An Annotated Review of 30 Studies Describing the Macroeconomic Impacts of State-Level Scenarios Which Promote Energy Efficiency and Renewable Energy Technology Investments

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Introduction

This preliminary review identifies 30 state-level studies that evaluate the macroeconomic impacts of a wide variety of cost-effective energy efficiency and renewable energy policy scenarios and programs. These assessments were conducted for a wide variety of clients and governmental agencies over the period 1995 through 2005. The studies evaluate a range of investment, technology, and program cost assumptions over a variety of time horizons, generally through the period 2010 to 2020. Two important points should be made with respect to the studies included here.

First, the studies are limited to a review of state level impacts that are likely to result from presumed state-initiated policies or efforts which are designed to achieve cost-effective reductions in state-level energy use. There are a large number of national assessments, and in some cases community level assessments, that are not included in this review. In addition, the list omits perhaps another 15 state level assessments done prior to 1995. This was done to maintain compactness in the review. Those who might be interested in learning about these other national, state, or local studies should contact Skip Laitner at the coordinates identified above. Perhaps just as important, those who may be aware of other studies that may be overlooked in this preliminary review are encouraged to contact me — either to forward an electronic copy of such assessments, or to provide details where those additional studies might be found.

Second, 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 those which I have personally undertaken). Indeed, the studies vary enormously in their detail and scope. This "meta-review" should be seen as merely an annotated description of the available literature — usually 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 and other air emissions.

With these caveats, the bibliographic citation and summary for each of the 30 studies follow, in alphabetical order according to the lead author. The reader is further encouraged to contact me with additional comments, or to highlight any critical oversights or misstatements that inevitably accompany any preliminary assessment. I am hopeful to improve on this background review over the next few months. From this first effort, I also hope to complete a more rigorous "meta-analysis" of these and other studies. Again, suggestions and comments in this regard are welcome.

The Studies

(1) Bailie, A., S. Bernow, et al. (2001). Clean Energy: Jobs for America's Future. Boston, MA, Tellus Institute.

In a study completed on behalf of the World Wildlife Fund (WWF), the Tellus Institute found that should Congress implement the policies outlined in WWF's Climate Protection Scenario, 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 percent between 2000 and 2010, as opposed to the increase of 20 percent that was forecast in the base case and a 28 percent decline between 2000 and 2020 rather than a 36 percent increase. A full 20 percent of the electricity generation needed in 2020 would come from wind, solar, biomass and geothermal energy. Oil consumption would decline by approximately 8 percent between 2000 and 2020, rather than increase by about 31 percent, 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 percent between 2000 and 2020, rather than increasing by 40 percent as in the base case.

On the economic side of the ledger, 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.

(2) Barrett, J., J. A. Hoerner, et al. (2005). Jobs and the Climate Stewardship Act: How Curbing Global Warming Can Increase Employment. Washington, DC, 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.

(3) Bernow, S., K. Cory, et al. (1999). The Impacts in Florida of a U.S. Climate Change Strategy. Boston, MA, 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 recent national policy study, America’s Global Warming Solutions (Bernow et al 1999), 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 percent and its carbon emissions by 36 percent. 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.

(4) Bernow, S., W. Dougherty, et al. (2000). Texas' Global Warming Solutions. Boston, MA, 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.) 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:

* Primary Energy Use and Carbon Emissions in Texas would decrease by 25 percent and 34 percent, respectively, below levels that would otherwise be reached by 2010.
* Renewable Energy Resources would increase six-fold between 1990 and 2010, reaching over 4 percent of total primary energy use by 2010 (and about 12 percent in the electric sector). Industrial co-generation would almost double over this timeframe.
* 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.
* Approximately 84,000 net additional jobs created in Texas by 2010.
* 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 percent, nitrogen oxides by 32 percent and fine particulate matter by 39 percent.

(5) Bernstein, M., C. Pernin, et al. (2002). The Public Benefit of Energy Efficiency to the State of Minnesota. Santa Monica, CA, 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 percent lower level of air emissions from stationary sources, and a reduced financial energy burden on low-income households.

(6) Geller, H., N. Elliott, et al. (2002). The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest. Boulder, CO, 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 percent per year in the Base Scenario to 0.7 percent per year in the High Efficiency Scenario; (ii) reducing total electricity consumption 18 percent (41,400 GWh/yr) by 2010 and 33 percent (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 percent) 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 percent in 2010 and 26 percent in 2020, relative to the emissions of the Base Scenario. These significant benefits can be achieved with a total investment of nearly $9 billion in efficiency measures during 2003-2020 (2000 $).

The total economic benefit during this period is estimated to be about $37 billion, meaning the benefit-cost ratio is about 4.2. The efficiency measures on average would have an annualized cost of $0.02 per kWh saved. The High Efficiency Scenario is based on the accelerated adoption of cost-effective energy efficiency measures, including more efficient appliances and air conditioning systems, more efficient lamps and other lighting devices, more efficient design and construction of new homes and commercial buildings, efficiency improvements in motor systems, and greater efficiency in other devices and processes used by industry. These measures are all commercially available but underutilized today. The study acknowledges that the High Efficiency future will not happen on its own. While some utility, state, and local energy efficiency programs are advancing energy efficiency in the region, these programs are relatively limited in scope and budget. The study recommends new and expanded initiatives to achieve the High Efficiency future and its benefits, including: (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 percent savings by 2010 and 33 percent saving by 2020 for the region as a whole.

(7) Goldberg, M. and S. 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 percent 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.

(8) Goldberg, M. and S. 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 percent in the years 1998 through 2010. This was slightly smaller than the 20 percent 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 percent 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.

(9) Goodman, I., B. Krier, et al. (1996). Employment, Earnings, and Environmental Impacts of Regional Improvements in Energy Efficiency. Boston, MA, The Goodman Group.

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 percent and 15 percent 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 percent of total U.S. population. The analysis suggests that both scenarios produce more employment per follar 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 ergional 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 underrepresent the actual impacts in the year in which they occur.

(10) Hewings, G. et al. (2004). Job Jolt The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland. Chicago, Illinois, Environmental Law and Policy Center.

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:

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

[2] Clean Renewable Energy Development. By 2010, electric utilities would supply a more diverse fuel mix to consumers in which 8 percent 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 percent 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 percent by 2010 and to 46 percent by 2020.

(11) Hoerner, A. J. and J. Barrett (2004). Smarter, Cleaner, Stronger: Secure Jobs, A Clean Environment, and Less Foreign Oil. Oakland, CA, 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.

(12) Jensen, V. and E. Lounsbury (2005). Assessment of Energy Efficiency Potential in Georgia. San Francisco, CA, 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 CO2 emissions.

(13) Kaiser, M. J., A. G. Pulsipher, et al. (2001). Economic and Environmental Impact of a Public Benefis Fund in Louisiana. Baton Rouge, LA, Center for Energy Studies, Louisiana State University.

This report assesses the potential economic and environmental impact of a public benefits fund (PBF) in teh 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 SO2, NOx, and carbon would be reduced by about 555, 396, and 36,000 tons, respectively.

(14) Laitner, S., J. DeCicco, et al. (1995). Energy Efficiency and Economic Development in the Midwest. Washington, DC, 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.

(15) Laitner, S. and M. Goldberg (1995). A Reevaluation of Economic Opportunities through Missouri Building Codes and Energy Efficiency Improvements. Jefferson City, MO, Missouri Division of Energy.

The Missouri legislature requested a 1993 study 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 one percent 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 percent 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.

(16) Laitner, S. and M. Goldberg (1996). Colorado's Energy Future: Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy. Denver, CO: Department of Energy and the National Renewable Energy Laboratory.

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 percent 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 percent 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 percent 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.

(17) Laitner, S. and M. 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.

(18) Laitner, S. and M. 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 percent 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.

(19) Laitner, S. and M. Goldberg (1997). Wyoming Energy Outlook: Energy Efficiency as an Economic Development Strategy. Cheyenne, WY, Wyoming Department of Economic Development's Energy Office.

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 percent 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.

(20) Management Information Services Inc. and 20/20 Vision Education Fund (2002). Fuel Standards and Jobs: Economic, Employment, Energy, and

Environmental Impacts of Revised CAFE Standards through 2020. Washington, DC, 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.

(21) Mulholland, D., J. A. S. Laitner, N. Dietsch (2004). Exploring the Economic Development Implications of Capacity Building within State and Local Energy Efficiency Programs. Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency In Buildings, Washington, DC, 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 percent 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.

(22) Nadel, S., S. Laitner, et al. (1997). Energy Efficiency and Economic Development in New York, New Jersey, and Pennsylvania. Washington, DC, American Council for an Energy Efficient 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 percent 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.

While the average wage would fall by about $94 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 would also fall by an average of $283 per job. Hence, Middle Atlantic workers' overall standard of living would be expected to increase by $189 by the end of the study period.

The alternative energy strategy would have a positive benefit for the region's air quality as well. Carbon dioxide emissions, believed to contribute to global climate change, would be reduced by 159 million short tons in 2010, a 29% decline over baseline 2010 emissions. Energy-related pollutants such as sulfur and nitrogen oxides would decline by over 1 million short tons in the year 2010, also providing significant reduction over the baseline use.

(23) Nayak, N. (2005). Redirecting America's Energy: The Economic and Consumer Benefits of Clean Energy Policies. Washington, DC, 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 percent national renewable energy standard, commonly referred to as a renewable portfolio standard or RPS, which would require the U.S. to generate 20 percent 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 percent compared to

2002 levels, smog-forming nitrogen oxide emissions by 17 percent of 2002 levels; and soot-forming sulfur dioxide emissions by 19 percent of 2002 levels, all by 2020.

(24) Pletka, R., J. Wynne, et al. (2004). Economic Impact of Renewable Energy In Pennsylvania: Analysis of the Advanced Energy Portfolio Standard. Overland Park, KS, 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 percent, 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 percent reduction in fossil fuel prices would lead to a $140 million reduction in annual fossil fuel expenditures for power generation.

(25) Prindle, W., N. Dietsch, et al. (2003). Energy Efficiency's Next Generation: Innovation at the State Level. Washington, DC, 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 percent of current energy use for a typical state.

(26) Sherman, M., L. Petraglia, et al. (2004). Focus on Energy Public Benefits Evaluation Economic Policy Analysis: Final Report. Middleton, Wisconsin, 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.

(27) Steinhurst, W., R. McIntyre, et al. (2005). Economic Impacts and Potential Air Emission Reductions from Renewable Generation & Efficiency Programs in New England: Final Report. Cambridge, MA, 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.

(28) Sumi, D., G. Weisbrod, et al. (2003). An Approach to Quantifying Economic and Environmental Benefits for Wisconsin's Focus on Energy. 2003 Energy Program Evaluation Conference, Seattle, WA, International Energy Program Evaluation Conference.

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 percent.

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.

(29) Weisbrod, G., K. Polenske, et al. (1995). The Economic Impact Of Energy Efficiency Programs And Renewable Power For Iowa: Final Report. Boston, MA, 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:

Energy Efficiency Programs

• 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.

• 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).

• 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.

• The overall impact of any of these scenarios, while significant, causes less than 0.1% change in Iowa's employment and income.

Biomass Energy Production

• If 1% of Iowa's electrical power could be obtained on a continuing basis from burning switchgrass in existing power plants (considered a possibly feasible goal), then there could be a net growth as high as 315 jobs/year of employment and $5.5 million/year of additional disposable income. Over 20 years, that represents 6,300 job-years and a net increased $110 million of disposable income. Assuming that the additional operating cost of doing this is $3.77 million per year (with no additional capital investment needed), that represents up to 84 job-years per million dollars invested, and $1.45 of additional disposable income per dollar invested.

• If 15% of Iowa’s electrical power could be obtained from burning switchgrass in existing power plants, then there could be a net growth of 4,725 jobs/year or 94,500 job-years of employment over 20 years. All of these figures, of course, assume that technological challenges concerning alkali slagging in combustion and logistical challenges concerning transportation and storage of switchgrass, as well as existing contracts for coal, will all be overcome.
• The job impact of biomass energy is particularly high, compared to the energy efficiency and wind energy scenarios, because it creates demand for a product which is produced entirely in Iowa. There is also no additional capital investment (and hence no adverse income impact) to the extent that there are existing electric generation facilities with excess capacity can be adapted to burn switchgrass instead of coal. However, even the 15% which market penetration scenario, which is not currently feasible, would cause no more than 0.2% change in Iowa’s employment and income.

Wind Energy Production
• If 1% of Iowa’s electrical power could be obtained on a continuing basis from wind power plants, (considered a possibly feasible goal), then there could be a net growth of 29 jobs/year and $1 million/year of additional disposable income. Over 20 years, that represents a net increase of 584 job-years and $14 million of disposable income. Assuming that the additional cost of doing this is $12 million per year (capital and operating costs), that represents 2.5 job-years per million dollars invested.
• The job impact of wind power is substantially lower than for an equivalent level of power generation from biomass because, unlike biomass, the wind is free and there are no associated increases in purchases of feedstock grown, harvested and transported by Iowa workers. In addition, wind power requires an additional capital investment in the purchase and installation of new electric power generation facilities. As long as there remains excess capacity at existing electric generating plants which can be used to serve Iowa, then there is an additional cost associated with the purchase and installation of new wind generator facilities which is ultimately borne by Iowa residents and businesses. The net effect of that additional capital cost is a reduction in disposable income which essentially offsets nearly all of the gains in income (and most of the gains in jobs) otherwise associated with expanding the wind power industry in the state.

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.

(30) Weisbrod, G. and J. L. Xiannuan (1996). The Economic Impact Of Generating Electricity From Biomass In Iowa: A General Equilibrium Analysis. Boston, MA, 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 percent 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 percent 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 percent 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.