Achieving 20% Energy Savings by 2020—How Can We Get There? An Energy Efficiency Program Analysis for the Southwest U.S. States

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ABSTRACT

About twenty-five states in the United States have an Energy Efficiency Resource Standard (EERS) requiring utilities or program administrators to reach long-term targets for energy savings through customer efficiency programs. The most aggressive EERS policies in the country—currently established by only a few states including Arizona and Massachusetts—require energy efficiency targets of about 2% per year, or about 20% electricity savings by 2020 using 2010 as the start year. This paper—a summary of a larger report—examines an aggressive but achievable utility energy efficiency programs scenario for states in the Southwest. We developed a suite of 18 "best practice" residential and business efficiency programs and included an individual analysis for each state in the Southwest: Arizona, New Mexico, Colorado, Utah, Nevada, and Wyoming. The analyses include detailed estimates of participation rates, electricity savings, and program and participant costs necessary to ramp up to aggressive savings levels. We found that a comprehensive set of aggressive but realistic utility programs can successfully hit the 20% savings target by 2020 in all states except Wyoming, with a total regional investment of about $8.2 billion (net present value, 2010$) from 2010 through 2020 in program costs, with the levelized costs for the efficiency programs on average 2.2 cents per kilowatt-hour (kWh) for business programs and 3.5 cents/kWh for residential programs. The study also includes an electricity supply analysis to determine the system-wide benefits of achieving the High Efficiency Scenario, which is estimated to avoid about 13,500 megawatts (MW) in new capacity. Finally, we estimate a benefit-cost ratio for customer bill savings to energy efficiency programs of 2.1.

Introduction

About twenty-five states in the United States have an Energy Efficiency Resource Standard requiring utilities or program administrators to reach long-term targets for energy savings through customer efficiency programs. The most aggressive EERS policies in the country—currently established by only a few states including Arizona and Massachusetts—require energy efficiency targets of about 2% per year, or about 20% electricity savings by 2020 using 2010 as the start year. This paper—a summary of a larger report—examines an aggressive but achievable utility energy efficiency programs scenario for states in the Southwest and Mountain United States: Arizona, New Mexico, Colorado, Utah, Nevada, and Wyoming. In addition to Arizona, several states in the region have an EERS, including Colorado, New Mexico, and Nevada, which includes efficiency as part of its renewable energy standard. Utah has a voluntary efficiency goal but not an EERS, which is a binding target. The states, which have been emerging as national leaders in energy efficiency policies and programs, will have to tap into the large amounts of remaining energy efficiency potential in order to meet their increasing targets and fully benefit from the economic and energy benefits of efficiency.

Policy Context

Some states and utilities in the Southwest have taken steps to achieve 20% or greater electricity savings by 2020, but others so far have not. Most notably, the Arizona Corporation Commission (ACC) in 2010 adopted electric energy efficiency standards requiring regulated utilities to achieve 22% savings by 2020, with 2% of the total possible through a credit for demand response efforts. Utilities in Arizona have rapidly scaled up efficiency programs as a result of this policy. In Colorado, the Public Utility Commission (PUC) adopted in 2008 energy savings goals through 2020 for Xcel Energy, the main electric utility in the state, along with performance-based incentives for Xcel's shareholders tied to meeting or exceeding the goals. The goals were increased in 2011, and if achieved would lead Xcel to achieve about 16% savings by 2020 from programs implemented during 2010-2020. New Mexico also has adopted energy savings requirements for regulated utilities, but they only require 10% savings by 2020 (10% of sales in 2005) from programs implemented during 2007-2020. Nevada, Utah, and Wyoming have not adopted long-term energy savings standards or goals, although major utilities in Nevada and Utah are saving 1% or more of retail sales from efficiency programs implemented each year (Geller and Schlegel 2012).

Overall Methodology

Our analysis covers the six states in the Southwest U.S. region: Arizona, Colorado, New Mexico, Nevada, Utah, and Wyoming. We first developed statewide Reference Case forecasts of electricity consumption through 2020 that would occur in the absence of energy efficiency programs, and then compared that to a high-efficiency scenario. For the high-efficiency scenario, we assumed adoption of a portfolio of 10 residential and 8 business (commercial and industrial, or C&I) "best practice" electricity energy efficiency programs. We assumed that these programs would ramp up during 2012-2020 to achieve aggressive but realistic energy savings. For each program, we assumed statewide levels of customer eligibility, program participation, energy and peak demand savings per customer, and costs for both program administrators and customers. We also accounted for existing program offerings in each state in the estimates for energy savings impacts and costs. We prepared a separate analysis for each state as well as the region as a whole.

Reference Case Assumptions

For each state analysis we developed a Reference Case forecast of electricity sales (GWh) and peak demand (MW), which excludes the projected impacts of either ongoing or potentially new utility energy efficiency programs. We started with 2010 baseline electricity sales data (EIA 2012). We analyzed recent available Integrated Resource Plans (IRP) for utilities in each state and collected data on electricity sales and peak demand forecasts (excluding energy efficiency program impacts). We then developed statewide sales and peak demand forecasts using a weighted average of the utility forecasts' annual growth rates.[1] While some states have projections of business-as-usual (BAU) energy efficiency levels and demand, we did not include a separate BAU scenario because not all states had undergone this energy efficiency resource planning process.

Choosing Model Programs

Our portfolio of model energy efficiency programs (see Table 1) covers a comprehensive set of strategies for residential, commercial, and industrial customers. We developed this list of best practice program offerings by examining what leading utilities and other program administrators in the U.S. and the Southwest region are typically offering in their program portfolios.

Table 1. List of Residential and Business Programs Analyzed

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

Treatment of Existing Utility Program Portfolios and Plans

Many utilities in the Southwest and Mountain states are currently administering some energy efficiency programs, and we accounted for these program impacts in the first few years of the analysis. For each state, we compiled utility program data and used this to estimate actual program impacts in the years 2010 and 2011. We also used 2012 program plans in some cases, if available, to inform our assumptions about 2012 program impacts. Some existing utility portfolios have programs that do not fit the same general definitions of our model programs above, however, so in these cases we had to re-categorize programs such as combining several utility program results into one model program category.

When a state did not already have 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., savings per participant, cost data); however, we scaled up model programs to the state level rather than to the utility level.

It is important to note that our program estimates are statewide values, and not just for major investor-owned utilities (IOUs), and therefore readers should be careful not to directly compare our analysis to individual utility plans.

[1] 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 Public Power Company (SPPC 2011); *Utah and Wyoming*—Rocky Mountain Power (PacifiCorp 2011a); *Colorado*—Tri-State Generation and Transmission (Tri-State 2010) and Xcel Energy (Xcel 2011a); *New Mexico*—Public Service Company of New Mexico (PNM 2011).

Participation, Energy and Peak Savings, and Cost Estimates

For each program, we first collected existing program data if currently offered in the state. We then developed forecasts of the number of eligible customers and estimated ramp-ups in participation rates based on best practice programs in Southwest states and across the U.S. As an example, program eligibility for the business retrocommissioning program includes large buildings greater than 100,000 square feet, which we estimated based on regional data from EIA's *Commercial Building Energy Consumption Survey* (EIA 2008). The existing program offered in Utah has reached about 1-2% of eligible customers per year, and we estimated a slow but steady ramp-up to about 12% per year so that 80% of eligible customers are reached by 2020. We performed a similar exercise for each program, and more details can be found in the forthcoming full report by SWEEP.

Gross energy savings (kWh) and peak impacts (kW) per participant were similarly estimated from best practice programs within or outside the region. Program costs and customer costs were estimated on a per participant basis or cost per first-year kWh saved. Incremental annual savings represent one program year's new impacts only, while total annual savings include the previous year's total savings plus incremental annual savings. We examined several resources on energy efficiency programs to develop these estimates for our analysis.[2]

Energy savings values were adjusted to take into account pending updates to federal product standards and assumptions on the adoption of statewide building energy codes. The per-unit savings generated by measures that are regulated by federal product standards are adjusted downward due to anticipated updates to the individual standards, which decrease per-unit energy consumption. Similarly, the per-participant savings generated in the residential and commercial new construction programs are adjusted downwards to take into account our assumptions on the adoption of new, more stringent building energy codes. In other words, as building energy codes become more stringent and building energy use declines, the potential savings generated by these programs also declines.

Benefit-Cost Analysis

Using the energy savings and cost estimates, we then examined the cost-effectiveness of each program. 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 estimated based on typical program assumptions and held constant across all states. For determining cost of saved energy and net present values of costs and benefits, we assumed a 5% real discount rate.[3] Measure lifetime assumptions were also held constant across all states. Table 2 presents the key assumptions regarding measure lifetime and net-to-gross energy savings ratios for each model program. Table 2 also includes the levelized cost of saved energy for each type of program, which is a function

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[2] Further details on each program analysis and the accompanying list of references can be found in the full-length report, which is forthcoming by SWEEP. Key regional sources include: APS 2010, 2011a; NPC 2011; PacifCorp 2011b; RMP 2010a, 2010b; and Xcel 2010, 2011b, 2011c.

[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 programs—for example, the California Energy Commission (CEC) has used real discount rates ranging from 3–5% since the 1980s (CEC 2005). In 2012, cost of capital rates for electric utilities in the U.S., which are generally used to estimate discount rates, are only about 4.2% nominal (NYU 2012). This makes our 5% real discount rate a conservative assumption for this analysis.

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.

Table 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	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 and Recycling	Varies over time	10	$0.02
Refrigerator Recycling	60%	9	$0.05
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 C&I Direct Install	98.5%	12.7	$0.05
Large C&I Custom Retrofits, Process and Self-Direct	80%	15	$0.02
Computer Efficiency and Other Plug Loads	90%	7	$0.02
Tenant Build-out Lighting Design	80%	13	$0.02
Prescriptive Rebates for C&I Equipment Replacement	80%	16	$0.04
Retrocomissioning	100%	7	$0.03
Combined Heat and Power	100%	19.6	$0.01

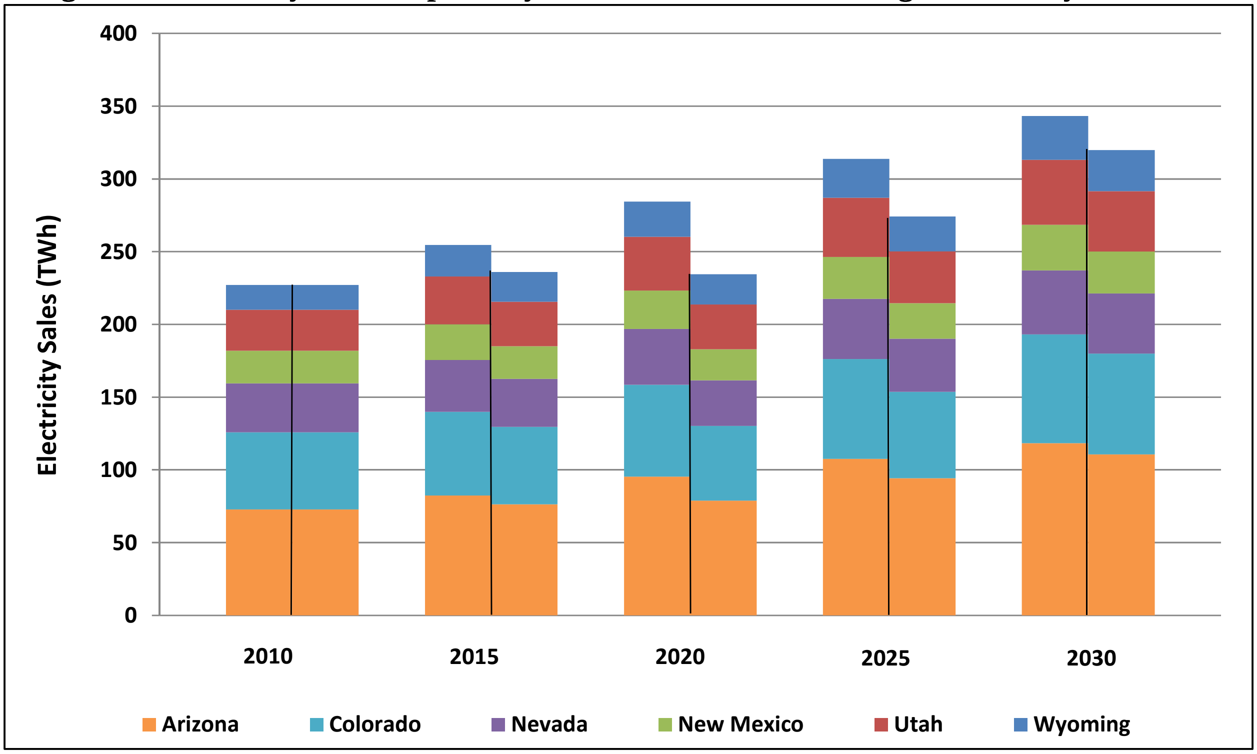
*1 year for enhanced billing, 5 years for in-home displays; ** Levelized costs of saved energy are calculated assuming total program costs only through 2020, a real discount rate of 5%, average measure life, and total annual energy savings in 2020. These costs do not include customer investments or operating costs, such as for CHP.

Table 2 includes estimates of the cost of saved energy based on utility program costs only (excluding participant costs). Considering the relative sizes of the different programs, the overall average cost of saved energy is $0.035/kWh for residential programs and $0.022/kWh for business programs. These values are consistent with the experience of leading utilities in the U.S., which have been saving electricity at an average overall cost of $0.025 per kWh saved (Friedrich et al. 2009).

High-Efficiency Scenario Results

The total annual electricity savings results of the high-efficiency scenario are summarized by state and region-wide in Figure 1. Tables 3 and 4 provide further detail of the estimated electricity and peak demand impacts, respectively, by state and year. By 2020, the region would save nearly 50,000 GWh or 21% (relative to sales in that year). And although we examined impacts of programs implemented through 2020, some of those savings would continue to occur through 2030 over the measure lifetimes, as shown in Figure 1.

Figure 1. Electricity Consumption by State in Reference and High-Efficiency Scenarios



Notes: Column on the right for each year shows the High Efficiency Scenario. 2010 shows actual electricity sales data; see Table 3 below for efficiency program saving contributions in 2010. The program analysis ends in 2020, but savings continue to occur through 2030.

As shown in Table 3, our analysis finds that each state except for Wyoming could reach at least 20% by 2020, while Wyoming could reach 15% savings by 2020. While we assumed the same set of best practice programs for each state, and similar ramp-ups in participation rates, differences in the results among states occurred due to several factors. These include the starting point of energy savings and participation of existing programs in 2010-2011; the relative mix of residential, commercial, and industrial customers; the relative size of customers; and forecasts for new construction rates; as well as differences in electricity end-use consumption (e.g., heating and cooling degree days).

Peak demand impacts, shown in Table 4, are the estimated impacts from the energy efficiency programs alone, which we developed for each program using per-participant peak demand reductions based on best practice program results. We did not estimate additional impacts from demand response—i.e., load management, programs. We estimate that the best practice portfolio of energy efficiency programs could save 9,681 MW by 2020, which is equivalent to 18% of the modified peak demand in the same year.

Table 3. Total Annual Electricity Savings by State (GWh)

State	2010	2015	2020	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	1,538	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%**
Regional Reference Case*	227,109	254,642	284,298	284,298	
High EE Case*	227,109	236,027	234,469	234,469	

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

Table 4. Total Annual Peak Demand Savings by State (MW)

State	2010	2015	2020	Peak Load in 2020	Savings in 2020 as % of Sales
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%**
Regional Reference Case*	52,009	57,651	63,875	63,875	
High EE Case*	52,009	54,029	54,194	54,194	

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

The relative savings contributions by sector and by program vary somewhat by state; however, overall in each state the business sector savings exceed the residential sector savings. Overall, we estimated that region-wide the residential sector accounts for 36% of the electricity savings and the C&I or business sector accounts for 64% of the savings (see Figure 2). The program-by-program breakdown of electricity savings also varied somewhat from state to state, and the overall regional results are shown in Figures 3 and 4.

Figure 2. Regional: Total Annual Electricity Savings in 2020 by Sector (GWh)

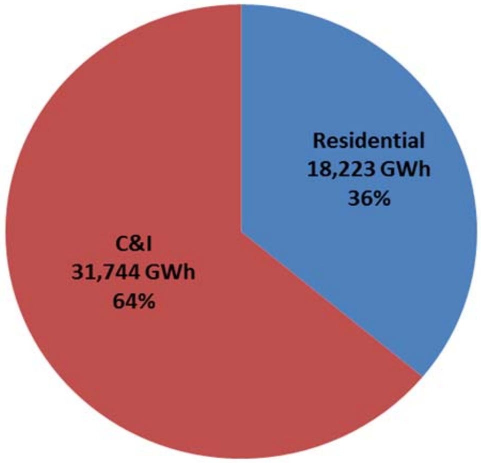


Figure 3. Regional: Total Annual Residential Electricity Savings in 2020 by Program (GWh)

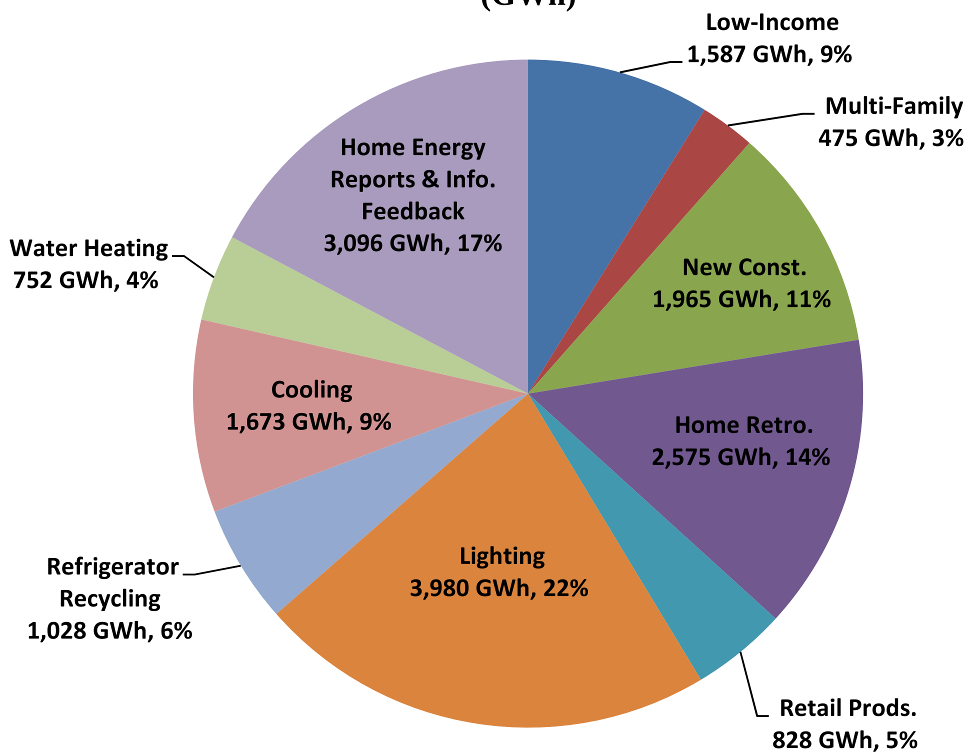
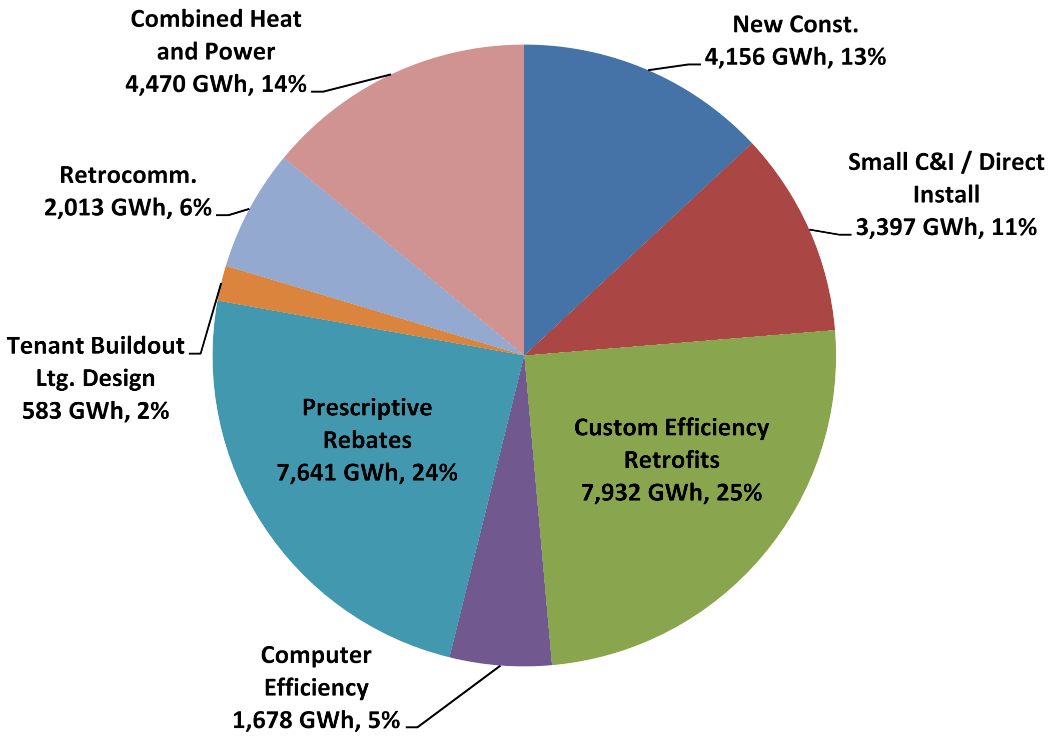


Figure 4. Regional: Total Annual Commercial and Industrial Electricity Savings in 2020 by Program (GWh)



We estimated costs to administer each type of program, including both incentives delivered to customers or other mid-stream/up-stream market players, as well as marketing and other associated administrative costs. As shown in Table 5, we estimated that overall program costs for the regions would reach about $1.78 billion annually in 2020, or about $8.23 billion net present value through 2020. As shown previously, estimated levelized costs are $0.022/kWh for business programs and $0.035/kWh for residential programs, which is far less than the levelized costs for new electricity generation supply.

Table 5. Program Costs by State (Million 2010$)

State	2010	2015	2020	NPV 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**

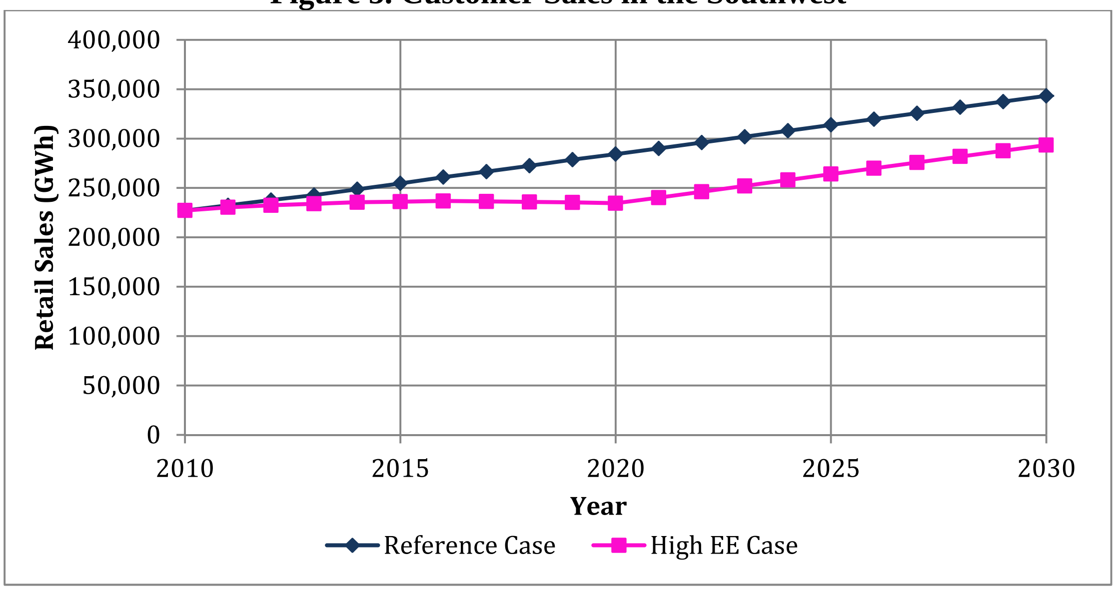
*Note: Assumes 5% real discount rate

Electricity Market Impacts Results

Synapse Energy Economics 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 since 2009 in a number of avoided cost studies.

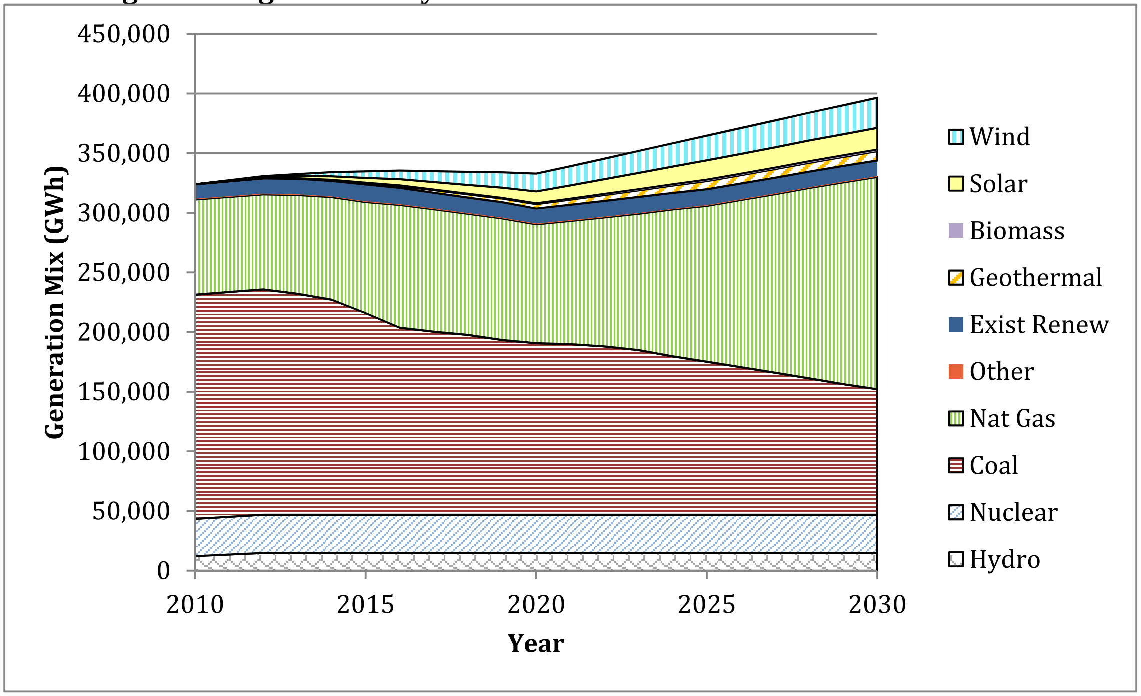
The High Efficiency Scenario reduces state sales in 2020 by 17.5% relative to the Reference Case, and the relative savings still remain at 14.5% by 2030. The overall growth rate in the Reference Case is 2.09%, which is lowered to 1.29% in the High Efficiency Scenario. Figure 5 below summarizes those differences.

Figure 5. Customer Sales in the Southwest



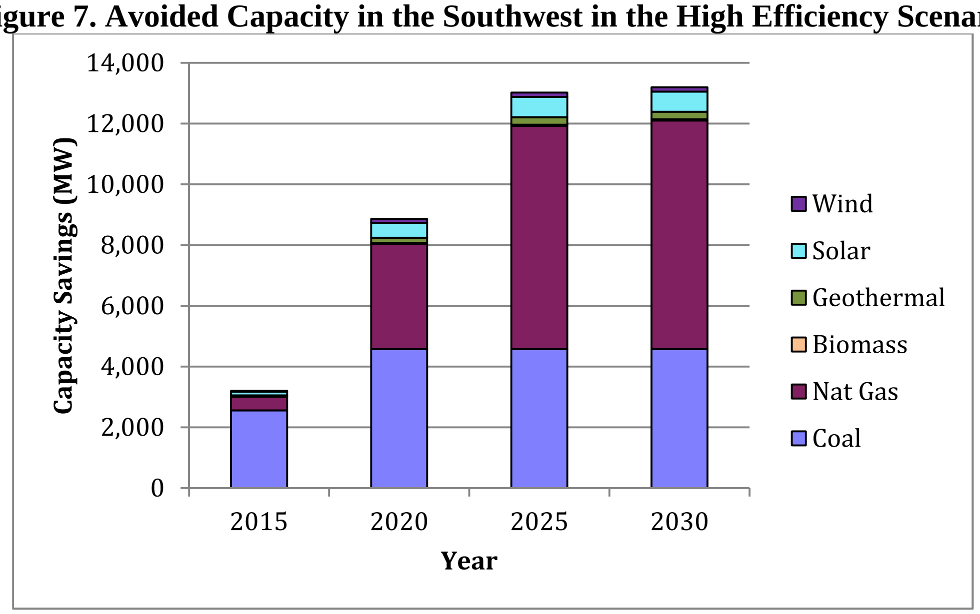
The generation mix for the Southwest region is currently dominated by coal, which makes up 58% of the generation mix. Natural gas makes up 25%, nuclear makes up 10%, and hydro and other renewable technologies make up the remaining 7% of generation. Figure 6 below shows how the generation mix changes over time in the High Efficiency Scenario. Generation from hydroelectric and nuclear generating resources stays constant over time. Some coal generation is retired for economic reasons, and natural gas and renewables not only make up the difference but also increase to meet higher loads. The amount of generation and new capacity required, however, is reduced compared to the Reference Case.

Figure 6. High Efficiency Scenario—Generation Mix in the Southwest



Reduced loads mean reduced generation costs and the delay and avoidance of new plant construction. Figure 7 shows the capacity savings in the Southwest associated with the High EE Case as compared to the Reference Case. The coal portion reflects the retirement of 4,371 MW of existing coal generation to avoid about $2,936M for new emission control equipment. The majority of avoided capacity is natural gas, with almost 8,000 MW of capacity avoided in the High Efficiency Scenario. Avoided capacity from coal follows next, with approximately 4,500 MW avoided. Fewer renewables are needed due to reduced loads, and more than 1,000 MW of a combination of wind, solar, geothermal, and biomass capacity could be avoided.

Figure 7. Avoided Capacity in the Southwest in the High Efficiency Scenario

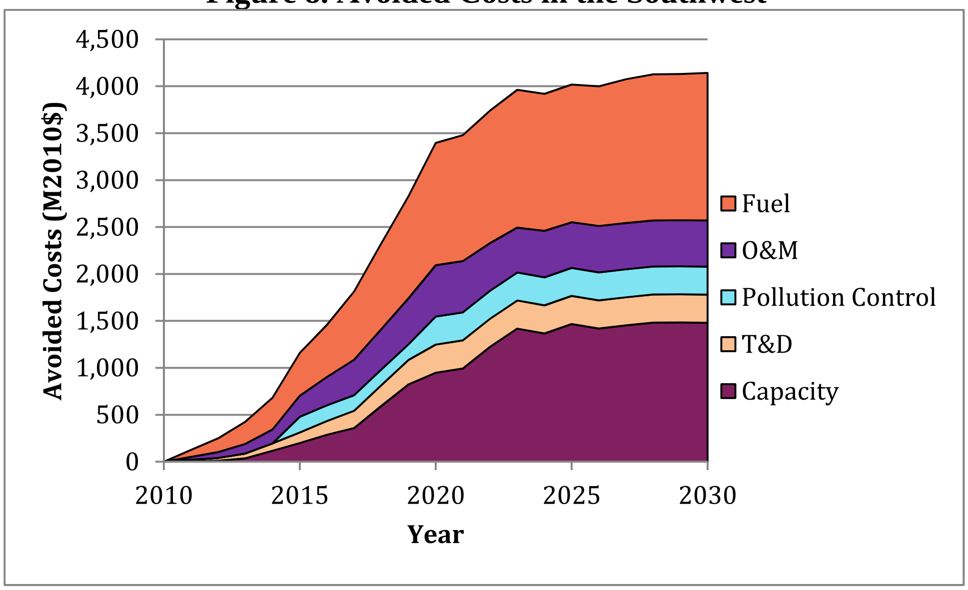


There are five major categories of avoided costs associated with reduced electricity:

1. Capital investment in new plants in levelized terms
2. Investment in Transmission and Distribution (T&D) system expansion
3. Avoided pollution control costs from retirement of existing coal plants (also levelized)
4. Operating and Maintenance (O&M) cost reductions due to decreased generation
5. Reduced fuel consumption (on an annual basis)

Figure 8 shows those results for the Southwest. The largest savings are fuel costs and avoided investments in new power plants. Then O&M and T&D savings grow along with cumulative load reduction. There are also avoided emission control costs associated with the retirement of some older coal facilities. Then as load growth returns after 2020 more capital investment is needed so that the net savings start to level off.

Figure 8. Avoided Costs in the Southwest



For comparison with the cost of the High EE programs, we present below the utility avoided costs and customer bill savings in Table 6, in net present value terms. The utility avoided cost categories do not reflect labor and material costs, nor taxes. The bill impacts represent a more complete representation of the total costs. Note that the savings from the High EE programs are significantly more than the total program and participant costs.

Natural gas prices represent a key uncertainty in this analysis. A sensitivity analysis indicates that a 30% increase in natural gas prices would increase total fuel cost savings for the High EE versus the Reference Case by 17% and increase overall customer savings by 5%. The benefit-cost ratio would also increase by 5% from 2.11 to 2.22. A decrease in the natural gas price would reduce the savings by the same amounts.

Table 6. Southwest Region Benefit & Cost Comparison

Utility Avoided Costs	NPV (M 2010$) (2010-2030)
Capacity	8,320
T&D	2,380
Pollution Control	2,084
O&M	4,070
Fuel	10,566
Customer Savings	
Bill Impacts	36,611
EE Costs	
Program Costs	8,230
Participant Costs	9,124
Total EE Costs	**17,354**
Benefit Cost Ratio	**2.11**

Conclusion

Our analysis of 18 “best practice” programs found that most states in the Southwest and Mountain U.S. (Arizona, Colorado, Nevada, New Mexico, and Utah) could scale up to at least 20% electricity savings by 2020 (starting with 2010 as year one), and that Wyoming could scale up to 15% savings by 2020. While existing program portfolios in the states give the region a head start toward these levels, the region still needs a steady and aggressive ramp-up in participation rates through a comprehensive set of best practice programs to achieve the estimated regional electricity savings of 21%. We find that these electricity savings would be generated mostly through business (commercial and industrial) programs (64%) and the rest through residential programs (36%). We estimate that this mix of best practice programs would cost the region about $17.4 billion (net present value, 2010$) from 2010 through 2020 in program and participant costs, with levelized costs for the efficiency programs on average 2.2 cents/kWh for business programs and 3.5 cents/kWh for residential programs. We estimate customer bill savings of $36.6 billion (net present value, 2010$), and a benefit-cost ratio of 2.1. Finally, we estimate avoided capacity of 13,500 MW by 2030.

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