Beyond the Payback Period: Measuring the Economic Impacts of Energy Efficiency Programs

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ABSTRACT

Energy efficiency programs are typically designed to meet cost-effectiveness standards, and the simple payback calculation is often used as a measure of potential benefits. While the payback calculation has the advantage of being easy to calculate, its simplicity comes at the cost of omitting other potential benefits that should be considered. In recent years, one category of benefits that is of increasing interest to policymakers is job creation associated with efficiency programs. In this research, we calculated the overall economic effects (including job impacts) of an energy efficiency program portfolio in Hawaii.

Our analysis used an input-output model to estimate economic impacts for the 2010 program year. The model tracks dollars as they move through an economy from one sector to the next. Expenditures on program implementation initiate changes that directly affect the Hawaiian economy. This spending then generates indirect impacts among businesses that supply the directly affected businesses. In addition, the direct and indirect impacts enhance overall economy purchasing power and generate induced or consumption-driven impacts. The sum of these direct, indirect, and induced impacts makes up the total economic impacts. Using the model, we determined the number of jobs, amount of income, and dollars of economic output that can be traced to the initial project.

Our economic impact analysis estimates the broad economic impacts from the spending on program measures—including the cost of equipment and installation. We also calculated the impact of reduced energy consumption. Our analysis determined that the program has positive economic impacts to Hawaii's economy that exceed the cost of implementing the program. The economic impact in Hawaii is particularly strong because of the geographic isolation and 80 percent of its electricity is generated from imported oil.

Introduction

Evergreen Economics was retained by the Hawaii Public Utilities Commission to conduct a comprehensive evaluation of the Hawaii Energy portfolio of energy efficiency programs implemented throughout the State of Hawaii. One of the research tasks for this evaluation is to estimate the economic impacts associated with the Hawaii Energy energy efficiency program portfolio. ECONorthwest (a subcontractor on the Evergreen Economics evaluation team) conducted the economic impact analysis with assistance from Evergreen Economics staff.

Using data from Hawaii Energy's program tracking system, economic impacts were estimated for the 2010 program year (PY2010) for each county that had active program participants.[1] In addition to the economic benefits that occur with the initial equipment purchase, Hawaii Energy efficiency programs create energy savings that continue for years after the initial equipment installation. To show the benefits of these savings accumulating over time, economic impacts are measured for future out-years over the expected lifespan of the equipment.

Analysis Methods

Measuring the economic impacts attributable to Hawaii Energy efficiency programs is a complex process, as spending by Hawaii Energy—and subsequent changes in spending by program participants—unfold over a lengthy period of time. From this perspective, the most appropriate analytical framework for estimating the economic impacts is to classify them into the following categories:

- *Short-term* impacts are associated with changes in business activity as a direct result of changes in spending (or final demand) by Hawaii Energy; energy efficiency program participants; and ratepayers who provide funding for energy efficiency programs.
- *Long-term* impacts associated with the potential changes in relative prices, factor costs, and the optimal use of resources among program participants, as well as industries and households linked by competitive, supply-chain, or other factors.

This analysis measures the short-term economic impacts associated with the Hawaii Energy efficiency programs. These impacts are driven by changes (both positive and negative) in final demand, and are measured within a static input-output modeling framework that relies on data for an economy at a point in time and assumes that program spending does not affect the evolution of the state economy. Energy efficiency programs may have longer lasting effects, and this is clearly the case for continued out-year energy savings. However, these long-term, dynamic effects are not measured in this analysis.

In addition to the short-term and long-term dimensions, expenditures resulting from the Hawaii Energy efficiency programs affect the Hawaii economy *directly*, through the purchases of goods and services in this state, and *indirectly*, as those purchases in turn generate purchases of intermediate goods and services from related sectors of the economy. In addition, the direct and indirect increases in employment and income enhance overall economy purchasing power, thereby *inducing* further consumption- and investment- driven stimulus. This cycle continues until the spending eventually leaks out of the local economy as a result of taxes, savings, or purchases of non-locally produced goods and services or "imports".

The economic modeling framework that best captures these direct, indirect, and induced effects is called input-output modeling. Input-output models provide an empirical representation of the economy and its inter-sectoral relationships, enabling the user to trace out the effects (economic impacts) of a change in the demand for commodities (goods and services). We use the IMPLAN input-output modeling software for this analysis, which utilizes Hawaii-specific multipliers to estimate spending impacts at the 4-digit SIC code level.

The IMPLAN model has several features that make it particularly well suited for this analysis.

[1] For PY2010, counties with program activity where energy efficient equipment was installed included Oahu, Hawaii, and Maui Counties.

- First, the IMPLAN model is widely used and well respected. The IMPLAN model is constructed with data assembled for national income accounting purposes, thereby providing a tool that has a robust link to widely accepted data development efforts. The United States Department of Agriculture (USDA) recognized the IMPLAN modeling framework as "*one of the most credible regional impact models used for regional economic impact analysis*" and, following a review by experts from seven USDA agencies, selected IMPLAN as its analysis framework for monitoring job creation associated with the American Recovery and Reinvestment Act (ARRA) of 2009.[2]
- Second, the IMPLAN model's input-output framework and descriptive capabilities allow for the construction of economic models for each island (or county) where Hawaii Energy provided energy efficiency program opportunities in 2010. Each model has county-specific data for 440 different industry sectors, as well as for households and government institutions. These details permit the most accurate mapping of Hawaii Energy program spending and energy savings to industry and household sectors in the IMPLAN model.
- Third, IMPLAN has an advanced multi-regional input-output modeling capability that can be used to measure linkages between different economies. MIG Inc., along with the U.S. Forest Service (USFS), recently developed a National Trade Flows Model that estimates gross trade flows between counties. This new Multi-Regional Input-Output (MRIO) modeling component can be used to conduct multi-regional, input-output analysis and estimate how the direct impacts in one island generate indirect and induced effects for industries and households in other islands.
- Fourth, the IMPLAN model is based on historical economic data for Hawaii and, therefore, reflects the unique nature of Hawaii's economy and the economic relationships across islands.

Using the IMPLAN model, we constructed individual models for Oahu, Hawaii, Maui, and Kauai.[3] These individual county models were then linked to each other using IMPLAN's MRIO modeling component to form a complex state model that measures impacts from energy efficiency spending in each county, as well as spillover impacts for other counties. For example, energy efficiency program spending and energy savings for program participants in Oahu will generate economic impacts in Oahu, and indirect and induced impacts for businesses in Hawaii, Maui, and Kauai that accommodate the supply-chain and consumption-driven spending initiated in Oahu.

For this analysis, economic impacts are reported as different types of income effects. In the following tables, the impact on "Wages" reflects the increase in wage income for all workers as a result of activities funded through the Hawaii Energy programs. Similarly, "Business Income" is the increase in income to local businesses as a result of spending associated with Hawaii energy program spending. Finally, "Jobs" reflects the number of full and part time jobs that result directly from Hawaii Energy program activities and from the increase in spending in other sectors of the economy.

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[2] See excerpts from an April 9, 2009 letter to MIG, Inc., from John Kort, Acting Administrator of the USDA Economic Research Service, on behalf of Secretary Vilsack, at www.implan.com.

[3] Hawaii Energy did not have energy efficiency program activity in Kauai. However, this island is included to capture potential spillover effects from the other three islands, and to develop the most reliable estimate of economic impacts for the state of Hawaii.

Commercial and residential customers that invest in energy efficiency have an additional impact on the economy due to lower production costs resulting from lower energy costs. This is particularly true for the commercial and industrial sector, as costs of production decrease and overall output will increase due to more efficient production processes.

Economic Impact Model Inputs

PY2010 Expenditures

To develop the IMPLAN model inputs, budget information provided by Hawaii Energy was aggregated into several general categories to facilitate economic impact modeling for similar areas of spending. Table 1 shows the general areas of spending for that resulted from the PY2010 efficiency programs. As shown at the bottom of the table, total spending due to the Hawaii Energy programs in PY2010 was just over $17.0 million. Note that here and elsewhere the economic impacts are divided into Oahu, Hawaii and Maui Counties as these are the only counties that had program participation in PY2010.

Table 1. Hawaii Energy Program Spending (2010 dollars)

Program / County	**Program Incentives**	**Program Administration**	**Total Program**
Residential			
Oahu	$4,685,744	$1,944,731	$6,630,475
Hawaii	$814,488	–	$814,488
Maui	$647,795	–	$647,795
Total Residential	**$6,148,028**	**$1,944,731**	**$8,092,759**
Business			
Oahu	$5,918,341	$1,635,284	$7,553,625
Hawaii	$393,894	–	$393,894
Maui	$999,190	–	$999,190
Total Business	**$7,311,425**	**$1,635,284**	**$8,946,710**
All Programs			
Oahu	$10,604,085	$3,580,015	$14,184,100
Hawaii	$1,208,382	–	$1,208,382
Maui	$1,646,986	–	$1,646,986
Total All Programs	**$13,459,453**	**$3,580,015**	**$17,039,468**

Source: Hawaii Energy efficiency program tracking system.

As a general rule, spending on program incentives goes directly to equipment purchases and labor for installation. In PY2010, program incentives totaled $13.5 million (79 percent of total program spending). Program administration costs (i.e., non-incentive spending) are estimated to be $3.6 million in PY2010.

Measure Spending

Table 2 summarizes participants' incremental measure spending by program and county in PY2010 based on information from the Hawaii Energy participant database. Common measures that received incentives include compact fluorescent lighting (CFLs); ENERGY STAR® refrigerators, dishwashers, clothes dryers, ceiling fans, and air conditioners; and HVAC systems, high efficiency water heaters, and heat pumps. In total, 72 different types of energy efficiency measures were installed as part of Hawaii Energy efficiency programs in 2010.

Table 2. Incremental Measure Spending (2010 dollars)

Program / County	Incremental Measure Spending
Residential	
Oahu	$31,486,726
Hawaii	$5,588,716
Maui	$3,644,491
Total Residential	**$40,719,933**
Business	
Oahu	$2,648,909
Hawaii	$303,892
Maui	$264,719
Total Business	**$3,217,521**
All Programs	
Oahu	$34,135,635
Hawaii	$5,892,608
Maui	$3,909,211
Total All Programs	**$43,937,454**

Source: Hawaii Energy program tracking database.

Energy Savings

Table 3 shows the total net annual energy saved by Hawaii Energy programs in PY2010. On an annualized basis, a total of 108.2 GWh were saved as a direct result of Hawaii Energy program activities in PY2010. This figure includes energy savings for both residential and business customers. To account for the fact the measure installations occurred throughout the program year (rather than all at the beginning of the year) and therefore less than a full year of energy saving is achieved in PY2010, the annual savings value is reduced by 50 percent prior to being used as an input in the IMPLAN model. Consequently, the economic impacts associated with the energy cost savings is also reduced by 50 percent in the first year. As discussed below, this assumption is relaxed when the economic impacts for future years are considered.

Table 3. Net Annual Energy Savings

Program / County	**Net Annual Energy Savings (MWh)**	**Net Annual MW Saved**
Residential		
Oahu	38,294	5.7
Hawaii	7,682	1.1
Maui	5,339	0.8
Total Residential	51,315	7.6
Business		
Oahu	47,004	6.9
Hawaii	3,305	0.5
Maui	6,543	1.0
Total Business	56,852	8.4
All Programs		
Oahu	85,298	12.6
Hawaii	10,987	1.6
Maui	11,883	1.8
Total All Programs	108,168	16.0

Source: Hawaii Energy program tracking database.

Economic Impact Results

Total Gross and Net Impacts

Table 4 shows the total gross and net economic impacts, by county and for the state of Hawaii, for Hawaii Energy efficiency programs in PY2010. For this analysis, *gross impacts* refer to *economic* impacts that do not include a counterfactual Base Case scenario that compares alternative uses of program funding. The gross impacts are calculated based on the input parameters discussed below and then compared against a Base Case spending scenario that assumes the Hawaii Energy program funding is returned to Hawaii ratepayers and spent following historical purchase patterns. The difference in economic impacts between the gross economic impacts attributed to Hawaii Energy program spending and energy savings and the Base Case scenario is referred to as *net impacts.*

Table 4. Total Gross and Net Economic Impacts, by County (PY2010)

County / Impact Measure	Gross Impacts	Net Impacts
Oahu		
Output	$41,725,500	$23,890,900
Wages	$13,330,300	$8,254,900
Business Income	$3,084,600	$2,465,100
Jobs (person-years)	385	246
Hawaii		
Output	$4,269,800	$3,008,600
Wages	$1,449,800	$1,128,600
Business Income	$460,900	$397,700
Jobs (person-years)	57	47
Maui		
Output	$2,518,400	$1,112,700
Wages	$934,500	$524,200
Business Income	$286,300	$239,800
Jobs (person-years)	35	23
Total Statewide		
Output	$48,653,300	$28,101,300
Wages	$15,745,400	$9,928,400
Business Income	$3,837,000	$3,106,400
Jobs (person-years)	478	316

Note: Total state impacts are slightly larger than the sum of the three county impacts due to modest spillover impacts for Kauai.

In 2010, the spending and energy savings attributed to Hawaii Energy efficiency programs increased economic output in Hawaii by $28.1 million, including increases of $9.9 million in wages and $3.1 million in business income. This activity also created 316 jobs in Hawaii. This reflects economic activity over and above what would have been created in the Base Case scenario.

Table 5 shows how the net economic impacts are distributed across industries. Although total net economic impacts are positive in 2010, changes in final demand and the associated income and job effects, can be either positive or negative across industries. This can occur for two reasons: 1) energy efficiency programs save energy that—as we have assumed in this analysis—can reduce utility revenues, and 2) energy efficiency program funding redistributes spending between program participants and ratepayers.

Table 5. Total Net Economic Impacts by Aggregate Industry Sector (2010)

Aggregate Industry Sector	Output	Wages	Business Income	Jobs (person-years)
Agriculture	$48,700	$9,300	$300	1
Mining	$100,800	$27,900	$9,100	0
Construction	$12,055,300	$3,748,400	$1,252,500	94
Manufacturing	$2,587,800	$372,300	$99,100	9
Transportation, Information, Utilities	-$14,088,500	-$2,915,800	-$9,200	-18
Trade	$9,854,800	$4,175,900	$385,200	102
Service	$17,068,800	$4,215,800	$1,369,400	124
Government	$473,600	$294,600	$0	3
Total	$28,101,300	$9,928,400	$3,106,400	316

Net Economic Impacts, By Type, and Economic Impact Multipliers

The direct changes in economic activity attributed to Hawaii Energy efficiency programs begins a multiplier spending process in the form of supply-chain (indirect impacts) and consumption-driven (induced impacts) spending that benefits workers and business owners in other sectors of Hawaii's economy. Economic multipliers are a shorthand way to understand these spending effects, i.e., the larger the multiplier, the greater the interdependence between an activity and the rest of the local economy. Table 6 reports the net economic impacts, by type, and the calculated economic impact multipliers for 2010.

This analysis reports Type SAM multipliers, which stands for "Social Accounting Matrix." A Type SAM multiplier is calculated by dividing the sum of direct, indirect, and induced impacts by the direct impacts. For PY2010:

- Hawaii Energy efficiency programs directly generated 197 full- and part-time jobs in 2010. This includes energy efficiency contractors, equipment manufacturers and retailers, as well as Hawaii Energy staff. Energy efficiency program spending was responsible for another 119 secondary jobs, for a total net employment impact of 316 jobs in 2010. Based on these results, the job multiplier for Hawaii Energy efficiency programs in 2010 is 1.6. Thus, every ten direct jobs were associated with another 6 jobs in other sectors of the Hawaiian economy in 2010.
- Similarly, Hawaii Energy efficiency programs generated wage and business income multipliers of 1.8 and 1.3, respectively. Thus, every $1 million in wages and business income directly attributed to Hawaii Energy efficiency program activities are linked to another $800,000 in wages and $300,000 in business income for workers and small business owners in other sectors of the Hawaiian economy.

Table 6. Net Economic Impacts, By Type, and Economic Multipliers (PY2010)

Impact Measure	Direct	Indirect	Induced	Total	Multiplier
Output	$12,556,700	$6,681,600	$8,863,000	$28,101,300	2.2
Wages	$5,587,300	$1,848,600	$2,492,500	$9,928,400	1.8
Business Income	$2,459,000	$340,400	$307,000	$3,106,400	1.3
Jobs (person-years)	197	50	69	316	1.6

Cumulative Economic Impacts of Energy Conservation

Energy efficiency measure installations occur in the same year that the equipment and program costs are incurred. The energy savings from these measures, however, extend into future years as most measures have expected useful lives of multiple years. In PY2010, the weighted average EUL for installed measures is 6.6 years and approximately 80.3 percent of the installed measures have an estimated EUL of five years or more.

The energy cost savings for homes and businesses also extend into future years (with some degradation as equipment ages). These energy cost savings continue to benefit the economy as households spend less on electricity and more on other consumer products, and businesses are able to produce goods and services more efficiently. As a consequence, the net economic impacts from the first year, when the equipment and program spending occur, only capture a fraction of the overall economic impacts of these programs.

Table 7 shows the annualized economic impacts due to energy cost savings from energy efficiency measures installed in 2010. These estimates were calculated using the input-output model to estimate the economic impacts of reduced energy costs while setting all other costs (i.e., equipment purchases and program implementation costs) equal to zero. Note also that these impacts reflect an entire year of energy cost savings and therefore are significantly higher than the impacts shown in Table 4 for PY2010, as the PY2010 impacts were adjusted downward by 50 percent to reflect the fact that the measures were installed throughout the year.

Table 7. Annualized Economic Impacts Due to PY2010 Energy Cost Savings Alone

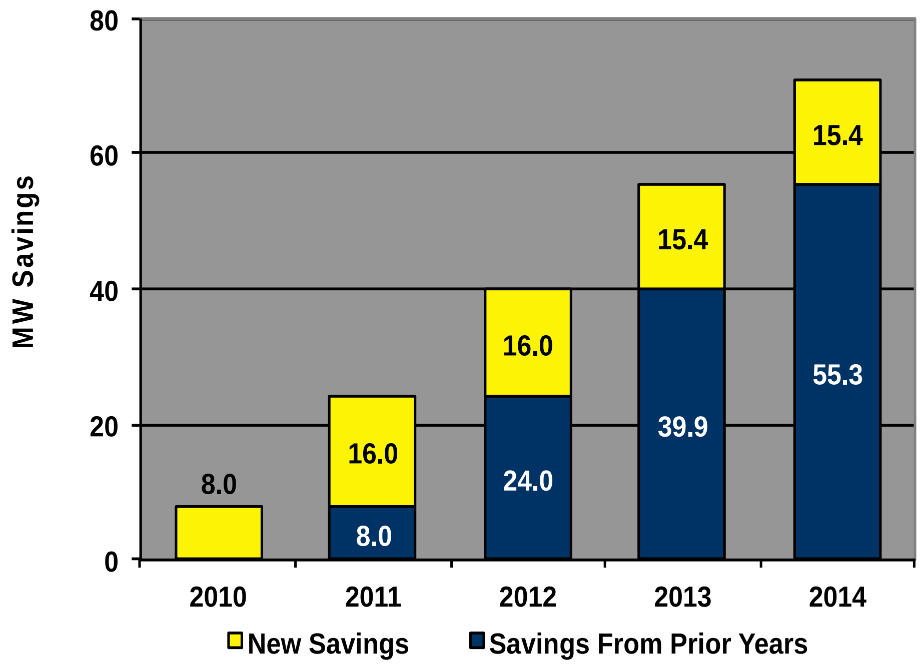
Impact Measure	Impacts Due to PY2010 Energy Cost Savings Only
Output	$37,198,800
Wages	$9,474,800
Business Income	$1,799,600
Jobs (person-years)	288

As shown in Table 7, on an annualized basis, 16.0 MW of savings from energy efficiency will increase economic output by $37.2 million, which includes increases of $9.4 million in wages and $1.8 million in business income. This increase in economic activity is associated with

288 jobs. The following figures illustrate how the effects of energy efficiency accumulate in the future, assuming that energy cost savings in future years continue at the annualized level estimated for energy efficiency measures installed in PY2010.

The following figures illustrate how the effects of energy efficiency accumulate in the future, assuming that energy cost savings continue in future post-installation years—albeit at a declining rate—for energy efficiency measures installed in PY2010. Figure 1 shows the cumulative energy cost savings resulting from Hawaii Energy efficiency program activities in PY2010. Note that the savings over time decreases in future years to take into account the measure life of the equipment installed in PY2010.

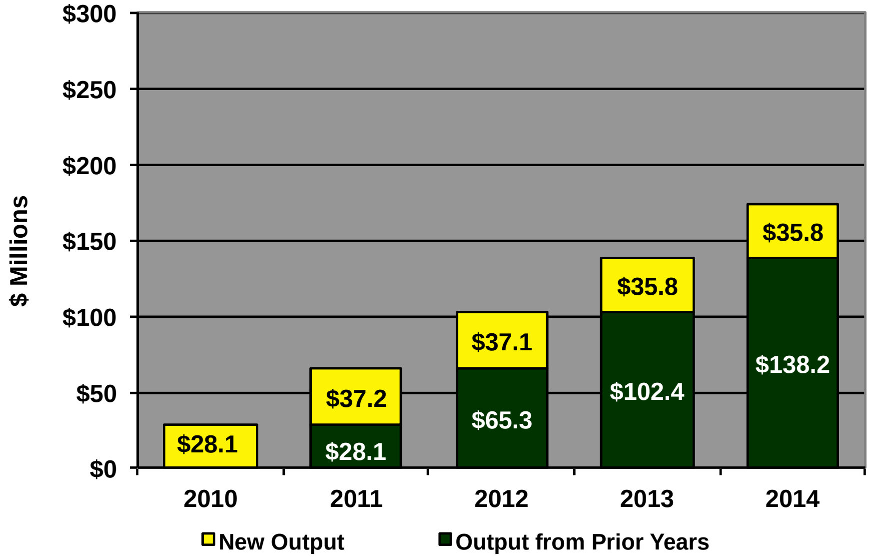
Figure 1. Cumulative Energy Cost Savings Over Time



In PY2010, Hawaii Energy's efficiency program installed measures that will generate, on an annualized net basis, 16 MW in electricity savings. As shown in Figure 1, these savings have been adjusted in the first program year to account for the timing of measure installations throughout the year (the 50 percent adjustment discussed earlier), and then continue— and decline somewhat due to the lifetime of installed efficiency measures—each year thereafter. By 2014, Hawaii Energy efficiency programs in PY2010 will have generated approximately 70.7 MW of net savings over the five-year period.

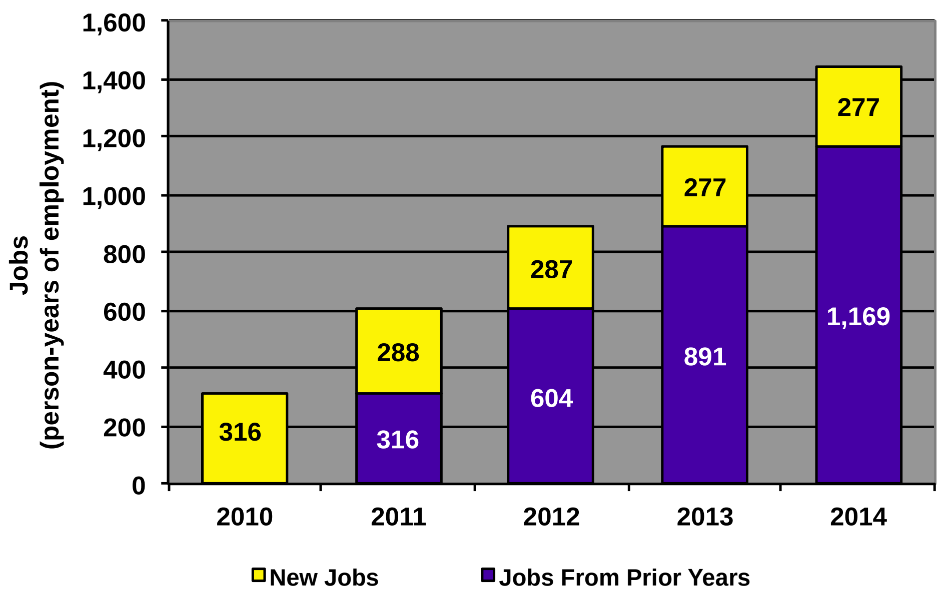
Figure 2 illustrates a similar cumulative effect for the economic activity that results from Hawaii Energy efficiency programs in the first program year and in subsequent post-installation years when energy savings are expected to occur. In 2010, economic output in Hawaii increased an additional $28.1 million based on program spending and energy cost savings achieved in that year. The energy cost savings will continue in future post-installation and generate additional economic impacts. By the end of 2014, Hawaii's economic output will have increased by $174.0 million due Hawaii Energy efficiency program activities in PY2010.

Figure 2. Cumulative Output Effects (millions of 2010 dollars)



In 2010, employment in Hawaii increased by 316 jobs based on Hawaii Energy efficiency program spending and energy savings in that year. If energy cost savings can be sustained over time, then the employment impacts should persist as well, at least in the short term. As shown in Figure 3, by the end of 2014, Hawaii Energy's PY2010 energy efficiency programs (through the increased spending of households and businesses due to lower energy costs) will have sustained 1,446 person-years of employment in Hawaii over the five-year period.[4]

Figure 3. Cumulative Employment Impacts



[4] We use person-years of employment to emphasize the transitory nature of these job impacts. That is, job impacts are attributed to spending and energy savings in the program year, and energy savings in future years.

There are other economic factors that could cause the economic impacts to decline over time in which case the economic impacts reported above would be overstated. Given the static nature of input-output modeling, in general, and the IMPLAN model used in this analysis, cumulative impacts do not take into account changes in production and business processes that Hawaii businesses make in anticipation of future higher energy prices and/or increased market pressure from international competition to increase production efficiency. To the extent that Hawaii businesses are already adjusting in anticipation of higher costs and/or tougher competition, then cumulative impacts presented here are overstated, as the overall market would become more efficient due to factors outside Hawaii Energy program influence.

The cumulative numbers also rely on the critical assumption that each dollar saved will translate into a dollar of increased economic output for those businesses adopting conservation measures. This assumption is a simplifying assumption made in absence of better information specific to Hawaii's economy. This assumption is reasonable in the short run, but in the long run it is likely that a dollar of energy savings will translate to less than a dollar of increased economic output as the overall market adopts more efficient production practices in anticipation of increased competition and higher energy costs. Consequently, the cumulative impacts shown here represent an upper bound. Despite these caveats, the ongoing and cumulative effect of conservation due to Hawaii Energy program activities is nevertheless a significant net benefit to Hawaii’s economy.