PART TWO
CHAPTER 5

Estimating the Economic Benefits of Energy Efficiency and Renewable Energy

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CHAPTER 5
Estimating the Economic Benefits of Energy Efficiency and Renewable Energy

ABOUT THIS CHAPTER

This chapter provides policy makers and analysts with information about a range of methods they can use to estimate the economic benefits of energy efficiency and renewable energy. It first describes the methods and key considerations for selecting or using the methods. The chapter provides case studies illustrating how the methods have been applied and then lists examples of relevant tools and resources analysts can use.

CHAPTER 5 CONTENTS

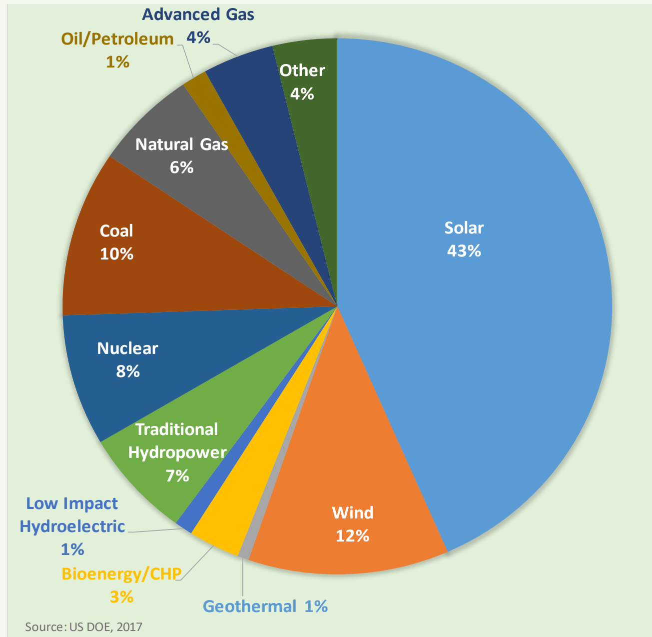
5.1. OVERVIEW

The benefits of cost-effective investments in energy efficiency and/or renewable energy can span the economy by lowering energy costs for consumers and businesses, increasing productivity for businesses, and creating jobs. According to the U.S. Department of Energy (U.S. DOE), the production, installation, and servicing of energy efficiency and renewable energy resources and technologies provide a growing number of economic benefits to and employment for millions of Americans (U.S. DOE, 2017; see Figure 5-1). Many state and local energy efficiency and renewable energy programs and policies are sustaining and enhancing these trends, generating numerous economic benefits along the way.

Quantifying the economic impacts of energy efficiency and renewable energy policies and programs can illustrate how the investments can spread economic value across the broader community. For example, a 2011 analysis of spending $44.4 million in a single future year on efficiency in Vermont results in a net increase of close to 1,900 jobs-years,[1] nearly $100 million in additional personal income, approximately $350 million in output, and $220 million in gross state product over the next 20 years. (For more information, see "Quantifying the Economic Benefits of Energy Efficiency Policies in Vermont" in Case Studies, Section 5.3.4.) Quantifying this type of information can help analysts and decision makers identify opportunities where meeting today's energy or environmental challenges can also serve as an economic development strategy.

This chapter is designed to help analysts and decision makers in states and localities understand the methods, tools, opportunities, and considerations for assessing the economic impacts of energy efficiency and renewable energy policies, programs, and measures. It is intended to help those who request analyses, those who conduct their own analyses, and those who review others' analyses to understand the types of questions to consider when planning, conducting, and/or reviewing an analysis. The range of methods and tools described is not exhaustive and inclusion of a specific tool does not imply EPA endorsement.

Figure 5-1: U.S. Electric Power Generation Employment in 2016, As a Percentage of Total, By Sub-Technology



As shown in Figure 5-1:

- U.S. solar employment in 2016 accounted for more than 350,000 jobs, or 43 percent of the electric power generation workforce—the largest share of workers in the electric power generation sector. This was an increase from 2015 levels by 25 percent.
- U.S. wind employment in 2016 represented just over 100,000 jobs, or 12 percent of the electric power generation workforce, an increase of 32 percent compared to 2015 numbers.

More than 2 million people were employed in the production or installation of energy efficiency products in 2016, a 7 percent increase from 2015 levels. Compared to expected growth rates in the electric power generation and the transmission, distribution, and storage sectors of 7 percent and 6 percent, respectively, solar and wind employment were expected to grow in 2017 by 7 percent and just under 4 percent, respectively, and energy efficiency was expected to grow by 9 percent in 2017 (U.S. DOE, 2017).

[1] Job-years are not the same as number of jobs. For example, 5 job-years can mean one job that lasts for 5 years or it can mean five jobs that last for 1 year. Additional information about jobs vs. job-years can be found in the box "Alternative Measures of Employment: Jobs vs. Job-Years vs. Wages."

5.2. APPROACH

Estimating the state- or local-level economic impacts of energy efficiency and renewable energy initiatives involves projecting likely changes in the flow of goods, services, and income, and then estimating the resulting economic benefits measured by key economic indicators, including employment, gross state product, economic growth, and personal income/earnings.[2] Economic impact models are used by many state agencies to measure the effects of energy efficiency and renewable energy policies (Sumi et al., 2003).

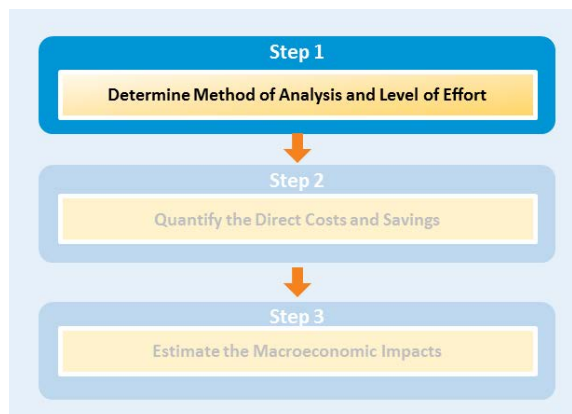
Figure 5-2: Steps for Analyzing the Macroeconomic Impacts of Energy Efficiency and Renewable Energy

An analyst typically follows several basic steps to analyze the economic impacts of energy efficiency and renewable energy initiatives:

1. Determine the method of analysis and level of effort, including the appropriate level of rigor and the desired level of detail about geographic and industrial sectors.
2. Quantify the direct costs and savings associated with the initiative.
3. Apply the costs and savings using the chosen method to estimate the macroeconomic impacts associated with the initiative.

Each of these steps, depicted in Figure 5-2, is discussed in greater detail below.

5.2.1. Step 1: Determine the Method of Analysis and Level of Effort



Several methods are available for quantifying the macroeconomic effects of energy efficiency and renewable energy initiatives. These methods range in complexity from applying basic rules of thumb for screening purposes to using sophisticated tools for dynamic modeling. Analyses may also involve multiple methods or models, such as the combination of an economic model with an energy model.

In selecting the most appropriate method or combination of methods, analysts can consider many factors, including time constraints, cost, data requirements, internal staff expertise, and overall flexibility and applicability. For example, a state or locality looking to quickly compare many policy options to get an approximate sense of their costs and benefits would select a different tool than one chosen by a state or locality interested in determining the sector-specific impacts of a particular policy or strategy. Consequently, it is useful for state policy makers to understand the basic differences between the broad types of available models and methods, their strengths and weakness, and their underlying assumptions. The following section introduces the foundational concepts associated with a range of methods and models that analysts can use to assess the state and local macroeconomic impacts of energy efficiency and

[2] *These indicators are described as benefits for the state and local-level analyses described in this chapter. For analysis of national regulations, some of these economic indicators may be described as either benefits, costs, or distributive impacts (Executive Order 12866, Federal Register Vol. 58, No. 190, 1993).*

renewable energy initiatives. It also describes some key considerations related to reviewing the baseline assumptions in any method chosen.

ALTERNATIVE MEASURES OF EMPLOYMENT: JOBS VS. JOB-YEARS VS. WAGES

Studies present employment estimates in terms of various measures of labor, including jobs, job years, and total wages. It is important to understand what a study is showing in terms of potential job impacts.

Sometimes employment-related results are presented as net jobs, jobs, job-years, or total wage income (or earnings):

- The term *jobs* is the least precise measure of labor: estimates of jobs typically do not distinguish between full-time and part-time employment, or by wages, benefits, or other details.
- If an analysis of an energy efficiency or renewable energy program refers to *net jobs*, it means the study factored in any job losses that may have occurred in non-energy efficiency or renewable energy-related sectors due to the policy (e.g., decrease in demand for coal) and presents the impacts on jobs after those losses have been subtracted from any increase.
- Estimates of *job years* include the time dimension, generally assuming a 40-hour week. For example, a study may predict the creation of 15 job years. Fifteen job years can mean one job that lasts for 15 years or it can mean 15 jobs that last for 1 year.
- Some approaches measure changes in terms of *total wage income* or *earnings*. This measure is more comprehensive, generally reflecting both time and labor market adjustments.

Table 5-1 lists the methods or models analysts can consider for different types of analysis. Table 5-2, later in the chapter, lists in greater detail the strengths and limitations of each method, along with key considerations for appropriate use.

Table 5-1: Types of Methods and Models and Their Typical Uses

States Might Consider This Type of Method or Model	For This Type of Analysis
Rules of thumb factors	High-level screening analysis
Input-output models	Short-term analysis of policies with limited scope and impact
Econometric models	Short- and long-term analysis of policies with economy-wide impact
Computable general equilibrium models	Long-term analysis of policies with economy-wide impact
Hybrid models	Short- and long-term analysis of policies with limited or economy-wide impact

Methods for Estimating Impacts

Rules of Thumb

Generic rules of thumb factors for economic impact analysis are simplified factors that represent relationships between key policy or program characteristics (e.g., financial spending, energy savings) and employment or output. They are typically drawn from other sources or analyses and provide first-order approximations of the direction (i.e., positive or negative) and magnitude of the impacts upon the economy. They require less precise data than those needed for more complex, dynamic models.

Table 5-2 lists a sampling of rules of thumb factors that states or national laboratories have developed, based on analyses of actual projects that can be used to estimate the income, output, and employment impacts of energy efficiency and renewable energy programs. For example, RTI International developed employment and energy savings factors for energy efficiency programs in North Carolina, where annual investments in clean energy increased twentyfold between 2007 and 2013. Through a retrospective analysis, the study was able to develop a high-

KEY CONSIDERATIONS WHEN PLANNING AN ECONOMIC ANALYSIS

- All methods involve predictions, inherent uncertainties, and many assumptions.
- The approach selected should match the question being asked. For example, simple tools should not be used to answer sophisticated, complex questions.
- The models, assumptions, and inputs used in the analysis should be transparent and well documented.
- Expert input on the analytic process and assumptions as well as expert peer review of the final results can enhance the credibility and usefulness of the analysis.

level relationship showing that for every $1 billion of investment in clean energy projects in North Carolina, up to 37,100 jobs (full-time equivalent) were supported and about 11 million Megawatt-hours (MWh) were saved (RTI, 2014). In this example, the analysis started with a large-scale assessment of the program's impacts and then simplified the results into output per billion dollars invested, creating rule of thumb factors that could be used in subsequent screening analyses. Additional information about these factors listed in the table can is available in Section 5.4., "Tools and Resources."

Table 5-2: Sample Rules of Thumb Factors for Estimating Income, Output, and Employment Impacts of Energy Efficiency and Renewable Energy Activities

Rule of Thumb Factor	Geographic Scope	Source
Type of Impact: Output		
$1 of spending on weatherization programs in Arkansas in 2009, generated a total of $2.09	Arkansas	Arkansas Advanced Energy Foundation, 2014. *http://www.arkansasadvancedenergy.com/files/dmfile/TheEconomicImpactofEnergyEfficiencyProgramsinArkansas.FINAL.pdf*
$1 spent on energy efficiency programs in Florida produces $1.9 value added	Florida	Southeast Energy Efficiency Alliance, 2013. *http://www.seealliance.org/wp-content/uploads/SEEA-EPS-EE-Report.pdf*
$1 spent on energy efficiency projects in North Carolina results in $1.67 in output	North Carolina	La Capra Associates, Inc., 2013. *https://www.rti.org/publication/economic-utility-portfolio-and-rate-impact-clean-energy-development-north-carolina-final*
Type of Impact: Employment		
$1 million dollars invested in residential and commercial energy efficiency generates about 11 jobs	National	Anderson et al. 2014. *http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23402.pdf*
$1 million spent on low-income weatherization yields 8.9 person-years of employment	National	Goldman, C. et al. 2010. *https://emp.lbl.gov/sites/all/files/presentation-lbnl-3163e.pdf*
$1 million saved on energy spending by retrofit building owners creates 6.5 direct jobs	National	Garrett-Peltier, 2011. *http://www.peri.umass.edu/fileadmin/pdf/research_brief/PERI_USGBC_Research_Brief.pdf*
$ 1 million spent on energy efficiency technology manufacturing and installation creates an average of 5.7 direct jobs	National	Garrett-Peltier, 2011. *http://www.peri.umass.edu/media/k2/attachments/PERI_USGBC_Research_Brief.pdf*
$1 million spent on commercial building retrofits generates 8.0 direct jobs	National	Garrett-Peltier, 2011. *http://www.peri.umass.edu/media/k2/attachments/PERI_USGBC_Research_Brief.pdf*
$1.04 billion in direct output from energy efficiency sector spending in Arkansas creates over 11,000 total full-time jobs	Arkansas	Arkansas Advanced Energy Foundation, 2014. *http://www.arkansasadvancedenergy.com/files/dmfile/TheEconomicImpactofEnergyEfficiencyProgramsinArkansas.FINAL.pdf*
$1 billion spent on renewable energy projects creates 37,100 full-time equivalents over a 7-year period	North Carolina	North Carolina Sustainable Energy Association, 2014. *http://www.rti.org/sites/default/files/resources/ncsea_2013_update_final.pdf*
$1 million spent on energy efficiency generates 18.5 jobs	Georgia	Southeast Energy Efficiency Alliance, 2013. *http://www.seealliance.org/wp-content/uploads/SEEA-EnergyPro3-Report.pdf*

When to Use

Rules of thumb factors are most applicable for use as screening-level tools for developing preliminary benefit estimates and for prioritizing potential energy efficiency and renewable energy activities. At the simplest level, rules of thumb provide rough approximations and can be used for quick, low-cost analyses of policies.

Strengths and Limitations

A key strength of rules of thumb factors:

- *Efficiency* and *convenience*, especially when time and resources are limited, or when many options are under consideration and limited resources are available to conduct advanced comparisons. For example, a state considering a lengthy list of energy efficiency or renewable energy options can use rules of thumb to help rank the candidates and create a short list of options that warrant further analysis. Rules of thumb are often derived from actual projects, can be broadly applied, and do not require significant project data or technical understanding.

Limitations of rules of thumb factors:

- *Fixed underlying* assumptions that may not currently apply. It is important to understand the assumptions and limitations inherent in a rule of thumb before using it. For example, rules of thumb may be based on outdated information, such as construction and material costs that have changed since the factor was derived.
- *Overly simplistic.* The simplicity of rule of thumb factors may mask important considerations, such as whether funds are likely to have come from elsewhere in the economy, shifting economic activity away from alternatives and toward energy efficiency and renewable energy activities.

Input-Output Models

Input-output models, also known as multiplier analysis models, can also be used to conduct analyses within a limited budget and timeframe, but provide more rigorous results than those derived from rules of thumb. Analysts can use these models to estimate the short-term economic impacts of their energy efficiency and renewable energy projects.

Input-output models depict relationships and interdependencies among industries in a state, regional, or national economy. At the core of any input-output model is an input-output table, which describes the flow of goods and services from producers to intermediate and final consumers. The input-output table in the most commonly used input-output models in the United States comes from national and regional public data sources such as the Bureau of Economic Analysis' national input-output table and regional economic accounts. Economic impacts in input-output models are driven by changes in demand for goods and services resulting from the policy being analyzed.

WHAT IS AN ECONOMIC MULTIPLIER ("RIPPLE EFFECT")?

A change in spending by governments, businesses, or individuals can have an impact on the overall economy that exceeds the original amount spent. The effect of the change in spending thus multiplies or ripples through the economy. For example, a boost in spending on energy efficient equipment can benefit the equipment manufacturers. Increased revenue for the manufacturers support investments by the manufacturers in equipment and labor to meet rising demand, make more sales, or install more equipment. This raises revenue for upstream equipment suppliers and increases worker earnings, which are then spent in different areas of the economy.

In economic analyses, an economic multiplier, usually expressed as a ratio, captures how much additional economic activity is generated in one industry from an expenditure (or change in demand) in another industry. It includes the initial direct economic impact of the stimulus (such as an increase in sales of energy efficient products above) as well as the indirect or ripple effects (such as expansions in manufacturing, sales, and installation jobs).

In input-output models, multipliers estimate the size of sector-specific indirect effects, as well as the economy-wide totals. Multipliers can be derived separately for employment, income, and economic output.

In Montana, for example, a study found that for each megawatt (MW) of renewable energy capacity added, small photovoltaic projects would add 9.2 jobs and large photovoltaic projects would add 5 jobs. Wind and energy efficiency projects would add 1.5 and 1.2 jobs, respectively, for each additional MW (Comings et al., 2014).

When to Use

Input-output models are most suitable for analyzing detailed sectoral impacts of regional, state, or local policies in the short term.

Strengths and Limitations

Key strengths of input-output models:

- *Ability to reveal high-level impacts*. They can quantify the total economic effects of a change in the demand for a given product or service.
- *Capture relationships and interdependencies*. They use a set of industry relationships that describe changes in employment, output, or income in one industry given a demand change in another industry.

Limitations of input-output models:

- *Static*. The multipliers derived from input-output models only represent a snapshot of the economy at a given point in time (i.e., they are static). Due to their static nature, input-output models generally assume fixed prices and do not account for substitution effects and changes in competitiveness or other demographic factors that occur over the longer run (RAP, 2005).
- *May overestimate employment impacts*. The absence of resource constraints or substitution effects over time means that input-output models tend to overestimate the employment effects of a policy (U.S. EPA, 2010).

Models for Comprehensive Analyses

Development and implementation of energy efficiency and renewable energy initiatives at the state level may require a more comprehensive analysis of the macroeconomic effects of alternative clean energy initiatives over time than what has been described up to this point. Although the approaches above are straightforward, and results can be produced relatively quickly, rules of thumb and input-output models may not provide the analytical rigor needed to evaluate long-term substantial investments in energy efficiency and renewable energy initiatives. Several well-established types of models, including macroeconometric models, computable general equilibrium models, and hybrid models, can be used to quantify more comprehensively the nature and magnitude of the economic effects of energy efficiency and renewable energy investments.

Macroeconometric Models

Macroeconometric models use mathematical and statistical techniques to analyze economic conditions both in the present and in the future. Macroeconometric models find relationships in the macro-economy and use those relationships to forecast how energy efficiency and renewable energy initiatives might affect income, employment, gross state product, and other common output metrics. For example, energy demand may be related to the price of fuel, the number of households, and/or the weather, but not to individual income levels. These models use historical data to project future outcomes.

Macroeconometric models are more complex than input-output models, as they include additional economic relationships beyond industry purchasing relationships. For example, macroeconometric models include representations of consumer and producer behavior, which allow these models to interpret the impact to the economy of changes in energy prices, changes to the production costs of an industry, or changes to household budgets.

Macroeconometric models generally have an aggregate supply component with fixed prices, and an aggregate demand component. Regression coefficients within the models' equations describe how one component of the economic system changes in response to a change in some other component of the economic system. Most macroeconometric models use a combination of coefficients, some of which are estimated from historical data, and others that are coefficients obtained from other sources.

When to Use

Macroeconometric models can be used for both short- and medium-term analyses where there is need for more sectoral and regional detail than can be provided by input-output models or rules of thumb.

Strengths and Limitations

Key strengths of macroeconometric models:

- *Dynamic capabilities*. They can estimate the effects of state or local policy impacts over time.
- *High level of detail and flexibility*. Macroeconometric models are based on an overarching economic theory but can have thousands of equations estimating the relationships between different economic variables using historical data. As a result, the level of detail they can achieve is much higher than that of computable general equilibrium (CGE) models (see below), which are restricted by using model equations derived from economic theory.
- *Data-driven, rather than theoretical, assumptions*. They are not restricted by some of the potentially unrealistic assumptions in many CGE models, such as perfect competition, complete foresight, or rational economic behavior.

A major limitation of macroeconometric models:

- *Heavy reliance on historical data as the pattern for future behavior*. As a result, the projected future behavior may be unrealistic because it neglects changes in consumer and business conduct or investments that may occur when future policies and price changes are anticipated. For example, if a state carbon policy standard were proposed today for implementation in 5 years, one might expect that firms would begin making decisions about investments in energy sources and carbon-efficient technology that would prepare them for when the mandatory provisions take effect. This limitation leads to macroeconometric models being best suited for short and medium-term length analyses.

Computable General Equilibrium and Hybrid Models

CGE models use equations derived from economic theory to trace the flow of goods and services throughout an economy and solve for the levels of supply, demand, and prices across a specified set of markets. CGE models use a framework based on the tenets of microeconomic general equilibrium theory: when the baseline equilibrium is shifted by, for example, an energy efficiency or renewable energy tax incentive, a new market equilibrium is created. This new equilibrium includes prices and output adjustments throughout the economy. In this way, CGE models can be useful for assessing the economy-wide impacts of an energy efficiency or renewable energy policy.

CGE models fall into two broad categories: static and dynamic. Static models lack a time element. They compare two "equilibrium" conditions, one before the policy and one after. The adjustment period could be weeks or, for large policy changes, decades. Dynamic models trace each variable over time (e.g., from policy initiation through each of the 10 subsequent years) and more explicitly capture interactions and complex relationships in the market. Static models are simpler to run but potentially less informative.

CGE models are calibrated using data from a Social Accounting Matrix, which is an extension of an input-output table that includes additional information such as the distribution of income and the structure of production. Unlike input-output models, CGE models are able to account for substitution effects, supply constraints, and price adjustments in the economy snapshot.

Hybrid models typically combine aspects of CGE modeling with those of macroeconometric models, and may be based more heavily on one or the other. They are able to achieve a high level of detail through many econometrically derived equations while retaining the consumer and producer theoretical components of CGE models. As a result, they can be complicated and expensive models to use.

When to Use

CGE models estimate what the economy will resemble in the new "steady state," or equilibrium, once all impacts of a policy or program have been fully realized. CGE models are thus best used for long-term analyses: they may not accurately depict the impacts an economy experiences on its way to the new equilibrium. Particularly when compared with a static CGE model, which only looks at a snapshot in time, macroeconometric models are typically better at capturing interim economic changes that will occur between the policy stimulus and the new equilibrium. Hybrid models are able to combine the best aspects of both CGE and macroeconometric models, and can depict pathways to a new equilibrium.

Strengths and Limitations

Strength of CGE models:

- *The theoretical foundation.* This provides an advantage in estimating the long-term impacts of policies because economic theory has been developed over hundreds of years of research in a variety of conditions.

Limitations of CGE models:

- *Limited availability for* subnational *analysis.* They are more readily available at the national level than at the state level, and most CGE models are highly aggregated. Some state agencies, however, have developed and/or used state-specific CGE models to analyze the impacts of energy efficiency and renewable energy initiatives.[3] State-level CGE models are often developed by universities, private consulting firms, or nonprofit organizations. In California, for example, the University of California at Berkeley developed a dynamic CGE model, the Berkeley Energy and Resources (BEAR) model.
- *Limited energy sector representation*. It is important to examine how the energy sector is treated within any specific CGE model. Although it may allow for substitution effects, it may not include an option for consumers or firms to switch to renewable energy or energy efficiency as a way to meet energy demand. Individual models will handle this differently depending upon the details (e.g., number of sectors) of the model (For more information, see the box "The Importance of Accurate Energy Data and Representation" below).

Hybrid models have the advantage of having the strong theoretical foundations of a CGE model combined with the greater detail of macroeconometric models. In addition, they are able to perform well in both the short and long term. The drawbacks to hybrid models are that they tend to be more of a "black box" (i.e., they do not readily reveal the internal mechanisms that underlie relationships depicted in the model) due to their complexity, and they tend to be the most expensive model type.

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[3] RTI International developed a CGE model (the Applied Dynamic Analysis of the Global Economy [ADAGE] Model) that can be used to explore dynamic effects of many types of energy, environmental, and trade policies, including climate change mitigation policies. For more information on CGE models and their application for macroeconomic impact analysis, see Sue Wing (2004).

Comparison of Models Commonly Used to Assess Energy Efficiency and Renewable Energy Initiatives

Table 5-3 summarizes key aspects of the most common methods and some sample models that are used for energy-related policy analyses.[4] State or local analysts may find this information useful in determining which model will best suit the needs of their particular analysis.

Table 5-3: Methods and Models for Quantifying Economic Impacts of Energy Efficiency and Renewable Energy Initiatives

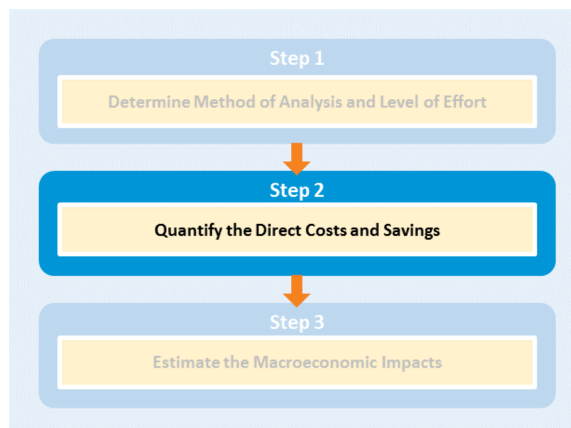
Type of Method	Strengths	Limitations	Typically Used For	Sample Tools or Resources[a]
Rules of Thumb	▪ May be transparent ▪ Require minimal input data, time, technical expertise, and labor ▪ Inexpensive, often free	▪ Overly simplified assumptions ▪ Approximate results ▪ May be inflexible ▪ Assume linearity in effects: e.g., if $1 million creates 10 jobs, then $1 billion will create 10,000 jobs	▪ High-level, screening analyses when time, budget, and technical expertise are limited	▪ Rules of thumb (e.g., impact per kWh, MMBtu or dollars spent as shown in Table 5-2)
Input-Output Models	▪ Can be inexpensive to purchase and to run ▪ Provide rich sectoral detail based on North American Industry Classification System ▪ Can be used to model regional interactions ▪ Can be linked to sophisticated energy models	▪ Assume fixed prices and wages (i.e., they do not account for price and wage changes that may result from increased demand) ▪ Typically do not account for substitution effects, opportunity costs, supply constraints, and changes in competitiveness or demographic factors ▪ Assume linearity in effects (see rules of thumb above)	▪ Short-term analyses ▪ Policies with limited scope and impact	▪ DEEPER ▪ IMPLAN ▪ Job and Economic Development Impact (JEDI) Model ▪ REAL models ▪ RIMS II
Macroeconometric Models	▪ Usually dynamic; can estimate and/or track changes in policy impacts over time ▪ Highly detailed due to the large number of equations that can be statistically estimated ▪ Can account for substitution effects, supply constraints, wage effects and price effects ▪ Can be used to model regional interactions	▪ Historical patterns may not be best indicator or predictor of future relationships ▪ Some do not allow foresight (i.e., the model assumes society does not plan for policies), leading to potentially unrealistic projected impacts	▪ Best used for short- and medium-term analysis; dynamic models with foresight are best for long-term analyses ▪ Generally, most appropriate for policies with economy-wide impact ▪ More comprehensive estimates of cost and benefits than those provided by simpler models	▪ ADAGE ▪ Cambridge Econometrics E3ME ▪ EViews ▪ IHS Markit Global Link ▪ Oxford Economics' Global Economic Model

[4] *Based on the sample of state analyses listed at the end of this report.*

Type of Method	Strengths	Limitations	Typically Used For	Sample Tools or Resources[a]
Computable General Equilibrium (CGE) and Hybrid Models	▪ Account for substitution effects, supply constraints, and price adjustments ▪ Strong theoretical foundations ▪ Can be used to model regional interactions ▪ Hybrid models can achieve high levels of detail	▪ CGE models are not widely available at state level and, when available, often are static or highly aggregated ▪ Energy sector may not allow for fuel substitution (e.g., may not include renewables) ▪ May not be feasible or practical to use when data and resources are limited ▪ Hybrid models can be cost-prohibitive	▪ CGE models best suited for long-term analysis; hybrid models able to perform in short- and medium-term as well ▪ Generally, most appropriate for policies with economy-wide impact	CGE: ▪ ADAGE ▪ BEAR ▪ ENERGY 2020 ▪ ILIAD and LIFT ▪ IPM® ▪ ReEDS ▪ STAMP Hybrid ▪ REMI Policy Insight+

[a] *For more information, see Section 5.4., "Tools and Resources" for Step 1.*

5.2.2. Step 2: Quantify Direct Costs and Savings from the Energy Efficiency or Renewable Energy Initiative



The second step in analyzing state- or local-level macroeconomic effects is to quantify the direct costs and savings from implementing the energy efficiency or renewable energy initiative. These direct costs and savings will serve as the primary inputs to the analysis (in Step 3) to quantify the macroeconomic effects on income, employment, and output. The specific expenditures and savings that analysts need to consider in this step may vary, but they generally include estimates of energy cost savings associated with the initiative, along with data on costs spent by participating entities to administer the program. An important element of this step is to review the baseline assumptions used in the model or method chosen to quantify costs and savings, to ensure they are reasonable for the analysis.

What Are the Direct Costs and Savings?

Part One of this *Guide*, "The Multiple Benefits of Energy Efficiency and Renewable Energy," describes the direct effects of state and local demand-side (e.g., energy efficiency) and supply-side (e.g., renewable energy) initiatives. These costs and savings will serve as inputs to the economic analysis.

Demand-side energy efficiency initiatives lead to direct costs and savings, including:

- *Household and business costs:* Costs for homeowners and businesses to purchase and install more energy-efficient equipment. For policies supported by a surcharge on electric bills, the surcharge is an included cost.
- *Program administrative costs:* Dollars spent operating the efficiency initiative—including labor, materials, and paying incentives to participants.
- *Energy cost savings:* The money saved by businesses, households, and industries resulting from reduced energy costs (including electricity, natural gas, and oil cost savings), reduced repair and maintenance costs, deferred

equipment replacement costs, and increased property values. Energy cost savings are typically reported in total dollars saved.

- *Sector transfers:* Both the increased flow of money to companies that design, manufacture, and install energy-efficient equipment and the reduced flow of dollars to other energy companies, including electric utilities, as demand for electricity and less-efficient capital declines.

The direct costs and savings of renewable energy, combined heat and power (CHP), and distributed generation (DG) initiatives include:

- *Construction costs:* Money spent to purchase the renewable energy, CHP, and DG equipment; installation costs; costs of grid connection; and onsite infrastructure construction costs (such as buildings or roads).
- *Operating costs:* Money spent to operate and maintain the equipment during its operating lifetime and the cost of production surcharges applied to consumers.
- *Program administrative costs:* Money spent operating the initiative—including labor, materials, and paying incentives to participants.
- *Displacement savings:* Money saved by utilities from displacing traditional generation, including reducing purchases (either local or imports) of fossil fuels and lowering operation and maintenance costs from existing generation resources.
- *Waste heat savings:* Savings accrued by utilities or other commercial/industrial businesses that use waste heat from CHP for both heating and cooling.

Additional savings, in the form of avoided costs, can occur under both demand-side and supply-side initiatives and can be used as inputs to an economic analysis. These avoided costs include, but are not limited to:

- *Avoided health-related costs*: Energy efficiency and renewable energy policies that reduce criteria air pollutants can improve air quality and avoid illnesses and deaths, as described in Chapter 4, Quantifying the Emissions and Health Benefits of Energy Efficiency and Renewable Energy. Fewer illnesses mean fewer sick days taken by employees or students, better productivity, and fewer hospitalizations associated with respiratory illnesses and cardiac arrest. These impacts can result in fewer lost wages and lower medical expenditures. Fewer worker deaths can result in continued economic benefits to the state
- *Avoided electricity system-related costs*: Energy efficiency and renewable energy initiatives can result in avoided capacity or transmission and distribution (T&D) costs to the electricity generators and/or distributors, as described in Chapter 3, Assessing the Electricity System Benefits of Energy Efficiency and Renewable Energy. Energy efficiency and renewable energy initiatives that reduce in criteria air pollutants can reduce the costs of complying with air quality standards when compared to more expensive technological options (e.g., scrubbers).

Some studies have monetized other benefits, including avoided environmental damages from CO_2 or economic benefits from avoiding electricity bill arrearages. The box below, "Quantifying the Economic Value of Energy Efficiency to Enhance Cost-effectiveness Assessments," describes one study conducted for the state of Maryland.

QUANTIFYING THE ECONOMIC VALUE OF ENERGY EFFICIENCY TO ENHANCE COST-EFFECTIVENESS ASSESSMENTS

EmPOWER Maryland is a state-wide energy efficiency initiative that was created by the legislature initially to reduce energy consumption by 15 percent by 2015. Participating utilities must evaluate their energy efficiency programs to ensure they are cost-effective. A study by Itron, Inc. (Itron, 2015) developed estimates of selected non-energy impacts (i.e., costs and benefits that are not related just to the utility) that could be included in a cost-effectiveness analysis of the program. The study analyzed four impacts: air emissions, comfort, commercial operations and maintenance (O&M), and utility bill arrearages (i.e., unpaid bills; this measure would be used to assess the cost-effectiveness of EmPOWER Maryland's low-income programs).

Itron assessed the feasibility of incorporating air emissions as an environmental externality into costs. The study calculated dollar damages per kWh, broken down by damages associated with NO_x, SO_2, and CO_2 emissions, for differing levels of emission reductions achieved by EmPOWER programs. It also calculated unit damage costs and hidden costs in the form of human health effects. Itron found that EmPOWER programs saved 1.1 cents per kWh in 2013 (with a range of 0.2 to 2.9 cents depending on the scenario considered) by reducing NO_x, SO_2, and CO_2 emissions.

The study quantified and monetized comfort benefits using a model created for an energy efficiency program in Massachusetts that was comparable to EmPOWER residential programs. It quantified comfort benefits through a survey that asked participants to value the comfort impacts of energy programs relative to bill savings. Applying this simple model, Itron determined that a comfort benefit of $136 should be applied to every participant in the EmPOWER program.

The study inventoried potential sources of O&M benefits, such as occupancy sensors and lamp replacements. Itron calculated labor hours, wage rate, and cost per lighting replacement and occupancy sensor, concluding that if these programs were included into the existing benefit-cost ratios the benefits would increase by up to 13%.

Finally, the study estimated benefits associated with avoiding arrearages. Utilities can reduce arrearages by offering programs that reduce customers' energy bills, making them more affordable for customers (particularly low-income customers). Based on the most recent available data, Itron found that EmPOWER low-income program participants saved an average of $253 annually, which translates (using a 5% discount rate) to a lifetime arrearage financing benefit of $55 per participant or 2% per kWh saved over the life of the energy efficiency measures.

The authors of the study concluded that all four non-energy related areas should be incorporated into cost-effectiveness calculations for the EmPOWER Maryland program, as they identify real costs and benefits associated with operating the program.

In July 2015, the Maryland Public Service Commission found that "the inclusion of these specific NEBs in … (cost-effectiveness) tests … will enhance the parity of cost-effectiveness screening" and ordered that these values be used by utilities for cost-effectiveness testing beginning in the 2015 program cycle (MD PSC, 2015).

Methods for Quantifying Direct Costs and Savings

States can use a wide range of methods to quantify the expected direct costs and savings associated with the efficiency or renewable energy initiative. Using the most straightforward approach, states can adapt and project results from existing initiatives in other states to their own conditions. This approach can be especially useful for estimating program costs. If an initiative has already been implemented, the direct costs and savings can be calculated based on actual expenditure and/or savings data from the program. Including actual expenditures and savings in a model or tool for projecting future direct effects likely will require some data manipulation and application of assumptions, such as mapping the actual costs or savings to defined economic sectors (e.g., by North American Industry Classification System or Standard Industrial Classification) and geographic regions, before entering them into the model.

Because the outputs of Step 2 will be used as inputs for Step 3, the choice of methods and data for quantifying costs and savings will be influenced by the economic analysis method selected in Step 1 and its associated data requirements. If a static model (such as input-output model or a static CGE model) is used, the analyst will calculate an annualized value for the year in which the direct program or policy activity occurred. For dynamic models that analyze direct activity and other changes due to a policy intervention on a year-by-year basis, the input values will be entered as nominal values in the year or years in which they occur.

Tools and methods for quantifying many of these direct costs, savings, and monetized benefits that can be used as inputs to a comprehensive economic analysis are described in the other chapters of this *Guide*:

- *To quantify the potential economic savings* from reductions in electricity demand due to energy efficiency, electricity savings from electricity supply options, such as CHP and DG, and increases in electricity generated from renewable sources, the analyst should translate the direct electricity impacts into dollars that can be input into the model. This monetization can be accomplished by applying projections of prices for different energy types (e.g., oil, gas, electricity) to the profile of expected energy savings. Estimates of expected energy savings need to account for the useful life of products and services, along with assumptions about the persistence of energy savings over time. For more information on persistence and other factors involved in calculating energy savings, see Chapter 2, "Assessing the Potential Electricity Impacts of Energy Efficiency and Renewable Energy Initiatives."

- *To quantify the direct economic savings of electricity system benefits* (e.g., avoided electricity generation, avoided capacity additions, avoided T&D losses), see the methods described in Chapter 3, "Assessing the Electricity System Benefits of Energy Efficiency and Renewable Energy."
- *To quantify emissions and air quality-related health benefits in economic terms*, see the methods described in Chapter 4, Step 4, "Quantifying the Emissions and Health Benefits of Energy Efficiency and Renewable Energy."

Key Considerations for Reviewing Baseline Assumptions

All methods and models include specific underlying assumptions that affect results. Many of these assumptions change over time and it is helpful to explore the baseline assumptions used in the specific rule of thumb or model selected to ensure they are reasonable for the current analysis. Even the most sophisticated model projections, when applied to an unrealistic or unrepresentative baseline, will be misleading.

At a minimum, an analyst can explore the following key assumptions within the method or model:

- *Population*: are the size and distribution across age categories accurate?
- *Economic growth rate:* is the expected rate of growth in line with current projections for the region?
- *Consumer behavior*: do the model's assumptions about how consumers change behavior in response to a change (i.e., elasticities) seem realistic?
- *Rate of technological change*: do the model's assumptions seem in line with reality?
- *Energy prices*: are they current?

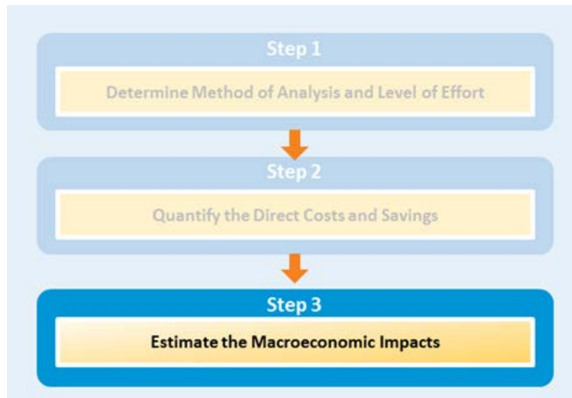
If the assumptions are out-of-date or not aligned with the geographic focus of the current analysis region, analysts can explore their ability to refine or calibrate the baseline to current conditions. If the baseline is not adjustable (e.g., in a rule of thumb factor), however, analysts can assess how the different assumptions might affect the current analysis. For example, a rule of thumb that assumes lower energy prices than are expected in the current analysis may yield more conservative (i.e., lower) estimates about the positive impacts of energy efficiency spending on jobs. By reviewing the underlying assumptions in any method or model, analysts can identify biases or data in need of updating.

The task of reviewing baseline assumptions becomes more complicated as the complexity of the tool increases, as described below.

- *Rules of thumb* estimates are specific to a geography, technology, and time so they are inherently limited. It is important to evaluate whether the factors and key assumptions used to derive the estimate are consistent with the current evaluation. If they are not, it may not be appropriate to apply that rule of thumb. For example, a rule of thumb estimate developed for a solar initiative in California will likely not be applicable to a wind initiative in Massachusetts, where the resource availability and cost may be very different. Applying a rule of thumb approach to an initiative with consistent scope/technology but similar geographies, however, might be sufficient for screening purposes, even if the initiatives were developed in different years.

- *Input-output models* compare the policy or project to a no-initiative base case. These models require calibration of the project scenario but do not allow much customization to the baseline, other than setting the year of impact and the geographic area under consideration. Baseline assumptions are typically tailored to a region, but the analyst should examine them to ensure they are still current. Because the assumptions cannot be customized, some analysts adjust their inputs if they believe the baseline assumptions will produce inaccurate estimates, or they treat the model's estimates as upper bounds (Bess and Ambargis, 2011).
- *More complex models*, such as macroeconometric, CGE, and hybrid models, allow for multiple scenarios of analysis and may require the construction of a base case scenario, or the updating of a default base case. Typically, the baseline scenario characterizes a business-as-usual forecast and may require updating the model's assumptions about energy use patterns, population, and economic growth within the region to ensure they reflect on-the-ground reality. The base case should be developed according to specifications associated with the particular method of analysis chosen.

5.2.3. Step 3: Apply the Method to Estimate Macroeconomic Impacts



Once the direct costs and savings of an energy efficiency or renewable energy initiative have been quantified, the final step is to use the data developed in Step 3 as inputs to the screening tool or model selected in Step 1 to estimate the state- or local-level macroeconomic effects of the initiative. Quantifying the macroeconomic effects provides an aggregate measure of the magnitude and direction (positive or negative) of the initiative's impacts. This full picture of costs and benefits can help decision makers choose among options.

The procedures involved in applying the screening tool or model depend on the method chosen and the type of initiative being analyzed. For example, the direct costs and savings estimates developed in Step 3 could be simply applied to a rule of thumb for screening purposes, or could be used as inputs to run an input-output model. The steps involved in entering inputs and running a more sophisticated model vary by model. For sophisticated analyses, it can also be helpful to test the sensitivity of key assumptions as part of the analysis. Analysts can do this by running alternative scenarios that vary parameters or detail "best case"/"worst case" outcomes (for more information, see the box "Sensitivity Analyses").

When interpreting and sharing the results of these analyses, it is important to consider the analytic method and program being analyzed, to explain the context for the assessment, to be transparent about any assumptions that were made, and to identify any experts who reviewed or contributed to the analysis.

SENSITIVITY ANALYSIS

A sensitivity analysis investigates the ways in which changes in assumptions affect a model's outputs. All models include assumptions that are subject to uncertainty and error, such as assumptions about future energy prices, discount rates, population and demographic characteristics, or the expected lifetime of energy efficiency measures. Sensitivity analyses explore the extent to which the model's outputs are influenced by assumptions about inputs.

Sensitivity analyses begin by selecting the variable or variables to be tested, and then selecting a range of alternative values for those variables. For sensitivity analyses of a single variable, analysts typically test the effect of extremely low and extremely high values on the model's output (e.g., 5^{th} and 95^{th} percentile values). More complex analyses will vary several inputs simultaneously to simulate interrelationships among variables.

While conducting a sensitivity analysis is an important step in economic modeling, there are several key limitations to keep in mind. First, the range of predictions that result from testing extremely low and extremely high values for a selected input may not fully capture the range of uncertainty: they will miss any changes in relationships that may occur at different points along the range. Second, a sensitivity analysis cannot reveal flaws in the model itself (Kann and Weyant, 2000).

Some key questions to consider when describing the methodology and results include:

- What are the specific strengths and limitations of the model or method used?
- How and for how long will costs and savings of the program flow through the economy?
- Are both costs and benefits included? Are any key ones missing?
- Are future costs or benefits discounted? If so, what is the discount rate?
- Does the study account for changes in conditions and technologies over time?
- What are the sources of funds that will be used to pay for the program? Where does the money come from (e.g., electricity surcharges) and go (e.g., rebates)?
- How many people will likely be reached through the program?
- How long will any energy savings likely last?
- Households, businesses, and/or utilities will be spending money on clean energy equipment or services that they are no longer spending on something else. What expenses are they cutting back? Where is it now going instead?
- Are the assumptions (and sources) regarding costs and benefits clear in terms of what the results do and do not include?
- If estimating jobs, are the estimates net or gross? Job-years or jobs? Is it a rough estimate or a reasonably sophisticated one?

USING IMPLAN TO MODEL JOB AND LABOR INCOME IMPACTS OF A BUILDING CODE

The Pacific Northwest National Laboratory (PNNL) undertook an analysis in 2013 to assess the potential impact of a proposed new residential building energy code in the state of Minnesota (PNNL, 2013). The analysis focused on average annual job creation and labor income impacts under two scenarios, comparing estimates of the annual incremental cost associated with building single-family and multifamily housing units in Minnesota that are compliant with the proposed new code, with estimates of costs under the then-current code. The number of housing starts was a key factor in determining the annual direct costs, so the study explored results using both a high and low housing-start scenario.

To estimate short-term job impacts of the incremental costs, the study used the IMPLAN model. IMPLAN provides results for direct and indirect job impacts with a high degree of sector granularity. The results of the IMPLAN analysis demonstrated that adoption of a new building code in Minnesota would generate significant positive annual impacts on employment. Under the high housing start scenario, for example, each year of code-compliant construction in Minnesota would support up to an additional 1,310 short-term jobs and up to an additional $64 million in short-term labor income per year.

The remainder of this chapter provides an overview of the tools and resources for conducting an economic analysis, along with case studies to illustrate how analysts have quantified the macroeconomic effects of energy efficiency and renewable energy policies, programs, and projects.

5.3. CASE STUDIES

The following case studies illustrate how estimating the economic benefits associated with energy efficiency and renewable energy can be used in the state energy planning and policy decision-making process. Information about a range of tools and resources analysts can use to quantify these benefits, including those used in the case studies, is available in Section 5.4., "Tools and Resources."

5.3.1. Energy Efficiency and Renewable Energy Investments in Montana

Benefits Assessed

Economic benefits estimated in this case study include:

- Job-years per million dollars spent

- Jobs-years per average Megawatt (MW)
- Annual jobs per average MW

Energy Efficiency/Renewable Energy Program Description

This study analyzed employment impacts associated with the construction, operation, and maintenance of four resources likely to play a role in Montana's energy efficiency and renewable energy future:

- Large-scale wind
- Large-scale solar photovoltaic (PV)
- Small-scale solar PV (e.g., rooftop)
- Energy efficiency

Methods(s) Used

The 2014 study estimated Montana-specific direct costs for the capital and ongoing operations and maintenance expenses associated with each of the four resources. Publicly available project cost estimates as well as National Renewable Energy Laboratory (NREL) data were used to calculate the wind and solar cost estimates. The study estimated the costs associated with energy efficiency projects based on a review of current programs offered by state utilities and on research of efficiency spending in other states.

The researchers used both the IMPLAN and JEDI input-output models to estimate the direct and indirect jobs associated with project costs by resource type. Specifically, they:

1. Customized IMPLAN's default spending pattern assumptions for each resource using NREL data found in JEDI, because IMPLAN groups all electricity generation into one sector automatically.
2. Ran IMPLAN to assess the in-state indirect impacts using the industry relationships and local purchase coefficients.
3. Translated direct and indirect impacts into construction and installation job-years and operations and maintenance job-years per average MW for each resource and per million dollars spent on each resource.
4. Calculated a cumulative employment impact per average MW generated by resource. They assumed that the operating life of each resource was 20 years and divided the construction jobs by that number and then combined the results with the annual operations and maintenance jobs per average MW.

Results

Assessing the impact in job-years per average MW generated or saved, the study found that more jobs are created during the initial construction and installation stage than during ongoing operations and maintenance across all resources. When assessed on a per average MW generated basis, it concluded that small PV supports the most job-years in either stage, followed by large-scale PV.

When evaluating the jobs impact on the basis of per million dollars spent, the study found that energy efficiency supports the most job-years during the construction and installation phase (see Figure 5-3) whereas PV supports the most job-years during the operations and maintenance phase. Energy efficiency supports nearly the same number of job-years per million spent in either the construction and installation stage or the ongoing operations and maintenance phase whereas solar and wind support more jobs during the operations and maintenance period than they supported during the earlier period. The study also estimated the average annual job impacts by resource and per average MW generated over a 20-year period and found that PV resources, small and large, support more construction, installation, operations, and maintenance jobs than wind or energy efficiency resources (see Figure 5-3 and Figure 5-4). Specific estimates are listed below.

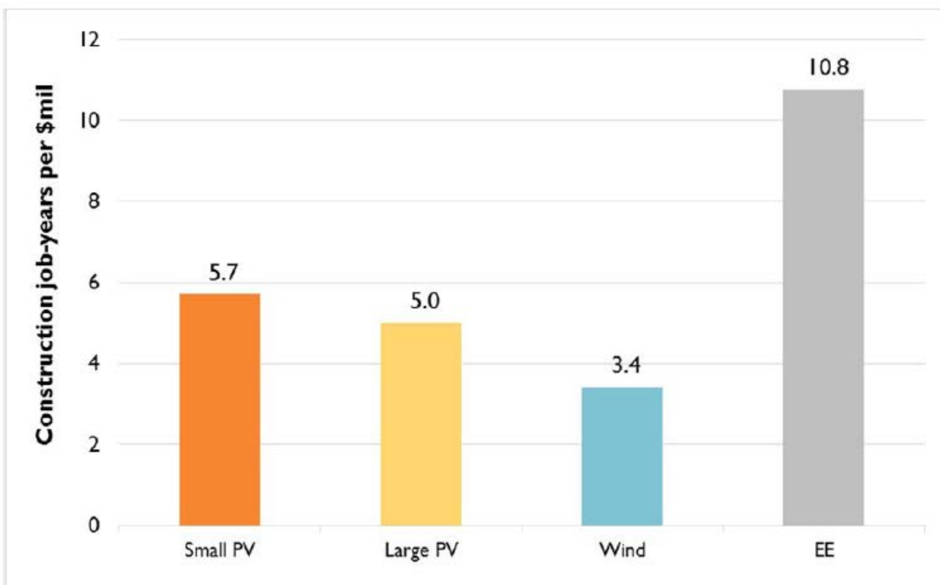
Construction and installation-related job-years

- Job-years per average MW generated (PV, wind) or saved (energy efficiency)
  - Small PV supports an estimated 136 total construction and installation job-years per average MW.
  - Large PV supported 69 job-years per average MW, followed by 19 for energy efficiency and 14 job-years for wind.

Annual operations and maintenance job-years

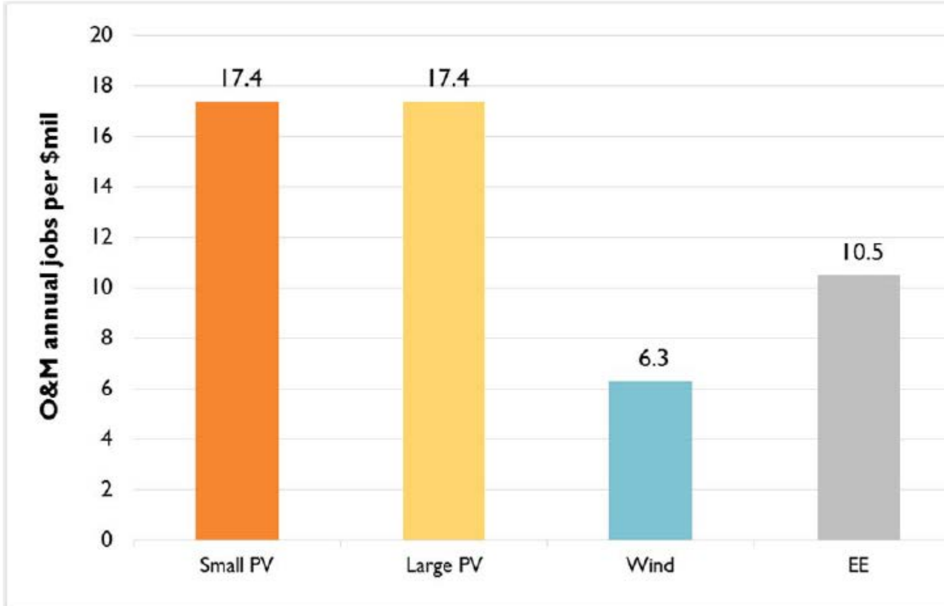
- Job-years per average MW generated (PV, wind) or saved (energy efficiency)
  - Small PV supports the most, 2.4, annual operations and maintenance jobs per average MW generated.
  - Large PV supports 1.5 annual operations and maintenance jobs per average MW generated, followed by wind and with 0.7 and 0.2 jobs annually per average MW generated or saved, respectively.

Figure 5-3: Construction and Installation Job-Years per Million Dollars Spent



Source: Synapse and NREL JEDI Model (industry spending patterns), IMPLAN (industry multipliers).

Figure 5-4: Operations and Maintenance Jobs per Million Dollars Spent



Source: Synapse and NREL JEDI Model (industry spending patterns), IMPLAN (industry multipliers).

For More Information

Resource Name	Resource Description	URL Address
Energy Efficiency and Renewable Energy Investments in Montana Case Study		
Employment Effects of Clean Energy Investment in Montana	This 2014 report from Synapse Energy presents an analysis of the employment impacts associated with the construction, operation, and maintenance of four resources likely to play a role in Montana's clean energy future: large-scale wind, large-scale solar photovoltaic (PV), small-scale solar PV (e.g., rooftop), and EE. It focuses on clean energy resources, and does not evaluate coal or natural gas generation.	http://www.synapse-energy.com/sites/default/files/SynapseReport.2014-06.MEIC_.Montana-Clean-Jobs.14-041.pdf

5.3.2. Southeast Region: The Impact of Energy Efficiency Investments Under DOE's Better Buildings Neighborhood Program

Benefits Assessed

Economic benefits estimated in this case study include:

- Jobs
- Labor income
- Total value added
- Output impacts

Energy Efficiency/Renewable Energy Program Description

The Southeast Energy Efficiency Alliance (SEEA) was one of 41 organizations across the United States that participated in the U.S. DOE Better Buildings Neighborhood Program (BBNP) from 2010 to 2013. BBNP aimed to develop sustainable programs to increase innovation and investment in energy efficiency and create new jobs. Under BBNP, SEEA assembled a consortium of 15 communities in the Southeast and managed 13 energy efficiency programs, primarily in the residential market but targeting multifamily and commercial markets as well.

Over the 3 years and with a $20.2 million budget, the communities in SEEA's consortium conducted 10,200 building audits and completed more than 6,200 energy efficiency building retrofits.

Method(s) Used

In 2014, the IMPLAN I/O model was used for an analysis to assess the economic impacts of SEEA's energy efficiency investments in the Southeast region under the BBNP.

Inputs for the study were based on funding from BBNP, delivered to states in the SEEA region through U.S. DOE Energy Efficiency and Conservation Block Grants and State Energy Programs. SEEA allocated the funds to residential, multifamily, and commercial investments for energy efficiency retrofit projects.

The analysts calculated the following inputs for the study:

1. Program spending, based on SEEA's line-item program budgets
2. Utility avoided fuel and capacity costs, based on utility data collected by SEEA
3. Incentives offered by local utilities and lenders, modeled as positive cash flows to households
4. Customer contributions to project costs, using financial incentive data wherever possible (and assumptions based on program descriptions and rules in cases where data were not available)

The IMPLAN model is driven by final demand, capturing how changes in final demand in one economic sector can affect other industries. Model assumptions derive from 2011 economic data relating local and regional industries to one another.

The IMPLAN model output includes three types of effects:

- *Direct effects:* production changes due to increases in demand
- *Indirect effects:* changes in the demand due to "factor inputs" (primary goods and operations necessary for operations) caused by program activities
- *Induced effects:* changes in the way households or individuals spend their additional funds on goods or services

Results

The analysis produced estimates of the direct, indirect, and induced net effects on jobs, labor income, total value added (i.e., gross state product or gross regional product) and total output as a result of the $20.2 million investment in energy efficiency in the Southeast, as shown in Table 5-4.

Table 5-4: Economic Impact Summary, Southeast Region

Type of Effect	Key Indicator			
	Jobs (#)	Labor Income ($)	Total Value Added ($)	Output ($)
Direct Effect	240	16,256,217	27,584,611	55,689,601
Indirect Effect	106	6,191,403	10,120,715	22,223,316
Induced Effect	3	131,923	265,598	366,471
Total Effect	349	22,579,544	37,970,924	78,279,388

Note: Columns may not add up to totals due to rounding.

Because of the rich sectoral detail available in the IMPLAN model, the analysis explored which sectors would be affected by the energy efficiency investments. Not surprisingly, at the regional level, the study found that the greatest increase in employment would be experienced by the sector classified as "Maintenance and repair construction of residential structures."

The study further assessed the return on investment to the Southeast region from the BBNP's energy efficiency investments. It found that every $1 million invested would yield 17.28 jobs, $1.1 million in labor income, $1.9 million in total value added, and $3.9 million in output. It compared these impacts against investing the same amount of money in five other sectors: trade and services, construction, renewable energy, manufacturing, and energy. As shown in Table 5-5 a $1 million investment would have positive economic impacts in all sectors. However, investment in an energy efficiency program, as demonstrated by the Southeast BBNP, had the greatest impact on job creation and overall economic output. Trades and services had the second-highest return on all factors, but yielded only $830,000 in labor income, $1.2 million in total value added, and $1.9 million in output. Construction showed the third highest return on investment, followed by renewable energy, manufacturing, and then energy.

Table 5-5: Summary of Returns on Investment, by Model

Model	Return per Million Dollars Invested			
	Jobs (#)	Labor Income ($)	Total Value Added ($)	Output ($)
BBNP Initiatives	17	1,117,099	1,878,571	3,872,789
Trade and Services	17	827,687	1,199,223	1,934,823
Construction	14	728,869	1,044,395	2,009,925
Renewable Energy	10	550,798	902,409	1,923,806
Manufacturing	9	510,495	790,710	1,921,881
Energy	8	549,817	768,785	2,077,489

The study also ran the model for multiple states, and concluded that not only did BBNP-funded initiatives produce net positive economic outcomes in the SEEA region, but the production of jobs, total value added, and output were similar across states in the region.

Key assumptions and limitations of the analysis:

- Results are static in time, meaning the multipliers represent only a snapshot of the economy at a given point in time.
- IMPLAN assumes fixed prices.
- IMPLAN does not account for opportunity costs, substitution effects, supply constraints, and changes in competitiveness or other demographic factors.

For More Information

Resource Name	Resource Description	URL Address
Southeast Region: The Impact of Energy Efficiency Investments Under U.S. DOE's Better Buildings Neighborhood Program Case Study		
Better Buildings Neighborhood Program	The BBNP from SEEA aims to help 41 competitively selected state and local governments develop sustainable programs to upgrade the energy efficiency of more than 100,000 buildings nationwide. These communities, including the 13 programs that SEEA managed in the Southeast, used innovation and	http://seealliance.org/resource-center/project-archive/better-buildings/

Resource Name	Resource Description	URL Address
	investment in energy efficiency to expand their building improvement industry, test program delivery business models and create new jobs.	
The Economic Impact of EE Investments in the Southeast	This report provides a detailed description of the methodology used by the Cadmus Group to evaluate the economic performance of SEEA's 16-city, U.S. DOE-funded energy efficiency retrofit consortium from 2010 to 2013. It includes regional and state-level findings that are presented in the form of a total economic impact summary, employment impacts and return on investment, by region and by state. Participant states include Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, Tennessee, and Virginia.	http://seealliance.org/wp-content/uploads/SEEA-EPS-EE-Report.pdf
Energy Pro3: Productivity, Progress and Prosperity for the Southeast	This 2013 report from SEEA describes results from the SEEA Southeast Community Consortium formed to implement community-based energy efficiency retrofit programs across the Southeast. The report found that $1 million invested in energy efficiency programs in Tennessee generated $1.3 million in labor income.	http://www.seealliance.org/wp-content/uploads/SEEA-EnergyPro3-Report.pdf
The Impact of Energy Efficiency Investments: Benchmarking Job Creation in the Southeast	This 2014 report from SEEA describes a macroeconomic analysis of the U.S. DOE BBNPs. The analysis found that in Florida, each $1 spent on energy efficiency programs in Florida produced $2.6 value added and $4.1 in output.	http://www.seealliance.org/wp-content/uploads/SEEA_EPS_EE_JOBReport_FINAL.pdf

5.3.3. The Economic Impacts of the Regional Greenhouse Gas Initiative 2015–2017

Benefits Assessed

Economic benefits estimated in this analysis include:

- Net economic impact (i.e., net present value, or NPV) of the Regional Greenhouse Gas Initiative (RGGI)
- Changes in payments to out-of-region power plant providers
- Energy bill savings
- Net employment impact in job-years

Energy Efficiency/Renewable Energy Program Description

RGGI is a market-based CO_2 cap-and-trade program for the power sector that first launched in 2009. As of 2018, nine northeast and mid-Atlantic states participate in RGGI, including Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. Each year, CO_2 allowances are made available through centralized auctions and the revenue is redistributed to the participating states. Since 2009, almost $2.8 billion in revenue has been raised through the auction of allowances, with nearly $1.0 billion raised from 2015–2017. The states disburse the money in a variety of ways, including to support energy efficiency, renewable energy, greenhouse gas emissions reduction measures, direct bill assistance, and education and job training programs. Electric generating units must demonstrate compliance every 3 years.

Methods(s) Used

The 2018 study, by The Analysis Group, used two models to analyze the economic impacts associated with the 3-year compliance period from 2015 to 2017.

First, analysts used the PROMOD electric system model to estimate the impacts on power system operations and outcomes. They simulated two scenarios, one “With RGGI” and the other “Without RGGI.” The difference between these two scenarios was used to represent the direct incremental impacts on the power system. The “With RGGI” scenario was derived from the actual system operations from 2015 to 2017. The “Without RGGI” included the “same inputs in terms of fuel prices, power plants available to be dispatched, power plant operational characteristics, NO_x and SO_2 allowance costs, baseline load levels” as the “With RGGI” scenario but it removed the costs and impacts attributable to RGGI (e.g., cost of CO_2 allowances, energy efficiency savings from EE investments, and additions of renewable resources resulting from RGGI investments).

Next, analysts used the IMPLAN input-output model to quantify value added and employment impacts based on changes in the movement of dollars (i.e., spending) throughout the economy. IMPLAN quantified the overall economic impacts of RGGI based on:

- *Direct effects*, including the direct effects on the owners of power plants, on consumer of energy who purchase electricity and fuels, and of the spending of RGGI auction allowance proceeds
- *Indirect effects*, including new demand for goods, services, and jobs from the spending of RGGI proceeds
- *Induced effects*, from increased spending by workers

Results

The Analysis Group concluded that RGGI has provided positive economic gains to the participating states overall, even after accounting for net losses to power plant owners. The overall drop in electric market revenue from a net present value perspective was just under $350 million. These impacts did not affect all power plant owners in the same manner, however. In general, carbon-emitting power plant owners lost revenue while zero-carbon or low-carbon power plant owners gained during this compliance period.

The impacts of spending the RGGI proceeds rippled through the state economies, generating benefits that exceeded the losses to power plant owners.

Estimates of specific benefits between 2015 and 2017 are listed below.

Net economic impact for the region

- $1.4 billion of net positive economic activity
  - Equivalent to $34 in net positive value added per capita

Reduced payments to out-of-region providers of fossil fuels

- Nearly $1.37 billion in NPV

Energy bill savings

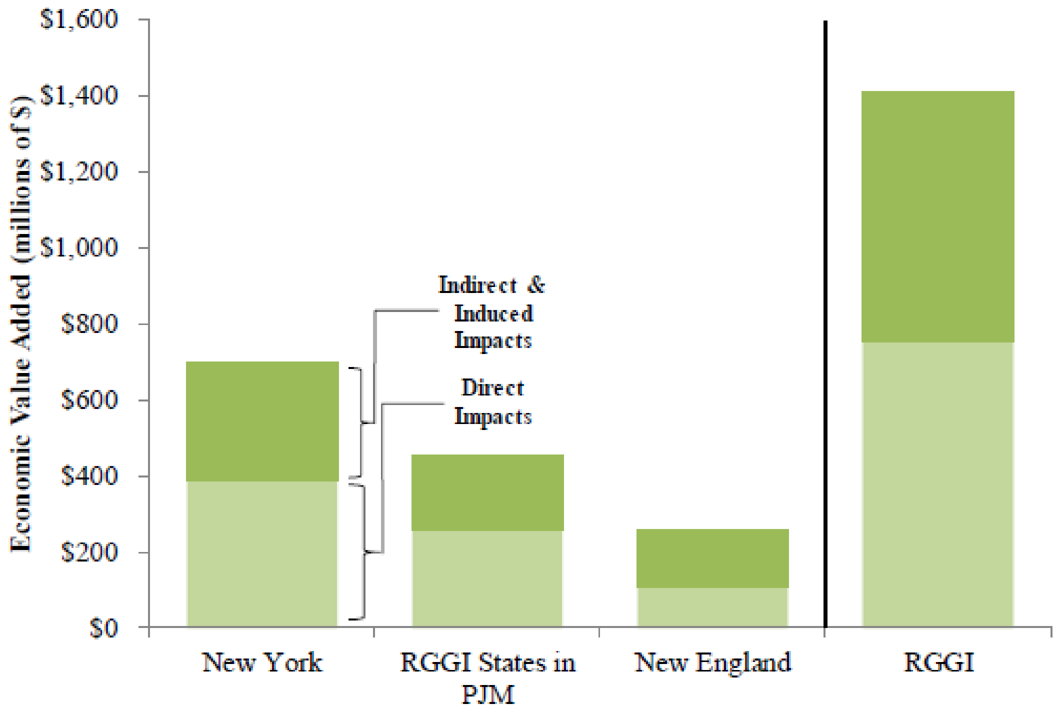
- Electricity consumers saved $99 million
- Natural gas and heating oil customers saved $121 million

Net employment impact in cumulative job-years

- Over 14,5000 new job-years for RGGI states between 2015 and 2017 as a result of RGGI implementation, including:
  - More than 6,000 new job-years for New York
  - More than 3,000 new job-years for the RGGI states in PJM
  - More than 4,000 new job-years for New England

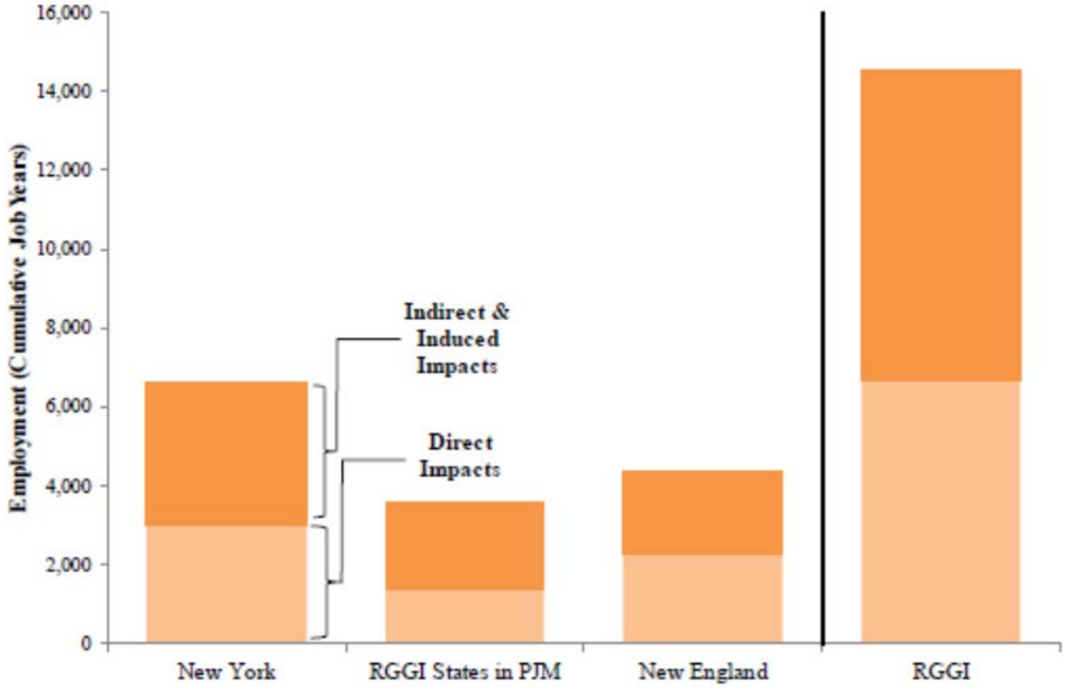
The Analysis Group previously conducted economic impact analyses of the first two compliance periods and compared the results across the studies. Although the numbers cannot be added due to differences in the years analyzed and how NPVs are reported, they show net economic benefits of RGGI over time. The 2015–2017 economic and employment impacts are presented in Figure 5-5 and Figure 5-6. Comparisons to previous compliance period impacts are shown in Table 5-6.

Figure 5-5: Net Economic Impact of the Implementation of RGGI During the 2015–2017 Period (NPV, $2018)



Source: Analysis Group, 2018.

Figure 5-6: Net Employment Impact to RGGI States as a Result of RGGI Implementation During the 2015–2017 Period (Cumulative Job Years)



Source: Analysis Group, 2018.

Table 5-6: Comparing Results of RGGI Economic Impact Analyses Across Compliance Periods

	2011–2013	2014–2016	2015–2017
Net Economic Impact (NPV, 201X$)	$1.6 billion (NPV, 2011$)	$1.3 billion (NPV, 2015$)	$1.4 billion (NPV, 2018$)
Job-Years (as of 201X)	16,000 (as of 2011)	14,200 (as of 2015)	14,500 (as of 2018)

For More Information

Resource Name	Resource Description	URL Address
The Economic Impacts of the Regional Greenhouse Gas Initiative 2015–2017 Case Study		
The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States: Review of RGGI's Third Three-Year Compliance Period (2015–2017)	This 2018 report from The Analysis Group presents an analysis of the economic impacts of the RGGI program between 2015–2017, including the net economic impacts, changes in power plant revenue, changes in payments to out-of-region power providers, energy cost savings, and the net employment impacts.	http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/analysis_group_rggi_report_april_2018.pdf
The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States: Review of RGGI's Second Three-Year Compliance Period (2012–2014)	This 2015 report from The Analysis Group presents an analysis of the economic impacts of the RGGI program between 2012–2014, including the net economic impacts, changes in power plant revenue, changes in payments to out-of-region power providers, energy cost savings, and the net employment impacts.	http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/analysis_group_rggi_report_july_2015.pdf
The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States Review of the Use of RGGI Auction Proceeds from the First Three-Year Compliance Period	This 2011 report from The Analysis Group presents an analysis of the economic impacts of the RGGI program between 2009–2011, including the net economic impacts, changes in power plant revenue, changes in payments to out-of-region power providers, energy cost savings, and the net employment impacts.	http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/economic_impact_rggi_report.pdf
The Regional Greenhouse Gas Initiative website	The RGGI program website includes overview information about the program, materials for participants in RGGI, and current information about the status of RGGI auctions and state rules.	https://rggi.org/

5.3.4. California: Analyzing Economic Impacts of the California's American Recovery and Reinvestment Act Programs

Benefits Assessed

Economic benefits estimated in this case study include:

- Net jobs and job-years
- Personal income
- Gross state product
- Tax and fee revenue

Energy Efficiency/Renewable Energy Program Description

The California Energy Commission (CEC) oversaw a number of energy efficiency programs with $257.6 million in funding the state received from the American Recovery and Reinvestment Act of 2009 (ARRA) between 2010 and 2012. Programs included:

- California Comprehensive Residential Retrofit
- Clean Energy Business Finance Program

- Clean Energy Workforce Training Program
- Energy Conservation Assistance Act-ARRA Program
- Energy Efficiency and Conservation Block Grant Small Cities and Counties Program
- Energy Efficient State Property Revolving Loan Fund Program
- Municipal and Commercial Targeted Measure Retrofit Program

Method(s) Used

A 2014 study examined the employment impacts associated with the spending on these programs from 2010 to 2012 and projected impacts out to 2026. This study used a seven-region Regional Economic Models, Inc. (REMI) Policy Insights Plus model to specifically calculate direct, indirect, and induced employment impacts, income effects, gross state product and gross state revenue for the programs.

For each of the seven California regions defined in the model, the researchers analyzed two distinct cases. A baseline case assumed no program spending, whereas the other case incorporated program expenditures and energy bill changes related to the programs. To assemble the direct model inputs, the researchers relied on CEC's program expenditure data and project-level data for information about regional spending, incentives, and energy savings. The analysis used monitoring and verification data from onsite energy efficiency and renewable energy projects.

The study presented results retrospectively (looking back to 2010) and prospectively (estimating impacts out to 2026). By using the REMI model, the researchers could define results at both the regional level and the program level, enabling a comparison of job impacts across programs to determine which subset of ARRA funding generated the most significant impacts.

Results

According to the study, ARRA-supported investments in energy efficiency programs in California from 2010–2012 have generated or are expected to generate:

- 3,723 full-time or part-time jobs from 2010 to 2012
- 16,946 full-time or part-time jobs from 2010 through 2026 including:
  - Direct jobs from the delivery of the program
  - Indirect jobs through purchases of equipment from suppliers, distributors, and manufacturers
  - Induced jobs that result from consumer spending made possible by energy bill reductions
- $1.27 billion of incremental personal income from additional wages and salaries from 2010 through 2026
- $2.04 billion in gross state product cumulatively over 16 years
- Approximately $243 million in additional revenue from taxes and fees

For More Information

Resource Name	Resource Description	URL Address
California: Analyzing Economic Impacts of the California's American Recovery and Reinvestment Act Programs Case Study		
Employment and Economic Effects from the CEC's American Recovery and Reinvestment Act of 2009 Programs	This 2014 report from DNV Kema Energy & Sustainability investigates the economic and employment effects of the American Recovery and Reinvestment Act of 2009.	http://www.energy.ca.gov/2014publications/CEC-400-2014-016/CEC-400-2014-016.pdf

5.3.5. Quantifying the Economic Benefits of Energy Efficiency Policies in Vermont

Benefits Assessed

Economic benefits in this study include:

- Jobs
- Personal income
- Total output in business sales
- Gross state product

Energy Efficiency/Renewable Energy Program Description

Efficiency Vermont (EVT) was created as the nation's first statewide energy efficiency utility in 1999. It "advances sustainable energy solutions for all Vermonters through education, services, and incentives, and promotes efficiency as a clean, cost-effective, and local fuel source." The utility is funded by an energy efficiency charge that appears on Vermonters' electricity bills and was $0.01/kWh or less in 2016 for residential, industrial, and commercial electricity customers. Funding for EVT also comes from RGGI revenues and EVT's sale of energy efficiency savings to the Forward Capacity Market.

In 2016, EVT reported that its programs had already increased Vermont ratepayers' discretionary incomes, supported 55 contracting businesses in the state, and strengthened the bottom lines of its retail partners. As shown below, savings of approximately $9 million were realized by both households and businesses, with every dollar invested in efficiency producing $2 in savings.

Sources: Optimal Energy and Synapse Energy, 2011; State of Vermont Public Service Board, 2016, 2017.

This 2011 study analyzed the potential state economic and employment impacts from 1 year of planned energy efficiency investments that were to be made by EVT and the Burlington Electric Department (BED) in 2012.

Methods(s) Used

Prepared by Optimal Energy and Synapse Energy for the Vermont Department of Public Service (DPS), the 2011 study examined the economic and employment impacts of proposed program spending to be made in 2012 by EVT and BED over a 20-year period from 2012 to 2031. The 2012 spending figures used in the analysis were sourced from the DPS budget proposal for that year and included both planned investments in electric efficiency and heat and process fuels (HPFs) efficiency.

The study used the Regional Economic Models, Inc. Policy Insights Plus (REMI PI+) model to estimate the direct, indirect, and induced impacts from the energy efficiency programs on employment, personal income, gross state product, and output in terms of business sales in 2012 compared to a scenario with no spending in that year. To assemble the inputs to the model, researchers relied on electricity efficiency measure-level data from the 2011 Demand Resource Planning Project conducted for DPS. Researchers modified the measure assumptions from the Demand Resource Planning Project to match targeted yields for 2012 programs and made adjustments to include the BED (which was not considered in the Demand Resource Planning Project). Researchers also accounted for geotargeting, which lowered the estimated energy savings realized from program spending.

Optimal Energy then used its Portfolio Screening Tool to calculate savings for program participants from electricity efficiency investments, and used 2012 projections from the Vermont Energy Investment Corporation to estimate efficiency savings for HPFs. To calculate benefit to end users, the researchers multiplied annual sector estimates of electricity and non-electricity savings by average retail rates.

They then used data on program and participant spending, net energy savings, and ratepayer effects from the energy efficiency charges on utility bills as inputs to the REMI PI+ model to estimate the economic stimulus from 2012 spending. The model assumed that only a certain portion of demand was met locally, so that only benefits to Vermont were included in the results.

Results

Over the 20-year period between 2012 and 2031, the study found that the total expected impacts of the energy efficiency programs on the Vermont economy include:

- A net increase of nearly 1,900 job-years
- $98 million in additional personal income (in 2011$)
- $351 million in additional output (in 2011$)
- $220 million in gross state product (in 2011$)

The analysis also presented the results in terms of value per program dollar spent based on the planned 2012 program budget of $44.4 million (in 2011 dollars). Researchers found that every $1 million in program spending would create a net gain of 43 job-years, while every $1 of program spending generated a net increase of nearly $5 in cumulative gross state product, an additional $2 in Vermonters' income over 20 years, and more than $6 in gross energy savings.

For More Information

Resource Name	Resource Description	URL Address
Quantifying the Economic Benefits of Energy Efficiency Policies in Vermont Case Study		
Economic Impacts of Energy Efficiency Investments in Vermont – Final Report	This 2011 study from Optimal Energy and Synapse Energy presents an analysis of the employment and economic impacts associated with energy efficiency spending that was considered as part of the Vermont DPS's 2012 budget proposal. This analysis focuses on benefits from electricity efficiency as well as heating and process fuel efficiency spending in the state.	http://publicservice.vermont.gov/sites/dps/files/documents/Energy_Efficiency/EVT_Performance_Eval/Economic%20Impacts%20of%20EE%20Investments_2011.pdf
Efficiency Vermont Annual Report for 2016	This report provides detailed information on Efficiency Vermont's activities in 2016.	https://www.efficiencyvermont.com/Media/Default/docs/plans-reports-highlights/2016/efficiency-vermont-annual-report-2016.pdf

5.3.6. Analyzing the Impacts of the Massachusetts Green Communities Act Using Two Different Models

Benefits Assessed

Economic benefits in this study include:

- Jobs
- Economic value added

Energy Efficiency/Renewable Energy Program Description

Signed into law in 2008, Massachusetts designed the Green Communities Act (GCA) to enable municipalities to overcome barriers to the implementation of energy efficiency and renewable energy programs and projects. The GCA strengthens the Commonwealth's renewable portfolio standard to rely on more renewable energy sources, and aims to expand renewable energy opportunities and promote energy efficiency throughout Massachusetts. Funding to implement the GCA comes from a variety of sources, including ratepayer funds.

A 2014 study quantified the economic impacts of GCA spending and implementation in total, accounting for both economic costs and benefits during its first 6 years of implementation from 2010 to 2015. It also estimated economic impacts of GCA programs and investments through 2025.

Methods(s) Used

To provide a comprehensive and robust perspective of the GCA's impacts in Massachusetts, the 2014 study relied on two modeling methods.

- First, once the researchers estimated how energy efficiency and technology investments spurred by the GCA would result in changes to electricity demand and supply, they used Ventyx's PROMOD model to analyze the impact of these changes on the electricity sector.
- Second, they used IMPLAN to perform a macroeconomic analysis using the dollar values derived from each PROMOD scenario. IMPLAN modeled the impact of GCA-related positive and negative changes in demand on the electricity sector and other industry sectors.

Direct inputs to the models were based on actual data for implemented GCA programs, covering past monitoring and verification activity, consumer energy costs, energy use reductions, generation capacity of new energy sources, revenue and ratepayer information, and fiscal investments in programs.

Each segment of the analysis considered a scenario with activities related to implementation of the GCA, along with an alternative counterfactual scenario modeling the impacts that would occur if the GCA had never been enacted. To compare the "with" and "without" GCA scenarios, factors such as power system infrastructure, fuel prices, emission allowance prices, and peak load forecasts were held constant.

The analysis also recognized sensitivities to key assumptions, including the discount rate and fuel prices. Specifically, it explored impacts of the first 6 years of GCA implementation on value added through 2025 by applying a "public" 3 percent discount rate and a "private" 7 percent discount rate to all dollar flows, converting them into 2013 net present value dollars. It also modified the scenario to assess changes in value added or jobs impacts if natural gas prices were 30 percent higher or lower than in the base scenario. The sensitivity analysis results in a range of values as shown below.

Results

The researchers found that, when fully implemented in 2016, efficiency measures supported by the GCA would achieve the following results annually (relative to the scenario without the GCA):

- Reduce electricity consumption by 3,617 GWh
- Reduce gas consumption by 4.6 MMBtu

As shown in Table 5-7, under the base scenario, researchers estimated that implementation of the GCA would generate 16,395 full-time job-years. It would also add between $0.63 and $1.17 billion (2013 dollars) in total economic value to the state, including between $113 and $155 million in additional state and local tax revenues. Expected job creation and economic value added were higher under the high gas price scenario and lower under the low gas price scenario, indicating that these results were sensitive to natural gas price assumptions.

Table 5-7. Massachusetts Economic Value Added and Jobs Created Resulting From the GCA

Description	3% Discount Rate		7% Discount Rate	
	Value Added[a]	Jobs[b]	Value Added[a]	Jobs[b]
Base Scenario	$1.17 billion	16,395	$0.63 billion	16,395
High Gas Price (+30%)	$1.80 billion	21,651	$1.13 billion	21,651
Low Gas Price (-30%)	$0.60 billion	11,781	$0.18 billion	11,781

Note: Reflects base case and alternative scenarios discounted at private and public discount rates.

[a] Economic Value Added reflects the total economic value added to the economy, which reflects the gross economic output of the area less the cost of the inputs. The reported numbers reflect net present value of economic value added.

[b] Jobs reflect the number of full-time job-years over time, and are not discounted.

Source: Analysis Group, 2014.

For More Information

Resource Name	Resource Description	URL Address
Analyzing the Impacts of the Green Communities Act Using Two Different Models Case Study		
The Impacts of the Green Communities Act on the Massachusetts Economy: A Review of the First Six Years of the Act's Implementation	This 2014 study from Analysis Group assesses the economic and employment impacts from Massachusetts' Green Communities Act from its first 6 years of implementation between 2010 and 2015.	http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/analysis_group_gca_study.pdf

5.3.7. Applying the Steps in a Macroeconomic Analysis: Wisconsin's Focus on Energy Program

Benefits Assessed

Economic benefits in this study include:

- Jobs
- Economic value added
- Personal income
- Sales generated

Energy Efficiency/Renewable Energy Program Description

Wisconsin's Focus on Energy Program advances cost-effective energy efficiency and renewable energy projects in the state through information, training, energy audits, assistance, and financial incentives. Its efforts are designed to help Wisconsin residents and businesses manage rising energy costs, promote in-state economic development, protect the environment, and control the state's growing demand for electricity and natural gas over the short and long term.

A 2015 study set out to quantify the net economic impacts of the Focus on Energy program for five periods, including the 2011, 2012, 2013, and 2014 program years, and for a quadrennial period from 2011 to 2014.

Methods(s) Used

Wisconsin performs periodic analyses of Focus on Energy's economic impacts based on actual and projected outcomes. The analyses attempt to capture how program-specific investments circulate through Wisconsin's economy, and how they continue to affect the economy over time. Focus on Energy has used Regional Economic Models, Inc.'s REMI Policy Insight (REMI PI+) model for its economic analyses since 2003.

For the 2015 study, analysts estimated the economic benefits from the Focus on Energy program for each program year and for the 25-year future period following these years. The study used the REMI PI+ model to estimate the direct, indirect, and induced economic impacts for Wisconsin in terms of employment, industry sales generated, value added, and disposable income. Using data from the Wisconsin Public Services Commission, the analysis team assembled the following inputs for the model:

- Program spending by Focus on Energy, including from administration, implementation, incentives, and participant spending on program goods and services
- Ratepayer payments from the surcharge on energy bills that supports the program

- Participant energy bill savings
- Avoided costs by utilities
- Reduced energy sales to utilities

The study methodology used a regional baseline scenario that models economic activity that would have occurred if the program were not implemented, and compared it with activity that resulted from changes in energy use and demand for products and services introduced by Focus on Energy programs. It also modeled the flow of program-related funds among stakeholders. The analysis team used the standard regional control scenario as the baseline.

Results

The results indicate that the Focus on Energy program provides net benefits to the State of Wisconsin. Specifically, the analysis of program effects for the quadrennial period from 2011 to 2014 estimated that between 2011 and 2038 Focus on Energy is expected to:

- Create more than 19,000 job-years
- Increase value added or gross state product by around $2.8 billion (2015 dollars)
- Increase disposable income for residents by more than $1.4 billion (2015 dollars)
- Generate sales for Wisconsin businesses of more than $5.5 billion (2015 dollars)

Table 5-8: Cumulative Economic Development Impacts in Wisconsin

Economic Development Impact	Program Calendar Year(s)				
	2011	2012	2013	2014	Quadrennial (2011–2014)[a]
Employment (job-years)	4,631	5,911	4,606	4,618	19,291
Economic Benefits (millions of 2015 dollars)	$571	$826	$685	$756	$2,854
Personal Income (millions of 2015 dollars)	$340	$497	$298	$320	$1,435
Sales Generated (2015 dollars)	$1,076	$1,593	$1,346	$1,454	$5,502

[a] *Individual program year values do not sum to quadrennial impacts due to differences between modeling runs.*

Source: Cadmus Group, 2015.

For More Information

Resource Name	Resource Description	URL Address
Applying the Steps in a Macroeconomic Analysis: Wisconsin's Focus on Energy Program Case Study		
Focus on Energy Economic Impacts 2011–2014	This 2015 study from the Cadmus Group analyzes the economic impacts of Wisconsin's Focus on Energy Program for each year from 2011 to 2014, and for a quadrennial period from 2011 to 2014.	https://focusonenergy.com/sites/default/files/WI%20FOE%202011%20to%202014%20Econ%20Impact%20Report.pdf

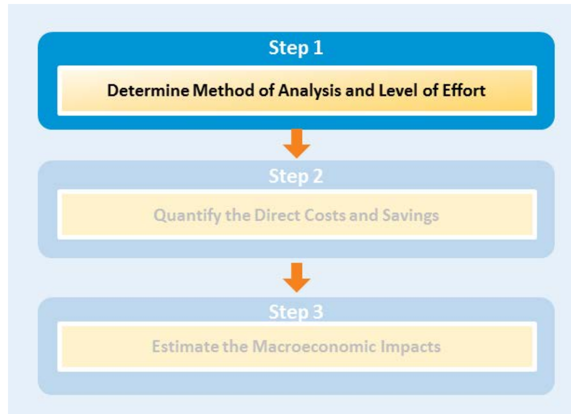
5.4. TOOLS AND RESOURCES

A number of data sources, protocols, general resources, and tools are available for analysts to implement the methods described in this chapter. This section organizes resources by the high-level steps in the analytical process.

Please note: While this Guide *presents the most widely used methods and tools available to states for assessing the multiple benefits of policies, it is not exhaustive. The inclusion of a proprietary tool in this document does not imply endorsement by EPA*.

5.4.1. Tools and Resources for Step 1: Determine the Method of Analysis and Level of Effort

Analysts can use a range of resources to determine the method of economic analysis and level of effort, as described in Step 1 in this chapter.



Resources for Conducting Economic Impact Analyses Using Rules of Thumb

This section lists rules of thumb from a variety of studies, organized by type of impact. Generic rules of thumb for economic impact analysis are simplified factors that represent relationships between key policy or program characteristics and employment or output. Examples listed in this section use rules of thumb that states or national laboratories have developed, based on analyses of actual projects, which can be used to estimate the income, output, and employment impacts of energy efficiency and renewable energy programs.

Type of Impact: Economic Output

- ***The Economic Impact of Minnesota's Weatherization Programs: An Input-Output Analysis***. This 2010 report from the University of Minnesota Extension Center for Community Vitality describes an economic impact analysis in Minnesota. The analysis found that each $1 of spending on weatherization programs in Minnesota in 2009 generated $2.09 in output. http://www.waptac.org/data/files/Website_Docs/Recovery_Act/Success_Stories/MN/eia-mn-wap-success-story.pdf
- ***The Economic, Utility Portfolio, and Rate Impact of Clean Energy Development in North Carolina****.* This 2013 report from La Capra Associates, Inc. describes an economic, utility, and rate impact analysis of clean energy development for the North Carolina Sustainable Energy Association. The analysis found that in North Carolina, each $1 spent on energy efficiency projects results in $1.67 in output. https://www.rti.org/publication/economic-utility-portfolio-and-rate-impact-clean-energy-development-north-carolina-final
- ***The Impact of Energy Efficiency Investments: Benchmarking Job Creation in the Southeast****.* This 2014 report from the Southeast Energy Efficiency Alliance describes a macroeconomic analysis of the U.S. DOE BBNPs. The analysis found that in Florida, each $1 spent on energy efficiency programs in Florida produced $2.6 value added and $4.1 in output. http://www.seealliance.org/wp-content/uploads/SEEA_EPS_EE_JOBReport_FINAL.pdf

Type of Impact: Employment

- ***Assessing National Employment Impacts of Investment in Residential and Commercial Sector Energy Efficiency: Review and Example Analysis*.** This 2014 report from the U.S. DOE Pacific Northwest National Laboratory focuses on job creation from increased levels of energy efficiency in the buildings sector. The analysis found that nationally, $1 million invested in residential and commercial energy efficiency generates about 11 jobs. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23402.pdf

- ***Economic Impact Analysis of Clean Energy Development in North Carolina – 2014 Update*.** This 2014 report from the North Carolina Sustainable Energy Association analyzes direct and secondary effects associated with major energy efficiency initiatives and the construction, operation, and maintenance of renewable energy projects. The analysis found that in North Carolina, $1 billion spent on renewable energy projects creates 37,100 full-time equivalents over a 7-year period. https://www.rti.org/sites/default/files/resources/ncsea_2013_update_final.pdf
- ***The Economic Impact of Energy Efficiency Programs in Arkansas: A Survey of Contractor Activity in 2013*.** This 2014 report from Arkansas Advanced Energy Foundation describes the results of a study of job creation, economic, growth, and other benefits from the energy efficiency resources standard program in Arkansas. The study found that $1.04 billion in direct output from energy efficiency sector spending in Arkansas creates over 11,000 total full-time jobs. https://www.arkansasadvancedenergy.com/files/dmfile/TheEconomicImpactofEnergyEfficiencyProgramsinArkansas.FINAL.pdf
- ***Employment Estimates for Energy Efficiency Retrofits of Commercial Buildings***. This 2011 report from the University of Massachusetts Amherst Political Economy Research Institute presents estimates of spending and employment that could results from a federal program to incentivize energy efficiency in commercial buildings. The analysis found that nationally, $1 million saved on energy spending by retrofit building owners creates 6.5 direct jobs, $1 million spent on energy efficiency technology manufacturing and installation creates an average of 5.7 direct jobs, and $1 million spent on commercial building retrofits generates 8.0 direct jobs. http://www.peri.umass.edu/fileadmin/pdf/research_brief/PERI_USGBC_Research_Brief.pdf
- ***Energy Efficiency Services Sector: Workforce Size, Expectations for Growth, and Training Needs***. This 2010 presentation from Lawrence Berkeley National Laboratory describes a study to determine the requirements for growing the energy efficiency services workforce. The study found that nationally, $1 million spent on low-income weatherization yields 8.9 person-years of employment. https://emp.lbl.gov/sites/all/files/presentation-lbnl-3163e.pdf
- ***The Impact of Energy Efficiency Investments: Benchmarking Job Creation in the Southeast****.* This 2014 report from SEEA describes a macroeconomic analysis of the U.S. DOE BBNPs. The analysis found that in Georgia, $1 million spent on energy efficiency generates 18.5 jobs. http://www.seealliance.org/wp-content/uploads/SEEA_EPS_EE_JOBReport_FINAL.pdf

Type of Impact: Labor Income

- ***Energy Pro3: Productivity, Progress and Prosperity for the Southeast****.* This 2013 report from SEEA describes results from the SEEA Southeast Community Consortium formed to implement community-based energy efficiency retrofit programs across the Southeast. The report found that $1 million invested in energy efficiency programs in Tennessee generated $1.3 million in labor income. http://www.seealliance.org/wp-content/uploads/SEEA-EnergyPro3-Report.pdf

Tools for Conducting Economic Impact Analyses Using Models

Analysts can use a range of software tools to conduct economic impact analyses to estimate the short-term and/or long-term economic impacts of their energy efficiency and renewable energy policies, programs, projects.

Input-Output Models

- **DEEPER.** The Dynamic Energy Efficiency Policy Evaluation Routine (DEEPER), developed by the American Council for an Energy-Efficient Economy (ACEEE), is a 15-sector input-output model of the U.S. economy that draws on social accounting matrices from the Minnesota IMPLAN Group, energy use data from the U.S. Energy Information Administration's Annual Energy Outlook, and employment and labor data from the Bureau of Labor Statistics. It includes a macroeconometric module. http://aceee.org/fact-sheet/deeper-methodology
- **IMPLAN Model**. The IMPLAN model, from the Minnesota IMPLAN Group, Inc., pairs classic input-output analysis with regional social accounting matrices to create economic models using data collected for a defined region. IMPLAN's analytical software uses data to allow users to model custom economic impacts, learn how economies function, and quantify contributions to them. http://www.implan.com/
- **Jobs and Economic Development Impact (JEDI) Model.** This free tool, developed by NREL, is designed to allow users to estimate the economic cost and impacts of constructing and operating power generation assets. It provides plant construction costs, as well as fixed and variable operating costs. http://www.nrel.gov/analysis/jedi/
- **Regional Economics Applications Laboratory (REAL).** The University of Illinois REAL focuses on the development and use of regional econometric input-output models for urban and regional forecasting and economic development. REAL has developed regional models for seven U.S. states and four U.S. metropolitan regions. http://www.real.illinois.edu/products/
- **RIMS II Model***.* The Regional Input-Output Modeling System (RIMS II) is a regional economic model used by investors, planners, and government agencies to assess the potential economic impacts of projects. This model produces multipliers that are used in economic impact studies to estimate the total impact of a project on a region. https://bea.gov/regional/rims/

Macroeconometric Models

- **Cambridge Economics E3ME.** E3ME is a global, macroeconometric model designed to address major economic and economy-environment policy challenges. The model provides a high level of sectoral and geographic disaggregation, covering 59 global regions. It provides social impact outputs, including unemployment levels and distributional effects. https://www.camecon.com/how/e3me-model/
- **EViews Econometric Modeling Software***.* EViews, from IHS Markit, is an econometric modeling software that allows the user to create statistical and forecasting equations. Functionality includes analysis of time series, cross section, and longitudinal data; statistical and econometric modeling; creation of graphs and tables; and budgeting strategic planning, and academic research. https://www.ihs.com/products/eviews-econometric-modeling-analysis-software.html
- **IHS Markit Global Link Model.** The Global Link Model is a global macroeconomic model designed for forecasting and scenario planning. The model provides baseline forecasts updated quarterly and 30-year outlooks that allows the user to assess changes in commodity prices, exchange rates, monetary and financial policy, energy prices, demographics and establishment-level performance. https://ihsmarkit.com/products/global-link-economic-model-and-scenarios.html
- **Oxford Econometrics Global Economic Model**. The Global Economic Model is a globally integrated macroeconomic model covering 80 countries; it links assumptions about trade volume and prices, competitiveness, capital flows, interest and exchange rates, and commodity prices. https://www.oxfordeconomics.com/global-economic-model

Computable General Equilibrium and Hybrid Models

- **Applied Dynamic Analysis of the Global Economy (ADAGE) Model***.* RTI International's ADAGE model is a dynamic CGE model capable of examining many types of economic, energy, environmental, climate change mitigation, and trade policies at the international, national, U.S. regional, and U.S. state levels. To investigate proposed policy effects, the model combines a consistent theoretical structure with economic data covering all interactions among businesses and households. ADAGE has three distinct modules: International, U.S. Regional, and Single Country. Each module relies on different data sources and has a different geographic scope, but all have the same theoretical structure, which allows for detailed regional and state-level results that incorporate international impacts of policies. The model is developed and run by RTI International for EPA. https://www.rti.org/publication/applied-dynamic-analysis-global-economy-rti-adage-model-2013-us-regional-module-final

- **Berkeley Energy and Resources (BEAR) Model***.* The BEAR model is a detailed and dynamic economic simulation model that traces the complex linkage effects across the California economy as they arise from changing policies and external conditions. https://policyinstitute.ucdavis.edu/uc-berkeley-energy-resources-bear-model/

- **ENERGY 2020***.* ENERGY 2020 is a simulation model available from Systematic Solutions that includes all fuel, demand, and supply sectors and simulates energy consumers and suppliers. This model can be used to capture the economic, energy, and environmental impacts of national, regional, or state policies. Energy 2020 models the impacts of an energy efficiency or renewable energy measure on the entire energy system. User inputs include new technologies and economic activities such as tax breaks, rebates, and subsidies. It is available at the national, regional, and state levels. http://www.energy2020.com/

- **ILIAD and LIFT Models***.* Inforum's ILIAD (Interindustry Large-scale Integrated and Dynamic) model is a 360-sector model of the U.S. economy, forecasting all components of final demand and value added, as well as prices and employment. ILIAD also forecasts employment, value added components, and prices. The ILIAD model currently relies on the Inforum LIFT (Long-term Interindustry Forecasting Tool) model for more aggregate drivers. LIFT is a dynamic general equilibrium representation of the U.S. national economy. Users of ILIAD can employ LIFT variables to directly index the growth of the corresponding detailed sectors in ILIAD, or use existing equations to forecast the detailed industries, and then control them to LIFT growth rates or levels. http://www.inforum.umd.edu/services/models/iliad.html

- **Integrated Planning Model (IPM)®.** IPM, developed and supported by ICF, simultaneously models electric power, fuel, and environmental markets associated with electricity production. It is a capacity expansion and system dispatch model. Dispatch is based on seasonal, segmented load duration curves, as defined by the user. IPM also has the capability to model environmental market mechanisms such as emissions caps, trading, and banking. System dispatch and boiler and fuel-specific emission factors determine projected emissions. IPM can be used to model the impacts of energy efficiency and renewable energy resources on the electricity sector in the short and long term. http://www.icf.com/resources/solutions-and-apps/ipm

- **Regional Economic Modeling, Inc. REMI Policy Insight+ Model.** REMI's Policy Insight+ model generates year-by-year estimates of the regional effects of policy initiatives. The model is available in single- and multi-area configurations with calibrated economic, demographic, and policy variables. REMI also offers the E3 model, which can be used to analyze the economic impacts of policies to reduce emissions. http://www.remi.com/

- **Regional Energy Deployment System (ReEDS).** ReEDS, developed by NREL, is a long-term capacity expansion model that determines the potential expansion of electricity generation, storage, and transmission systems throughout the contiguous United States over the next several decades. ReEDS is designed to determine the cost-optimal mix of generating technologies, including both conventional and renewable energy, under power demand requirements, grid reliability, technology, and policy constraints. Model outputs include generating capacity, generation, storage capacity expansion, transmission capacity expansion, electric sector costs, electricity prices, fuel prices, and carbon dioxide emissions. https://www.nrel.gov/analysis/reeds/

- **State Tax Analysis Modeling Program (STAMP)**. The STAMP model, developed by the Beacon Hill Institute, is a 5-year dynamic CGE model that simulates changes in taxes, costs (general and sector-specific) and other economic inputs to provide a mathematical description of the economic relationships among producers, households, governments and the rest of the world. Models are available for individual U.S. states. http://www.beaconhill.org/STAMP_Web_Brochure/STAMP_EconofSTAMP.html

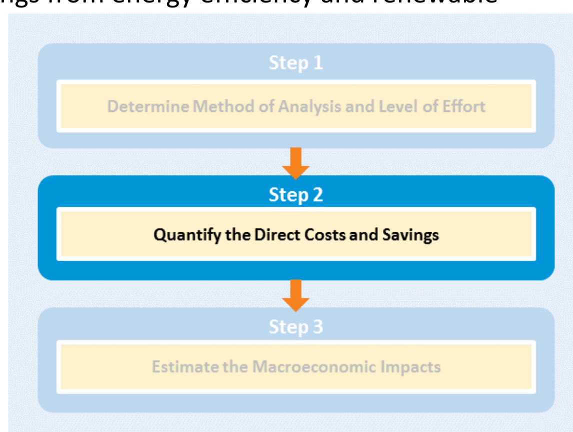
General Resources for Evaluating Baseline Assumptions When Conducting Economic Impact Analyses

Analysts can use a range of available resources to review baseline assumptions as outlined in Step 2 in this chapter.

- **Bureau of Economic Analysis Regional Economic Accounts***.* The Bureau of Economic Analysis provides a number of resources on regional economic accounts, including data and maps of gross domestic product and personal income and employment. http://www.bea.gov/regional/index.htm
- **Census Bureau***.* The Census Bureau mission is to serve as the leading source of quality data about the nation's people and economy. The Census Bureau conducts censuses and surveys and provides populations estimates and projections. http://www.census.gov/
- **EIA's Annual Energy Outlook.** This resource provides long-term electricity and fuel price projections. https://www.eia.gov/outlooks/aeo/
- **EPA's *Guidelines for Preparing Economic Analyses, Chapter 5***. This report chapter describes factors that should be considered in developing baseline analyses and assumptions. https://www.epa.gov/sites/production/files/2017-09/documents/ee-0568-05.pdf

5.4.2. Tools and Resources for Step 2: Quantify Direct Costs and Savings from the Energy Efficiency or Renewable Energy Initiative

Most of the tools and resources for quantifying the direct costs and savings from energy efficiency and renewable energy initiatives are described in other chapters of this *Guide* (as outlined in Section 5.2.2., "Step 2: Quantify Direct Costs and Savings from the Energy Efficiency and Renewable Energy Initiative"). Additional resources that may be useful in this step are described below.

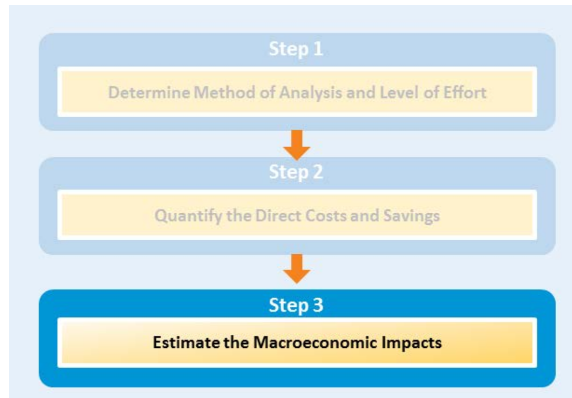


- **The American Council for an Energy-Efficient Economy (ACEEE).** ACEEE focuses on energy policy (federal, state, and local), research (including programs on buildings and equipment, utilities, industry, agriculture, transportation, behavior, economic analysis, and international), and outreach. ACEEE has developed reports, data compilations, and other resources that may be useful in quantifying direct costs and savings from energy efficiency programs. http://www.aceee.org/
- **DOE's Argonne National Laboratory Long-Term Industrial Energy Forecasting (LIEF) Model***.* The LIEF model is designed for convenient study of future industrial energy consumption, taking into account the composition of production, energy prices, and certain kinds of policy initiatives. The model enables direct comparison

econometric approach with conservation supply curves from detailed engineering analysis. It also permits explicit consideration of a variety of policy approaches other than price manipulation. https://www.osti.gov/scitech/biblio/10169987

- **DOE's Lawrence Berkeley National Laboratory DOE-2.2 Model***.* DOE-2 is a building energy analysis program that can predict the energy use and cost for all types of buildings. DOE-2 uses a description of the building layout, constructions, usage, conditioning systems (lighting, HVAC, etc.) and utility rates provided by the user, along with weather data, to perform an hourly simulation of the building and to estimate utility bills. http://www.doe2.com/

5.4.3. Tools and Resources for Step 3: Estimate the Macroeconomic Impacts



In Step 3, the direct costs and savings from Step 2 are entered into the tools and resources described in Step 1 to quantify macroeconomic impacts. Additional resources that may be useful in the analysis are described below.

- ***Alternative Measures of Welfare in Macroeconomic Models*****.** This working paper from EIA describes several methods of calculating impacts, costs, and benefits of policies. https://www.eia.gov/workingpapers/pdf/welfare-vipin-wappendix.pdf
- ***An Evaluation of Macroeconomic Models for Use at EIA***. This working paper reviews macroeconomic models used by EIA to create forecasts and to evaluate the impact of different government policies. https://www.eia.gov/workingpapers/pdf/macro_models-vipin-wappendix.pdf
- ***EPA's Guidelines for Economic Analysis****.* EPA's Guidelines for Preparing Economic Analyses establish a sound scientific framework for performing economic analyses of environmental regulations and policies. They incorporate recent advances in theoretical and applied work in the field of environmental economics. The Guidelines provide guidance on analyzing the benefits, costs, and economic impacts of regulations and policies, including assessing the distribution of costs and benefits among various segments of the population. https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses

5.4.4. Examples of State-Level Economic Analyses Performed with Commonly Used Tools

Examples of state energy efficiency and renewable energy analyses are provided below, organized by type of tool. The examples below employed some of the most commonly used tools to conduct this type of analysis.

Input-Output Models

State-Level Energy Efficiency and Renewable Energy Analyses That Used ACEEE's DEEPER Model

Note that DEEPER is an input-output model that includes a macroeconometric module, so the examples below could be considered examples of input-output and macroeconometric analyses.

- ***Advancing Energy Efficiency in Arkansas: Opportunities for a Clean Energy Economy*****.** This 2011 report from ACEEE examines the potential electricity, natural gas, and fuel savings that could be realized in Arkansas through the implementation of a suite of 11 energy efficiency and nine transportation policies and quantifies the growth in gross state product and employment that would result from these investments. http://aceee.org/research-report/e104

State-Level Energy Efficiency and Renewable Energy Analyses That Used IMPLAN

- ***Economic Analysis of Nevada's Renewable Energy and Transmission Development Scenarios.*** This 2012 report from Synapse Energy Economics, Inc. explores topics surrounding the development of new generation and transmission within Nevada, and between Nevada and neighboring areas; derives the levelized costs of transmission additions using appropriate economic assumptions for the cost of capital, the annual revenue requirement and the expected energy generation and utilization of the lines from the generation projects; and provides the estimates for the costs of delivered energy. http://energy.nv.gov/uploadedFiles/energynvgov/content/Synapse%20Nevada%20RE%20Report%20w%20Disclaimer%20and%20Comments%20112812.pdf

- ***Economic Impact Analysis of Clean Energy Development in North Carolina – 2014 Update.*** This 2014 report from the North Carolina Sustainable Energy Association analyzes direct and secondary effects associated with major energy efficiency initiatives and the construction, operation, and maintenance of renewable energy projects. The analysis found that in North Carolina, $1 billion spent on renewable energy projects creates 37,100 full-time equivalents over a 7-year period. https://www.rti.org/sites/default/files/resources/ncsea_2013_update_final.pdf

- ***The Economic Impact of the Renewable Energy Production Tax Credit in New Mexico.*** This 2017 report from O'Donnell Economics & Strategy used IMPLAN to estimate the economic impact of New Mexico's Renewable Energy Production Tax Credit from 2013 through 2016. http://familybusinessesforaffordableenergy.org/wp-content/uploads/2017/03/EconImpactStudy-022817-1.pdf

- ***The Impact of Energy Efficiency Investments: Benchmarking Job Creation in the Southeast.*** This 2014 report from SEEA describes a macroeconomic analysis of the U.S. DOE BBNPs. The analysis found that in Florida, each $1 spent on energy efficiency programs in Florida produced $2.6 value added and $4.1 in output. http://www.seealliance.org/wp-content/uploads/SEEA_EPS_EE_JOBReport_FINAL.pdf

- ***Potential Job Creation in Minnesota as a Result of Adopting New Residential Building Energy Codes.*** This 2013 report from the U.S. DOE Pacific Northwest National Laboratory describes whether jobs would be created in Minnesota based on their adoption of model building energy codes. http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-21538.pdf

- ***Projected Job and Investment Impacts of Policy Requiring 25 Percent Renewable Energy by 2025 in Michigan.*** This 2012 report from Michigan State University assesses the investment and job impacts that would be the result of increasing Michigan's renewable energy generation to 25 percent of total electricity by 2025. https://www.canr.msu.edu/cea/uploads/files/25by25Report_Final_081012.pdf

State-Level Energy Efficiency and Renewable Energy Analyses That Used JEDI

- ***An Assessment of the Economic, Revenue, and Societal Impacts of Colorado's Solar Industry.*** This 2013 report from the Solar Foundation describes a comprehensive economic analysis of the jobs, economic, and environmental impacts of the Colorado solar industry. This report identifies a number of benefits resulting from solar photovoltaic (PV) development in Colorado and includes projections of future magnitude and value of these benefits under a scenario in which Colorado realizes the goal of the Colorado Solar Energy Industries Association's "Million Solar Roofs" campaign: 3 gigawatts (GW) of total solar capacity by 2030. http://solarcommunities.org/wp-content/uploads/2013/10/TSF_COSEIA-Econ-Impact-Report_FINAL-VERSION.pdf

- ***A Clean Energy Economy for Indiana: Analysis of the Rural Economic Development Potential of Renewable Resources.*** This 2010 report from the National Resource Defense Council examines the potential of Indiana's renewable resources and finds unprecedented opportunity for long-term economic growth in rural communities as well as new income sources for farmers from an array of emerging clean energy technologies, particularly wind, biofuels, biopower, and biogas. https://www.nrdc.org/sites/default/files/cleanenergyindiana.pdf

- ***Economic Development Opportunities for Arizona in National Clean Energy and Climate Change Legislation*.** This 2010 report from the Landsward Institute at Northern Arizona University analyzes the potential economic impacts on Arizona of a United States clean energy and climate change mitigation policy similar to that contained in several proposed pieces of legislation in the United States Congress. http://www.landsward.nau.edu/energy_climate_change_legislation_page.html
- ***Economic Impact Potential of Solar Photovoltaics in Illinois*.** This 2013 report from the Center for Renewable Energy at Illinois State University examines the jobs and total economic impact of technical potentials and examines the existing and potential PV supply chain in the State of Illinois. http://renewableenergy.illinoisstate.edu/downloads/publications/FINAL%20Solar%20Economic%20Impact%20Report%20Dec%202013.pdf
- ***Potential Economic Impacts from Offshore Wind in the Southeast Region*.** This 2013 report from the U.S. DOE focuses on the employment opportunities and other potential regional economic impacts from offshore wind developed in four regions of the United States. The studies use multiple scenarios with various local job and domestic manufacturing content assumptions. Each regional study uses the new offshore wind Jobs and Economic Development Impacts (JEDI) model, developed by the National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy13osti/57565.pdf

CGE Models

State-Level Energy Efficiency and Renewable Energy Analyses That Used STAMP

- ***The Cost and Economic Impact of Delaware's Renewable Portfolio Standard*.** This 2011 report from the American Tradition Institute estimates the economic effects of the Delaware Renewable Portfolio Standard mandate. The study estimates the cost of the Delaware state renewable portfolio standard (RPS) accounting for different cost and capacity factor estimates for electricity-generating technologies from the academic literature. http://www.caesarrodney.org/pdfs/RPS_Delaware.pdf
- ***The Economic Impact of Arizona's Renewable Energy Standard and Tariff*.** This 2013 report from the Beacon Hill Institute at Suffolk University estimates the economic impacts of the Arizona Renewable Energy Standard and Tariff (REST) rule. This study bases estimates on EIA projections and also provide three estimates of the cost of Arizona's REST mandates using different cost and capacity factor estimates for electricity-generating technologies from the academic literature. http://www.beaconhill.org/BHIStudies/AZ-REST/AZ-BHI-REST-2013-0403FINAL.pdf
- ***The Economic Impact of the Kansas Renewable Portfolio Standard*.** This 2012 report from the Beacon Hill Institute at Suffolk University estimates the economic impacts of the Kansas RPS mandates. Specifically, the study provides three estimates of the cost of Kansas' RPS mandates using different cost and capacity factor estimates for electricity-generating technologies. http://www.protecttheflinthills.org/information/the_economic_impact_of_the_kansas_rps[1].pdf

State-Level Energy Efficiency and Renewable Energy Analyses That Used REMI

- ***The Economic Impacts and Macroeconomic Benefits of Energy Efficiency Programs in Oregon***. This 2016 report, sponsored by member companies of the Northwest Energy Efficiency Council and written by ECONorthwest, describes and updates a 2014 analysis about the economic effects of energy conservation in Oregon using IMPLAN to estimate short-run impacts and REMI for projections to 2021. https://www.neec.net/wp-content/uploads/2017/10/neec-econ-oregon-update-aug2016.pdf
- ***The Economic Impacts of Energy Efficiency in the Midwest.*** This 2016 analysis, conducted by Cadmus, uses the REMI model to estimate the economic effects expected to occur between 2014 and 2038 due to Midwestern energy efficiency investments made in 2014. http://www.neo.ne.gov/neq_online/mar2017/Midwest-Report-FINAL.pdf
- ***Employment and Economic Effects from the CEC's American Recovery and Reinvestment Act of 2009 Programs***. This 2014 report from DNV Kema Energy & Sustainability investigates the economic and employment effects of the American Recovery and Reinvestment Act of 2009. http://www.energy.ca.gov/2014publications/CEC-400-2014-016/CEC-400-2014-016.pdf
- ***Focus on Energy Economic Impacts 2011–2014***. This 2015 report from the Cadmus Group summarizes the statewide economic development impacts of Focus on Energy's 2011–2014 energy efficiency and renewable energy programs. Cadmus analyzed these economic impacts using Regional Economic Models, Inc.'s Policy Insight+ model (REMI PI+), an economic forecasting tool that models the annual and long-term effects of different spending choices on multiple components of the state economy. https://focusonenergy.com/sites/default/files/WI%20FOE%202011%20to%202014%20Econ%20Impact%20Report.pdf
- ***New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation from Photovoltaic Devices in New York***. This 2012 report from the New York State Energy Research and Development Authority describes the results of a study regarding policy options that could be used to achieve goals of 2,500 MW of installed capacity operating by 2020 and 5,000 MW operating by 2025. https://www.nyserda.ny.gov/About/Publications/Solar-Study

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