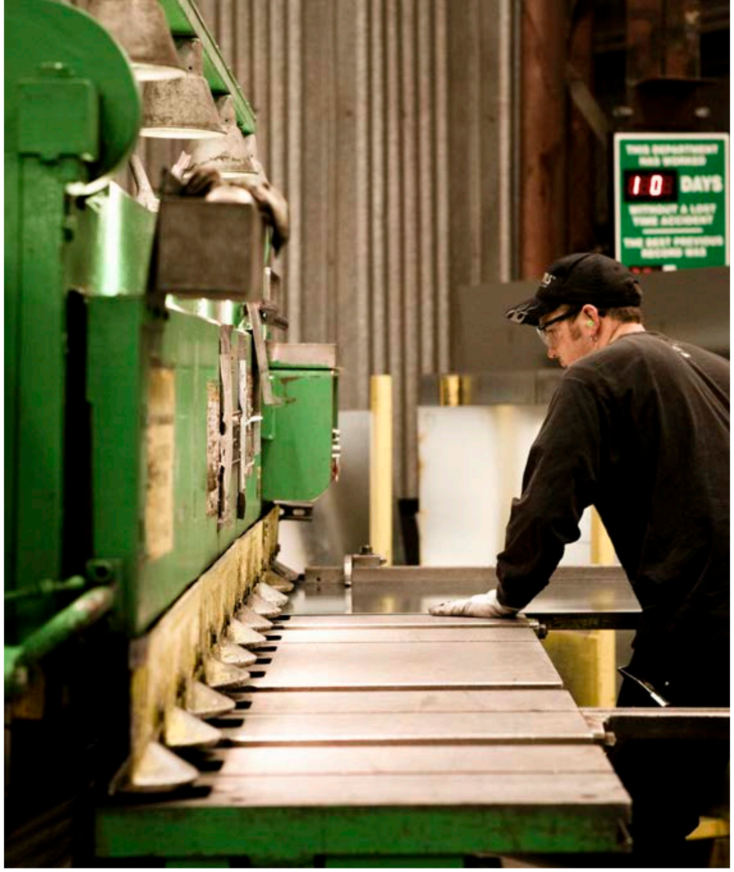

The Economic Impacts and Macroeconomic Benefits of Energy Efficiency Programs in Washington

August 2016

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EXECUTIVE SUMMARY

This report, sponsored by member companies of the Northwest Energy Efficiency Council (NEEC) and written by ECONorthwest, describes and updates a 2014 analysis about the economic effects of energy conservation work done in Washington. NEEC members provide products and services that improve energy efficiency.

Traditionally, economic impact reports on energy efficiency programs have a narrow focus. They all consider the impacts of spending on energy efficiency products and services (investment impacts). Those are impacts limited to one year and within one state. Since utility customers enjoy lower utility bills in the years following the implementation of energy efficiency measures and practices, they have more money to spend each year and this causes economic impacts (savings impacts).

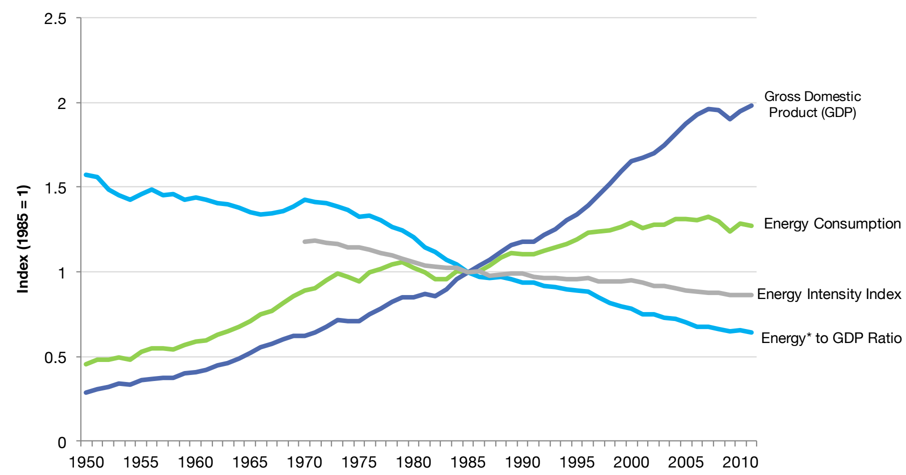
Rarely addressed, however, are the long-run macroeconomic effects arising from productivity growth. Our economy produces goods and services by using "factor inputs." These inputs include labor, capital, raw materials, and energy. Becoming more productive means society produces more output with the same amount of factor inputs. Making Washington more energy efficient increases productivity growth.

Productivity growth is the cornerstone of long-run economic health. It also affects a region's competitive position. The more productive Washington is, the better it competes in national and world markets. In short, productivity growth is the source of a higher standard of living.

ECONorthwest starts the report with the standard view, also considered by other states when looking at the impacts of energy efficiency investments. NEEC asked that our analysis of investment impacts consider an average year, providing data for 2008 through 2012 (the most recent data available).[1] This incorporates five years of spending by utilities and utility customers on energy efficiency products and services. We refer to this as the "average year" of investment spending. We use a traditional economic impact analysis, which tells us the effects an average year of investment in Washington has on the state's economy.

The report then addresses the long-run effects with a discussion of the macroeconomic benefits of improving energy efficiency in Washington. ECONorthwest presents the economic outcomes at three levels of energy bill savings, over seven years, using a macroeconomic model. This analysis is based on energy savings data from the "average year," and a set of specific assumptions to bookend future savings developed by NEEC and ECONorthwest.

Figure 1. Economy Growth vs. Energy Use



Source: A Comprehensive System of Energy Intensity Indicator for the U.S.: Methods, Data, and Key Trends. (Pacific Northwest National Laboratory)

Note: Energy* = Total energy as measured for system of intensity indicators (excludes military use, fuels used as materials). Energy intensity is measured by the quantity of energy required per unit output or activity, so using less energy to produce a product reduces the intensity.

MACROECONOMIC EFFECTS

Making businesses and households more energy efficient causes macroeconomic effects. Unlike economic impacts, which focus on spending passed along the supply chain, macroeconomic effects are felt more broadly. Better efficiency means that Washington's economy can produce more goods and services with less energy and at lower costs.

Over time, the cumulative investments in energy efficiency can raise the overall productivity of the economy. This improves economic welfare and elevates the standard of living of Washington residents. Higher incomes, more jobs, and better quality of life are among the potential results.

Historically, energy use kept pace with the economy, until the mid-1970s. An analysis by the U.S. Department of Energy, illustrated in Figure 1, shows the tight connection between the nation's gross domestic product (GDP) and energy consumption. The GDP is the value of the domestic production of goods and services. That relationship between energy use and GDP was close from 1950 to the mid 1970s.

Then, sharply higher oil prices drove conservation; consequently, energy use and GDP began to diverge. Since then, the adoption of improved energy efficiency technologies, leading to productivity gains, have caused macroeconomic effects leading to higher GDP growth. The divergence widened considerably after 2000, as GDP grew while energy consumption did not.

A review of the U.S. experience in the 1970s and 1980s suggests that increased energy efficiency leads to increased productivity growth and a significant rise in economic well-being.

Predicting the degree of future macroeconomic improvements is a matter of great uncertainty. As with any long-term forecast, the range of possible outcomes is wide. However, this report attempts to shed some light on the magnitude of productivity growth that energy efficiency could potentially have in the long run.

SHORT-RUN ECONOMIC IMPACTS OF ENERGY EFFICIENCY INVESTMENTS

In the "average year," $613.6 million dollars of Washington State's gross regional product (GRP) is linked to energy efficiency investments.[2] The gross impact of that spending reverberates throughout the economy, affecting jobs, income, and output.

But how much extra GRP and how many more jobs were there in Washington because of the investments? For that, the analysis subtracts the alternative case; that is, what would have happened had people and businesses not spent the half billion dollars on energy efficiency. Had no money been spent on efficiency measures, some of that money would have been spent elsewhere in Washington on other goods and services, and that spending would have had economic impacts.

Figure 2. Short-Run Economic Impacts of Energy Efficiency Investments

	Gross Impacts		Minus the Alternative*		Equals the Net Impact:
job growth by 2021*	7,577	-	3,770	=	**3,807**
labor compensation	$470.2M	-	$195.4M	=	**$274.8M**
gross regional product	$613.6M	-	$390.6M	=	**$223M**

*The "Alternative" refers to what happens if the money that went toward energy efficiency was spent elsewhere.

Subtracting the alternative from the gross impacts gives us net impacts. That is the net difference energy efficiency spending had on Washington in the average year. Figure 2 illustrates the calculation of net economic impacts for a single year of energy efficiency investment in 2015 dollars.

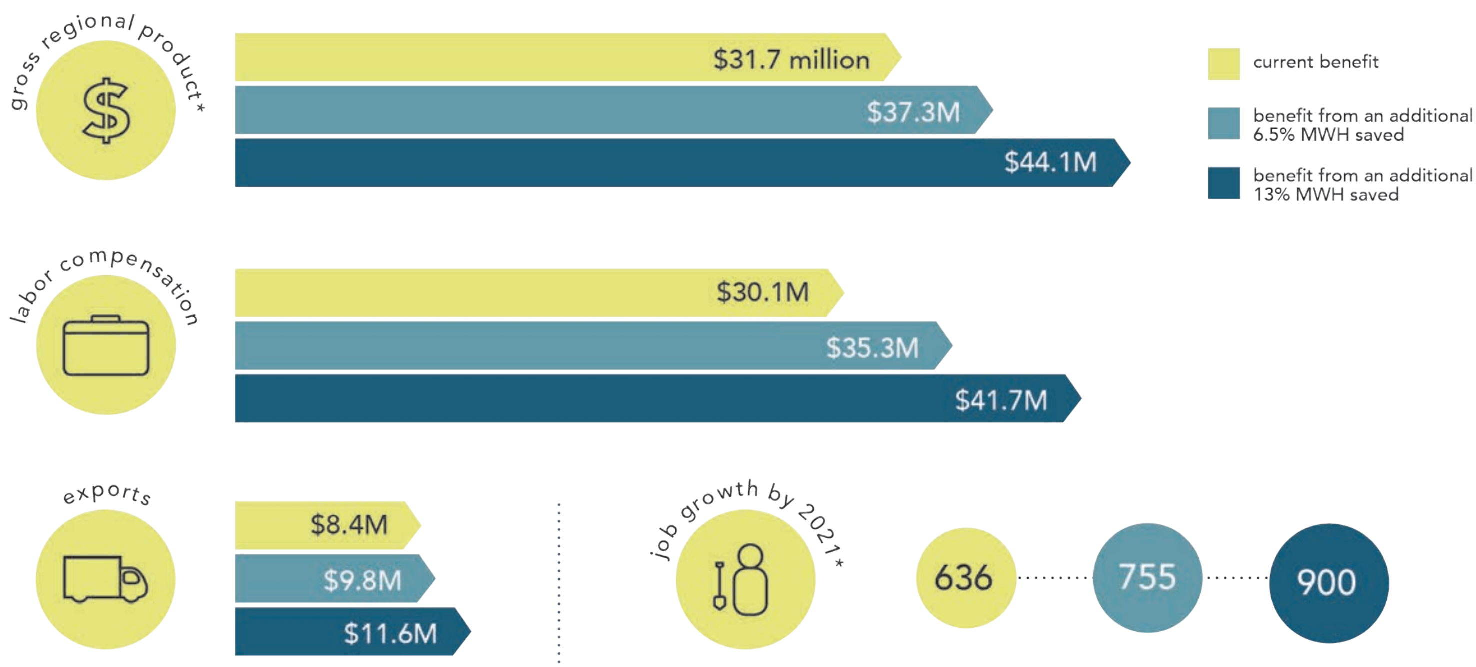
LONG-RUN MACROECONOMIC EFFECTS OF ENERGY-BILL SAVINGS

The second analysis measures the potential cumulative effects of energy efficiency on the broader economy between 2015-2021. Utility bills are lower when homes, farms, and businesses are more energy efficient. In turn, this frees up money, which businesses and households can then spend elsewhere.

We assume that some of that new business and household spending would occur in Washington, which triggers new economic impacts. These annual effects are reported in Figure 3. Like the short-run analysis, these results represent net impacts. In this case, the net impacts represent what the impacts would be if the money saved on energy costs were spent in the broader economy.

Additionally, ECONorthwest estimates what the impact of two alternative scenarios would mean for Washington. While these scenarios are meant to be illustrative, they estimate what higher savings targets in electricity and natural gas could mean for the broader regional economy.

Figure 3. Long-Run Macroeconomic Effects of Energy Bill Savings



These results represent "net" impacts of energy bill savings on the broader economy.

Literature about projected savings on a statewide level is scarce. Studies primarily focus on the potential decrease in energy consumption, given a specific set of efficiency policy initiatives.

This analysis does not consider specific policy changes, but rather, the alternative levels of energy savings are intended to illustrate outcomes at higher *growth rates* in energy savings than the state is currently achieving—the scenarios are not predictions about the actual amount of likely savings.

Related literature estimates between a 2.5 and 7.1 percent savings increase annually,[3] and a total future savings increase, by 2025, of between 12 and 126 percent.[4] Historic Washington State data show a long term trend of 6.2 percent growth over the past three decades. Although, recent trends in the state show much slower growth—1 percent over the past ten years.[5] In addition, regional data show 13 percent annual increases in megawatt savings from 2002 to 2013.[6] The scenarios in this analysis bookend future savings estimates as follows:

- **Scenario 1: Current.** This scenario assumes the current level of savings from energy efficiency measures remains unchanged in the future.
- **Scenario 2: Medium.** The medium scenario is a 6.5 percent increase in annual bill savings. This represents half of the 13 percent increase, and is close to the long term trend of 6.2 percent. This translates to an almost 50 percent increase in energy efficiency savings by 2021.
- **Scenario 3: High.** This scenario is a 13 percent increase in annual savings. This is the high scenario because the gains to savings will be more and more difficult to achieve and at some point the savings will taper off (and stop increasing at an increasing rate). Under this scenario, by 2021, energy efficiency savings will be double its current level.

BACKGROUND

Currently, the utility industry uses benefit-cost tests to assess energy efficiency potential and help establish the magnitude of their incentive payments. These tests are a way of ensuring that conservation efforts are cost-effective, reliable, and feasible. The total cost of installing energy efficiency measures (for the customer and the utility), including administrative and program expenses, must be generally less than what the utility would have had to pay to secure the alternative. That alternative is known as the avoided cost. It is the marginal cost of power generation and distribution of energy from conventional power plants and natural gas lines.

Effectively, a utility satisfies the needs of its customers by delivering energy to them. If the customer can get the same satisfaction installing efficiency measures instead, and do so at a total cost less than the avoided cost, then *both* the utility and consumer benefit. The utilities assess measures and, in the case of investor-owned utilities, the public utility commissions ensure the cost-effectiveness of the programs. Traditional benefit-cost analyses are narrowly focused on identifying any net benefits of a *specific* program or policy—however, there are also economy-wide benefits.

Benefit-cost analyses do not address the broader economic impacts and macroeconomic changes to a regional economy. Thus, benefit-cost tests, by design, understate the contribution of energy efficiency on long-term economic growth and employment. This report, however, addresses these important economic benefits.

ECONorthwest built two models of Washington State, one using IMPLAN and another using REMI software. NEEC provided average annual spending data on energy efficiency products and services put into place in Washington between 2008 and 2012. ECONorthwest used the spending data, along with data from the U.S. Department of Energy and other government sources, in the economic models.

SHORT-RUN ECONOMIC IMPACT ANALYSIS

ECONorthwest determined the gross and alternative economic impacts of electric and natural gas energy efficiency measures in Washington State. The difference between the two is the net economic impact.

> The Northwest Energy Efficiency Council is an association of businesses that provides energy efficiency products and services to the residential, commercial, industrial, and agricultural sectors.
>
> Examples of the energy conservation measures that NEEC members provide include better insulation and windows for homes, the design of more efficient retail space, software that enhances office-building operations, the installation of more efficient air conditioning, and the replacement, in businesses and factories, of old natural-gas furnaces with more effective and efficient ones. These conservation efforts are paid for by consumers, often with financial incentives from utilities.
>
> ECONorthwest is an economic consulting firm established in the Pacific Northwest in 1974. The company's 40-plus professionals have worked on projects for power producers, consumers, and regulators in Oregon, Washington, California, and elsewhere.

ECONorthwest calculated impacts by industry and reported them as sector subtotals: commercial, industrial, and agriculture. We also calculated impacts of households, as utilities direct energy savings efforts towards owners of homes and multifamily housing. These are collectively reported as impacts on the residential sector.

Investment Spending and Alternatives

Utilities and utility customers buy energy efficiency goods and services in Washington, which triggers economic impacts. These are gross impacts. Calculating their net impact requires first estimating the alternative case.

The alternative case to making energy efficiency investments is what would have happened had people and businesses not spent their money on efficiency measures. Money would have been diverted to other uses, including spending in Washington, as well as savings and spending outside the state. The in-state spending would cause economic impacts in Washington.

The net impacts are the gross impacts minus the alternative case: In other words, the change in total jobs, output,[7] and incomes in Washington caused by directing spending towards energy efficiency efforts, as opposed to other uses.

Table 1: Annual Washington Energy Efficiency Measure Spending, in 2015 Dollars by Sector

Sources of Direct Gross Impacts by Utility Type, Millions, Values in 2015 $	Residential Sector	Commercial Sector	Industrial Sector	Agricultural Sector	Total of All Sectors
Electricity					
Total Resource Cost of Installation:					
Paid by Utilities	$86	$82	$39	$9	$214
Paid by Utility Customers	$96	$90	$43	$10	$239
Spending on Energy Efficiency	$182	$171	$82	$18	$453
Natural Gas					
Total Resource Cost of Installation:					
Paid by Utilities	$11	$11	$5	$1	$28
Paid by Utility Customers	$14	$13	$6	$2	$35
Spending on Energy Efficiency	$25	$24	$11	$3	$63
Combined Electric & Natural Gas					
Total Resource Cost of Installation:					
Paid by Utilities	$97	$92	$44	$10	$242
Paid by Utility Customers	$110	$103	$50	$11	$274
Spending on Energy Efficiency	$207	$195	$93	$21	$516

Sources: The NEEC collected data from utilities and the BPA. ECONorthwest calculated annual customer savings by multiplying units of energy saved by the average price by sector as reported by the Energy Information Administration, U.S. Department of Energy.

Table 1 lists efficiency measure spending by sector for the average year. The impacts of energy efficiency efforts are based on these figures. They show $516 million spent on such measures, including program costs, throughout Washington per year. Of this, $453 million went to conservation measures for electric usage and $63 million for natural gas. Investor-owned electric and natural gas utilities, utility customers, and public-energy providers, such as the BPA and local utility districts, all share in the costs of energy efficiency projects. On average, between 2008 and 2012, about 90 percent of all the spending went directly towards installation and design work. The remainder went to program administration.

In all of the report tables, values are expressed in millions of 2015 dollars and jobs are reported as full-year equivalents. Only the impacts occurring inside the State of Washington are counted in these tables.

The gross direct output in Washington, as shown on Table 2, is the same $516 million shown under total spending for all sectors on Table 1.

In Washington, the $516 million in direct output rippled through the state economy, causing indirect and induced impacts. The sum of these, or total economic output from energy efficiency work, is $932 million. This supported the equivalent of 7,577 full-year jobs with a total compensation of $470 million. That is more than $62,030 per job in wages and benefits. The total value added or state GRP attributable to this investment activity was $614 million. Those were the combined gross economic impacts from electric and natural gas energy efficiency program spending.

The alternative case answers the "what-if" question. Had there been no such investment spending during the year, where would those dollars have gone and how much would have been spent in Washington? ECONorthwest looked at the savings patterns of commercial, industrial, residential, and agricultural sectors.

Using the spending functions of IMPLAN, which are based on data collected in Washington, we find that approximately $0.67 of every dollar not spent on installation efforts would have been spent on buying goods or services within Washington. That spending would have caused economic impacts. The other $0.33 would have been spent outside of Washington, saved, or used to pay off debt.

In other words, had the $516 million spent on energy efficiency not been used for that purpose, households, businesses, and farms would have spent most of the money elsewhere.

Table 2: Gross, Alternative, and Net Economic Impacts of Energy Efficiency Investment Spending in Washington

Total Energy Efficiency Investment Spending Impacts by Type, Values in 2015 $	Gross Impacts of Energy Efficiency Spending	Minus the Opportunity Cost (In-State Spending Alternative)	Net Impact of Energy Efficiency Installation
Direct Impacts:			
Output (millions)	$516	-$345	$171
Value-Added or GDP (millions)	$388	-$249	$139
Labor Income (millions)	$304	-$118	$186
Jobs (full year equivalents)	4,405	-2,348	2,057
Indirect Impacts:			
Output (millions)	$131	-$103	$28
Value-Added or GDP (millions)	$111	-$61	$50
Labor Income (millions)	$69	-$36	$33
Jobs (full year equivalents)	1,254	-624	630
Induced Impacts:			
Output (millions)	$285	-$120	$165
Value-Added or GDP (millions)	$115	-$78	$37
Labor Income (millions)	$98	-$42	$56
Jobs (full year equivalents)	1,918	$798	1,120
Total Impacts:			
Output (millions)	$932	-$568	$364
Value-Added or GDP (millions)	$614	-$389	$225
Labor Income (millions)	$470	-$196	$275
Jobs (full year equivalents)	7,577	-3,770	3,807

Sources: ECONorthwest IMPLAN analysis of data from the NEEC and others.

About $345.4 million would have generated economic output inside Washington and triggered indirect and induced impacts. Total output arising from this spending would have been $568 million. So, the net impact of energy efficiency investment spending on total output is $364 million (gross output of $932 million minus the alternative case of $568).

Overall, the net economic impacts are substantial. The GRP is $225 million higher. There would be $275 million more in labor income and a net increase of 3,807 full-year equivalent positions. A reason why the net impacts are positive is because energy efficiency spending, along with local and labor-intensive installation work, all occur within the state. IMPLAN does account for equipment and materials that installers import from out of state, and this does mute the gross indirect impacts, but not to the degree that total indirect impacts fall below zero.

MACROECONOMICS OF ENERGY EFFICIENCY PROGRAMS

Macroeconomic effects include productivity improvements, reductions in production costs, lower prices, higher standards of living, capacity expansions, and competitive gains for the statewide economy.

Improving energy efficiency contributes to productivity. It is possible to spend so much more on capital to promote energy efficiency that total factor productivity falls rather than rises. However, we assume economic agents (businesses, farms, and households) on average only engage in energy efficiency measures if they do indeed yield net savings and therefore enhance their overall productivity.

The following section explains how and why these macroeconomic effects occur.[8]

AGGREGATE MEASURES OF LONG-RUN ECONOMIC PERFORMANCE

Policies encouraging energy efficiency affect the economy in the long run. They do so by causing changes in the behaviors of consumers and industries, causing price shifts, and changing the structure of the economy. Changes like these alter the economy in total, as measured in macroeconomic aggregates. This report focuses on three macroeconomic aggregates, which reflect both the health of a region's economy and welfare (or general well-being) induced by this economic health.

First is real gross regional product (GRP), a broad gauge of economic activity in a region. Real GRP may also be identified with the total income generated within a region.[9]

Second is the median real wage rate for workers in a region. This measure refers to the amount of output the median worker in a region is able to produce in a set amount of time or given a fixed amount of inputs—the worker's productivity.

Third is the unemployment rate, which, together with the rate of job creation, provides a measure of the health of a region's labor market.

None of these measures are static over time. Indeed, because GRP and the median real wage rate grow over time, a long-run macroeconomic analysis is inherently concerned with the rates of growth, or trends, in these measures.

THE THEORY OF THE AGGREGATE MEASURES AND THEIR TRENDS

A necessary prerequisite for our assessment of energy efficiency programs is an understanding of the relationships between the aggregate economic measures identified above.

GRP is an important metric, in that it represents the long-run growth rate of output per capita, or how the ratio of GRP to the population grows over time. This growth rate stems from the rate of technological progress in a region.[10] The rate of technological advance derives (in part) from innovation and the creation and application of new ideas.[11] Importantly, the link between the growth rates of per capita GRP and technological progress means that an increase in the rate of technological advance also increases the long-run growth rate of output per capita.

In the long run, labor productivity, or real wage, drives firms' demand for labor: firms will hire more workers until the real productivity of the most recent hire is equal to the real wage of laborers in the labor market. As with the case of per capita GRP, the rate of technological progress partially drives the growth rate of labor productivity.[12] Consequently, as technological advance increases labor demand, both real wage and employment levels also rise in the long run.[13]

The unemployment rate is best understood by Okun's law, which summarizes the complicated interaction between changes in aggregate production and the labor market.[14] It provides a statistical relationship between short-run changes in economic growth and short-run changes in the unemployment rate. This relationship can be concretely quantified. Current estimates of Okun's law indicate that a 1.0% increase in the growth rate of the national GDP corresponds to a 0.4% reduction in the unemployment rate.[15]

No matter how much GDP is increased, the unemployment rate will never reach zero. The long-run (natural) unemployment always present in an economy is determined by two key variables: one is the action of participants in the labor market, the other is the nature of the long-run costs of production faced by firms. To illustrate the relationship between these factors, consider the effect of a reduction in the average cost of production of one additional unit of a good. This will increase the supply of that good, thereby stimulating labor demand and driving down the long-run unemployment rate.[16]

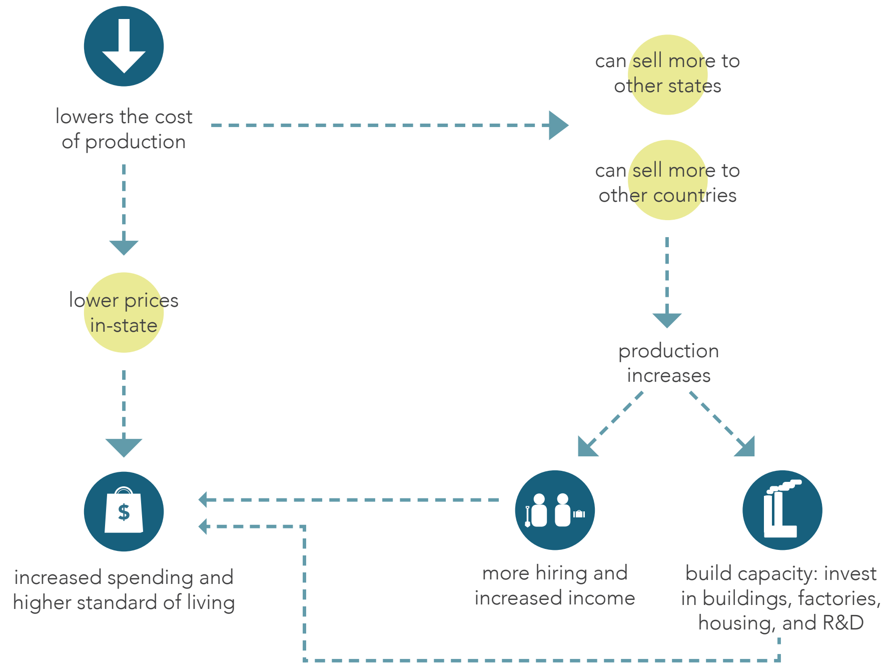
ENERGY EFFICIENCY PROGRAMS AS TECHNOLOGICAL ADVANCE

Linking energy efficiency programs to technological progress—and thus to the corresponding impacts of such progress on long-run aggregate trends—requires connecting the adoption of energy efficiency technologies to the more general notion of technological advance.

The current state of an economy's technology captures that economy's productive capacity. This is the maximum total amount of goods and services an economy is theoretically capable of producing. This capacity is modeled by a production possibilities frontier, which identifies all possible combinations of outputs that can be produced given available inputs. An efficient economy is on the boundary of this frontier: production of any one output cannot be increased without reducing the production of one or more other outputs. An inefficient economy is inside the frontier: an increase in production of some (or possibly all) outputs is possible without reducing the production of any outputs.

Technological advance may involve the adoption of existing technology. For this reason, it can be viewed as the movement of an inefficient economy toward its production possibilities frontier. Technological advance may also involve the creation of new technology. In this case, it can be viewed as the movement of an efficient economy along an expanding frontier.

Figure 4. Energy Efficiency as Technological Advance



The incorporation of both new and existing technologies into the production process is beneficial for several reasons. The learning-by-doing inherent in technological adoption encourages further innovation and technological advance.[17] Moreover, the specialization and modification gains made by adopters further lower production costs and increase efficiency. Ultimately, these expand an economy's productive capacity.

If energy efficiency programs are considered technological advances, the implementation of these programs will, in turn, lead to the adoption of technologies that increase energy efficiency. Under this assumption, it follows that energy efficiency programs:

- Move the economy toward the frontier by lowering production costs and allowing for the production of more output using the same inputs; and
- Expand the frontier through subsequent innovation and further technological advance.

Therefore, we can view energy efficiency programs as tangible representations, or animators, of technological progress.

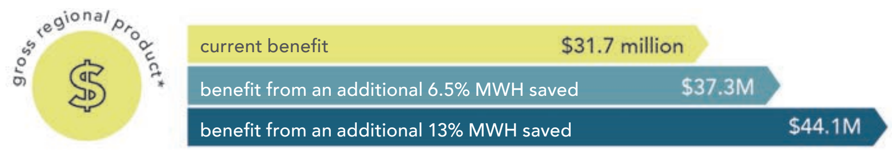
ENERGY EFFICIENCY PROGRAMS AND THE AGGREGATE MEASURES OF MACROECONOMIC PERFORMANCE

We have shown that energy efficiency programs increase the economy's productive capacity in two distinct dimensions: (1) by moving the economy toward the production possibilities frontier through direct efficiency gains; and (2) by expanding the production possibilities frontier through innovation. On the previous page, we detailed the mechanisms through which this increase in the economy's productive capacity—viewed broadly as raising the rate of technological advance—impacts the measures of long-run economic performance. From here, we can reach three primary conclusions regarding the relationship between energy efficiency programs and our aggregate measures of macroeconomic performance. Although the conclusions are mostly qualitative, the results from the REMI model are included to provide a magnitude of these effects. They are:

Gross Regional Product

Energy efficiency programs increase the long-run growth rate of GRP. The macroeconomic modeling suggests that in 2021, the high savings scenario results in a 0.005% higher rate of growth compared to the current scenario; this translates to $91.3 million in that year. Energy efficiency programs, when implemented, lower production costs and increase input productivity, meaning they increase per capita income. Personal income per capita increases by $5.40 under all three savings scenarios in 2015, but in the high scenario, it reaches $5.90, while under the current scenario, by 2021, per capita income is just $0.50 higher than the baseline. Real GRP rises as energy efficiency technologies and programs are adopted within a state or region.

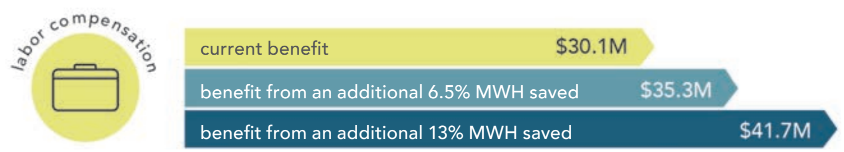
Figure 5. Gross Regional Product Impact Under the Three Savings Scenarios, Annual Average Difference from the Baseline (2015-2021)



Labor Impacts

Energy efficiency programs increase median real wages in the long run. Viewed as animating technological progress, energy efficiency programs improve long-run labor productivity. From an increase in labor productivity comes an increase in labor demand. And from an increase in labor demand comes higher equilibrium real wages.

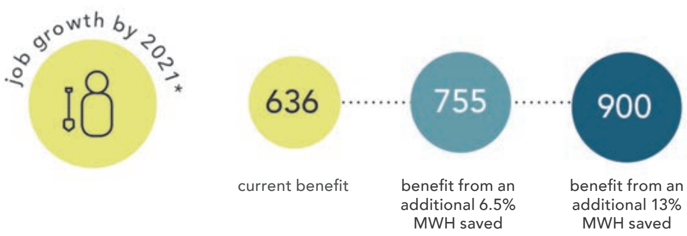
Figure 6. Total Labor Compensation Impact Under the Three Savings Scenarios, Annual Average Difference from the Baseline (2015-2021)



Jobs

Energy efficiency programs create jobs and lower the unemployment rate. The adoption of energy-efficient technologies moves the economy toward the production possibilities frontier. This means it creates short-run increases in the growth rate of GRP. These increases require more labor inputs, thus raising the employment level and lowering the short-run unemployment rate. The magnitude of the change in the unemployment rate is determined through Okun's law.[18] The simulations reveal that 542 more jobs each year, on average, are associated with high energy savings compared to remaining at the current level.

Figure 7: Job Impact under Three Savings Scenarios, Annual Average Difference from the Baseline, 2015-2021



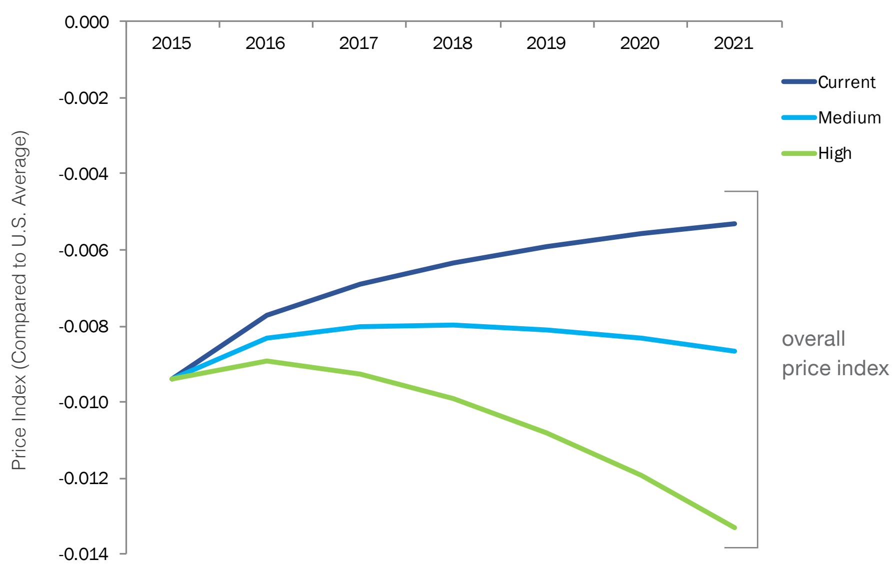
Furthermore, the adoption of energy efficient technologies (and the innovation they engender) lowers the long-run marginal cost of production. The result is increased labor demand and a lower long-run unemployment rate.

OTHER IMPACTS OF ENERGY EFFICIENCY PROGRAMS

There are other possible long-run macroeconomic impacts of energy-efficient technology that are not captured by our abstract analysis, such as:

- **Increased demand for highly-skilled workers, availability of energy-efficient residences, improved environmental conditions associated with reduced energy use, and the "warm glow" of living in an environmentally-conscious community** attract skilled laborers and raise the satisfaction of workers living in a region. Subsequently, this region becomes more attractive to firms requiring highly skilled labor.
- **Relative price changes reduce real income inequality.** The adoption of energy-efficient technology reduces the relative price of energy-intensive goods and services. Because less wealthy individuals spend a larger percentage of their income on necessities like energy,[19] this relative price change helps to mitigate real income inequality. This makes Washington more competitive versus the U.S. overall.
- **Induced innovation.** Precisely predicting the future path of technological advance is not possible; however, innovation involving energy production and use will be central to the future. The most successful regional economies will, by necessity, be at the frontier of energy innovation.
- **Resilience to exogenous energy price shocks.** Sharp rises in the real price of energy in the 1970s and from 2000 forward negatively affected real GRP growth and employment levels at the regional and national level. Reduced reliance on energy, both for production and consumption, will smooth the regional (and national) economy's response to future changes.

Figure 8. Overall Price Index Under The Three Savings Scenarios, Difference from the Baseline, 2015-2021



CONCLUSION: WHAT MACROECONOMICS TELLS US ABOUT THE LONG RUN EFFECTS OF ENERGY EFFICIENCY

The complexity of relationships (which change over time), the unpredictability of innovations and their effect on what we consume and how we produce, plus the paucity of historic data (which leaves us with estimates that have high standard-error levels), result in models that forecast the effects of energy efficiency (i.e., productivity) on the economy that are little more than an order-of-magnitude estimation. However, economists can look back and draw lessons from how economic welfare in the U.S. was affected by changes in energy productivity. The events of the 1970s prove informative.

ECONOMIC WELFARE AND GRP GROWTH

Economic welfare means the living standards, quality of life, and general well-being of people. There is no one measure of economic welfare, but real GRP per capita serves as a natural, if coarse, measure of average welfare.[20] Thus, economic welfare improves in a country when its real GDP per capita rises, or in a state when its real GRP per capita rises.

It is well known that while the average growth rate in real U.S. GDP per capita (over long time periods) is roughly constant, a significant decline was experienced in the 1970s and 1980s. Stanley Fischer estimates that the average annual growth rate of real U.S. GDP per capita from 1955 to 1973 was 2.0 percent, and that from 1973 to 1986, it was 1.3 percent.[21]

If this reduction in growth had been avoided, real GDP per capita would have been considerably higher in 1986. Under the hypothesized 2.0 percent growth rate, the average inflation-adjusted household income would have been more than 10 percent higher in 1986, than it was under the realized 1.3 percent growth rate.

The average American would have enjoyed a higher standard of living in 1986 had per capita real GDP continued to grow at the historic rate. Improving economic welfare comes with growing per capita real GDP. But why did real GDP growth slow between 1973 and 1986?

Explaining the slow-down in U.S. GDP growth in the 1970s and 1980s

In the short run, many types of macroeconomic shocks affect real GDP growth; however, many economists, including Fischer, attribute the 1973-1986 slowdown to a reduction in productivity growth. While the cause of this reduction remains a matter of some debate, the sharp rise in real energy prices in the 1970s is thought to be a significant contributing factor.

Dale Jorgenson[22] observed that real energy prices rose by 23 percent from 1973 to 1975 and by 34 percent from 1978 to 1980. He then conducted a sector-level empirical investigation and found that these rising prices resulted in lower productivity growth for 29 of the 35 industrial sectors he examined, which, he concludes, is more than sufficient to explain the decline in U.S. productivity growth.

The connection to energy efficiency

Increased energy efficiency allows for the production of goods and services at lower energy costs. The rise in real energy prices in the 1970s, then, may be interpreted as analogous to a decrease in energy efficiency.

To the extent that increases and decreases in energy efficiency have symmetric impacts on the economy, our examination of the U.S. experience in the 1970s and 1980s has a simple lesson: Increased energy efficiency leading to increased productivity growth will significantly raise average welfare.

APPENDIX: DETAILED METHODOLOGY

DATA SOURCES AND MODELS

As previously mentioned, NEEC asked that the analysis of investment impacts consider an average year of spending, and providing data for 2008 through 2012 (the most recent data available). This incorporates five years of spending by utilities and utility customers on energy efficiency products and services. We refer to this as the "average year" of investment spending. We estimate the portions paid by utilities and their customers. ECONorthwest uses IMPLAN 2012 Washington State data to estimate one year of investment impacts.

ECONorthwest uses the REMI macroeconomic model for Washington State to speculate the effects to the economy of projected savings from 2015 to 2021 using the three different savings scenarios: current, medium, and high. The alternative scenarios are based on the current savings and a set of specific assumptions to project future savings developed by NEEC and ECONorthwest. The model reports results compared to the standard control, or the difference in inputs versus the economic projections.

DESCRIPTION OF ECONOMIC IMPACT ANALYSIS

An economic impact analysis measures the effects of spending from an initial source and traces that spending as it flows through the economy.

Input-output tools take into account the countless links between different industries and consumers, as well as the diminishing effects of savings, taxes, and import purchases. Thus, knowing how much was spent in Washington on energy efficiency, these tools can tell us how many jobs those projects employed, how many workers suppliers employed, and so on. It also follows household spending arising initially from the wages and benefits of the employees involved with energy efficiency work.

Spending causes businesses to produce goods and services, also known as output. In addition, spending stimulates business income, self-employment income, and payroll earnings and benefits. Input-output models measure these.

The models trace how spending in one part of the economy creates work and output in other parts. That work, in turn, puts money in the hands of workers and business owners who buy goods and services from others, causing additional output and employment elsewhere. The models track these linkages between hundreds of industries and households.

These linkages measure the flows through the economy, which diminish because some spending and hiring goes out of state, some money is saved, not spent, and some is taxed rather than used for buying goods or services. So initial impacts multiply, but do not expand indefinitely. Further, since these tools use census data, the strength of linkages within a state and between households of various income levels are considered, making the model a fair estimator of what actually happens in the inner workings of local economies.

When run through their logical conclusion, input-output models measure the total effects, or impacts, in terms of the jobs, income, output, value added, etc.

Different models are built to examine changes in the economy for different lengths of time. The IMPLAN model reports impacts for one year only, while the REMI model is built to consider impacts over time. As such, the results from the short-term impacts from one-off spending on energy efficiency installation come from IMPLAN, and the long-term impacts from energy efficiency bill savings are modeled in the REMI system. The REMI model solves for changes in one year before moving on to estimate changes in the economy over a longer period of time.

Limitations of the Analysis

Economic models portray the structure of the economy as it actually was. For instance, the models for this report use the most recent Washington State economic data available at the time of the analyses – 2012 for IMPLAN and 2015 for REMI. The value of using REMI to forecast future impacts of energy efficiency is that is allows for changes in demand, prices and production. IMPLAN cannot accommodate these dynamic changes due to large shocks in the economy.

Another limitation, one we address in this analysis, is that impacts are triggered by the size of initial spending. The more of it, the greater total impacts are. But higher spending is not always beneficial. For instance, overpaying for something causes higher economic impacts in total, but is not necessarily more beneficial as some of that spending may have created additional economic benefits in other parts of the economy.

Gross Versus Net Impacts

Energy efficiency investments involve hiring labor, buying materials and services, and paying for construction. We call the value of this work, and the jobs involved in it, gross direct impacts. They are direct because it is the direct installation work. They are gross impacts because it is the gross total of the work done.

To determine the net, or additional economic activity associated with energy efficiency, we need to understand the counterfactual, or alternative, scenario. That is, what would the economy have looked like if the energy investments had not been made?

By spending money on energy efficiency, you have less money to spend elsewhere in the economy. Had the energy efficiency investments not been made, some of that money would be spent on other goods and services in the regional economy. The economic impact of spending money elsewhere in the economy is the counterfactual. The gross impacts minus the alternative impacts equal the net economic impacts. Therefore, net impacts are less than gross impacts.

The American Council for an Energy-Efficient Economy published an overview of this concept.[23] It is an excellent example of measuring net impacts by deducting the alternative from gross impacts. ECONorthwest uses this methodology.

ENDNOTES

1. Total installation spending statewide in 2012 was within one percent of the 2008–2012 average. However, spending on specific subsectors of the economy fluctuate, so that taking a multi-year average produces a more reliable assessment of normal conditions.

2. GRP is the aggregate value of all the domestic production of goods and services done within a region or a state. GDP is the national equivalent for this measure.

3. Assessment of Electricity Savings in the U.S. Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010-2020).

4. The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings to 2025. January, 2013.

5. Northwest Energy Efficiency Council.

6. Energy Trust of Oregon.

7. Output is the gross value of production for an economic sector or industry.

8. Internal ECONorthwest document, Dr. Bruce McGough and Dr. Ed Whitelaw of the University of Oregon, with edits for clarity by Robert Whelan of ECONorthwest.

9. This measure is adjusted for inflation, as indicated by the modifier "real," which will always imply "inflation-adjusted" in economic contexts.

10. Solow, R.M. 1956. "A Contribution to the Theory of Economic Growth".

11. Romer, P. 1990. "Endogenous Technical Change".; & Romer, D. 2012. *Advanced Macroeconomics*. 4th ed. McGraw-Hill-Irwin: Boston, MA. Print.

12. The productivity of a given worker involves not only the technology available to the worker, but also the worker's skill level, or "human capital," which measures the worker's ability to apply that technology to production.

13. Romer, D. 2012. *Advanced Macroeconomics*.

14. Okun, A.M. 1974. "Unemployment and Output in 1974". *Brookings Papers on Economic Activity*. 1974 (2): 495-504.

15. Blanchard, O., & D. Johnson. 2012. *Macroeconomics*. 8th ed. Prentice Hall: Upper Saddle River, NJ.

16. Blanchard, O., & D. Johnson. 2012. *Macroeconomics*.

17. Romer, D. 2012. *Advanced Macroeconomics*.

18. Okun, A.M. 1974. "Unemployment and Output in 1974".

19. See, for example: Soytas, U., & Sari, R. 2003. "Energy Consumption and GDP: Causality Relationship in G-7 Countries and Emerging Markets". *Energy Economics*. 25.1.; Eden, Y., & Jang, J. "Co-integration Tests of Energy Consumption, Income, and Employment". *Resources and Energy*. 14.3.

20. Lucas, R. 1987. *Models of Business Cycles*. Cambridge: Oxford University Press. 1-47.

21. Fischer, S. 1988. "Symposium on the Slowdown in Productivity Growth." *Journal of Economic Perspectives*, 2(4): 3-7.

22. Jorgenson, D. 1988. "Productivity and Postwar U.S. Economic Growth." *Journal of Economic Perspectives*, 2(4): 23-41.

23. "How does energy efficiency create jobs?" American Council for an Energy-Efficient Economy. Fact Sheet. Available on-line at aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf