The Economic Benefits of an Energy Efficiency and Onsite Renewable Energy Strategy to Meet Growing Electricity Needs in Texas

John “Skip” Laitner, Maggie Eldridge, and R. Neal Elliott

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1001 Connecticut Avenue, N.W., Suite 801, Washington, D.C. 20036
(202) 429-8873 phone, (202) 429-2248 fax, http://aceee.org

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ABSTRACT

Texas is one of the most rapidly growing states in the country. One of the critical concerns in maintaining the robustness of the Texas economy is supporting the growing demand for electricity—especially when that growth is rising more quickly than for the United States as a whole. The challenge is to meet the new demand for electricity in ways that maintain competitive electricity costs and also reduce environmental impacts. In March 2007, ACEEE published a report suggesting that a combination of energy efficiency and renewable energy technologies can meet the growing need for electricity. The findings of that report indicated that the alternative energy efficiency and renewable energy scenario could help stabilize overall energy prices, lower electricity bills, and increase system reliability within the state's utility sector. The question answered in this companion study is whether the recommended alternative policy scenario could enable, perhaps even spur, continued economic growth within Texas.

In this follow-up report, we review the macroeconomic impacts that likely would unfold under these alternative policy recommendations. Generally, we find that cost-effective investments in the combination of energy efficiency and alternative generation technologies can actually reduce overall electricity costs, boost net employment, and reduce air pollutants within the state. For example, by 2023 (the last year of this analysis), businesses and households in Texas are expected to enjoy a net savings of more than $5 billion. As a result of this greater energy productivity, the state is projected to show a net employment increase of about 38,300 jobs. This is roughly equivalent to the employment that would be directly and indirectly supported by the construction and operation of 300 small manufacturing plants within Texas. In addition, air emissions from power plants might be reduced by 20–22 % (also by 2023). The extent to which these benefits are realized will depend on the willingness of business and policy leaders to implement the recommendations that are found in the earlier assessment.

INTRODUCTION

Texas is one of the most rapidly growing states in the country. Its population is expected to increase 1.7% annually over the next 15 years. Economic activity, on the other hand, is expected to grow 3.2% per year over that same period. With this combined population and income growth, electricity consumption is similarly projected to grow an estimated 1.7% annually.[1] At the same time, however, the state is facing tight reserve margins for electric generation capacity. This means that Texas may not have sufficient power plants online to meet this new growth. Moreover, Texas has one of the most natural gas dependent electric generation sectors within the United States. This lack of resource diversity exposes the state to rising and volatile natural gas prices in addition to the many vulnerabilities associated growing constraints on its generation capacity. Hence, there is a clear need for new energy resources to meet the expected growth in electricity demand.

The challenge confronting Texas is to meet the demand for new electricity services and to do so in ways that maintain competitive electricity costs and reduce environmental impacts. In March 2007, ACEEE published a report suggesting that a combination of energy efficiency and renewable energy technologies can meet the growing need for electricity (Elliott et al. 2007). The findings of that report indicated that the alternative energy efficiency and renewable energy scenario could help stabilize overall energy prices, lower electricity bills, and reduce impacts on state air quality. But the question remains, could this recommended alternative policy scenario enable, perhaps even spur, continued economic growth within the state? In this follow-up report, we review the macroeconomic impacts that likely would unfold under these alternative policy recommendations. In the sections that follow, we briefly review the key findings from the earlier ACEEE study, describe the economic model used to assess the larger employment and other macroeconomic impacts, and finally, report on the study findings themselves. Generally, we find that cost-effective investments in the combination of energy efficiency and alternative generation technologies can actually boost net employment and overall economic activity in the state. The extent to which those benefits are realized depends on the extent to which Texas and its business and policy leaders decide to implement the recommendations in the earlier report.

BACKGROUND

The state's rapidly growing peak electric demand and electricity consumption have led the electric generators and their allies to suggest that Texas take actions to change the mix of its current generating resources. The dominant resource in the new expansion plans was a series of coal-fired power plants. In a March 2007 report, ACEEE suggested, instead, that energy efficiency and renewable resources should be considered as the critical resource of first choice. The group also recommended a series of policies to bring those resources online at the rate that they will actually be needed.

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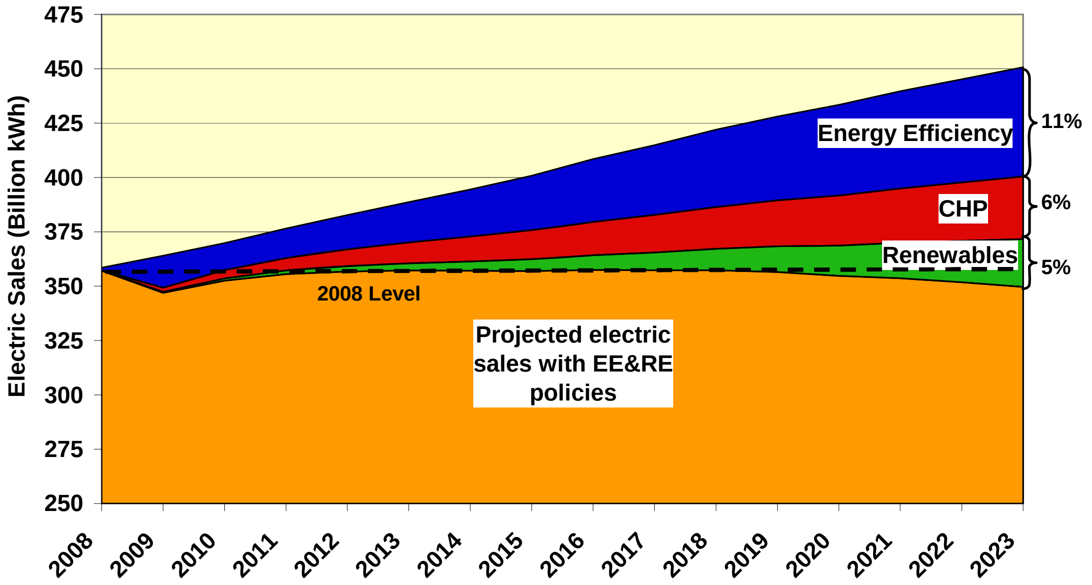
[1] For comparison, total population in the United States as a whole is expected to grow only 0.8% while U.S. economic activity and electricity consumption are expected to grow 2.9% and 1.4%, respectively (EIA 2007).

Indeed, Texas has already taken progressive steps in the area of clean energy through its roughly 5% renewable portfolio standard (RPS)[2] and its energy efficiency improvement programs (EEIP). The latter directs transmission and distribution utilities in areas of Texas open to retail electric competition to serve 10% of load growth through greater investments in energy efficiency. The utilities have easily met the efficiency target, and the state already gets more than 4% of its electricity from wind so it is on track to exceed the levels specified in the RPS. For all of this progress, however, there is much more that can be achieved from available and cost-effective energy efficiency and renewable energy resources. In particular, the level of savings that utilities might obtain through the EEIP can be greatly expanded. In addition, the EEIP does not apply to cooperative and municipal utilities in the state. While some of these utilities are already active in this area, expanding coverage to all electric utilities would greatly increase the efficiency resource in ways that satisfies the growing demand for energy services in Texas.

Figure 1. Share of Future Electricity Consumption that Can Be Met with Efficiency and Renewable Resources



In the March 2007 report, ACEEE assembled a portfolio of nine policies that are both cost-effective and politically viable in Texas. These included: (1) an expanded utility-sector energy efficiency improvement program; (2) new state-level appliance and equipment standards; (3) more stringent building energy codes; (4) an advanced energy-efficient building program; (5) an energy-efficient state and municipal buildings program; (6) short-term public education and rate incentives; (7) increased demand response programs; (8) specific capacity targets for combined heat and power (CHP); and (9) onsite renewable energy incentives. By implementing these clean energy resource policies, ACEEE indicated that Texas could meet its

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[2] In 1999, the Texas Public Utility Commission adopted rules for a renewable portfolio standard, calling for 2,000 megawatts (MW) of new renewables to be installed in Texas by 2009. In August 2005, the legislature passed Senate Bill 20, which increased the renewable energy mandate to 5,000 MW of new renewables by 2015 (about 5% of the state's electricity demand) and set a goal to reach 10,000 MW by 2025 (SECO 2007).

summer peak demand needs without any additional coal-fired power plants or other conventional generation resources. Figure 1 above highlights the overall impacts of these combined policy measures.[3]

In general, the March 2007 report found that a combination of energy efficiency investments, combined heat and power technologies, and new onsite renewable resources could provide sufficient generation equivalent to reduce conventional electricity use by 22% over the period 2008 through 2023: energy efficiency by 11%; expanded CHP by 6%; and onsite renewable energy resources by 5%. More critically, the report noted that the required 15-year cumulative investment of nearly $50 billion, including both program and administrative costs, would save about $73 billion in avoided cumulative electricity expenditures. But the question remains, what are the likely impacts on jobs and the economy over that same 15-year period? In the sections of the report that follow, we describe the methodology, model, and findings of our assessment.

STUDY METHODOLOGY

In this economic evaluation we generally follow three steps that build on the March 2007 ACEEE study. First, we calibrate an economic assessment model (described below) to reflect the economic profile of the Texas economy. Second, we draw a set of key policy scenario results from the March 2007 study and transform them as inputs into the economic model. The resulting inputs include such things as: (1) the level of annual program spending that drives the policy scenario; (2) the electricity savings that result from the various energy efficiency policies or the level of alternative electricity generation from onsite renewable and combined heat and power technologies; and (3) the capital and operating costs associated with those technology investments. Finally, we run the model and check both the logic and the internal consistency of the modeling results. These steps are explained next.

The Economic Model

The economic assessment model used in this exercise is a quasi-dynamic, input-output analytical tool we call DEEPER—or the Dynamic Energy Efficiency Policy Evaluation Routine. Although recently given a new name, the model's origins can be traced back to modeling assessments that ACEEE and others first completed in the early 1990s (see the appendix for historical information and other details on the DEEPER model).

The model is "quasi-dynamic" in that it adjusts energy costs based on the level of energy quantities produced in a given year, and it adjusts labor impacts given the anticipated productivity gains within the key sectors of the Texas economy. So, for example, if efficiency measures or alternative generation technologies reduce the amount of natural gas otherwise consumed in Texas, one might naturally expect natural gas prices to be affected. Or if the construction and manufacturing sectors increase their output as a result of the alternative policy scenario, the employment benefits are likely to be affected based on expected labor

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[3] For a more complete description and summary of costs and benefits associated with this portfolio of policy measures, see Elliott et al. (2007).

productivity gains within each of those sectors. DEEPER includes these changes as they might impact the annual costs and benefits of the policy scenario.

Input-output models initially were developed to trace supply linkages in the economy. For example, an input-output accounting framework can show how purchases of lighting technologies or industrial equipment benefit not only the lighting and other equipment manufacturers in a state, but it can also reveal the multiplicative impacts that such purchases are likely to have on other industries and businesses that might supply the necessary goods and services to those manufacturers.

The net economic gains of any new investments in energy efficiency and renewable energy technologies will depend on the structure of the local economy. For instance, states that already produce electronic products or renewable energy technologies will likely benefit from the expanded local sales of high-efficiency ballasts and solar electric technologies; states without such production capabilities will not benefit in the same way. Moreover, different kinds of expenditures support different levels of total economic activity within a state. To illustrate this point, Table 1, on the following page, compares the direct and indirect economic impacts that are supported for each major category of purchases that are made in a given sector of the Texas economy.

As shown in Table 1, three categories of economic impacts are summarized for key sectors of the Texas economy. These include agriculture, construction, manufacturing, utility services, wholesale and retail trade, commercial services, and government.[4] The employment effects highlight the total number of Texas jobs that are supported for every one million dollars of spending within a given sector. For purposes of this study, a job is defined as sufficient wages to employ one person full-time for one year.

Of immediate interest in Table 1 is the relatively small number of jobs supported for each one million dollars spent on natural gas and electric utility services. Texas' electric utility industry provides, for example, only 2.4 jobs per million dollars of revenues that it receives. This includes both jobs directly supported by the industry as well as those jobs linked to businesses that support the utility industry. On the other hand, one million dollars spent in manufacturing supports 6.7 jobs, both directly and indirectly.

As it turns out, much of the job creation from energy efficiency programs is derived by the difference between jobs within the utility supply sectors and jobs that are supported by the respending of energy bill savings in other sectors of the economy.

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[4] The model used for the assessment described here relies on the IMPLAN datasets for Texas. IMPLAN stands for "IMpact Analysis for PLANning" (IMPLAN 2000). These 2004 historical economic accounts (IMPLAN 2007) provide a critical foundation for a wide range of modeling techniques, including the input-output model used as a basis for the assessment described here (Laitner 2007b). Table 1 presents what are referred to as Type I impact coefficients, incorporating only the direct and indirect effects of a given expenditure. Adding the induced effect (i.e., the additional level of impact made possible by the respending of wages in the Texas economy) would generate what are known as the Type II impacts (as referenced in the IMPLAN model). However, since household spending is part of the final demand changes we decided to limit the employment and other macroeconomic impacts to the Type I multipliers. This will tend to understate the net effect of the alternative policy scenario. For more information on this point, see, Miller and Blair (1985), pages 25-30.

Table 1. Key Texas Impact Coefficients by Major Economic Sector

Sector	Total Employment per Million Dollars of Spending	Total Wage and Salaries per Dollar of Spending	Total Gross State Product (GSP) per Dollar of Spending
Agriculture	20.4	0.227	0.689
Oil and Gas Extraction	3.8	0.196	0.756
Coal Mining	4.9	0.280	0.752
Other Mining	7.6	0.337	0.811
Electric Utilities	2.4	0.144	0.803
Natural Gas Distribution	2.2	0.151	0.625
Construction	13.5	0.445	0.788
Manufacturing	6.7	0.315	0.626
Wholesale Trade	8.1	0.436	0.874
Transportation, Other Public Utilities	10.7	0.455	0.800
Retail Trade	17.9	0.450	0.854
Services	12.2	0.378	0.840
Finance	8.5	0.388	0.814
Government	17.9	0.859	0.979

Source: IMPLAN (2007), a 2004 input-output database for Texas

The different sector impacts on wages and salaries as well as GSP are also shown in Table 1. In contrast to the employment effects, these two categories of impacts are shown per dollar of spending within each of the sectors listed.

An Illustration: Texas Jobs from Improvements in Commercial Office Buildings

To illustrate how a job impact analysis might be done, we will use the simplified example of installing one million dollars of efficiency improvements in a large office building. Office buildings (traditionally large users of energy due to heating and air-conditioning loads, significant use of electronic office equipment, and the large numbers of persons employed and served) provide substantial opportunities for energy-saving investments. The results of this example are summarized in Table 2 on the next page.

The assumption used in this example is that the investment has a positive benefit-cost ratio of 1.5. In other words, the assumption is that for every dollar of cost used to increase a building's overall energy efficiency, the upgrades might be expected to return a total of 1.5 dollars in reduced electricity costs over the useful life of the technologies. This ratio is similar to those cited elsewhere in this report. At the same time, if we anticipate that the efficiency changes will have an expected life of roughly 12 years, then we can establish a 12-year period of analysis. In this illustration, we further assume that the efficiency upgrades take place in the first year of the analysis, while the electricity bill savings occur in years 1 through 12.

Table 2. Job Impacts from Office Building Energy Efficiency Improvements

Expenditure Category	Amount (Million $)	Employment Coefficient	Job Impact
Installing Efficiency Improvements in Year 1	$1.0	13.5	13.5
Diverting Expenditures to Fund Efficiency Improvements	$-1.0	11.9	-11.9
Energy Bill Savings in Years 1 through 12	$1.5	11.9	17.9
Lower Utility Revenues in Years 1 through 12	$-1.5	2.4	-3.6
Net Twelve-Year Change	**$0.0**		**15.9**

Note: The employment multipliers are taken from the appropriate sectors found in Table 1. The utility multiplier is assumed to be for electric utilities. The benefit-cost ratio is assumed to be 1.5. The jobs impact is the result of multiplying the row change in expenditure by the row multiplier. For more details, see the text that follows.

The analysis also assumes that we are interested in the *net effect* of employment and other economic changes. This means we must first examine all changes in business or consumer expenditures—both positive and negative—that result from a movement toward energy efficiency. Each change in expenditures must then be multiplied by the appropriate multiplier (taken from Table 1) for each sector affected by the change in expenditures. The sum of these products will then yield the net result for which we are looking.

In our example, there are four separate changes in expenditures, each with their separate effect. As Table 2 above indicates, the net impact of the scenario suggests a gain of 15.9 job-years in the 12-year period of analysis. This translates into an average net increase of 1.3 jobs each year for 12 years. In other words, the efficiency investment made in the office building is projected to sustain an average of just over one job each year over a 12-year period compared to a "business-as-usual" scenario.

Evaluating Texas' Alternative Policy Scenario

The economic assessment of the alternative energy scenarios was carried out in a very similar manner as the example described above. That is, the changes in energy expenditures brought about by investments in energy efficiency and renewable technologies were matched with their appropriate employment multipliers. There are several modifications to this technique, however.[5]

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[5] For a more complete review of how this type of analysis is carried out, see Laitner et al. (1998).

First, it was assumed that only 79% of both the efficiency investments and the savings are spent within Texas. We based this initial value on the IMPLAN dataset as it describes local purchase patterns that typically now occur in the state. We anticipate that this is a conservative assumption since most efficiency and renewable energy installations are likely (or could be) carried out by local contractors and dealers. As we will discuss later in this sector of the report, if the set of policies encourages local participation so that the share was increased to 90%, for example, the net jobs might grow another 15% compared to our standard scenario exercise. At the same time, the scenario also assumes Texas provides only 40% of the manufactured products within the state. But again, a concerted effort to build manufacturing capacity for the set of clean energy technologies would increase the benefits from developing a broader in-state energy efficiency and renewable energy manufacturing capability.

Second, an adjustment in the employment impacts was made to account for assumed future changes in labor productivity. As outlined in the Bureau of Labor Statistics *Outlook 2004–2014*, productivity rates are expected to vary widely among sectors (BLS 2005). For instance, the BLS projects a 2.2% annual productivity gain as those sectors better integrate information technologies and become even more critical to the economy. To illustrate the impact of productivity gains on future employment patterns, let us assume a typical labor productivity increase of 2.2% per year. This means, for example, that compared to 2008, we might expect that a one million dollar expenditure in the year 2023 will support only 72% of the number of jobs as in 2008.[6]

Third, for purposes of estimating energy bill savings, it was assumed that current electricity prices in Texas would follow the same growth rate as those in the West South Central region, as published by the Energy Information Administration in its *Annual Energy Outlook* (EIA 2006, 2007). Fourth, it was assumed that approximately 80% of the efficiency investments upgrades are financed by bank loans that carry an average 8% interest rate over a five-year period. Similarly, it was assumed that all renewable and clean energy technology investments are financed at an average 6% interest rate over a 20-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 investments) are substituted for conventional supply strategies, or in labor participation rates—all of which might affect overall spending patterns.

While the higher cost premiums associated with the energy efficiency investments might be expected to drive up the level of borrowing (in the short term), and therefore interest rates, this upward pressure would be offset to some degree by the investment avoided in new power plant capacity, exploratory well drilling, and new pipelines. Similarly, while an increase in demand for labor would tend to increase the overall level of wages (and thus lessen economic activity), the job benefits are small compared to the current level of unemployment or underemployment. Hence the effect would be negligible.

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[6] The calculation is $1/(1.022)^{12} * 100$ equals $1/1.386 * 100$, or 72%.

Fifth, for the buildings and industrial sectors it was assumed that a program and marketing expenditure would be required to promote market penetration of the efficiency improvements. This was set at 15% of the efficiency investment for those sectors.[7]

Sixth, following insights from the *Annual Energy Outlook 2006* (EIA 2007), we assume that reduced demand for energy places a downward pressure on the wholesale prices for coal, petroleum, and natural gas as the Texas energy policies reduce or displace consumption of electricity generation. Because of the size of the Texas energy market, significant changes in consumption of fuels in the state are likely to have a small impact on the national wholesale prices. As we now estimate these impacts, a 10% decline in consumption compared to year 2023 projects show a decline of 5%, 2%, and 7% for coal, oil, and natural gas wholesale prices, respectively. As one might expect, these impacts are significant but minimal since the impact of efficiency gains in any one state—even one with a large economy such as Texas now enjoys—would be small. Nonetheless, this impact highlights the benefits to the U.S. economy as a whole should multiple states undertake similar cost-effective energy efficiency investments.

Finally, it should again be noted that the full effects of the efficiency investments are not accounted for since the savings beyond 2023 are not incorporated in the analysis. Nor does the analysis include other productivity benefits that are likely to stem from the efficiency investments. These can be substantial, especially in the industrial sector. Industrial investments that increase energy efficiency often result in achieving other economic goals such as improved product quality, lower capital and operating costs, increased employee productivity, or capturing specialized product markets.[8] To the extent these "co-benefits" are realized in addition to the energy savings, the economic impacts would be amplified beyond those reported here.

ECONOMIC IMPACT OF THE TEXAS CLEAN ENERGY TECHNOLOGY INITIATIVE

The investment and savings data from the efficiency and renewables scenario were used to estimate three sets of impacts for the five-year periods of 2008, 2013, 2018, and 2023. For each benchmark year, each change in a sector's spending pattern for a given year—relative to the baseline or business-as-usual scenario—was matched to the appropriate sectoral impact coefficient. These negative and positive changes were summed to generate a net result shown in the series of tables that follow.

Table 3 summarizes, for selected years, two sets of key changes in the Texas electricity production patterns that are driven by the alternative policy initiatives reviewed in the ACEEE March 2007 study. The table also summarizes the initial financial impacts from these two sets of changes as then estimated by the Investment and Spending module within the DEEPER model. It is this combined set of three financial impacts that are then further evaluated by DEEPER's macroeconomic module to estimate the larger net gains to the Texas economy.

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[7] For example, this was the same value as used in Laitner et al. (1998) and other studies.

[8] For a more complete discussion on this point, see Elliott, Laitner, and Pye (1997) and Worrell et al. (2003).

Table 3. Changes in Texas Electricity Production and Financial Impacts

	2008	2013	2018	2023
Implied Program Spending (Millions of 2004 Dollars)				
Annual Policy and Program Costs	285	712	536	691
Annual Technology Investments	1,000	2,218	3,140	4,567
Changes in Electricity Production Patterns				
Efficiency Gains (GWh)	1,192	28,149	54,790	79,081
Renewables Production (GWh)	142	3,272	9,911	22,010
Total Change in Production (GWh)	1,334	31,421	64,701	101,091
Change from Reference Case	0.4%	8.1%	15.3%	22.4%
Financial Impacts (Millions of $2004)				
Annual Consumer Outlays	436	2,555	3,449	4,833
Annual Electricity Savings	94	1,800	3,491	5,521
Electricity Supply Cost Adjustment	(49)	(1,837)	(3,078)	(4,390)
Net Consumer Savings	(293)	1,082	3,120	5,078
Net Cumulative Energy Savings	(293)	4,159	15,580	37,400

Starting with very small impacts in 2008, the set of energy efficiency and clean energy policies spur both program costs and technology investments that, in turn, begin to change the production patterns of electricity consumption and production. Program spending of $285 million in 2008 leverages $1,000 million or $1.0 billion in alternative technology investments in that same year. The initial impacts on electricity production are quite small in 2008, reducing electricity demand by only 1,192 GWh or gigawatt-hours (which is the same as 1,192 million kilowatt-hours) and spurring an increase of 142 GWh in renewable energy generation. Combined, these impacts reduce or displace conventional electricity generation by only 0.4% in 2008. However, both program spending and technology investments rise to 691 and 4.6 billion dollars (rounded), respectively, by 2023. The cumulative impact of activities over the 15-year time horizon steadily reduces the demand for conventional electricity generation so that by 2023 a combination of efficiency and renewables displaces the forecasted electricity production by 22%.

As might be expected, the program spending and changed investment patterns have a distinct financial impact within Texas. The third set of information in Table 3 highlights the key financial impacts for the same years. For example, program costs and technology investments are only part of the expenditures paid by consumers (including both households and businesses). Notably, the utility customers will likely borrow money to pay for these investments. Thus, consumer outlays, estimated at $436 million in 2008 and rising to $4.8 billion in 2023, include actual "out-of-pocket" spending for programs and investments, but also money borrowed to underwrite the larger technology investments. Annual electricity savings is a function of reduced electricity purchases from the Texas utilities at the initial electricity prices in a given year. This starts slowly with a savings of $94 million in 2008 and rising to $5.5 billion in 2023.

On the other hand, the changed electricity production patterns, including both reduced electricity demands and alternative technology investments, forces an adjustment in the electricity supply costs. Table 3 shows a negative impact. This means that there are lower capital and operating expenditures associated with the alternative policy scenario. This, in turn, results in a savings to consumers. Hence, the alternative policies actually reduce costs to consumers, starting by an estimated savings of $49 million in 2008 and rising to nearly $4.4 billion in 2023.

The category of net consumer savings—with businesses and households in 2008 spending $426 million, but then saving $94 million in reduced electricity consumption, and then benefiting from lower electricity costs of $49 million—shows a net cost to consumers in 2008 of $293 million. In other words, in the first years of the program, outlays are greater than savings. But as electricity savings increases and as costs further decline, the net consumer savings quickly grows positive and rises to a net gain of about $5.1 billion by 2023. Finally, the cumulative net savings in the last row of Table 3 suggests a net gain to consumers of $37.4 billion by 2023.

With the set of program spending, investment changes, and financial impacts identified in Table 3, and given the other modeling assumptions described earlier in this report, the macroeconomic module of the DEEPER model then traces how each set of changes works or ripples its way through the Texas economy in each year of the assessment period. Table 4 summarizes the estimated change in sector spending within Texas, given the policy and program expenditures for the same benchmark years.

Table 4. Changes in Sector Spending (Millions of 2004 Dollars)

Sector	2008	2013	2018	2023
Agriculture	-2.8	5.1	17.4	25.7
Oil and Gas Extraction	-12.8	16.4	61.6	82.4
Coal Mining	-0.1	0.2	0.7	0.9
Other Mining	-0.5	0.6	2.2	2.9
Electric Utilities	-140.9	-3,407.1	-6,019.7	-8,908.7
Natural Gas Distribution	-0.6	2.6	7.5	12.7
Construction	506.9	576.7	1,122.1	2,148.6
Manufacturing	-97.7	172.8	589.3	864.8
Wholesale Trade	-9.1	39.9	113.1	194.0
Transportation, Other Public Utilities	-4.6	20.0	56.7	97.3
Retail Trade	-20.6	89.1	253.3	434.5
Services	-94.3	405.9	1,155.2	1,981.6
Finance	27.4	182.8	425.7	994.2
Government	99.1	208.3	243.2	266.5

Several points should be noted from Table 4. First, most sectors in 2008 show a negative impact on spending within Texas. This is because the net consumer impacts, as suggested in Table 3, are negative in 2008. However, the construction sector shows a net positive increase in spending as new investments lead to the installation of new efficiency and alternative energy technologies in that year. But the sum of investment are less than the $1.0 billion shown in Table 3 as Texas is likely to import some of the technologies to be installed, and as that sector also faces changes in costs associated with the program spending and its own investment outlays. But the financial sector and government sectors are also benefiting in small ways during the early part of the program. The financial sector receives early interest on loan payments while the government sector (or its surrogate in the business service sector) is responsible for operating and monitoring many of the program activities. By 2023, however, all sectors other than electric utilities show positive spending changes as the benefits clearly exceed the costs.

Once each of the net sector spending changes has been evaluated for a given year, the DEEPER model then evaluates the sector-by-sector jobs and wages. It also evaluates their contribution to the state's value-added or GSP. Table 5 highlights the net impacts, again by the benchmark years.

Table 5. Net Economic Impacts for Benchmark Years

Category of Impact	2008	2013	2018	2023
Jobs (Actual)	5,573	10,459	22,872	38,291
Wages (Million $2004)	$216	$295	$835	$1,657
GSP (Million $2004)	$223	-$1,334	-$1,599	-$1,475

The first of the three impacts evaluated here is the net contribution to the Texas employment base as measured by full-time jobs equivalent. In other words, once the gains and losses are sorted out in each year, the analysis provides the net annual employment benefit of the policies as they impact the larger Texas economy. In 2008, the impact starts small with a net gain of 5,600 jobs (in rounded numbers), rising to a net gain of 38,300 jobs. While this seems like a significant number, it represents a net gain of only 0.3% to the state's employment base. The second impact is the net gain to the state's wage and salary compensation, measured in millions of 2004 dollars. Showing a similar pattern of job impacts, wages rise from a net gain of $216 million in 2008 to a final value of $1.7 billion by 2023 in 2023. Again, this is a significant but small impact, increasing net wage compensation by only 0.1%.

The impact on the Texas GSP might suggest a somewhat counterintuitive result, however. While job and wage benefits are small but net positive, the impact on GSP is small but generally negative. By 2023, for example, GSP is down by about $1.5 billion or 0.1% compared to a business-as-usual forecast. The reason is that the electric utilities are a capital-intensive sector, but one that is also generally non-labor intensive. Movement away from greater capital intensity to a more labor-intensive energy policy shifts the composition of GSP away from utility plant investment toward more productive and more jobs creating spending. As it turns out, this generates a small but negative impact on GSP while the changed spending patterns positively impact jobs and wages. The lower GSP is in part an artifact of the time frame of the analysis period and how we account for the benefits. Investments in new power plants occur near the start of the period so the off-setting positive cash flow from these investments are largely captured, while the energy efficiency and on-site renewable energy investments are distributed throughout the analysis period. With these investments having an average economic life of 15 years, the benefits for those investments made in the latter years of the study period are not fully captured. So the costs are fully accounted for, but the benefits are not. Although we did not perform the detailed analysis beyond 15 years, if the time horizon is extended beyond 15 years, we would in all likelihood see a positive GSP impact from the energy efficiency and renewable energy investments relative to the business as usual scenario. To better understand both the ebb and flow of changes in sector spending, Table 6 on the next page provides greater detail for the year 2023, which is the last year of the analysis.

Table 6. Detailed Sector Results for 2023

Sector	Changes in Final Demand (Millions of 2004$)	Net Gain in Jobs (Actual)	Net Gain in Wage and Salary Compensation (Millions of 2004$)	Net Gain in GSP (Millions of 2004$)
Agriculture	$25.7	725	$8	$33
Oil and Gas Extraction	$82.4	(82)	($8)	($40)
Coal Mining	$0.9	(102)	($15)	($44)
Other Mining	$2.9	15	$1	$2
Electric Utilities	($8,908.7)	(5,246)	($755)	($6,012)
Natural Gas Distribution	$12.7	13	$2	$11
Construction	$2,148.6	15,021	$604	$996
Manufacturing	$864.8	1,317	$209	$374
Wholesale Trade	$194.0	601	$122	$241
Transportation, Other Public Utilities	$97.3	(409)	($32)	($52)
Retail Trade	$434.5	4,409	$221	$403
Services	$1,981.6	14,838	$722	$1,627
Finance	$994.2	3,732	$346	$725
Government	$266.5	3,458	$230	$259
TOTAL	($1,802.5)	38,291	$1,657	($1,475)
Change from Reference Case	n/a	0.32%	0.11%	-0.09%

There are a number of different aspects of Table 6 worth noting before commenting on the impacts in more detail. The first is that while there are winners and losers among the sectors, the larger economic impacts are largely positive. To recap from Table 5, as also shown in Table 6, wage earnings as well as employment are shown to rise by 2023—by a net of $1.7 billion and 38,300 jobs, respectively. At the same time, Texas' GSP is projected to decrease by $1.5 billion above the reference case projection. With the exception of electric utility services, all sectors are positively impacted with net increases in spending by 2023. However, oil and gas extraction, coal mining, and the transportation services and other public utility sectors show small but negative impacts for jobs, wages, and GSP.

Second, while these gains are significant, the impacts are relatively small in comparison to overall activity of the Texas economy. By the year 2023, for instance, GSP might grow to over

$1.7 trillion (in 2004 dollars). Thus, as previously suggested, decreasing GSP by $1.5 billion in that year represents a loss of just under 0.1%.[9]

On the other hand, if the impacts are small in relation to the larger economy, it is only because the scale of investment is also relatively small. The anticipated $50 billion in cumulative efficiency and renewable investments program costs are the order of 0.2% of the cumulative GSP for Texas in the period 2008 through 2023. Perhaps translating to a different scale, however, we can think of the net job gains as if they were provided by the relocation of a series of small manufacturing plants to Texas. In that case, we then can say that a 22% displacement of conventional electricity generation would produce new employment that is equivalent to the jobs supported by about 300 small manufacturing plants that might open in the year 2023.[10] Alternately, we can think of the additional wage and salary compensation from the energy savings as an equivalent amount of spending by tourists and visitors in the state. In this instance, the 22% electricity savings and use of renewables would provide the dollar equivalent of spending from 6.6 million visitor days.[11]

FURTHER DISCUSSION

While the economic gains reported here are clearly positive, there are a number of issues that merit additional discussion. These issues include the impact such a transition might have on the electric utility sector, the cost of living within the state, and the expected impact on air pollutants. In addition, it is helpful to review the context of this report as it might compare with other similar studies. Finally, it is useful to at least acknowledge other possible benefits from the alternative policy scenario—principally the potential lower rate of air pollution. Each of these topics is briefly reviewed in the order listed.

As might be expected, the electric utilities incur overall losses in jobs, compensation, and GSP. But this result must be tempered somewhat as the industries themselves are undergoing internal restructuring. For example, as the electric utilities engage in alternative energy investment activities, they will undoubtedly employ more people from the construction and service sectors (including engineering and business services). Hence the negative employment impacts in the electric utility sector should not necessarily be seen as pure job losses; rather they might be more appropriately seen as a redistribution of jobs in the overall economy and future occupational tradeoffs.

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[9] The projections for jobs, wages, and GSP are adapted from forecasts provided by Economy.com. The projections were originally reported in 2000 dollar values but have been adjusted to reflect 2004 dollar values for our analysis here.

[10] This estimate is based on the net gain of 38,300 jobs in the year 2023. It assumes that a small manufacturing plant would employ 50 persons directly. For each job in the manufacturing plant, a total of 2.5 jobs might be supported in the economy for a total impact of 125 total jobs per manufacturing plants. Therefore, each 125 jobs created by the alternative energy scenario is equivalent to the output of one small manufacturing plant. Dividing 38,300 by 125 suggests the equivalent of 306 small manufacturing plants within the Texas economy.

[11] This estimate is based on the net gain in wage and salary compensation of $1,657 million in the year 2023. It assumes that tourists and visitors to Texas might spend approximately $250 each day on recreation, eating and drinking, and lodging. Dividing $1,657 million by $250 suggests the equivalent of 6.6 million visitor days within the Texas economy.

Explained differently, while the electric utilities may lose an estimated 5,000 traditional jobs due to selling less energy (see Table 6), they are likely to gain many if not all of those jobs back if they move aggressively into the energy efficiency and renewable energy services. In the results shown from this set of modeling runs, for example, employment in the construction and service sectors is up by almost 30,000 jobs (also from Table 6). In effect, if they expand their participation in the energy efficiency and renewable energy markets (i.e., absorbing some of the job gains assigned to other sectors such as the construction and service sectors), their job totals could increase relative to the estimates based on a more conventional definition of an electric utility as an energy supplier.

In fact, Table 6 shows four big "winners" under the alternative energy and renewables scenario. These are the construction, manufacturing, services, and finance sectors. These sectors are winners largely for two reasons. First, they benefit from the actual investments in energy efficiency programs and renewable technologies made cumulatively through the year 2023. Second, they benefit from the higher level of goods and services produced and sold specifically in Texas as ratepayers and businesses re-spend their energy bill savings elsewhere in the economy and as investments are made in energy efficiency and renewable technologies. Again, sectors that appear to be losers might actually benefit from an alternative energy policy if they interpret the market transition as a signal to diversify their business into these new markets.

Yet another perspective on the impacts from the alternative policy scenario is the potentially positive effect on the cost of living in Texas. In a first calculation, some analysts might point out from Table 1 that the electric utility industry supports an average wage of $60,000 ($140,000 divided by 2.4 jobs). At the same time, the additional 38,300 jobs in the policy scenario, together with the added $1,657 million in wage and salary compensation, may support an average wages of only $43,000. Hence, we might have slightly more jobs but at a smaller average compensation. At the same time, however, the $5 billion (rounded) in net consumer savings shown in Table 3 is considerably larger than the implied loss in average job compensation. While not a strictly comparable set of results, the lower cost of living implied by the alternative policy scenario is likely to provide a much larger benefit compared with the smaller net wages implied by the net increase in jobs.

At the same time, there are some early transition job losses that might occur if the scenario moves too aggressively toward the alternative policy scenario in ways that quickly ramp down jobs from power plant construction. The reason is that there are large ongoing jobs within the utility and construction sectors that, if immediately stifled rather than transitioned to new construction and engineering jobs, could reduce employment by a small amount in 2009 or 2010. At the same time, however, it is clear that the net employment effects from the alternative policy scenario are both steadier and more sustained compared to traditional power plant expansion. This impact is a fairly robust one that is consistent with any number of other similar state-level studies (Laitner 2007a).

Perhaps one particularly useful comparison to underscore the robustness of the results in this assessment is a 1998 study funded by the Texas Department of Economic Development (Goldberg and Laitner 1998). Like the current study, the 1998 assessment analyzed the economic benefits of accelerated investments in energy efficiency and renewable energy technologies. It analyzed two alternative energy strategies for Texas.

The first assessment in the 1998 study followed a so-called "moderate" energy path. That scenario—looking from a 1998 vantage point out to the year 2010 (hence, a 12-year time horizon compared to the 15-year study period examined here)—identified a cumulative electricity bill savings of about $22 billion. The second alternative energy strategy for Texas followed what was termed an "advanced energy course." That strategy identified a potential savings of about $32 billion in lowered electricity bills over that 12-year study period (i.e., 1998 through 2010). Using a similar input-output model of the Texas economy, the 1998 report suggested a net employment increase between 36,300 and 49,300 jobs by 2010. Despite the changes in base years, electricity prices, and sector productivity gains, the results of the 1998 and the current study are reasonably similar. Hence, we might plausibly conclude that increased investments in both energy efficiency and renewable energy technologies would be an important step toward promoting a sustainable economic and energy future for the state.

But there are other benefits that might be further explored—in this case, the contribution to overall environmental quality as indicated by substantially reduced levels of air pollution. Table 7 (below) highlights the reduction of three separate air pollutants as reported by the DEEPER model based on average rates of emissions from conventional fossil fuel generation units. The bottom line is that the alternative energy scenario is also a clean energy scenario, with substantial reductions in sulfur dioxide (SO_2), nitrogen oxides (NO_X), and carbon dioxide (CO_2) emissions. The latter is a so-called greenhouse gas pollution that is now widely believed to contribute to global climate change.

Table 7. Estimate of Avoided Air Pollutants*

Category of Pollutant	2008	2013	2018	2023
SO_2 (thousand short tons)	0.9	14.4	22.2	31.4
NOx (thousand short tons)	0.6	9.1	16.0	23.4
CO_2 (million metric tons)	0.7	15.5	29.7	44.0

* Note: Emissions are based on average rather than marginal emission rates.

While these are substantial reductions, an estimated 20–22% of the reference case projections for the year 2023, several thoughts should be noted. First, these estimates are based on average emission rates (as noted in the table). Actual emission reductions will depend on the kind of generation unit that is actually displaced by the alternative technology investments. Still, this is a positive secondary benefit that would be significant even if the levels are significantly less than anticipated. Second, the utilities may be required in any event to achieve additional reductions of conventional air pollutants beyond the standard forecast. Such reductions could be a result of other emerging federal policies. In this case, the SO_2 and NO_X emissions may not reflect "new reductions" as such, but they clearly reflect a cheaper way to reduce otherwise mandated emissions since the energy efficiency and renewable energy technologies tend to pay for themselves while conventional pollution control strategies typically do not. Finally, the substantial reductions in carbon dioxide emissions would provide Texas with an important means to reduce greenhouse gas emissions in a way that is almost entirely cost-effective. This would be an important hedging strategy for the state's electric utilities should concerns about global climate change prompt some form of required emissions reductions.

CONCLUSION

Texas is one of the most rapidly growing states in the country. One of the critical concerns in maintaining the robustness of the Texas economy is supporting the growing demand for electricity—especially when that growth is rising more quickly than for the United States as a whole. The challenge is to meet the new demand for electricity in ways that maintain competitive electricity costs and also reduce environmental impacts. In March 2007, ACEEE published a report suggesting that a combination of energy efficiency and renewable energy technologies can meet the growing need for electricity (Elliott et al. 2007). The findings of that report indicated that the alternative energy efficiency and renewable energy scenario could help stabilize overall energy prices, lower electricity bills, and increase system reliability within the state's utility sector. The question answered in this companion study is whether the recommended alternative policy scenario could enable, perhaps even spur, continued economic growth within Texas.

In this follow-up to the March 2007 report, we review the macroeconomic impacts that likely would unfold under these alternative policy recommendations. Generally, we find that cost-effective investments in the combination of energy efficiency and alternative generation technologies can actually reduce overall electricity costs, boost net employment, and reduce air pollutants within the state. For example, by 2023 (the last year of this analysis), businesses and households in Texas are expected to enjoy a net savings of more than $5 billion. As a result of this greater energy productivity, the state is projected to show a net employment increase of about 38,300 jobs. This is roughly equivalent to the employment that would be directly and indirectly supported by the construction and operation of 300 small manufacturing plants within Texas. In addition, a variety of air emissions from power plants might be reduced by as much as 20–22% (also by 2023). The extent to which these benefits are realized will depend on the willingness of business and policy leaders to implement the recommendations that are found in the earlier assessment.

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APPENDIX: THE DEEPER MODEL

The Dynamic Energy Efficiency Policy Evaluation Routine—or the DEEPER Model—is a 15-sector economic impact model of the U.S. economy. Although an updated model with a new name, the model has a 15-year history of development and use for state energy policy assessments. See, for example, Laitner, Bernow, and DeCicco (1998) and Laitner (2007a) for a review of past modeling efforts. The model is generally used to evaluate the macroeconomic impacts of a variety of energy efficiency and renewable energy technologies at both the state and national level. The model now evaluates policies for the period 2008 through 2030. DEEPER is an Excel-based analytical tool that consists generally of six key modules or worksheets. These modules include:

Global data: The information in this module consists of the critical time series data and key model coefficients and parameters necessary to generate the final model results. The time series data includes the projected reference case energy quantities such as trillion Btus and kilowatt-hours, as well as the key energy prices associated with their use. It also includes the projected gross state product, wages, and salary earnings, as well as information on key technology assumptions. The source of data includes both the Energy Information Administration and Economy.com. One of the more critical assumptions in this study is the that alternative patterns of consumption will defer conventional power plants that, on average, will cost $1800 per kilowatt of installed capacity. This module also contains annual coefficients to estimate the impact a given scenario or policy will have on air emissions (as shown in Table 7 of the main report).

Macroeconomic model: This module contains the “production recipe” for the region’s economy for a given “base year”—in this case, 2004, which is the latest year for which a complete set of economic accounts are available for the regional economy. The I-O data, currently purchased from the Minnesota IMPLAN Group, is essentially a set of input-output accounts that specify how different sectors of the economy buy (purchase inputs) from and sell (deliver outputs) to each other. In this case, the model is now designed to evaluate impacts for 15 different sectors, including: Agriculture, Oil and Gas Extraction, Coal Mining, Other Mining, Electric Utilities, Natural Gas Distribution, Construction, Manufacturing, Wholesale Trade, Transportation and Other Public Utilities (including water and sewage), Retail Trade, Services, Finance, Government, and Households.

Investment and savings: Based on the scenarios mapped into the model, this worksheet translates the energy policies into physical energy impacts, investment flows, and energy expenditures over the desired period of analysis.

Price dynamics: With the estimated demand for energy consumption established, this module evaluates the impact of those new quantities on wholesale energy prices. Such prices include the minemouth cost of coal, the world oil price, and the wellhead price of natural gas, based on the following economic relationship:

$$\text{Price}_j = \text{EnergyIndex}_j^{\text{Elasticity}_j}$$

In other words, the price of energy for *j* is a function of a new Energy Index (e.g., 0.9 of the reference case) to some elasticity *j*. The assumed elasticities are 0.5, 0.2, and 0.7 for coal, oil, and natural gas, respectively. Given this relationship, for example, a 10% reduction in consumption—or an Energy Index of 0.9—implies a 5%, 2%, and 7% decline in the national wholesale energy price for coal, oil, and natural gas prices, respectively. These values are based on a review of various historical relationships and other modeling assessments found in the literature. Although Texas is a large state, if it is the only state to pursue the kinds of policies envisioned in this report, the impact on national wholesale energy prices will be very small.

Final demand: Once the changes in spending and investments have been established and adjusted within the previous modules of the DEEPER model, the net spending changes in each year of the model are converted into sector-specific changes in final demand, which drives the input-output model according to the following predictive model:

$$X = (I-A)^{-1} * Y$$

where:

X = total industry output by sector
I = an identity matrix consisting of a series of 0's and 1's in a row and column format for each sector (with the 1's organized along the diagonal of the matrix)
A = the production or accounting matrix also consisting of a set of production coefficients for each row and column within the matrix
Y = final demand, which is a column of net changes in final demand by sector

This set of relationships can also be interpreted as

$$\Delta X = (I-A)^{-1} * \Delta Y$$

which reads, a change in total sector output equals $(I-A)^{-1}$ times a change in final demand for each sector. Table 2 in the main report provides an illustration of the general approach used in this kind of model.

Results: For each year of the analytical time horizon, the model copies each set of results in this module in a way that can also be exported to the report. These different reports are summarized in Tables 3 through 7 of the main report.

There are other support spreadsheets as well as visual basic programming that supports the automated generation of model results and reporting. For more detail on the model assumptions and economic relationships, please refer to the forthcoming model documentation (Laitner 2007b). For a review of how an I-O framework might be integrated into other kinds of modeling activities, see Hanson and Laitner (2007).