Positive Returns:
State Energy Efficiency Analyses Can Inform
U.S. Energy Policy Assessments

John A. "Skip" Laitner and Vanessa McKinney

June 2008

Report Number E084

American Council for an Energy-Efficient Economy
529 14th St. N.W., Suite 600, Washington, D.C. 20045
(202) 507-4000 phone, (202) 429-2248 fax, www.aceee.org

Contents

About ACEEE

The American Council for an Energy-Efficient Economy is a nonprofit organization dedicated to advancing energy efficiency as a means of promoting economic prosperity, energy security, and environmental protection. ACEEE fulfills its mission by

- Conducting in-depth technical and policy assessments
- Advising policymakers and program managers
- Working collaboratively with businesses, public interest groups, and other organizations
- Organizing conferences and workshops
- Publishing books, conference proceedings, and reports
- Educating consumers and businesses

For further information on this and related research activities, contact the authors at:

John A. "Skip" Laitner: jslaitner@aceee.org or by phone at (847) 865-5106
Vanessa McKinney: vmckinney@aceee.org or by phone at (202) 507-4034

Acknowledgments

Funding for this analysis was provided, in part, through a grant from the U.S. Environmental Protection Agency. The authors also gratefully acknowledge the ongoing support of the Energy Foundation, which provided us with the means to establish the analytical framework to undertake this research and assessment.

We are also grateful to the many colleagues with whom we spoke about the emerging role of state leadership, and especially about the role of policy analysis within the states. In that regard we offer our special thanks to Jim Barrett of Redefining Progress, Chris Busch of the Union of Concerned Scientists, and Donald Hanson of the Argonne National Laboratory, among others. Their support and encouragement were invaluable in thinking through our research strategy and in the development of our thinking around many of the issues discussed herein.

Finally, the authors would like to recognize the wide-ranging support provided by numerous ACEEE staff members. Karen Ehrhardt-Martinez provided thoughtful feedback on the use of study parameters as an assessment tool. Steven Nadel and Neal Elliott gave us the all-important reality check to ensure a credible result. And as always, the authors would like to thank Renee Nida for her patience, careful review, and production of this report.

Executive Summary

Despite very strong evidence of the many cost-effective investments that could enhance further gains in energy productivity, the national energy and climate policy debates too often overlook the energy efficiency resource. The result is an ongoing series of national modeling assessments that tend to overstate the cost of needed changes in the nation's energy and climate change policies. At the same time, however, there are a large number of state-level studies that suggest a small but net positive benefit for the American economy as a result of policies that emphasize investment-led energy efficiency improvements. These studies suggest that energy efficiency policies offer a significant return on investment in ways that create jobs, promote a more robust economy, and insulate businesses and consumers from highly volatile changes in fossil fuel prices.

Based on a review of 48 different assessments, this report highlights the findings of a wide variety of studies that explore the many possibilities of further gains in energy efficiency, especially at the regional and state level. The studies reviewed here show an average 23 percent efficiency gain with a nearly 2 to 1 benefit-cost ratio. From analyzing this set of studies, we estimate that a 20 percent to 30 percent energy efficiency gain within the U.S. economy might lead to a net gain of 500,000 to 1,500,000 jobs by 2030. Based on these studies, the expectation is that efficiency-led policies would likely increase the nation's GDP by about 0.1 percent, also by 2030. By highlighting the potential outcomes and methodologies, this report seeks to inform the national energy and climate policy debates now before Congress.

Introduction

Our nation consumes more energy than any other country in the world. Historically, our growing demand for energy services has been satisfied by a wealth of many different energy resources. Among those resources have been fossil fuels, which provide (1) fuel for our cars and trucks and (2) natural gas fuels to heat our homes and power our industrial processes, as well as a variety of chemical feedstocks. Fossil fuels also include coal and nuclear energy for the generation of electricity. However, the energy-related challenges of the 21st century require a dramatic shift in direction. These challenges—ranging from the possibility of disruptive climate change and other environmental concerns, to the adequacy of reliable energy supplies at stable and reasonable prices—compel us to develop a more energy-efficient vision for the future.

Energy efficiency improvements save consumers and businesses money even as they productively reduce energy waste and significantly lower greenhouse gas emissions. Despite the evidence of the many cost-effective investments that could maximize energy efficiency, the national policy debates traditionally overlook this critical resource (Ehrhardt-Martinez and Laitner 2008; McKinsey Global Institute 2008; Expert Group on Energy Efficiency 2007). Indeed, one might conclude that our national discussions on energy and climate policy are misinformed about the size and scale of the energy efficiency resource. In fact, the backbone of such policy discussions seems to be modeling assessments that suggest an economic penalty if we were to do things differently than have been done in the past (Parker and Yacobucci 2008).

Emerging in the many extended debates on climate and energy policy are statements by a growing number of policy analysts who suggest there is "an implausibly high pressure on energy supply innovations while the potential for energy efficiency improvements is systematically underestimated" (Hummel 2007). At the same time, economists also suggest the "era of cheap energy is over" and that we must take bold steps to promote a more energy-efficient economy to offset the growing supply-side constraints that are driving those prices higher (Lave 2008). Against these twin backdrops, however, there is good news. The largely "supply-side only" perspective seems to be limited to discussions within the national policy arena. Looking elsewhere, especially at the state level, there are many policy assessments that suggest a huge opportunity for energy efficiency improvements—improvements that actually strengthen overall economic activity.

In this report we examine this idea more closely by undertaking a review of four dozen studies that previously evaluated the macroeconomic impacts of a wide variety of cost-effective energy efficiency and renewable energy policy scenarios. These assessments were conducted for an array of clients and governmental agencies over the period 1992 through 2008. The various studies evaluated a range of investment, technology, and program cost assumptions over a variety of time horizons, generally including the period 2010 to 2020. Several of the more recent studies looked at the period through 2025 or even 2030.

This report provides an overview of these studies to determine if and how they might inform the national climate and energy policy debates, especially as Congress continues to craft new policy language and supporting analyses. Toward that end, this report contains four major sections and two appendices that build a compelling case in favor of accelerating energy efficiency investments as an economic productivity tool.

The section that immediately follows this introduction provides a working description of the 48 studies. It complements this overview with a case study to illustrate the analytical framework that is typical of these past studies. In that regard, the case study also highlights the rather typical findings as they are summarized in this specific report. The next section offers key insights that underscore our findings. Drawing from a subset of the studies referenced in Appendix A, we next describe and quantify the relevant impacts of these studies as if they formed the basis of a national economic policy model. In effect, we use the smaller database of these studies to suggest how national-level modeling impacts might appear—if the energy efficiency resource were properly characterized and represented within the national-level economic models. In the final section, we offer further conclusions and next steps forward. The main body of the report is then supported by two appendices: Appendix A, which we've already referenced, and Appendix B, which describes our methodology to estimate national-level impacts based on these past 48 energy efficiency assessments.

The Studies in Review

Before we describe the 48 studies tht are reviewed within this document, four important points should be made with respect to the insights offered by these past assessments.

First, the four dozen studies cited in this paper are a limited subset of the complete library of reports that might be assembled. In fact, there are a large number of national, state-level and community-level assessments that are not included in this specific review. Those who might be interested in learning more about the studies we cite and many other national, state, or local studies should contact the authors of this study. Perhaps just as important, this is an ongoing assessment. Those who are aware of other studies that have been overlooked in this initial review are encouraged to contact the authors as well—either to forward an electronic copy of such assessments, or to provide details where those additional studies might be found.

Second, any review of anticipated economic impacts are presumed to follow a set of policies or incentives that governments and businesses might implement as a critical first step toward achieving cost-effective reductions in state-level energy use. In other words, if there were no policy action or signal, none of the energy productivity investments described in any of the studies would likely occur; therefore, none of the impacts described in those reports would likely follow.

Third, the listing of these studies should not be interpreted as an endorsement of the assumptions, methodologies, or results contained in any of the studies (including studies previously undertaken by the authors here). Indeed, the studies vary enormously in their detail and scope. This "meta-review" should be seen primarily as an annotated description of the available literature —relying on the description provided by the authors or the investigators themselves. With this collection of studies, however, the intent is to provide potentially useful insights about the prospect for future cost-effective reductions in energy use as well as a reduction in energy-related carbon dioxide and other associated air emissions.

Finally, a number of the studies reviewed here also include several supply-side resource options—notably the incorporation of combined heat and power technologies and a variety of renewable energy systems. Because so many of the studies integrated both demand-side efficiency gains and the alternative energy supply options, we made no effort to distinguish between the two as they impact either the displacement of conventional energy resources or the resulting net benefits of the policy scenarios. To the extent that these alternative supply-side options are less cost-effective than energy efficiency investments, this would have reduced the reported benefit-cost ratios, although by only a small amount.

The Studies in General

As previously indicated, we reviewed more than 48 past reports that were completed over the period 1992 to the present. We analyzed them for key energy efficiency and economic variables. The table below highlights our initial findings. Appendix A provides an annotated review and citation of all such reports.

Table 1. Summary of Past Energy Efficiency Studies

Key Indicator	Low	High	Average
Period of Analysis (Years)	5	26	12
Efficiency Potential (Savings over Reference Case)	6%	33%	23%
Benefit-Cost Ratio of Policy Scenario	1.10	4.80	1.95
Net Jobs Gained per TBtu of Efficiency Gains	9	95	49
Net Impact on GDP (as Percent Change in Ref. Case)	-0.1%	+0.6%	+0.15%

Most of the studies included in this survey provide one or more estimates of the efficiency potential within specific states or regions.[1] A few of the studies examine the potential for the entire U.S. with strong implications for state and regional economies. Generally the size of the economy and the cost-effectiveness of a given policy scenario play the more critical parts in determining the impact of energy efficiency potential. The many study results are a product of the wide range of efficiency options and opportunities that are available throughout the key end-use sectors within the United States. Again, Appendix A provides a more detailed annotation and review of each of the study findings.

[1] The term "efficiency potential" refers to prospective cost-effective energy efficiency improvements as a percent of the projected energy demand in the last year of a study's analysis. In other assessments this might be referred to as either an economic or an achievable efficiency potential (as opposed to what otherwise might be termed a technical efficiency potential). For further discussion on this point and related insights, see Eldridge et al. (2008a).

The average energy efficiency potential study had a time horizon of 12 years. The shortest period of analysis was 5 years while the longest period covered 26 years. The typical study included either all end-use energy efficiency options regardless of fuel or sector, or it was limited to only end-use electricity efficiency potential. The savings potential within these studies indicate a range of 6 percent to 33 percent savings over the forecasted reference case level of consumption. The average level of energy savings was 23 percent, with an average benefit-cost ratio of about 1.95. That is, for every dollar invested in energy efficiency potential over the study time horizon, total energy bill savings averaged about $1.95 (in the base-year dollars). This return is a strong indication that energy efficiency is a low cost investment that yields substantial returns. For studies that reported benefit-cost ratios, or for which they could be calculated, such ratios ranged from 1.1 to 4.8.

These studies also indicate that there would be a net increase in jobs resulting from a more productive investment in energy-using technologies. The number of jobs per trillion Btus of efficiency gains ranged from a low of 9 to a high of 95. The average among all studies was a net benefit of 49 jobs per trillion Btus of savings. Many of the studies in this survey did not report a specific change in gross state product (GSP). From among those that did provide such information (see the key data in Appendix B), it appears that the net impacts are on the order of -0.1 percent to about 0.6 percent net increase above the reference case.[2] The reason for this small but generally net positive impact is two-fold. First, the net benefits (primarily the energy bill savings) outweigh the investment costs over each study's time horizon. Second, energy-producing sectors appear to be less labor-intensive and provide a smaller value-added contribution to a regional economy compared to almost all other sectors of the economy. Hence, a cost-effective shift away from energy production to energy efficiency investments provides a small employment and economic boost for the regions considered within this survey (Laitner 2008). Therefore, energy efficiency represents a cost-effective investment in greater economic productivity, but also in promoting a more robust level of economic activity.

A Typical Example: The Case of the Maryland 2008 Study

Typical among the reports reviewed here and cited within Appendix A is an ACEEE report released in 2008. This specific study detailed the economic benefits of a statewide energy efficiency target for the state of Maryland. The ACEEE analytical team showed that adopting a 15 percent energy efficiency target by 2015 in Maryland, as proposed by Maryland Governor Martin O'Malley, would create numerous economic benefits (Eldridge et al. 2008b). The study described a suite of policy recommendations that the state could adopt to tap into its energy efficiency resource potential and enable Maryland to meet the 15 percent electricity target by 2015. Some of the policies recommended in

[2] Two of the studies referenced in Appendix B suggest a small but negative impact on GSP. Two points should be noted. First, those studies focus on electricity-only efficiency gains. Since electricity generation tends to be capital-intensive but not labor-intensive, one can imagine a change in the composition of GSP that increases employment while also slightly reducing value-added returns. But second, for all of the studies that suggest an economy-wide efficiency improvement (as we might expect to happen under new climate and energy policies), the returns to GSP are small but net positive.

the study include appliance standards, more stringent building energy codes, and utility and state investments in sector-specific energy efficiency programs. The analysis extended the study period to 2025, and estimated the potential for 29 percent electricity savings by that year through the adoption of the recommended policies.

The Maryland analysis indicated that $3.4 billion in program spending and incentives together with an additional $5.9 billion in customer efficiency investments over the 2008-2025 time period would result in net cumulative savings of $21 billion in avoided energy bills in Maryland by 2025. In addition, an estimated $3.9 billion in utility investments would be avoided. Even as overall utility investments decline, energy efficiency investments would create jobs and new areas of economic growth. The study estimates that about 12,000 jobs would be created in the state in 2025 and that the state would be given a small but net positive boost to overall economic activity.

Building the Case for a National-Level Impact

While a significant number of states are taking independent action to improve overall energy productivity within their economies, much of the attention remains on the national debate. Hence, the question might be asked, “What might this series of studies tell us about the potential economic impact of efficiency gains at the national level?” Among the 48 reports listed in Appendix A, there are 24 that have sufficiently comparable data to allow us to estimate the impact of efficiency gains on both net jobs and net change in GDP. Appendix B summarizes the key data from those 24 studies and describes the methodology used to generate our working estimates of impacts that follow in the paragraphs below.

In general we find the net economic impact to be a function of two key variables: the magnitude of total energy savings, and the benefit-cost ratio. In short, we find that the greater the energy savings and the greater the level of cost-effectiveness, the larger the generally positive impact on regional economies.[3] In effect, the energy productivity gains implied by the various studies nudge the regional economies ahead compared to the business-as-usual scenario. It’s also worth repeating that energy-related sectors such as oil and gas extraction, coal mining, and electric and natural gas utilities tend to support a smaller number of jobs and a smaller contribution to GSP or GDP (again, see Laitner 2008).

Given this analytical framework, the magnitude of impact on the U.S. economy is evaluated against the year 2030 reference case forecast for energy consumption as projected by the *Annual Energy Outlook* (Energy Information Administration 2008). As it turns out, this most recent projection suggests that—given: (1) currently expected economic activity and energy prices through 2030, (2) current laws and policies now in

[3] Generally speaking the studies imply that the net positive economic impacts will hold up to a roughly 30% savings over the next 25 years or so. Presumably one can push the savings too hard and too fast so that negative impacts will, indeed, begin to emerge. Since all the studies reviewed in this assessment seem to generate a positive benefit-cost ratio, and for the most part, none exceed a 30% savings over the study period, it is hard to know at what point negative impacts would begin to accrue.

place, and (3) the likely mix of technologies that will impact the market demand for energy—the U.S. will require about 118,000 Trillion Btus (TBtu) of total energy by the year 2030. The question then becomes: How might efficiency gains change both the total number of jobs and the scale of overall economic activity?

As we note within the discussion in Appendix B, a working estimate of net employment impacts from an energy efficiency-led investment scenario was generated. First, the range of potential energy efficiency gains is estimated, and second, the range of overall cost-effectiveness implied by the policies, which drive those investments needed to improve overall energy productivity, is determined. Since we are not trying to evaluate any specific policy at this point, only a range of likely outcomes is provided to illustrate the magnitude of net benefits that might follow from a desired gain in energy productivity. Indeed, our larger purpose is merely to document the logic of how energy efficiency gains are more likely to boost economic activity compared to a standard set of reference case assumptions. Table 2 below highlights these results.

Table 2. Net Employment Impacts in 2030 as a Matrix of Energy Savings and Benefit-Cost Ratios

	Percent Savings, or	**20%**	**25%**	**30%**
	Equivalent Savings in Trillion Btus	**23,600**	**29,500**	**35,400**
Benefit-Cost Ratio	1.0		539,000	640,000
	2.0	838,000	1,034,000	1,227,000
	3.0	1,227,000	1,513,000	

Based on these studies, there would be a likely net positive impact on employment in the year 2030. Presumably, there would be a slow ramping up beginning in, say, 2010 so that by 2030 the anticipated level of cost-effective energy efficiency investments would be completed. For example, an anticipated 20 percent (or a 23,600 TBtu) savings through energy efficiency investments, at a net benefit cost ratio of 2.0, is expected to produce a net gain on the order of about 838,000 jobs in 2030. By pushing the efficiency investment such that a 30 percent (or a 35,400 TBtu) savings is realized, then net employment gains might increase to about 1.2 million jobs. With an estimated total employment of about 168 million people in 2030 (Energy Information Administration 2008), this is a small but net gain of 0.5 percent and 0.7 percent, respectively. On the other hand, by pushing the economy too hard, using less-cost effective technologies, such that costs are about equal to energy bill savings, then net gains in employment might increase to only 640,000 (0.4%) jobs by 2030.[4]

[4] While this metareview extrapolates from many other studies, the national models can incorporate this kind of assessment within their analytical framework should they choose to follow the kind of evidence reflected here and in the many other studies. For more detail on how this might be done, see Laitner and Hanson (2006). For an example of actual modeling work that reflects these kinds of policy scenarios, see Laitner et al. (2006).

Note that the authors also applied some additional judgment in constructing this table. In particular, we suggest that there is sufficient potential for large gains in energy productivity such that a 20 percent saving is likely to have a benefit-cost ratio significantly larger than 1.0. For this reason that specific result was omitted from Table 2. At the same time, it might be pushing the economy too hard and too fast to achieve a 30 percent savings by 2030 so that a benefit-cost ratio of 3.0 is unlikely. As a result, that calculation was omitted as well.[5] Finally, as suggested in Appendix B, note that there were too few data points of GDP impacts so this specific metric was not estimated. However, since any national energy policy, and especially any national climate policy, is likely to require cost-effective energy productivity investments among all sectors, the studies indicate a small but likely net positive gain on overall economic activity. If we accept the mean of the GDP impacts reported in Appendix B, the expectation is that efficiency-led policies would likely increase the nation's GDP by about 0.1 percent.

Conclusions

Given the backdrop of evidence and assessments reflected in the many studies reviewed here, it appears that the national debates on energy and climate solutions may be seriously misinformed. The use of modeling assessments that overlook the potentially significant contribution of energy efficiency investments has led to an apparent overestimation of net costs (Ehrhardt-Martinez and Laitner 2008). Just as they have taken the lead on addressing climate change, it also appears that states have also sponsored and/or funded a more robust set of modeling assessments. This same approach used in these many studies may also inform the national debate as the array of studies cited here clearly indicates that energy efficiency investments are a critical resource and solution that can lead to a net positive return for the U.S. economy.

Based on a review of 48 different assessments, this report highlights the findings of a wide variety of studies that explore the many possibilities of further gains in energy efficiency—especially at the regional and state level. The studies reviewed here show an average 23 percent efficiency gain with a nearly 2 to 1 benefit-cost ratio. By analyzing this set of studies, we estimate that a 20 percent to 30 percent energy efficiency gain within the U.S. economy might lead to a net gain of 500,000 to 1,500,000 jobs by 2030. Based on these studies, the expectation is that efficiency-led policies would likely increase the nation's GDP by about 0.1 percent, also by 2030. By highlighting the potential outcomes and methodologies, this report seeks to inform the national energy and climate policy debates now before Congress.

[5] Again, we might note that a bad choice of policy instruments, combined with less cost-effective technologies that push the nation's capital stock too hard and too fast, could result in negative economic impacts. Hence, we offer a cautionary note about appropriate choice of timing, technologies, and policy instruments. Generally speaking, however, the evidence suggests that a 20% to 30% efficiency gain is a reasonable policy target by 2030. With further policy support and developing technologies, additional cost-effective savings might be anticipated beyond this mid-term time horizon.

References

Ehrhardt-Martinez, Karen and John A. "Skip" Laitner. 2008. *The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Eldridge, Maggie R., Neal Elliott, and Max Neubauer. 2008a. "State-Level Energy Efficiency Analysis: Goals, Methods and Lessons Learned." In the *Proceedings of the 2008 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Eldridge, Maggie., R. Neal Elliott, William R. Prindle, Katie Ackerly, John A. "Skip" Laitner, Vanessa McKinney, Steven Nadel, Max Neubauer, Alicia Silverstein, Bruce Hedman, Anne Hampson, and Ken Darrow. 2008b. "Energy Efficiency: The First Fuel for a Clean Energy Future—Resources for Meeting Maryland's Electricity Needs." Washington, D.C.: American Council for an Energy Efficiency Economy.

Energy Information Administration. 2008. *Annual Energy Outlook 2008 with Projections to 2030*. Washington, D.C.: U.S. Department of Energy (Revised March 2008).

Expert Group on Energy Efficiency. 2007. "Realizing the Potential of Energy Efficiency: Targets, Policies, and Measures for G8 Countries." Washington, D.C.: United Nations Foundation.

Hummel, Holmes. 2007. *Interpreting Global Energy and Emission Scenarios: Methods for Understanding and Communicating Policy Insights*, PhD Dissertation, Stanford University.

Laitner, John A. "Skip". 2008. "Increasing Job Creation and Economic Value Added from Cost-Effective Energy Efficiency Investments. ACEEE Working Paper, Washington, DC: American Council for an Energy-Efficient Economy.

Laitner, John A. "Skip" and Donald A. Hanson. 2006. "Modeling Detailed Energy-Efficiency Technologies and Technology Policies within a CGE Framework." *Energy Journal*, 2006, *Special Edition, Hybrid Modeling of Energy-Environment Policies: Reconciling Bottom-Up and Top-Down*, 151-69.

Laitner, John A. "Skip"; Donald A. Hanson, Irving Mintzer, and Amber J. Leonard, 2006. "Adapting in Uncertain Times: A Scenario Analysis of U.S. Energy and Technology Futures. *Energy Studies Review*, 2006, 14(1)L 120-35.

Lave, Lester. 2008. "The Era of Cheap Energy Is Over; We Must Take Bold Steps to Conserve or We'll Drive Prices Even Higher and Send More Money to Those Who Would Do Us Harm" Pittsburgh Post-Gazette (May 4). Editorial Page G-1.

McKinsey Global Institute. 2008. "The Case for Investing in Energy Productivity." Washington, D.C.: McKinsey & Company.

Parker, Larry and Brent Yacobucci. 2008. "Climate Change: Costs and Benefits of S. 2191." Washington, DC: Congressional Research Service.

Appendix A. The Studies

(1) Bailie, Alison, Stephen Bernow, William Dougherty, Michael Lazarus, and S. Kartha. 2001. *The American Way to the Kyoto Protocol: An Economic Analysis to Reduce Carbon Pollution.* Boston, Mass.: Stockholm Environment Institute.

This report presents a study of policies and measures that could dramatically reduce US greenhouse gas emissions over the next two decades. It examines a broad set of national policies to increase energy efficiency, accelerate the adoption of renewable energy technologies, and shift energy use to less carbon-intensive fuels. The policies address major areas of energy use in residential and commercial buildings, industrial facilities, transportation, and power generation. This portfolio of policies and measures would allow the United States to meet its obligations under the Kyoto Protocol Together when combined with steps to reduce the emissions of non-CO_2 greenhouse gases and land-based CO_2 emissions, and the acquisition of a limited amount of allowances internationally. This package would bring overall economic benefits to the US, since lower fuel and electricity bills would more than pay the costs of technology innovation and program implementation. In 2010, the annual savings would exceed costs by $50 billion, and by 2020 by approximately $135 billion.

(2) Bailie, Alison, Stephen Bernow, William Dougherty, Michael Lazarus, S. Kartha, and Marshall Goldberg. 2001. *Clean Energy: Jobs for America's Future.* Boston, Mass.: Tellus Institute.

In a study completed on behalf of the World Wildlife Fund (WWF), the Tellus Institute found that should Congress implement the climate protection policies advocated by WWF, the United States could reap gain a net annual employment increase of over 700,000 jobs in 2010, rising to approximately 1.3 million by 2020. Moreover, U.S. carbon emissions would decline 8.5% between 2000 and 2010, as opposed to the increase of 20% that was forecast in the base case and a 28% decline between 2000 and 2020 rather than a 36% increase. A full 20% of the electricity generation needed in 2020 would come from wind, solar, biomass and geothermal energy. Oil consumption would decline by approximately 8% between 2000 and 2020, rather than increase by about 31%, thereby saving money and reducing the vulnerability of citizens and our economy to oil price shocks. In fact, overall dependence on the consumption of fossil fuels would decline more than 15% between 2000 and 2020, rather than increasing by 40% as in the base case.

This study also found that households and businesses would accumulate savings of over $600 billion by 2020. The nation's Gross Domestic Product would be about $43.9 billion above the base case in 2020. Finally, energy-related emissions of air pollution would be dramatically reduced. For example, the study suggested that by 2020, emissions of sulfur dioxide would be virtually eliminated, while nitrogen oxide emissions would be almost halved, and emissions of fine particulates, carbon monoxide, volatile organic compounds and mercury would be substantially reduced. Each state would experience a positive net job impact, rising to about 140,000 in California by 2020. Electricity sales from central station power stations would be about half of projections for 2020, owing to the policy of promotion of more efficient equipment in homes and offices and the use of waste heat in combined heat and power plants in buildings and factories.

(3) Barrett, James, J. Andrew Hoerner, Jan Mutl, Alison Bailie & Bill Dougherty. 2005. *Jobs and the Climate Stewardship Act: How Curbing Global Warming Can Increase Employment.* Washington, D.C.: Redefining Progress.

Among the legislative proposals in 2005, the broadest and most comprehensive effort to reduce the pollution that causes global warming, and thus shift away from the dirty and insecure energy sources of the past, is said to be the *Climate Stewardship Act of 2004* (CSA), sometimes called the McCain-

Lieberman bill. The CSA would limit total U.S. emissions of carbon dioxide, the primary source of global warming pollution, and five other heat-trapping gases, through a tradable permit system analogous to the highly successful sulfur dioxide permit system used to reduce acid rain. In so doing, the CSA would also reduce many other dangers posed by our current energy system, including the risk of energy-caused recessions, our dependence on foreign oil, and energy-related air pollution. It would also, according to the modeling results presented in this study, have a small but overall net positive effect on U.S. employment. The CSA incorporates, explicitly promotes, or allows for certain key policy features that tend to reduce the costs or increase the economic benefits of energy efficiency and environmental programs. These include the use of flexible, market-based approaches; recycling the revenues generated by these systems to reduce distorting taxes on work or investment; gradual phase-in to allow for planning and effective use of capital replacement cycles; and policies to encourage the development, commercialization, diffusion, and adoption of new clean technologies and remove market barriers to their adoption.

To assess the employment impacts of the CSA, this study used results from a highly disaggregated engineering model of the energy sector, the National Energy Modeling System (NEMS), developed by the Energy Information Administration of the U.S. Department of Energy, augmented by other modeling tools. These systems are used to estimate the impact of the CSA and associated policies on energy prices and costs, investment levels, permit prices, and other energy-related variables. The Tellus Institute performed this portion of the analysis. Redefining Progress then estimated the outcomes of these changes on labor demand for 192 industries through the use of a Leontief input-output model developed by the U.S. Bureau of Labor Statistics (BLS). These outcomes were estimated for the period from 2010 to 2025. Finally, the employment changes for 192 industries were distributed among the 50 states plus the District of Columbia.

The overall result is that the CSA creates a net increase in U.S. employment, albeit a small one compared to the size of the economy as a whole. At the national level, jobs created outweigh jobs lost by a factor of five by 2015, rising to nearly seven to one by 2025. The economic adjustments to the policy promote a small loss of 20,000 jobs in 2010, about 0.01% of the expected employment base in that year. However, by 2013 the energy savings show a net positive increase in employment—reaching 510,000 net job gains (a 0.31% increase) in 2015, and then rising to about 801,000 net jobs (a 0.48 % increase) by 2025.

(4) Bernow, Stephen, Karlynn Cory, et al. 1999. *The Impacts in Florida of a U.S. Climate Change Strategy.* Boston, Mass.: Tellus Institute.

Florida has unique opportunities to contribute to and benefit from policies that avert climate change, owing to its geographic location and the character of its economy. Efforts to curb climate change, by development and use of technologies that reduce emissions of carbon dioxide, would have ecological, economic health and social benefits throughout the State. This paper discusses the benefits that Florida would derive from national policies and measures that combat global warming. Many of these policies and measures, appropriately tailored to local conditions and institutions, could be pursued on the state level to achieve similar results and benefits to Florida's citizens. Building on a national policy study developed by the Tellus Institute, this report assesses how the set of national actions presented in *America's Global Warming Solutions* would affect Florida's energy systems, carbon emissions and economy. This study finds that by 2010, the set of national actions to reduce global warming would decrease Florida's primary energy use by 26% and its carbon emissions by 36%. They would also provide increasing annual savings reaching about $300 per-capita in 2010 and averaging about $110 per-capita per year between now and 2010. Thus, on a cumulative basis the State would save about $17 billion over that period. The set of national actions would also create about 27,000 net additional jobs in the State by 2010. They would reduce emissions of other pollutants and begin to shift the basis of the State's economy towards more advanced, energy-efficient technologies and cleaner resources.

(5) Bernow, Stephen, William Dougherty, et al. 2000. *Texas' Global Warming Solutions.* Boston, Mass.: Tellus Institute.

Texas has important opportunities to contribute to and benefit from policies to avert dangerous climate change. It has a unique combination of energy supply and demand—large supplies of clean energy resources, such as wind, solar, biomass and natural gas, and high demand for energy, with significant potential for more efficient energy technologies in its industry, transportation, homes and offices. It also has a strong technology and knowledge-based economy, which could contribute to the development and deployment of these twenty-first century energy resources and technologies. A shift to these new energy technologies and resources to reduce carbon dioxide emissions would have ecological, economic, health and social benefits throughout the State. The economic analyses of the 1999 study, *America's Global Warming Solutions* (Bernow et al. 1999) indicated that Texas would be the state with the highest net job creation from the national policies evaluated. This current report presents a new detailed analysis of the benefits that Texas would derive from those national policies and measures to combat global warming. Many of these policies and measures could be pursued in the State, appropriately tailored to its conditions and institutions, with similar results and benefits for Texas citizens. Texas has passed an electric industry restructuring bill that contains elements to help ensure a significant role for clean energy under increased competition. Moreover, as many Texas agencies (including the Energy Coordinating Council and the Natural Resource Conservation Commission) are undergoing Sunset reviews, the State is developing its State Implementation Plan to meet EPA's air quality requirements. It is thus an opportune time to harmonize the State's economic, environmental and public health goals with a national energy and climate strategy.

Overall, the set of national policies in America's Global Warming Solutions would begin to shift the basis of the State's economy towards more advanced, energy-efficient technologies and cleaner resources. Specifically, this study finds that:

a. Primary Energy Use and Carbon Emissions in Texas would decrease by 25% and 34%, respectively, below levels that would otherwise be reached by 2010.
b. Renewable Energy Resources would increase six-fold between 1990 and 2010, reaching over 4% of total primary energy use by 2010 (and about 12% in the electric sector). Industrial co-generation would almost double over this timeframe.
c. Increasing Net Annual Savings in Texas result from the national policies, reaching about $700 per-capita in 2010 and averaging about $200 per-capita per year through 2010. Thus, the State would cumulatively save about $35 billion over that period in present value terms.
d. Approximately 84,000 net additional jobs created in Texas by 2010.
e. Air Pollutant Emissions in Texas, harmful to its citizens and environment, are reduced by the national policies. By 2010, annual emissions of sulfur dioxide are cut by 60%, nitrogen oxides by 32% and fine particulate matter by 39%.

(6) Bernstein, Mark, Christopher G. Pernin, Sam Loeb & Mark Hanson. 2002. *The Public Benefit of Energy Efficiency to the State of Minnesota.* Santa Monica, Calif.: RAND Science and Technology.

This RAND econometric analysis shows that changes in energy intensity—controlled for such exogenous factors as price, industrial mix, and capital expenditures—are associated with important economic and environmental benefits for Minnesota and its citizens from 1979 to 1997. Since 1977 the improvements in energy efficiency among all sectors of the state's economy generate a statewide benefit that ranges from $793 per capita to $903 per capita (in 1998 dollars). The improvements also appear to support an approximate 18% lower level of air emissions from stationary sources, and a reduced financial energy burden on low-income households.

(7) The Center for Applied Research. 1997. *The Contribution of DOE's Energy Efficiency and Renewable Energy Programs to Emissions and Visibility Improvements in the Western United States.* Denver, Colo.: The Center for Applied Research.

The U.S. Department of Energy's (DOE) Denver Regional Support Office contracted with The Center for Applied Research to assess the contribution that DOE's Energy Efficiency and Renewable Energy (EERE) programs are making related to the *air and pollution prevention recommendations* of the Grand Canyon Visibility Transport Commission (GCVTC). This study found that over 57,000 jobs would be created with investment in energy efficiency measures to meet those recommendations. Additionally, over $72 billion would be saved with slightly less than an 8% energy use reduction. The geographic scope of this project corresponds with the geography of the GCVTC's study region and includes the states of Arizona, California, Colorado, Idaho, New Mexico, Nevada, Oregon, Utah and Wyoming.

(8) Colgan, Charles, Samuel Merrill, and Jonathan Rubin. 2008. *Energy Efficiency, Business Competitiveness, and Untapped Economic Potential in Maine.* Portland, Me.: Muskie School of Public Service, University of Southern Maine and Margaret Chase Smith Policy Center, University of Maine.

The economic stresses on Maine's businesses are growing. A slowing economy and rising input costs, particularly for energy, are increasing pressures in a state where concerns about the costs of doing business remain high. But there is much that businesses can do on their own to relieve some of these pressures. Even a quick examination of Maine's energy situation shows that there are both real challenges and opportunities. Perhaps the single most effective action to enhance Maine's business climate and economic competitiveness is to aggressively increase the energy efficiency of Maine's economy.

"The importance of energy to Maine's businesses is illustrated by an analysis of the economic impact of implementing some of the most cost-effective energy efficiency measures that have been identified for other states. If Maine could reduce expenditures by adopting the cost-effective measures identified for other states, businesses in the commercial (non-manufacturing) sector could save $230 million in energy costs, while businesses in the industrial (manufacturing) sector could save up to $129 million, for a total savings to the Maine economy of over $450 million per year at today's energy prices and utilization rates. In terms of potential benefits to the Maine economy, the analysis suggests that by 2020 Maine stands to create between 1,500 and 2,500 new jobs and expand Maine's GDP by between 170 and 260 million depending on overall energy prices.

(9) Eldridge, Maggie, R. Neal Elliott, William Prindle, Katie Ackerly, John A. "Skip" Laitner, Vanessa McKinney, Stephen Nadel, Max Neubauer, Alicia Silverstein, Bruce Hedman, Anne Hampson, and Ken Darrow. 2008. *Energy Efficiency: The First Fuel for a Clean Energy Future—Resources for Meeting Maryland's Electricity Needs.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Energy efficiency and demand response are not only the least-cost resources for meeting Maryland's future electricity needs: they also help the economy by creating new "green collar" jobs. Maryland has begun to lay the groundwork for a clean energy future with the recent enactment of a renewable electricity standard, appliance efficiency standards, and its participation in the Regional Greenhouse Gas Initiative (RGGI). Despite these important steps, much more is needed. In 2008, the state of

Maryland passed legislation to meet Governor O'Malley's goal to reduce per-capita electricity usage 15% by 2015.

The energy efficiency policies assessed in this report hold the potential to meet 15% of forecasted electricity consumption by 2015, enough to meet Governor O'Malley's goal, and 29% by 2025. This resource assessment identifies over 22,000 GWh of cost-effective electricity efficiency, more than sufficient to meet the projected 2015 policy suite savings of 10,500 GWh. Reducing summer peak demand is equally important as reducing overall electricity consumption. These energy efficiency initiatives, along with expanded demand response programs, have the potential to reduce summer peak demand by 32% in 2015 and 47% in 2025.

The energy savings from these efficiency policies can cut the electricity bills of participating customers by a net $860 million in 2015 and $2.6 billion in 2025. While these savings will require some public and customer investment, they yield an impressive return of $4 in reduced consumer electricity bills for every dollar invested. By 2015, an average household will save a net $8 on their monthly electricity bill from residential efficiency programs. In addition, because of the current volatility in energy prices, efficiency strategies have the added benefit of improving the balance of demand and supply in energy markets, thereby stabilizing regional electricity prices for the future. These reduced wholesale prices can save a typical household another $2 on monthly electricity bills.

Investments in efficiency have the additional benefit of creating new, high-quality "green-collar" jobs for the state. This analysis shows that these investments will create more than 12,000 new jobs in the state (see Table ES-2), including well-paying trade and professional jobs needed to design and install energy efficiency measures. These new jobs, including both direct and indirect employment effects, would be the equivalent of some 100 new manufacturing plants relocating to Maryland, but without the public costs for infrastructure or the environmental impacts of new facilities.

(10) Elliott, R. Neal, Maggie Eldridge, Anna M. Shipley, John "Skip" Laitner, Steven Nadel, Alison Silverstein, Bruce Hedman, & Mike Sloan. 2007. *Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's Growing Electricity Needs.* Washington, D.C.: American Council for an Energy-Efficient Economy.

In this study, the authors suggest that efficiency and renewable energy resources, combined with a significantly expanded demand response, can meet 107% of the projected growth in summer peak demand by 2013, heading off the reserve margin crisis that is forecast for the state and actually reducing the overall summer peak demand in key years. These goals can be accomplished at a lower cost than by constructing new conventional generation resources, thus enhancing the energy security and sustaining the state's economic growth. The study assesses a portfolio of nine policies that are both effective and potentially politically viable in Texas:

a. Expanded Utility-Sector Energy Efficiency Improvement Program
b. New State-Level Appliance and Equipment Standards
c. More Stringent Building Energy Codes
d. Advanced Energy-Efficient Building Program
e. Energy-Efficient State and Municipal Buildings Program
f. Short-Term Public Education and Rate Incentives
g. Increased Demand Response Programs
h. Combined Heat and Power (CHP) Capacity Target
i. Onsite Renewable Energy Incentives

By implementing these clean energy resource policies, Texas can meet its summer peak demand needs without any additional coal-fired power plants or other conventional generation resources. Expanded demand response programs, combined with the demand reduction from energy efficiency investments, combined heat and power, and onsite renewables, would reduce the 2013 projected summer peak (MW) by 12% and the 2023 peak by 33%.

In addition to their peak demand capacities, these combined policies would meet 8% of Texas's electricity consumption in 2013 and 22% in 2023. The most significant energy efficiency recommendations are for improved Combined Heat and Power policies and a Utility-Sector Energy Efficiency Program. In our recommendations, an Energy Efficiency Improvement Program (a utility savings target similar to the Renewable Portfolio Standard concept) and improved policies to expand CHP would each produce about 30% of the total savings. Creating incentives for building owners to invest in solar and other onsite renewable energy would produce 22% of the total savings. Improved building codes, appliance standards, and public building efficiency initiatives would meet 13% of the 2023 electricity usage, and are important due to the rapid growth of electricity usage in buildings.

The clean energy policies analyzed in this report will spur investments in energy efficiency and renewable energy, resulting in utility bill savings of $73 billion or more over the next 15 years for the consumers who make these investments, while helping to moderate electricity prices for all consumers. The suite of policies we recommend has a levelized energy cost of 4.5¢ per kilowatt-hour, including capital investment in clean energy technology and administrative costs. This compares favorably with a current average retail electric price of 9.1¢ per kilowatt-hour. The total cost of implementing all of these programs (incentives plus program and administrative costs) averages about $800 million per year. These public investments leverage much larger total investment by consumers (fourfold higher). While these public investments will be borne in most cases by Texas's electric consumers in the form of a public benefits charge, their net impact will reduce future electricity costs for all consumers.

(11) Elliott, R. Neal, Maggie Eldridge, Anna Shipley, John A. "Skip" Laitner, Steven Nadel, Phil Fairey, R. Vieira, and J. Sonne; A. Silverstein, Bruce Hedman & Ken Darrow. 2007. *Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Florida's energy vulnerabilities have become more apparent during the past several years. Florida is one of the most natural gas-dependent states in the country, with more than a third of its electricity generated by natural gas. In December 2005, the natural gas "crisis" drove utility prices from less than $3 per thousand cubic foot to over $14, a price that hurt Floridians' pocketbooks. The pain intensified when Hurricane Katrina disrupted natural gas supplies and jeopardized electricity generation. While the price of natural gas has fallen over the past year, it still costs more than two and a half times more than it did when many of the state's new natural gas power plants were planned. It is not the bargain we once thought. The state now faces plans for major investments in new power plants. While many of the new power plants will be coal- or nuclear-powered, Florida will still need more natural gas plants to meet the peak electricity demand.

Fortunately, another suite of energy resource options is available—slowing energy demand growth with energy efficiency resources and demand response, and diversifying the supply resources with renewables. This report explores the magnitude of the efficiency and renewable resources that are available to the state, and suggests some specific policies that could be implemented to reduce future energy demands.

If all the policies in this report were implemented, the state could reduce its projected future use of electricity from conventional sources (i.e., natural gas, coal, oil, and nuclear fuels) by over 45% in the next 15 years. Renewable energy accounts for almost two-thirds of the 2023 total 153,595 Million kWh electricity reductions, with the energy efficiency provisions accounting for the balance.

(12) Geller, Howard, Neal Elliott, Toru Kubo, Steve Nadel, and Anna Shipley, Robert Mowris, Patti Case, Steve Bernow, Rachel Cleetus, Alison Bailie, Bill

Dougherty, Ben Runkle, Marshall Goldberg, Larry Kinney & Mark Ruzzin. 2002. *The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest.* Boulder, Colo.: Southwest Energy Efficiency Project.

This report, including the work of more than a dozen analysts and investigators, 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: (i) reducing average electricity demand growth from 2.6% per year in the Base Scenario to 0.7% per year in the High Efficiency Scenario; (ii) reducing total electricity consumption 18% (41,400 GWh/yr) by 2010 and 33% (99,000 GWh/yr) by 2020; (iii) eliminating the need to construct thirty-four 500 megawatt power plants or their equivalent by 2020; (iv) saving consumers and businesses $28 billion net between 2003-2020, or about $4,800 per current household in the region; (v) increasing regional employment by 58,400 jobs (about 0.45%) and regional personal income by $1.34 billion per year by 2020; (vi) saving 25 billion gallons of water per year by 2010 and nearly 62 billion gallons per year by 2020; and (vii) reducing carbon dioxide emissions, the main gas contributing to human-induced global warming, by 13% in 2010 and 26% 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. 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: (a) adopting Systems Benefit Charges or Energy Efficiency Performance Standards to expand utility-based energy efficiency programs; (b) providing utilities with financial incentives to implement effective energy efficiency programs; (c) reforming utility rates to encourage greater energy efficiency; (d) upgrading to state-of-the-art building codes and promoting the construction of highly efficient new buildings that exceed these codes; (e) adopting minimum efficiency standards on products not yet covered by national standards; (f) providing sales tax waivers or income tax credits for innovative energy-efficient technologies; (g) expanding participation in industrial voluntary commitment programs; (h) adopting "best practices" in public sector energy management; (i) expanding energy efficiency training and technical assistance programs; and (j) 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% savings by 2010 and 33% saving by 2020 for the region as a whole.

(13) Goldberg, Marshall & Skip Laitner. 1998. *Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy for Texas.* Alexandria, Va.: Economic Research Associates.

This study, undertaken for the Texas Department of Economic Development, analyzes the economic benefits of accelerated investments in energy efficiency and renewable energy technologies. The energy efficiency target evaluated in this study is the level of investment needed to create an economy that is 30% more efficient than 1988 levels. This is the target suggested by the Energy Policy Act, first enacted by Congress and signed by then-President George Bush in October 1992. Although the federal target is not a mandate, it was seen as a reasonable objective to encourage the development of a more energy efficient economy whenever cost-effective technologies are available to ratepayers and businesses. The study analyzes two alternative energy strategies for Texas. The first follows a "Moderate" energy course. This strategy identifies an "alternative energy path" for Texas in which, by the year 2010, residents and businesses pay approximately $22 billion less in energy bills. Using an input-output model of the Texas economy, the analysis suggests that under this moderate scenario, the state would support at net increase of 36,300 jobs by 2010. The second alternative energy strategy for

Texas follows an "Advanced energy course." This strategy identifies an "alternative energy path" in which, by the year 2010, residents and businesses pay approximately $32 billion less in energy bills. Under this more aggressive scenario, the economy would have about 49,300 more jobs compared to the standard "business-as-usual" projections. The study suggested that in both scenarios, everyone would benefit from a cleaner environment. Hence, the authors concluded 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.

(14) Goldberg, Marshall & Skip Laitner. 2000. *Assessing the Impacts of Electric Retail Competition on Mississippi's Residents and Businesses.* Alexandria, Va.: Economic Research Associates.

The purpose of this report was to quantify some of the economic impacts which might result from the trend toward retail electric competition in Mississippi through 2010. The analysis evaluated the impact of higher and lower electricity prices together with and without additional investments in energy efficiency technologies. Under the reference case assumptions, electricity use in Mississippi was expected to grow by about 16% in the years 1998 through 2010. This was slightly smaller than the 20% growth rate expected for the United States within that same period of time. Electricity rates, under reasonable assumptions about retail competition, are expected to decline by about 10% compared to the reference case forecast. A decline in electricity rates will generate an estimated $378 million in electricity bill savings (in constant 1996 dollars) for residents and businesses in 2010. However, this is less than the electricity bill savings that might be supported by a set of policies which emphasize modest electricity efficiency improvements. In the efficiency case, annual electricity bill savings might exceed $400 million. The most positive economic outcome for Mississippi was a situation in which electric retail competition reduced the price of electricity and a mix of policies to promote energy efficiency investments reduced the amount of electricity needed to sustain the economy. In that scenario, electricity bill savings might exceed $700 million in 2010 (in 1996 dollars) while state employment would be projected to increase by a net gain of 7,500 jobs.

(15) Goodman, Ian, Betty Krier, et al. 1996. *Employment, Earnings, and Environmental Impacts of Regional Improvements in Energy Efficiency.* Atlanta, Ga.: Southern States Energy Board.

This study, undertaken at the behest of the Southern States Energy Board (SSEB), estimates the employment and earnings impacts which would flow from both a 10% and 15% increase in regional energy efficiency over the period 1990 to 2010. It focuses on the electric and gas utility sectors with more limited attention paid to the transportation sector. In addition, the report provides estimates of reductions in emissions from both carbon dioxide and criteria air pollutants. Under scenario 1 the net present value of efficiency improvements (in 1992 dollars) are estimated at $128 billion with an avoided cost of energy supply estimated to be $152 billion. In scenario 2 the estimated incremental cost and savings are both $68 billion more than in the first scenario. These totals represent efficiency investments in a region that was then about 40% of total U.S. population. The analysis suggests that both scenarios produce more employment per dollar of efficiency expenditure compared to the supply-side activities they avoid. Scenario 1 would create about 2.2 million per-person years of employment from efficiency gains compared to 1.6 million person-years from the displaced supply side investments. The comparable figures for scenario 2 are 1.5 million and 0.9 million person-years of employment, respectively. Because both scenarios are shown to lower energy bills, the respending of the energy bill savings support an addition 1.5 million and 0.3 million person-years of employment for scenarios 1 and 2, respectively. The efficiency gains also reduce regional emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide by about 0.8 million, 1.3 million, and 2.0 billion tons for scenario 1, respectively. The reductions in scenario 2 are similar: approximately 0.9 million, 1.1 million, and 1.7 billion tons, respectively. Note that all data reflect discounted values over the 20-year time horizon. To that extent they under-represent the actual impacts in the year in which they occur.

(16) Hewings, Geoffrey, Moshe Yanai, Howard Learner, Hans Detweiler, Jill Geiger, Charles Kubert, Kappy Laing, John Moore & Lauren Sharfman. 2004. *Job Jolt: The Economics Impacts of Repowering the Midwest The Clean Energy Development Plan for the Heartland.* Champaign-Urbana, Ill.: Regional Economics Applications Laboratory.

In this macroeconomic state impacts study, the authors found that implementing the *Repowering the Midwest Clean Energy Development Plan* would create a net increase of more than 200,000 new jobs across the 10-state Midwest region by 2020. It would also generate a net increase in additional worker income of up to $5.5 billion, and up to $20 billion in increased economic activity. The major sources of these impacts were stimulated by:

By 2010, energy efficiency would provide electricity consumers in all sectors—industrial, commercial and residential— improved efficiency and reduce power demand by 17% below the projected business - as - usual rate of consumption. By 2020, the difference would be a 28% reduction. These reductions would be more than enough to achieve a flattening-out of Midwest electricity demand at current levels.

By 2010, clean renewable energy would yield electric utilities a more diverse fuel mix to consumers in which 8% of electricity is generated by cleaner renewable energy technologies including wind power, biomass energy, and solar power. By 2020, this clean renewable energy would increase to 22% of electricity supplied to consumers. Moreover, developing and implementing efficient natural gas uses in appropriate locations, especially Combined Heat and Power (CHP), district energy systems and fuel cells, would boost the cleaner energy component of the electricity supply to 18% by 2010 and to 46% by 2020.

(17) Hoerner, Andrew J. & James Barrett. 2004. *Smarter, Cleaner, Stronger: Secure Jobs, a Clean Environment, and Less Foreign Oil.* Oakland, Calif.: Redefining Progress.

Building on a series of national studies which demonstrate the capacity for significant improvements in the nation's overall energy efficiency, this report outlines the macroeconomic benefits of such improvements at both the national and the state levels. Compared to continuing policies and investments, an accelerated rate of efficiency improvements would create an additional 652,000 high-quality jobs for the United States within 10 years, rising to 1.4 million added jobs by 2025. The new investment strategy would also generate an average household energy bill savings of $373 as early as 2010, rising to $1,275 by 2025. The strategy would also significantly reduce dependence on foreign oil and strengthen both national and economic security for all Americans. Finally, the plan would cut energy-related carbon emissions in half within the next 20 years. The study provides estimates of state-specific impacts in addition to the national benefits.

(18) Jensen, Val & E. Lounsbury. 2005. *Assessment of Energy Efficiency Potential in Georgia.* San Francisco, Calif.: ICF Consulting.

The results presented in this report reflect ICF energy efficiency projections based on current technical, economic, achievable potential in the state of Georgia for the period 2005 through 2015. By 2010, ICF projects achievable energy efficiency gains of between 2.3% and 8.7% of electricity sales, 1.7% and 6.1% of electricity peak demand, and 1.8% and 5.5% of natural gas sales. Three intervention scenarios were modeled: Minimally Aggressive, Moderately Aggressive, and Very Aggressive. The achievable energy efficiency potential identified in this study has significant direct net economic benefits for the state of Georgia. From a "Total Resource Cost" or TRC perspective, the total net benefits to the state from energy efficiency improvements implemented from 2005-2015 in each of the policy intervention scenarios are between $0.9 billion and $1.6 billion in net present value dollars. The benefit-cost ratios for the three intervention scenarios are between 1.5 and 2.2. To assess economic development impacts, ICF subcontracted with the University of Georgia's Carl Vinson Institute of Government to use the Georgia Economic Modeling System (GEMS), a regional simulation model for the Georgia economy. Given several inputs on the costs of energy efficiency equipment, customer energy bill savings, and program administrative and incentive costs, the GEMS model suggested long-term net employment increases in Georgia compared to the reference case projections. By 2015, GEMS projects that these increases would range between 1,500 and 4,200 jobs. Each scenario would also produce increases in personal income relative to the baseline forecast. GEMS projected that these increases would be between $48 million and $157 million by 2015. In addition to these impacts, water savings from reduced power consumption would reach 124 to 164 million gallons of water per day. The study also showed significant reductions in SOx, NOx, and CO_2 emissions.

(19) Kaiser, Mark J., Allan G. Pulsipher, & Robert H. Baumann. 2001. *Economic and Environmental Impact of a Public Benefits Fund in Louisiana.* Baton Rouge, La.: Center for Energy Studies.

This report assesses the potential economic and environmental impact of a public benefits fund (PBF) in the state of Louisiana for the year 2001-2002. The fund is capitalized by a 1 million per kilowatt-hour surcharge on the electric rates of all electricity uses and is expected to generate approximately $82 million in revenue. The funds were to be distributed equally across four programs: (i) low-income bill assistance; (ii) low-income weatherization programs; (iii) residential energy efficiency programs; and (iv) commercial energy efficiency programs. Based on the IMPLAN model, the investigators found that the program would generate a value-added for Louisiana of about $95 million. A total of about 2,200 jobs would also be supported. Emissions of SO_2, NOx, and carbon would be reduced by about 555, 396, and 36,000 tons, respectively.

(20) Laitner, John A. "Skip." 1992. *The Economic Impacts of the Proposed US Virgin Islands Energy Code.* Alexandria, Va.: Economic Research Associates.

This study evaluates the potential for Home Energy Rating Systems (HERS) and Energy–Efficient Mortgages (EEMS) offer a new home buyer information on the annual operating cost and the ability to qualify for a larger loan on an energy–efficient home as a result of lower operating costs. One study noted, for instance, that targeted energy improvements of $250 per home add only $2.50 to the mortgage payment, but they save buyers about $35 in lower energy bills. In the case of the U.S. Virgin Islands, it may be especially appropriate to extend EEM coverage to water efficiency where residents pay as much as 20 times for water consumption as many residents on the U.S. mainland.

(21) Laitner, John A. "Skip" & Goldberg, Marshall. 1993. *Energy Efficiency and Minnesota Jobs: The Employment Impacts of Electric Utility Demand-Side Management Programs.* Eugene, Oreg.: Economic Research Associates.

Minnesota began the development of demand-side management (DSM) initiatives when the state's legislature required the launch of Conservation Improvement Programs (CIP) in 1983. One particular CIP effort developed by Northern States Power (NSP) targeted a cumulative electricity savings of about 4,757 gigawatt-hours (GWh) by 2005. This represented a projected 10% savings of electricity sales in that year. The net benefit to NSP ratepayers was estimated at $192 million, also in the year 2005. The analysis extended the review of benefits by examining the net employment impacts from the expanded level of energy efficiency investments. In this case, the projected employment impact was anticipated to rise from 270 net new jobs in 1993, and further increase to 3,810 net new jobs in 2005. The results of this study appear to be fairly robust—that is, there is a net positive benefit to the state's employment base under widely different assumptions. A more aggressive "climate stabilization" DSM scenario showed a smaller marginal though still highly positive net benefit. In that case, a 30% efficiency gains would increase the savings to 14,415 GWh. The net financial gain was estimated to be a smaller but still net positive $157 million in 2005. While the electricity savings were estimated to roughly triple under the climate scenario, net employment impacts were estimated to increase to only 5,693 jobs as a result of a reduced net financial savings.

(22) Laitner, Skip, John DeCicco, R. Neal Elliott, Howard Geller, Marshall Goldberg, Robert Mowris, & Stephen Nadel. 1995. Energy Efficiency and Economic Development in the Midwest. Washington, D.C.: American Council for an Energy-Efficient Economy.

This study notes that energy which is inefficiently or inappropriately used can constrain the economic activity of a state or region and thereby limit the job creation process. To that extent, it examined the energy consumption patterns within the Midwest regional economy, including the states of Illinois, Indiana, Michigan and Ohio. More specifically, it projected what "business-as-usual" energy consumption patterns might look like through the year 2010. It then analyzed the potential economic benefits of accelerated investment in energy-efficient technologies. The study indicated that a $104 billion investment in cost-effective energy efficiency technologies between 1995 and 2010 would yield a cumulative energy bill savings of $183 billion over that same period. These values were measured in 1990 dollars. This implies a net positive benefit-cost ratio of 1.75 over the 16-year period of analysis. (The study authors also noted that this value understated the cost-effectiveness of the energy efficiency investments since energy savings would continue for many years after 2010.) Using a partially dynamic input-output model for this region, the study indicated that investment in energy efficiency technologies would increase the region's employment base from a modest increase of 3,000 jobs in 1995 to 205,000 jobs by the year 2010. That rise in employment, driven by an increase in net energy bill savings, was equivalent to the number of jobs supported by the output, expansion, or relocation to the region of 1,367 small manufacturing plants.

(23) Laitner, John A. Skip & Marshall Goldberg. 1994. *Energy Efficiency and Renewable Energy as an Investment in Alabama's Future.* Alexandria, Va.: Economic Research Associates & Washington, D.C.: American Council for an Energy-Efficient Economy.

This study analyzes the potential for Alabama to move toward a sustainable energy future. At the time of the study, the state of Alabama imported approximately one-third of its energy needs. Perhaps more importantly, it spent a significant share of its Gross State Product (GSP) to provide power and transportation fuels for residents and businesses alike. Moving toward a more efficient use of fossil fuels would provide the state with 10,590 jobs and over $20 billion in savings.

(24) Laitner, Skip & Marshall Goldberg. 1994. *Energy Efficiency and Renewable Energy as an Investment in Pennsylvania's Future.* Alexandria, Va.: Economic Research Associates & Washington, D.C.: American Council for an Energy-Efficient Economy.

This study analyzes the potential for Pennsylvania to move from a heavy reliance on fossil and nuclear fuels toward a sustainable energy future. At the time of the study, Pennsylvania spent a significant share of its Gross State Product (GSP) to provide power and transportation fuels for residents and businesses alike. Energy efficiency and renewable energy technologies offered Pennsylvania the opportunity to create 59,900 jobs and save over $53 billion.

(25) Laitner, Skip & Marshall Goldberg. 1994. *Energy Efficiency and Renewable Energy as an Investment in Washington's Economic Future.* Alexandria, Va.: Economic Research Associates.

This study analyzes the potential the abundant opportunities for energy efficiency improvements and biomass, solar and wind resource development, in Washington. At the time of the study, Washington spent a significant share of its Gross State Product (GSP) to provide power and transportation fuels for residents and businesses alike. Energy efficiency and renewable energy technologies offer an opportunity to create 18,800 jobs and save over $21 billion in Washington state.

(26) Laitner, Skip & Marshall Goldberg. 1995. *A Reevaluation of Economic Opportunities through Missouri Building Codes and Energy Efficiency Improvements.* Alexandria, Va.: Economic Research Associates.

This report fulfills a Missouri legislature request in 1993 to evaluate the potential impact of the 1992 Energy Policy Act (EPAct). The resulting EPAct study provided a well-documented, estimate of the direct costs and benefits of implementing statewide energy codes for new residential and commercial buildings. A subsequent review of that study by Laitner and Goldberg found, however, that the 1993 study's use of a gross rather than net macroeconomic impact analysis overstated the employment, income and retail sales benefits of the three scenarios reviewed. The updated stated found, nonetheless, that the adoption of statewide building codes has been shown to be consistently cost-effective. It suggested that macroeconomic and environmental benefits would continue to be positive as well.

The updated study noted that some reviewers might initially believe that the net impacts of new building codes might be too small to be worth much trouble in implementing and enforcing them. But this was only because the building codes themselves affected only a small proportion of Missouri's total energy requirements. It was noted that the implementation of the energy codes would save only about two trillion Btus of energy in the year 2000. Two trillion Btus represent only about one-tenth of 1% of the anticipated energy to be consumed in that year.

Scaling up the level of efficiency improvements in the existing stock of buildings, industries and transportation systems will similarly increase the macroeconomic benefits. The authors noted, for example, that a 1995 Midwest energy efficiency study completed by the American Council for an Energy-Efficient Economy (see reference 8 above) found that cost-effective energy efficiency investments could reduce energy consumption in the year 2010 by about 4,300 trillion Btus. This would be a 26% reduction compared to baseline projections. Measured on a net basis, employment would be expected to rise by about 205,000 jobs in the four-state region.

The 1995 updated study for Missouri found that a two trillion Btu savings in the year 2000 would support a net employment gain of about 100 jobs, or about 50 jobs per trillion Btus saved through cost-effective building energy efficiency codes. Interestingly, the study noted that this figure was similar to one cited in the 1995 Midwest study. In that latter analysis, the modeling exercise suggested that for each one trillion Btus of energy saved through cost-effective efficiency improvements, employment would increase by a net of about 48 jobs.

(27) Laitner, Skip & Marshall Goldberg. 1996. *Colorado's Energy Future: Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy.* Alexandria, Va.: Economic Research Associates.

This 1996 report examined the current energy consumption patterns and expenditures within the Colorado economy. It projected what "business-as-usual" energy patterns might look like through the year 2010. The study then analyzed the economic and environmental benefits of an accelerated investment in energy efficiency and renewable energy technologies. The energy efficiency target evaluated in this study is the level of investment needed to create an economy that is 30% more efficient by the year 2010. This was the target suggested by the Energy Policy Act, first enacted by Congress and signed by then-President George Bush in October 1992. If achieved, the reduced energy intensity implied by the EPAct target (compared to a BAU scenario) would imply a 14% reduction over the baseline energy projections for the year 2010—without reducing either the services or the standard of living for Colorado residents and businesses.

Under the alternative EPAct energy scenario for the year 2010, new energy efficiency investments would provide 185 trillion Btus of energy savings while renewable energy technologies would provide another 27 trillion Btus of energy services. Colorado ratepayers in 2010 would save an estimated $1.2 billion in lower energy costs. Energy efficiency and renewable energy investments, on the other hand, would require a total of $300 million from residents and businesses in 2010. Net energy bills, therefore, would decline by $800 million in 2010 (in 1996 dollars).

According to the study, the energy efficiency and renewable energy scenario would require a $4.4 billion cumulative investment in the years 1997 through 2010. That relatively small level of investment (less than 0.2% of Colorado's cumulative GSP in that same period) could be achieved by redirecting technology investments toward more productive energy efficiency investments. If successful, Colorado ratepayers would enjoy a cumulative energy bill savings of $8.5 billion over that same period of time. With all values in 1996 dollars, the energy efficiency and renewable energy scenario generates a positive benefit-cost ratio of 1.94 over the 14-year period of analysis. As with other studies, this ration understated the cost effectiveness of the alternative energy investments since the energy savings and environmental benefits would likely continue for many years after the year 2010. Using an input-output model of the Colorado economy, the study indicated that the investment in energy efficiency and renewable energy technologies would increase the state's employment base—from a net increase of 600 jobs in the year 2000 to a net gain of 8,400 jobs by the year 2010. The rise in employment, driven largely by an increase in net energy bill savings, was estimated to be the equivalent of the number of jobs supported by the expansion or relocation of 67 small manufacturing plants in Colorado. Wage and salary compensation would similarly rise by a net of $171 million by 2010 (in 1996 dollars), the equivalent of tourist expenditures from approximately 1.1 million visitor days. The alternative energy strategy would have a positive benefit for Colorado's air quality as well. Energy-related pollutants such as sulfur and nitrogen oxides and particulate matter would decline by 133,000 tons in the year 2010. Carbon dioxide emissions, believed to contribute to global climate change, would be reduced by 18 million tons in 2010.

(28) Laitner, John A. "Skip" & Marshall Goldberg. 1997. *Arizona Energy Outlook 2010: Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy.* Alexandria, Va.: Economic Research Associates.

Similar to other studies, this report examined the current energy consumption patterns and expenditures within the Arizona economy. It projected what "business-as-usual" energy patterns might look like through the year 2010. The study then analyzed the economic benefits of an accelerated investment in energy efficient and renewable energy technologies. The accelerated energy efficiency and renewable energy scenario outlined in this study would lower Arizona's energy needs by 13% compared to the baseline energy projections for the year 2010—without reducing either the services or standard of living for Arizona residents and businesses. Under the alternative energy scenario for the year 2010, new energy efficiency investments would provide 179 trillion Btus of energy savings while new renewable energy technologies would provide another 5.6 trillion Btus. Arizona ratepayers in 2010 would save approximately $1.4 billion in lower energy costs. Energy efficiency and renewable energy investments, on the other hand, would require a total of $461 million from residents and businesses in 2010. Net energy bills, therefore, would decline by approximately $952 million in 2010 (in 1996 dollars). New investments in energy efficiency and renewable energy technologies would increase Arizona's employment base—from a net increase of 900 jobs in the year 2000 to a net gain of 11,100 jobs by the year 2010. If successful, Arizona ratepayers would enjoy a cumulative energy bill savings of almost $9.2 billion over that same period of time. With all values in 1996 dollars, the energy efficiency and renewable energy scenario generates a positive benefit-cost ratio of 1.92 over the 13-year period of analysis. The rise in employment in year 2010, driven largely by an increase in net energy bill savings, is equivalent to the number of jobs supported by the expansion or relocation of almost 90 small manufacturing plants in Arizona. Total wage and salary compensation would similarly rise by a net of $233 million by 2010 (in 1996 dollars), the equivalent of tourist expenditures from approximately 1.5 million visitor days.

(29) Laitner, Skip & Marshall Goldberg. 1997. *Energy: A Major Economic Development Strategy for Nevada.* Alexandria, Va.: Economic Research Associates.

This 1997 study analyzed the economic benefits of an accelerated investment in energy efficiency and renewable energy technologies. Toward the end, the study paints a picture of two Nevadas. The first followed a "business as usual" energy course. The second identified an "alternative energy Nevada" which, in the year 2010, paid approximately $800 million less in energy bills, had 4,300 more jobs, and enjoyed a cleaner environment. Hence, the increased investments in both energy efficiency and renewable energy technologies were described as important steps toward promoting a sustainable energy future for Nevada. Under the alternative energy scenario for the year 2010, new energy efficiency investments would provide 124 trillion Btus of energy savings while renewable energy technologies would provide another 43 trillion Btus. While Nevada ratepayers in 2010 would save approximately $800 million in lower energy costs, energy efficiency and renewable energy investments, on the other hand, would require a total of $250 million from residents and businesses in 2010. Net energy bills, therefore, would decline by approximately $550 million in 2010 (in 1996 dollars). If successful, Nevada ratepayers would enjoy a cumulative energy bill savings of $5.1 billion over that same period of time. With all values in 1996 dollars, the energy efficiency and renewable energy scenario generates a positive benefit-cost ratio of 2.02 over the 13-year period of analysis. Furthermore, the study suggested that if Nevada were able to develop a renewables manufacturing industry that produced an annual sales of 1,000 MW of new capacity by 2010, the market potential from the in-state manufacturing and installation of the plants alone would be about $225 million per year in 2010 and generate 2,700 new jobs in that year.

(30) Laitner, Skip & Marshall Goldberg. 1997. *Wyoming Energy Outlook: Energy Efficiency as an Economic Development Strategy.* Alexandria, Va.: Economic Research Associates.

This report examined the current energy consumption patterns and expenditures within the Wyoming economy. It projected what "business-as-usual" energy patterns might look like through the year 2010. The study then analyzed the economic benefits of an accelerated investment in energy efficiency. The study painted two pictures of Wyoming. The first picture followed a "business as usual" energy course. The second identified an "alternative energy Wyoming" in which consumers and businesses paid approximately $360 million less in energy bills by the year 2010. Also by 2010, the alternative energy future would support 2,700 more jobs and enjoy a cleaner environment. Hence, the study noted that increased investments in energy efficiency would be an important step towards promoting a sustainable energy and economic future for Wyoming. Although the report noted a 2010 savings of $360 million in lower energy costs, a total of $97 million in energy efficiency investments would be required from residents and businesses in 2010. Net energy bills, therefore, would decline by only $263 million in 2010 (in 1996 dollars). The energy efficiency scenario was estimated to require a $1.1 billion cumulative investment in the years 1997 through 2010. The authors noted that this relatively small level of investment (less than 0.1% of Wyoming's cumulative GSP in that same period) could be achieved by redirecting technology investments toward more productive energy efficiency investments. If successful, Wyoming ratepayers would enjoy a cumulative energy bill savings of $2.4 billion over that same period of time. With all values in 1996 dollars, the energy efficiency scenario generates a positive benefit-cost ratio of 2.15 over the 14-year period of analysis. But as with other studies, this value understates the cost-effectiveness of the alternative energy investments since the energy savings and environmental benefits would likely continue for many years after the year 2010. The investment in energy efficiency would increase Wyoming's employment base—from a net increase of approximately 400 jobs in the year 2000 to a net gain of 2,700 jobs by the year 2010. The rise in employment, driven largely by an increase in net energy bill savings, is equivalent to the number of jobs supported by the expansion or relocation of 22 small manufacturing plants in Wyoming. Wage and salary compensation will similarly rise by a net of $45 million by 2010 (in 1996 dollars), the equivalent of tourist expenditures from approximately 300,000 visitor days. While the average wage will fall by about $150 per job in 2010 under the alternative energy scenario (the result of a slightly larger increase in the number of jobs relative to the rise in wage and salary compensation), the cost of living will also fall by an average of $243 per job. Hence, Wyoming's overall standard of living will be expected to increase by $93 per job by the end of the study period.

(31) Laitner, S., Maggie Eldridge, & R. Neal Elliott. 2007. *The Economic Benefits of an Energy Efficiency and Onsite Renewable Energy Strategy to Meet Growing Electricity Needs in Texas.* Washington, D.C.: American Council for an Energy-Efficient Economy.

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 in Texas. 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 report, ACEEE reviewed the macroeconomic impacts that likely would unfold under these alternative policy recommendations. The report found 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.

(32) Laitner, John A. "Skip" & Martin G. Kushler. 2007. *More Jobs and Greater Total Wage Income: The Economic Benefits of an Efficiency-Led Clean Energy Strategy to Meet Growing Electricity Needs in Michigan.* Washington, D.C.: American Council for an Energy-Efficient Economy.

In January 2007 the Michigan Public Service Commission released the "21st Century Energy Plan", presenting the results of a six month study by MPSC Staff and a number of other interested parties. The conclusions of that study indicated that a combination of energy efficiency and renewable energy technologies could help meet the growing need for electricity in the state. By incorporating those technologies into the resource mix, particularly energy efficiency, the PSC plan would actually reduce total electric system costs as compared to a 'business-as-usual approach. The question answered in this new study is whether this alternative "clean energy" policy scenario could provide additional economic benefits in terms of net growth in jobs and wages in Michigan.

In this report, ACEEE reviewed the macroeconomic impacts that likely would unfold under an alternative set of policy recommendations. The report found that cost-effective investments in the combination of energy efficiency and renewable energy 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 Michigan are expected to enjoy a net cumulative savings of at least $2.6 billion and likely more. As a result of this greater energy productivity, the state is projected to show a net annual employment increase of between 3,000 and 10,000 jobs (depending on the level of energy efficiency policy pursued - the greater the level of cost-effective energy efficiency investments, the greater the number of net new jobs). This is roughly equivalent to the employment that would be directly and indirectly supported by the construction and operation of 25 to 75 small manufacturing plants within Michigan. In addition, air emissions from conventional power plants could be reduced by 15-28 % (also by 2023). The extent to which these benefits are realized will depend on the willingness of business and policy leaders to implement or even expand the kinds of energy efficiency and renewable energy recommendations that are found in the earlier MPSC 21st Century Energy Plan.

(33) Madsen, Travis, Timothy Telleen-Lawton, Will Coyne, & Matt Baker. 2007. *Energy for Colorado's Economy: Creating Jobs and Economic Growth with Renewable Energy.* Denver, Colo.: Environment Colorado.

This report detailed how Colorado's renewable energy resources will yield better results for Coloradans than building more coal- or gas-fired power plants. By investing in renewable energy to meet the state's electricity needs, jobs are created, energy prices are stabilized, and the long-term economic and environmental risk from global warming pollution is reduced.

In this report, an economic model evaluated the net impacts of expanding Colorado's commitment to clean and renewable energy was used. By extending the renewable energy standard established under *Amendment 37* to 20% by 2020 for investor-owned utilities, plus expanding it to include Colorado's cooperative electricity companies and eligible municipal utilities with a target of 10% by 2020. Renewable energy improves Colorado's economy and environment, and should form a central part of Colorado's electricity system.

(34) Management Information Services Inc. & 20/20 Vision Education Fund. 2002. *Fuel Standards and Jobs: Economic, Employment, Energy, and Environmental Impacts of Revised CAFE Standards through 2020.* Washington, D.C.: 20/20 Vision Education Fund.

This report finds that increasing the Corporate Average Fuel Economy (CAFE) standards for automobiles, light trucks, minivans, and sport utility vehicles (SUVs) could result in the creation of more than 300,000 jobs distributed widely through the U.S. economy across states, industries, skills, and occupations. In addition, enhanced CAFE standards could, each year, reduce U.S. oil consumption by more than 30 billion gallons, save drivers $40 billion in fuel costs, and reduce U.S. greenhouse gas emissions by 100 million tons. GDP impacts would be small but net positive with respect to the business as usual case projections. (Note that all dollar figures are in constant 2002 dollars.) The study used technology and cost data for increased vehicle fuel efficiency developed by the National Research Council (NRC) of the National Academy of Sciences in its 2002 report, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards*, to estimate the requirements and costs for specified increases in miles per gallon (mpg). The results are shown as national totals with a state-by-state distribution of impacts.

(35) Mulholland, Denise, John A."Skip" Laitner, & Nikolaas Dietsch. 2004. "Exploring the Economic Development Implications of Capacity Building within State and Local Energy Efficiency Programs." In *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, D.C.: American Council for an Energy-Efficient Economy.

In this paper the authors suggest that the deployment of cost-effective energy efficiency technologies could help state and local governments meet economic development and pollution reduction goals. Enhancing the ability of governments, businesses, organizations, and individuals to accelerate market penetration through information-based capacity building programs could therefore lead to added economic and environmental benefits. They explore this concept in two ways. First, they turn to the literature to determine whether state and local capacity-building strategies might actually improve technology deployment. Based on that literature review, they develop a series of program designs which drive three technology diffusion scenarios for the State of Connecticut. These scenarios include: (i) a Reference Case; (ii) a Market Response Case, illustrating the effects of a moderately funded technology diffusion program (e.g., ENERGY STAR) aimed at boosting the supply and adoption of energy efficient building technologies; and (iii) a Capacity Building Case, in which the demand for efficiency is increased through an information-based capacity building program. The second task was to evaluate the economic impacts of each scenario using the IMPLAN model. IMPLAN is an established regional macroeconomic model that uses a combination of input-output and econometric linkages to explore a wide variety of economic policies. Focusing only on the improve efficiency of electricity use in Connecticut's commercial building sectors, the paper identified a cost-effective electricity savings of 3.7 to 6.1% through moderate program design by 2020. With paybacks ranging from 2.7 to 3.7 years, net electricity bill savings were projected to reach $40 to $60 million by 2020 (in 2001 dollars). Accounting for gains in labor productivity and changes in energy prices and investment costs, the authors noted that net employment gains would range from 367 to 622 jobs by the year 2020.

(36) Nadel, Steven, Skip Laitner, Marshall Goldberg, Neal Elliott, John DeCicco, Howard Geller, & Robert Mowris. 1997. *Energy Efficiency and Economic Development in New York, New Jersey, and Pennsylvania.* Washington, D.C.: American Council for an Energy Efficiency Economy.

This report examined the current energy consumption patterns and expenditures within each of the three states, New York, New Jersey, and Pennsylvania. It projected what "business-as-usual or baseline" energy patterns might look like through the year 2010. The study then developed two high efficiency scenarios (one for total energy consumption and one for electricity consumption only) for the region through the year 2010. These high efficiency scenarios are based upon detailed analysis of energy efficiency potential in buildings in the residential, commercial and industrial sectors as well as efficiency improvements in light duty vehicles in the transportation sector. The analysis also provided estimates of the investments needed to achieve future energy savings as well as the resulting economic and environmental benefits.

The findings of the study indicated that the energy efficiency and renewable energy scenario would require a $65.6 billion cumulative investment in the years 1997 through 2010. The authors noted that the relatively small level of investment (less than 1% of the region's cumulative GSP in that same period) could be achieved by redirecting technology investments toward more productive energy investments. If successful, Middle Atlantic ratepayers would enjoy a cumulative energy bill savings of $153.4 billion over that same period of time. With all values in 1993 dollars, the energy efficiency and renewable energy scenario generates a positive benefit-cost ratio of 2.35 over the 14-year period of analysis.

The investment in energy efficiency and renewable energy technologies would increase Middle Atlantic's employment base—from a net increase of 24,561 jobs in the year 2000 to a net gain of 164,319 jobs by the year 2010. The rise in employment, driven largely by an increase in net energy bill savings, was estimated to be equivalent to the number of jobs supported by the expansion or relocation of 1,095 small manufacturing plants in Middle Atlantic region. Wage and salary compensation would similarly rise by a net of $3.5 billion by 2010 (in 1993 dollars), the equivalent of tourist expenditures from approximately 14.7 million visitor days.

(37) Nayak, Navin. 2005. *Redirecting America's Energy: The Economic and Consumer Benefits of Clean Energy Policies.* Washington, D.C.: U.S. PIRG Education Fund.

This study asks the question: what would be the economic and consumer impacts of pursuing cleaner energy policies? And, how would a shift in federal policy away from fossil fuels and nuclear power and toward renewable energy and energy efficiency affect the economy, consumers, and the environment in the U.S.? Specifically, the study examined the economic and consumer impacts of pursuing two policies: (1) enacting a 20% national renewable energy standard, commonly referred to as a renewable portfolio standard or RPS, which would require the U.S. to generate 20% of its electricity from clean energy by the year 2020; and (2) shifting the amount it would cost American taxpayers to subsidize fossil fuels and nuclear power under last year's federal energy proposals, $35 billion, toward renewable energy and energy efficiency.

Using an input-output model that incorporated dynamic price changes in response to the various policies, PIRG found that implementing these policies would greatly benefit the economy and consumers in the U.S. while reducing air pollution from power plants. In the U.S., investing in these clean energy policies would: (i) create 215,000 net jobs in 2020 and a net annual average of 155,000 jobs between 2005-2020; (ii) increase wages by $6.8 billion in 2020; (iii) increase the gross domestic product (GDP) by an annual average of $5.9 billion between 2005 and 2020; (iv) save all consumers—residential, commercial, and industrial—$11 billion on natural gas bills in 2020; (v) save consumers $16.2 billion on electricity bills in 2020; (vi) reduce global warming carbon dioxide emissions from power plants by 27% compared to 2002 levels, smog-forming nitrogen oxide emissions by 17% of 2002 levels; and soot-forming sulfur dioxide emissions by 19% of 2002 levels, all by 2020.

(38) Ryan Pletka, John Wynne, Jason Abiecunas, Sam Scupham, Nate Lindstrom, Ryan Jacobson & Bill Stevens. 2004. *Economic Impact of Renewable Energy in Pennsylvania: Analysis of the Advanced Energy Portfolio Standard.* Overland Park, Kans.: Black & Veatch Corporation.

Black & Veatch analyzed the potential economic impacts of an Advanced Energy Portfolio Standard (AEPS) in Pennsylvania. The study was performed for the Community Foundation for the Alleghenies with funding from the Heinz Endowments. The study found that compared to conventional fossil fuels, the proposed AEPS would result in lower electricity costs and would provide a windfall of economic benefits to Pennsylvania. The report covers a broader array of advanced energy sources including renewable energy, advanced fossil fuel technologies, energy efficiency and conservation, and greenhouse gas reductions. The economic impacts of the AEPS portfolio were compared to a "business as usual" (BAU) case of building all fossil fuel resources. The analysis revealed that over 20 years the AEPS portfolio would cost $1.8 billion less than the BAU scenario on a present value basis. When spread over all retail electric customers, this would lower electric rates about 1%, or about $0.46, $3.12, and $75.61 per month for the average residential, commercial, and industrial customer, respectively. Further, the AEPS portfolio would result in $9.0 billion more in gross state output over 20 years than the BAU portfolio. In addition, the AEPS portfolio would provide a $2.7 billion advantage in earnings and generate over 70,000 more job-years over 20 years than the BAU portfolio. In addition, a review of recent studies revealed that there is strong evidence for fossil fuel price and consumption decreases as a result of renewable energy development. This analysis revealed that even a 1% reduction in fossil fuel prices would lead to a $140 million reduction in annual fossil fuel expenditures for power generation.

(39) William Prindle, Nikolaas Dietsch, R. Neal Elliott, Martin Kushler, Therese Langer, & Steven Nadel. 2003. *Energy Efficiency's Next Generation: Innovation at the State Level.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Based on a review of a number of state and local energy efficiency initiatives, the authors estimate an average state could save about 400 trillion Btus of primary energy by expanding existing policies to promote additional efficiency gains. These cost-effective savings amount to about 20% of current energy use for a typical state.

(40) William Prindle, Anna Monis Shipley, & R. Neal Elliott. 2006. *Energy Efficiency's Role in a Carbon Cap-and-Trade System: Modeling Results from the Regional Greenhouse Gas Initiative.* Washington, D.C.: American Council for an Energy-Efficient Economy.

This report summarizes the results of a ground-breaking effort to calculate the regional benefits of increased energy efficiency investment in the Regional Greenhouse Gas Initiative (RGGI), an eight-state carbon cap-and-trade program stretching from Maine to Maryland. It is an important advance in the climate policy sphere because it is the most specific study yet conducted of energy efficiency's impacts on such important factors as allowance prices, energy prices, and economic growth. ACEEE served as a stakeholder in the two-year RGGI development process, which encompassed a state agency working group, a stakeholder group, and other mechanisms set up to develop a model regulatory document. As a core part of the rule's development, the working group conducted extensive modeling of the regional power sector using ICF Consulting's linear programming Integrated Planning Model (IPM) model plus Regional Economic Models, Inc.'s (REMI) 20/20 Insight™ regional economic model to assess RGGI's potential impacts. Part of the IPM and REMI modeling effort was dedicated to simulating the impact of accelerated energy efficiency deployment scenarios. The RGGI staff working group invited ACEEE to develop energy efficiency resource data as input for the IPM efficiency runs. ACEEE used a 2003 study of electric efficiency potential developed for the New York State Energy Research and Development Authority (NYSERDA) as the basis for this analysis.

IPM's outputs showed that doubling the current level of energy efficiency spending in the RGGI region would have several very favorable effects on the carbon cap-and-trade system. It would reduce electricity load growth, future electricity prices, carbon emissions, carbon emission prices, and total energy bills for electricity customers of all types. In particular, comparing the reference case to cases with increased efficiency investment shows that doubling efficiency would cut load growth by about two-thirds in 2024, from about 20% to about 6% above 2006 levels. Moreover, the doubled-efficiency scenario would reduce 2024 capacity additions by about 8,000 MW, or about 25% of the reference case forecast for new capacity. The increased-efficiency scenarios show that efficiency investments would keep carbon emissions virtually flat through 2024, compared to about 15% growth in the reference case. Existing electricity prices were held to an almost negligible increase and that carbon dioxide allowance prices would also be substantially lower with increased energy efficiency investments, falling by about one-third to around $2/ton in 2024. Finally, the regional economic impacts, as projected by the REMI input-output model, also would show positive impacts from increased efficiency investment. More specifically, the IPM modeling results showed that under the doubled-efficiency scenario, household electricity bills in 2021 would be an average of $109 lower than under the reference case, regional economic growth from almost no effect to 0.6% positive in 2021, relative to the reference case, personal income by almost 1% in 2021, private-sector job growth by 0.8% in 2021.

(41) Ruth, Matthias, Steven Gabriel, Kimberly Ross, Dan Nees, Russell Conklin, Julia Miller, Sanjana Ahmad, Jennifer Cotting, Karen Palmer, Dallas Burtraw, Benjamin Hobbs, Yihsu Chen, Daraius Irani, & Jeffrey Michael. 2007. *Economic and Energy Impacts from Maryland's Potential Participation in the Regional Greenhouse Gas Initiative.* Annapolis, Md.: Maryland Department of the Environment.

In April, 2006, Maryland enacted the Healthy Air Act (HAA), mandating reductions in three major pollutants from coal-fired power plants: nitrogen oxides (NOx), sulfur dioxide (SO_2) and mercury. In addition, the HAA addresses carbon dioxide (CO_2) emissions—a major greenhouse gas (GHG) contributing to climate change—by requiring Maryland to become a full participant of the Regional Greenhouse Gas Initiative (RGGI). As a participant in RGGI Maryland joins a consortium of Northeastern and Mid-Atlantic states prescribing a common policy for reducing CO_2 emissions from power plants via a market-based cap-and-trade program (www. rggi.org).

The Maryland Department of the Environment (MDE) is charged with implementing the HAA through regulations principally designed to reduce air pollution from Maryland power plants and to meet National Ambient Air Quality Standards (NAAQS) for ozone and fine particulate matter. Notably, Maryland is the first state to adopt four-pollutant legislation; and the first state that derives most of its electricity from coal, to commit to CO_2 reductions statewide.

The purpose for this study was to assess the impacts of RGGI on power generators, rate payers and the economic welfare of the state due to the stricter environmental constraints of RGGI. Although changes in CO_2 emissions due to Maryland joining RGGI were also analyzed, benefits to the economy, society and the environment from reductions in CO_2 emissions and mitigation of climate change, were not topics of this study. UMD is the primary contractor on this project drawing upon scientific experts from both inside and outside the University. CIER specializes in the development and use of new knowledge and tools to inform policy and investment decision makers. Other sources of expertise tapped for the study are, as subcontractors to UMD, Resources for the Future (RFF), the Johns Hopkins University (JHU), and Towson University (TU). These institutions have extensive and complementary expertise in the economic and engineering modeling necessary to measure reductions of CO_2 emissions mandated by RGGI. In addition, CIER tasked a team from UMD with engaging stakeholders in the study. This was largely accomplished through a series of in-person and/or telephone meetings, as well as written comments.

(42) Scott, M. J., D. M. Anderson, D. B. Belzer, K.A. Cort, J.A. Dirks, D.B. Elliott, & D.J. Hostick. 2004. *Impact of the FY 2005 Weatherization and Intergovernmental Program on United States Employment and Earned Income.* Richland, Wash.: Pacific Northwest National Laboratory.

The Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) is interested in assessing the potential economic impacts of its portfolio of subprograms on national employment and income. A special purpose of version of IMPLAN input-output model called ImBuild II is used in this study of 20 subprograms of the weatherization and Intergovernmental Program contained in the EERE final FY 2005 budget request to the office of Management and Budget on February 2, 2004. Energy savings, investments, and impacts on the U.S. national employment and earned income are reported by subprogram for selected years to the year 2030. Energy savings and investments from these subprograms have the potential of creating a total of 228,000 jobs and about $3.1 billion in earned income (2003$) by the year 2030.

(43) Sherman, Mike, Lisa Petraglia, and Glen Weisbrod, Bryan Ward, Carmen Best & David Sumi. 2004. *Focus on Energy Public Benefits Evaluation Economic Policy Analysis: Final Report.* Middleton, Wisc.: PA Government Services Inc.

This report was prepared for the Wisconsin Department of Administration (DOA) as part of the overall evaluation of the Focus on Energy (Focus) set of energy efficiency programs funded by Wisconsin utility ratepayers and administered by the DOA throughout the state. The economic impacts projected were based on actual spending levels and implemented projects for the first 18 months of program operations and projected program budgets out ten years. Recurring annual cost savings from first year participants alone exceeded $8.7 million for residential participants and $7.3 million for business participants. The average residential participant saved $52 in their cost of living, which reflects a mix of small average savings from purchases of compact fluorescent light bulbs and much larger average savings from weatherization and heating/cooling projects. The average business participant saved $7,958 in annual business operating costs, reflecting the fact that some of the business projects involved major refrigeration and industrial process projects.

The Focus on Energy program reaches all sectors of the economy: households, commercial and industrial businesses, as well as government and nonprofit agencies. The results of the REMI economic analysis, which tracks all of the short-term impacts and forecasts longer-term implications for Wisconsin's economy, shows that economic effects of Focus on Energy grow over time. Focus supported $46 million of business sales in Wisconsin in its first year, and this is projected to grow to $224 million per year by the tenth year. Focus supported 630 jobs in Wisconsin in its first year and this is projected to grow to over 2,700 jobs by the tenth year. The economic analysis model shows that Focus on Energy is supporting job growth in all occupational groups, spanning skilled and unskilled jobs in white-collar and blue-collar occupations. However, this effect is not distributed equally across all sectors of the economy. Overall, the mix of jobs that it is supporting is disproportionately white-collar occupations—both skilled and semi-skilled. The job impacts of Focus on Energy are concentrated in the medium wage category. This reflects the programs' impact on business and professional services (including energy services). There are proportionately fewer jobs in the high wage category. This reflects the relatively modest representation of (high-paying) manufacturing job impacts that would be expected if there were a greater participation by industrial customers.

(44) Sierra Club Maryland Chapter. 1997. *Maryland's Energy Future: Energy Efficiency & Renewable Energy Provide a Strong Foundation for an Economic Development Strategy.* Annapolis, Md.: Sierra Club Maryland Chapter.

This report details how inefficient energy use will constrain Maryland's economy. This reports analysis shows that energy efficiency will lower energy bills for residents and businesses. These lower energy bills, in turn, will promote overall economic efficiency in the state and create jobs. Moreover, accelerated investments in both energy efficiency and renewable energy technologies will enhance Maryland's air quality. Such investments will also diversify the mix of energy resources available to homes and businesses to ensure a stable and reliable resource base to meet future energy needs. Finally, new investments in energy efficiency and renewable energy technologies will encourage the development of new clean technologies and industries in Maryland, creating 15,300 jobs and saving more than 27 billion dollars..

(45) Steinhurst, William, Robert McIntyre, Bruce, Biewald, Cliff Chen & Kenji Takahashi. 2005. *Economic Impacts and Potential Air Emission Reductions from Renewable Generation & Efficiency Programs in New England: Final Report.* Cambridge, Mass.: Synapse Energy Economics.

Synapse Energy Economics, Inc. (Synapse) prepared this analysis to assist the Regulatory Assistance Project (RAP) in analyzing the impact of renewable generation projects and electric energy efficiency programs in New England. Much of the program funding for these programs came through a combination of system benefit charges and various renewable energy portfolio standards. By 2010 the study shows a combination of 7,821 gigawatt-hours (GWh) of electricity savings and 5,367 GWh of renewable energy generation. Economic output and labor income are shown to rise by a small by net positive amount by 2010. Jobs increase by a net positive average of 5,475 jobs per year over the period 2000 through 2010.

(46) David Sumi, Glen Weisbrod, Bryan Ward & Miriam L. Goldberg. 2003. "An Approach to Quantifying Economic and Environmental Benefits for

Wisconsin's Focus on Energy." 2003 Energy Program Evaluation Conference, Seattle, Wash.

The structure and approach for evaluating the Wisconsin Focus on Energy (Focus) Program provided an opportunity for taking a more holistic approach to energy efficiency evaluation than is commonly used. This paper provided an overview the methodological approaches taken to quantify the environmental benefits, and the economic benefits of the Focus on Energy program. It also provided a brief overview of the benefit-cost analysis which provides an important input into estimating the environmental and economic impacts. The economic analysis examined the nature and magnitude of economic development impacts of Focus—tracing changes in the flow of income and spending caused by the program, and showing how the program causes both direct and indirect effects on the flow of money in the Wisconsin economy as well as effects on the state's economic development. Economic development (which is an explicit goal of the Focus on Energy program) is demonstrated through increased job opportunities, increased business sales and increased personal income that result from program activities. The environmental analysis takes the Focus programs' energy impacts and estimates and monetizes the associated reductions in electricity power plant emissions. There is also a brief discussion addressing a more far-reaching question: What is the potential value of pollution credits that could be generated by public benefits programs? One answer is provided using prices from a "Multi-Pollutant Optimization Model," based on a scenario assuming enactment of the Bush Administration's "Clear Skies" proposal for SOx, NOx, and mercury reductions.

The most recent figures as reported in the "Focus on Energy Public Benefits Evaluation Quarterly Report," Contract Year 2, Quarter 3, Final on May 30, 2003, indicate that the Focus program is responsible for over 161 million kilowatt hours of annual electricity savings and over 4.4 million therms of annual natural gas savings, resulting in millions of dollars in savings on consumers' utility bills. The authors note that the potential value of related pollution reductions should be viewed as a multi-year stream of savings. As the program continues, and ramps up to full funding and increased effectiveness, the paper suggests that the energy savings stream will grow in size. The paper reports benefit cost ratios for the overall Focus program as ranging from 3.0 to 5.7. Based on a REMI modeling analysis of program spending and benefits, the first year of the program resulted in a net increase of 582 jobs. This figure rose to an estimated 17,243 jobs by the 10th year of the Focus program. Gross regional product (GRP) similarly increased from 24 million dollars in the program's first year with an expected increase of $824 million (all in 2001 dollars) by the 10th year. Including additional market interactions were shown to increase these totals by about 10%.

For a more complete discussion on the economic impact analysis see the report titled, Economic Development Benefits: Interim Economic Impacts Report, Final: March 31, 2003 by Mike Sherman, Lisa Petraglia, and Glen Weisbrod.

(47) Weisbrod, Glen, Karen R. Polenske, Teresa Lynch & Xianuan Lin. 1995. *The Economic Impact of Energy Efficiency Programs and Renewable Power for Iowa: Final Report.* Boston, Mass.: Economic Development Research Group.

The REMI economic model was used to evaluate the relative impacts of various energy efficiency and renewable scenarios in Iowa. The results included impacts in terms of business output, personal income and employment. These results were distinguished by year over a twenty-year period, and broken down by business type. The energy efficiency program scenarios were defined to assume that levels of energy efficiency program spending either continue at current levels or are phased out, and include either the existing program mix or else special targeting to specific customer sectors and end uses (types of equipment). The scenarios for renewable energy focused on the two most promising technologies for large scale implementation in Iowa—wind power plants and switchgrass combustion in existing coal-fired plants—under alternative assumptions concerning magnitude of their adoption and relative cost differential of their implementation. Key findings were:

a. Investing around $80 million on energy efficiency programs in one year can lead to the accumulation of roughly 2000 job-years of employment and $144 million of disposable income spread over the subsequent decade. That averages 200 job/years and $14 million/year of income over the period. It represents 25 job-years per million dollars invested, and $1.50 of additional disposable income per dollar invested.
b. Continuing the investment of $80 million/year for ten consecutive years can lead to the creation of nearly over 19,000 job-years over that decade of spending and the subsequent decade of continuing energy savings).
c. These impacts represent both the jobs created by spending on energy efficiency in Iowa (rather than allowing additional fuel cost to flow out of the Iowa economy) and the income created in subsequent years from respending of energy savings—after adjusting for increases in energy costs to pay for these programs.
d. The overall impact of any of these scenarios, while significant, causes less than 0.1% change in Iowa's employment and income.

The modeling results presented here indicate that, if properly targeted, energy efficiency and renewable power programs can contribute to the state economy. These results can be achieved with relatively little difference in state economic impact through any set of programs which satisfy the following two criteria: (a) the long-term energy cost savings exceeds the associated program costs by a sufficient amount so that business growth and income are enhanced, and (b) the flow of dollars to generate additional income for Iowa residents more than offsets the reduction in available income associated with funding the program. The economic model results provided here also suggest that energy efficiency programs targeted at residential energy savings and programs targeted to HVAC can keep more dollars in the Iowa economy than broad, untargeted spending in the commercial and industrial sectors. The results also indicate that biomass power has a particularly high potential for benefiting the Iowa economy.

(48) Weisbrod, Glen & Lin (James) Xiannuan. 1996. *The Economic Impact Of Generating Electricity from Biomass in Iowa: A General Equilibrium Analysis.* Boston, Mass.: Economic Development Research Group.

In this paper, the authors apply a dynamic economic simulation model of the Iowa economy, developed by Regional Economic Models, Inc. (REMI), to conduct a general equilibrium analysis of the economic impacts of generating electricity from switchgrass in Iowa. Of the money spent on resources to generate electricity, more than 90% flows to the out-of-state suppliers. This is a tremendous burden on the state economy. The outflow of dollars to pay for this energy includes over $300 million for purchased coal, which provides fuel for 85% of all electricity generated in the state. To reduce this economic leakage, the state government of Iowa has been promoting the investments in energy efficiency and encouraging the development of renewable energy supply. One of the most important sources of renewable energy in Iowa is biomass. One 1994 study identifies switchgrass as one of the most cost-effective biomass fuels for generating electricity. For that reason, the authors focus on the economic impact of switchgrass electricity. The methodology presented in this paper can be used to analyze economic impacts of other renewable energy technologies

The modeling results show that generating switchgrass electricity does produce employment, income, and output gains. The magnitude of those gains, however, is very small. Even in Iowa which has low switchgrass production cost and imports almost all the coal it uses, replacing 10% of the coal used in electric power generation with switchgrass would increase the total employment, gross state product, and disposal income by only about 0.1-0.2% annually. Similar results are found in an analysis of macroeconomic impacts of renewable energy program in Wisconsin. There appears to be a paradox. While the micro-level comparison of alternative energy technologies suggests that renewable energy has large job creation potentials, its overall macroeconomic impacts seems to be small. There are two possible explanations for this paradox. First, unlike conventional fossil fuel and nuclear technologies, renewable energy sources are diverse and decentralized. Each individual renewable energy source is small relative to the total energy supply. When placed in the context of macroeconomy, its economic impact tends to be lost in the "ocean". In other words, the development of a single renewable energy technology seldom has significant macroeconomic effects. Second, most micro-level studies of job creation potentials of alternative energy technologies are based on the assumption that total energy consumption would be the same. They do not account for the effect of alternative technologies on energy prices and the effect of energy-price changes on total energy consumption and macroeconomy.

Because the renewable technology is often more expensive than conventional fossil fuel and nuclear power, its application tends to increase the energy costs thus, ceteris paribus, reducing energy consumption. Furthermore, high energy costs have negative macroeconomic impacts. The development of renewable energy, therefore, should not be viewed just as a substitution of energy technologies, but as a re-direction of resources and modification of economic activities. Through backward and forward linkages, renewable energy expenditures will result in changes in the circular flow of the economy, affecting both producers and consumers. In this process, some businesses grow, while others decline. The net economic impacts are often very difficult to predict ex ante. Our finding of no significant macroeconomic impact at the state level from co-firing switchgrass in coal-fueled power plant does not means that the Iowa should not encourage the development of biomass energy. There may be large enough economic benefits for some communities, industries, or utilities which can justify the investment in biomass energy technology. More importantly, there are many motivations for promoting renewable energy technologies. Economic development is only one of them, and it is often not the primary motivation. Other motivations, such as diversifying energy resource base, reducing environmental pollution, buying technological options for the future, and enhancing self-reliance and energy security, may be more important. They may also be in conflict with the objective of maximizing economic benefits. Job creation potential, therefore, should not be the only or even primary criterion used to evaluate renewable energy technologies.

Appendix B. Estimating National Impacts from the State Studies

Of the nearly four dozen assessments that are reviewed in this report, we've drawn a sampling of 24 studies that have sufficient and comparable data to provide a basis for estimating employment impacts for the U.S. economy. The key data from those 24 studies are provided in Table B-1 on the following page. To confirm the estimates reported in Table 2 of the main report, two different perspectives in setting up the estimate of national impacts are provided. As a first step, an average ratio of jobs per trillion Btus of savings to generate a working magnitude of net employment impacts is calculated. The second step is to look for a regression that depicts how the employment impacts might vary as a function of both savings and benefit-cost rations.

Looking at Table B-1, the average net gain is estimated to be 35.5 jobs per trillion Btus (TBtu) of efficiency gains. Hence, a 20% efficiency improvement in 2030 implies a savings of 23,600 TBtus. The employment impacts would then be about 837,000 net jobs for that level of energy savings in 2030. Impacts at a 30% efficiency improvement, or a savings of 35,400 TBtus, would suggest a net gain of about 1,255,000 jobs. At the same time, we can easily imagine that the employment impacts would vary significantly according to cost-effectiveness. For that reason this analysis turned to a regression-based estimate that sets up the Net Jobs impact as a function of trillion Btus of primary energy savings (TBtu Save) and the Benefit-Cost Ratio (BenefitCost).

After exploring a large number of functional forms, a log-linear estimation using the following multiplicative relationship was produced (with the reported T-statistics shown in parentheses):

$$\text{Net Jobs} = \underset{(8.660)}{34.233} * (\text{TBtu Save} * \text{BenefitCost})^{\overset{0.939}{}} \quad (15.888)$$

An adjusted R-Square of 0.916 was found based on the data shown in Table B-1. Both coefficients are highly significant. By plugging in the desired level of savings as a function of the benefit-cost ratio, one is then able to report the values shown in Table 2. As confirmation of this result, it should be noted that the values reported in Table 2 are fully consistent with both the data in Table B-1 and the resulting working estimations suggested in the above paragraph.

Finally, there was little data available of an efficiency investment's GDP impacts, such that a reliable estimate could not be produced. However, we provide the data to illustrate the suggested magnitude of change—given the level of savings and the cost-effectiveness implied by a given scenario. Note that in the two instances where there is a small GDP loss, it is driven by an electricity-only savings analysis. The explanation for such an occurrence is reasonably straightforward. Electric utilities are very capital-intensive industries relative to other sectors of the economy. Depending on other assumptions, there are instances in which employment can be net positive while the composition of GDP changes in a way that leads to a slightly smaller level of economic activity. In those studies that report both changes in GDP and in which all sectors contribute to gains in energy productivity, the changes in GDP are small but net positive. The average change in GDP from the efficiency gains shown in Table B-1 is 0.1%.

Table B-1. Summary Impacts by Region and Year of Analysis

Region	Year of Study	Quantity Saved	Physical Units	TBtu Equivalent	Benefit-Cost Ratio	Net Jobs	Percent GDP
Florida	2007	153,595	GWh	1,567	1.70	14,264	-0.10%
Texas	2007	101,091	GWh	1,031	2.20	38,291	-0.10%
Midwest	1995	4,300	trillion Btu	4,300	1.75	205,200	0.10%
Michigan	2007	32,859	GWh	335	2.36	7,506	n/a
MidAtlantic	1997	2,868	trillion Btu	2,868	2.35	164,320	0.60%
Texas	1998	95,686	GWh	976	1.10	45,000	n/a
Arizona	1997	185	trillion Btu	185	1.92	11,076	0.10%
Colorado	2007	7,800	GWh	80	1.89	4,100	n/a
Maryland	1996	278	trillion Btu	278	1.90	15,300	n/a
Missouri	1995	2	trillion Btu	2	1.57	100	n/a
Mississippi	2000	4,762	GWh	49	1.50	4,600	n/a
Nevada	1997	131	trillion Btu	131	2.02	4,300	0.10%
U.S.	2005	1,346,800	GWh	13,737	1.10	215,308	0.05%
Washington	1994	365	trillion Btu	365	1.65	18,800	n/a
U.S.	2001	37,600	trillion Btu	37,600	1.96	800,000	n/a
Wyoming	1997	87	trillion Btu	87	2.15	2,700	0.20%
Colorado	1996	212	trillion Btu	212	1.94	8,400	0.04%
Alabama	1994	266	trillion Btu	266	1.69	10,590	n/a
Western States	1997	1,303	trillion Btu	1,303	1.74	57,651	n/a
Maine	2008	68	trillion Btu	68	2.00	2,070	0.40%
Minnesota	1993	4,757	GWh	49	2.58	3,810	n/a
Southwestern States	2002	99,000	GWh	1,010	3.11	58,400	n/a
Southeastern States	1996	6,600	trillion Btu	6,600	1.12	900,000	n/a
Connecticut	2004	1,074	GWh	11	2.10	622	n/a
Study Totals	n/a	n/a	trillion Btu	73,109	1.72	2,592,408	n/a