THE NEW MOTHER LODE

The Potential for More Efficient Electricity Use in the Southwest

A report in the Hewlett Foundation Energy Series

November 2002

THE NEW MOTHER LODE

The Potential for More Efficient Electricity Use in the Southwest

A report in the Hewlett Foundation Energy Series

November 2002

Southwest Energy Efficiency Project
2260 Baseline Road, Suite 212
Boulder, CO 80302
(voice) 303.447.0078
(fax) 303.786.8054
www.swenergy.org

This study is available on the SWEEP (www.swenergy.org) and Energy Foundation (www.ef.org) websites.

PREFACE

This study was prepared by a team of researchers commissioned by the Southwest Energy Efficiency Project (SWEEP). Howard Geller, director of SWEEP, conceived the study and supervised the project. He also wrote the Executive Summary, Chapters 1 and 5, and edited the entire study. Chapter 2 along with Appendices A, B, and C were prepared by Neal Elliott, Toru Kubo, Steve Nadel, and Anna Shipley of the American Council for an Energy-Efficient Economy, along with Robert Mowris of Robert Mowris and Associates, Patti Case of the Etc Group, Inc., and Steve Bernow and Rachel Cleetus of the Tellus Institute. Chapter 3 and Appendix D were prepared by Alison Bailie, Steve Bernow, Bill Dougherty, and Ben Runkle of the Tellus Institute. Chapter 4 was prepared by Marshall Goldberg of MRG & Associates. Larry Kinney and Mark Ruzzin of SWEEP assisted with portions of Chapter 5, the appendices, editing, and formatting.

A number of individuals provided valuable information and/or reviewed a draft of the study. We thank Jeff Bumgarner, Jeff Burks, Mark Case, Ed Lewis, Arnold Lopez, John Nielsen, Jeff Schlegel, Chris Schroeder, Harold Trujillo, and Heidi VanGenderen for their assistance in this regard.

The Energy Foundation and the Hewlett Foundation provided primary funding for this study. In addition, the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy and the U.S. Environmental Protection Agency, Office of Air and Radiation provided supplemental funding. All views and opinions expressed herein are those of SWEEP and do not necessarily reflect the views of the funders, contributors, or reviewers.

TABLE OF CONTENTS

HIGHLIGHTS

The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest examines the potential for and benefits from increasing the efficiency of electricity use in the southwest states of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming. The study models two scenarios, a "business as usual" Base Scenario and a High Efficiency Scenario that gradually increases the efficiency of electricity use in homes and workplaces during 2003-2020.

Major regional benefits of pursuing the High Efficiency Scenario include:

- Reducing average electricity demand growth from 2.6 percent per year in the Base Scenario to 0.7 percent per year in the High Efficiency Scenario;
- Reducing total electricity consumption 18 percent (41,400 GWh/yr) by 2010 and 33 percent (99,000 GWh/yr) by 2020;
- Eliminating the need to construct thirty-four 500 megawatt power plants or their equivalent by 2020;
- Saving consumers and businesses $28 billion net between 2003-2020, or about $4,800 per current household in the region;
- Increasing regional employment by 58,400 jobs (about 0.45 percent) and regional personal income by $1.34 billion per year by 2020;
- Saving 25 billion gallons of water per year by 2010 and nearly 62 billion gallons per year by 2020; and
- Reducing carbon dioxide emissions, the main gas contributing to human-induced global warming, by 13 percent in 2010 and 26 percent in 2020, relative to the emissions of the Base Scenario.

These significant benefits can be achieved with a total investment of nearly $9 billion in efficiency measures during 2003-2020 (2000 $). The total economic benefit during this period is estimated to be about $37 billion, meaning the benefit-cost ratio is about 4.2. The efficiency measures on average would have a cost of $0.02 per kWh saved.

The High Efficiency Scenario is based on the accelerated adoption of cost-effective energy efficiency measures, including more efficient appliances and air conditioning systems, more efficient lamps and other lighting devices, more efficient design and construction of new homes and commercial buildings, efficiency improvements in motor systems, and greater efficiency in other devices and processes used by industry. These measures are all commercially available but underutilized today. Accelerated adoption of these measures cannot eliminate all the electricity demand growth anticipated by 2020 in the Base Scenario, but it can eliminate most of it.

The High Efficiency Scenario indicates slightly different savings levels among the six states. The savings potential in 2010 equals 17 percent in Colorado and Utah, 18 percent in Arizona and Nevada, and 19 percent in New Mexico and Wyoming. The savings potential in 2020 equals 31 percent in Colorado, Nevada, and Utah, 34 percent in Arizona, and 36 percent in New Mexico and Wyoming.

The study acknowledges that the High Efficiency future will not happen on its own. While some utility, state, and local energy efficiency programs are advancing energy efficiency in the region, these programs are relatively limited in scope and budget. The study recommends new and expanded initiatives to achieve the High Efficiency future and its benefits, including:

- Adopting Systems Benefit Charges or Energy Efficiency Performance Standards to expand utility-based energy efficiency programs;
- Providing utilities with financial incentives to implement effective energy efficiency programs;
- Reforming utility rates to encourage greater energy efficiency;
- Upgrading to state-of-the-art building codes and promoting the construction of highly efficient new buildings that exceed these codes;
- Adopting minimum efficiency standards on products not yet covered by national standards;
- Providing sales tax waivers or income tax credits for innovative energy-efficient technologies;
- Expanding participation in industrial voluntary commitment programs;
- Adopting "best practices" in public sector energy management;
- Expanding energy efficiency training and technical assistance programs; and
- Incorporating energy efficiency initiatives in pollution control strategies.

Implementing a combination of these policies could result in achieving the full savings potential identified in this study, 18 percent savings by 2010 and 33 percent saving by 2020 for the region as a whole. The time has come for the southwest to "mine" this most attractive energy resource—greater energy efficiency.

EXECUTIVE SUMMARY

INTRODUCTION

The southwest region, consisting of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming, is the fastest growing region of the country in terms of both population and electricity demand. Electricity demand in this region rose 3.7 percent per year on average during 1990-2000, compared to 2.5 percent per year for the nation as a whole. The region is also heavily dependent on coal-fired power plants. These plants provided 72.5 percent of the 269,000 GWh of electricity generated in the six-state region in 1999.

Both coal and natural gas are produced in large quantities in the region. With plentiful and inexpensive fuels, electricity is relatively low cost. The consumption-weighted average electricity price in the region was about 6.2 cents per kWh as of 2000, about 10 percent less than the national average of 6.8 cents per kWh. Within the region, prices are above average in Arizona and New Mexico mainly because of the expensive nuclear power capacity co-owned by utilities in these states.

The region as a whole spent $11.6 billion on electricity purchases as of 2000. This is equivalent to about $2,100 per household (i.e., the sum includes the money spent by businesses and households on electricity, not just direct household purchases). For comparison, this is slightly more than property taxes paid in these states and about half what state and local governments spend on education in these states. Electricity expenditures are increasing due to both rising electricity prices and growing electricity consumption.

Due to high growth in electricity use, many new power plants and associated transmission and distribution (T&D) facilities are under construction or proposed in the region. Today utilities are mainly constructing gas-fired power plants, but some new coal-fired power plants have been proposed and are undergoing regulatory review. High growth in electricity use causes a number of problems including:

- placing upward pressure on electricity and natural gas prices,
- causing power plant and transmission line siting controversies,
- increasing the risk of power outages and diminished electrical reliability,
- increasing air pollution and other adverse environmental impacts,
- increasing the social and monetary costs associated with pollution-related illnesses,
- increasing water consumption, and
- increasing the "greenhouse gas" emissions that are contributing to global warming.

This study analyzes the technical and economic potential for improving the efficiency of electricity use in the southwest region. It develops a High Efficiency Scenario assuming aggressive but achievable implementation of cost-effective efficiency measures, as well as a

Base Scenario assuming a continuation of current policies and trends. The two scenarios are compared in terms of their impacts on construction of new power plants, total energy supply costs, regional employment and income, water consumption, and pollutant emissions. In addition, this study reviews the policies and programs that are promoting more efficient electricity use in the region, and recommends new or expanded policies that would accelerate the implementation of cost-effective efficiency measures.

ENERGY EFFICIENCY POTENTIAL (Chapter 2)

Specific Savings Opportunities

Many cost-effective energy savings measures are available in the marketplace today. For commercial buildings, large energy savings can be achieved through: 1) installing more efficient lighting systems, 2) replacing HVAC equipment with more efficient units and improving the efficiency of existing HVAC systems, 3) testing and sealing air distribution ducts, and 4) replacing inefficient office equipment with more energy-efficient products. Replacing lighting systems in commercial buildings with more efficient fixtures, lamps, ballasts, and improved controls can save more than 50 percent of lighting energy use. We estimate that the payback period for lighting efficiency improvements in commercial buildings is only 1.3 years on average. Installing more efficient fans, chillers, and packaged air conditioning equipment in commercial buildings can reduce overall electricity consumption by 14-18 percent with a payback of 1.3-2.0 years on the incremental first cost. Testing and sealing air distribution ducts can save 9-15 percent of a building's total electricity consumption with a payback period of 2.8-3.4 years on average. And energy-efficient office equipment can reduce total electricity consumption by 15-20 percent in office buildings at minimal incremental cost.

In the residential sector, the major electricity savings opportunities are in the areas of lighting, water heating, and air conditioning. Use of more energy efficient lamps can save approximately 630 kWh per year per home, over two-thirds of the energy used for lighting in a typical home. We estimate that the payback period for these efficiency measures is around 2.4 years on average. Electricity use for water heating can be cut by 50 percent or more through measures that lower hot water use as well as increase the efficiency of water heating. Substantial electricity savings also will occur when older refrigerators and freezers are replaced with new models. But these savings are occurring due to national appliance efficiency standards that have already been adopted, so we do not include these savings in the High Efficiency Scenario.

There are many techniques for reducing electricity use for air conditioning through lowering cooling load (e.g., installing energy-efficient windows, programmable thermostats, reflective roofs, and more efficient lighting) and increasing cooling system efficiency (e.g., high efficiency air conditioners, air conditioner tune-ups, duct testing and sealing, and conversion to evaporative cooling). The overall savings potential from a combination of these measures can be 70 percent or greater, with an estimated payback period of 3.2 years on average in the southwest region.

In the industrial sector, motors consume about two-thirds of electricity used in general. Furthermore, motors consume about 90 percent of the electricity used in the mining industry, the most important industrial sub-sector in the southwest. Energy savings opportunities exist in both the motor, the motor-driven device (e.g., fan, compressor, or pump), and in overall motor system design. These measures include replacing oversized motors, cutting unnecessary flows and friction losses in fluid systems, improving gear ratios, changing fan pulleys or trimming pump impellers, and replacing throttling valves with adjustable speed drives or other speed control devices. Electricity use can drop by 5-50 percent depending on the characteristics of the initial system.

Compressed air systems often present a significant opportunity for cost-effective energy savings through cutting leaks and inappropriate uses, reducing operating pressure, improving maintenance, and installing better controls. The overall savings range from 25 to over 60 percent.

Increasing energy efficiency can provide a variety of non-energy benefits in addition to saving energy. For example, sealing and properly sizing air distribution ducts as well as properly sizing air conditioning systems can greatly improve thermal comfort within homes. Use of daylighting can increase worker productivity or retail sales in the commercial sector, as well as student performance in schools. And industrial process efficiency improvements can improve productivity, reduce materials use and waste, and save energy. These non-energy benefits were not considered or included in this study, suggesting that our results are conservative.

Analytical Methodology

In the Base Scenario, we estimate that residential electricity demand will increase 2.4 percent per annum, commercial sector electricity demand 3.5 percent per annum, and industrial electricity demand by 1.6 percent per annum during 2003-2020. The overall growth rate for electricity demand is 2.6 percent per annum in the Base Scenario.

The High Efficiency Scenario assumes widespread adoption of cost-effective, commercially available energy efficiency measures during 2003-2020. For the buildings sectors, the analysis was conducted using a “bottom up” approach that considers a wide range of efficiency measures for different end uses and building types. The analysis examined six different building types: single family homes, multifamily homes, office buildings, retail stores, schools, and food service/sales buildings. For each building type, separate analyses were carried out for typical new and existing buildings. Furthermore, in-depth analyses were carried out for two cities in the region: Denver (representative of the northern tier states) and Las Vegas (representative of the southern tier states). The cost-effective savings potential identified for these building types and cities was then extrapolated to other building types and locales in the region.

Aggregate energy savings potential was estimated by first determining the proportion of the building stock for which each efficiency measure is appropriate (i.e., had not been installed yet, is technically feasible, and is cost-effective to consumers on a life-cycle cost basis). Efficiency measures were considered cost effective if they exhibited a cost of saved energy below the retail electricity price, with a 5 percent real discount rate used to compute cost of saved energy. For measures such as high efficiency appliances or air conditioners, the "cost" of the measure is the incremental cost for greater energy efficiency at the time of equipment replacement or purchase for a new building. In addition, we added 10 percent to the installed cost of all efficiency measures to account for policy and program implementation costs.

Regarding implementation rates, we assumed aggressive but potentially achievable implementation of cost-effective efficiency measures. For existing buildings, we assumed that cost-effective measures would be gradually installed during 2003-2020, specifically that 4.4 percent of cost-effective measures would be implemented each year. This means that 80 percent of the identified cost-effective savings potential would be realized in existing buildings by 2020. For new buildings, we assumed that 50 percent of the cost-effective measures would be installed starting in 2003 and that this fraction gradually increases, reaching 100 percent in new buildings constructed in 2010 and thereafter. A high level of implementation is possible in new buildings through the adoption and enforcement of building energy codes. However, our analysis is conservative in that it does not include additional energy efficiency measures beyond those identified as cost-effective today, even though it is nearly certain that additional measures will be developed and commercialized in the future.

In the industrial sector, the Long-Term Industrial Energy Forecasting (LIEF) model was used to analyze cost-effective electricity savings potential. This computer model, developed by Argonne National Laboratory, projects future electricity consumption by industrial sub-sector based on growth in output and changes in energy intensity. Energy intensity is influenced by three key variables in the model related to the cost effectiveness and adoption of energy efficiency measures – the assumed penetration rate, the capital recovery factor (CRF), and projected electricity prices. The LIEF model contains assumptions regarding the cost for achieving different levels of energy savings in 17 industrial sub-sectors.

For the Base Scenario, we assumed a CRF of 33 percent and a penetration rate for cost-effective energy efficiency measures of 3.25 percent. This CRF and penetration rate are typical of decision making in industries today where a host of factors discourages pursuit of energy efficiency measures with more than a 2 or 3 year payback.

For the High Efficiency Scenario, we assumed that industries accept a longer payback period and implement energy efficiency measures more rapidly because they are better informed about energy efficiency opportunities and their potential benefits, the transaction costs for obtaining efficiency measures are reduced, technical assistance is offered, and financial incentives are provided. In particular, the CRF was reduced to 9.6 percent and the penetration rate for cost-effective efficiency measures was increased to 6.5 percent per year in the High Efficiency Scenario.

Results

Figure ES-1 shows growth in electricity demand in 2010 and 2020 in the Base and High Efficiency Scenarios for the region as a whole. In the Base Scenario, electricity demand increases 59 percent between 2002 and 2020. In the High Efficiency Scenario, the increase in electricity demand is limited to 13 percent during this time period. The overall cost-effective electricity savings potential for the region is about 18 percent (41,400 GWh/yr) by 2010 and 33 percent (99,000 GWh/yr) by 2020 in the High Efficiency Scenario (relative to electricity demand in the Base Scenario).

Figure ES-1. *Total Electricity Consumption in the Base and High Efficiency Scenarios*

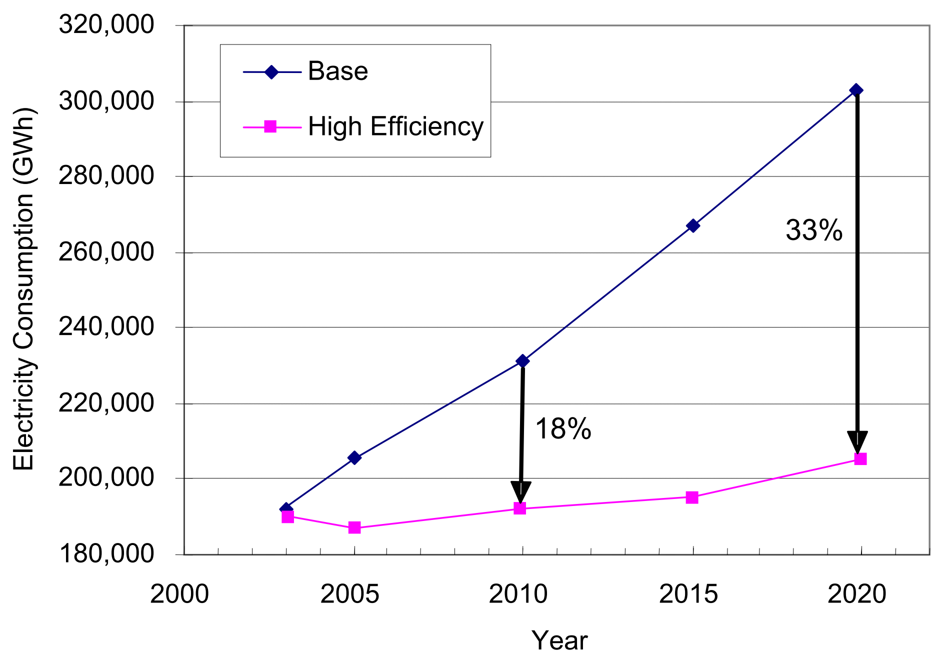


Table ES-1 shows the energy savings potential results for the six states as well as the region in 2020, disaggregated by sector. The savings potential is highest in the commercial sector (37 percent by 2020), followed by the industrial sector (33 percent by 2020), and then the residential sector (26 percent by 2020). The savings potential is approximately the same in percentage terms among states for the commercial sector. However, there is moderate variation in savings potential among states in the residential and industrial sectors due to differences in climate, industrial mix, and electricity prices. The overall savings potential varies from a low of 31 percent in Colorado, Nevada, and Utah to a high of nearly 36 percent in New Mexico and Wyoming.

Table ES-1. *Energy Savings Potential in 2020 by Sector and State*

		Region	AZ	CO	NV	NM	UT	WY
Commercial Sector								
Baseline Consumption	GWh	134,780	50,667	36,903	16,625	11,261	15,645	3,680
Savings Potential	GWh	50,291	18,862	13,655	6,087	4,356	5,866	1,465
Savings Potential	%	**37.3**	**37.2**	**37.0**	**36.6**	**38.7**	**37.5**	**39.8**
Residential Sector								
Baseline Consumption	GWh	93,557	38,602	19,902	14,085	7,488	10,474	3,007
Savings Potential	GWh	24,593	11,546	4,408	3,067	2,319	2,506	748
Savings Potential	%	**26.3**	**29.9**	**22.1**	**21.8**	**31.0**	**23.9**	**24.9**
Industrial Sector								
Baseline Consumption	GWh	74,043	18,522	14,875	14,812	6,122	10,766	8,947
Savings Potential	GWh	24,150	6,180	4,290	5,000	2,220	3,130	3,340
Savings Potential	%	**32.6**	**33.3**	**28.8**	**33.8**	**36.3**	**29.1**	**37.3**
All Sectors								
Baseline Consumption	GWh	302,381	107,790	71,680	45,521	24,871	36,885	15,633
Savings Potential	GWh	99,039	36,584	22,351	14,154	8,896	11,500	5,552
Savings Potential	%	**32.8**	**33.9**	**31.2**	**31.1**	**35.8**	**31.2**	**35.5**

UTILITY ANALYSIS (Chapter 3)

To estimate the energy, economic and environmental benefits of the electricity savings in the High Efficiency Scenario, we used the National Energy Modeling System (NEMS), a computer model developed and routinely used by the Energy Information Administration of the U.S. Department of Energy. For each scenario, NEMS determines the construction and operation of power plants required to meet electricity demand and to comply with various regulations. The difference in costs, energy consumption, water consumption, and emissions between the two scenarios represents the impacts of the energy efficiency measures.

The High Efficiency Scenario leads to a wide range of energy, economic and environmental benefits for the region as a whole including:

- Avoiding the construction of thirty-four 500 MW power plants (or equivalent) during 2003-2020;
- Saving households and businesses $28 billion net during 2003-2020, or about $4,800 per current household in the region;

- Saving nearly 25 billion gallons of water annually by 2010 and 62 billion gallons by 2020; and
- Cutting pollutant emissions during 2003-2020 by:
    - 176 million metric tons of carbon;
    - 57,000 tons of SO_2;
    - 347,000 tons of NO_x; and
    - 2.2 tons of mercury.

Table ES-2 presents more details regarding the regional economic results. The expenditure of almost $8.9 billion on energy-efficient measures in the High Efficiency Scenario results in about $34.7 billion in reduced electricity sector costs and an additional $2.4 billion in reduced natural gas costs, leading to a net benefit of $28 billion and region-wide benefit-cost ratio of about 4.2.

Table ES-2. *Regional Economic Analysis Results (2000 dollars)*

	2010	2020	Cumulative present value 2003-2020
Cost of Energy Efficiency Measures (billion $)			
Commercial	0.27	0.73	3.04
Residential	0.30	0.71	3.20
Industrial	0.26	0.42	2.60
Total:	0.84	1.86	8.85
Benefits (billion $)			
Avoided Electric Supply Costs[a]	3.32	7.92	34.66
Natural Gas Price Effects[b]	0.18	0.42	2.39
Total:	3.50	8.34	37.06
Net Benefit (billion $)	**2.66**	**6.48**	**28.21**
Net Benefit per household ($)[c]	**451**	**1,100**	**4,788**
Benefit-Cost Ratio	**4.15**	**4.48**	**4.19**

[a] *Represents avoided capital and operating costs in electricity, including generation, transmission and distribution.*
[b] *Accounts for reduced natural gas prices in the residential, commercial, and industrial sectors as a result of less natural gas demand for electricity generation.*
[c] *Calculated as the net benefit, combining benefits to households and businesses, divided by the number of households in the region in 2000.*

Table ES-3 presents the environmental results for the region as a whole. Carbon dioxide (often referred to and measured in terms of tons of carbon) is the main "greenhouse gas" contributing to human-induced global warming. The High Efficiency Scenario reduces carbon emissions by 13 percent in 2010 and 26 percent in 2020 relative to emissions in the Base Scenario. The carbon emission reductions are relatively close to the electricity savings in percentage terms.

Reductions in other pollutant emissions are positive but relatively modest in percentage terms. Sulfur dioxide (SO_2) emissions reductions are regulated under the federal cap and trade program. Utilities respond to lower electricity demand in the High Efficiency Scenario by limiting their investments, compared to the Base Scenario, in measures to reduce SO_2 emissions, such as installing scrubbers or shifting to lower sulfur coal. The utilities save money through these actions but the total amount of SO_2 emissions is only decreased by 1 percent in 2010 and 4 percent in 2020 in the High Efficiency Scenario, relative to emissions in the Base Scenario.

Nitrogen oxides (NO_x) emissions reductions are relatively modest (2 percent by 2010 and 5 percent by 2020) because new power plants generally have much lower NO_x emissions rates than existing plants. Mercury emission reductions are also relatively modest (3 percent by 2010 and 7 percent by 2020) because of the type of power plants and fuels that are avoided, and their level of pollution control.

Table ES-3. *Regional Environmental Results*

	2010		2020	
Pollutant	Reductions	% Change[a]	**Reductions**	% Change[a]
Carbon (MMTCE)	8.40	13	19.84	26
SO_2 (million tons)	0.005	1	0.015	4
NO_x (million tons)	0.016	2	0.036	5
Mercury (tons)	0.110	3	0.275	7

[a] *Reduction in emissions relative to levels in the Base Scenario.*

State-by-state economic and environmental results are presented Table ES-4. While there are not large differences among states in terms of benefit-cost ratio or percentage emissions reductions, there are some differences due to variations in savings potential, the type of generation avoided, and the ratio of savings to total power generation among the states.

Table ES-4. *Economic and Environmental Impacts of the High Efficiency Scenario by State*

Parameter:	State					
	AZ	CO	NV	NM	UT	WY
Economic impacts, cumulative present value during 2003-2020 in billion dollars						
Cost of efficiency measures	3.3	2.0	1.1	0.8	1.1	0.5
Benefits of efficiency measures	13.8	8.5	5.2	3.6	3.9	2.1
Net benefits	10.5	6.4	4.1	2.8	2.9	1.5
Benefit-cost ratio	4.2	4.2	4.6	4.3	3.7	3.9
Environmental impacts, percent reduction in emissions in 2020						
Carbon emissions	36	30	30	20	19	8
SO_2 emissions	11	5	3	3	2	0
NO_x emissions	11	7	7	3	3	1
Mercury emissions	12	17	15	2	12	1

Conventional fossil fuel-based power plants consume a substantial amount of water for power generation, primarily in their cooling systems. We estimate that a typical new coal-fired power plant in the region consumes about 0.67 gallons of water per kWh while a typical new natural gas-fired combined cycle power plant consumes about 0.33 gallons of water per kWh. In addition to water savings from reduced conventional power generation, the High Efficiency Scenario will lead to water savings from the accelerated adoption of resource-efficient clothes washers and other water conservation measures in homes.

Table ES-5 shows the estimated water savings in 2010 and 2020 from both reduced power generation and increased penetration of resource-efficient clothes washers. The overall water savings for the region as a whole reach about 25 billion gallons per year in 2010 (equivalent to about 76,000 acre-feet or the water consumed annually by around 137,000 households). The water savings reach nearly 62 billion gallons per year in 2020 (equivalent to about 189,000 acre-feet or the water consumed annually by around 339,000 households).

Table ES-5. *Water Savings Results (billion gallons per year)*

STATE	**2010**	**2020**
Arizona	8.99	22.41
Colorado	5.78	14.24
Nevada	3.35	8.46
New Mexico	3.26	6.53
Utah	2.25	6.93
Wyoming	1.10	3.00
Region	**24.7**	**61.6**

MACROECONOMIC IMPACTS (Chapter 4)

We used input-output analysis to estimate the potential employment and other macroeconomic impacts of the High Efficiency Scenario, in contrast to the Base Scenario. Input-output analysis considers the direct as well as indirect effects from shifting expenditures in a state or regional economy. For example, it takes into account how a purchase of energy-efficient lighting affects the purchaser, lighting suppliers and manufacturers, utilities, and the economy as a whole through spending energy bill savings on other goods and services.

The analysis finds that shifting expenditures away from electricity purchases and towards energy efficiency measures has a positive effect on state and regional economies. As it turns out, the electric utility industry in the region supports only four to five jobs per million dollars of expenditures, as compared to 11 – 16 jobs in the construction sector, 17 – 27 jobs in the services sector, and 23 – 33 jobs in the retail sector. Likewise the coal mining industry supports relatively few jobs, just 5 – 8 jobs per million dollars of expenditures. Much of the net job creation from energy efficiency improvements is derived from the difference between jobs intensity between the electric utility and other sectors.

Using a state-specific input-output model known as IMPLAN, we estimated the changes in Gross State Product (GSP), wage and salary compensation, and employment levels that would occur if the High Efficiency Scenario were to occur rather than the Base Scenario. Table ES-6 presents the results in 2010 and 2020 by state and for the region as a whole. Both wage and salary earnings and employment rise as a result of pursuing the High Efficiency Scenario rather than the Base Scenario. By 2020, regional wage and salary earnings increase by $1.34 billion (in 2000 dollars) and regional employment increases by 58,400 jobs. However, regional GSP declines slightly in the High Efficiency Scenario for a number of reasons, primarily due to declining capital investment (see Chapter 4). Even though GSP falls, wage and salary compensation rises as labor payments are substituted for capital investment in the larger economy.

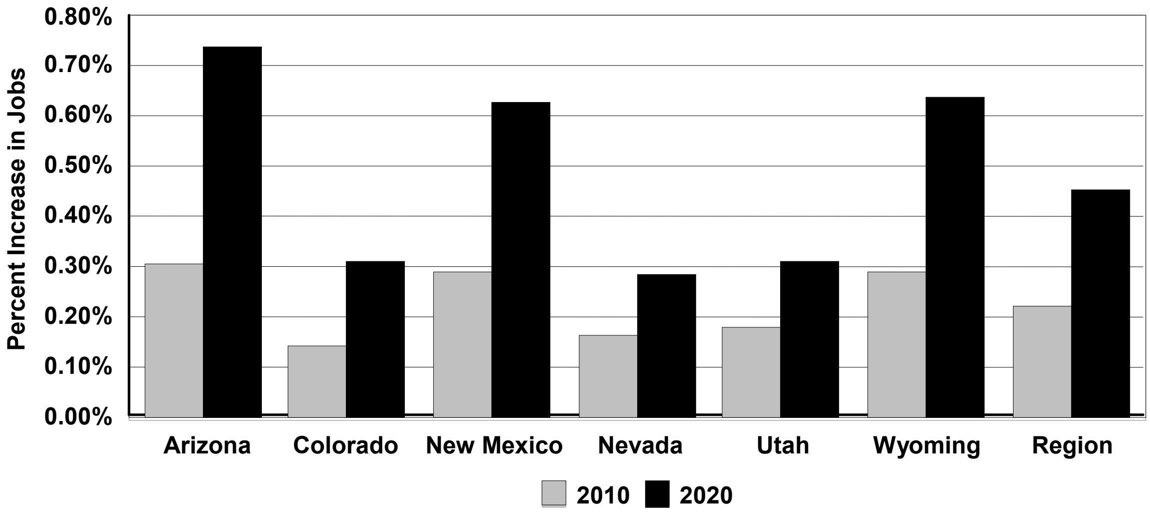
Table ES-6. *Macroeconomic Impacts from the High Efficiency Scenario*

Year	Net Change in Jobs	Change in Wage and Salary Compensation (Million $)	Change in Gross State Product (Million $)
Arizona			
2010	8,100	$180	($130)
2020	24,100	$550	($230)
Colorado			
2010	4,000	$90	($60)
2020	12,200	$280	($100)
New Mexico			
2010	2,600	$50	($50)
2020	6,900	$130	($110)
Nevada			
2010	2,400	$60	($40)
2020	6,300	$180	($90)
Utah			
2010	2,200	$50	$0
2020	6,300	$160	$50
Wyoming			
2010	800	$20	($30)
2020	2,000	$40	($60)
Region			
2010	20,500	$450	($320)
2020	58,400	$1,340	($560)

Notes: *Dollar figures are in millions of 2000 dollars while employment is expressed in full-time equivalent. Region totals are slightly different from the sum of six states due to independent rounding.*

As shown in Figure ES-2, the increase in employment in 2010 averages slightly over 0.2 percent for the region as a whole and ranges from 0.14 percent in Colorado to 0.30 percent in Arizona. By 2020, the increase in employment averages about 0.45 percent for the region as a whole and ranges from 0.28 percent in Nevada to 0.74 percent in Arizona. The variation among states is caused by differences in economic and population structure, electricity savings potential, and projected job growth. Arizona has the highest percent increase in jobs primarily because it has a relatively low employment-to-population ratio (i.e., there are a large number of retirees in Arizona).

Figure ES-2. *Job Increases Due To the High Efficiency Scenario*



Chapter 4 also includes estimates of job gain and loss by sector, for each state and the region as a whole. In general, the utility and energy supply sectors (coal, oil, and gas production) are the only sectors that lose jobs in moving from the Base to the High Efficiency Scenarios. All other sectors including manufacturing, services, retail trade, government, and construction gain jobs. Furthermore, the total regional jobs gain by 2020 (66,000) is about nine times the jobs loss (7,500).

Electric utilities are the main sector that loses jobs in the High Efficiency Scenario. Fewer utility jobs are sustained as fewer new power plants are needed and less electricity is produced. But utilities could mitigate or offset this effect if they move into the energy efficiency business, thereby absorbing some of the job gains assigned to other sectors — such as the construction and service sectors.

Finally, it should be noted that the full economic effects of the efficiency improvements are not accounted for since the analysis ignores electricity bill savings beyond 2020. Nor does the analysis include the non-energy benefits that are likely to result along with energy savings. These can be substantial, especially in the industrial sector. To the extent these "co-benefits" are realized in addition to the energy savings, the macroeconomic benefits would be greater than those reported here.

POLICY REVIEW AND RECOMMENDATIONS (Chapter 5)

Some utility, state, and local energy efficiency programs are advancing energy efficiency in the southwest including but not limited to:

- Utility energy efficiency programs operating in Colorado and Utah;
- Reasonably up-to-date building energy codes in some jurisdictions in Colorado, Nevada, and all of Utah;
- Energy-efficient new home promotion, training, and incentive programs in Phoenix, Tucson, Las Vegas, and Utah;
- Initiatives to upgrade the energy efficiency of public sector buildings (i.e., state and local buildings and schools) in nearly all of the southwest states; and
- Energy audits and technical assistance provided by the three Industrial Assessment Centers in the region.

Presently, these programs are relatively limited in scope and budget, and not adequate for overcoming the barriers inhibiting widespread improvements in efficient electricity use. More important, many critical policies and programs are absent in parts of the region. As a result, inefficient electricity use is commonplace in homes, commercial buildings, and industries. The status of energy efficiency policies and programs in each of the six states is reviewed in Chapter 5. In addition, we recommend a broad set policy initiatives that would lead to greater adoption of cost-effective energy savings measures in the region. These recommendations are summarized below.

Recommendation: ***Adopt Systems Benefit Charges or Energy Efficiency Performance Standards to Expand Utility-based Energy Efficiency Programs***

A Systems Benefit Charge (SBC) is a small surcharge paid by all electric utility consumers to fund energy efficiency programs implemented by either utilities or other program administrators. About 20 states across the country have adopted SBCs. We recommend that the southwest states adopt SBC mechanisms (or in some cases expand existing SBC mechanisms) to greatly increase funding for utility energy efficiency programs, except perhaps in Utah where utility efficiency programs are expanding already. Doing so could increase funding for energy efficiency programs in the region by 9 times or more, and could result in 10-15 percent electricity savings in the region by 2020.

The adoption of an Energy Efficiency Performance Standard (EEPS), which Texas has pioneered, is an alternative approach to achieving these savings. An EEPS would specify energy savings targets and timetables for electric utilities, rather than specifying funding levels. As part of this policy, it may be possible to establish a market for energy savings certificates or credits, thereby enabling independent developers of energy efficiency projects (e.g., energy service companies) to participate in and benefit from the energy savings requirements.

Recommendation: ***Undertake Energy Efficiency and Load Management Efforts to Help Defer Transmission and Distribution (T&D) System Investments***

Geographically-targeted energy efficiency improvements and peak load reduction efforts can help to defer costly investments in T&D systems and can help to improve power reliability in areas with heavily loaded T&D lines. Utility regulators in the region should insist that utilities undertake targeted DSM efforts if this appears to be technically and economically feasible as a means for deferring T&D system investments. A targeted DSM program would attempt to achieve high participation rates in a particular neighborhood or community. It might involve additional efficiency measures and/or program delivery mechanisms, increased financial incentives, and enhanced marketing.

Recommendation: ***Provide Utilities with Financial Incentives to Implement Effective Energy Efficiency Programs***

Many utilities resist operating vigorous end-use energy efficiency programs because it reduces their sales and revenues in the short run. Therefore, utility regulators or legislatures in states such as California, Massachusetts, Minnesota, New York, and Oregon have offered utilities the opportunity to benefit financially from operating effective energy efficiency programs. These financial incentives, sometimes known as shareholder incentives, reward utilities based on the level of energy savings produced and/or cost effectiveness of their energy efficiency programs. We recommend offering shareholder incentives to all investor-owned utilities that operate substantial and cost-effective energy efficiency programs in the southwest region. An incentive level of 15-25 percent of the net economic benefits provided by the programs should be adequate. This recommendation is consistent with the energy policy approved by the Western Governors' Association.

Recommendation: ***Reform Utility Rates to Encourage Greater Energy Efficiency***

Today residential and smaller commercial customers in the southwest states generally pay flat rates; i.e., they pay the same amount per kWh of electricity consumed. Instead of flat rates, customers could pay tiered rates (also known as inverted block rates), whereby rates increase as usage increases. This would give consumers and businesses an additional financial incentive to reduce their overall electricity consumption.

Time-of-use rates charge more for electricity use during high load, high cost periods (and less during off-peak, low cost periods). As much as a 10 percent average electricity savings has occurred in well-designed time-of-use rates programs, due in part to providing participants with practical load control devices. We recommend adopting tiered rates and time-of-use rates in the southwest states, in conjunction with expanded utility (or state-based) energy efficiency programs and financial incentives to reward utilities for operating effective programs.

Recommendation: ***Upgrade to State-of-the-Art Building Energy Codes***

State-of-the-art energy codes such as the latest version of the International Energy Conservation Code (IECC) will reduce electricity use and peak load in new homes and commercial buildings. State-of-the-art building energy codes should be adopted statewide in New Mexico, Nevada, and Wyoming since these are not home rule states. Likewise, state-of-the-art codes should be adopted at the local level where this has not yet been done in Arizona (especially in Phoenix) and Colorado (especially in the Denver and Colorado Springs areas) given that these are home rule states. All of these states and localities should consider enhancing the IECC or ASHRAE standards with modifications that further improve energy efficiency in a hot, dry region.

Recommendation: ***Expand Training and Technical Assistance Efforts to Achieve High Levels of Code Compliance***

Training and assisting architects, builders, contractors, and building code officials is critical to the successful implementation of building energy codes. Training and technical assistance is needed in a variety of areas including integrated building design, proper sizing and installation of HVAC systems, proper air tightness and insulation procedures, and the use of state-of-the-art technologies and design strategies. We recommend that state energy agencies, local energy offices, utilities, and private organizations in the southwest expand their efforts related to energy code training and enforcement. Utilities in particular should support code implementation as part of their energy efficiency programs, in addition to encouraging construction of highly efficient "beyond code" new homes and commercial buildings.

Recommendation: ***Expand Efforts to Promote the Construction of Highly Efficient New Buildings that Exceed Minimum Code Requirements***

It is possible to reduce the energy consumption of new homes and commercial buildings by 30 to 50 percent relative to code requirements, and do so in a cost-effective manner, through an integrated design approach. This potential is not speculative; it has been proven in Civano, AZ, and in the housing developments of Ence, Pulte, and other leading builders in the region. We recommend that energy agencies and utilities in the region replicate the training, promotion, financial incentive, and energy bill guarantee programs that are leading to large numbers of highly efficient new homes in the Phoenix, Tucson, and Las Vegas areas. Also, we recommend expansion and replication of exemplary commercial building new construction programs such as Utah's state buildings design assistance and incentive program or the Energy Design Assistance Program implemented on a pilot scale by Xcel Energy in Denver.

Recommendation: ***Adopt Minimum Efficiency Standards on Products not yet covered by National Standards***

Appliance efficiency standards adopted at the state and federal levels have been a very effective energy conservation strategy. We recommend that the southwest states emulate the appliance efficiency standards recently adopted in California if the federal government does not do so. In addition, the southwest states should follow California's lead on standards pertaining to the standby and/or active mode power consumption of electronic devices, should California move ahead with standards in this area.

Recommendation: ***Provide Sales Tax Waivers or Income Tax Credits for Innovative Energy-Efficient Technologies***

We recommend that the southwest states adopt either sales tax waivers or income tax credits on highly energy-efficient products and new buildings, preferably modeled on the successful tax credits program in Oregon. These tax credits can and should be justified based on the net economic benefits they would provide to all consumers and businesses in a state, not just to those that participate. Tax credits should be carefully designed to avoid a high number of "free riders" and consequently high loss of tax revenue and/or small energy benefits, as occurred with the tax credit for alternative fuel vehicles in Arizona. Implementing this policy may be difficult given that most states are now experiencing budget deficits, but the policy merits consideration and implementation once the state budget outlook improves.

Recommendation: ***Adopt "Best Practices" in Public Sector Energy Management***

States and municipalities in the southwest region have adopted a number of useful policies that are cutting energy use and energy bills in public buildings. We recommend that all states and major municipalities adopt "Best Practices" already demonstrated somewhere in the region including: 1) establishing energy savings goals for state and municipal agencies and tracking progress towards the goals; 2) providing technical and financial assistance for implementation of energy savings projects in existing buildings and facilities; 3) constructing new buildings that are exemplary and surpass minimum energy code requirements by a wide margin; and 4) purchasing only Energy Star® labeled products where available.

Recommendation: ***Expand Education and Training in the Buildings Sector***

Many efforts are underway in the southwest region to educate and train consumers and businesses about ways to improve energy efficiency in residential and commercial buildings. We recommend that energy agencies and utilities undertake additional training and technical assistance efforts including training of HVAC contractors in order to improve air conditioner sizing and installation practices and training to improve the skills of the managers and operators of commercial buildings. Also, public agencies and utilities should collaborate and expand efforts to promote Energy Star® products and buildings, as well as state-of-the-art energy efficiency measures such as new types of evaporative cooling devices, sealing thermal distribution systems, use of reflective roofing materials, and daylighting techniques.

Recommendation: ***Expand Industrial Voluntary Commitment Programs***

Some major companies such as BP, DuPont, and Johnson & Johnson have made significant quantitative commitments for improving energy efficiency and/or reducing greenhouse gas emissions. We recommend initiating or expanding industrial voluntary commitment programs at the state level in the southwest, and/or encouraging greater participation in national commitment programs such as EPA's Climate Leaders program. In all cases, companies would agree to accelerate the implementation of cost-effective efficiency measures and make quantitative energy savings, energy intensity reduction, or carbon emissions reduction commitments. Energy agencies or programs in the region could provide technical assistance to companies that need help, as well as recognition to outstanding companies.

Recommendation: ***Expand Training and Technical Assistance Programs for the Industrial Sector***

We recommend that state energy offices and utilities expand their support for industrial energy efficiency efforts in general by sponsoring additional training courses for industrial energy managers. This training could include well-regarded courses and tools such as the courses, software, and manuals developed by the U.S. Department of Energy (DOE) Motor Challenge and Compressed Air Challenge programs. Training and technical assistance should be offered to all companies, large and small. Also, states and utilities should consider providing supplemental funding to the DOE-sponsored Industrial Assessment Centers in the region.

Recommendation: ***Incorporate Energy Efficiency Initiatives into Air Pollution Control Strategies***

As demonstrated in this study, end-use energy efficiency improvements can reduce pollutant emissions from fossil fuel-based power plants in a cost-effective manner. Environmental officials should support the initiation or expansion of energy efficiency efforts in their states, and incorporate these efforts in their air quality and emissions reduction plans. Environmental agencies, energy agencies, and energy efficiency program managers should work together to develop reasonable estimates of future energy savings and the emissions reductions associated with these savings. In addition, both state and local energy efficiency initiatives should be incorporated into the regional haze reduction plan being developed by the Western Regional Air Partnership.

Achieving the Savings in the High Efficiency Scenario

From the discussion above, it is clear that a wide range of policies and programs can be implemented to promote greater adoption of cost-effective energy efficiency measures. In the final section of this study, we present quantitative estimates of the savings that could result from six of our recommended policies and programs. In addition, we include a modest "market transformation" effect from expanding the energy efficiency supply infrastructure and changing consumer awareness and behavior as a result of implementing these (and other) policies and programs. This means that households and businesses will adopt efficiency measures to a greater degree in the market without incentives or other program-related assistance.

Table ES-7 shows the range of savings from each policy, assuming either moderately aggressive or very aggressive implementation, along with the market transformation effect. The overall savings potential is 28-47 percent by 2020, demonstrating that a combination of policies could result in achievement of the full cost-effective savings identified in this study--33 percent savings by 2020.

Table ES-7. *Potential Electricity Savings from Different Policy Options*

Policy or program	Electricity savings potential in 2020 (%)
Utility-based Energy Efficiency Programs	10 – 15
Utility Rate Reform	3 – 6
Building Codes	4 – 8
Appliance Standards	4
Tax Incentives	1 – 2
Public Sector Investment	1 – 2
Market Transformation Effect	5 – 10
Total	28 – 47

CONCLUSION

This study shows that there is large potential for increasing the efficiency of electricity use and reducing load growth in the southwest region, and doing so cost effectively in spite of the relatively low electricity prices in the region. It does not appear that end-use efficiency improvements can eliminate all the load growth anticipated over the next 18 years, but they can eliminate most of this growth. This study also shows that accelerating energy efficiency improvements will save consumers and businesses money while leading to a net increase in employment and personal income. Thus increasing energy efficiency can be an important economic development strategy for the region.

Accelerating energy efficiency improvements will also help to mitigate other problems associated with high electricity demand growth including rising water consumption, increasing risk of power outages, local and regional air pollution, and greenhouse gas emissions. Many new power plants can be avoided if vigorous energy efficiency improvements occur, thereby eliminating the need for the most contentious power plants and associated T&D facilities. Thus increasing energy efficiency is a "win-win" strategy from the perspective of saving money, boosting the region's economy, conserving precious water resources, and protecting the environment.

The High Efficiency Scenario, and its benefits, will not be realized without the adoption and implementation of new policies and programs to advance energy efficiency. Fortunately, many of these policies and programs have been proven either within the southwest or in other regions. We urge policy makers throughout the southwest to make increasing energy efficiency a high priority. The time has come for the southwest to "mine" this most attractive energy resource.