7 MACROECONOMIC RESULTS: EMPLOYMENT, INCOME, AND ECONOMIC ACTIVITY

Up to this point in the analysis we have examined the potential costs and benefits of implementing policies that might stimulate greater levels of energy efficiency within the Appalachian Region. The evidence suggests that smart policies and programs can drive more productive investments in energy-efficient technologies, and they can do so in ways that reduce the Region's total energy bill. But the question remains, what does this mean for the Regional economy? Do the higher gains in energy productivity – that is, do the increased levels of efficiency investment with their concomitant reduction in the need for conventional energy resources – create a net economic boost for Appalachia? Or, does the diversion of revenues away from energy-related industries negatively impact the Regional economy? In this chapter, we explore those issues and we present the analytical results of an economic model used to evaluate the impact of efficiency investments on jobs, income, and the overall size of the economy.

A recent meta-review of some past 48 energy policy studies done within the United States suggests that if investments in more efficient technologies are cost-effective, the impacts on the economy should be small but net positive (Laitner and McKinney, 2008). As shown elsewhere in the report, it turns out that from a total resource cost perspective, the benefits (i.e., the energy bill savings) outweigh both the policy costs and investments by about two and one-half times. In other words, the energy-efficiency policy recommendations highlighted in the "Region-at-Risk" scenario result in a substantial savings for households and businesses compared to the costs of implementing the policies. As we also discuss below, this consumer energy bill savings can drive a significant increase in the number of net new jobs within the Appalachian Region.[43] In fact, continued investments in energy-efficiency resources would maintain the energy resource benefits for many years into the future, well beyond the period of analysis examined in this report.[44] The Region therefore has the opportunity to transition its energy markets to a more sustainable pattern of energy production and consumption in ways that benefit consumers.

7.1 METHODOLOGY

The macroeconomic evaluation that we report in this chapter is undertaken in three separate steps. First, we calibrate ACEEE's economic assessment model called DEEPER (Dynamic Energy Efficiency Policy Evaluation Routine) to reflect the economic profile of the Appalachian economy (Laitner and McKinney, forthcoming). This is done for the period 2006 (the base year of the model) through 2030 (the last year of the analysis). In this respect, we incorporate the anticipated investment and spending patterns that are suggested by the standard forecast modeling assumptions. These range from typical spending by businesses and households in the analytical period to the anticipated construction of new electric power plants and other energy-related spending that might also be highlighted in the forecast. Second, we transform the set of key efficiency scenario results

[43] As we use the term here, the word "consumer" refers to any one who buys and uses energy. Thus, we include both households and businesses as among the consumers who benefit from greater investments in energy efficiency.

[44] As we note elsewhere, the policy analysis ends in the year 2030. Yet, many of the investments we describe have a technology of perhaps 15 years. This means that investments made in 2030 would continue to pay for themselves through perhaps the year 2044 and beyond; and none of those ongoing energy bill savings are reflected in the analysis described in this chapter.

from the policy analysis into the direct inputs which are needed for the economic model. The resulting inputs include such parameters as:

1. The level of annual policy and/or program spending that drives the key policy scenario investments;
2. The capital and operating costs associated with more energy-efficient technologies;
3. The energy bill savings that result from the various energy-efficiency policies described in the main body of the report; and
4. Finally, a set of calibration or diagnostic model runs to check both the logic and the internal consistency of the modeling results.

So that we can more fully characterize the analysis that was completed for this report, we next provide a simplified working example of how the modeling is done. We first describe the financial assumptions that underpin the analysis. We then highlight the analytical technique by showing the kinds of calculations that are used and then summarize the overall results in terms of net job impacts. Following this example, we then review the net impacts of the various policies as evaluated in our DEEPER model. A more detailed description of the economic model is presented in Appendix F.

7.2 ILLUSTRATING THE METHODOLOGY: APPALACHIAN JOBS FROM EFFICIENCY GAINS

To illustrate how a job impact analysis might be done, we will use the simplified example of installing one hundred million dollars of efficiency improvements within large office buildings throughout the Appalachian Region. Office buildings (traditionally large users of energy due to heating and air-conditioning loads, significant use of electronic office equipment, and the large numbers of persons employed and served) provide substantial opportunities for energy-saving investments. The results of this example are summarized in Table 7.1.

The assumption used in this example is that the investment has a positive benefit/cost ratio of 2.0. In other words, the assumption is that for every dollar of cost used to increase a building‘s overall energy efficiency, the upgrades might be expected to return a total of two dollars in reduced electricity and natural gas costs over the useful life of the technologies. This ratio is similar but generally lower to those cited elsewhere in this report. At the same time, if we anticipate that the efficiency changes will have an expected life of roughly 15 years, then we can establish a 15-year period of analysis. In this illustration, we further assume that the efficiency upgrades take place in the first year of the analysis, while the electricity bill savings occur in years one through 15.

Table 7.1 Job Impacts from Commercial Building Efficiency Improvements

Expenditure Category	Amount (million $)	Employment Coefficient	Job Impact
Installing Efficiency Improvements in Year One	$100	13	1,300
Diverting Expenditures to Fund Efficiency Improvements	$-100	12	-1,200
Energy Bill Savings in Years One through 15	$200	12	2,400
Lower Utility Revenues in Years One through 15	$-200	5	-1,000
Net 15-Year Change	**$0.0**		**1,500**

Note: The employment multipliers are adapted from the appropriate sector multipliers found in Appendix F. The benefit/cost ratio is assumed to be 2.0. The jobs impact is the result of multiplying the row change in expenditure by the row multiplier. The sum of these products yields a working estimate of total net job-years over the 15-year time horizon. To find the average annual net jobs in this simplified analysis we would divide the total job-years by 15 years which, of course, gives us an estimated net gain of 100 jobs per year for each of the 15 years. For more details, see the text that follows.

The analysis assumes that we are interested in the *net effect* of employment and other economic changes. This means we must first examine all changes in household and business expenditures – both positive and negative – that result from a movement toward greater levels of energy efficiency. Although more detailed and complicated within the DEEPER model, for this heuristic exercise we then multiply each change in expenditures by the appropriate sector employment coefficient (adapted from the values shown in Appendix F). The sum of these products will then yield the net result for which we are looking.

In our example above, there are four separate changes in expenditures, each with their separate impact. As Table 7.1 indicates, the net impact of the scenario suggests a cumulative gain of 1,500 jobs in each of the 15-year period of analysis. This translates into an average net increase of 100 jobs each year for 15 years. In other words, the $100 million efficiency investment made in Appalachian office buildings is projected to sustain an average of 100 jobs each year over a 15-year period compared to a ―business-as-usual" scenario.

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

First, it was assumed that only 72 percent of both the efficiency investments and the savings are spent within the Appalachian Region. We based this initial value on the Minnesota IMPLAN Group, Inc. (IMPLAN, 2008) dataset as it describes local purchase patterns that typically now occur in the

Region. We anticipate that this is a conservative assumption since most efficiency and renewable energy installations are likely (or could be) carried out by local contractors and dealers. If the set of policies encourages greater local participation so that the share was increased to 90 percent, for example, the net jobs might grow another 15 percent compared to our standard scenario exercise. At the same time, the scenario also assumes Appalachia provides only 40 percent of the manufactured products consumed within the Region. But again, a concerted effort to build manufacturing capacity for the set of clean energy technologies would increase the benefits from developing a broader in-state energy efficiency and renewable energy manufacturing capability.

Second, an adjustment in the employment impacts was made to account for assumed future changes in labor productivity. As outlined in the Bureau of Labor Statistics Outlook 2006–2016, productivity rates are expected to vary widely among sectors (BLS, 2008). For instance, drawing from the BLS data we would expect that electric utilities might increase labor productivity by 1.8 percent annually while the business and personal service sectors of the economy might increase productivity by 2.2 percent per year. This means, for example, that we might expect a one million dollar expenditure for utility services in the year 2030 would support only 68 percent of the jobs that the same expenditure would have supported in 2008, while other services sectors of the economy would support only 62 percent of the jobs as in 2008.

Third, for purposes of estimating energy bill savings, it was assumed that all energy prices within Appalachia would follow the same growth rate as those published by the Energy Information Administration in its *Annual Energy Outlook* (EIA, 2008a).[45] Fourth, it was assumed that approximately 80 percent of the efficiency investments‘ upgrades are financed by bank loans that carry an average eight percent interest rate over a five-year period. To limit the scope of the analysis, however, no parameters were established to account for any changes in interest rates as less capital-intensive technologies (i.e., efficiency investments) are substituted for conventional supply strategies, or in labor participation rates – all of which might affect overall spending patterns. Fortunately, however, it is unlikely that these sensitivities would greatly impact the overall outcome of this analysis.

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

Fifth, as described in the previous chapters for the buildings, industrial, and transportation end-use sectors it was assumed that a program and marketing expenditure would be required to promote market penetration of the efficiency improvements. Since these vary significantly by policy bundle we don‘t summarize them here but payment for these policy and program expenditures were treated as if new taxes were levied on the Region commensurate with the level of energy demands within the Region. Hence, the positive program spending impacts are offset by reduced revenues elsewhere in the economy.

[45] In fact, we used a population-weighted average of regional energy prices referenced in the *Annual Energy Outlook* as they overlapped with the states and counties found within the jurisdiction of the Appalachian Regional Commission.

Sixth, it should be noted that the full effects of the efficiency investments are not accounted for since the savings beyond 2030 are not incorporated in the analysis. Nor does the analysis include other benefits and costs that can stem from the efficiency investments. Non-energy benefits can include increased worker productivity, comfort and safety, and water savings, while non-energy costs can include aesthetic issues associated with compact fluorescent lamps and increased maintenance costs due to a lack of familiarity with new energy-efficiency equipment (NAPEE, 2007b, p. 3-8). Productivity benefits, for example, can be substantial, especially in the industrial sector. Industrial investments that increase energy efficiency often result in achieving other economic goals such as improved product quality, lower capital and operating costs, increased employee productivity, or capturing specialized product markets (see, for example, Worrell et al., 2003). To the extent these ―co-benefits" exceed any non-energy costs, the economic impacts of an energy-efficiency initiative in Appalachia would be more favorable than those reported here. Finally, although we show how the calculations would look from an employment perspective, we don't show the same kind of data or assumptions for either income or for impacts on the Gross Regional Product (the sum of value-added contributions to the Appalachian Regional economy). Nonetheless, the approach is very similar to that described for net job impacts.

7.3 IMPACTS OF RECOMMENDED ENERGY-EFFICIENCY POLICIES

For each year in the analytical period, the given change in a sector spending pattern (relative to the reference scenario) was matched to the appropriate sectoral impact coefficients. Two points are worth special note: first, it was important to match the right change in spending to the right sector of the Appalachian economy; and second, these coefficients change over time. For example, labor productivity changes mean that there may be fewer jobs supported by a one million dollar expenditure today compared to that same level of spending in 2030. Both the negative and positive impacts were summed to generate the estimated net results shown in the series of tables that follow. Presented here are two basic sets of macroeconomic impacts for the benchmark years of 2010, 2013, 2020, and 2030. These include the financial flows that result from the policies described in the previous chapters. They also include the net jobs, income, and GRP impacts that result from the changed investment and spending patterns.

Table 7.2 presents the changes in consumer expenditures that result from these policies. While the first row in the table presents the full cost of the energy-efficiency policies, programs, and investments, the utility customers will likely borrow a portion of the money to pay for these investments. Thus, ―annual consumer outlays," estimated at about $1,083 million 2010, rise to $6,165 million (or nearly $6.2 billion) in 2030. These outlays include actual ―out-of-pocket" spending for programs and investments, along with money borrowed to underwrite the larger technology investments. The annual energy bill savings reported in Table 7.1 are a function of reduced energy purchases from the many Appalachian utilities and other energy providers within the Region.

As we further highlight in the table that follows, the annual energy bill savings begins with a modest first year benefit of $708 million. As more and more investments are directed toward the purchase of more energy-efficient technologies, the annual consumer energy bill savings rise to about $27.6 billion by 2030.

Table 7.2 Financial Impacts from Energy-Efficiency Policy Scenario

(Millions of 2006 $)	2010	2013	2020	2030
Annual Consumer Outlays	1,083	2,734	4,564	6,165
Annual Energy Savings	788	2,577	9,944	27,567
Annual Net Consumer Savings	(295)	(157)	5,380	21,402
Cumulative Net Energy Savings	(295)	(1,230)	15,226	150,809

_Annual‘ refers to the total that is reported in the benchmark year while _Cumulative‘ is the total from previous years beginning in 2010 through the benchmark year.
Annual consumer outlays include administrative costs to run programs, incentives provided to consumers, investments in energy-efficiency devices and interest paid on loans needed to underwrite the needed efficiency investments.
Annual energy savings is the reduced energy bill expenditures that benefit both households and businesses within a given year. The net savings is the difference between savings and outlays. The numbers in parentheses are losses in that specific year.

Perhaps the critical element that jumps out in Table 7.2 is that, in the early years and especially as the policies ramp up quickly to simulate a greater level of efficiency improvements, the consumer outlays outweigh the energy bill savings. In 2010, the net costs begin at $295 million and rise through 2013. Although not shown in the table, this remains the case through the year 2014 when the savings show a small net return of $11 million. These savings mount steadily through the year 2030 by when they nearly reach an estimated $21.4 billion for the Region as a whole. The last row of the table highlights cumulative impacts with losses peaking in 2013 and ending in 2015 (not shown). By 2030 the net cumulative savings over the period 2010 through 2030 are strongly net positive at just under $151 billion.

While the annual net consumer savings first turn positive in 2014 – four years after the policy initiatives are in operation – the simple payback period to participants is much shorter, ranging from 1.54 to 3.75 years, from 2010 to 2030 or 2.24 to 3.75 from 2011 to 2030, depending on the year of participation. The shortest payback is for investments made in 2010 and the longest in 2011, in the aggregate. The benefits, from a TRC perspective, outweigh costs by about 3.3 times.

At this point we then have the financial flows estimated as they are distributed across the end-use sectors described earlier in the report. The question then becomes what might be the impacts on the Regional economy as we‘ve been able to evaluate them for a given year using the DEEPER model. The modeling then evaluates impact on jobs and wages sector-by-sector, and evaluates their contribution to Appalachia‘s Gross Regional Product (GRP), which is a sum of the net gain in value-added contributions provided by the energy productivity gains throughout all sectors of the Regional economy. As with the previous table on financial impacts, Table 7.3 highlights the net impacts for the benchmark years 2010, 2013, 2020, and 2030.

Table 7.3 Economic Impact of Energy-Efficiency Investment in Appalachia				
Macroeconomic Impacts	**2010**	**2013**	**2020**	**2030**
Jobs (Actual)	16,231	15,466	37,268	77,378
Wages (million $2006)	517	450	1,169	3,018
GRP (million $2006)	763	444	1,197	3,056

Given both the financial flows and the modeling framework, the analysis suggests a net contribution to the Appalachian employment base as measured by full-time jobs equivalent. In the year 2010 we see a small net increase of 16,231 jobs which increases to a significantly larger total of 77,378 net jobs by 2030. This significantly positive impact might seem to provide us with a counterintuitive result. The early years of the policy scenarios show small net cost to the economy. Yet we continue to see a net increase in jobs. How is this possible?

In Appalachia, the electric utility and the natural gas service sectors directly and indirectly employ about 5.3 and 3.7 jobs, respectively, for every $1 million of spending (as highlighted in the multiplier table in Appendix F). But, sectors vital to energy-efficiency improvements, like construction and manufacturing, utilize 13.3 and 8.3 jobs per $1 million of spending. Once job gains and losses are netted out in each year, and following a similar logic shown in Table 7.1, the analysis suggests that, by diverting expenditures away from non-labor intensive energy sectors, the cost-effective energy policies can positively impact the larger Appalachia economy – even in the early years, but especially in the later years of the analysis as the energy savings continue to mount.

To highlight the results of this analysis in a little more detail, Figure 7.1 provides year-by-year impacts on net jobs within the Appalachia Region. Figure 7.2 highlights the anticipated net gain to the state‘s wage and salary compensation and GRP, both measured in millions of 2006 dollars.

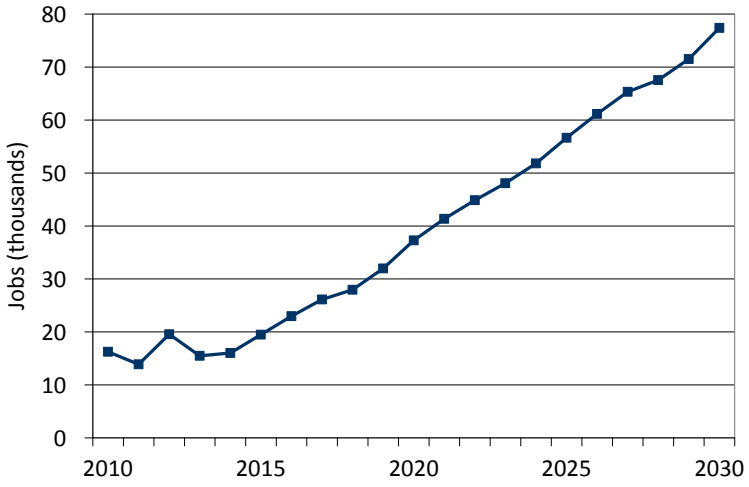

Figure 7.1 Net Job Impacts for Appalachia (2008-2030)

The end result of this policy analysis, then, suggests that an early program stimulus which drives a higher level of efficiency investments can actually increase economic impact, creating an average of 16,000 net new jobs each year in the first five years of the study, and rising to an estimated average of 60,000 net new jobs over the last decade of the analysis. This is roughly equivalent to the employment that would be directly and indirectly supported by the construction and operation of 480 small manufacturing plants within Appalachia. As indicated by Figure 7.2, these investments also increase both wages and Gross Regional Product throughout Appalachia.

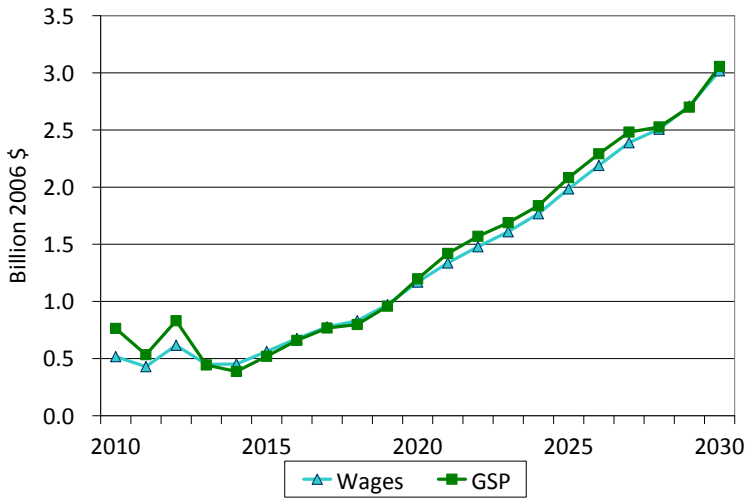

Figure 7.2 Wages and Gross Regional Product Impacts for Appalachia (million 2006$), 2008-2030

In short, the more efficient use of energy resources provides a cost-effective redirection of spending away from less labor-intensive sectors into those sectors that provide a greater number of jobs within Appalachia. Similarly, cost-effective energy productivity gains also redirect spending away from sectors that provide a smaller rate of value-added into those sectors with slightly higher levels of value-added returns per dollar of revenue. The extent to which these benefits are realized will depend on the willingness of business and policy leaders to implement the recommendations that are at the heart of this report and found earlier in this assessment.