nat Gas | 0 | 0 | 1,769 | 2,638 | 2,438 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Exist Renew | 0 | 0 | 0 | 0 | 0 |
| Biomass | 0 | 0 | 0 | 0 | 0 |
| Solar | 0 | 24 | 96 | 96 | 95 |
| Wind | 0 | 21 | 86 | 86 | 86 |
| **Grand Total** | **0** | **45** | **2,324** | **3,193** | **2,992** |

**Table B-12. Colorado Emissions Impacts – High Efficiency vs. Reference Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Savings** | | | | | |
| $CO_2$ Emissions | 1000 mT | 2,759 | 5,450 | 4,576 | 4,934 |
| $NO_x$ Emissions | mTons | 1,560 | 700 | -181 | 158 |
| $SO_2$ Emissions | mTons | 843 | 827 | 389 | 569 |
| Water Withdrawal | M Gal | 2,042 | 3,087 | 1,952 | 2,423 |
| Water Consumption | M Gal | 1,618 | 2,500 | 1,566 | 1,953 |
| **Savings Percent** | | | | | |
| $CO_2$ Emissions | 1000 mT | 7.0% | 15.4% | 13.2% | 14.7% |
| $NO_x$ Emissions | mTons | 8.6% | 8.8% | -2.5% | 2.6% |
| $SO_2$ Emissions | mTons | 5.6% | 9.4% | 5.2% | 9.6% |
| Water Withdrawal | M Gal | 6.6% | 11.8% | 8.2% | 11.6% |
| Water Consumption | M Gal | 6.6% | 11.7% | 8.1% | 11.5% |

## D. Nevada

Table B-13. Nevada Customer Sales (GWh)

| | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| Reference Scenario | 33,773 | 35,644 | 38,361 | 41,220 | 44,030 | 1.41% |
| High Efficiency Scenario | 33,773 | 32,922 | 31,321 | 34,180 | 36,991 | 0.48% |
| Difference | 0 | 2,722 | 7,040 | 7,040 | 7,040 | |

Table B-14. Nevada Generation Mix Including Exports (GWh)

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| **Reference Scenario** | | | | | | |
| Hydro | 2,157 | 2,583 | 2,583 | 2,583 | 2,583 | 0.95% |
| Nuclear | 0 | 0 | 0 | 0 | 0 | #N/A |
| Coal | 6,997 | 7,283 | 6,504 | 5,448 | 4,062 | -2.82% |
| Nat Gas | 23,688 | 24,314 | 25,826 | 27,442 | 31,358 | 1.49% |
| Other | 11 | 28 | 24 | 20 | 14 | 1.37% |
| Exist Renew | 2,287 | 2,320 | 2,258 | 2,236 | 2,172 | -0.27% |
| Geothermal | 0 | 472 | 1,841 | 3,389 | 3,690 | #N/A |
| Biomass | 0 | 22 | 88 | 161 | 176 | #N/A |
| Solar | 0 | 225 | 877 | 1,614 | 1,757 | #N/A |
| **Grand Total** | **35,141** | **37,246** | **40,001** | **42,892** | **45,813** | **1.41%** |
| **High Efficiency Scenario** | | | | | | |
| Hydro | 2,157 | 2,583 | 2,583 | 2,583 | 2,583 | 0.95% |
| Nuclear | 0 | 0 | 0 | 0 | 0 | #N/A |
| Coal | 6,997 | 5,103 | 3,674 | 3,763 | 2,528 | -5.22% |
| Nat Gas | 23,688 | 23,844 | 22,148 | 22,860 | 26,636 | 0.62% |
| Other | 11 | 27 | 18 | 20 | 14 | 1.33% |
| Exist Renew | 2,287 | 2,305 | 2,147 | 2,244 | 2,169 | -0.28% |
| Geothermal | 0 | 358 | 1,377 | 2,693 | 2,995 | #N/A |
| Biomass | 0 | 17 | 66 | 128 | 143 | #N/A |
| Solar | 0 | 170 | 656 | 1,282 | 1,426 | #N/A |
| **Grand Total** | **35,141** | **34,407** | **32,669** | **35,575** | **38,495** | **0.48%** |

**Table B-15. Nevada Capacity Savings – High Efficiency vs. Reference Scenario (MW)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Hydro | 0 | 0 | 0 | 0 | 0 |
| Nuclear | 0 | 0 | 0 | 0 | 0 |
| Coal | 0 | 805 | 805 | 805 | 805 |
| Nat Gas | 0 | 0 | 8 | 891 | 894 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Exist Renew | 0 | 0 | 0 | 0 | 0 |
| Geothermal | 0 | 19 | 76 | 113 | 113 |
| Biomass | 0 | 1 | 4 | 5 | 5 |
| Solar | 0 | 10 | 42 | 63 | 62 |
| **Grand Total** | **0** | **835** | **934** | **1,877** | **1,880** |

**Table B-16. Nevada Emissions Impacts – High Efficiency vs. Reference Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Savings** | | | | | |
| $CO_2$ Emissions | 1000 mT | 2,437 | 4,425 | 3,469 | 3,377 |
| $NO_x$ Emissions | mTons | 1,053 | 1,759 | 6,272 | 6,159 |
| $SO_2$ Emissions | mTons | 881 | 1,085 | 641 | 585 |
| Water Withdrawal | M Gal | 1,516 | 2,713 | 1,639 | 1,597 |
| Water Consumption | M Gal | 1,382 | 2,378 | 1,433 | 1,387 |
| **Savings Percent** | | | | | |
| $CO_2$ Emissions | 1000 mT | 13.9% | 25.7% | 20.8% | 20.3% |
| $NO_x$ Emissions | mTons | 10.3% | 14.7% | 36.6% | 23.9% |
| $SO_2$ Emissions | mTons | 29.7% | 43.3% | 30.6% | 37.4% |
| Water Withdrawal | M Gal | 14.0% | 26.4% | 17.5% | 18.8% |
| Water Consumption | M Gal | 15.1% | 27.5% | 18.3% | 19.8% |

## E. New Mexico

**Table B-17. New Mexico Customer Sales (GWh)**

| | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| Reference Case | 22,428 | 24,344 | 26,480 | 28,820 | 31,324 | 1.77% |
| High EE Case | 22,428 | 22,480 | 21,370 | 23,711 | 26,215 | 0.82% |
| Difference | 0 | 1,863 | 5,110 | 5,110 | 5,110 | |

**Table B-18. New Mexico Generation Mix Including Exports (GWh)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| **Reference Scenario** | | | | | | |
| Hydro | 217 | 303 | 303 | 303 | 303 | 1.77% |
| Nuclear | 0 | 0 | 0 | 0 | 0 | #N/A |
| Coal | 25,618 | 24,176 | 24,027 | 20,496 | 16,597 | -2.26% |
| Nat Gas | 8,512 | 10,844 | 10,958 | 16,676 | 22,977 | 5.37% |
| Other | 50 | 53 | 52 | 46 | 37 | -1.51% |
| Exist Renew | 1,855 | 2,365 | 2,348 | 2,354 | 2,304 | 1.15% |
| Biomass | 0 | 101 | 318 | 353 | 391 | #N/A |
| Solar | 0 | 269 | 847 | 942 | 1,043 | #N/A |
| Wind | 0 | 729 | 2,294 | 2,552 | 2,825 | #N/A |
| **Grand Total** | **36,252** | **38,839** | **41,148** | **43,722** | **46,477** | **1.32%** |
| **High Efficiency Scenario** | | | | | | |
| Hydro | 217 | 303 | 303 | 303 | 303 | 1.77% |
| Nuclear | 0 | 0 | 0 | 0 | 0 | #N/A |
| Coal | 25,618 | 18,368 | 16,354 | 13,490 | 9,386 | -5.15% |
| Nat Gas | 8,512 | 14,407 | 13,781 | 18,664 | 25,188 | 5.88% |
| Other | 50 | 74 | 55 | 57 | 46 | -0.46% |
| Exist Renew | 1,855 | 2,735 | 2,403 | 2,569 | 2,501 | 1.59% |
| Biomass | 0 | 83 | 242 | 277 | 315 | #N/A |
| Solar | 0 | 221 | 644 | 739 | 841 | #N/A |
| Wind | 0 | 597 | 1,745 | 2,002 | 2,277 | #N/A |
| **Grand Total** | **36,252** | **36,787** | **35,527** | **38,101** | **40,856** | **0.63%** |

**Table B-19. New Mexico Capacity Savings – High Efficiency vs. Reference Scenario (MW)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Hydro | 0 | 0 | 0 | 0 | 0 |
| Nuclear | 0 | 0 | 0 | 0 | 0 |
| Coal | 0 | 1,117 | 1,117 | 1,117 | 1,117 |
| Nat Gas | 0 | 0 | -255 | 258 | 258 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Exist Renew | 0 | 0 | 0 | 0 | 0 |
| Biomass | 0 | 3 | 12 | 12 | 12 |
| Solar | 0 | 10 | 40 | 40 | 40 |
| Wind | 0 | 6 | 24 | 24 | 23 |
| **Grand Total** | **0** | **1,135** | **938** | **1,452** | **1,452** |

**Table B-20. New Mexico Emissions Impacts – High Efficiency vs. Reference Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Savings** | | | | | |
| $CO_2$ Emissions | 1000 mT | 4,135 | 6,229 | 5,829 | 6,010 |
| $NO_x$ Emissions | mTons | 364 | 983 | 706 | 779 |
| $SO_2$ Emissions | mTons | 3,099 | 3,872 | 3,551 | 3,700 |
| Water Withdrawal | M Gal | 3,600 | 5,177 | 4,666 | 4,897 |
| Water Consumption | M Gal | 3,223 | 4,559 | 4,117 | 4,317 |
| **Savings Percent** | | | | | |
| $CO_2$ Emissions | 1000 mT | 14.3% | 21.8% | 21.4% | 23.4% |
| $NO_x$ Emissions | mTons | 6.6% | 18.4% | 14.8% | 19.2% |
| $SO_2$ Emissions | mTons | 24.0% | 30.7% | 33.0% | 42.5% |
| Water Withdrawal | M Gal | 17.0% | 24.9% | 25.0% | 29.9% |
| Water Consumption | M Gal | 17.6% | 25.4% | 25.7% | 30.9% |

## F. Utah

Table B-21. Utah Customer Sales (GWh)

| | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| Reference Scenario | 28,044 | 33,095 | 36,990 | 40,646 | 44,666 | 2.48% |
| High Efficiency Scenario | 28,044 | 30,641 | 30,757 | 34,413 | 38,432 | 1.67% |
| Difference | 0 | 2,455 | 6,234 | 6,234 | 6,234 | |

Table B-22. Utah Generation Mix Including Exports (GWh)

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| **Reference Scenario** | | | | | | |
| Coal | 34,057 | 32,841 | 30,090 | 28,876 | 26,593 | -1.29% |
| Nat Gas | 6,455 | 11,110 | 15,206 | 16,765 | 22,495 | 6.79% |
| Other | 50 | 33 | 22 | 30 | 33 | -2.15% |
| Hydro | 696 | 843 | 843 | 843 | 843 | 1.02% |
| Exist Renew | 781 | 899 | 821 | 907 | 981 | 1.21% |
| Geothermal | 0 | 1,032 | 2,852 | 5,005 | 5,546 | #N/A |
| Biomass | 0 | 17 | 48 | 83 | 92 | #N/A |
| Solar | 0 | 34 | 95 | 167 | 185 | #N/A |
| Wind | 0 | 637 | 1,759 | 3,086 | 3,420 | #N/A |
| **Grand Total** | **42,039** | **47,446** | **51,736** | **55,762** | **60,188** | **1.91%** |
| **High Efficiency Scenario** | | | | | | |
| Coal | 34,057 | 31,310 | 24,747 | 23,546 | 21,795 | -2.32% |
| Nat Gas | 6,455 | 10,219 | 14,625 | 16,610 | 21,754 | 6.60% |
| Other | 50 | 27 | 19 | 29 | 37 | -1.56% |
| Hydro | 696 | 843 | 843 | 843 | 843 | 1.02% |
| Exist Renew | 781 | 856 | 800 | 901 | 1,019 | 1.41% |
| Geothermal | 0 | 893 | 2,303 | 4,181 | 4,725 | #N/A |
| Biomass | 0 | 15 | 38 | 70 | 79 | #N/A |
| Solar | 0 | 30 | 77 | 139 | 158 | #N/A |
| Wind | 0 | 551 | 1,420 | 2,578 | 2,914 | #N/A |
| **Grand Total** | **42,039** | **44,743** | **44,871** | **48,897** | **53,323** | **1.26%** |

**Table B-23. Utah Capacity Savings – High Efficiency vs. Reference Scenario (MW)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Coal | 0 | 0 | 751 | 751 | 751 |
| Nat Gas | 0 | 0 | 0 | 0 | 350 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Hydro | 0 | 0 | 0 | 0 | 0 |
| Exist Renew | 0 | 0 | 0 | 0 | 0 |
| Geothermal | 0 | 23 | 90 | 134 | 134 |
| Biomass | 0 | 0 | 1 | 2 | 2 |
| Solar | 0 | 1 | 4 | 5 | 5 |
| Wind | 0 | 4 | 14 | 22 | 22 |
| **Grand Total** | **0** | **28** | **860** | **915** | **1,264** |

**Table B-24. Utah Emissions Impacts – High Efficiency vs. Reference Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Savings** | | | | | |
| $CO_2$ Emissions | 1000 mT | 747 | 2,389 | 2,313 | 2,509 |
| $NO_x$ Emissions | mTons | 309 | 833 | 831 | 748 |
| $SO_2$ Emissions | mTons | 732 | 2,051 | 2,046 | 1,841 |
| Water Withdrawal | M Gal | 1,200 | 3,615 | 3,521 | 3,183 |
| Water Consumption | M Gal | 1,041 | 3,184 | 3,110 | 2,810 |
| **Savings Percent** | | | | | |
| $CO_2$ Emissions | 1000 mT | 4.7% | 14.2% | 13.8% | 14.0% |
| $NO_x$ Emissions | mTons | 4.7% | 17.8% | 18.5% | 18.0% |
| $SO_2$ Emissions | mTons | 4.7% | 17.8% | 18.5% | 18.0% |
| Water Withdrawal | M Gal | 5.1% | 16.2% | 16.2% | 15.2% |
| Water Consumption | M Gal | 5.0% | 16.4% | 16.4% | 15.5% |

## G. Wyoming

Table B-25. Wyoming Customer Sales (GWh)

| | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| Reference Scenario | 17,113 | 21,618 | 24,009 | 26,902 | 30,155 | 3.03% |
| High Efficiency Scenario | 17,113 | 20,475 | 20,771 | 23,664 | 26,917 | 2.41% |
| Difference | 0 | 1,143 | 3,238 | 3,238 | 3,238 | |

Table B-26. Wyoming Generation Mix Including Exports (GWh)

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 | Growth Rate |
|---|---|---|---|---|---|---|
| **Reference Case** | | | | | | |
| Hydro | 1,024 | 1,083 | 1,083 | 1,083 | 1,083 | 0.30% |
| Nuclear | 0 | 0 | 0 | 0 | 0 | #N/A |
| Coal | 42,987 | 46,214 | 43,591 | 37,745 | 33,755 | -1.26% |
| Nat Gas | 459 | 537 | 3,565 | 10,137 | 14,987 | 20.14% |
| Other | 403 | 337 | 334 | 328 | 323 | -1.16% |
| Exist Renew | 3,247 | 3,338 | 3,031 | 2,978 | 3,197 | -0.08% |
| Biomass | 0 | 0 | 0 | 0 | 0 | #N/A |
| Solar | 0 | 0 | 0 | 0 | 0 | #N/A |
| Wind | 0 | 2,102 | 4,730 | 7,358 | 9,986 | #N/A |
| **Grand Total** | **48,119** | **53,613** | **56,335** | **59,629** | **63,332** | **1.46%** |
| **High EE Case** | | | | | | |
| Hydro | 1,024 | 1,083 | 1,083 | 1,083 | 1,083 | 0.30% |
| Nuclear | 0 | 0 | 0 | 0 | 0 | #N/A |
| Coal | 42,987 | 44,436 | 40,515 | 35,152 | 30,762 | -1.75% |
| Nat Gas | 459 | 606 | 2,755 | 8,745 | 13,976 | 19.70% |
| Other | 403 | 341 | 336 | 330 | 325 | -1.12% |
| Exist Renew | 3,247 | 3,742 | 3,228 | 3,273 | 3,512 | 0.41% |
| Biomass | 0 | 0 | 0 | 0 | 0 | #N/A |
| Solar | 0 | 0 | 0 | 0 | 0 | #N/A |
| Wind | 0 | 2,102 | 4,730 | 7,358 | 9,986 | #N/A |
| **Grand Total** | **48,119** | **52,311** | **52,648** | **55,942** | **59,645** | **1.14%** |

**Table B-27. Wyoming Capacity Savings – High Efficiency vs. Reference Scenario (MW)**

| Resource Type | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Hydro | 0 | 0 | 0 | 0 | 0 |
| Nuclear | 0 | 0 | 0 | 0 | 0 |
| Coal | 0 | 634 | 634 | 634 | 634 |
| Nat Gas | 0 | 0 | 111 | 317 | 317 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Exist Renew | 0 | 0 | 0 | 0 | 0 |
| Biomass | 0 | 0 | 0 | 0 | 0 |
| Solar | 0 | 0 | 0 | 0 | 0 |
| Wind | 0 | 0 | 0 | 0 | 0 |
| **Grand Total** | **0** | **634** | **745** | **951** | **951** |

**Table B-28. Wyoming Emissions Impacts – High Efficiency vs. Reference Scenario**

| Category | Units | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Savings** | | | | | |
| $CO_2$ Emissions | 1000 mT | 1,800 | 3,510 | 3,214 | 3,456 |
| $NO_x$ Emissions | mTons | 4,239 | 337 | 206 | -318 |
| $SO_2$ Emissions | mTons | 1,802 | 2,360 | 1,990 | 2,297 |
| Water Withdrawal | M Gal | 2,530 | 1,934 | 1,719 | 1,909 |
| Water Consumption | M Gal | 967 | 1,817 | 1,601 | 1,790 |
| **Savings Percent** | | | | | |
| $CO_2$ Emissions | 1000 mT | 3.7% | 7.4% | 7.3% | 8.3% |
| $NO_x$ Emissions | mTons | 31.5% | 4.7% | 2.9% | -3.3% |
| $SO_2$ Emissions | mTons | 3.8% | 7.1% | 6.9% | 8.9% |
| Water Withdrawal | M Gal | 3.8% | 7.3% | 7.2% | 8.6% |
| Water Consumption | M Gal | 3.8% | 7.2% | 7.1% | 8.7% |

# Appendix C: Electricity Planning and Costing Model

## A. Background

Synapse Energy Economics, Inc. initially developed the state electricity production and avoided cost model to support a series of state-specific "Clean Energy" potential studies. Those studies worked with key stakeholders in order to build a common understanding of, and consensus on, the role that clean energy resources (i.e., energy efficiency and demand response) can play in 1) meeting the future electricity end-use requirements in each state; 2) the economic benefits of treating those resources as the "first fuel" for meeting future requirements; and 3) the policies for maximizing reliance upon those resources.

Those studies evaluated the cost-effectiveness of reductions from energy efficiency and demand response, and also demonstrated the benefits of those reductions to all consumers in the state by estimating retail prices in the long-term under a clean energy policy case.

Synapse provided three deliverables to support these studies:

- projections of long-term wholesale electricity supply prices under a reference, or business-as-usual case;
- credible, consistent, "high-level" estimates of avoided electric energy ($/kwh) and capacity costs ($/kw-year); and
- projections of long-term electricity supply prices under a clean energy policy case.

In light of time and budget constraints, and the policy nature of these studies, Synapse developed and applied an electricity planning and costing model that produced "high-level" estimates of each of these deliverables in a well-documented, transparent manner.

Synapse developed an electricity planning and costing model that is:

- applicable to planning and costing from a state perspective, although most electric utility operations cross state boundaries;
- applicable from state to state, although some states are part of deregulated multi-state markets while others operate under traditional utility regulation;
- applicable using public data;
- inexpensive to setup and run; and
- relatively transparent.

Since its initial creation this model has been extended in a number of directions to represent additional resources, calculate emissions and to produce inputs for macroeconomic models.

## B. Methodology

The model begins with an analysis of actual physical and cost data for a base year, develops a plan for meeting projected physical requirements in each future year of the study period and then calculates the incremental wholesale electricity costs associated with that plan (incremental to electricity supply costs being recovered in current retail rates).

## C. Base Year Data

The actual data for the base year, and prior years, provides our starting point. That dataset contains historical data in the following categories:

1. Recent year summary statistics
2. Listing of the ten largest plants in the state
3. Top five providers of retail electricity
4. Electric capability by primary energy source
5. Generation by primary energy source
6. Fuel prices and quality
7. Emissions
8. Retail sales and revenues by customer class
9. Retail sales by various provider types
10. Supply and distribution of electricity

This data enables us to characterize the electric supply system and its costs for a given state. For example, we calculate the capacity, generation and capacity factor, average heat rate and fuel costs for different classes of resources. We calculate the retail margin (i.e. the margin between average retail rates and variable production costs) from this data. The retail margin reflects the transmission and distribution costs being recovered in retail rates plus the fixed generation costs being recovered in those rates. This data is a very broad brush since the resources are grouped by fuel type and their operation is not characterized in great detail.

## D. Future Years

We begin with the forecast of annual demand and electricity consumption in each future year provided in Chapter 2.

Next we develop a physical plan to meet the load in each of those future years. This is done in the model via the following steps:

1. Derive annual capacity and generation requirements from the forecast of retail annual demand and energy, and reserve margins.

2. Determine the relative quantities of annual capacity and generation to be provided by in-state and out-state resources based on the current mix of in-state and out-of-state resources.

3. Estimate resource retirements. It is quite difficult to predict the timing of actual plant retirements, but it is reasonable to assume that some older facilities will be retired during the study period. We assume gradual retirement of existing resources over time based on typical operating lifetimes. This is explicitly specified in the input data section and can easily be modified if more specific data becomes available.

4. Estimate the capacity and timing of new generation additions, in-state and out of state. Our model is not a capacity expansion model and therefore does not make capacity additions "automatically." Instead, after we include "planned" capacity additions, we add enough "generic" capacity additions to maintain the reserve margin. Our generic additions are a mix of peaking, intermediate and baseload units that maintains the historical mix of those categories in the state. This approach is transparent as the additions are explicitly specified in the input data section.

5. Calculate the quantity of annual generation from each category of capacity, existing and new, in-state and out-of-state. The estimated quantity of generation from each category of capacity is derived from the operating capacity factors. These are generally based upon economic dispatch, i.e. dispatch from each category in order of increasing variable production costs.

## E. Calculate Average Production Costs (Average Supply Costs)

The model calculates the average production costs (i.e., energy plus capacity) for the particular case in the Production Model worksheet.

## F. States With Regulated Wholesale Markets

For states with regulated wholesale markets which is the case in this study, the Production Model worksheet calculations are made as follows:

6. Calculate total cost of generation from existing in-state resources, purchases from out-of-state resources, and new in-state resources.

    a. The unit production cost of existing in-state generation includes variable operating costs plus fixed costs.[19] The aggregate cost of generation from these resources decline over time as existing coal, oil and gas plants are retired, while the existing nuclear plants with low operating costs continue operation.

    b. The unit production cost of new in-state generation consists of the levelized capital cost of new capacity additions plus their variable operating costs. The capacity cost of new capacity additions is levelized using the capital recovery factors developed in the Capital Recovery Calculation (CRC) worksheet.

[19] For existing resources fixed costs are estimated on an aggregate basis based on the base year difference between fuel and other variable costs and the retail revenues less a retail markup component.

c. The cost of power imported or exported is indexed to the generation-weighted average cost of generation from both existing and new in-state resources. That is, the base-year import/export price changes in parallel with the in-state cost (e.g. an x% change of in-state production costs is reflected in an x% change of import/export prices). The rationale is that relative changes of in-state costs will be reflected outside the state as well.

## G. States With De-Regulated Wholesale Markets

For states with de-regulated wholesale markets (not the case in this study), the Production Model worksheet calculations are made as follows:

7. The first step is to calculate the reference year market prices for the state being studied. The next step is to calculate the relationship between those state prices and the market location for which future prices are available. The third step is to then apply that relationship to future prices to produce a forecast for market prices in the study state.

## H. Calculate Avoided Costs

### States With Regulated Wholesale Markets

For states with regulated wholesale markets the Production Model worksheet calculates the total avoided costs, avoided capacity costs and avoided energy costs via the following steps:

8. Total avoided costs: The worksheet calculates "all-in" avoided costs that include both energy and capacity costs.

    a. Years 1 to 5: For the first five years the avoided costs are a mix of avoided dispatch of existing resources and avoided total cost of new resources that would otherwise come on line during that period. The percentage of new resources included in that mix is phased in, starting at 0% in year 1 and rising to 100% in year 5.

    b. Year 6 onward: After year 5 the avoided costs in each year equal the average total costs of new resources in that year. This calculation assumes that the capital costs of new resources are avoidable either through avoiding their actual construction or through recovery from revenues from off-system sales.

9. Avoided capacity cost: To estimate the avoided cost of capacity only, we use the proxy plant approach which is used by several ISOs. This avoided capacity cost is based upon cost of "capacity only" from a new gas combustion turbine "peaker" unit. Basing avoided capacity cost on the capital cost of a new peaker is a commonly accepted method.

10. Avoided energy cost: The avoided energy cost is the total avoided cost from step 8 minus the avoided capacity cost from step 9.

**States With De-Regulated Wholesale Markets**

For states with de-regulated wholesale markets the Production Model worksheet calculates the total avoided costs, avoided capacity costs and avoided energy costs differently for different time periods.

11. Near-term years for which futures prices are available, e.g. first 4 to 5 years:

    a. Avoided energy cost: This is calculated from future market prices with appropriate historically based adjustments for the state service area.

    b. Avoided capacity cost: This is based on the available appropriate capacity market results.

    c. Total avoided cost: This is obtained by combining the avoided energy cost with the avoided capacity cost using the base year system load factor to arrive at the combined total avoided cost on a per MWh basis.

12. Long-term years for which futures prices are not available:

    a. After the period for which futures are available, the total avoided costs, avoided capacity cost and avoided energy cost are developed in the same manner as for regulated states in steps 8, 9 and 10.

# Appendix D: Macroeconomic Impacts in 2015

Table D-1. Regional Impacts by Sector in 2015

| Sectors | Jobs (Actual) | Wage and Salary Compensation (million $) | GSP (million $) |
|---|---|---|---|
| Construction | 7,090 | 389 | 483 |
| Services | 4,550 | 218 | 282 |
| Retail Trade | 750 | 29 | 42 |
| Finance | 570 | 27 | 42 |
| Other Manufacturing | 490 | 38 | 70 |
| Insurance/Real Estate | 210 | 5 | 44 |
| Wholesale Trade | 100 | 8 | 14 |
| Oil Refining | 0 | (0) | (1) |
| Natural Gas Utilities | (10) | (3) | (10) |
| Food | (10) | 0 | 0 |
| Primary Metals | (10) | (0) | 0 |
| Agriculture | (30) | (1) | (2) |
| Other Mining | (30) | (3) | (10) |
| Transportation, Communication & Utilities | (50) | (4) | (7) |
| Oil and Gas Mining | (320) | (27) | (47) |
| Coal Mining | (840) | (102) | (213) |
| Government | (1,000) | (78) | (92) |
| Electric Utilities | (1,330) | (180) | (635) |
| **TOTAL** | **10,120** | **317** | **(39)** |

***Notes:*** *The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the energy efficiency scenario. Jobs refer to the net jobs created or lost in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net gain or loss in the states combined Gross State Product by sector. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

Table D-2. Arizona Impacts by Sector in 2015

| Sectors | Jobs (Actual) | Wage and Salary Compensation (million $) | GSP (million $) |
|---|---|---|---|
| Construction | 2,330 | 128 | 157 |
| Services | 1,770 | 85 | 112 |
| Retail Trade | 320 | 13 | 18 |
| Finance | 190 | 10 | 16 |
| Other Manufacturing | 170 | 13 | 25 |
| Insurance/Real Estate | 80 | 2 | 18 |
| Wholesale Trade | 20 | 2 | 3 |
| Oil and Gas Mining | 0 | 0 | 0 |
| Food | 0 | 0 | 0 |
| Oil Refining | 0 | 0 | 0 |
| Primary Metals | 0 | 0 | 1 |
| Other Mining | 0 | 0 | 1 |
| Natural Gas Utilities | (10) | (2) | (5) |
| Agriculture | (20) | (1) | (1) |
| Transportation, Communication & Utilities | (60) | (5) | (8) |
| Coal Mining | (70) | (8) | (17) |
| Government | (240) | (19) | (22) |
| Electric Utilities | (660) | (93) | (306) |
| **TOTAL** | **3,810** | **128** | **(9)** |

***Notes:*** *The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the energy efficiency scenario. Jobs refer to the net jobs created or lost in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net gain or loss in the state's Gross State Product by sector. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

Table D-3. Colorado Impacts by Sector in 2015

| Sectors | Jobs (Actual) | Wage and Salary Compensation (million $) | GSP (million $) |
|---|---|---|---|
| Construction | 1,460 | 81 | 99 |
| Services | 970 | 52 | 65 |
| Retail Trade | 210 | 8 | 11 |
| Finance | 130 | 7 | 11 |
| Other Manufacturing | 110 | 10 | 19 |
| Insurance/Real Estate | 50 | 2 | 12 |
| Wholesale Trade | 30 | 3 | 5 |
| Transportation, Communication & Utilities | 10 | 1 | 2 |
| Agriculture | 0 | (0) | (0) |
| Natural Gas Utilities | 0 | (1) | (2) |
| Food | 0 | 0 | 0 |
| Oil Refining | 0 | 0 | (0) |
| Primary Metals | 0 | 0 | 0 |
| Other Mining | 0 | (0) | (1) |
| Oil and Gas Mining | (50) | (4) | (7) |
| Coal Mining | (100) | (12) | (25) |
| Government | (200) | (17) | (20) |
| Electric Utilities | (240) | (31) | (114) |
| **TOTAL** | **2,380** | **98** | **54** |

***Notes:*** *The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the energy efficiency scenario. Jobs refer to the net jobs created or lost in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net gain or loss in the state's Gross State Product by sector. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

Table D-4. Nevada Impacts by Sector in 2015

| Sectors | Jobs (Actual) | Wage and Salary Compensation (million $) | GSP (million $) |
|---|---|---|---|
| Construction | 880 | 61 | 76 |
| Services | 730 | 35 | 48 |
| Retail Trade | 140 | 6 | 8 |
| Finance | 100 | 3 | 6 |
| Other Manufacturing | 70 | 5 | 9 |
| Insurance/Real Estate | 50 | 1 | 10 |
| Wholesale Trade | 20 | 2 | 3 |
| Transportation, Communication & Utilities | 20 | 1 | 2 |
| Agriculture | 0 | 0 | (0) |
| Oil and Gas Mining | 0 | 0 | 0 |
| Coal Mining | 0 | 0 | 0 |
| Natural Gas Utilities | 0 | (0) | (1) |
| Food | 0 | 0 | 0 |
| Oil Refining | 0 | 0 | 0 |
| Primary Metals | 0 | (0) | (0) |
| Other Mining | 0 | 0 | 1 |
| Government | (90) | (8) | (9) |
| Electric Utilities | (110) | (16) | (62) |
| **TOTAL** | **1,820** | **92** | **91** |

***Notes:*** *The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the energy efficiency scenario. Jobs refer to the net jobs created or lost in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net gain or loss in the state's Gross State Product by sector. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

Table D-5. New Mexico Impacts by Sector in 2015

| Sectors | Jobs (Actual) | Wage and Salary Compensation (million $) | GSP (million $) |
|---|---|---|---|
| Construction | 980 | 44 | 59 |
| Services | 410 | 18 | 23 |
| Other Manufacturing | 70 | 4 | 8 |
| Retail Trade | 50 | 2 | 3 |
| Finance | 50 | 2 | 4 |
| Wholesale Trade | 10 | 0 | 1 |
| Insurance/Real Estate | 10 | 0 | 1 |
| Agriculture | 0 | (0) | (0) |
| Natural Gas Utilities | 0 | (0) | (1) |
| Food | 0 | 0 | (0) |
| Oil Refining | 0 | (0) | (1) |
| Primary Metals | 0 | (0) | (0) |
| Other Mining | (10) | (1) | (5) |
| Transportation, Communication & Utilities | (20) | (2) | (3) |
| Electric Utilities | (140) | (17) | (62) |
| Oil and Gas Mining | (160) | (13) | (23) |
| Government | (160) | (12) | (14) |
| Coal Mining | (180) | (22) | (47) |
| **TOTAL** | **890** | **2** | **(58)** |

***Notes:*** *The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the energy efficiency scenario. Jobs refer to the net jobs created or lost in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net gain or loss in the state's Gross State Product by sector. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

Table D-6. Utah Impacts by Sector in 2015

| Sectors | Jobs (Actual) | Wage and Salary Compensation (million $) | GSP (million $) |
|---|---|---|---|
| Construction | 960 | 48 | 59 |
| Services | 530 | 23 | 28 |
| Finance | 80 | 3 | 5 |
| Other Manufacturing | 60 | 5 | 8 |
| Retail Trade | 50 | 2 | 3 |
| Wholesale Trade | 20 | 1 | 2 |
| Insurance/Real Estate | 20 | 0 | 3 |
| Transportation, Communication & Utilities | 10 | 0 | 1 |
| Agriculture | 0 | (0) | (0) |
| Natural Gas Utilities | 0 | (0) | (1) |
| Food | 0 | 0 | (0) |
| Oil Refining | 0 | (0) | (0) |
| Primary Metals | 0 | 0 | 0 |
| Other Mining | (10) | (1) | (3) |
| Oil and Gas Mining | (110) | (10) | (16) |
| Electric Utilities | (110) | (15) | (54) |
| Coal Mining | (120) | (15) | (30) |
| Government | (190) | (14) | (16) |
| **TOTAL** | **1,190** | **30** | **(12)** |

***Notes:*** *The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the energy efficiency scenario. Jobs refer to the net jobs created or lost in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net gain or loss in the state's Gross State Product by sector. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

Table D-7. Wyoming Impacts by Sector in 2015

| Sectors | Jobs (Actual) | Wage and Salary Compensation (million $) | GSP (million $) |
|---|---|---|---|
| Construction | 480 | 27 | 33 |
| Services | 140 | 6 | 8 |
| Finance | 20 | 1 | 1 |
| Other Manufacturing | 10 | 1 | 1 |
| Oil and Gas Mining | 0 | 0 | 0 |
| Natural Gas Utilities | 0 | (0) | (1) |
| Oil Refining | 0 | 0 | 0 |
| Wholesale Trade | 0 | 0 | 0 |
| Insurance/Real Estate | 0 | 0 | 0 |
| Agriculture | (10) | (0) | (0) |
| Food | (10) | (0) | (0) |
| Primary Metals | (10) | (1) | (1) |
| Other Mining | (10) | (1) | (4) |
| Transportation, Communication & Utilities | (10) | (1) | (1) |
| Retail Trade | (20) | (1) | (1) |
| Electric Utilities | (70) | (10) | (37) |
| Government | (120) | (9) | (10) |
| Coal Mining | (370) | (45) | (94) |
| **TOTAL** | **30** | **(32)** | **(105)** |

***Notes:*** *The numbers in parentheses reflect losses that are projected to occur in that sector as a result of the energy efficiency scenario. Jobs refer to the net jobs created or lost in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net gain or loss in the state's Gross State Product by sector. All dollar values are in millions of 2010 dollars. Totals may not add up due to independent rounding.*

# Appendix E: List of Tables & Figures

## A. Tables

## B. Figures

SOUTHWEST ENERGY EFFICIENCY PROJECT
2334 North Broadway, Suite A , Boulder, CO 80304
T: 303.447.0078 | Fax: 303.447.0158 | swenergy.org

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