# More Jobs and Greater Total Wage Income:

# The Economic Benefits of an Efficiency-Led Clean Energy Strategy to Meet Growing Electricity Needs in Michigan

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Support for our work comes from a broad range of foundations, governmental organizations, research institutes, utilities, and corporations.

## ABSTRACT

One of the critical concerns regarding maintaining the robustness of the future Michigan economy is supporting the growing demand for electricity. The challenge is to meet the new demand for electricity in ways that maintain competitive electricity costs and also reduce environmental impacts. In January 2007, the Michigan Public Service Commission (MPSC) released the *21st Century Electric Energy Plan* presenting the results of a six-month study by MPSC staff and a number of other interested parties. The conclusions of that study indicated that a combination of energy efficiency and renewable energy technologies could help meet the growing need for electricity in the state. By incorporating those technologies into the resource mix (particularly energy efficiency), the MPSC plan would actually reduce total electric system costs as compared to a "business-as-usual" approach. The question answered in ACEEE's study is whether this alternative "clean energy" policy scenario could provide additional economic benefits in terms of net growth in jobs and wages in Michigan.

In this report, ACEEE reviews the macroeconomic impacts that likely would unfold under an alternative set of policy recommendations. Generally, we find that cost-effective investments in the combination of energy efficiency and renewable energy generation technologies can actually reduce overall electricity costs, boost net employment, and reduce air pollutants within the state. For example, by 2023 (the last year of this analysis), businesses and households in Michigan are expected to enjoy a net cumulative savings of at least $2.6 billion and likely more. As a result of this greater energy productivity, the state is projected to show a net annual employment increase of between 3,900 and 10,000 jobs (depending on the level of energy efficiency policy pursued — the greater the level of cost-effective energy efficiency investments, the greater the number of net new jobs). This is roughly equivalent to the employment that would be directly and indirectly supported by the construction and operation of 25 to 75 small manufacturing plants within Michigan. In addition, air emissions from conventional power plants could be reduced by 15–28 % (also by 2023). The extent to which these benefits are realized will depend on the willingness of business and policy leaders to implement or even expand the kinds of energy efficiency and renewable energy recommendations that are found in MPSC's *21st Century Electric Energy Plan*.

## INTRODUCTION

Like many states, Michigan is expected to grow in ways that — without new policies — will require substantial new supplies of electricity. With new economic growth, electricity consumption is projected to grow an estimated 1.3% annually (MPSC 2007). This means that in just 15 years Michigan will require 21% more electricity than it now uses today. At the same time, however, the state is facing tight reserve margins for electric generation capacity. The challenge confronting Michigan is to meet the demand for new electricity services and to do so in ways that maintain competitive electricity costs and reduce environmental impacts.

In January 2007, the Michigan Public Service Commission released a report, *Michigan's 21st Century Electric Energy Plan* (MPSC 2007). The plan suggested that the state had the capacity to meet the growing demand for electricity "through the use of renewable resources, energy efficiency measures, and the cleanest available utility-built generation." But the question remains: could this recommended alternative policy scenario enable, perhaps even spur, continued economic growth within the state? In this follow-up report to that *21st Century Electric Energy Plan*, we review the macroeconomic impacts that likely would unfold in this alternative scenario. In addition, we explore the possible impacts of roughly doubling the goals envisioned by the MPSC.

In the sections that follow, we briefly review the key findings from the MPSC report, describe the economic model used to assess the larger employment and other macroeconomic impacts, and finally, report on the study findings themselves. Generally, we find that cost-effective investments in the combination of energy efficiency and alternative generation technologies can actually boost net employment and overall economic activity in the state. The extent to which those benefits are realized depends on the extent to which Michigan and its business and policy leaders decide to implement or expand the recommendations in the MPSC study.

## BACKGROUND

The state's continuing growth in peak electric demand and electricity consumption has led the electric generators and their allies to suggest that Michigan take actions to increase its current generating resources. The dominant resource in the new expansion plans was a series of coal-fired power plants. In a January 2007 report, the Michigan Public Service Commission (MPSC 2007) suggested, instead, that energy efficiency and renewable resources should be included as critical priority resources. The report also recommended a series of policies to bring those resources online at a moderately aggressive pace.

These recommendations were particularly timely, because Michigan has had virtually no policies or programs in place to capture energy efficiency and renewable energy resources for over a decade. Michigan has fallen far behind the leading states in this region, and nationally. (The good news is that Michigan has considerable available potential for acquiring these resources.)

In the January 2007 report, the MPSC described a number of options that are both cost-effective and politically viable in Michigan. If the state implemented these clean energy resource policies, the MPSC indicated that Michigan could substantially reduce the number of new electric generating plants it would need to meet its electricity needs.[1] Moreover, the MPSC found that the use of strong energy efficiency programs as a utility system resource would provide billions of dollars of savings in total electric system costs. [2]

Overall, the January 2007 report found that a combination of energy efficiency investments, combined heat and power technologies, and new renewable resources could provide sufficient generation equivalent to reduce conventional electricity use by 15% over the period 2008 through 2023. Of the total generation still needed in this scenario, 7% would come from renewable energy resources. More critically, data within the report indicates that within the 15-year period of analysis that we review here, the required 15-year cumulative investment of $7.2 billion, including both program and administrative costs, would save more than $9.2 billion in avoided electricity expenditures over that same time horizon. But the question remains: what are the likely impacts on jobs and the economy over that same 15-year period? In the sections of the report that follow, we describe the methodology, model, and findings of our assessment.

## STUDY METHODOLOGY

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

### The Economic Model

The economic assessment model used in this exercise is a quasi-dynamic, input-output analytical tool we call DEEPER, or the Dynamic Energy Efficiency Policy Evaluation Routine. Although recently given a new name, the model's origins can be traced back to modeling

[1] To quote from the *Michigan's 21st Century Electric Energy Plan*: "modeling for the Plan showed that, in the absence of any energy efficiency programming, Michigan would need no fewer than four new 500 MW baseload units by 2015 to meet forecasted demand. With energy efficiency programming, the model decreased the forecasted need to two new baseload units on a staggered basis; and with the addition of the RPS, this projection has been decreased further to one new unit by 2015." (p. 32)

[2] From the *Michigan's 21st Century Electric Energy Plan*: "By displacing traditional fossil fuel energy, the energy efficiency program alone could save Michigan $3 billion in electricity costs over the next 20 years." (p. 33)

assessments that ACEEE and others first completed in the early 1990s (see the appendix for historical information and other details on the DEEPER model).

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

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

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

As shown in Table 1, three categories of economic impacts are summarized for key sectors of the Michigan economy. These include agriculture, construction, manufacturing, utility services, wholesale and retail trade, commercial services, and government.[3] The employment effects highlight the total number of Michigan jobs that are supported for every one million dollars of spending within a given sector. For purposes of this study, a job is defined as sufficient wages to employ one person full-time for one year.

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

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

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

**Table 1. Key Michigan Impact Coefficients by Major Economic Sector**

| Sector | Total Employment per Million Dollars of Spending | Total Wage and Salaries per Dollar of Spending | Total Gross State Product (GSP) per Dollar of Spending |
|---|---|---|---|
| Agriculture | 17.2 | 0.207 | 0.638 |
| Oil and Gas Extraction | 6.1 | 0.125 | 0.718 |
| Other Mining | 6.9 | 0.370 | 0.661 |
| Electric Utilities | 2.8 | 0.201 | 0.773 |
| Natural Gas Distribution | 2.9 | 0.175 | 0.452 |
| Construction | 12.1 | 0.437 | 0.708 |
| Manufacturing | 5.4 | 0.311 | 0.511 |
| Wholesale Trade | 8.1 | 0.445 | 0.853 |
| Transportation, Other Public Utilities | 11.2 | 0.513 | 0.770 |
| Retail Trade | 19.1 | 0.480 | 0.841 |
| Services | 11.9 | 0.397 | 0.822 |
| Finance | 8.0 | 0.366 | 0.794 |
| Government | 17.1 | 0.845 | 0.970 |

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

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

## An Illustration: Michigan Jobs from Improvements in Commercial Office Buildings

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

The assumption used in this example is that the investment has a positive benefit-cost ratio of 2.5. In other words, the assumption is that for every dollar of cost used to increase a building's overall energy efficiency, the upgrades might be expected to return a total of 2.5 dollars in reduced electricity costs over the useful life of the technologies. At the same time, if we anticipate that the efficiency changes will have an expected life of roughly 12 years, then we can establish a 12-year period of analysis. In this illustration, we further assume that the efficiency upgrades take place in the first year of the analysis, while the electricity bill savings occur in years 1 through 12.

**Table 2. Job Impacts from Office Building Energy Efficiency Improvements**

| Expenditure Category | Amount (Million $) | Employment Coefficient | Job Impact |
|---|---|---|---|
| Installing Efficiency Improvements in Year 1 | 1.0 | 12.1 | 12.1 |
| Diverting Expenditures to Fund Efficiency Improvements | -1.0 | 11.6 | -11.6 |
| Energy Bill Savings in Years 1 through 12 | 2.5 | 11.6 | 29.0 |
| Lower Utility Revenues in Years 1 through 12 | -2.5 | 2.8 | -7.0 |
| **Net Twelve-Year Change** | **0.0** | | **22.5** |

**Note:** The employment multipliers are taken from the appropriate sectors found in Table 1. The utility multiplier is assumed to be for electric utilities. The benefit-cost ratio is assumed to be 2.5. The jobs impact is the result of multiplying the row change in expenditure by the row multiplier. For more details, see the text that follows.

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

In our illustration, there are four separate changes in expenditures, each with their separate effect. As Table 2 above indicates, the net impact of the scenario suggests a gain of 22.5 job-years in the 12-year period of analysis. This translates into an average net increase of 1.9 jobs each year for 12 years. In other words, the efficiency investment made in the office building is projected to sustain an average of almost two jobs each year over a 12-year period compared to a "business-as-usual" scenario.

## Evaluating Michigan's Alternative Policy Scenarios

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.[4]

First, it was assumed that only 80% of both the efficiency investments and the savings are spent within Michigan. We based this initial value on the IMPLAN® dataset as it describes local purchase patterns that typically occur in the state. We anticipate that this is a conservative assumption since most efficiency and renewable energy installations are likely (or could be) carried out by local contractors and dealers. As we will discuss later in this sector of the report, if the set of policies encourages local participation so that the share was increased to 90%, for example, the net jobs might grow another 15% compared to our standard scenario exercise. At the same time, the scenario also assumes Michigan now provides only 40% of its needed manufactured products. But again, if the state were to build up its internal manufacturing capacity for the recommended set of clean energy technologies, the economic benefits would increase as the energy efficiency investments would also given Michigan new momentum to strengthen its manufacturing capability more generally.

Second, an adjustment in the employment impacts was made to account for assumed future changes in labor productivity. As outlined in the Bureau of Labor Statistics *Outlook 2004–2014*, productivity rates are expected to vary widely among sectors (BLS 2005). For instance, the BLS projects a 2.2% annual productivity gain in the service industries as those sectors better integrate information technologies and become even more critical to the economy. To illustrate the impact of productivity gains on future employment patterns, let us assume a typical labor productivity increase of 2.2% per year. This means, for example, that compared to 2008, we might expect that a one-million dollar expenditure in the year 2023 will support only 72% of the number of jobs as in 2008.[5]

Third, for purposes of estimating energy bill savings, it was assumed that current electricity prices in Michigan would follow the same growth rate as those in the East North Central region, as published by the Energy Information Administration in its *Annual Energy Outlook* (EIA 2006, 2007). Fourth, it was assumed that approximately 80% of the efficiency investments upgrades are financed by bank loans that carry an average 8% interest rate over a five-year period. Similarly, it was assumed that all renewable and clean energy technology investments are financed at an average 6% interest rate over a 20-year period. To limit the scope of the analysis, however, no parameters were established to account for any changes in interest rates as less capital-intensive technologies (i.e., efficiency investments) are substituted for conventional supply strategies, or in labor participation rates — all of which might affect overall spending patterns.

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

[4] For a more complete review of how this type of analysis is carried out, see Laitner, Bernow, and DeCicco (1998).
[5] The calculation is $1/(1.022)^{12} * 100$ equals $1/1.386 * 100$, or 72%.

activity), the job benefits are small compared to the current level of unemployment or underemployment. Hence the effect would be negligible.

Fifth, for the buildings and industrial sectors it was assumed that a program and marketing expenditure would be required to promote market penetration of the efficiency improvements. Based on estimates derived from the *21st Century Electric Energy Plan* (MPSC 2007), this was set at 34% of the efficiency investment for those sectors.

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

Finally, it should again be noted that the full effects of the efficiency investments are not accounted for since the savings beyond 2023 are not incorporated in the analysis. Nor does the analysis include other productivity benefits that are likely to stem from the efficiency investments. These can be substantial, especially in the industrial sector. Industrial investments that increase energy efficiency often result in achieving other economic goals such as improving product quality, lowering capital and operating costs, increasing employee productivity, or capturing specialized product markets.[6] To the extent these "co-benefits" are realized in addition to the energy savings, the positive economic impacts would be amplified beyond those reported here.

## ECONOMIC IMPACT OF MICHIGAN'S CLEAN ENERGY TECHNOLOGY INITIATIVE

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

Table 3 summarizes, for selected years, two key sets of changes in the Michigan electricity production patterns that are driven by the alternative policy initiatives suggested by the MPSC staff. The first change is an increase in program spending and the resulting level of technology investments. This covers investments for both energy efficiency and renewable energy technologies. The second is the resulting change in the level and pattern of electricity

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

generation. By definition, if there are changes in demand as well as an expectation for a generation mix that will eventually include the 7% renewable resource requirement, this will impact the overall pattern of electricity production in Michigan. The table also summarizes the initial financial impacts from these two sets of changes as those impacts are estimated by the investment and spending module within the DEEPER model. It is this combined set of three financial impacts that are then further evaluated by DEEPER's macroeconomic module to estimate the larger net gains to the Michigan economy.[7]

A quick review of Table 3 shows clearly a net positive benefit to Michigan businesses and consumers. However, the early ramp up of renewables and efficiency investments in the early years means that while there are reduced electricity bills in those early years, the first couple of years show a net cost — but a cost that is quickly recovered over time as the technologies tend to pay for themselves in typically 2-3 years or less.

**Table 3. Changes in Michigan Electricity Production and Financial Impacts: Adapting MPSC Staff Base Case Energy Efficiency Program Parameters***

| | 2008 | 2013 | 2018 | 2023 |
|---|---|---|---|---|
| **Implied Program Spending (Millions of 2004 Dollars)** | | | | |
| Annual Policy and Program Costs | 50 | 78 | 89 | 91 |
| Annual Technology Investments | 457 | 1,020 | 165 | 136 |
| **Changes in Electricity Production Patterns** | | | | |
| Efficiency Gains (GWh) | 657 | 4,323 | 9,132 | 12,417 |
| Renewables Production (GWh) | 0 | 4,332 | 8,518 | 8,894 |
| Total Change in Production (GWh) | 657 | 8,655 | 17,650 | 21,311 |
| Change from Reference Case | 0.6% | 7.1% | 13.5% | 15.3% |
| **Financial Impacts (Millions of $2004)** | | | | |
| Annual Consumer Outlays | 142 | 583 | 692 | 642 |
| Annual Electricity Savings | 56 | 347 | 766 | 1,055 |
| Electricity Supply Cost Adjustment | (13) | (103) | (215) | (280) |
| Net Consumer Savings | (73) | (132) | 288 | 693 |
| Net Cumulative Energy Savings | (74) | (489) | (130) | 2,560 |

* This was the primary energy efficiency scenario analyzed in the *21st Century Electric Energy Plan* process, and was based on documented results from other states, and calibrated with the assistance of the Energy Center of Wisconsin. This Base Case Energy Efficiency Scenario assumed statewide utility energy efficiency spending at an average of $114 million per year for the first five years, and an average of $146 million over the first ten years (see the *Michigan 21st Century Electric Energy Plan*, Appendix, Volume II, page 103).
Note: Numbers in parentheses are negative numbers.

Starting with very small impacts in 2008, the set of energy efficiency and clean energy policies spur both program costs and technology investments that, in turn, begin to change the

[7] One caveat should be noted at this point. While we have made every effort to capture the magnitude and direction of spending changes recommended by the MPSC staff, there will be inevitable differences between the financial summaries reported in the *21st Century Electric Energy Plan* and the DEEPER model. While we have tried to minimize those differences, the overall results continue to be robust. This will be more evident as we discuss the sensitivity cases that have been run as part of this assessment.

production patterns of electricity consumption and production. Program spending[8] of $50 million in 2008 leverages $457 million in alternative technology investments in that same year. The initial impacts on overall electricity production are relatively small in 2008, reducing electricity demand by only 657 GWh or gigawatt-hours (which is the same as 657 million kilowatt-hours). In 2008 there are no incremental increases in renewable energy electricity generation. Combined, these impacts reduce or displace conventional electricity generation by only 0.6% in 2008. However, program spending steadily rises to $91 million per year by 2023 while technology investments peak at just over $1 billion in 2013 (driven largely by a ramping up of renewable energy technologies) and then decline to $136 million per year by 2023. The cumulative impact of activities over the 15-year time horizon steadily reduces the demand for conventional electricity generation so that by 2023 a combination of efficiency and renewables displaces the forecasted electricity production by 15%.

As might be expected, the program spending and changed investment patterns have a distinct financial impact within Michigan. The third set of information in Table 3 highlights the key financial impacts for the same years. For example, program costs and technology investments are only part of the expenditures paid by consumers (including both households and businesses). Notably, the utility customers will likely borrow money to pay for these investments. Thus, consumer outlays, estimated at $142 million in 2008 and rising to $642 million in 2023, include actual "out-of-pocket" spending for programs and investments, but also money borrowed to underwrite the larger technology investments. Annual electricity savings is a function of reduced electricity purchases from the Michigan utilities at the initial electricity prices in a given year. This starts slowly with a savings of $56 million in 2008 and rising to just over $1 billion annually by 2023.

On the other hand, the changed electricity production patterns, including both reduced electricity demands and alternative technology investments, forces an adjustment in the electricity supply costs. Table 3 shows a negative impact. This means that there are lower capital and operating expenditures associated with electric utility revenues in the alternative policy scenario. This, in turn, results in a savings to consumers. Hence, the alternative policies actually reduce costs to consumers, starting by an estimated savings of $13 million in 2008 and rising to nearly $280 million annually in 2023.

The category of net consumer savings — with businesses and households in 2008 spending $142 million, but then saving $56 million in reduced electricity consumption, and then benefiting from lower electricity costs of $13 million — shows a net cost to consumers in 2008 of $73 million. In other words, in the first years of the program, outlays are greater than savings. But as electricity savings increases and as costs further decline, the net consumer savings quickly grow positive and rise to a net gain of about $693 million by 2023. Finally, the cumulative net savings in the last row of Table 3 suggests a net gain to consumers of $2.6 (rounded) billion by 2023. Of course, the benefits continue into the future for those investments made through 2023, but they are not captured here since we evaluate only 15 years of economic impacts.

[8] The "program spending" here excludes the cost of rebates and other direct financial incentives paid by the program to participants, because those costs are captured in the "annual technology investments" category.

With the set of program spending, investment changes, and financial impacts identified in Table 3, and given the other modeling assumptions described earlier in this report, the macroeconomic module of the DEEPER model then traces how each set of changes works or ripples its way through the Michigan economy in each year of the assessment period. Once each of the net sector spending changes has been evaluated for a given year, the DEEPER model then evaluates the sector-by-sector jobs and wages. It also evaluates their contribution to the state's value-added or GSP. Table 4 highlights the net impacts, again by the benchmark years.

**Table 4. Net Economic Impacts for Benchmark Years**

| Category of Impact | 2008 | 2013 | 2018 | 2023 |
|---|---|---|---|---|
| Jobs (Actual) | 3,411 | 8,112 | 3,170 | 3,888 |
| Wages (Million $2004) | 139 | 323 | 86 | 125 |
| GSP (Million $2004) | 175 | 328 | (247) | (307) |

The first of the three impacts evaluated here is the net contribution to the Michigan employment base as measured by full-time jobs equivalent. In other words, once the gains and losses are sorted out in each year, the analysis provides the net annual employment benefit of the policies as they impact the larger Michigan economy. In 2008, the impact starts with a net gain of 3,400 jobs (in rounded numbers) as initial programs and investment expenditures take hold. The job total rises to a net gain of 8,100 jobs as renewable energy technologies in particular increase in scale. However, as the renewable investments level off in the middle years, net employment gains are driven by a smaller level of efficiency investments, and in particular, by the re-spending of electricity bill savings on other goods and services within the Michigan economy.

The second impact is the net gain to the state's wage and salary compensation, measured in millions of 2004 dollars. Showing a similar pattern of job impacts, wages rise from a net gain of $139 million in 2008, peaking at $323 million in 2013, and declining to a smaller but still net positive value of $125 million in 2023. This is a significant but small impact, increasing net income by only 0.02%.

The impact on the Michigan GSP might suggest a somewhat counterintuitive result, however. While job and wage benefits are small but net positive, the impact on GSP is small but generally negative. By 2023, for example, GSP is down by $300 million (rounded), or 0.05% compared to a business-as-usual forecast. The reason is that the electric utilities are a capital-intensive sector, but one that is also generally non-labor intensive. Movement away from greater capital intensity to a more labor-intensive energy policy shifts the composition of GSP away from utility plant investment toward more productive and more labor-intensive spending. As it turns out, this generates a small but negative impact on GSP compared to how the changed spending patterns impact jobs and wages.

If the impacts are small in relation to the larger economy, it is only because the scale of investment is also relatively small. The anticipated $6 billion in cumulative efficiency and renewable investments costs is on the order of 0.07% of the cumulative GSP for Michigan in the period 2008 through 2023. Perhaps by translating to a different scale, however, we can think of the net job gains as if they were provided by the relocation of a series of small manufacturing plants to Michigan. In that case, we then can say that a 15% displacement of conventional electricity generation would produce new employment that is equivalent to the jobs supported by about 31 small manufacturing plants that might open in the year 2023.[9] Alternately, we can think of the additional wage and salary compensation from the energy savings as an equivalent amount of spending by tourists and visitors in the state. In this instance, the 15% electricity savings and use of renewables would provide the dollar equivalent of spending from 500,000 visitor days.[10]

## AN EXTENDED ANALYSIS

One immediate conclusion drawn from the preceding modeling assessment is that the Michigan economy clearly benefits over time. New investments drive employment and wages in a small but upward direction, and the greater energy productivities save consumers and businesses money. But the question arises: is this the best Michigan can do? To explore the expanded opportunities we ran an additional scenario that reflects a doubling of the investment identified in the MPSC base case energy efficiency scenario described earlier. The same financial impacts as shown in Table 3 are summarized and discussed in this next section of the report. We call this sensitivity case the doubling efficiency scenario and its financial implications are summarized in Table 5.

Table 5 highlights the financial flows and impacts if we assume a simple doubling of the annual investments in energy efficiency compared to the MPSC staff base case energy efficiency scenario. Because this scenario also assumes the same investment cost per kWh as suggested by the MPSC, it has the effect of also doubling the electricity efficiency savings. At the same time we continue to impose the same requirement that 7% of the remaining generation needs must be met by some combination of renewable energy resources. By definition the greater level of penetration of energy-efficient technologies slightly reduces the demand for more renewables even as we impose the same 7% requirement.

Similar to the results shown in Table 4 for the MPSC's *21st Century Electric Energy Plan,* the macroeconomic impacts are highlighted in Table 6 below. This also shows net jobs, wages, and impact on GSP.

This doubling efficiency scenario continues to show net positive impacts on employment and wages. As we noted earlier in the discussion, the reasons include a greater level of investment that stimulates new jobs as well as growing electricity bill savings. The latter means that consumers and businesses have even more effective income to spend on other goods and services rather than on their electricity bills. The big conclusion from this alternative scenario is that the savings and economic impacts tend to be a robust outcome —

[9] This estimate is based on the net gain of 3,900 jobs in the year 2023. It assumes that a small manufacturing plant would employ 50 persons directly. For each job in the manufacturing plant, a total of 2.5 jobs might be supported in the economy for a total impact of 125 total jobs per manufacturing plant. Therefore, each 125 jobs created by the alternative energy scenario is equivalent to the output of one small manufacturing plant. Dividing 3,900 by 125 suggests the equivalent of 31 small manufacturing plants within the Michigan economy.

[10] This estimate is based on the net gain in wage and salary compensation of $125 million in the year 2023. It assumes that tourists and visitors to Michigan might spend approximately $250 each day on recreation, eating and drinking, and lodging. Dividing $125 million by $250 suggests the equivalent of 500,000 visitor days within the Michigan economy.

and that greater levels of energy efficiency investment produce greater gains in net employment and total wages in Michigan.

**Table 5. Changes in Michigan Electricity Production and Financial Impacts: Doubling Efficiency Scenario**

| | 2008 | 2013 | 2018 | 2023 |
|---|---|---|---|---|
| **Implied Program Spending (Millions of 2004 Dollars)** | | | | |
| Annual Policy and Program Costs | 95 | 122 | 132 | 132 |
| Annual Technology Investments | 500 | 1,177 | 283 | 272 |
| **Changes in Electricity Production Patterns** | | | | |
| Efficiency Gains (GWh) | 1,314 | 8,646 | 18,264 | 24,834 |
| Renewables Production (GWh) | 0 | 4,174 | 7,879 | 8,025 |
| Total Change in Production (GWh) | 1,314 | 12,820 | 26,143 | 32,859 |
| Change from Reference Case | 1.1% | 10.4% | 20.0% | 23.6% |
| **Financial Impacts (Millions of $2004)** | | | | |
| Annual Consumer Outlays | 230 | 795 | 919 | 799 |
| Annual Electricity Savings | 113 | 694 | 1,532 | 2,110 |
| Electricity Supply Cost Adjustment | (25) | (186) | (389) | (518) |
| Net Consumer Savings | (92) | 86 | 1,002 | 1,828 |
| Net Cumulative Energy Savings | (93) | 38 | 2,829 | 10,402 |

**Table 6. Net Economic Impacts for Doubling Efficiency Scenario**

| Category of Impact | 2008 | 2013 | 2018 | 2023 |
|---|---|---|---|---|
| Jobs (Actual) | 3,262 | 9,203 | 5,731 | 7,506 |
| Wages (Million $2004) | 133 | 342 | 150 | 245 |
| GSP (Million $2004) | 117 | 173 | (512) | (605) |

## FURTHER DISCUSSION

While the economic gains reported here are clearly positive, there are a number of issues that merit additional discussion. These issues include the impact such a transition might have on the electric utility sector and the expected impact on air pollutants. In addition, it is helpful to review the context of this report as it might compare with other similar studies. We also evaluate how the results might differ if the state were to roughly double its investments in energy efficiency and renewable energy technologies. Finally, it is useful to at least acknowledge other possible benefits from the alternative policy scenarios — principally the potential lower rate of air pollution. Each of these topics is briefly reviewed in the order listed.

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

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

Perhaps one particularly useful comparison to underscore the robustness of the results in this assessment is a 2007 study funded by Environment Michigan (Madsen, Telleen-Lawton, and Shriberg 2007). Like this ACEEE analysis, the Environment Michigan assessment analyzed the economic benefits of the MPSC's *21st Century* scenario impacts. In addition, the Environment Michigan evaluated a more aggressive alternative energy strategy for Michigan following what was termed an "advanced energy course." In both cases, the analysis showed significant net positive benefits. A comparable result was highlighted in another study that evaluated potential national energy policy impacts in Michigan (Nayak 2005). An even earlier ACEEE study (Laitner et al. 1995), using a similar input-output model of the Michigan economy, also suggested positive returns to the Michigan economy from greater levels of efficiency investments.

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

**Table 7a. Estimate of Avoided Air Pollutants: MPSC Base Case EE Scenario**

| Category of Pollutant | 2008 | 2013 | 2018 | 2023 |
|---|---|---|---|---|
| $SO_2$ (thousand short tons) | 1.7 | 10.4 | 16.4 | 18.5 |
| NOx (thousand short tons) | 0.8 | 3.9 | 6.0 | 6.6 |
| $CO_2$ (million metric tons) | 0.5 | 6.0 | 12.1 | 14.3 |

**Table 7b. Estimate of Avoided Air Pollutants: Doubling Efficiency Scenario**

| Category of Pollutant | 2008 | 2013 | 2018 | 2023 |
|---|---|---|---|---|
| $SO_2$ (thousand short tons) | 3.5 | 15.5 | 24.2 | 28.5 |
| NOx (thousand short tons) | 1.6 | 5.7 | 8.8 | 10.1 |
| $CO_2$ (million metric tons) | 0.9 | 8.9 | 18.0 | 22.1 |

While both scenarios indicate substantial reductions, as much as 28% of the anticipated reference case projections for the year 2023, several thoughts should be noted. First, these estimates are based on average emission rates. Actual emission reductions will depend on the kind of generation unit that is actually displaced by the alternative technology investments. To that extent, and consistent with the overall thrust of this analysis, the results should be seen as indicative of the potential rather than a precise forecast of impacts. Still, this is a positive secondary benefit that would be significant even if the levels are less than anticipated. Second, the utilities may be required in any event to achieve additional reductions of conventional air pollutants beyond the standard forecast. Such reductions could be a result of other emerging federal policies. In this case, the $SO_2$ and $NO_X$ emissions may not reflect "new reductions" as such, but they clearly reflect a cheaper way to reduce otherwise mandated emissions since the energy efficiency and renewable energy technologies tend to pay for themselves while conventional pollution control strategies typically do not. Finally, the substantial reductions in $CO_2$ emissions would provide Michigan with an important means to reduce greenhouse gas emissions in a way that almost entirely pays for itself in reduced electric system costs. This would be an important hedging strategy for the state's electric utilities should concerns about global climate change prompt some form of required emissions reductions.

## CONCLUSION

One of the critical concerns in maintaining the robustness of the Michigan economy is supporting the growing demand for electricity in a way that minimizes overall costs, reduces economic risks, produces beneficial economic effects, and minimizes environmental impacts. Results of analyses in other states (e.g., Elliott, Laitner, and Pye 2007; Laitner *forthcoming #2*) indicate that a "clean energy" scenario of energy efficiency and renewable energy could help stabilize overall energy prices, lower electricity bills, and increase system reliability within the state's utility sector. The question answered in this current study is whether such a clean energy policy scenario could enable, perhaps even spur, continued economic growth within Michigan.

In this report, we reviewed the macroeconomic impacts that likely would unfold under MPSC's alternative policy recommendations. Generally, we find that cost-effective investments in the combination of energy efficiency and renewable energy generation technologies can actually reduce overall electricity costs, boost net employment, and reduce air pollutants within the state. For example, by 2023 businesses and households in Michigan are expected to enjoy a net savings of $2.6 billion or more (depending on the level of energy efficiency pursued — the higher the energy efficiency requirements, the greater the savings). As a result of this greater energy productivity, the state is projected to show a net employment increase of about 3,900 to potentially nearly 10,000 jobs. This is roughly equivalent to the employment that would be directly and indirectly supported by the construction and operation of 30 to 75 small manufacturing plants within Michigan. In addition, a variety of air emissions from power plants might be reduced by as much as 28% (also by 2023). The extent to which these benefits are realized will depend on the willingness of business and policy leaders to implement moderate to aggressive utility sector energy efficiency and renewable energy policy requirements in Michigan.

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## APPENDIX: THE DEEPER MODEL

The Dynamic Energy Efficiency Policy Evaluation Routine — or the DEEPER Model — is a 15-sector economic impact model of the U.S. economy. Although an updated model with a new name, the model has a 15-year history of development and use for state energy policy assessments. See, for example, Laitner, Bernow, and DeCicco (1998) and Laitner (*forthcoming #1*) for a review of past modeling efforts. The model is generally used to evaluate the macroeconomic impacts of a variety of energy efficiency and renewable energy technologies at both the state and national level. The model now evaluates policies for the period 2008 through 2030. DEEPER is an Excel-based analytical tool that consists generally of six key modules or worksheets. These modules include:

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

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

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

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

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

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

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

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

where:

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

This set of relationships can also be interpreted as

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

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

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

There are other support spreadsheets as well as visual basic programming that supports the automated generation of model results and reporting. For more detail on the model assumptions and economic relationships, please refer to the forthcoming model documentation (Laitner *forthcoming #2*). For a review of how an I-O framework might be integrated into other kinds of modeling activities, see Hanson and Laitner (2007).