PART TWO
CHAPTER 2

Estimating the Direct Electricity Impacts of Energy Efficiency and Renewable Energy

DOCUMENT MAP

CHAPTER 2 CONTENTS

ABOUT THIS CHAPTER

This chapter provides policy makers and analysts with information about methods they can use to estimate the future electricity savings of energy efficiency programs and future electricity generation from renewable energy options. These direct electricity impacts serve as a basis for analyzing the benefits described in later chapters of this *Guide*, and help demonstrate the value of a policy, project, or program.

2.1. OVERVIEW

Policies and programs to improve energy efficiency and increase the use of renewable energy can have direct, measurable impacts on electricity demand and production. Estimating these impacts can help state officials:

- Demonstrate the electricity-related impacts of energy efficiency, renewable energy, and combined heat and power (CHP) programs
- Evaluate the potential impacts of new goals, targets, or legislative actions
- Evaluate the potential effectiveness (including cost-effectiveness) of technology- or sector-specific energy efficiency and renewable energy programs in saving electricity or increasing renewable energy generation
- Compare energy efficiency and renewable energy options under consideration

Estimates of potential electricity savings or renewable energy generation provide the foundation for all of the analyses described in subsequent chapters of this *Guide*. They form the basis for a comprehensive analysis of a program's multiple benefits—including benefits to the electricity system, economy, environment, and public health—and can help demonstrate the potential value of a program.

This chapter is designed to help analysts and decision makers in states and localities understand the methods, tools, opportunities, and considerations for assessing the direct electricity impacts of energy efficiency and renewable energy policies, programs, and measures. The range of methods and tools in this chapter is not exhaustive, and inclusion of a specific tool does not imply U.S. Environmental Protection Agency (EPA) endorsement. Although not the explicit focus of this chapter, energy efficiency and renewable energy initiatives can also affect the use of onsite fuels, such as natural gas. Many of the methods and tools to estimate direct electricity impacts can be used more broadly to determine other energy impacts, if desired.

Direct electricity impacts can be estimated prospectively, for planning purposes, or retrospectively, such as to evaluate the performance of initiatives after implementation. These two approaches may complement each other: for example, data from retrospective analyses can be used to inform prospective estimates of the impacts of new or expanded initiatives. This *Guide* is intended to inform analyses for planning purposes so it focuses mainly on techniques for estimating *prospective* electricity savings or renewable energy generation; i.e., impacts expected to occur in the future as a result of a state's proposed energy efficiency and renewable energy initiatives.[1] Section 2.4., "Tools and Resources," includes resources analysts can use to learn more about retrospective methods.

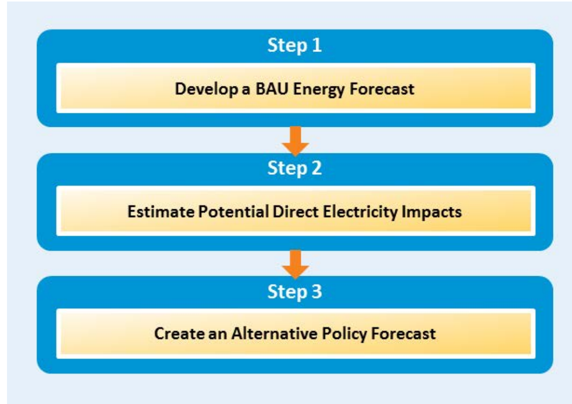
2.2. APPROACH

Direct electricity impacts for prospective analyses of future policies can be estimated using three steps as depicted in Figure 2-1 and described below:

[1] *For information on retrospective methods for estimating energy savings from energy efficiency, see the* National Action Plan for Energy Efficiency, Model Energy Efficiency Program Impact Evaluation Guide*, December 2012 (http://energy.gov/sites/prod/files/2013/11/f5/emv_ee_program_impact_guide.pdf), EPA's* Lead by Example Guide*, June 2009 (https://archive.epa.gov/epa/statelocalclimate/state-lead-example-guide.html), and EPA's* Draft Evaluation, Measurement, and Verification (EM&V) Guidance for Demand-Side Energy Efficiency*, August 2015 (https://blog.epa.gov/blog/wp-content/uploads/2016/12/EMV-Guidance-12192016.pdf).*

1. **Develop a business-as-usual (BAU) forecast** of energy supply and demand. This involves taking a look at the historical demand-and-supply portfolio within a state (i.e., developing the historical baseline), identifying any energy-related policies or modifications to existing ones that have been approved but not yet implemented, and then projecting demand and supply forward based on assumptions about the future. The projection is a BAU energy forecast that illustrates what energy demand, consumption, and supply will most likely be in the absence of additional energy efficiency and renewable energy policies (beyond those already considered in planning for future energy efficiency opportunities, energy supply requirements, and infrastructure needs).[2]

Figure 2-1: Steps to Estimate Future Electricity Impacts of Energy Efficiency and Renewable Energy



2. **Estimate the potential direct electricity impacts** from an energy-related target, from a proposed energy efficiency or renewable energy initiative, or from a portfolio of planned initiatives. These impacts include the expected electricity savings or renewable energy generation levels that are determined by estimating the impact on energy consumption levels and patterns of a specific policy approach, or the energy output from renewable resources.

3. **Create an alternative policy forecast** that adjusts the BAU energy forecast developed under Step 1 to reflect the electricity savings or renewable energy generation estimates developed in Step 2 in a new policy forecast. In the case of energy efficiency, the electricity savings estimates developed in Step 2 are subtracted from the BAU energy forecast developed under Step 1 to create a new policy forecast. For renewable energy supply alternatives, generation estimates from Step 2 are added to the BAU energy forecast. Both types of impacts are used to assess the overall effects of energy efficiency and/or renewable energy on the electric power system (in terms of what is displaced that otherwise would have been operated).

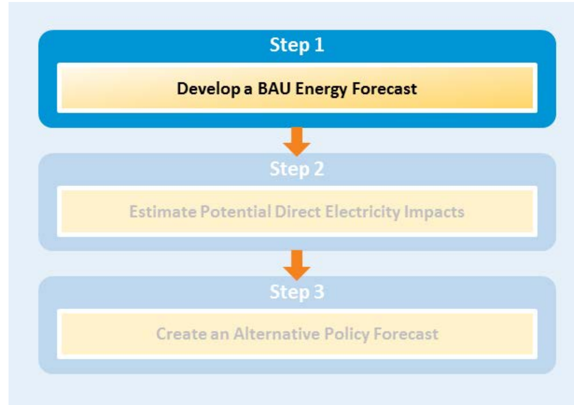
For each of the three steps, the remainder of this chapter describes a range of basic-to-sophisticated modeling methods, along with related protocols, tools, resources, and data analysts can use to quantify the direct electricity impacts of energy efficiency and renewable energy initiatives. Because many details and assumptions are involved in estimating energy efficiency or renewable energy generation and in creating an alternative policy forecast, an analyst needs to choose an approach that is appropriate to the scope of the analysis. As described below, the level of available resources (including budget, personnel, and data) often guides which approach and/or model, if appropriate, to select when developing an estimate of direct electricity impacts. For a quick comparison of policy alternatives, a top-down approach that looks at high-level impacts across the economy may be acceptable, whereas a bottom-up approach that provides greater sector-by-sector detail may be more appropriate for program planning and budget setting.

[2] *Analysts interested solely in electricity-related policies may limit the focus of their baseline forecast to electricity, but a more comprehensive energy baseline forecast can facilitate greater understanding of trade-offs and implications between sectors for cross-cutting policies, such as electrification.*

2.2.1. Step 1: Develop a BAU Energy Forecast

A BAU energy forecast illustrates what energy use will look like in the future, in the absence of additional policies beyond those already in place and planned. It typically includes current and confirmed future programs, such as regulations, standards, and existing energy efficiency programs. The forecast is a reference case against which to measure the electricity impacts of future policy initiatives or unexpected system shocks (e.g., severe weather-related disruptions in energy supply).

The six activities involved in developing a BAU energy forecast are shown in Figure 2-2 and described below.



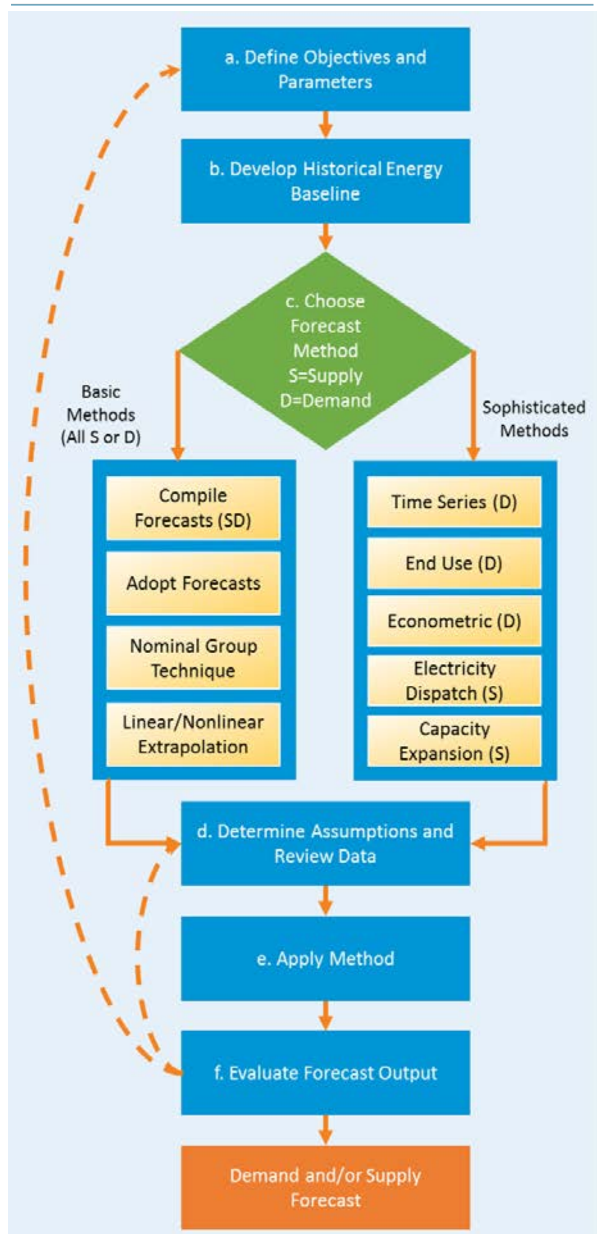
Step 1a: Define Objectives and Parameters

As part of the process to develop the BAU forecast, analysts:

- Decide if the forecast will be short- or long-term.
- Choose whether the forecast will be built up from estimates of changes at the end-use level (such as changes in the amount of energy used by buildings and equipment) or instead use a top-down model to estimate total sectoral or economy-wide demand.
- Determine the level of detail and rigor necessary (e.g., forecasts for regulatory purposes may have stricter requirements compared with a basic screening effort to evaluate options and impacts).
- Consider the availability of financial, labor, and time resources to complete the forecast.
- Verify the amount of energy data available to inform the forecast.

Collectively, these considerations help analysts choose whether to pursue basic or more sophisticated forecasting approaches.

Figure 2-2: Sample Framework for Developing a BAU Energy Forecast



Step 1b: Develop a Historical Energy Baseline

Establishing a historical energy baseline helps analysts understand energy use by sector, as well as their energy resource mix. A baseline can also be used as a yardstick against which to measure the projected energy impacts (such as reductions in demand) of proposed targets, policies, and initiatives.

A comprehensive energy baseline includes the following historical energy data:

- Consumption (demand) by sector or fuel
- Generation (supply) by fuel and/or technology

Consumption (Demand) Data by Sector or Fuel

- Consumption data are typically broken down by type of fuel and/or by the sectors that consume those fuels (i.e., commercial, residential, industrial, transportation, and utility). Each sector can be further disaggregated to show individual sources of energy consumption within that sector. For example, the industrial sector may be disaggregated to mining, construction, and manufacturing, and manufacturing can be further broken down to types of products such as textiles, paper, cement, and electronics.
- The type of consumption data needed for the historical baseline in a BAU forecast is dictated by whether the BAU forecast takes a top-down or bottom-up approach, as explained below.

Top-Down Baselines

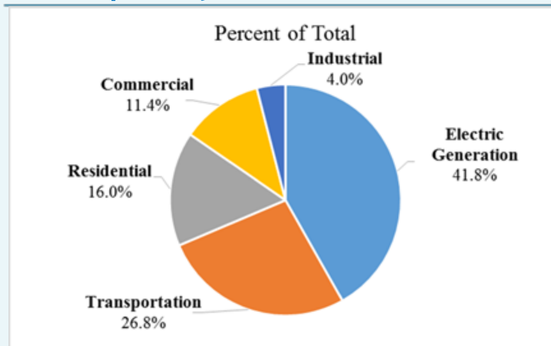
A top-down baseline, using data aggregated by fuel (e.g., natural gas, petroleum, coal, nuclear, and renewables) and sector (e.g. electricity generation, transportation, commercial, residential, and industrial), shows how a state's total energy consumption is spread across sectors. It can reveal trends and opportunities in sectors and help analysts identify which sectors seem most appropriate for further investigation and potential program intervention. A top-down approach would be appropriate if an analyst plans to evaluate or quantify the requirements of a broad, statewide energy efficiency or renewable energy goal.

For example, in 2015, New York released a State Energy Plan, which included a goal to use renewable energy to generate 50 percent of the state's electricity, increase building energy efficiency by 23 percent from 2012 levels, and reduce greenhouse gas emissions by 40 percent below 1990 levels by 2030.

Figure 2-3 illustrates an energy consumption baseline by sector that the New York State Energy Research and Development Authority (NYSERDA) developed. This top-down baseline helped analysts understand how the state's total energy consumption is spread across sectors (e.g. electric generation, transportation, residential, commercial, and industrial) and identify which sectors seem most appropriate for focusing their efforts (NYSERDA, 2013).

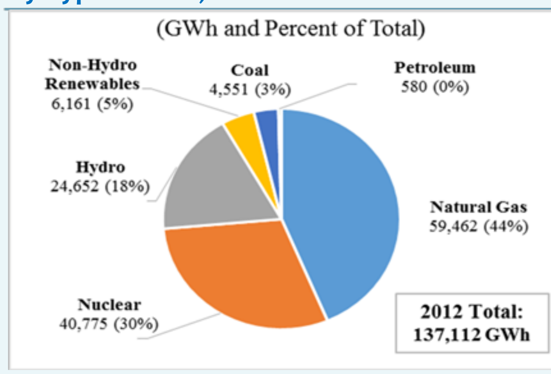
Figure 2-4 illustrates New York's supply-side baseline, which shows electricity generation by type of fuel for 2012, and Figure 2-5 shows how electricity consumption is spread across sectors. These baselines allowed the planning board to evaluate the impact of potential programs relative to baseline generation and consumption.

Figure 2-5: New York Primary Energy Consumption by Economic Sector, 2011



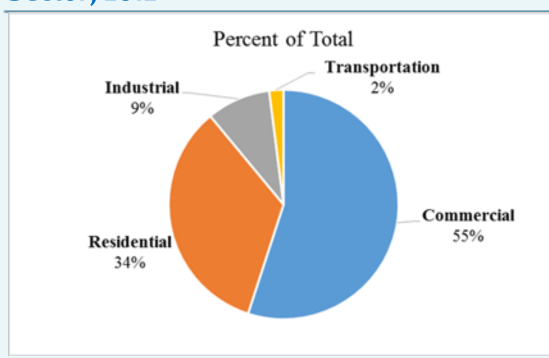
Source: NYSERDA, 2013, p. 4.

Figure 2-5: New York Electricity Generation by Type of Fuel, 2012



Source: EIA State Electricity Profiles, New York.

Figure 2-5: New York Electricity End-Use by Sector, 2012



Source: New York State Energy Planning Board, 2015, page 26.

Bottom-Up Baselines

An alternative or complement to the top-down approach is to develop a bottom-up baseline. A bottom-up baseline is very data-intensive but provides more information about activities within a particular sector than can be obtained from a top-down baseline.

The bottom-up approach is most appropriate if an analyst is exploring a sector- or technology-specific energy efficiency and renewable energy policy. For example, if a state or locality wants to explore which types of buildings are likely to have the greatest potential to help it meet an efficiency improvement goal for buildings, the analyst could develop a bottom-up baseline that depicts the amount of energy per square foot consumed by different types of buildings (e.g., hospitals, schools, low-income housing, and maintenance facilities). If it finds that particular types of buildings tend to consume more energy than others, it might focus on the most cost-effective and efficient opportunities for improvements within those building types.

Both past and future demand for energy reflect the economic and weather conditions of the state or the locality as well as the types and efficiencies of end-use appliances and equipment. Thus, bottom-up BAU forecasts often use a state's official economic projections as a starting point and typically assume normal weather conditions, as described later in this chapter.

Generation (Supply) Data by Fuel and/or Technology

Generation data typically include in-state electricity generation and, to be consistent with in-state consumption, may reflect electricity imports and exports. Electricity generation data also account for transmission and distribution (T&D) losses. As with consumption data, electricity generation data can be categorized by fuel type and sector.[3] Depending on a state's definition of "renewable," renewable fuels can include wood, landfill gas, pyrolysis liquid/gas, geothermal, hydro, solar photovoltaics (PV)/thermal, wind, and municipal solid waste.

There are many sources of consumption and/or generation-related baseline data, as shown in Section 2.4., "Tools and Resources," of this chapter. These sources provide different types of data, including historical and projected supply and demand for electricity, natural gas, and other fuels (discussed in the next section). Note that consumption and generation data (including projections) may not include the impacts of new policies that have been approved but not yet implemented; the impacts of those policies should be estimated and included in the BAU energy forecast.

Step 1c: Choose Forecast Method

Analysts can use a range of basic-to-sophisticated modeling methods to develop their BAU energy forecast and project energy supply and demand. These approaches are based on expectations of future population changes, energy data, and economics. They also depend on assumptions about the performance of current energy efficiency and renewable energy policies that are already included in the historical baseline. This section provides information about basic and sophisticated methods, data needs, and the respective strengths and limitations of each of the methods.

Basic vs. Sophisticated Methods

Basic methods may call for an analyst to either:

- Adopt assumptions made by utilities, independent system operators (ISOs), and regulatory agencies about the projected population, energy situation, and the economy; or
- Compile and develop its own assumptions.

[3] *Local energy baselines can focus on end-use sectors (i.e., residential, commercial, industrial, and transportation) and allocate the fuel used to generate electricity across the sectors that consumed the electricity.*

Basic methods are generally appropriate when conducting screening analyses or developing high-level forecasts when the amount of time or funding is limited or when the forecasted time period is short.

Sophisticated methods can be used for short- or long-term analyses. They provide greater detail than the basic methods, and can capture complex interactions within the electricity and/or energy system. Some analysts might want to consider a more sophisticated modeling method for their demand-and-supply forecasts when they want to:

- Better understand the effects of demand growth on their planned energy supply portfolio in the future, or
- Analyze the impact of significant changes in economic patterns (e.g., a dramatic decrease in housing starts) or energy costs on energy demand and supply.

The tools used in these more advanced methods vary in their complexity and cost. The most sophisticated methods are often data-, time-, and labor-intensive. They can lack transparency, involve software model licensing and data fees, and/or require a significant commitment of staff resources to develop expertise in a model. Unless the tool is used for broader or multiple analyses (e.g., statewide energy planning), it may be impractical for the state or local government to build the capacity to run these models in-house. However, most models are supported by one or more consultants who have access to data and who may be retained for specialized studies.

Basic Forecast Methods: Demand and Supply

Analysts can use a range of basic methods to forecast their BAU energy demand and supply without using rigorous, complicated analyses and software models. These methods generally produce aggregate information about a state's energy future, perhaps with a larger margin of error than more sophisticated approaches.

Basic approaches for forecasting energy demand and supply include a compilation of individual forecast by others, adoption of a preexisting forecast used by others, nominal group techniques, and linear/non-linear extrapolation, as described below.

- *Compilation of individual forecasts by others.* Energy plans from utilities, ISOs, and regulatory agencies often include a demand forecast that reflects electricity savings from energy efficiency programs. Similarly, a corresponding supply plan is likely to include data on existing and projected renewable energy sources, including CHP plants, if significant. Analysts can also aggregate individual load forecasts, generation expansion plans, and evaluations of energy efficiency and renewable energy programs from state agencies, utilities, ISOs, local educational institutions, and special interest groups, such as interveners in rate cases. Compiling forecasts created by different entities can be challenging, because they can vary significantly from each other in terms of underlying assumptions, proprietary concerns, data transparency (e.g., unit generation, costs), and time frame.
- *Adoption of a preexisting forecast used by others.* In some states, an energy office, utility commission, revenue department, or academic organization may have prepared a suitable energy forecast. The U.S. Energy Information Administration's (EIA's) Annual Energy Outlook includes regional demand forecasts. Also, utilities and ISOs may have their own specific forecasts. A regulatory filing requirement (e.g., an integrated resource plan) typically involves development of a comprehensive long-term plan that includes impacts from energy efficiency, reliable demand response, if any, and existing renewable energy plans.[4] However, there may be proprietary constraints to obtaining this information and these forecasts may reflect economic conditions that differ from those in the state where the policies are under consideration.

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[4] *For information about how utilities integrate energy efficiency into resource planning, see* Guide to Resource Planning with Energy Efficiency: A Resource of the National Action Plan for Energy Efficiency*, November 2007. See* https://www.epa.gov/sites/production/files/2015-08/documents/resource_planning.pdf*, or Lawrence Berkeley National Laboratory's 2016 report,* The Future of Electricity Resource Planning, *at* https://emp.lbl.gov/publications/future-electricity-resource-planning.

- *Nominal group techniques (NGTs).* NGTs are structured group discussions (in-person or through multi-stage questionnaires)[5] among a small group of experts or stakeholders to form consensus opinions, including expectations and assumptions for the future. They can be used to develop forecasts or to develop inputs to the preceding methods or more complex models. The type most commonly used in forecasting is the Delphi method.[6] Working with multiple experts in group discussions provides value, but the resulting forecasts depend strongly on which experts or other stakeholders are chosen.
- *Linear/non-linear extrapolation.* This method involves spreadsheet analysis where historical demand growth rates and electricity production trends (or trends from an alternative forecast) are used to extrapolate base-year data into the future. The accuracy of this approach depends on the accuracy of the "borrowed" growth rates, and the knowledge and experience of the analyst when applying historical trends. A strength of this approach is that it is easy to set data up in a spreadsheet and extrapolate it for preliminary forecasting. A limitation is that this method may result in an inaccurate forecast if it excludes important variables beyond demand growth factors and electricity—such as weather; season; plant retirements or construction, operation, or capital costs; emissions; or macroeconomic growth.

Table 2-1 summarizes the strengths and limitations of each basic method and describes when each can be used.

Table 2-1: Comparison of Basic Methods for Forecasting Energy Demand and Supply

Methods	Strengths	Limitations	When It Can Be Used
Compilation of individual forecasts by others	Easy to gather	Driven by different and in some cases outdated assumptions; proprietary concerns; possible short time horizons; may or may not provide information on construction requirements, fuel use, emissions, and costs; gaps in coverage	For high-level, low-cost, preliminary and quick analysis
Adoption of a complete forecast used by others	Easiest method	May not cover the desired timeframe; assumptions may not comport with desired state/regional outlook; may lack comparable geographic scope; may be proprietary	For high-level, low-cost, preliminary and quick analysis
Nominal group techniques (NGT)	Consensus building	Time consuming and may be relatively expensive	When input and buy-in from multiple experts are desired
Linear and/or non-linear extrapolation of baseline	Quick (easy to implement); more robust data analysis	May not capture impact of significant changes (e.g., plant retirements); possible errors in formulas, inaccurate representation of demand and supply	For high-level analysis with simple escalation factors based on history or from other sources; when generation dispatch by type of plant is known

Sophisticated Forecast Methods

Analysts may want to consider a sophisticated forecasting method when they require a more comprehensive understanding of their energy profile or when they have experienced or anticipate significant changes in their energy or economic patterns.

Sophisticated methods involve the use of data- and resource-intensive computer-based models to generate detailed forecasts that may reflect:

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[5] In multi-stage questionnaires, a first questionnaire typically presents a series of statements that participants rate on a scale. Responses to it are used to create the second questionnaire, which includes the individual respondent's rating for each statement together with the median rating from all participants for comparison.

[6] In Vermont, a similar approach was used through a public workshop process in which electric industry stakeholders provided their input on the state's energy plan.

- Historical trends
- Economic and/or engineering relationships
- Future expectations about prices
- Technologies and technology development
- Operating constraints
- Regulatory expectations (e.g., environmental regulations)

Whereas basic forecast methods are applied similarly to demand-and-supply forecasts, sophisticated approaches generate separate demand-and-supply forecasts that can be integrated once developed. As such, sophisticated models that apply the sophisticated methods for developing demand-and-supply forecasts are described separately below.

Demand Forecast

Once the historical baseline is developed, analysts can develop an energy demand forecast using time-series, end-use, or econometric models. These models can be used for short- and long-term load forecasting, comprehensive load analysis, modeling, and "day-after" settlement. Each model and its strengths and limitations are described below.

Time-Series Models

Time-series models apply a trend line to historical data and assume the future will roughly follow that line. These analyses are based on the assumption that the data (and the variable being forecast) have a structure or pattern, such as a trend and/or seasonal variation. Future events are forecast based on known past events and patterns. Inputs require an analysis of historical patterns in demand for electricity. Performing a time-series analysis can involve simply looking at aggregate demand and developing a forecast based on the pattern of that demand, or analysts may decide to perform a more detailed breakdown of the demand into customer type (e.g., residential, commercial, industrial) and application of each cyclical pattern over time to develop the total demand forecast.

Strengths of time-series models:

- *Simplicity.* These analyses are relatively straightforward to conduct.
- *Data availability.* Historical data are widely available by year, fuel, end-use, or sector (residential, commercial, and industrial).

Limitations of time-series models:

- *Data limitations.* Historical data may reflect technological changes and other unique phenomena that are unlikely to occur again, thus complicating or invalidating the forecast.
- *Structural limitations.* It is hard to reflect future structural changes even if they are anticipated.
- *Static relationships.* Time-series models cannot reflect dynamic supply-demand-price feedbacks.

End-Use Models

End-use models develop load profiles (charts illustrating variations in demand over a specific time) of each customer type—such as residential, commercial, and industrial—by analyzing the historical energy consumption of appliances and equipment, including the impact of any existing demand-side management (DSM) programs. They may also use specific surveys from customers about future growth and contraction. This approach can also include an economic forecast that provides gross state product (GSP) and consumer electricity prices.

Strengths of end-use models:

- *Reasonableness.* Use of load profiles for each customer class being served provides a reasonable estimate of demand.
- *Specificity.* Users can elect to use project-specific models to help assess building demand estimates.

Limitations of end-use models:

- *Time- and resource-intensive.* Collecting the data can require considerable time and expense.

Econometric Models

Econometric models quantify relationships over time between energy demand and variables that affect it, such as economic activity, energy prices, and weather. For example, the model output may show that as income increases, energy demand increases. These relationships can be applied in detailed demand and energy consumption forecasting. Econometric methods are sometimes used in combination with end-use methods. Examples of and more information about econometric models are provided in Chapter 5 of this *Guide*.

Strengths of econometric models:

- *Robustness.* They create a robust demand forecast if driven with a robust economic forecast.

Limitations of econometric models:

- *Time- and resource-intensive.* Significant time and cost may be required to prepare the inputs and review the results.

Supply Forecast

Utilities, ISOs, and other sophisticated energy market participants use economic dispatch or capacity expansion models for hourly, daily, monthly, and long-term forecasting of electricity supply. These models require large volumes of data on electric generating plants, transmission capabilities, and a demand forecast. As with any analysis, the better the quality of that data, the better the results. Although the costs to acquire the software and data may be prohibitive for some users, these models generally provide more comprehensive estimates on energy and capacity output than basic modeling approaches. The complexity of these models often results in agencies and stakeholders working with utilities to coordinate the application of the models in policy analyses and in regulatory proceedings.

Economic Dispatch Models

Economic dispatch models determine the optimal output of electric generating units (EGUs) over a given timeframe for a given time resolution (sub-hourly to hourly). These models generally include a high level of detail on the unit commitment and economic dispatch of EGUs, as well as on their physical operating limitations.

Key uses: An economic dispatch model typically answers the question: How will this energy efficiency or renewable energy measure affect the operations of *existing* power plants? Economic dispatch models provide forecasts of wholesale electric prices for each hour (i.e., system marginal costs) and the hourly operations of each unit that occur in the short term (0–5 years).

Capacity Expansion or Planning Models

Capacity expansion models determine the optimal generation capacity and/or transmission network expansion in order to meet an expected future demand level and comply with a set of national, regional, or state specifications.

Key uses: A capacity expansion model answers the question: How will this energy efficiency or renewable energy measure affect the composition of the fleet of plants in the future? A capacity expansion model typically takes a long-term view (5–40 years) and can estimate electricity sector impacts including the addition and retirement of power plants, rather than changes in how a set of individual power plants is dispatched. Some capacity expansion models include economic dispatch modeling capability, although typically on a more aggregated time scale than dedicated hourly dispatch models. Capacity expansion models that also include dispatch modeling capabilities can be used to address both the short and long-term implications of energy efficiency and renewable energy initiatives.

Table 2-2 compares the types of models covering both economic dispatch and capacity expansion (or planning) and lists examples of specific modeling tools. Information about the tools listed is available in Section 2.4., "Tools and Resources." These methods are described in more detail in Chapter 3, "Assessing the Electricity System Benefits of Energy Efficiency and Renewable Energy."

Table 2-2: Comparison of Sophisticated Modeling Methods for Forecasting Electricity Supply

Strengths	Limitations	When to Use This Method	Examples of Models[a]
Economic Dispatch			
▪ Provides very detailed estimations about specific plant and plant-type effects within the electric sector ▪ Provides highly detailed, geographically specific, hourly data ▪ Ideal for estimating wholesale electric prices and hours of operation and production	▪ Often lacks transparency ▪ Requires technical experience to apply ▪ May be labor-, data-, and time-intensive ▪ Often involves high labor and software licensing costs ▪ Requires establishment of a specific operational profile for the energy efficiency or renewable energy resource ▪ Cannot estimate avoided capacity costs from energy efficiency and renewable energy investments	Often used for evaluating: ▪ Specific projects in small geographic areas ▪ Short-term planning (0–5 years) and regulatory proceedings	▪ GE MAPS™ ▪ IPM® ▪ PLEXOS® ▪ PROMOD IV® ▪ PROSYM™
Capacity Expansion or Planning			
▪ Selects optimal changes to the resource mix based on energy system infrastructure over the long term (5–30 years) ▪ May capture the complex interactions and feedbacks that occur within the entire energy system ▪ Provides estimates of emissions reductions from changes to the electricity production and/ or capacity mix ▪ May provide plant-specific detail and perform dispatch simultaneously (IPM) ▪ Designed specifically for resource planning ▪ Can estimate avoided capacity costs	▪ Often lacks transparency due to complexity ▪ Requires significant technical experience to apply ▪ May be labor- and time-intensive ▪ Often involves high labor and software licensing costs ▪ Requires assumptions that have a large impact on outputs (e.g., future fuel costs)	Used for long-term studies (5–40 years) over large geographical areas such as: ▪ SIPs ▪ Late-stage resource planning ▪ Statewide energy plans ▪ Greenhouse gas mitigation plans	▪ AURORA ▪ DOE's NEMS ▪ EGEAS ▪ e7 Capacity Expansion ▪ e7 Portfolio Optimization ▪ ENERGY 2020 ▪ EPA's GLIMPSE ▪ IPM® ▪ LEAP ▪ NREL's ReEDS ▪ NREL's RPM

[a] For more information about individual tools, see Section 2.4., "Tools and Resources."

Step 1d: Determine Assumptions and Review Data

After choosing the forecasting approach or model type, the next step is to determine or review assumptions about population, energy, and economic variables, such as energy prices, existing energy efficiency programs, productivity, GSP, and the labor force upon which projections of energy demand and supply depend. If the BAU forecast is adopted from another information source, such as EIA's Annual Energy Outlook, regional transmission organization (RTO), or regional council, it is useful to review the growth rates, policy assumptions, and economic conditions to ensure they represent a state's best available assumptions and are aligned with the goals of the forecast.

It is also useful to review possible data sources and collect the data required for the analysis. The following types of data are used in estimating energy consumption and supply baselines and forecasts:

- *Population data* are used to estimate the amount and types of demand expected in the future and to examine trends.
- *Economic variables* are projected as they relate to energy so that the analyst can better understand the historical relationships between energy and the economy, and anticipate how these relationships may exist in the future.
- *Electricity and fuel prices* are projected using assumptions as to how they may change in the future based on supply and demand expected.
- *Impacts of existing and on-the-books energy efficiency programs* avoid the double-counting of impacts, as described in the box "Projecting Future Emissions from the Power Sector."

For a list of available data sources for this information, see Section 2.4., "Tools and Resources."

Almost all providers of economic dispatch and capacity expansion models also offer a data set that can be used to apply these models to a regional electricity system. Data from any source must be examined to ensure that they are consistent with the assumptions of the entities that will use the model results, and to check for outliers, errors, and inconsistencies in the data. Typically, the data available for a historical baseline and BAU forecast lag several years. For this reason, the current and most recent years may be part of the forecast and not the history. It is important, therefore, to ensure that the data derived for recent years reflect the current energy supply and demand as much as possible.

At this point in the process, it may be necessary to review the data to detect and remove corrupt or inaccurate records and/or fill in any data gaps. If data points are missing for particular years, it may be necessary to interpolate the existing data or use judgment to fill in gaps. This will minimize the likelihood of generating results based on calculations that are skewed due to missing or out-of-range data, producing an inaccurate forecast. Some private data providers also offer data cleaning services. Practical application of any of these data bases, however, requires due diligence in looking for data outliers, missing values, and screening for errors in data. It is rare for users to obtain a fully clean data set, consistent with their individual assumptions, from any one source.

Step 1e: Apply Forecast Method

The next step is to apply the selected method or model to forecast the historical baseline energy data, based on the assumptions about future population, economic, and energy expectations. Clearly documenting the assumptions used in the forecast is a key aspect of this step. When documenting an energy forecast, consider both the historical baseline (using consumption or generation data) and the expected impacts of any energy policies that have been approved but not yet implemented (and thus not reflected in the baseline). A historical baseline alone may not accurately represent BAU; the impacts of policies that are already "on the books" but not yet in force also need to be considered in the BAU forecast. Clearly documenting the expected impacts of energy efficiency policies already incorporated in the historical baseline and BAU assumptions helps avoid double-counting when examining future program potential or impacts and builds credibility. When using a model, it is worth taking time to verify whether the assumptions are documented in a transparent way, and to ensure that the analyst has a solid understanding of the basic operations of the model (i.e., the algorithms used to produce the model outputs).

PROJECTING FUTURE EMISSIONS FROM THE POWER SECTOR

Projecting future emissions from the power sector normally requires information from an electricity demand forecast as a basis for predicting how future generation requirements will grow over time. Many demand forecasts are available, including EIA's Annual Energy Outlook. For any forecast, it is important to understand the underlying assumptions, including which energy efficiency and renewable energy programs are already incorporated in the forecast.

EPA has developed a methodology that states can use to estimate the energy impacts of key energy efficiency and renewable energy on-the-books policies that are not explicitly reflected in the EIA's Annual Energy Outlook electricity projections, and include them in their baseline projections. These policies include Energy Efficiency Resource Standards, dedicated sources of energy efficiency program funding that are adopted in state law and/or codified in rule or order, such as programs funded by RGGI, public benefits funds and forward capacity market revenues. EPA solicited peer and public review of its methodology, and comments received have been addressed and incorporated into a paper (*Including Energy Efficiency and Renewable Energy Policies in Electricity Demand Projections*) that describes the methodology, available at https://www.epa.gov/sites/production/files/2015-08/documents/including_ee_and_re_policies_in_ed_projections_03302015_final_508.pdf.

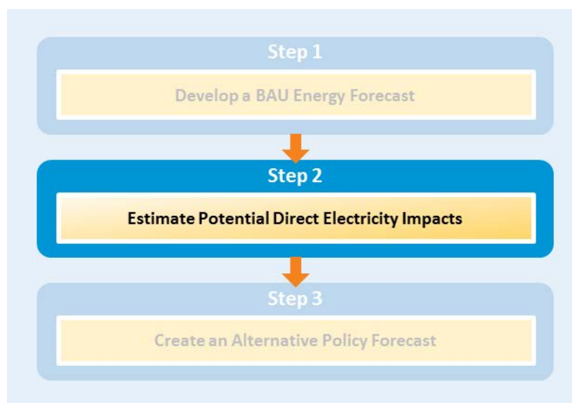
EPA originally developed this methodology to illustrate how energy efficiency and renewable energy policies could be accounted for in the context of National Ambient Air Quality Standards (NAAQS) State Implementation Plans (SIPs), but the basic methodology can be used by states to develop baseline projections that include a more complete set of policies than those considered in EIA's Annual Energy Outlook projections.

Step 1f: Evaluate Forecast Output

The last step of developing a BAU energy forecast is to review the output to ensure that it is realistic and meets the original objectives. If the analyst determines that any of the forecast does not seem realistic, he or she may need to revisit assumptions and then reapply the approach or model to achieve an acceptable forecast.

Technologies change over time and can alter energy savings estimates. This can alter the BAU forecast and the potential for energy savings. BAU forecasts and energy savings projections should be reevaluated periodically (every 1 to 2 years). This is particularly important under conditions of rapid change.

2.2.2. Step 2: Estimate Potential Direct Electricity Impacts



Once the BAU energy forecast is complete, the next step is to estimate the potential direct electricity impacts of the proposed energy efficiency and renewable energy programs or policies that are under consideration. Direct electricity impacts include:

- Electricity savings from new energy efficiency initiatives
- Electricity production from new renewables
- Electricity savings, if any, from other new electricity supply options such as CHP and distributed generation

Analysts can estimate the direct electricity impacts from broad goals and targets, often using top-down approaches that look at high-level impacts across the economy, or from specific policies or programs, typically using bottom-up approaches that provide greater sector-by-sector detail. Approaches to estimating both types of direct electricity impacts are described below.

Step 2a: Estimate Potential Direct Electricity Impacts of Broad Goals and Targets

If a state or locality has or is considering a broad energy efficiency and/or renewable energy goal, it is helpful to estimate the potential impacts of the goal before evaluating specific energy efficiency and/or renewable energy programs and implementation options. For example, an analyst may need to quantify—in terms of kilowatt-hours (kWh) or Megawatt-hours (MWh)—the requirements of an energy efficiency goal or target. If the policy or goal is to have zero growth in electricity demand over the next 10–20 years, it would be necessary to estimate how much energy efficiency would be required to meet that goal. Alternatively, the analyst may need to quantify the impacts of a renewable portfolio standard. These estimates will indicate how much electricity must be saved each year, or how much renewable energy must be provided, respectively, to meet the goals.

ENERGY EFFICIENCY POTENTIAL STUDIES

Energy efficiency potential studies are quantitative analyses of the technical, economic, or achievable/program potential of energy efficiency policies and programs. Many states have used energy efficiency potential studies to make the initial case (or support continued/increased funding) for energy efficiency programs and measures. States have also used potential studies to identify alternatives to new generation, or to identify the specific market sectors, geographic areas, end uses, measures, and programs that have the greatest potential for cost-effective energy savings, or as basis for setting goals/targets such as EERS.

U.S. DOE has developed a catalog of state energy efficiency potential studies, available at http://energy.gov/eere/slsc/energy-efficiency-potential-studies-catalog.

An estimate of direct electricity impacts shows only what the goal or target could achieve. It is not focused on estimating what is cost-effective, what the market might adopt, or when the specific technologies might be adopted. The electricity estimates of any goals, therefore, should be checked against existing energy efficiency or renewable energy potential studies (see box "Energy Efficiency Potential Studies") to make sure they are plausible.

Methods for Estimating Potential Direct Electricity Impacts of Broad Goals and Targets

Methods for these estimates can include both basic and sophisticated approaches, but these high-level estimates will most likely require only the most basic approaches because the focus is simply on quantifying the meaning of the goal (e.g., a 2 percent reduction in demand per year implies a savings of x MWh). Basic approaches typically start with a BAU energy forecast as developed under Step 1. This can be a key input in the effort to determine electricity savings or energy efficiency and renewable energy supply required. The exact methodology chosen, however, will depend on how the goal or target is specified and a host of other factors, such as whether the electricity savings from efficiency are measured from the BAU forecast or from prior years' sales. Also, the extent to which existing programs do or do not count toward the target may affect the calculations. It is helpful for the analyst to think through the details of the goal, policy, or legislation, and how they might affect the methodology and calculations.

THREE EXAMPLES OF STATE ENERGY TARGETS OR GOALS

- Have a rate of zero load growth by 2020.
- Reduce electricity demand by 2 percent per year by 2025, and 2 percent every year thereafter, with reductions to be based on prior three years' actual sales.
- Require utilities to meet 20 percent of generation (or sales) through renewable energy sources by some date in the future (sometimes with interim targets). In some instances, the eligible resource types (including existing), the required mix of renewables types, and geographic source of the renewables may be specified.

Suppose an analyst is determining the anticipated electricity savings or generation needed to achieve an energy efficiency or renewable energy initiative in a target year, such as a renewable energy target to build 100 Megawatts (MW) of wind power capacity by 2020. If appropriate financial incentives are in place to encourage construction of the wind facility, the electricity available in the year after 100 MW of wind facilities are placed in service can be estimated at a very basic level as: 100 MW * 0.28 capacity factor[7] * 8,760 hours/year = 245,280 MWh/year.

[7] Capacity factor is defined as the ratio of the electrical energy produced by a generating unit for the period of time compared to the electrical energy that could have been produced at continuous full power operation during the same period. Typical monthly capacity factors for wind range from 20 percent to 40 percent; see http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_6_07_b.

An important activity in this example would be to ensure that the capacity factor chosen is applicable to the wind resource being considered. The output of a wind turbine depends on the turbine's size and the wind's speed through the rotor, but also on the site's average wind speed and how often it blows. Data to assess appropriate capacity factors can be identified based on geographic data on wind class (speed). Various guidance resources are available to aid in determining capacity factors and are listed in Section 2.4., "Tools and Resources."

Alternatively, suppose a state agency is considering an Energy Efficiency Resource Standard (EERS) that calls for a 22 percent reduction in electricity sales between 2020 and 2030, based on the achievable potential identified by an energy efficiency potential study. An analyst might estimate the annual impacts of the policy as outlined below (with calculations illustrated in Table 2-3).

First, the analyst needs to develop a pathway, with annual percentage savings targets, that would assure the 22 percent total reduction is reached by the target year. Table 2-3 shows one possible pathway with column 3 showing incremental annual increases in percentage savings from the previous years' sales until the 22 percent target is reached. Next, the analyst applies each year's percentage savings target in column 3 to the previous year's sales in column 2, to calculate energy efficiency savings required. Column 4 shows the cumulative electricity savings required to meet each year's percentage savings target and column 5 shows the cumulative level of electricity savings in kWhs for each year.

Table 2-3: Example of Estimation of Required Energy Efficiency Savings Based on Long-Term Savings Goal or Performance Standard (KWh)

1	2	3	4	5
	Retail Electricity Sales (kWh)	**Annual Electricity Savings as a Percentage of Retail Sales in Prior Year**	**Cumulative Electricity Savings (%)**	**Required Cumulative Electricity Savings (kWh)**
2020	100,000,000			0
2021	100,750,000	1.25%	1.25%	1,250,000
2022	101,017,500	1.75%	3.00%	3,022,500
2023	101,069,925	2.00%	5.00%	5,050,875
2024	100,915,646	2.25%	7.25%	7,327,570
2025	100,821,094	2.25%	9.50%	9,586,986
2026	100,517,711	2.50%	12.00%	12,098,531
2027	100,293,499	2.50%	14.50%	14,575,068
2028	100,116,043	2.50%	17.00%	17,049,895
2029	99,986,628	2.50%	19.50%	19,522,628
2030	99,902,384	2.50%	22.00%	21,997,058

Although the actual path that is followed or the estimates of achieved savings (quantified using evaluation, measurement, and verification [EM&V]) may differ from those shown in this simple exercise, this type of calculation gives an indication of the implications for program requirements and the resulting impact on growth.

If the state has an emissions-related goal, this type of quick, top-down analysis can then be linked to emissions data to determine what portion of the state's emissions targets could be met with a specific percentage EERS. Similar linkages could be made to economic or other goals as well.

Considerations

Factors analysts can consider when estimating the impacts of targets and goals for electricity demand and resources include:

- The historical baseline level of electricity demand and supply (described earlier in this chapter)
- Expected growth over time under BAU (described earlier), including any ongoing energy efficiency or renewable energy efforts that may or may not contribute to the new goal, but will influence baseline conditions
- The likely persistence of energy efficiency savings over time (or changes in the supply of renewable energy)
- Other considerations that may affect the level of savings or supply required, such as rebound effects[8] in energy efficiency programs
- The remaining electricity demands (or supply) after the impacts occur

Quantifying the impacts of broad goals and targets typically requires straightforward mathematical calculations, as shown above, and do not usually involve sophisticated approaches. However, advanced modeling and economic analysis may be required if, for example, a goal or target is tied in some way to an economic indicator or requirement (e.g., if a goal or target has some circuit-breaker or threshold provision, for example, requiring that only energy efficiency costing less than a certain amount be required), or has some dynamic aspects to it (e.g., changing targets in response to achievements).

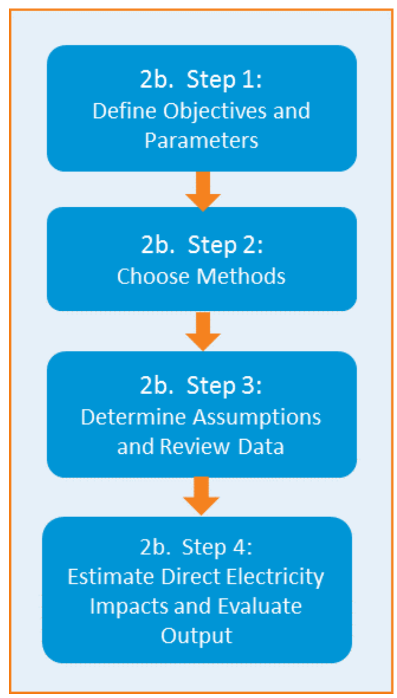
Step 2b: Estimate Potential Direct Electricity Impacts of Specific Policies, Programs, or Measures

Step 2a demonstrated how estimates of potential direct electricity impacts can be developed to evaluate a *goal or target*. Step 2b discusses ways to estimate the expected results of a specific *policy or program* that is under consideration and has been sufficiently defined to allow meaningful analysis (see Figure 2-6).

For example, under Step 2b, an analyst might be looking to estimate:

- The impact of appliance standards in a way that considers the existing stock, current efficiency levels, and consumer decision-making
- The expected response to a utility energy efficiency program, with or without specific information on program focus (what sectors and end uses) and design challenges (e.g., rebate levels)
- The impact of a renewables incentive program

Figure 2-6: Steps to Estimate Direct Electricity Impacts of Specific Policies, Programs, or Measures



[8] *Energy efficiency reduces the cost of operating energy-consuming technologies. In response, people tend to increase their use of those technologies, partially offsetting the gains from energy efficiency. This phenomenon is known as the rebound effect.*

See the box "Policies and Programs for Which Energy Impacts Might Be Estimated" for more examples.

Estimating the potential direct electricity impacts of specific policies, programs, or measures under Step 2b involves the following sub-steps:

1. Define objectives and parameters.
2. Choose method to estimate potential direct electricity impacts.
3. Determine assumptions and review available data.
4. Estimate direct electricity impacts and evaluate output.

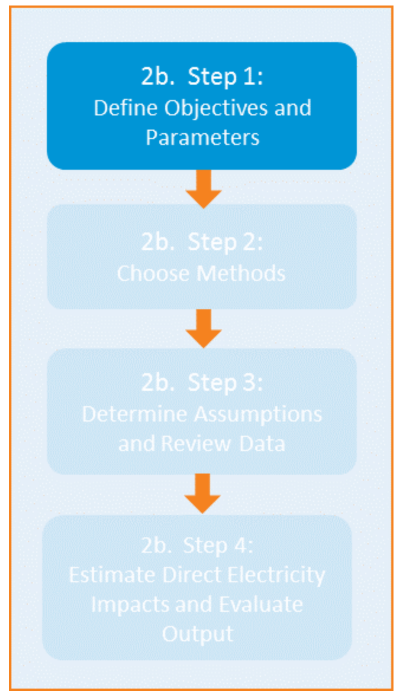
Each of these activities is described in detail below.

POLICIES AND PROGRAMS FOR WHICH ENERGY IMPACTS MIGHT BE ESTIMATED

- Energy efficiency resource standards
- Renewable portfolio standards
- Appliance standards
- Building codes
- Public benefits funds (to fund state or utility-run efficiency or renewables)
- Energy efficiency and renewable energy tax or other financial incentives
- Rebate programs
- Lead by example programs

2b. Step 1: Define Objectives and Parameters

The process of estimating potential direct electricity impacts begins by defining the objectives and parameters of the energy impacts that the analyst plans to estimate. If the objective is to quantify the required electricity savings and/or renewable energy generation from a planned energy efficiency and/or renewable energy initiative or goal for the state legislature, for example, the parameters of the analysis may already be dictated. For example, the legislature has likely specified a due date, a time period to be analyzed, and a desired level of rigor, and may even have required the government to spend a certain amount of money on the analysis. Other analyses, such as those conducted to screen a range of energy efficiency and/or renewable energy options based on a range of benefits, may be less defined.

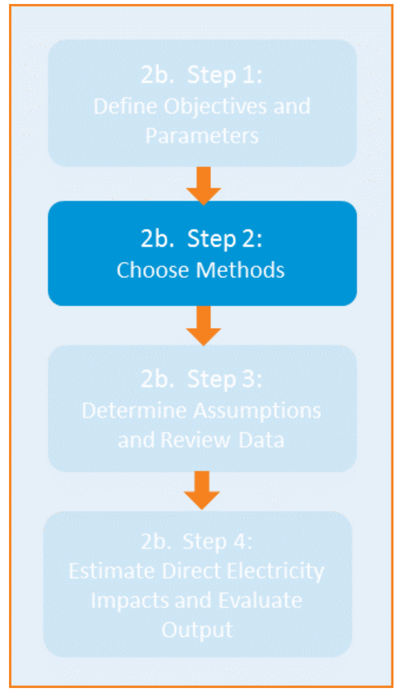


Analysts should consider the following parameters before choosing an analysis method, model, or dataset(s) to use:

- *Time period for the direct electricity impacts*: Is it a short-term or longer-term projection?
- *Timeliness of the estimates*: Is this due next week or in a year?
- *Level of rigor necessary* to analyze policy impacts: Is this for a screening study or a regulatory analysis that is likely to be heavily scrutinized?
- *Availability of financial, staff, and outside resources* to complete the analysis in the required time period: Is there a budget available for the analysis? Does the agency have internal modeling capabilities?
- *Amount of data available*, or that can readily be acquired, to develop the savings estimate: Are there existing energy efficiency and renewable energy potential studies or similar projects elsewhere that can be adapted to the analysis?

These factors will help analysts choose between simple and more rigorous approaches based upon specific needs and circumstances.

2b. Step 2: Choose Method to Estimate Potential Direct Electricity Impacts



Assessing the potential impacts of energy efficiency or renewable energy programs requires "bottom-up" techniques that build up estimates of impacts based on the considerations described above, along with the fundamentals of the technology, the economics, and market behavior. Bottom-up approaches involve estimating potential energy savings at a very detailed level and rolling up these estimates to the initiative or policy level.

Bottom-up analyses can involve basic calculations, detailed surveys, and/or sophisticated spreadsheet analyses or tools. At a minimum, the analysis will require some level of detail about:

- Individual measure savings or renewable energy generation that can be rolled up into an aggregate estimate or statewide strategy
- Saturation of energy efficiency or renewable energy equipment in the market so that the analyst can determine how much opportunity for new investment is feasible when compared against energy efficiency potential studies (see the box, "Using Energy Efficiency Potential Studies," for more information about these studies)

Depending upon the level of detail desired, estimating the potential impacts can require large amounts of data and, for the more detailed analyses, may be costly. For this reason, analysts often use a combination of methods that involve adapting existing surveys and studies by utilities, trade groups, other states, or the federal government where appropriate and conducting new analyses to fill information gaps or to determine the localized or detailed effects of the proposed policy or program. These two approaches are described below.

Adapt Existing Studies

To reduce time and expense, analysts can explore existing bottom-up studies of similar programs in their state or other states, and adapt the results to their conditions. At the aggregate level this basic method may involve scaling results to the state's BAU energy forecast, perhaps accounting for sectoral share differences if data are available at the sectoral level. For estimates of individual measure or site-level impacts associated with energy efficiency and renewable energy measures, analysts can look to available retrospective studies that can be extrapolated into prospective savings based on an understanding of the state's sectoral and end-use mix. Many resources are available that can provide historical results and/or projected energy efficiency and renewable energy savings, including those listed in Section 2.4., "Tools and Resources."

Analysts can also capture useful data from available potential studies that support the energy efficiency and renewable energy policy decision. For example, a potential study conducted for another state may contain valuable information on the electricity savings associated with different energy efficiency and renewable energy programs, and deemed savings databases from other states will include energy savings for specific energy efficiency measures.[9] Public service commissions' websites usually post utility DSM filings and integrated resource plans, which contain details on energy efficiency and renewable energy plans with estimated electricity impacts.

When using data from other states or regions, it is best to choose areas that have similar climate and customer characteristics. Even so, the assumptions about operating characteristics of different energy efficiency and renewable energy technologies typically need to be adjusted for the specifics of the geographic location that is the focus of the

[9] *Deemed savings are validated estimates of energy savings associated with specific energy efficiency measures that may be used in place of project-specific measurement and verification.*

study. For example, for energy efficiency measures, adjustments for differences in weather are typically made, along with adjustments for state-specific population characteristics.

TOOLS FOR DIRECT SAVINGS OR GENERATION ESTIMATES

Many modeling and analytics tools are available to help analysts estimate the potential direct electricity impacts of energy efficiency and renewable energy measures. An overview of these tools is presented in Section 2.4., "Tools and Resources."

Estimates adapted from existing studies can be summed across the populations in each sector, remembering to subtract the market penetration levels for the energy efficiency and renewable energy measures that are already installed (based on the saturation data, described in greater detail in the box below, "Saturation of Energy Efficiency or Renewable Equipment and Practices"). When adapting existing studies to evaluate renewable energy options, decision makers should correct for the relative resource base available given that states have different levels of renewable energy resources (e.g., wind, solar) available.

SATURATION OF ENERGY EFFICIENCY OR RENEWABLE ENERGY EQUIPMENT AND PRACTICES

It is valuable to understand how much equipment is already in the market so that analysts can determine a feasible level of investment that a new energy efficiency and renewable energy program or policy could induce. Similarly, information on the prevalence of energy-efficient practices in operations and maintenance (O&M) can inform estimates. The equipment and practices saturation data are typically determined using one or more methods, including:

- *End-use customer saturation surveys.* These surveys provide a relatively cost-effective method of estimating saturation levels for both standard and efficient equipment as well as energy-efficient practices. These on-site, telephone or Internet surveys are conducted to gather information regarding the end-use equipment currently installed at a statistical sample of homes and businesses.
- *Site visits.* Facility managers can provide high-quality estimates of equipment saturations and energy-efficient practices. However, due to the tremendous amount of energy consumption represented by large nonresidential facilities, and the limited amount of program audit data available, it is often necessary to conduct primary data collection at a sample of sites that represent the sub-sectors in the population.
- *Survey of retailers.* Retailers can provide important insight into the market share and saturation of many products, including programmable thermostats, water heaters, clothes washers, clothes dryers, and refrigerators.
- *Surveys of building code officials, builders, architectural and engineering firms, and other trade allies.* These data can also be used to characterize the equipment saturations in the new construction and retrofit markets if samples are carefully selected and appropriate surveys developed. Interviews with contractors, dealers, distributors, and other trade allies provide a cost-effective research approach, as business activity tends to be concentrated among relatively few of these market actors. Interviews can also be used to assess market share and saturation for multiple sectors.

Once equipment saturation and the prevalence of energy-efficient practices are understood, analysts can compare them against energy efficiency potential studies to determine the feasible level of investment opportunity available.

As an example of this kind of approach, imagine a state agency that is considering a new efficiency standard for air conditioning. Analysts at the agency could estimate electricity savings based on a variety of already available data, such as measure-specific electricity savings from a deemed savings database from another state (e.g., the California Database of Energy Efficiency Resources or the Michigan Energy Measures Database), and adjust the measure-specific savings to account for the weather zones present in the state, especially for weather-specific measures such as air conditioning with a high Seasonal Energy Efficiency Ratio (SEER). These adjustments might require the use of building simulation models (e.g., eQuest; see Section 2.4., "Tools and Resources") to get reasonably accurate estimates of electricity savings at the site level. These site-level savings would ideally be generated for each housing type, air conditioning rating level above federal standards, and weather zone. This can create a large matrix of possible combinations.

Determining historical baseline market penetration of the higher efficiency technology without conducting surveys of heating, ventilation, and air conditioning dealers can be accomplished by reviewing studies of market penetration rates from another state or states. These studies would need to be from states that had not already adopted a higher efficiency technology standard, and the results of the studies would need to be adjusted for demographic differences between the states.

Combined with some thoughtful analysis, these data can help define the potential electricity savings for the proposed air conditioning measures without incurring the time and expense of collecting all new data. Making choices about which data to use and how to adjust those data involves inherent trade-offs between the expected accuracy and the level of effort expended. Some analysis of the uncertainty surrounding each key variable is recommended to understand the relative accuracy of the estimates obtained through this method.

In a similar manner, an analyst looking to estimate of the potential renewable energy generation associated with a renewable portfolio standard (RPS) can use data from surrounding states and/or those that have adopted similar rules regarding the implementation of their RPS. For example, an analyst might look at adoption rates for roof-mounted solar PVs in other states that have similar net metering rules for solar systems and have established incentives for installation that reward end-users and developers in a similar manner financially.[10]

Assumptions regarding the electricity production of the system, financial discount rate, and other factors must be reviewed and projected to estimate attractive rates of return that will stimulate the market at the project level.

Extrapolating the project-level analyses to the statewide population requires demographic data, information on the current status of the solar industry in the state, and data on the current economic client to estimate a range of renewable energy generation levels that could be achieved over a given time period.

EXTRAPOLATING ENERGY EFFICIENCY DATA USING EXAMPLES FROM OTHER STATES

The Vermont Public Service Department updated its energy efficiency potential report in 2014. The report is designed to quantify the potential of electric energy efficiency to reduce both electricity consumption and peak demand in Vermont. The report updated previous assumptions on savings, cost, and useful life data using Technical Reference Manuals (TRMs) and evaluation from other states. Vermont used assumptions for other states that were relevant and applicable to its own economic and weather conditions. For example, Vermont modified the energy savings potential for weatherization and HVAC equipment measures based on Vermont-specific housing characteristics.

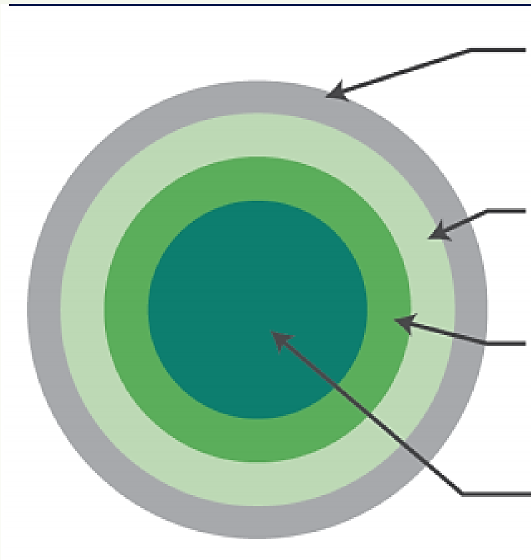
Conduct New Analyses

Analysts will typically conduct new analyses when no relevant or recent analyses are available or easily adaptable, or when they are seeking very localized or tailored detail about potential site-level or program-level impacts.

A new analysis of direct electricity impacts from a specific policy or program can involve the development of an energy efficiency or renewable energy potential study (see Figure 2-7) if a recent one is not available. A potential study can let the analyst know how much opportunity is available to pursue energy efficiency or renewable energy in the state so that they can make reasonable assumptions. Detailed guidance for energy efficiency potential studies is available in EPA's *Guide for Conducting Energy Efficiency Potential Studies*, at https://www.epa.gov/sites/production/files/2015-08/documents/potential_guide_0.pdf.

[10] If the comparison state's financial incentives took the form of an upfront rebate, and a future revenue stream based on renewable energy certificates is assumed for the state being analyzed, then a discounted cash flow analysis would be required to analyze the net present value of each approach to the project owner and solar developer to compare the costs of the two approaches fairly.

Figure 2-7: Using Energy Efficiency Potential Studies



To estimate the potential savings of energy efficiency and renewable energy measures, analysts can conduct simple analyses by extrapolating the results of existing energy efficiency or renewable energy potential studies. These studies may be sector-specific (residential, commercial, industrial), or aggregated at a geographic level (state or region). They may reflect technical potential, economic potential, achievable potential, program potential, or all four. If only the technical and economic potential are estimated, the analysis should consider what is achievable

EPA developed guidance in 2007 (still relevant today) on conducting an energy efficiency potential study. See the *Guide for Conducting an Energy Efficiency Potential Studies: A Resource of the National Action Plan for Energy Efficiency*, November 2007 at https://www.epa.gov/sites/production/files/2015-08/documents/potential_guide_0.pdf. U.S. DOE also provides a catalog of energy efficiency potential studies at http://energy.gov/eere/slsc/energy-efficiency-potential-studies-catalog.

A number of modeling and analytic tools are available to help analysts estimate potential site-level or program-level electricity impacts that can be aggregated up to the state level. For example, building simulation tools, such as EPA's ENERGY STAR® Portfolio Manager® or DOE's eQuest model, can be used to estimate energy savings per building and scale up to larger portfolios. The free RETScreen® model can evaluate energy production and savings, costs, risk, emissions reductions, and other characteristics of energy efficiency and renewable technologies. Section 2.4., "Tools and Resources," lists a number of these tools and related resources.

Analysis of a renewable energy policy or program would examine the costs and operation of eligible renewable resources and their interaction with the existing (and planned future) generation system. This type of analysis is often more complex, and may require a more sophisticated approach. Guidance for renewable energy potential studies is available in *A Framework for State-Level Renewable Energy Market Potential Studies*, published by the National Renewable Energy Laboratory, at https://www.nrel.gov/docs/fy10osti/46264.pdf.

As an example, imagine that a state agency wants to determine the energy impacts from a proposed lead-by-example policy of reducing energy consumption by 20 percent in all state-owned buildings by 2030. The first step in the process would be to gather historical baseline data on energy consumption for state-owned facilities, along with the square footage associated with each facility. These data may take some time and effort to gather, as they do not typically reside in one file or with one person. The baseline data will allow analysts to calculate target kilowatt-hour (and therm reductions) across all facilities. If the policy will reduce energy consumption in existing buildings alone, calculating the savings number is as simple as determining whether each facility will achieve 20 percent savings, or whether the portfolio as a whole will achieve a 20 percent reduction in annual consumption. Either way, it is a straightforward exercise to take 20 percent of the total kWh (and therms) consumed for the base year.

If the policy will include new construction as well, analysts would need to determine the baseline construction for new state facilities in the absence of the initiative, as well as the energy consumption associated with facilities built to that evolving standard multiplied by the square footage of planned additions.

To build a true bottom-up analysis of savings, analysts will need to find where the 20 percent savings are likely to come from. Individual building audits will provide the best data on where to achieve savings, and can be summed by end-use, facility, and organization up to the state level. This process is relatively expensive and time consuming; a first-level screening could involve benchmarking the facilities with national averages and best-practice energy consumption per square foot.[11]

After initial screening, walk-through audits can be used to confirm where to target the most cost-effective initial investments. Most cost-effective energy efforts start with lighting retrofits, as they are a proven energy savings that can be easily achieved. Heating, ventilating, and air conditioning (HVAC) improvements or control system upgrades will require a more detailed audit, often take longer to complete, and require less modular investments. Engineering algorithms or simulation models are used to estimate the savings from HVAC and other energy efficiency measures, and to estimate interactive effects that may decrease the combined savings of individual measures.

The level of detail desired may depend on the purpose of the estimates. If, for example, agency budgets were determined based on their energy savings, a more detailed analysis would provide better information about specific technology performance and payback than a screening-type of analysis. Regardless of the level of detail, the analyst would sum up the measure and building savings estimates across all facilities to assure that the 20 percent by 2030 statewide target can be met within the budgets allocated.[12]

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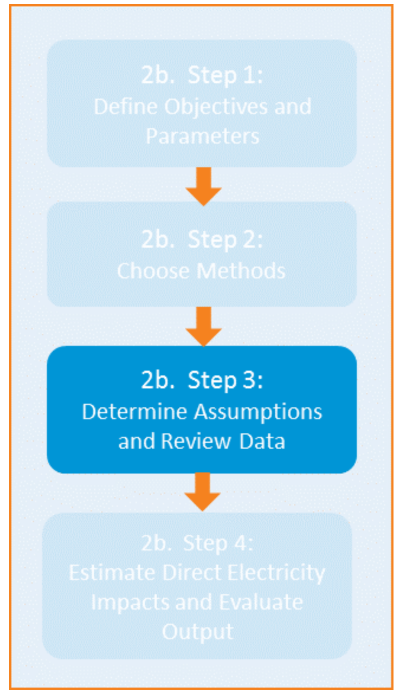
[11] When benchmarking facilities in this way, it is helpful to use benchmarks specific to that building type. For example, a hospital has a very different energy profile than does an office building, so only hospital-specific benchmarks would be useful for benchmarking a hospital. See ENERGY STAR's Portfolio Manager® at http://www.energystar.gov/benchmark.

[12] Of course, other financing mechanisms for energy efficiency are available, including bidding out the services to energy service companies. This chapter does not explore financing mechanisms, but focuses on energy savings calculation methods and mentions the budget implications only as a consideration for policy makers.

2b. Step 3: Determine Assumptions and Review Available Data

Determining potential direct electricity impacts attributable to energy efficiency and renewable energy programs and policies requires careful selection of assumptions based on state-specific demographic and climatic conditions. Several key assumptions should be considered when estimating the prospective energy savings of an energy efficiency and renewable energy initiative. Key assumptions to consider include:



- *Program period*: What year does the program start? End?
- *Program target:* What sector or consumer type is the focus of the program?
- *Anticipated compliance or penetration rate:* How many utilities will achieve the target or standard called for? How many consumers will invest in new equipment based on the initiative? How will this rate change over the time period?
- *Annual degradation factor:* How quickly will the performance of the measure installed degrade or become less efficient?
- *T&D loss:* Is there an increase or decrease in T&D losses that would require adjustment of the energy savings estimate?
- *Adjustment factor:* How should the estimate be adjusted to factor in any inaccuracies in the calculation process? For example, if a program estimates energy generation and capacity of a solar power system, it may adjust the estimates if it suspects there could be variations in system efficiency once implemented.[13]
- *Non-program effects*: What portion of the savings is due to factors outside of the initiative?
- *Funding and administration:* What is the budget for the program and how will it be administered? What are the administrative costs? How much will this reduce the amount of money available to directly obtain energy savings?
- *Energy efficiency and renewable energy potential*: How do the savings projected compare to the potential available? Are they realistic and consistent with other relevant studies?

To save time and ensure completeness, analysts can look to existing analyses to discover the assumptions others have made while analyzing similar programs.

2b. Step 4: Estimate Direct Electricity Impacts and Evaluate Output

In this step, analysts use the assumptions they develop, apply the selected method to the energy efficiency and renewable energy initiative to estimate impacts, and evaluate the output. Factors analysts can consider when estimating the direct electricity impacts of specific programs or policies include:

- *Cost-effectiveness:* When estimating the potential direct electricity impacts, analysts should consider the cost-effectiveness of the measure or programs in the context of the avoided costs[14] of the utility system or region where they are implemented. To evaluate cost-effectiveness, they can conduct simple economic analyses such as project-level discounted cash flow analysis. Discounted cash flow analysis uses projections of future free cash flow (calculated by subtracting the cost of projected capital expenditures from projected operating cash flow)

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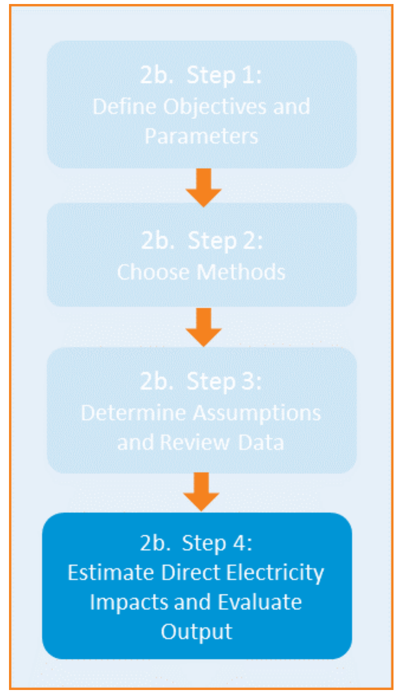
[13] *To understand how an adjustment factor may be applied, see New Jersey's Clean Energy Program Energy Impact Evaluation at http://www.njcleanenergy.com/files/file/Library/CORE%20Evaluation%20Report%20-%20Draft%20July%2013%202009.pdf.*

[14] *For more information about avoided costs, see Chapter 3, "Assessing the Electricity System Benefits of Energy Efficiency and Renewable Energy."*



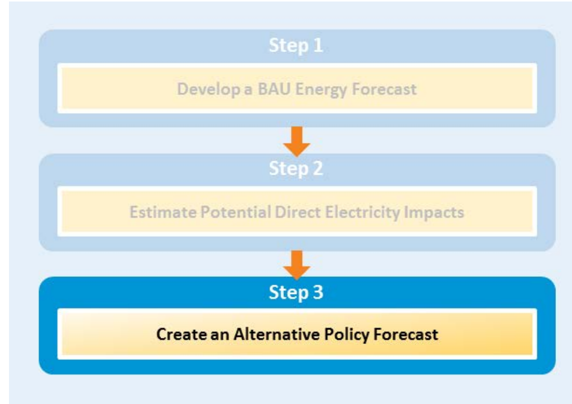
and applying a discount rate to estimate current value.[15] Using cash flow analysis, the analyst develops estimates of the discounted cash flow of alternative options reflecting any incentives available under the program or policy, and simply compares those with avoided costs (obtained from the public utility commission [PUC] or other entity, or estimated as discussed in Chapter 3, "Assessing the Electricity System Benefits of Energy Efficiency and Renewable Energy") in the region. For financial incentive-based programs, measures that are less than the avoided cost (considering the incentive) could be expected to enter the mix. For renewable mandates, technologies ranging from least-to-most cost could be considered part of the potential compliance set, up to the minimum amount of capacity required by the portfolio standard or goal.

- *Non-compliance:* It is key to remember that there will be some degree of non-compliance for certain mandated programs. For example, building codes do not achieve 100 percent compliance and enforcement is not complete. Calculations should factor non-compliance into the equation.
- *Impacts of incentives*: Incentives associated with an energy efficiency and renewable energy policy can alter the energy savings estimates (e.g., a renewable tax credit could increase renewable energy production beyond RPS levels). If historical trends do not reflect these incentives, or non-economic based methods are used, analysts should attempt to reflect the potential response to these incentives.
- *Effective useful life and persistence of energy savings*: The effective useful life of energy efficiency measures refers to the length of time that they continue to save energy. Persistence refers to the change in savings throughout the functional life of an energy efficiency measure or activity. Both of these factors should be accounted for in calculations.
- *Methodological limitations*: There are limits to any methodology. For example, the revenue stream received by renewables will depend on when they are operative (especially in competitive markets). A basic method may miss the true distribution of costs that developers would face, and thus would provide only a rough estimate of the financial performance of these projects. More sophisticated methods may require this type of data for modeling the performance, economics, and penetration of these technologies.
- *Transparency*: As with all analyses, transparency increases credibility. Be sure to document all sources and assumptions.

Once potential electricity savings or generation impacts are estimated, the analyst can evaluate the output to ensure that the numbers are reasonable and meet the policy goals. If the results do not seem realistic, the analyst may need to review assumptions and reapply the approach or model in an iterative fashion to achieve reasonable electricity savings or renewable energy generation estimates. The resulting electricity estimates can be compared to an energy efficiency or renewable energy potential study, if available, to ensure that the policy analysis does not overestimate the possible savings or generation levels.

[15] *A basic description of discounted cash flow analysis is available at http://www.investopedia.com/terms/d/dcf.asp.*

2.2.3. Step 3: Create an Alternative Policy Forecast



Using the direct electricity impacts of energy efficiency and renewable energy estimated under Step 2, the analyst can then create an alternative policy forecast (using the same methods used to develop the BAU energy forecast under Step 1) that adjusts the BAU energy forecast to reflect the energy efficiency and renewable energy policy or program. In the case of efficiency, the electricity savings estimates would be subtracted from the BAU energy forecast to create a new alternative policy forecast; renewable energy generation estimates would be added to it.[16] The assumptions in the model would need to be adjusted to reflect any change in renewable energy supply expected from the initiative.

The impact estimates—and many of the same sophisticated demand-and-supply models—can also be used to assess impacts on the electric power system and project what generation is likely to be displaced that otherwise would have been in operation. This is discussed in more detail in Chapter 3, "Assessing the Electricity System Benefits of Energy Efficiency and Renewable Energy." The estimates can also be used to determine environmental and economic benefits as described in Chapter 4, "Quantifying the Emissions and Health Benefits of Energy Efficiency and Renewable Energy Initiatives," and Chapter 5, "Estimating the Economic Benefits of Energy Efficiency and Renewable Energy Initiatives."

2.3. CASE STUDIES

The following two case studies illustrate how estimating the direct electricity impacts 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 impacts, including those used in the case studies, is available in Section 2.4., "Tools and Resources."

2.3.1. Texas Building Code

Benefits Assessed in Analysis

- Electricity savings
- NO_x reductions

Energy Efficiency/Renewable Energy Program Description

The Texas Emissions Reduction Plan (TERP), initiated by the Texas Legislature (Senate Bill 5) in 2001 and authorized to run through 2019, establishes voluntary financial incentive programs and other assistance programs to improve air quality (i.e., ozone formed from nitrogen oxides (NO_x) and volatile organic compounds) in the state. One component of TERP recognizes the role of energy efficiency and renewable energy measures in contributing to a comprehensive approach for meeting federal air quality standards. Consequently, the legislation requires the Energy Systems Laboratory (ESL) at the Texas Engineering Experiment Station of the Texas A&M University System to submit an annual report to the Texas Commission on Environmental Quality estimating the historical and potential future energy savings from energy building code adoption and, when applicable, from more stringent local codes or above-code performance ratings. The report also includes estimates of the potential NO_x reductions resulting from these energy savings. ESL has

[16] *Alternatively, two forecasts may be produced, with and without the energy efficiency or renewable energy initiatives, and the difference would represent their impacts. This methodology would be more likely when using bottom-up economic-engineering approaches.*

conducted this annual analysis since 2002 and submits it in a report entitled *Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan*. ESL also provides assistance to building owners on measurement and verification activities.

Method(s) Used

ESL determined the energy savings and resulting NO_x emissions for new residential single- and multi-family construction and for commercial office buildings in Texas counties that have not attained federal air quality standards. A brief summary of the approach for estimating energy savings for both types of buildings is provided below.

Step 1: Develop BAU Forecast

- *Residential buildings.* First, ESL determined new construction activity by county. The baseline for estimating energy savings for single- and multi-family buildings uses published data on residential construction characteristics by the 2008 National Association of Home Builders, based on the International Energy Conservation Code (IECC) 2006 building code.
- *Commercial buildings*. The process to estimate energy savings begins with estimating the number of buildings and relative energy savings. ESL used Dodge Data and Analytics MarketShare, a proprietary database that provides construction start data, to gather the square footage of new commercial construction in Texas.

Step 2: Estimate Potential Direct Electricity Impacts

- *Residential buildings*. Annual and peak day energy savings (in kWh) attributable to the Texas building code are modeled using a DOE-2 simulation that ESL developed for the TERP. These estimates are then applied to National Association of Home Builders survey data to determine the appropriate number of housing types.
- *Commercial buildings*. Energy savings are estimated from code-compliant buildings (American Society of Heating, Refrigerating and Air-Conditioning Engineers [ASHRAE] Standard 90.1-2007) against pre-code buildings (ASHRAE Standard 90.1-2004), using data from the U.S. Department of Energy (U.S. DOE) and constructed square footage in Dodge data.

Step 3: Create Alternative Policy Forecast

After residential and commercial building savings are estimated, these savings are projected to 2020 by incorporating a variety of adjustment factors. These factors include:

- *Annual degradation factor:* This factor was used to account for an assumed decrease in the performance of the measures installed as the equipment wears down and degrades. With the exception of electricity generated from wind (which is assumed to have a degradation factor of zero), ESL used an annual degradation factor of 2 percent for single-family, multi-family, and commercial programs, and an annual degradation factor of 5 percent for all other programs. The 5 percent value was taken from a study by Kats et al. (1996).
- *T&D loss:* This factor adjusts the reported savings to account for the loss in energy resulting from the T&D of the power from the electricity producers to the electricity consumers. For this calculation, the electricity savings reported at the consumer level were increased by 7 percent to give credit for the actual power produced that is lost in the T&D system on its way to the customer. In the case of electricity generated by wind, it was assumed there was no net increase or decrease in T&D losses given that wind energy is displacing power produced by conventional power plants.
- *Initial discount factor*: This factor was used to discount the reported savings for any inaccuracies in the assumptions and methods employed in the calculation procedures. For the single-family, multi-family, and commercial programs, the discount factor was taken as 10 percent. For the savings and State Energy

Conservation Office (SECO) programs, the discount factor was 60 percent. The discount factor for SEER 13 single-family and SEER 13 multi-family program was 20 percent.

- *Annual growth factor*: These factors for single-family (3.3 percent), multi-family (1.5 percent), and for commercial (3.3 percent) construction are derived from recent U.S. Census data for Texas. The growth factor for wind energy (3.9 percent) is a linear projection based on the installed wind power capacity from 2009 to 2012 from the Public Utility Commission of Texas. No growth was assumed for PUC programs, SECO, and SEER 13 entries. The analysis assumed that the same amount of electricity savings from the code-compliant construction would be achieved for each year after 2013 through 2020.

Results

The ESL 2015 annual report on the energy efficiency and renewable energy impacts of the TERP, submitted to the Texas Commission on Environmental Quality in February 2017, describes prospective energy savings (compared with 2008 base-year levels) resulting from implementing the International Residential Code (IRC) and the IECC in residential and commercial buildings, respectively, through 2020. According to the report, the annual energy savings from code-compliant residential and commercial construction were estimated to be:

- 1,158,444 MWh of electricity/year in 2015 (3.9 percent of total electricity savings from TERP) and 2,454,765 MWh/year by 2020 (5.4 percent of total electricity savings from TERP)
- ESL divided the actual and projected energy savings into the different Power Control Authorities and, using EPA's eGRID emission factors, calculated the cumulative annual NO_x emissions reduction values as follows:
- 292 tons of NO_x/year in 2015 (3.6 percent of total NO_x savings from TERP)
- 620 tons of NO_x/year by 2020 (5 percent of total NO_x savings from TERP)

For More Information

Resource Name	Resource Description	URL Address
Texas Building Code Case Study		
Energy Efficiency/ Renewable Energy Impact in the Texas Emissions Reduction Plan	Annual Report to the Texas Commission on Environmental Quality (TCEQ) January 2015–December 2015, Volume I: Technical Report (submitted to TCEQ in February 2017).	http://oaktrust.library.tamu.edu/handle/1969.1/160308

2.3.2. Vermont – Energy Demand and Energy Savings Forecasting

Benefits Assessed in Analysis

- Electricity savings

Energy Efficiency/Renewable Energy Program Description

The Vermont Department of Public Service (DPS) forecasts energy demand and energy efficiency program savings as part of its long-term state energy policy and planning process. This process includes developing strategies and studies, including:

- The Comprehensive Energy Plan (required under statute to be conducted every 5 years)
- The 20-Year Electric Plan (also required every 5 years)

- The Vermont Energy Efficiency Potential Study (most recently updated in 2013 as a limited update to a more comprehensive study in 2011)
- A variety of other state planning initiatives, including a Total Energy Study released in 2014 (Vermont DPS, 2016)

The DPS uses these publications as tools to help manage the transition from traditional energy fossil fuel to cleaner energy supplies to benefit Vermont's economic and environmental future and to track progress toward the achievement of Vermont's renewable energy goals (see Table 2-4). These resources provide a means for them to show how energy demand and energy efficiency program forecasts fit into the bigger planning picture.

Table 2-4: Cumulative Annual Residential (MWh) Savings Potential for Vermont

Year	Statewide Cumulative Annual Savings – Max. Achievable (MWh)
2014	77,286
2015	159,651
2016	242,951
2017	319,935
2018	381,341
2019	439,261
2020	494,935
2021	467,060
2022	504,617
2023	538,433
2024	563,622
2025	588,142
2026	609,965
2027	631,020
2028	651,189
2029	668,674
2030	684,205
2031	698,925
2032	771,096
2033	723,116
Total	**10,215,424**

Source: GDS Associates, Inc., Electric Energy Efficiency Potential for Vermont (For VT DPS, 2013), http://publicservice.vermont.gov/sites/dps/files/documents/Energy_Efficiency/2013%20VT%20Energy%20Efficiency%20Potential%20Study%20Update_FINAL_03-28-2014.pdf.

Method(s) Used

For the 2013 update to the 2011 *Vermont Energy Efficiency Potential Study*, Vermont DPS collaborated with a team of consultants to estimate the state's potential to reduce electricity consumption and peak demand by implementing energy efficiency measures. The study relied on Vermont-specific cost estimates based on fuel and electricity cost projections, as well as assessments of building and equipment characteristics. One of the savings categories analyzed is the statewide cumulative annual residential energy savings potential in MWh. The process to forecast energy savings in Vermont required several steps:

Step 1: Develop BAU Energy Forecast

This step was completed under the original 2011 study; the 2013 study applied updated load forecasts.

Step 2: Estimate Potential Direct Electricity Impacts

- *Determine energy efficiency technical potential by measure* (i.e., retrofit, early retirement, and replace-on-burnout approaches to increase efficiency of a building, leading to savings in electricity, natural gas, and other fuels from a range of DSM programs). Measures analyzed in this report included appliances, electronics, HVAC, lighting, water heating, and fuel switching. The research team separated existing and new homes into single- and multi-family markets because of differences in energy consumption. The savings estimates were based on the most recent available residential electric sales forecasts for Vermont's service territories for 2014 through 2033.

- *Estimate the achievable, cost-effective potential for electric energy and peak demand savings.* The analysis relied on a bottom-up approach to calculate residential energy savings, using Vermont-specific conditions. This bottom-up approach started with the number of residential customers in each category (single- or multi-family, old or new construction). The equation used for residential sector technical potential was as follows: technical potential of efficient measure = (total # households x base case equipment end-use intensity x saturation share x applicability factor x savings factor).

Step 3: Create Alternative Policy Forecast

- *Develop a 20-year forecast of electric energy use.* DPS hired consultants to develop a baseline projection of energy demand given current trends and use patterns and a forecast of expected demand, assuming implementation of the new DSM measures, built up from estimates of energy use by appliance type and end-use category by sector (e.g., the number of refrigerators in the residential sector) and the savings potential for each. The level of maximum efficiency potential in Vermont by DSM programs was determined by using a market penetration scenario that aims for installation of energy efficiency measures in 80–90 percent of the remaining eligible market over a 20-year period. The potential energy efficiency efforts could reduce the residential winter peak demand by nearly 25 percent of the 2033 projected demand. Results presented in Table 2-4, above, show the statewide potential for cumulative annual residential energy savings (MWh) through 2033, but the analysis also reported results by energy efficiency measure, winter and summer peak demand potential by measure, incremental savings, benefits and cost associated with potential savings, and results by service territory. Metrics were also reported for commercial and industrial potential savings.

Results

- These projections and the analysis show that the cumulative savings potential over the next 20 years could be significant for households and commercial and industrial entities in Vermont.

- The report estimates a maximum achievable potential electricity savings of 1,450,000 MWh for the entire state, or a 23.4 percent reduction from projected 2033 electricity sales.

- A Vermont societal test[17] found that the benefit/cost ratio of implementing the maximum achievable potential energy savings was 3.6.

- Vermonters could benefit significantly from greater implementation of energy efficiency measures, and could save up to $3.6 billion in net present savings over the next two decades.

[17] *The Vermont Societal Test, originally adopted by the PSC in 1997, includes a $.0070 per kWh saved adder to program electric energy benefits for environmental benefits, and a 10 percent reduction to program costs to account for the risk diversification benefits of energy efficiency measures and programs.*

- Important caveats include the fact that the savings realized by the people of Vermont will ultimately be determined by their participation in available DSM programs and state funding, and that the analysis assumed unconstrained budget amounts for Vermont's DSM programs through 2033; actual budget allocations determined by the state will affect the actual savings realized.
- The Vermont DPS can choose to use this analysis to target resources for energy efficiency programs over the next 20 years, enabling energy efficiency to play an increasingly critical role in the state's resource mix.

For More Information

Resource Name	Resource Description	URL Address
Vermont – Energy Demand and Energy Savings Forecasting Case Study		
Vermont Energy Efficiency Potential Study Update Final Report	This 2013 technical memorandum presents results from the evaluation of opportunities for energy efficiency programs in the service areas of Vermont's two energy efficiency utilities (EEU). The Vermont Public Service Board appointed the Burlington Electric Department as the EEU for the City of Burlington, and the Vermont Energy Investment Corporation as the EEU for the remainder of the State, under the name Efficiency Vermont. Prepared by for the Vermont DPS by GDS Associates, Inc.	http://publicservice.vermont.gov/sites/dps/files/documents/Energy_Efficiency/2013%20VT%20Energy%20Efficiency%20Potential%20Study%20Update_FINAL_03-28-2014.pdf
Vermont Comprehensive Energy Plan	This 2016 plan makes specific recommendations on ways in which the state can support, guide, expand, or take the critical next steps to help lead Vermont, the region, and the nation into a sustainable, affordable renewable-energy future. Developed by the Vermont DPS.	https://outside.vermont.gov/sov/webservices/Shared%20Documents/2016CEP_Final.pdf

2.4. TOOLS AND RESOURCES

This section lists and describes available data sources, tools, and other resources analysts can use to implement the methods described in this chapter, organized by step.

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.*

2.4.1. Tools and Resources for Step 1: Develop a BAU Forecast

A range of baseline data resources and tools are available to analysts to develop a BAU energy forecast.

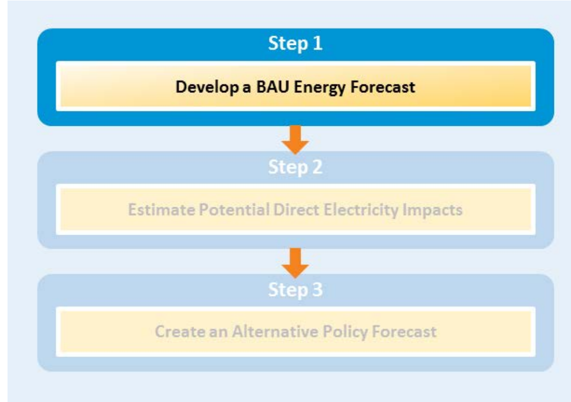
Sources for Baseline Data and Forecasts

Analysts can use a variety of data sources to develop their energy baseline and forecasts. Note that some of these sources provide historical data, some provide forecasted data, and some provide both.

Population Data

- The **U.S. Census Population Estimates Program** provides historical and projected population data. https://www.census.gov/programs-surveys/popest.html

Economic Variables



- The **Bureau of Economic Analysis** (http://www.bea.gov/), **Bureau of Labor Statistics** (http://www.bls.gov/), and the **U.S. Census Economic Census** (https://www.census.gov/programs-surveys/economic-census.html) all provide macroeconomic data on variables that analysts can use, such as full-time equivalent and short-term jobs created, dollar value of additional wages per year, job-years per dollar invested, dollar value of energy savings generated, dollar value of total value added, and dollar value of GSP generated.

Electricity and Fuel Prices

- EIA provides regional electricity and fuel price forecasts out to 2040 in the **Annual Energy Outlook** (http://www.eia.gov/forecasts/aeo/index.cfm). Price projections may also be available from PUCs and ISOs, although proprietary constraints may limit the amount available. Many private data providers may also be able to offer data that are more recent than those from publicly available sources.

State Sources

- **State Energy Offices and Departments of Transportation**. Most states collect historical and forecast data for both supply and demand information. Other agencies may have compiled similar energy information that could be used for this effort. Examples of state demand forecasts from California are provided below.
  - California Energy Commission. 2005. ***Energy Demand Forecast Methods Report***. Companion Report to the California Energy Demand 2006–2016 Staff Energy Demand Forecast Report. http://www.energy.ca.gov/2005publications/ CEC-400-2005-036/CEC-400-2005-036.PDF
  - CEC. 2007. ***California Energy Demand 2008-2018, Staff Revised Forecast***. http://www.energy.ca.gov/2007publications/CEC-200-2007-015/CEC-200-2007-015-SF2.PDF

Utility Sources

- **Consumer Energy Use Profiles by Sector**. Most utilities conduct audits or energy efficiency evaluation studies as part of energy efficiency programs' regular reporting. Data are customer-specific load profiles that can be used to build up total demand.
- **Independent System Operators (ISOs) or Regional Transmission Organizations (RTOs)**. Supply and total demand information to be used for planning purposes. Available from the Midwest Independent System Operator (MISO), ISO-New England, Pennsylvania-New Jersey Maryland Interconnection, Southwest Power Pool, California ISO, Electric Reliability Council of Texas, Florida Reliability Coordinating Council, and New York Independent System Operator.
- **North American Electric Reliability Corporation (NERC).** Capacity and demand, up to 10-year projections of electricity demand, electric generating capacity, and transmission line mileage. Generation data include unit-level statistics on existing generators, planned generator additions and retirements, and proposed equipment modifications. Free to government agencies. http://www.nerc.com/pa/RAPA/ESD/Pages/default.aspx
- **Public Utility Commissions (PUCs)**. Most PUCs collect historical and forecast data. These are usually supplied from utilities and studies and can be used to collect supply and demand data.

- **Regional Councils That Coordinate Energy Planning**. Regional councils, such as the Northwest Power and Conservation Council that covers Idaho, Montana, Oregon, and Washington, may be able to provide regional baseline and other data.
- **Utility Integrated Resource Planning Filings**. Most utilities collect historical and forecast data.

Federal Agency Sources

- DOE's Energy Information Administration (EIA)
- **EIA Annual Energy Outlook.** National forecast of supply and demand. http://www.eia.gov/forecasts/aeo/
- **EIA Electric Power Annual**. National, some regional and state level capacity and demand, margin, energy retail sales (MWh), revenue, emissions, short-term plans, etc.
  http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html
- **EIA Electric Sales, Revenue, and Price Tables or EIA Annual Electric Utility Data—EIA-860, 906, 861 Data File**. Annual data, peak, generation, demand/consumption, revenues, utility type, and state.
  http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html
  http://www.eia.doe.gov/cneaf/electricity/page/eia861.html
  http://www.eia.doe.gov/cneaf/electricity/page/eia906_920.html
- **EIA Energy Consumption Surveys.** *EIA Manufacturing Energy Consumption Survey (MECS); Commercial (CBECS); Residential (RECS)***.** EIA's national surveys provide data on energy consumption in the manufacturing, commercial, and residential sectors. http://www.eia.doe.gov/emeu/mecs/contents.html; http://www.eia.doe.gov/emeu/cbecs/; http://www.eia.doe.gov/emeu/recs/contents.html
- **EIA State Electricity Profiles**. Detailed electricity data by state. https://www.eia.gov/electricity/state/
- **EIA State Energy Profile, State Energy Data (SEDS).** Annual production, consumption, prices, and expenditures by energy source. http://tonto.eia.doe.gov/state/
  http://www.eia.doe.gov/cneaf/electricity/epm/table1_6_a.html
  http://www.eia.doe.gov/emeu/states/_seds.html
- **DOE's National Renewable Energy Laboratory (NREL).** Data on various renewable energy technologies and some costs. http://www.nrel.gov/rredc/
- **Baseline Cost of Energy for Renewable Energy Technologies**. NREL prepares annual input assumptions (e.g., technology and fuel costs) and scenarios to support and inform electric sector analysis in the United States. http://www.nrel.gov/analysis/data_tech_baseline.html
- **EPA's Emissions & Generation Resource Integrated Database (eGRID).** https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
- **EPA's Energy-Environment Guide to Action.** A guide to state policies and best practices for advancing energy efficiency, renewable energy, and CHP. https://www.epa.gov/sites/production/files/2015-08/documents/guide_action_full.pdf
- **EPA's Webinar on Assessing Energy Efficiency Potential in Your State**, November 13, 2015. https://www.energystar.gov/index.cfm?c=partners.pt_state_resources

Table 2-5: Sample Energy Data Sources for Developing Baselines and BAU Forecasts

	Electric		Natural Gas		Other Fuels	
	Historic	Forecast	Historic	Forecast	Historic	Forecast
State Sources						
State Energy, Utility Commissions, Transportation, or Other Offices	X	X	X	X	X	X
Utility-Related Sources						
Utilities	X	X	X	X	X	X
Consumer Energy Profiles (Residential, Commercial, Industrial)	X		X		X	
Public Utility Commissions (PUCs)	X	X	X	X	X	X
Independent System Operators/ Regional Transmission Organizations (ISOs/RTOs)	X	X				
North American Electric Reliability Corporation (NERC) Electricity Supply and Demand Database	X	X				
Federal Agency Sources						
EIA Electric Power Annual	X					
EIA State Energy Profile, State Energy Data (SEDS)	X		X		X	
EIA Electric Sales, Revenue, and Price Tables or EIA Annual Electric Utility Data—EIA-860, 906, 861 Data File	X					
EIA Manufacturing Energy Consumption Survey (MECS); Commercial (CBECS); Residential (RECS)	X		X		X	
EIA Annual Energy Outlook	X	X	X	X	X	X
EPA Emissions & Generation Resource Integrated Database (eGRID)	X					
NREL	X		X	X	X	X

Models and Tools for Developing a Baseline Forecast

Economic dispatch and capacity planning models can provide detailed forecasts of regional supply and demand, and be used to compare baseline energy and emissions forecasts with scenarios based on implementation of energy efficiency and renewable energy measures. Using these types of models generally results in more rigorous baseline forecasts than using basic-to-intermediate methods. However, these tools can also be more resource-intensive.

Economic Dispatch Models

Economic dispatch models determine the optimal output of the EGUs over a given timeframe (one week, one month, one year, etc.) for a given time resolution (sub-hourly to hourly). These models generally include a high level of detail on the unit commitment and economic dispatch of EGUs, as well as on their physical operating limitations.

- **GE Multi-Area Production Simulation (MAPS)™.** A chronological model that contains detailed representation of generation and transmission systems, MAPS can be used to study the impact on total system emissions that result from the addition of new generation. MAPS software integrates highly detailed representations of a system's load, generation, and transmission into a single simulation. This enables calculation of hourly production costs in light of the constraints imposed by the transmission system on the economic dispatch of generation. http://www.geenergyconsulting.com/practice-area/software-products/maps
- **Integrated Planning Model (IPM)®.** This model simultaneously models electric power, fuel, and environmental markets associated with electric 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 electric sector in the short and long term. http://www.icf.com/resources/solutions-and-apps/ipm

- **PLEXOS®**. A simulation tool that uses linear programming/mixed integer programming optimization technology to analyze the power market, PLEXOS contains production cost and emissions modeling, transmission modeling, pricing modeling, and competitiveness modeling. PLEXOS allows the user to select emissions of interest (e.g., CO_2, NO_x, SO_2, etc.). The tool can be used to evaluate a single plant or the entire power system. http://www.energyexemplar.com

- **PROMOD IV®**. A detailed generator and portfolio modeling system, with nodal locational marginal pricing forecasting and transmission analysis, PROMOD IV can incorporate extensive details in generating unit operating characteristics and constraints, transmission constraints, generation analysis, unit commitment/operation conditions, and market system operations. http://new.abb.com/enterprise-software/energy-portfolio-management/market-analysis/promod

- **PROSYM (Zonal Analysis)™.** A chronological electric power production costing simulation computer software package, PROSYM is designed for performing planning and operational studies. As a result of its chronological nature, PROSYM accommodates detailed hour-by-hour investigation of the operations of electric utilities. Inputs into the model are fuel costs, variable operation and maintenance costs, and startup costs. Output is available by regions, by plants, and by plant types. The model includes a pollution emissions subroutine that estimates emissions with each scenario. http://new.abb.com/enterprise-software/energy-portfolio-management/market-analysis/zonal-analysis

Capacity Expansion Models

Capacity expansion models determine the optimal generation capacity and/or transmission network expansion in order to meet an expected future demand level and comply with a set of national, regional, or state specifications.

- **AURORA**. The AURORA model, developed by EPIS LLC, provides electric market price forecasting, estimates of resource and contract valuation and net power costs, long-term capacity expansion modeling, and risk analysis of the energy market. http://epis.com/aurora/

- **DOE's National Energy Modeling System (NEMS).** NEMS is a system-wide energy model (including demand-side sectors) that represents the behavior of energy markets and their interactions with the U.S. economy. The model achieves a supply/demand balance in the end-use demand regions, defined as the nine U.S. Census Bureau divisions, by solving for the prices of each energy product that will balance the quantities producers are willing to supply with the quantities consumers wish to consume. The system reflects market economics, industry structure, and existing energy policies and regulations that influence market behavior. https://www.eia.gov/outlooks/aeo/info_nems_archive.php

- **Electric Generation Expansion Analysis System (EGEAS).** EGEAS was developed by the Electric Power Research Institute, is a set of computer modules that are used to determine an optimum expansion plan or simulate production costs for a pre-specified plan. Optimum expansion plans are based on annual costs, operating expenses, and carrying charges on investment. http://eea.epri.com/models.html#tab=3

- **e7 Capacity Expansion.** e7 Capacity Expansion is an energy portfolio management solution from ABB covering resource planning, capacity expansion, and emissions compliance. It enables resource planners and portfolio managers to assess and develop strategies to address current and evolving RPSs and emissions regulations. http://new.abb.com/enterprise-software/energy-portfolio-management/commercial-energy-operations/capacity-expansion

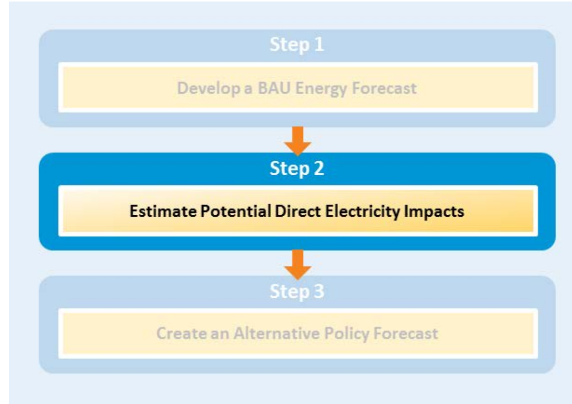
- **e7 Portfolio Optimization**. Portfolio optimization models unit operating constraints and market conditions to facilitate the analysis and simulation of scenarios. The model optimizes a combined portfolio of supply resources and energy efficiency or distributed generation assets modeled as virtual power plants. http://new.abb.com/enterprise-software/energy-portfolio-management/commercial-energy-operations/portfolio-optimization
- **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/
- **Integrated Planning Model (IPM)®.** This model simultaneously models electric power, fuel, and environmental markets associated with electric production. It is a capacity expansion and system dispatch model. 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 electric sector in the short and long term. http://www.icf.com/resources/solutions-and-apps/ipm
- **Long-Range Energy Alternatives Planning System (LEAP).** LEAP is an integrated, scenario-based modeling tool developed by the Stockholm Environment Institute. LEAP can be used to track energy consumption, production, and resource extraction in all sectors of the economy at the city, regional, state, or national scale. Beginning in 2018, LEAP includes the integrated benefits calculator, which can be used to estimate health (mortality), agriculture (crop loss) and climate (temperature change) impacts of scenarios. It can be used to account for both energy sector and non-energy sector greenhouse gas emissions sources and sinks, and to analyze emissions of local and regional air pollutants, and short-lived climate pollutants. www.energycommunity.org
- **NREL's Regional Energy Deployment System model (ReEDS).** This 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 are generating capacity, generation, storage capacity expansion, transmission capacity expansion, electric sector costs, electricity prices, fuel prices, and carbon dioxide emissions. http://www.nrel.gov/analysis/reeds/
- **NREL's Resource Planning Model (RPM).** RPM is a capacity expansion model designed to examine how increased renewable deployment might impact regional planning decisions for clean energy or carbon mitigation analysis. RPM includes an optimization model that finds the least-cost investment and dispatch solution over a 20-year planning horizon for different combinations of conventional, renewable, storage, and transmission technologies. The model is currently only available for regions within the Western Interconnection, while a version for regions in the Eastern Interconnection is under development. https://www.nrel.gov/analysis/models-rpm.html

2.4.2. Tools and Resources for Step 2: Estimate Potential Direct Electricity Impacts

Analysts can use the tools described below to develop estimates of potential direct electricity benefits.

Tools for Estimating Direct Electricity Impacts

Internet-Based Methods



- **EPA's ENERGY STAR® Portfolio Manager® Portfolio of Buildings**. Free online, interactive tool that benchmarks the performance of existing commercial buildings on a scale of 1–100 relative to similar buildings. Tracks energy and water consumption for a building or portfolio of buildings and calculates energy consumption and average energy intensity. Analysts can use to evaluate potential energy savings of existing buildings by building type for an energy efficiency and renewable energy policy (e.g., a building code policy) and apply savings across the population. https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

  Level of analysis: Existing buildings

- **Roofing Savings Calculator**. Free calculator that estimates energy and cost savings from installing an ENERGY STAR® labeled roof product in a home or building. http://rsc.ornl.gov/

  Level of analysis: Buildings

- **EPA's ENERGY STAR® Target Finder Calculator**. Free tool that helps planners, architects, and building owners set aggressive, realistic energy targets and rate a building design's estimated energy use. Use the tool to determine: energy performance rating (1–100), energy reduction percentage (from an average building), source and site energy use intensity (kBTU/sf/yr), source and site total annual energy use (kBTU), and total annual energy costs. Analysts can use to evaluate potential energy savings of new/planned buildings by building type for an energy efficiency and renewable energy policy (e.g., a building code policy) and apply savings across the population. http://www.energystar.gov/targetfinder

  Level of analysis: New buildings

- **NREL's Wind Integration Data Sets**. Free datasets that can help users estimate power production from hypothetical wind power plants. http://www.nrel.gov/grid/wind-integration-data.html

  Level of analysis: Wind energy projects

- **PVWatts™**. A free solar technical analysis model available from NREL that produces an estimate of monthly and annual PV production (kWh) and cost savings. Users can select geographic location and use either default system parameters or specify parameters for their PV system. Data can be used to accumulate project-specific savings toward renewable energy policy goals for solar-related technologies. http://pvwatts.nrel.gov/

  Level of analysis: Grid-connected PV systems

Spreadsheet-Based Methods

- **CHP Spark Spread Estimator**. A free Excel-based tool used to evaluate a prospective CHP system for its potential economic feasibility. The CHP Spark Spread Estimator calculates the difference between the delivered electricity price and the total cost to generate power with a prospective CHP system. In addition to comparing a preliminary estimate of the cost to generate power onsite (in terms of $/kWh) to the retail price of power at the site, the estimator provides an approximate comparison of energy consumption and costs with and without CHP. https://www.epa.gov/sites/production/files/2015-09/spark_spread_estimator.xlsm

Level of analysis: CHP systems

- **EPA's ENERGY STAR Savings Calculators**. Series of free tools that calculate energy savings and cost savings from ENERGY STAR-qualified equipment. Includes commercial and residential appliances, heating and cooling, lighting, office products, and other equipment. https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/purchase-energy-saving-products

  Level of analysis: Energy Efficiency measures

- **State and Utility Pollution Reduction Calculator Version 2 (SUPR2).** Free tool that provides high-level estimates of energy savings from various policies and technologies that could help an individual state meet its air quality goals. SUPR2's policy and technology options include energy efficiency, renewable energy, nuclear power, emissions control options, and natural gas. http://aceee.org/research-report/e1601

  Level of analysis: Energy efficiency measures

Software Methods

- **DSMore™**. Commercial model designed to evaluate the costs, benefits, and risks of DSM programs and services. Evaluates thousands of DSM scenarios over a range of weather and market price conditions. Although it requires detailed input data, the model uses these data to produce detailed outputs, including energy savings impacts associated with the type of fuel that is being saved (gas or electricity), and provides for expansive scenario analyses. http://www.integralanalytics.com/products-and-services/dsm-planning-and-evaluation/dsmore.aspx

  Level of analysis: DSM programs

- **eQuest®**. Free building simulation model for weather-dependent energy efficiency measures. Energy savings can be applied across the population. http://www.doe2.com/equest/

  Level of analysis: Buildings

- **EnergyPlus**. Free, whole-building energy simulation model from the U.S. DOE for modeling energy consumption—for heating, cooling, ventilation, lighting, and plug and process loads—and water use in buildings. https://energyplus.net/

  Level of analysis: Buildings

- **fChart and PV-fChart**. fChart Software produces the commercial programs fChart and PV-fChart for the design of solar thermal and PV systems, respectively. Both programs provide estimates of performance and economic evaluation of a specific design using design methods based on monthly data. http://www.fchart.com/pvfchart/

  Level of analysis: Solar PV or solar thermal systems

- **HOMER Energy**. Commercial software that evaluates design options for both off-grid and grid-connected power systems for remote, stand-alone, and distributed generation applications. http://homerenergy.com/

  Level of analysis: Microgrids and distributed generation

- **NREL System Advisor Model (SAM)**. A free model that predicts performance and estimates costs for grid-connected power projects based on installation and operating costs and system design parameters that the user specifies as inputs to the model. Projects can be either on the customer side of the utility meter, buying and selling electricity at retail rates, or on the utility side of the meter, selling electricity at a price negotiated through a power purchase agreement. https://sam.nrel.gov/

  Level of analysis: Renewable energy systems

- **RETScreen®**. Energy efficiency and renewable energy project analysis software. Use to evaluate the energy production and savings, costs, emissions reductions, financial viability, and risk for various types of energy efficiency and renewable energy technologies, including renewable energy, cogeneration, district energy, clean power, heating and cooling technologies, and energy efficiency measures. Free version will work for most uses; additional features are available in a paid version. http://en.openei.org/wiki/RETScreen_Clean_Energy_Project_Analysis_Software

  Level of analysis: Renewable energy and energy efficiency projects

- **WindPro.** Commercial Windows modular-based software suite for designing and planning single wind turbines and wind farms. http://www.emd.dk/windpro/

  Level of analysis: Wind turbines and wind farms

Resources for Predicting Load Profiles

Several resources are available to help predict the load profile of different kinds of renewable energy and energy efficiency projects:

- **The Connecticut Energy Efficiency Board** maintains a dashboard showing electricity and natural gas energy efficiency savings and spending data, broken out by utility, sector, and year. http://www.energizect.com/connecticut-energy-efficiency-board
- **Load impact profile data** for energy efficiency measures may be available for purchase from various vendors, but typically is not publicly available in any comprehensive manner.
- **NREL** provides solar insolation data and maps, from which solar power generation output can be modeled. Solar insolation data and maps provide monthly average daily total solar energy availability for any area of the country on a per kWh/m^2/day basis. These data sets are used in several publicly available tools, such as NREL's free PV Watts or Homer Energy's commercial microgrid software, where users can specify different solar PV project attributes and estimate the output of the solar generator. http://www.nrel.gov/analysis/
- **The Open PV Project**, also hosted by NREL, is a collaborative effort among government, industry, and the public to compile a database of available public data for PV installations in the United States. https://openpv.nrel.gov
- **State technical resource manuals (TRMs)** contain information on the features and energy savings of a wide range of energy efficiency measures. Approximately 20 states have published TRMs. For example, the California Database for Energy Efficient Resources provides estimates of energy and peak demand savings values, measure costs, and effective useful life of efficiency measures. http://www.deeresources.com/
- Some states or regions have **technology production profiles** in their efficiency and renewable energy potential studies (e.g., NYSERDA's report, *Energy Efficiency and Renewable Energy Resource Development Potential Study of New York State*, 2014. https://www.nyserda.ny.gov/-/media/Files/EDPPP/Energy-Prices/Energy-Statistics/14-19-EE-RE-Potential-Study-Summary.pdf
- **Wind profiles** can be obtained from many sources, including the **U.S. DOE's NEMS model** (https://www.eia.gov/outlooks/aeo/info_nems_archive.php), **NREL's Eastern and Western Wind Datasets** (https://www.nrel.gov/grid/eastern-western-wind-data.html), and the **American Wind Energy Association** (www.awea.org). All data will likely require some extrapolation or transposition for the intended use. Customized data and services are available for purchase from AWS Truepower (https://www.awstruepower.com/) and 3Tier (https://www.3tier.com), which NREL sources for its Eastern and Western Wind Datasets.

Resources and Protocols for EM&V

Use the EM&V resources and protocols below for assessing retrospective impacts of energy efficiency programs.

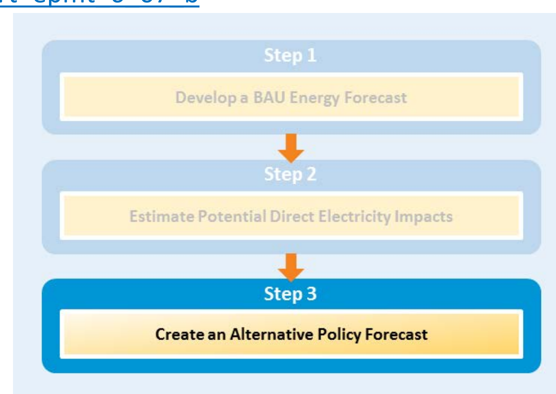
- **California Energy Efficiency Evaluation Protocols**. California Public Utility Commission. Requirements for evaluating energy efficiency programs in California. http://www.calmac.org/publications/EvaluatorsProtocols%5FFinal%5FAdoptedviaRuling%5F06%2D19%2D2006%2Epdf
- **Energy Efficiency Program Impact Evaluation Guide**. U.S. DOE and U.S. EPA. Describes common terminology and approaches used to determine electricity savings and avoided emissions from energy efficiency. https://www4.eere.energy.gov/seeaction/publication/energy-efficiency-program-impact-evaluation-guide
- **Regional EM&V Methods and Savings Assumptions Guidelines, 2010**. Northeast Energy Efficiency Partnerships. Includes methods in determining gross energy and demand savings, and savings assumptions for EE programs. http://www.neep.org/regional-emv-methods-and-savings-assumptions-guidelines-2010
- **Uniform Methods Project**. U.S. DOE. EM&V protocols for common efficiency programs and technologies. http://www.energy.gov/eere/about-us/ump-protocols

2.4.3. Tools and Resources for Step 3: Create an Alternative Policy Forecast

Resources for Determining Capacity Factors

The resources below can be helpful for determining capacity factors for renewables.

- **EIA Electric Power Monthly Capacity Factors for Utility Scale Generators Not Primarily Using Fossil Fuels** http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_6_07_b
- **NREL System Advisor Model (SAM) Capacity Factor** https://www.nrel.gov/analysis/sam/help/html-php/index.html?mt_capacity_factor.htm
- Summary of Time Period-Based and Other Approximation Methods for Determining the Capacity Value of Wind and Solar in the United States http://www.nrel.gov/docs/fy12osti/54338.pdf



Resources for Energy Efficiency and Renewable Energy Retrospective Data and Potential Studies

- **American Council for an Energy-Efficient Economy (ACEEE).** Consumer resources on appliances, policy, potential study workshops, and technical papers such as the two examples provided below. http://www.aceee.org/
  - Elliott, R. Neal and Anna Monis Shipley. 2005. "Impacts of Energy Efficiency and Renewable Energy on Natural Gas Markets: Updated and Expanded Analysis." ACEEE. April. http://aceee.org/files/pdf/e052full.pdf
  - Elliot, R. Neal and Maggie Eldridge. 2007. "Role of Energy Efficiency and Onsite Renewables in Meeting Energy and Environmental Needs in the Dallas/Fort Worth and Houston/ Galveston Metro Areas." ACEEE. September. http://aceee.org/node/3078?id=93

- **California Database of Energy Efficiency Resources.** Provides documented estimates of energy and peak demand savings values, costs, and effective useful life. In this California Energy Commission and California Public Utilities Commission sponsored database, data are easy to research and could be used as input into internally developed spreadsheets on appliances and other energy efficiency measures, which can be adjusted for the circumstances of different states. http://www.deeresources.com/
- **Entergy Texas Deemed Savings Entergy**. This investor-owned utility provides deemed energy savings for energy efficiency measures, much as the other investor-owned utilities in Texas do. It accounts for the weather zone of the participants. These data could be used as input into internally developed spreadsheet regarding appliances and other energy efficiency measures for a bottom-up method. The data may have to be adjusted for a different state. http://www.entergy-texas.com/ content/Energy_Efficiency/ documents/HelperApplication_ HTR_Entergy_2006.xls
- **Lawrence Berkeley National Laboratory**. Technical resource that tests and invents energy-efficient technologies and provides publicly available research reports and case studies on energy efficiency and renewable energy. http://www.lbl.gov
- **Michigan Energy Measures Database.** Offers information on potential technologies or measures that could be used in an energy efficiency programs and for integrated resource planning, including customized measures for Michigan-specific weather conditions and loads. http://www.michigan.gov/mpsc/0,4639,7-159-52495_55129---,00.html
- **National Renewable Energy Laboratory (NREL).** Provides data on renewable energy and energy efficiency technology, market, benefits, costs, and other energy information. http://www.nrel.gov/analysis/
- **Regional Technical Forum (RTF) deemed savings database**. This was developed by the Northwest Planning Council staff, with input from other members of the RTF, which includes utilities in the four-state region of Oregon, Washington, Idaho, and Montana. Both residential and commercial energy efficiency measures are included. http://www.nwcouncil.org/ energy/rtf/supportingdata/ default.htm
- **Tellus Institute**. High-level reports presenting scenarios on increased efficiency and renewable energy standards, reporting on their impact on the environment. Also provides additional links to the software models used by the Institute, including LEAP (Long-range Energy Planning). http://www.tellus.org/

2.5. REFERENCES

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New York State Energy Planning Board. 2015. 2015 New York State Energy Plan, Volume 2, Technical Appendix: End-Use Energy.	https://energyplan.ny.gov/Plans/2015
New York State Energy Research and Development Authority (NYSERDA). 2013. Patterns and Trends, New York State Energy Profiles: 1997–2011.	https://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/1997-2011-patterns-and-trends-report.pdf
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Vermont DPS. 2016. Vermont Comprehensive Energy Plan 2016.	https://outside.vermont.gov/sov/webservices/Shared%20Documents/2016CEP_Final.pdf