Guide for Conducting Energy Efficiency Potential Studies

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

NOVEMBER 2007

Schedule RAV-E2

About This Document

This *Guide for Conducting Energy Efficiency Potential Studies* is provided to assist state officials, regulators, legislators, and others in the implementation of the recommendations of the National Action Plan for Energy Efficiency (Action Plan) and the pursuit of its longer-term goals.

This Guide identifies three main applications for energy efficiency potential studies and provides examples of each, along with a description of how key decisions regarding scope and methodology are made to best achieve the studies' objectives. It also provides an overview of the main analytical steps in conducting a potential study and introduces several related concepts.

The primary intended audience for this Guide is policy-makers, state officials, utility staff, and efficiency advocates looking for guidance on the process of conducting potential studies. These individuals can also use the Guide to review the results of already-completed studies.

Guide for Conducting Energy Efficiency Potential Studies

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

NOVEMBER 2007

Schedule RAV-E2

The *Guide for Conducting Energy Efficiency Potential Studies* is a product of the National Action Plan for Energy Efficiency Leadership Group and does not reflect the views, policies, or otherwise of the federal government. The role of the U.S. Department of Energy and U.S. Environmental Protection Agency is limited to facilitation of the Action Plan.

This document was final as of December 2007 and incorporates minor modifications to the original release.

If this document is referenced, it should be cited as:

National Action Plan for Energy Efficiency (2007). *Guide for Conducting Energy Efficiency Potential Studies*. Prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc. <www.epa.gov/eeactionplan>

For More Information

Regarding the *Guide for Conducting Energy Efficiency Potential Studies*, please contact:

Niko Dietsch
U.S. Environmental Protection Agency
Office of Air and Radiation
Climate Protection Partnerships Division
Tel: (202) 343-9299
E-mail: dietsch.nikolaas@epa.gov

Regarding the National Action Plan for Energy Efficiency, please contact:

Stacy Angel
U.S. Environmental Protection Agency
Office of Air and Radiation
Climate Protection Partnerships Division
Tel: (202) 343-9606
E-mail: angel.stacy@epa.gov

Larry Mansueti
U.S. Department of Energy
Office of Electricity Delivery and Energy Reliability
Tel: (202) 586-2588
E-mail: lawrence.mansueti@hq.doe.gov

or visit www.epa.gov/eeactionplan

Schedule RAV-E2

Table of Contents

Table of Contents (continued)

List of Figures

List of Tables

List of Abbreviations and Acronyms

A

Action Plan National Action Plan for Energy Efficiency

AC air conditioning

ACEEE American Council for an Energy Efficient Economy

ARC alternative resource configuration

ARI American Refrigeration Institute

C

CBECS Commercial Building Energy Consumption Survey

CEE Consortium for Energy Efficiency

D

DEER Database for Energy Efficiency Resources (California)

DOE U.S. Department of Energy

DSM demand-side management

E

EIA Energy Information Administration

EPA U.S. Environmental Protection Agency

ERCOT Electric Reliability Council of Texas

G

GWh gigawatt-hour

H

HVAC heating, ventilation, and air conditioning

I

IOU investor-owned utility

K

kW kilowatt

kWh kilowatt-hour

L

LBL Lawrence Berkeley National Laboratory

M

MCES Manufacturing Energy Consumption Survey

MCF thousand cubic feet

MW megawatt

MWh megawatt-hour

N

NEMA National Electrical Manufacturers Association

R

RECS Residential Energy Consumption Survey

RIM ratepayer impact measure

S

SCT societal cost test

SWEEP Southwest Energy Efficiency Project

T

TRC total resource cost

V

VELCO Vermont Electric Power Company, Inc.

Acknowledgements

The Guide for Conducting Energy Efficiency Potential Studies is a key product of the Year Two Work Plan for the National Action Plan for Energy Efficiency. This work plan was developed based on feedback from Action Plan Leadership Group members and observers during the fall of 2006. The work plan was further refined during the March 2007 Leadership Group meeting in Washington, D.C. A full list of Leadership Group members is provided in Appendix A.

Philip Mosenthal of Optimal Energy, Inc., served as project manager and co-authored the Guide along with Jeffrey Loiter, under contract to the U.S. Environmental Protection Agency (EPA). In addition to direction and comment by the Action Plan Leadership Group, Rich Sedano of the Regulatory Assistance Project and Alison Silverstein of Alison Silverstein Consulting provided their expertise during review and editing of the Guide.

The U.S. Department of Energy (DOE) and EPA facilitate the National Action Plan for Energy Efficiency, including this Guide. Key staff include Larry Mansueti (DOE Office of Electricity Delivery and Energy Reliability), Dan Beckley (DOE Office of Energy Efficiency and Renewable Energy), and Kathleen Hogan, Niko Dietsch, Stacy Angel, and Katrina Pielli (EPA Climate Protection Partnership Division).

Eastern Research Group, Inc., provided technical review, copyediting, graphics, and production services.

Schedule RAV-E2

Executive Summary

This Guide provides information on standard approaches for parties looking to build the policy case for energy efficiency, evaluate efficiency as an alternative to supply-side resources, and formulate detailed program design plans by understanding the potential for cost-effective energy efficiency. Policy-makers, state officials, utility staff, efficiency advocates, and others can use this information to quantify the magnitude of the energy efficiency resource. The Guide is provided to assist in the implementation of the National Action Plan for Energy Efficiency's five key policy recommendations for creating a sustainable, aggressive national commitment to energy efficiency.

Importance of Conducting Energy Efficiency Potential Studies

Improving energy efficiency in our homes, businesses, schools, governments, and industries—which consume more than 70 percent of the natural gas and electricity used in the country—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change. Despite these benefits and the success of energy efficiency programs in some regions of the country, energy efficiency remains critically underutilized in the nation's energy portfolio. It is time to take advantage of more than two decades of experience with successful energy efficiency programs, broaden and expand these efforts, and capture the savings that energy efficiency offers. Conducting a potential study provides key information to inform policies and approaches to advance energy efficiency.

The National Action Plan for Energy Efficiency was released in July 2006 as a call to action to bring diverse stakeholders together at the national, regional, state, or utility level, as appropriate, and foster the discussions, decision-making, and commitments necessary to take investment in energy efficiency to a new level. This Guide directly supports the Action Plan recommendation to "make a strong, long-term commitment to implement cost-effective energy efficiency as a resource." A key option to consider under this recommendation is establishing the potential for long-term, cost-effective energy efficiency savings (see page 1-2 for a full listing of options to consider under each Action Plan recommendation). Conducting a potential study supports this option and provides critical data for the design of policies and programs aimed at increasing investment in energy efficiency, including:

- Setting attainable energy savings targets.
- Quantifying the energy efficiency resource for system planning.
- Determining funding levels for delivering energy efficiency programs.
- Designing programs to achieve the long-term potential.
- Reassessing energy efficiency opportunities as conditions change.

Energy efficiency potential studies are an effective tool for building the policy case for energy efficiency, evaluating efficiency as an alternative to supply side resources, and formulating detailed program design plans. They are typically the first step taken by entities interested in initiating or expanding a portfolio of efficiency programs, and serve as the analytic basis for efforts to treat energy efficiency as a high-priority resource equivalent with supply-side options.

Potential studies conducted by utilities, state agencies, advocacy groups, and other entities consistently find that significant gains in cost-effective energy savings (e.g., MWh of electricity, MCF of natural gas) and capacity (e.g., MW, MCF/day) are currently possible in all sectors and regions of the country, and are likely to continue to be available at low cost in the future. These studies show that energy efficiency can yield more than 20 percent savings in total electricity demand nationwide by 2025. This is equivalent to reducing the forecast growth in electric demand by 50 percent under some forecasts (Nadel et al., 2004; NEEP, 2005; SWEEP, 2002).

Energy efficiency potential studies can be broadly characterized by how the results are applied in a policy and program development context. In each case, the cost and time needed to complete a study is directly correlated with the level of detail and accuracy of results. This Guide identifies three main applications for energy efficiency potential studies:

1. Potential studies that are written with the aim of *building policy support and making the case for energy efficiency programs and funding*. Usually these types of studies are done at a high level of aggregation, and focus on the macro-level societal benefits of doing efficiency.

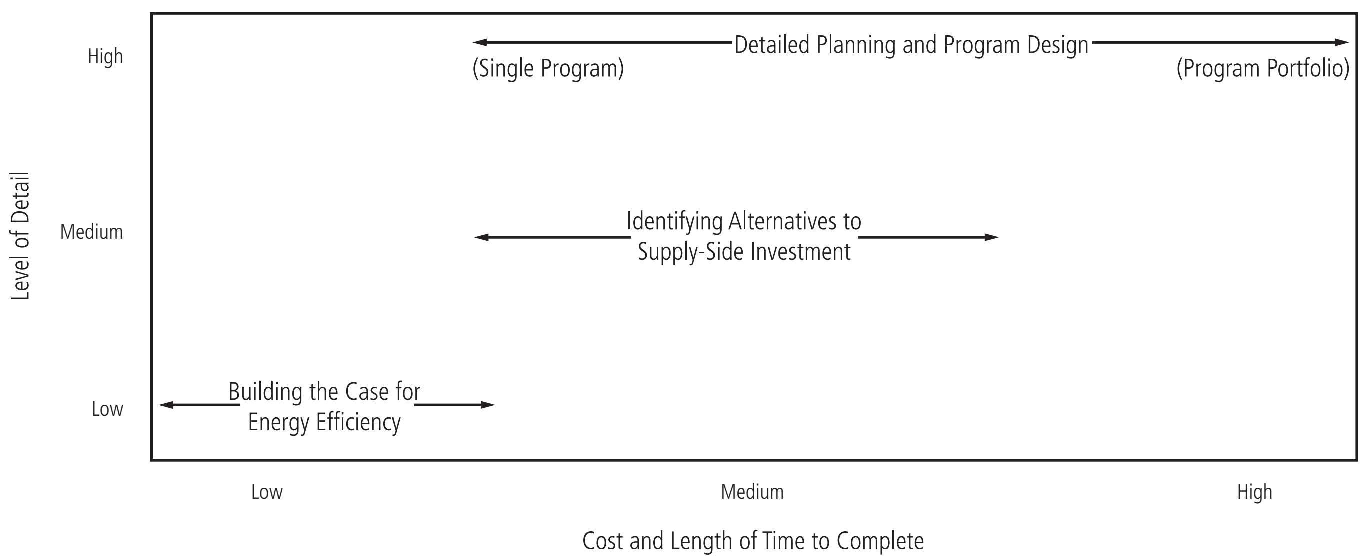
2. Potential studies that are written with the aim of *evaluating efficiency as an alternative to a specific supply-side project*. These types of studies present highly accurate estimates of the energy efficiency potential, as they need to provide certainty and foster confidence in energy resource planners to invest in energy efficiency instead of traditional "steel in the ground" resources.

3. Potential studies that are written with the aim of *determining how much to spend on efficiency, and how that money can best be spent*. These potential studies are conducted in situations where the policy decision to invest in efficiency has already been made and there is no need to make a case for supporting efficiency. These studies focus more on the disaggregated results (e.g., is there more opportunity in lighting or HVAC?) than other types of potential studies.

Each of these potential study applications incorporates general concepts and steps (discussed in Chapter 3), which include potential-type analyzed (technical, economic, or achievable), data collection approaches, level of aggregation, expected accuracy of results, and the type of output produced. Chapters 4 through 6 describe these concepts and steps, briefly address their implications for study cost and completion time, and provide recommendations for how each should be handled in the context of the three potential study applications (given a state or utility's overall policy goals).

After reading this Guide, parties seeking to undertake a potential study will better understand: (a) the questions to ask to ensure that the appropriate potential study

Figure ES-1. Considerations for Conducting Potential Studies



Schedule RAV-E2

application is selected, (b) the basic approach and steps for conducting the study, including the key questions and issues to raise with the analyst doing the work, and (c) the types of results and insights that can (and cannot) be expected, including how potential studies can be used to advance the Action Plan recommendations.

Table ES-1. Key Issues for Selecting a Potential Study Application

	Building a Case for Energy Efficiency	Identifying Alternatives to Supply-Side Investments	Detailed Planning and Program Design
Typical Cost*	$20,000–$75,000	$75,000–$300,000	$75,000–$500,000
Estimated Time*	1 to 4 months	4 and 12 months	4 and 12 months
Key Questions	• Are we in the process of deciding whether to invest in efficiency and if so, are we deciding how much to invest? • Is the primary motivation of this study to demonstrate the benefits of efficiency and build policy support? • Can we accept a fairly high level of aggregation and thus uncertainty in our results? • Are the desired outputs primarily macro-level energy and capacity savings, and is there a role for related economic and environmental data?	• Will this study determine whether energy efficiency can be used to defer or eliminate plans to build new capacity or upgrade transmission lines? • Are energy efficiency objectives best supported by "investment-grade" analysis with the aim of ensuring the future reliability of the power system? • Are energy efficiency objectives best supported by detailed measure-level data? Should certain measures (i.e., those that provide summer peak reductions) be given priority?	• Has the decision to invest in efficiency already been made? • Are data needed primarily to aid in decisions about which market sectors, targeted geographic areas, end uses, measures, and programs should be tapped to realize efficiency potential? • Are study findings intended primarily for energy efficiency planners who will incorporate the results into portfolio decisions? • What is the history of efficiency programming in this area? What effect does this history have on the assumptions we make about program potential? • Should the study focus on one particular end use, customer segment, or set of measures? Are data available that can give reasonable disaggregated results?

* These ranges should be viewed as approximate. They are based on a sample of studies and are not intended to define the absolute limit of these parameters.

1: Introduction

Improving the energy efficiency of homes, businesses, schools, governments, and industries—which consume more than 70 percent of the natural gas and electricity used in the United States—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change. Mining this efficiency could help us meet on the order of 50 percent or more of the expected growth in U.S. consumption of electricity and natural gas in the coming decades, yielding many billions of dollars in saved energy bills and avoiding significant emissions of greenhouse gases and other air pollutants.[1]

Recognizing this large opportunity, more than 60 leading organizations representing diverse stakeholders from across the country joined together to develop the National Action Plan for Energy Efficiency. The Action Plan identifies many of the key barriers contributing to underinvestment in energy efficiency; outlines five key policy recommendations for achieving all cost-effective energy efficiency, focusing largely on state-level energy efficiency policies and programs; and provides a number of options to consider in pursing these recommendations (Figure 1-1). As of November 2007, nearly 120 organizations have endorsed the Action Plan recommendations and made public commitments to implement them in their areas. Understanding the potential for cost-effective energy efficiency is key to making the Action Plan a reality.

1.1 Guide for Conducting Energy Efficiency Potential Studies

The Leadership Group of the National Action Plan for Energy Efficiency (see Appendix A for a list of group members) identified the area of energy efficiency potential studies as one where additional guidance is needed to help parties pursue the recommendations and meet their commitments to energy efficiency. Specifically, this Guide directly supports the Action Plan recommendation to "make a strong, long-term commitment to implement cost-effective energy efficiency as a resource." A key option to consider under this recommendation is establishing the potential for long-term, cost-effective energy efficiency savings. Further, this Guide was developed in conjunction with and complements other documents prepared as part of the Action Plan.

Potential studies of a state or region inform the comparison of energy efficiency with supply-side options, and therefore serve as the analytic basis for implementing four key options to consider under the Action Plan:

- Integrate energy efficiency into utility, state, and regional resource planning activities.
- Establish funding requirements for delivering long-term, cost-effective energy efficiency.
- Develop long-term energy saving goals as part of energy planning processes.
- Establish and educate stakeholders on the business case for energy efficiency.

1.1.1 How to Use This Guide

This Guide is provided as a resource for implementing the recommendations of the Action Plan. It was developed in conjunction with and complements other documents prepared as part of the Action Plan. One such document is the *Guide to Resource Planning with Energy Efficiency* (National Action Plan for Energy Efficiency, 2007), which details how potential studies play a critical role in the utility resource planning process.

The audience for the Guide includes policy-makers, state officials, utility staff, efficiency advocates, and other entities interested in conducting an energy

Figure 1-1. National Action Plan for Energy Efficiency Recommendations and Options

Recognize energy efficiency as a high-priority energy resource.

Options to consider:

- Establishing policies to establish energy efficiency as a priority resource.
- Integrating energy efficiency into utility, state, and regional resource planning activities.
- Quantifying and establishing the value of energy efficiency, considering energy savings, capacity savings, and environmental benefits, as appropriate.

Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.

Options to consider:

- Establishing appropriate cost-effectiveness tests for a portfolio of programs to reflect the long-term benefits of energy efficiency.
- Establishing the potential for long-term, cost-effective energy efficiency savings by customer class through proven programs, innovative initiatives, and cutting-edge technologies.
- Establishing funding requirements for delivering long-term, cost-effective energy efficiency.
- Developing long-term energy saving goals as part of energy planning processes.
- Developing robust measurement and verification procedures.
- Designating which organization(s) is responsible for administering the energy efficiency programs.
- Providing for frequent updates to energy resource plans to accommodate new information and technology.

Broadly communicate the benefits of and opportunities for energy efficiency.

Options to consider:

- Establishing and educating stakeholders on the business case for energy efficiency at the state, utility, and other appropriate level, addressing relevant customer, utility, and societal perspectives.
- Communicating the role of energy efficiency in lowering customer energy bills and system costs and risks over time.
- Communicating the role of building codes, appliance standards, and tax and other incentives.

Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective.

Options to consider:

- Deciding on and committing to a consistent way for program administrators to recover energy efficiency costs in a timely manner.
- Establishing funding mechanisms for energy efficiency from among the available options, such as revenue requirement or resource procurement funding, system benefits charges, rate-basing, shared-savings, and incentive mechanisms.
- Establishing funding for multi-year period.

Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.

Options to consider:

- Addressing the typical utility throughput incentive and removing other regulatory and management disincentives to energy efficiency.
- Providing utility incentives for the successful management of energy efficiency programs.
- Including the impact on adoption of energy efficiency as one of the goals of retail rate design, recognizing that it must be balanced with other objectives.
- Eliminating rate designs that discourage energy efficiency by not increasing costs as customers consume more electricity or natural gas.
- Adopting rate designs that encourage energy efficiency by considering the unique characteristics of each customer class and including partnering tariffs with other mechanisms that encourage energy efficiency, such as benefit-sharing programs and on-bill financing.

Source: National Action Plan for Energy Efficiency, 2006.

efficiency potential study for the purpose of initiating or expanding a portfolio of efficiency programs. It will also be useful for regulators, legislators, and other decision-makers tasked with overseeing utilities and assessing the merits of a particular energy efficiency approach or outcome. The Guide provides answers to—or the information needed to develop answers to—the following questions:

- What is a potential study?
- What objectives are met by a potential study?
- Do I need to conduct or commission a potential study for my jurisdiction?
- What are the key steps in conducting a potential study?
- What are the likely costs of different types of potential studies, and what are the pros and cons of each?
- Based on stated objectives, what type of potential study should I conduct or commission? What should its boundaries and analytical parameters be?

The Guide is "policy-neutral" such that it can be applied to energy efficiency programs irrespective of their policy objectives and constraints. The Guide lays out a basic potential study structure and methodology while flagging issues that need to be addressed in specific circumstances. Chapters 2 and 3 present key topics and approaches applicable to all potential studies. They define the types of potential that are typically analyzed and the expected range of results from each. They also summarize the most important steps in performing a potential study. The Guide also identifies three contexts for application of potential studies. Chapters 4 through 6 identify specific approaches and provide guidance for each step in relation to these three study applications. Case studies are used to illustrate best practices, with pros and cons of different methods presented so that users can make the best decision for their circumstances. Chapter 7 summarizes the discussion and identifies important considerations in conducting a potential study. Appendix C provides a detailed discussion on potential study methodology.

Note that this guide is *not* intended to give the general reader enough information to conduct a potential study on their own. Rather, we hope that after reviewing this document, the reader will be able to participate in efforts to plan for, contract for, contribute to, and review the results of potential studies. Where potential studies are conducted, the reader should be able to effectively collaborate with the entity doing the work. To this end, specific "questions for the analyst" are provided at the beginning of Chapters 4 through 6.

1.1.2 Structure of the Guide

This document presents much of its information in the context of several example studies. To avoid repetition, different aspects of conducting a potential study are emphasized in Chapters 4 through 6. Appendix C repeats much of this information in a more linear fashion that does not rely on the examples in the main text, while Appendix D contains a list of common data sources used for potential studies and a short description of each. Appendix E provides short descriptions of 17 recent potential studies, with Web links where available.

1.1.3 Development of the Guide

The Guide is a key product of the Year Two Work Plan for the National Action Plan for Energy Efficiency. This work plan was developed based on feedback from Action Plan Leadership Group members and observers during the fall of 2006. The work plan was further refined during the March 2007 Leadership Group meeting in Washington, D.C. A full list of Leadership Group members is provided in Appendix A.

Philip Mosenthal of Optimal Energy, Inc., served as project manager and co-authored the Guide along with Jeffrey Loiter, under contract to the U.S. Environmental Protection Agency.

1.2 Notes

1. See the *National Action Plan for Energy Efficiency* (2006), available at <www.epa.gov/cleanenergy/actionplan/report.htm>.

2: Energy Efficiency Potential Studies as a Policy Tool

This chapter of the Guide explains why conducting potential studies is a critical best practice for establishing energy efficiency as a first-priority resource, and describes how such studies can serve as the quantitative basis for actions aimed at achieving the Action Plan's recommendations.

2.1 What Is a Potential Study?

Simply put, a potential study is a quantitative analysis of the amount of energy savings that either exists, is cost-effective, or could be realized through the implementation of energy efficiency programs and policies. The Action Plan notes that "potential studies illuminate the nature of the energy efficiency resource, and can be used by legislators and regulators to inform efficiency policy and programs."[1] The boundaries of a potential study can be as small as a neighborhood experiencing transmission or distribution constraints, or as large as an entire region of the country. The study may consider all sectors of the economy or focus on a particular industry or type of energy-user. It may focus solely on electricity, natural gas, or another fuel or provide a comprehensive look at all energy consumption. As with any analysis used to support public policy, the scope of the study depends on the question being answered.

2.2 Definition of Key Terms

As in any field of study, energy efficiency practitioners use a vocabulary of terms with generally accepted meanings to convey their ideas, methods, and results. The following list defines some of the key terms used in this guide.

- **Energy efficiency:** using less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way. Sometimes "conservation" is used as a synonym, but that term is usually taken to mean using less of a resource even if this results in a lower service level (e.g., setting a thermostat lower or reducing lighting levels). The Action Plan recognizes that energy efficiency includes using less energy at any time, including at times of peak demand through demand response and peak shaving efforts.
- **Measure:** any action taken to increase efficiency, whether through changes in equipment, control strategies, or behavior. Examples are higher-efficiency central air conditioners, occupancy sensor control of lighting, and retro-commissioning. In some cases, bundles of technologies or practices may be modeled as single measures. For example, an ENERGY STAR™ home package may be treated as a single measure.
- **Program:** a mechanism for encouraging energy efficiency. May be funded by a variety of sources and pursued by a wide range of approaches. Typically includes multiple measures.[2]
- **End-use:** a category of equipment or service that consumes energy (e.g., lighting, refrigeration, heating, process heat).
- **Cost-effectiveness:** a measure of the relevant economic effects resulting from the implementation of an energy efficiency measure. If the benefits outweigh the cost, the measure is said to be cost-effective.
- **Lost-opportunity:** refers to an efficiency measure or efficiency program that seeks to encourage the selection of higher-efficiency equipment or building practices than would typically be chosen at the time of a purchase or design decision.
- **Retrofit:** refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units (also called "early retirement") or the installation of additional

Schedule RAV-E2

controls, equipment, or materials in existing facilities for purposes of reducing energy consumption (e.g., increased insulation, lighting occupancy controls, economizer ventilation systems).

2.3 Potential Studies as Policy Tool

Potential studies can serve multiple objectives in support of efforts to advance a long-term commitment to cost-effective energy efficiency. Their results provide critical input for the design of policies and programs aimed at increasing the penetration of efficiency, including:

- Setting attainable energy savings targets.
- Quantifying the energy efficiency resource for system planning.
- Determining a funding level for delivering energy efficiency programs.
- Designing programs to achieve the long-term potential.
- Reassessing energy efficiency opportunities as conditions change.

The type of report and analysis methodology will vary depending on the ultimate goal or objective, so it is important to have a clear idea of the objectives of the study and type of information needed before beginning the analysis. This section describes three applications for which a potential study can inform policy decisions:

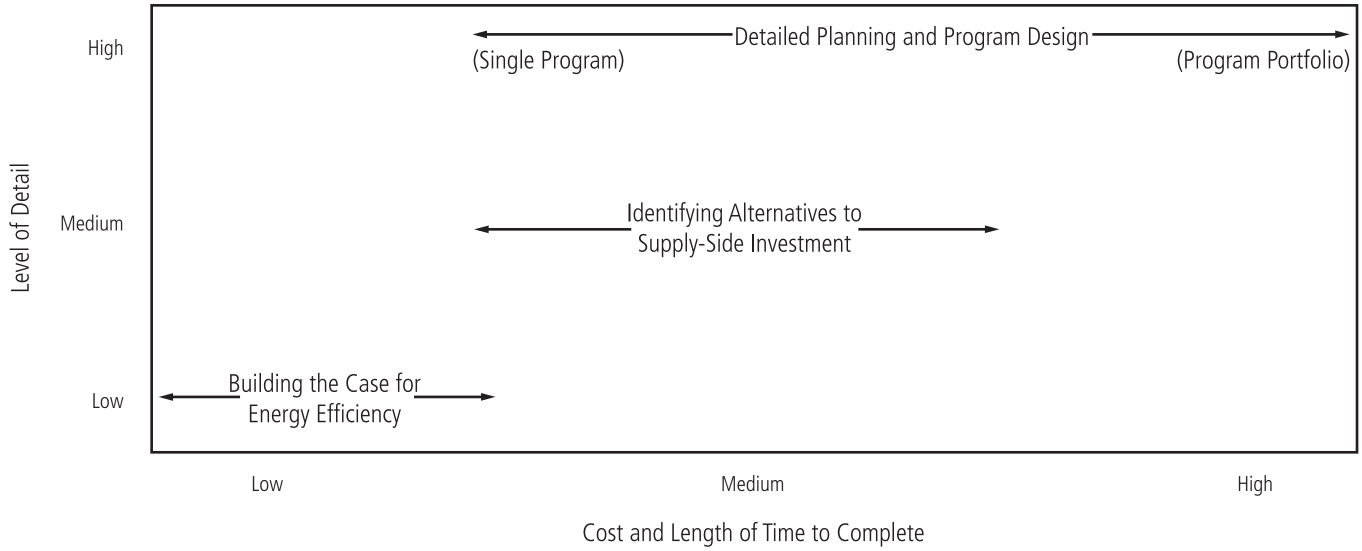
- Building a case for investment in energy efficiency.
- Identifying alternatives for supply-side investments.
- Detailed efficiency program design and planning.

These were chosen because the studies that result from these objectives cover a range of approaches, levels of detail, and costs. They also represent the majority of studies conducted. For each, we touch on some of the concepts discussed in greater detail later on, such as the level of detail of the potential study and whether site-specific data are gathered to support the potential analysis. In general, the greater the detail and data needs for a study, the greater the specificity of the results and the greater the cost and time to complete a study. The figure below depicts this relationship graphically, placing the three potential study scenarios in context with one another.

2.3.1 Building a Case for Efficiency Investment

Potential studies are most frequently used either to make the initial case for energy efficiency programs and efficiency portfolio investments or to support continued (and possibly increased) funding of existing programs. In this situation, a study seeks to answer the two-part question of whether to invest in efficiency and if so,

Figure 2-1. Considerations for Conducting Potential Studies



Schedule RAV-E2

how much to invest.[3] To support this objective, decision-makers need to understand the overall magnitude of the efficiency resource and the associated costs and benefits. The analysis in this case focuses on providing a reasonable estimate of efficiency potential at a high level[4] of aggregation. Results from these studies are typically used to establish the magnitude of efficiency opportunities and to support high-level decisions on funding levels for efficiency portfolios. While the level of funding allocated to efficiency programs is ultimately a political decision, a potential study can help all stakeholders to clearly see the possibilities.

In many cases, needlessly detailed and expensive studies are performed where simpler analyses would suffice. For example, if available program funding (whether proposed or currently available) will only support a modest level of efficiency investment, a high-level study conducted for a relatively modest budget will typically provide the necessary information to support policy decisions (see Section 3.4). In cases where jurisdictions are beginning to pursue a high percentage of efficiency opportunities, more detailed studies may be necessary to refine estimates of cost-effective spending levels as well as to provide information on the remaining efficiency opportunities.

2.3.2 Identifying Alternatives to Supply-Side Investments

Energy efficiency is increasingly being considered as an alternative to supply-side investment in generation or transmission resources, especially in the context of reliability constraints. In cases where parties wish to understand the relative magnitude of the efficiency potential and whether it can defer alternative investments, a potential study can answer the question: Can efficiency displace needed investments in supply-side or transmission resources? Investment decisions, especially those regarding investments to meet future reliability, may require a more detailed potential study than under the previous scenario. These studies typically focus on a specific set of conditions (e.g., geographic area, customer loads) to facilitate comparison with alternative solutions. Ideally, the methodology is based on detailed, site-specific data to support investment-grade analysis. Such a potential study is designed to produce estimates of what can be accomplished from a specific program design, rather than on generally aggressive efficiency investments.

2.3.3 Detailed Planning and Program Design

In some cases, policy-makers have decided to invest in efficiency and need guidance on which market sectors, targeted geographic areas, end uses, measures, and programs should be tapped to realize the efficiency potential in their regions of interest. For example, when dealing with equity issues, a policy-maker may wish to fully understand the level of cost-effective efficiency investment that can be achieved in the low-income sector. It may also be desirable to establish specific savings, spending, or net benefits goals for one or more market segments (e.g., new construction). For this purpose, detailed potential studies are needed to describe the efficiency potential by specific characteristics or to analyze various program options for the purpose of understanding additional opportunities for efficiency. Very detailed studies may be warranted to determine the magnitude and economics of specific measures, market segments, or detailed program designs. A greater level of segmentation generally requires a more detailed and expensive study. The effort required for a greater level of detail may be offset by limiting the analysis to one or a few program concepts or market sectors, rather than addressing all efficiency opportunities.

2.4 Types of Efficiency Potential

Energy efficiency practitioners often distinguish between four different types of efficiency potential analysis: technical, economic, achievable, and program. Still, there are often important definitional issues between studies, and terms are used in different ways by different people. Therefore, it is important when reviewing studies to fully understand the definition and scope that applies to any given estimate. Below are typical definitions of these terms. The first two types of studies—technical and economic—provide a theoretical upper bound of existing efficiency resources. Even the best-designed portfolio of programs, with unlimited funding, will not capture 100 percent of the technical or economic potential. The latter two types—achievable and program—tend to be more useful in that they estimate what can actually be achieved, when it can be captured, and how much it will cost to do so.

- **Technical potential** is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.
- **Economic potential** refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential are theoretical numbers that assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.
- **Achievable potential** is the amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g., providing end-users with payments for the entire incremental cost of more efficiency equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.[5]
- **Program potential** refers to the efficiency potential possible given specific program funding levels and designs. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable." In effect, they estimate the achievable potential from a given set of programs and funding. Program potential studies can consider scenarios ranging from a single program to a full portfolio of programs. A typical potential study may report a range of results based on different program funding levels.

Variations exist on the above definitions. For example, most studies consider achievable potential as a subset of economic potential, but some studies consider it as a subset of technical potential. The rationale for this is that as avoided costs and measure costs change over time, non-cost-effective measures may become economical. *Maximum technically achievable* would be a more informative term for such a view. This is especially true when considering efficiency resources as an alternative to defer or replace substantial new supply-side investment. In this case, what is economical may not be known until the magnitude of efficiency is established and components or new supply-side investments can be analyzed to determine the potential cost and benefits of deferral. Finally, we note that in reality, potential exists along a continuum rather than in discrete steps. While the terms defined above facilitate discussion and comparison of different studies, it is important to understand the scope of the particular definition of potential in use for any given study.

2.5 Review of Results from Previous Potential Studies

There have been numerous potential studies released in the past decade covering regions throughout the United States and Canada. The tables below summarize the technical, economic, and achievable potential found in 21 studies, 19 of which are from the United States.[6] It is important to note that the studies vary in their scope, objectives, methodology, time horizon, and definitions. This is especially true in regard to achievable potential. Some studies define this as the maximum potential that could be captured assuming infinite budget (i.e., 100 percent of incremental efficiency costs covered by incentives, as well as aggressive marketing and other supporting initiatives). Other studies define achievable potential as that which could reasonably be captured through likely policies or specific funding constraints.

Schedule RAV-E2

Regardless of definition, the results reported in the tables as "achievable" are those for the most aggressive program evaluated in that study.

Despite the differences, it is informative to compare the range of results found in these studies. To provide some context for these values, reaching the maximum achievable potential (i.e., approaching the total economic potential) of between 20 and 30 percent would require efficiency spending in excess of 5 percent of utility revenue. Historically, this has been beyond levels pursued by even the most aggressive jurisdictions and has not been accomplished except in a few limited instances.

Tables 2-1 and 2-2 present detailed results for specific studies for both electric and natural gas potential, respectively.[7] Recognize that the wide divergence of results tends to have more to do with the scope, comprehensiveness of the studies, and timeframe rather than the different regions considered. For example, the number of measures analyzed can vary widely from study to study, from less than 20 to over 1,000. Some studies may eliminate new construction, early retirement, or other important markets. In addition, many studies will use simplified methods for economic screening or for factors such as equipment stock adjustments that can bias results. While the potential in each region is influenced by the climate and mix of customers (e.g., prominent industrial sectors), the overall percentage of savings potential does not vary dramatically. For many efficiency technologies, the percentage energy savings is only minimally dependent on operating conditions. For example, higher efficiency cooling equipment may save, say, 15 percent of cooling energy used by commercial buildings, regardless of climate. In warmer climates, where more energy is used for cooling, the total energy savings in MWh will be higher than in cooler climates.

Table 2-1. Sample of Natural Gas Savings Potential Studies

Area(s) Covered	Author(s)	Year Completed	Type of Savings Potential	Total Gas Reduction as a % of Sales	Years to Achieve Estimated Savings Potential
California	ACEEE	2003	Technical Economic Max. Achievable	35% 21% 9%	20
Georgia	ICF	2000	Technical Economic Max. Achievable	10% 11% 1.8–5.5%	5
Iowa	ORNL	2001	Max. Achievable	3.7%	15
Midwest	ACEEE	2003	Max. Achievable	9.30%	20
Midwest	Quantec	2005	Technical Max. Achievable	46.6% 25.2%	20
New York	OEI/VEIC/ACEEE	2002	Economic Max. Achievable	28% 1.5%	5
Utah	GDS/Quantum	2004	Technical Max. Achievable	38% 20%	10

Table 2-2. Sample of Electricity Savings Potential Studies

Area(s) Covered	Author(s)	Year Completed	Type of Savings Potential	Estimated Consumption Savings as % of Sales				Estimated Summer Peak Demand Savings as % of Total Capacity	Years to Achieve Estimated Savings Potential	Comments
				Res.	Comm.	Indus.	Total			
New Brunswick	Énergie NB Power	2004	Technical Economic Economic	32% 7% 3%	32% 14% 6%	13% 12% 1%	24% 10% 3%	N.A.	17	Includes fuel switching; excludes street lights
British Columbia	BC Hydro	2002	Economic Max. Achievable	17% 4%	17% 4%	27% 11%	N.A.	N.A.	9	
California	Xenergy	2002	Technical Economic Max. Achievable Budget Constrained	21% 15% 10% 8%	17% 13% 13% 7%	13% 12% 11% 4%	19% 14% 10% 6%	25% 16% 10% 6%	10	Integrated measures not addressed; agriculture included in industrial sector
Manitoba	Manitoba Hydro	2002	Economic Max. Achievable	19% 4%	19% 6%	5% 1%	N.A.	N.A.	9	Apartment buildings included in commercial
Midwest	ACEEE	2003	Max. Achievable	N.A.	N.A.	N.A.	11%	N.A.	20	
New Mexico	Itron	2006	Max. Achievable	N.A.	N.A.	N.A.	8%	8.90%	10	
Connecticut	GDS Associates/ Quantum-Consulting	2003	Technical Max. Achievable	24% 13%	25% 14%	20% 13%	24% 13%	24% 13%	10	Also includes results for Southwest CT region

Schedule RAV-E2

Table 2-2. Sample of Electricity Savings Potential Studies (continued)

Area(s) Covered	Author(s)	Year Completed	Type of Savings Potential	Estimated Consumption Savings as % of Sales				Estimated Summer Peak Demand Savings as % of Total Capacity	Years to Achieve Estimated Savings Potential	Comments
				Res.	Comm.	Indus.	Total			
Georgia	ICF	2005	Technical Economic Max. Achievable	N.A.	N.A.	N.A.	29% 20% 2.3%–8.7%	33% 18% 1.8%–5.5%	5	
Illinois	ACEEE	1998	Achievable	N.A.	N.A.	N.A.	43%	N.A.	20	
Iowa	ORNL	2001	Max. Achievable	5.3%	5.1%	6%	5.4%	N.A.	15	
Massachusetts	RLW Analytics/ SFMC	2001	Economic Budget Constrained	31% 5%	21%	N.A.	24% 5%	N.A.	5	Excludes non-utility impacts and low income
New York	OEI/VEIC/ ACEEE	2002	Technical Economic	37% 26%	41% 38%	22% 16%	37% 30%	N.A.	10	A lso 5- and 20-year scenarios
Ontario	ICF	2005	Technical Economic	N.A.	N.A.	N.A.	26% 21%	33% 21%	20	
Oregon	Technical	2003	Ecotope/ ACEEE/Tellus	28%	32%	35%	31%	N.A.	10	Residential includes manufactured housing
Puget Sound Region	Puget Sound Energy	2003	Max. Technically Achievable Max. Economically Achievable	17% 7%	7% 6%	0% 0%	12% 6%	33% 11%	20	

Table 2-2. Sample of Electricity Savings Potential Studies (continued)

Area(s) Covered	Author(s)	Year Completed	Type of Savings Potential	Estimated Consumption Savings as % of Sales				Estimated Summer Peak Demand Savings as % of Total Capacity	Years to Achieve Estimated Savings Potential	Comments
				Res.	Comm.	Indus.	Total			
Quebec	OEI/VEIC	2004	Max. Technically Achievable Max. Economically Achievable	8% 2%	19% 6%	1% 1%	7% 3%	N.A.	8	Residential sales include farms; no farm savings estimated
Texas	OEI	2007	Max. Achievable	N.A.	N.A.	N.A.	20%	22%	15	
Utah	Tellus Institue	2001	Max. Achievable	N.A.	N.A.	N.A.	9%	N.A.	6	
Vermont	OEI/VEIC	2002	Max. Technically Achievable	30%	32%		31%	37%	10	Includes fuel switching; also 5-year scenario
VELCO	OEI/VEIC	2002	Max. Achievable	18%	17%		23%	23%	10	Excludes measures with little peak demand, that require regional coordination, and emerging technologies; includes fuel switching; also 5-year scenario

Schedule RAV-E2

Table 2-2. Sample of Electricity Savings Potential Studies (continued)

Area(s) Covered	Author(s)	Year Completed	Type of Savings Potential	Estimated Consumption Savings as % of Sales				Estimated Summer Peak Demand Savings as % of Total Capacity	Years to Achieve Estimated Savings Potential	Comments
				Res.	Comm.	Indus.	Total			
AZ,CO,NV,NM, UT,WY	SWEEP/ ACEEE/ Tellus	2002	Max. Achievable	14%	20%	19%	18%	N.A.	8	Also 18-year scenario
NY, NJ, PA	ACEEE	1997	Max. Achievable	35%	35%	41%	N.A.	N.A.	14	Residential savings are for all fuels, not just electricity

2.6 Notes

1. *National Action Plan for Energy Efficiency* (2006), pp. 6-15.

2. Projects, one or more measures at a single facility or site, are also aggregated into programs. Considerations at the measure level are most applicable to potential studies.

3. These questions may arise from a variety of policy, economic, or energy supply needs. For example, one might wish to understand the potential role of energy efficiency in meeting emissions reduction targets or energy portfolio standards such as the Regional Greenhouse Gas Initiative.

4. Note that the term "high-level" is used as in "a high-level view." It implies a lesser level of detail, not greater.

5. Maximum achievable potential generally refers to assuming the most aggressive, fully funded programs possible. However, studies will sometimes refer to achievable potential while estimating the savings from a less aggressive strategy (e.g., programs that are limited to funding a fraction of the cost of efficiency measures). These funding- or program-constrained scenarios may more closely represent program potential as defined here.

6. In some cases, achievable potential is for a limited funding or program scenario and more closely reflects what this document refers to as "program potential."

7. Potential studies, like many quantitative policy analyses, have a "useful life" determined in part by changes in the markets, technologies, and demographic entities being analyzed. For example, future changes in appliance standards not captured in a potential study may dramatically alter the savings available from an appliance program. On the other hand, the efficiency of the best units continues to improve with new technologies, creating additional efficiency opportunities between the new, higher efficiency level and the new, higher baseline.

3: General Concepts and Steps to Completing a Potential Study

This chapter of the Guide describes general concepts relevant to completing a potential study and breaks the process down into five broad steps: (1) identify the objective and the audience, (2) select the potential type(s) to analyze, (3) determine the appropriate level of detail, (4) select and define the methodology, and (5) present the results. The specifics of these five steps need to be explored with or communicated to the entity performing the study. The general information provided in this chapter informs this process, and is supplemented with "questions for the analyst" listed at the beginning of Chapters 4, 5, and 6. The concepts introduced here are expanded upon in these subsequent chapters.

3.1 Identify the Objective and the Audience

There are a number of different objectives for undertaking a potential study, each with important implications for the necessary rigor and cost of the study. Clearly identifying the objective and the desired results is the necessary first step in planning a study. Where there are multiple and perhaps competing objectives, there should be an attempt to reach consensus as to which objective is most important. This will facilitate decisions regarding any analytical trade-offs that become necessary as a result of limitations in data, resources, or time available to undertake the study.

The audience for a potential study can inform the analytical methods and data used to produce the final report. Typically, the audience is closely related to the objective, and may be implicitly or explicitly defined once the objectives are determined. Regardless, specific attention should be paid to the needs of the audience. Since potential studies often look 10 or 20 years into the future, questions arise as to the reliability and trustworthiness of the data and results. For this reason, audiences should be consulted to determine what data sources they trust, what issues need addressing, and what level of detail they require. In some cases, a formal advisory board of stakeholders or a collaborative may be formed to guide or manage the study.

3.2 Select Potential Type(s) to Analyze

Estimates of technical and economic potential are independent of the efforts necessary to actually capture that potential. As described above, technical potential is the maximum amount of energy use that could be displaced by efficiency, assuming immediate implementation of all technically feasible energy-saving measures. This includes, for example, the replacement of every incandescent bulb with a compact fluorescent lamp or high-efficiency fixture, regardless of cost. Considerations of initiative strategies, performance, willingness of end-users to adopt technologies, or budget do not affect this potential estimate. Economic potential can then be determined by factoring in the measure cost.

Because of the disconnect between implementation issues and estimates of technical and economic potential, these potential estimates do little more than set the context for estimates of achievable and program potential, or for actual program results. Technical potential in particular has little bearing on decision-making, as failure to meet standard cost-effectiveness tests (i.e., economic potential) generally excludes opportunities from inclusion in actual implemented efficiency programs. Economic potential estimates do not include initiative budgets, do not provide likely timelines of energy efficiency acquisition, and do not represent quantities of efficiency that can actually be acquired. As a result, technical and economic potential studies are of

Schedule RAV-E2

limited value for planning purposes. While they set the theoretical upper bound for efficiency, they cannot be readily captured.

In most cases, policy-makers should consider foregoing technical potential analyses altogether. In practice, most technical and economic potential studies generate very similar estimates. Because analysts generally pre-screen possible efficiency technologies and practices based on an understanding of which measures are likely to be cost-effective, most measures that are technically feasible but very unlikely to pass a cost-effectiveness screening will not be included in the analysis in the interest of conserving time and effort for other aspects of the analysis. This results in the technical potential being virtually the same as the economic potential.

It may be more difficult to determine where along the continuum of potential studies to focus efforts for a particular objective. Chapters 4 through 6 discuss this issue with respect to the examples presented and the objective of the study. The type of potential analyzed should be chosen to best support the objectives of the work.

3.3 Determine Appropriate Level of Detail and Assess Data Requirements

This section describes two related activities in planning a potential study: selecting a level of detail and gathering the data necessary to support the study. These activities are discussed separately here, but in reality the analyst will likely consider them simultaneously, with each influencing the other. Some iteration may also be required; if the analyst does not find appropriate data sources, she may need to modify the level of detail for the study. For more information on data sources, see Appendix D.

3.3.1 Level of Detail

Energy efficiency potential studies can be conducted at a range of detail levels. There are, of course, cost implications for this—many high-level energy efficiency potential studies can be completed for under $50,000 in total costs, while more detailed potential studies can cost anywhere from $200,000 to $1 million depending upon the geographic area in question, the degree to which results are segmented, and the level of detail and data collection required.[1] Ultimately, the level of detail should be driven by the study objectives. High-level studies can drive "yes/no" policy decisions and/or rough budget allocations, while more detailed potential studies give shape to or refine existing efficiency efforts.

The level of detail of a potential study might also be driven by data availability. As discussed below, a wide range of data are needed to support a potential study. While information is generally available to disaggregate electricity or natural gas sales into residential, commercial, and industrial sectors, the data needed to further disaggregate sales into building types or end-uses are more difficult to obtain.[2] Information on current standard ("baseline") practices and penetrations of efficiency measures may also be scarce. Decision-makers may wish to pursue a high-level study in the absence of fully disaggregated sales data, as a more detailed study would imply a false level of precision.

When data are not available to support a detailed and disaggregated study, primary research may be conducted. This will typically take the form of onsite data collection from a sampling of different building types, along with modeling. This type of effort can significantly refine baseline assumptions and accuracy, but at substantial cost. These types of detailed studies tend to cost in the $500,000 to $1 million range.

If the costs or time required for primary research are prohibitive, studies typically rely on secondary research data.[3] In this case, detailed studies from neighboring regions or similar market segments may be used as a proxy for the actual region or segment being analyzed. With appropriate adjustments and careful selection of comparison areas, this can provide a fairly high level of accuracy. However, one must ensure that they fully understand the data being used, how they were collected, and whether they introduce bias into the analysis.

Schedule RAV-E2

3.3.2 Common Data Sources

The quality and availability of data is often the limiting factor of a potential study and drives the methods used. Data issues can drive the cost of the potential study as well as limit its possible scope. Detailed potential studies must include data in the following areas:

- Baseline end-use and efficiency data.
- Energy forecasts.
- Measure costs and savings as well as measure life.
- Sales disaggregation information.

As described below, all of these data can be found with varying levels of ease and reliability. Data collection is one major additional cost in performing a detailed study over a high-level study.

In general, good-state level end-use data are not readily available and must be patched together using a variety of different sources. **The Energy Information Agency** (EIA) of the U.S. Department of Energy (<http://www.eia.doe.gov>) publishes three surveys about energy consumption in the major sectors of the economy: The **Residential Energy Consumption Survey** (RECS), **Manufacturing Energy Consumption Survey** (MECS), and **Commercial Building Energy Consumption Survey** (CBECS).[4] While these surveys contain a wealth of information on energy use by different types of buildings sorted by a variety of characteristics (e.g., energy use by commercial buildings, by number of floors in the building), they have two primary limitations. First, they only provide data aggregated at either the level of four Census regions or nine Census divisions. (They also provide data for the four most populous states: California, Florida, New York, and Texas.) Second, while they give the total energy use sorted by end-use characteristics, current versions of the surveys do not provide the energy consumption associated with that end-use. For example, while RECS presents the total electricity consumed by houses that have central air conditioning, it does not provide data on how much of that electricity is consumed by the air conditioning system. Some older versions of the survey do provide this type of information, but these data are several years old and should be used with caution, as the efficiency and characteristics of some major energy-consuming equipment has changed dramatically over time.

Some household data are available at much finer resolution than in RECS from the **U.S. Bureau of the Census** (<http://www.census.gov>). The U.S. Census Fact Finder allows users to access census data tables by geographic location and attribute, including profiles of selected social, economic, and housing characteristics. Housing characteristics include units in structure, year structure built, number of rooms, and type of heating fuel. Census data are particularly helpful for determining both the relative number of single-family vs. multi-family structures and for accessing historical data that may inform forecasts of new residential construction activity.

Energy profiles that provide hourly end-use data on energy consumption by building type can be purchased from businesses specializing in these data. Typically available at the state level and for major metropolitan areas, these datasets are usually the result of many thousands of energy audits conducted on commercial, industrial, and residential buildings throughout the United States. Energy profiles are particularly important for determining the effect of energy savings on peak system loads and for distributing energy savings into different energy use periods (e.g., seasonal peak hours, daily peak hours). Another source of energy profiles are existing efficiency programs. Long-established programs at large utilities occasionally conducted evaluation studies on their customers and may have generated data on customer load-shapes and energy use profiles. Care must be taken when using older studies, as energy use patterns have changed over time.

The EIA is also a source of energy forecast data. The **Annual Energy Outlook** provides forecasts of energy consumption by sector for the nine census divisions as well as by Electricity Market Module Region, which disaggregates the data into 12 regions covered by electric coordinating organizations. A different report, **Electric Power Annual,** contains historical data and a forecast, although the forecast is for fewer years than found in the Energy Outlook. **Public utility commissions** often have forecasts for their states, and most utilities have forecasts for their service territories. The analyst should consider all of the potential data sources and develop a supportable forecast. For past years, energy sales can often be disaggregated into building type based on historical data from the utilities or states' public utility commissions.

For current year data, forecasts of economic growth are often used. These forecasts can also help derive important information about the relative importance of end use sales in future years. It may be, for example, that over the 10-year study period, computers and televisions use more and more energy, while at the same time more and more people replace their old refrigerators with newer, more efficient models. It is important that these shifts in the relative importance of end-use sales be captured in the energy forecast. Economic forecasts are available from several public and private sources.

Some publicly available data exist on measure savings and costs. For example, the **DEER database** (<http://www.calmac.org>) provides estimated incremental costs in California from a variety of measures culled from utility program databases. Commercial construction cost publications such as those by the construction trades can be a source of measure installation labor costs and are often used by contractors to estimate construction budgets.

In general, the above national public data sources should be considered sources of last resort: they provide data averaged over large regions, sometimes are not very current, and it is often difficult to ascertain sufficient background information to fully understand the underlying methods used to determine what biases may exist. For many studies, utility, state, or other local data may be available that is specific to the geographic area being studied and will provide greater detail and accuracy. In some cases, studies from reasonable comparison areas may exist. As with energy profiles, utilities may be a good source of this information. Examples of locally developed data that may exist include:

- Appliance saturation studies.
- Baseline studies that characterize the types and efficiency of equipment in existing and new buildings.
- Energy use forecasts, often separately estimating existing and new construction energy use and separated by major consuming sector.
- End-use disaggregation data—this may be from statistical models, metering, or simulation models.
- Program evaluations that identify measure savings and document penetration rates and baseline practices.

If resources are available, primary data can be collected through phone and onsite surveys of samples of facilities and market actors in the region being analyzed. This can provide the most specific and accurate data, but obviously requires higher commitments of time and budget.

Finally, any effort to "transfer" data from one geographic or demographic unit to another should be done with caution and an understanding of the factors that might affect the applicability of the data to the new situation. Differences in climate, economic and demographic factors, and the prevalent commercial and industrial customer types should be investigated and adjustments made if supported by good data.

3.4 Select and Define the Methodology

In general, a potential analysis involves the following steps:

- Identify the baseline energy consumption forecast, including a specific understanding of what it does and does not include in terms of future changes to codes and standards, natural efficiency adoption, planned efficiency programs, etc.
- Disaggregate the baseline forecast into customer and other segments (e.g., end uses) appropriate for the analysis.

Schedule RAV-E2

- Characterize efficiency measures:
  - Identify energy, demand, and other savings (e.g., operations and maintenance) of each measure, including changes over time.[5]
  - Identify costs associated with each measure, including changes over time, such as prices coming down because of greater volume sold and technology improvements.
- Screen measures for economic effects, cost-effectiveness, and other resource effects.
- Develop program designs, in terms of bundled measures targeting particular customer groups and/or end-uses.
- Estimate measure penetrations for baseline and efficient scenarios for each program year using program design information, available studies, past program results, understanding of the specific markets, etc.
- Calculate total savings for all efficiency measures.
- Present the results.

The following sections provide additional detail on each step and examples of how these steps were handled in several example potential studies. Appendix C presents a more detailed discussion of these steps and some of the key analytical issues that arise with each.

3.4.1 Forecast and Disaggregate the Baseline

Broadly speaking, the objective of a potential study is to estimate future energy savings opportunities resulting from the presence of some program or policy to promote efficiency. That is, the potential estimate is relative to some scenario that represents "business as usual." Therefore, the first step in any potential study is to predict the future in the absence of intervention to promote additional efficiency investments. This "baseline scenario" forecast provides the context for the comparison of the "efficient scenario." The baseline can be characterized in terms of annual kWh consumed, peak demand of the system (whatever its boundaries) in MW, tons of pollutants emitted, or other metrics. In practice, the first two metrics are most typically used.

It is critical to understand what the baseline forecast represents. For example, many jurisdictions have some existing efficiency programming. The analyst should determine if the forecasts include continuation of the existing program, ignore it altogether, or something in between. Furthermore, the forecast might include assumptions about "natural efficiency" (the proportion of all equipment purchases that will flow to efficient products in the absence of any programmatic incentives) or changes in building codes or other energy use standards (e.g., national ENERGY STAR requirements). In some cases, the analyst may choose to add the projected energy savings from such programs back into the forecast in order to have an appropriate baseline from which to develop the economic or maximum achievable potential. The total potential estimate can then be divided into the "existing" potential and the "additional" potential that would be available from new or expanded efficiency programming.

Baseline disaggregation will be determined in part on the data available, as described in Section 3.3. When disaggregated data specific to the area of the analysis are not available, data from other areas may be used as a proxy. The uncertainty in using energy end-use patterns from a neighboring state is likely to be of similar magnitude to other sources of uncertainty in the analysis. This is particularly true for residential efficiency measures, whereas industrial energy use varies widely from industry to industry. Transferring industrial energy data from state to state should be done with caution.

3.4.2 Characterize Efficiency Measures

Measure characterization is the determination of parameters for individual or bundles of technologies, services, or design practices that define the costs, savings, and lifetimes for different measures. Measure characterization will typically rely on research about existing technologies available in the market and their performance, as well as engineering calculations and cost estimation. Typical steps include:

- Identifying an efficiency measure, including defining the baseline efficiency or practice as well as that of the efficient scenario.

Schedule RAV-E2

- Calculating the annual energy savings (measured in kilowatt-hours [kWh]) and peak demand impact coincident with the utility system (measured in kilowatts [kW]). This is generally specific to individual customer types, reflecting differences in operating hours, load shapes, existing efficiency levels, etc.

- Determining the pattern of savings over time. This is dependent on the energy-use load shape of the measure. Because energy reductions are more valuable at some times than others (e.g., electric system peaks typically occur during business hours on a hot summer day, driving up energy prices and therefore the economic benefit of energy savings at that time), some method of accounting for this variability should be included in the analysis. At a minimum, the analysis should account for seasonal on- and off-peak periods.

- Determining other costs and benefits of the measure, such as differences in operation and maintenance costs between efficient and baseline measures and any non-energy costs and benefits such as water savings, waste reduction, or productivity improvements.

- Determining the measure cost. For "lost opportunity" measures such as in new construction and planned replacement of failing equipment, this will typically be the incremental cost of efficient equipment as compared to baseline equipment. For discretionary early retirement measures that replace functioning equipment or other retrofit measures such as building shell improvements, costs will typically represent the total labor and equipment costs of new systems.

3.4.3 Screen Measures and Programs for Cost-Effectiveness

Once all of the data are available to determine the energy savings and costs associated with a forecast set of efficiency investments, the analyst can determine the overall effects of efficiency investments or policies. Economic effects are of particular interest to decision-makers. The process of assessing the economic effects of efficiency investments is typically referred to as "cost-effectiveness screening." This refers to the comparison of the benefits of the investment to its cost. Efficiency measures should pass the "cost-effectiveness screen" of having positive net benefits (i.e., benefits greater than costs), based on whatever economic tests are applied.

A primary consideration in cost-effectiveness analysis is choosing the cost and benefit components that are included within the boundary of the comparison, whether at the measure or program level. A particular boundary definition is referred to as a "test." The test used depends upon the perspective of the decision-makers and where their concern lies: overall societal impact, utility system impact, or customer-level impact. The standard range of economic tests (CPUC, 2001) includes:

- **Total resource cost (TRC) test.** One of the most common tests, the TRC assesses the impacts of a portfolio of energy efficiency initiatives on the economy at large. It does not concern itself with distributional equity between different segments of society. The test compares the present value of costs of efficiency for all members of society (including costs to participants and program administrators) compared to the present value of benefits, including avoided energy supply and demand costs.[6] The assessment of participant costs extends beyond the energy source in question to increases or decreases in operations and maintenance costs and costs for other resources (e.g., water), as well as non-resource cost impacts. Results are typically expressed as either net benefits or a benefit-to-cost ratio.

- **Societal cost test (SCT).** This test is a variation of the TRC test that includes monetized effects of externalities (e.g., emissions impacts) benefits.[7] It may also use a "social" discount rate that is lower than that used in the TRC. Note that the lower the discount rate selected, the more cost-effective efficiency will appear.[8]

- **Participant cost test.** This test focuses on either "typical" or aggregate participating customer(s), comparing quantifiable benefits and costs. Benefits include reductions in utility bills, incentive payments, and tax credits. Costs include ratepayer-funded spending on energy efficiency technologies and changes in other fuel or resource costs.

Schedule RAV-E2

- **Ratepayer impact measure (RIM) test.** This test evaluates the impacts on customer rates. It does so by evaluating changes in utility revenues and operating costs, comparing savings (or increases) from avoided supply costs, changes in revenues, and incurred administration costs. There are many ways to express the results, including lifecycle revenue impact, annual or first-year revenue impact, benefit-cost ratio, and net benefits.

- **Program administrator cost test.** This test evaluates the impacts of the efficiency initiatives on the administrator or energy system (sometimes referred to as the utility cost test or energy systems test). It compares administrator costs (e.g., incentives paid, staff labor, marketing, printing, data tracking and reporting) to accrued benefits, including avoided energy and demand supply costs, and also revenues for any forward capacity market auctions. It does not assess issues of utility revenue not directly related to the value in a secondary market from efficiency credits (see RIM test, above).

The test selected for a potential study should ensure that results are comparable to the criteria being used to evaluate other options, either for electric supply or public funds. The most common test in most jurisdictions is the TRC, as it provides an understanding of the overall effect on society. Because it includes all of the benefits of efficiency investment, regardless of beneficiary, it typically generates the greatest net benefit estimates, which supports a strong commitment to energy efficiency. On the other hand, the TRC does not capture all of the distributional effects of efficiency investments on all parties (e.g., utilities, non-participants, and program administrators). More than one test may be necessary to understand all of the potential effects from multiple perspectives. Nevertheless, if efficiency investments generate a positive net benefit to society (as demonstrated by the TRC), policy-makers should be able to devise ways of addressing distributional concerns. The examples in Chapters 4 through 6 describe the conditions under which different tests may be most appropriate.

3.4.4 Develop Program Designs and Estimate Measure Penetrations

This step is highly specific to the analysis being performed. Measure penetrations are dependent in part on the potential type (i.e., achievable vs. program). Chapters 4 through 6 describe the program designs assumed in each of the example studies and some of the important factors to consider when selecting penetration values.

3.4.5 Calculate Total Savings

While the forecast and measure characterization data provide many of the inputs to a potential estimate, an analytical approach to combine all these data and take account of the many moving parts is necessary. In general, there are two main approaches to calculating the potential of an efficiency measure or set of measures: top-down and bottom-up.

A bottom-up approach first starts with the savings and costs associated with replacing one piece of equipment with its efficient counterpart, and then multiplies these values by the number of measures expected to be installed throughout the life of the program. The key factor in the energy savings calculation is the number of kilowatt-hours saved annually from the installation of a more efficient unit such as a dishwasher, air conditioner, or boiler. Often, a bottom-up approach is preferred for residential analysis because of better data availability and greater homogeneity of the building and equipment stock to which measures are applied. The residential sector portions of the potential studies presented in Chapter 5 are examples of bottom-up analyses.

A top-down approach begins with a disaggregated energy sales forecast over the time period under study and then determines what percentage of these sales a given efficiency measure will save. For more detailed studies, the sales data are broken down by end use and building type before the savings percent is applied. The key factor is then expressed as, for example, the percentage of all energy used for interior lighting in an office building that would be saved by switching to high performance lighting fixtures. The potential studies presented in Chapter 4 are examples of top-down analyses.

3.5 Present the Results

The results generated from potential studies are a function of both the type of potential study (e.g., economic, achievable) and the level of detail and aggregation. One of the key objectives of a potential study is to provide an estimate of the energy and demand impacts of energy efficiency. For an economic potential study, the result is essentially a single set of numbers representing the amount of cost-effective energy efficiency available over an analyzed time horizon. For an achievable potential study, the result is not just the amount of energy efficiency potential, but also the time horizon over which planners can expect efficiency savings to be generated by the programs. In both of these cases, the presentation should also include the economic effects of the efficiency investments.

The presentation will be driven in part by the type of study conducted and in part by the audience for the study and their needs. Study authors or those who commission a study should also address where and when results will be presented. If the objective of the study is to influence change, then an influential presentation is needed. A detailed discussion of strategic marketing and media approaches is beyond the scope of this document, but the following list highlights some strategies that have proven effective for supporting potential studies in the past:

- For studies that are likely to be widely distributed, energy-related information should be translated into terms that the lay reader can understand. For example, stating that a program will save enough energy to power 16,000 homes has broader appeal that saying it will save 100 gigawatt-hours of electricity.
- Develop an executive summary that presents the key findings of the study in clear, user-friendly language.
- Use figures and tables to convey numerical information.
- Support the publication of the report with a press release. Notify any reporters with whom you have relationships or who report on relevant issues (e.g., climate change, consumer affairs, electricity and energy markets).
- Look for opportunities to partner with other organizations. Organizations interested in the topic and the results of the study can alert their own constituents and their own network of organizations and partners.

3.6 Notes

1. This and all references to the range of potential study costs should be viewed as approximate. They are based on a sample of studies and are not intended to define the absolute limit of the cost range.
2. In the context of a potential study, the term "disaggregate" means to divide a total value (e.g., annual kWh consumed by the customers of a particular utility) into component parts such as customer building type (e.g., single-family house, office building, warehouse, retail), energy end-use (e.g., lighting, appliances, water heating), or other characteristic.
3. Primary research refers to collection of new data directly for the area being analyzed (e.g., the energy use in buildings within the study area). Secondary research generally refers to the adoption and use of data already collected from outside the specific customers or region being analyzed, and applying it—often with appropriate adjustments—to the specific analysis area.
4. These surveys can be found on EIA's Web site at <http://www.eia.doe.gov/emeu/recs (or /mecs or /cbecs)>.
5. The energy savings from a measure are not necessarily constant over time. For example, consider the replacement of an operating piece of equipment before the end of its life with a more-efficient unit (a so-called "retrofit" measure). If the replacement unit is equal in efficiency to that required by code or standard practice, then the savings should only count until the end of the original equipment's life. At that time, the old unit would have been replaced by a unit with the same efficiency as the retrofit measure. There is no increase in efficiency after the end of the original equipment's life. This effect is called the retrofit baseline adjustment and is important to consider so as to not overstate the savings from retrofit measures.
6. Refer to the *Guide to Resource Planning with Energy Efficiency* (National Action Plan for Energy Efficiency, 2007) for additional discussion of avoided costs.
7. If emissions have a market value (as with the current program for sulfur dioxide allowances), then these should be included as a cost or benefit in any test. "Externalities" refers to impacts that are external to existing markets. They have societal costs or benefits that are not captured in any market. The emissions costs or benefits captured in an SCT, but not a TRC, might include emissions without market value or with additional value over and above any market prices.
8. Selecting a lower discount rate will result in energy efficiency measures appearing to be more cost-effective because the pres-

ent value of the benefits (i.e., future energy savings) is greater under this condition, while the present value of the costs will remain largely unchanged. Analysts should use a discount rate that is consistent with that chosen for other policy studies in the same jurisdiction. From a policy perspective, it is preferable to demonstrate the cost-effectiveness of energy efficiency through careful and thorough accounting of its costs and benefits rather than through inconsistently low discount rates or other potentially controversial analytical assumptions.

4: Applying the Concepts: Building a Case for Energy Efficiency

This chapter discusses potential studies that are written with the aim of building policy support for energy efficiency programs and funding. Usually these types of studies are done at a high level of aggregation, and focus on the macro-level opportunities for savings and societal benefits of doing efficiency. They typically cost in the range of $20,000 to $75,000 and take anywhere from 1 to 4 months to complete, depending on factors such as data availability.[1]

4.1 Key Questions

The following questions will help entities ensure that a potential study to build a case for energy efficiency is the appropriate application:

- Are we in the process of deciding whether to invest in efficiency and, if so, are we deciding how much to invest?
- Is the primary motivation of this study to demonstrate the benefits of efficiency and build policy support?
- Can we accept a fairly high level of aggregation and thus uncertainty in our results?
- Are the desired outputs primarily macro-level energy and capacity savings, and is there a role for related economic and environmental data?

4.2 Objective and Audience

Potential studies are most frequently associated with a desire to support energy efficiency investments. Whether put forward by utilities, state or local governments, or advocacy groups, the potential study provides quantitative evidence that energy efficiency will generate economic and/or environmental benefits for the public and for both public and private institutions. Potential studies with this objective may present a macro-level look at efficiency potential in support of: (1) discussions over whether or not to implement efficiency programs and initiatives where none currently exist, (2) consideration of whether to continue existing programs, (3) changes in funding level for existing programs, (4) establishing funding levels for programs where none currently exist, or (5) efforts to understand the potential for efficiency to contribute to emissions or portfolio standards. These studies have a wide-ranging audience that is likely to include state and local governments, public utility commissions, regional interest groups, utilities, ratepayers, and advocacy groups.

4.3 Example Applications: SWEEP "Mother Lode" and Texas "Power to Save"

To illustrate potential studies aimed at building the case for energy efficiency, this chapter presents two recently completed and related examples. These two case studies are used to represent high-level studies that can provide important information to decision-makers at a relatively low cost.

- *The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest* (SWEEP, 2002) examines the potential for and benefits from increasing the efficiency of electricity use in the southwest states of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming. Using energy modeling at a moderate level of detail and with limited data collection, it provides an estimate of the maximum achievable electric efficiency potential.

Questions for the Analyst

After deciding that the objective for a potential study is to build a case for energy efficiency, the project manager should ask the analyst the following questions to help guide the contracting process. Raising these issues early can ensure that key assumptions and data inputs are incorporated into the analysis, and that the final "deliverable" meets the project manager's requirements for cost, scope, and rigor.

- Who is the target audience for the study?
- What specific results are necessary? Does the audience require only overall percent savings and costs, or more disaggregated results that identify savings by sector, building type, market, or technology?
- What data are available?
- Are other studies available that can be relied on for key information and data?
- Does the contracting firm have access to proprietary data?
- What local utility data are available?
- What is the most compelling way to present results to the target audience?
- Should the analyst focus on the economic benefits to society? What about energy reliability and/or environmental benefits?
- How should naturally occurring efficiency be accounted for?
- Are the costs and benefits of efficiency carefully accounted for and presented in cost-effectiveness tests? Are discount rates and other assumptions clearly stated and reasonable?
- What demand-side resources should the analyst include? Efficiency only? Demand response? Combined heat and power? Fuel switching? Onsite distributed generation? Renewables?

- *Power to Save: An Alternative Path to Meet Electric Needs in Texas* (Optimal Energy, 2007), commissioned by national nonprofit groups with an interest in energy efficiency and climate change, estimates the potential for efficiency and other demand-side strategies to offset Texas' growing electricity needs. It relied upon the results of other studies in similar or nearby regions to develop an achievable potential estimate at a high level. While Texas currently has some efficiency programming, many stakeholders felt that the level of spending on efficiency should be increased. This report assessed the potential for greater efficiency savings with commensurately higher spending.

4.4 Potential Type

To make a case for energy efficiency, one must consider the economic impacts of energy efficiency, and likely address market barriers that are incorporated into achievable potential estimates. Therefore, a technical potential estimate is not particularly useful in this context. Indeed, neither of the two example studies reviewed here present the technical potential for the areas under study.

The SWEEP study began with a list of technically feasible measures but only aggregated the savings potential of a package of these measures up to the cost-effectiveness threshold; it does not give an estimate of total technical potential. The "maximum cost-effective savings potential" (i.e., economic potential) served as the basis for developing a "high-efficiency" scenario which represented "aggressive but potentially achievable implementation of cost-effective measures" (SWEEP, 2002, p. 2-7). Using the definitions presented in Section 2.4, this is a version of achievable potential, likely approaching maximum achievable. Only this potential is

Schedule RAV-E2

fully analyzed and applied to the forecast energy needs of the region to develop a savings estimate in both energy (kWh) and dollar terms. The economic potential is presented simply as a percentage of energy savings for a variety of building types. In this way, the study provides some indication of the possible upper limit of savings (the economic potential) while focusing attention on results that are more relevant to policy-making.

The Texas study began with a review of existing studies, particularly those that included Texas, nearby regions, or regions with similar climate zones. It adopted economic savings potential percentages by customer sector, and major building types based on these studies, and then applied penetration rates considering the market barriers and likely programs. This generated a set of estimates that can be supported as realistic assuming an appropriately structured regulatory and political climate. Because the purpose of the Texas study was to establish the *ability* of energy efficiency to meet future load growth and reliability constraints, a high-level approach was sufficient.

4.5 Level of Detail and Data Requirements

For any potential study, regardless of application, there are many parameters and dimensions for which the analyst must determine the level of detail to include. Ultimately, the level of aggregation depends upon the needs and objectives of the study, the available data and budgetary resources, and the uniqueness of a given region. With respect to the latter factor, greater detail may be necessary if there are specific market segments that strongly dominate loads (e.g., mobile homes, chemical plants). The following summary of the different levels of aggregation and categorization schemes generally proceeds from lesser to greater levels of detail.

- **Programs.** Efficiency programming can be considered at a high level or programs targeted at particular opportunities (e.g., residential new construction, small business retrofits) or energy end-uses (e.g., lighting, HVAC).
- **Market decisions.** Potential studies often differentiate the savings potential by the type of investment decision to be made, particularly between retrofit measures and incremental improvements at the time of planned investment in equipment and systems ("lost opportunity").
- **Market segments.** At the least detailed level, a potential study might estimate savings relative to total energy consumption. More typical is an estimate differentiated by structural sector (e.g., residential, commercial, industrial). More detailed studies estimate efficiency potential by smaller market segments, for example dividing residential potential into single-family, multifamily, and mobile home sub-segments.
- **End-uses.** Many mid-level potential studies will evaluate energy efficiency opportunities by assigning an efficiency potential to a type of customer, such as an office building or a school. The potential is then estimated against the total number of offices or schools affected. More detailed studies can determine savings by specific end-uses within each of these segments, such as office cooling. Such an approach allows for a more detailed analysis of baseline technology penetrations and can better support program design activities.[2]
- **Measures.** At the most detailed level, individual measure potential broken out by facility or customer type can be considered. This approach provides the greatest level of information to support program design. In reality, most studies begin with measure-level detail even if the ultimate results and purpose is to present higher-level aggregated results.

To build the case for energy efficiency, the example studies in this section rely on a moderate level of detail to generate potential estimates. They aim to engender confidence in the results without striving for a level of precision unsupported by the underlying data. For example, both the Texas study and the SWEEP study included only four commercial building types (office, retail, school, and food service/sales) and two residential building types (single- and multifamily). While there are clearly many buildings that do not fall into these categories (say, hospitals and warehouses), the six selected building types likely represent a sizable majority of square footage and energy use in the area under study. Furthermore, because other parameters were included at a lower level of detail (e.g., only two locations for the climate data were used in the energy modeling to represent all six states), the purpose of the study, data available, resources needed for increased detail, and improvement in accuracy must be weighed when selecting an approach.

An additional factor to consider when determining the level of detail necessary in a potential study is the availability and/or cost of data. As good end-use energy data are not available for all locales, data availability may be the limiting factor in an analysis. A potential study conducted to build the case for energy efficiency may not require a high level of detail and therefore not warrant the expenditure of resources on a primary data collection effort.

4.6 Methodology

As a reminder, completing a potential analysis involves the following steps:

- Identify and disaggregate the baseline energy forecast.
- Characterize efficiency measures.
- Screen measures for cost-effectiveness.
- Develop program designs and measure penetrations.
- Calculate total savings for all efficiency measures and present the results.

This section addresses some of these steps with respect to building the case for energy efficiency and their treatment in the SWEEP and Texas studies. Subsequent sections will address other steps with respect to additional examples.

In general terms, both of the examples presented in this section are high-level estimates that relied upon a simple top-down methodology to estimate electric efficiency potential. As pieces intended to support energy efficiency at a broad political level, they relied on cost-effectiveness tests that incorporate a broad view of costs and benefits to demonstrate the value of efficiency investments. These choices are described in more detail below.

4.6.1 A Simple Approach to Building the Case for Efficiency: Top-Down Potential Estimates

When seeking support for efficiency investments (or support for continued or increased efficiency funding), a simple top-down approach is often sufficient to support the political process that will ultimately result in efficiency program implementation; both of the examples presented here rely on a top-down approach to generate a potential estimate.

A top-down potential estimate begins with a disaggregated energy sales forecast over the time period under study and then determines what percentage of these sales a given efficiency measure will save. Often, the sales data are broken down by end-use and building type before the savings percent is applied. In the case of the SWEEP study, the savings estimates were applied to sales disaggregated by building type, but not by end use. For example, the study authors determined that the *economic* savings potential from a package of efficiency measures for new office buildings is 54 percent.[3] In this case, it was not necessary to determine the savings potential with greater detail, say, for office building lighting or residential HVAC. Addressing the different distribution of a few key building types in the six states covered by the study increased the specificity and (presumably) the accuracy of the estimate without incurring substantial additional cost. In short, the level of detail selected for analysis matched the application.

To generate an estimate of the *achievable* savings potential, the economic savings potential was adjusted using penetration factors to account for the existence of market barriers to efficiency investment and the time needed to design and implement programs to overcome these barriers. Continuing with the SWEEP study, the authors assumed that in the first year of implementation, 50 percent of the efficiency potential could be realized, increasing to 100 percent by the seventh year.[4] A set of penetration factors over time such as this is

Schedule RAV-E2

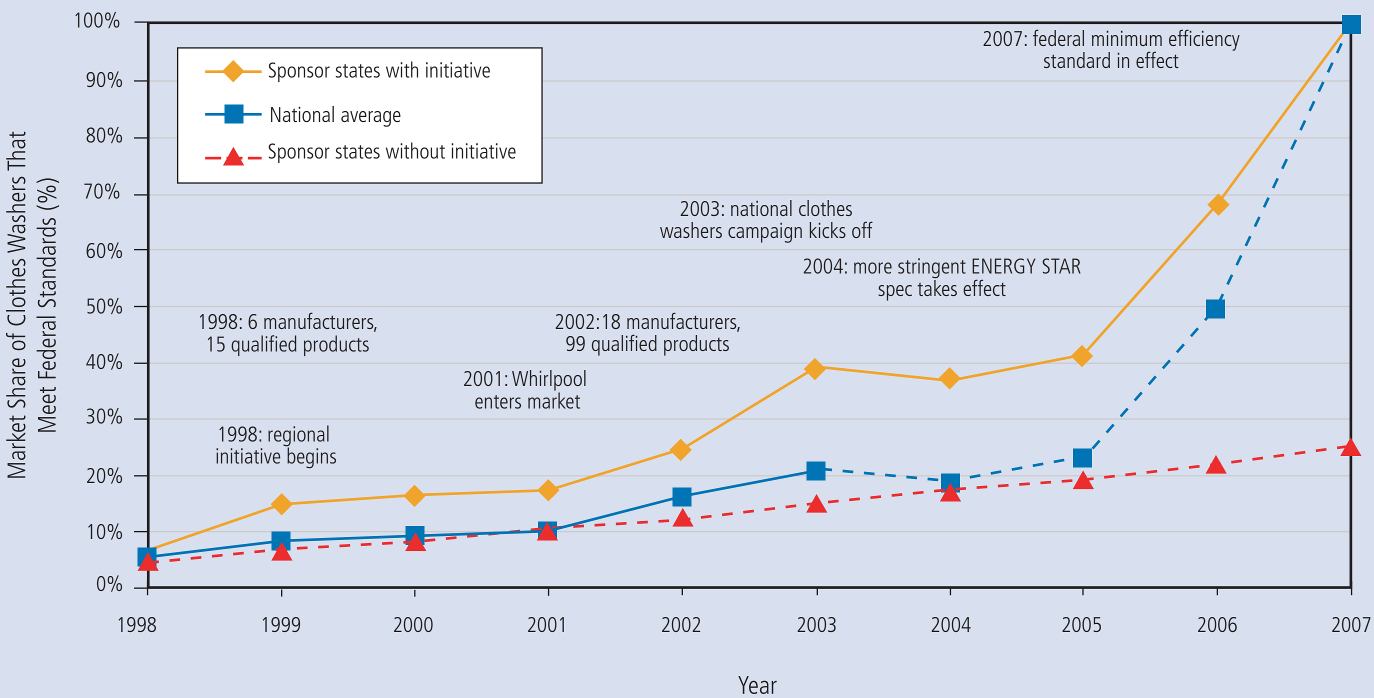
often referred to as a penetration curve. Sources for penetration factors and curves include other evaluations of successful efficiency programs, a full understanding of the markets addressed and the program or policy strategies that would be used to intervene in these markets, extrapolation from observed penetration of efficiency measures to date, and assumptions regarding mandatory efficiency standards and natural turn-over in equipment stock.

The set of assumptions regarding the penetration of efficiency savings is a key factor in the ultimate savings estimate. The penetrations are a function of the program designs and will drive program funding levels. Analysts typically assume greater penetration levels for comprehensive programs with widespread marketing efforts and high incentives than for less-aggressive programs that provide only a small portion of the added cost of efficient equipment or that rely solely on information and education efforts. The Texas study relied on the economic savings potential factors from the SWEEP study but assumed a lower level of penetration and thus a lower (relative) achievable potential. In this case, the objective was not to present a maximum or highly

Forecasting Measure Predictions

Developing efficiency measure penetrations under various program scenarios is not an exact science. It relies on a detailed understanding of the market for a given technology, the barriers faced by a given customer type, and likely future efficiency policies and standards. In addition, many programs are design to transform the market for a particular appliance or equipment type, with the goal of influencing state or national codes or standards. To properly estimate savings impacts and cost-effectiveness, accurate modeling of current and likely future penetrations for each individual combination of technology, market, and customer type under both the business-as-usual scenario and the "with program" intervention is necessary. Below is an example of the penetration curve for a clothes washer program that specifically affected the start date of federal standards. It shows the percentage of new clothes washers sold in each year that meet a federal efficiency standard (i.e., ENERGY STAR). The graph demonstrates how explicitly modeling both baseline and "with program" penetrations is important to determining the net effect of efficiency programming.

Figure 4-1. Sample Penetration Curve for a Clothes Washer Program



aggressive efficiency effort. Any potential study, regardless of objective, should clearly state the assumptions underlying the selection of penetration rates. In the Texas case, lower penetration rates were selected based on the limited existing efficiency programming and a desire to acknowledge the real difficulties in developing, funding, and implementing efficiency programming to the maximum achievable level.

4.6.2 Building the Case for Everyone: Total Resource Cost-Effectiveness

Investment in energy efficiency generates a variety of benefits and costs. Benefits include the avoided cost of generating electricity or supplying a fuel in the amount saved by the investment; reduced need for transmission and distribution capacity; avoided water costs; avoided pollutant emissions,[5] whether from electric generation or fuel end-use; savings in maintenance costs; and other non-resource benefits. The costs of the investment include the actual cost of the equipment and potential increases in other costs, such as the need for additional heating energy that results when more efficient lighting generates less waste heat. If the investment occurs as the result of an energy efficiency program, the costs of administering the program might also be included. This sub-section discusses ways in which the costs and benefits of efficiency investments can be compared with one another. It also discusses the application of one of these comparisons in the context of building the case for energy efficiency.

In most potential studies, there are actually two levels of cost-effectiveness screening. A measure-level screening first considers the costs and benefits of each efficiency measure to determine if that measure is cost-effective and therefore warrants inclusion in an efficiency program. For example, a measure to support the purchase of high-efficiency clothes washers would compare the value of energy savings (both electric and fossil fuel, if used for water heating) from the new appliance with the cost difference between the higher-efficiency the standard units.[6] If the value of the savings outweighs the additional costs, the measure would be included in a bundle of measures making up an efficiency program or initiative. The program-level screening adds the costs of delivering an efficiency program made up of one or more (presumably) cost-effective measures to the comparison. Program delivery costs can include utility or other administrator staff and operating costs, program-wide marketing costs, training costs and other costs not attributable to a specific measure. In addition, it accounts for free ridership where participants in the program may have implemented the efficiency measure anyway, and spillover or market effects where energy users not participating in the program may still benefit from it and adopt efficiency measures.

The most common test used in many jurisdictions is the TRC because it provides an understanding of the overall effect on society. This is certainly true when building a case for energy efficiency, where the objective is to provide support for efficiency programming on the grounds that it will provide economic benefits to society overall. Despite this, the SWEEP study diverged slightly from the typical tests, adopting something similar to a participant test for the measure-level analysis. All measures with overall lifecycle costs less than retail electric rates were considered to be economic. This differs from a true TRC test because retail electric rates reflect an average cost of service (including amortized capital costs), rather than the costs avoided by saving 1 kWh on the margin.

Measure-level cost-effectiveness screening was not conducted for the Texas study, which was done at a higher level of aggregation. The overall efficiency savings for each of the three sectors were screened using the TRC. As with the SWEEP study, externality impacts in the form of pollutant reductions were not monetized, but were reported in physical quantities.

While they were not performed for the two examples presented here, other economic tests may be desired to better understand issues such as the impact on a utility's economics and possible rate impacts. These issues are often important to public discourse over the desirability of efficiency programming. Other economic tests are often best used in conjunction with, rather than as a substitute for, a broader test such as the TRC and SCT, where they can identify some of the potential distributional effects of public policy alongside the overall societal impacts.

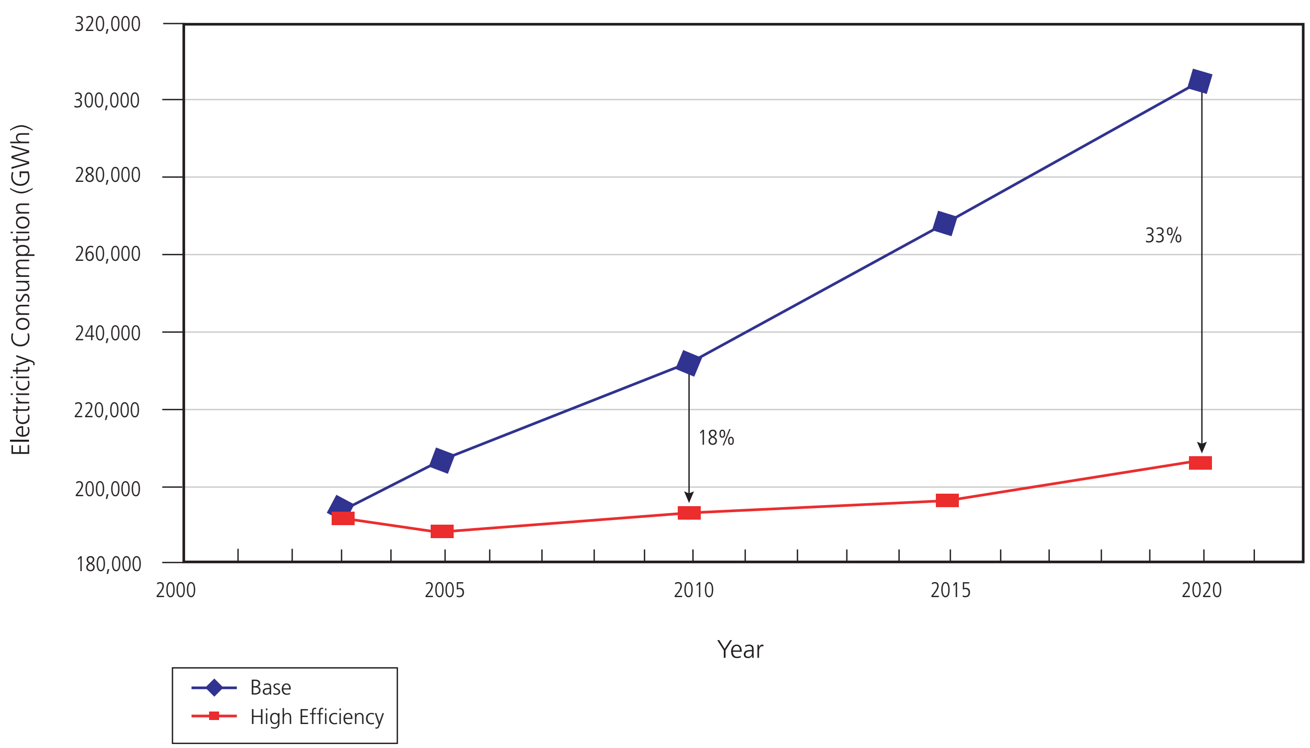
4.7 Presentation of Results

The results that can be generated from potential studies are a function of both the type of potential study (e.g., economic, achievable) and the level of detail and aggregation. Furthermore, there are a range of outputs that are relevant to decision-makers and other stakeholders. These include the potential energy savings and peak demand reductions, the cost of capturing this potential, the economic benefits from avoided energy purchases, other resource benefits such as reduced water usage, and non-resource benefits such as emissions reductions. For studies that aim to support efficiency programming and that therefore must reach a wide audience, simple presentations of energy and economic savings should be the primary means of communication the results of the analysis. All presentations of energy savings should clearly distinguish between energy savings (measured in kWh) and peak demand savings (measured in kW).

There are some challenges to generating these data. Because efficiency technologies create savings for multiple years following installation, energy efficiency savings are cumulative. That is, the total savings in any particular year of the program are the sum of the annual savings generated by all of the installations in all of the previous years.[7] The figure below, taken from the SWEEP study, demonstrates the accumulation of savings as a program progresses. The difference between the "base" case (blue line) and "high-efficiency" case (pink line) represents the cumulative annual savings, which increase each year the program continues.

It is important to distinguish between incremental savings and cumulative savings when reporting the future effects of a program. The cumulative energy or demand savings each year is more relevant to comparisons with load forecasts and for power planning purposes, while the incremental savings are more closely correlated with program spending in any given year, as the full cost of the measure is usually borne at the time of installation. Looking at the example studies referenced above, SWEEP uses both figures and tables to convey the cumulative energy savings potential.

Figure 4-2. Total Electricity Consumption in the Base and High Efficiency Scenarios



Source: SWEEP, 2002.

Figure 4-3. Energy Savings Potential in 2020 by Sector and State in the Southwest

		Region	AZ	CO	NV	NM	UT	WY
Commercial Sector								
Baseline Consumption	GWh	134,780	50,667	36,903	16,625	11,261	15,645	3,680
Savings Potential	GWh	50,291	18,862	13,655	6,087	4,356	5,866	1,465
Savings Potential	**%**	**37.3**	**37.2**	**37.0**	**36.6**	**38.7**	**37.5**	**39.8**
Residential Sector								
Baseline Consumption	GWh	93,557	38,602	19,902	14,085	7,488	10,474	3,007
Savings Potential	GWh	24,593	11,546	4,408	3,067	2,319	2,506	748
Savings Potential	**%**	**26.3**	**29.9**	**22.1**	**21.8**	**31.0**	**23.9**	**24.9**
Industrial Sector								
Baseline Consumption	GWh	74,043	18,522	14,875	14,812	6,122	10,766	8,947
Savings Potential	GWh	24,150	6,180	4,290	5,000	2,220	3,130	3,340
Savings Potential	**%**	**32.6**	**33.3**	**28.8**	**33.8**	**36.3**	**29.1**	**37.3**
All Sectors								
Baseline Consumption	GWh	302,381	107,790	71,680	45,521	24,871	36,885	15,633
Savings Potential	GWh	99,039	36,584	22,351	14,154	8,896	11,500	5,552
Savings Potential	**%**	**32.8**	**33.9**	**31.2**	**31.1**	**35.8**	**31.2**	**35.5**

Source: SWEEP, 2002.

In addition to providing this information at the aggregate level, more detailed presentations may be possible. For example, the SWEEP study includes potential estimates for each of the six states analyzed by sector (see example table on the next page); the Texas study estimated the savings potential by sector (i.e., residential, commercial, industrial).

The economic effects of efficiency investment can be difficult to convey in a manner readily understood by the broad audience typical for a high-level potential study. While policy-makers are usually familiar with terms such as benefit-cost ratio, most lay readers are not. Often, the net benefit (total benefits minus total costs) is the simplest and most accessible result: "This program will save $X million dollars over 5 years."

4.8 Conclusion

The table on the next page summarizes the key attributes of the two example studies presented in this chapter. A similar table appears in the each of the next two sections.

Table 4-1. Summary of Example Potential Studies: Building a Case for Energy Efficiency

	SWEEP "Mother Lode"	"Power to Save"
Scope	Electric potential in six Southwest states	Electric potential in Texas
Potential Type	Maximum achievable	Maximum achievable
Objective	Build a case for energy efficiency programs	Build a case for increased funding in efficiency as an alternative to investment in new traditional power supply
Audience	Political policy groups	Texas legislature and action groups
Data Sources	Primary (modeling), Census, and EIA	EIA, ERCOT (system operator), SWEEP "Mother Lode"
Analytical Methodology	Bottom-up and top-down: modeling used to estimate percent savings from a set of efficiency measures for several building types; savings applied to total electrical use by building type	Top-down, using savings percentages from SWEEP study applied to Texas load forecast
Program Design/Penetrations	Assumed aggressive pursuit of efficiency opportunities and high percentages of retrofit and new construction opportunities over 10 years	Assumed moderate pursuit of efficiency opportunities and percentages of retrofit and new construction opportunities over 10 years
Cost-Effectiveness Tests	Modified participant	Modified participant (based on SWEEP savings estimates)
Results	Efficiency could: • Reduce demand growth from 2.6% to 0.7% • Eliminate the need to build 34 500 MW plants • Save consumers $28 billion net • Increase regional employment by 0.45% per year	Efficiency could: • Shrink demand by 0.5% per year • Cause a 20% reduction in energy use • Generate $38 billion in net benefits • Prevent 52 million tons of carbon dioxide emissions per year

4.9 Notes

1. These ranges should be viewed as approximate. They are based on a sample of studies and are not intended to define the absolute limit of these parameters.

2. For example, single-family detached homes may have higher levels of central air conditioning than duplexes or multifamily dwellings.

3. The building-specific savings estimates in the SWEEP study were developed by using a building energy model to aggregate the savings from specific efficiency measures. While this is a type of "bottom-up" approach, it is different from the approach applied in more detailed potential studies (described in later sections) where the actual energy savings over the entire area of study are calculated on a measure-by-measure basis.

4. The study notes that "a high level of implementation is possible in new buildings through the adoption and enforcement of building energy codes" (SWEEP, 2002, p. 2-7).

5. Monetized pollution values are generally considered a benefit under the societal cost test, but not included under a total resource cost test.

6. Note that there may also be other costs and savings. High-efficiency washers also save energy for drying, since they extract more water from the clothes. On the other hand, they may have shorter lifetimes or require additional maintenance, which should be counted on the cost side of the comparison.

7. Savings continue for the life of the measure, which for most efficiency measures is greater than 7 years. Compact fluorescent lamps are an important exception: they have a relatively short life (between 3 and 6 years, depending on where they are installed) and can be responsible for a substantial portion of overall program savings, depending on the program design.

5: Applying the Concepts: Identifying Alternatives to Supply-Side Investments

This chapter discusses potential studies that are written with the aim of evaluating efficiency as an alternative to a specific supply-side project. It is critical that these applications present highly accurate estimates of the energy efficiency potential, as they need to provide certainty and foster confidence in supply-side resource planners to invest in energy efficiency instead of supply resources. The study applications described in this chapter typically cost anywhere between $75,000 and $300,000 and can take between 4 and 12 months to complete. Studies that involve primary data collection efforts are more expensive and take longer to complete compared to studies where building and measure characteristics in the region are known in advance.[1]

5.1 Key Questions

The following questions will help entities ensure that a potential study that identifies alternatives to supply-side investments is the appropriate application:

- Will this study determine whether energy efficiency can be used to defer or eliminate plans to build new capacity or upgrade transmission lines?
- Are energy efficiency objectives best supported by "investment grade" analysis with the aim of ensuring the future reliability of the power system?
- Are energy efficiency objectives best supported by detailed measure-level data? Should certain measures (e.g., those that provide summer peak reductions) be given priority?

5.2 Objective and Audience

While all potential studies are at some level designed to make the case for energy efficiency, some support a more specific objective. Efficiency is now considered as an alternative to supply-side investments as utilities and others gain experience with it and other demand-side resources. In the past, utilities or states facing generation or transmission shortfalls in the face of growing electric consumption and peak loads would consider building new generation or transmission facilities to maintain reliability and sufficient power supply without looking to increasing investment in energy efficiency to provide relief. In many jurisdictions, utilities are now required to also consider demand-side resources as alternatives to these construction projects. To support this type of planning effort, the characteristics of the efficiency potential (effect on peak demand, timing of savings, economic effects) must be known with more certainty than is typically required for a potential study that simply builds the case for efficiency as a policy outcome. This type of study is also likely to have an informed audience that is more familiar with efficiency and power system concepts.

5.3 Example Applications: VELCO "Southern Loop" and ACEEE "Texas" Potential Studies

This section discusses some of the issues to consider when planning a potential study to identify alternatives to supply-side investments, using two recent example studies. These studies were chosen as representative of moderately detailed studies aimed at providing a robust potential estimate using a combination of primary and secondary data. The studies are:

- *Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's Growing Electricity Needs* (ACEEE, 2007) was prepared by the American Council for an Energy Efficient

Schedule RAV-E2

Questions for the Analyst

After deciding that the objective for a potential study is to identify alternatives to supply-side investments, project managers should ask the analyst the following questions to help guide the contracting process. Raising these issues early can ensure that key assumptions and data inputs are incorporated into the analysis, and that the final deliverable meets the project manager's requirements for cost, scope, and rigor.

- What is the current reliability need? Should a high-level *scoping study* be performed first to identify whether efficiency is likely to defer or replace supply resources?
- What does the load forecast include and rely on?
  - Does it assume any efficiency capture already?
  - What is the uncertainty associated with it?
- What demand-side resources should the analyst include? Efficiency only? Demand response? Combined heat and power? Fuel switching? Onsite distributed generation? Renewables?
- What specific results are necessary?
  - Does the target audience need only overall annual and peak demand savings?
  - Does the analyst need to separately evaluate specific geographic regions to address transmission and distribution constraints?
- What data are available?
  - What other studies can be relied on for information?
  - Does the analyst have access to proprietary data?
  - What local utility data are available?
- What kind of risk analysis should be performed?
  - Should a range of scenarios be analyzed or a sensitivity analysis conducted?
  - Should economic scenarios that include the costs associated with air emissions such as carbon dioxide be analyzed?
- What kind of integration with supply resources should be performed?
  - Will the analyst need hourly data to perform production cost simulations?
  - Do the data support such analysis?
- Are the costs and benefits of efficiency carefully accounted for and presented in cost-effectiveness tests? Are discount rates and other assumptions clearly stated and reasonable?
- How should results be presented to be most compelling to the target audience? Should the analyst focus on the economic benefits to society? Reliability benefits? Environmental benefits? Risk mitigation benefits?

Economy (ACEEE) in 2007. Its title accurately describes the objective of the analysis. This study was prepared in response to announced plans to construct several large coal-fired power plants to meet future peak loads in Texas. This chapter focuses on the efficiency potential estimate contained in the report.

- *Assessment of Energy Efficiency and Customer-Sited Generation Investments in the Southern Loop* (Optimal Energy, forthcoming) was prepared on behalf of the Vermont Electric Power Company, Inc. (VELCO) in relation to efforts to build a new transmission line serving a small geographic region in Southern Vermont.[2] This area faces transmission capacity constraints during the winter peak. As a result, the transmission and distribution utilities proposed to upgrade the transmission line. This study was commissioned because Vermont statutes and regulation require the utilities to consider non-transmission alternatives to the project, including efficiency.

Schedule RAV-E2

These two studies differ in their approach to assessing alternatives to supply-side investment. The ACEEE study was prompted by public concern regarding traditional supply-side investments to meet growing energy demand. In contrast to the VELCO case, there was no specific proceeding or pending decision regarding a specific investment. In addition, the study included potential estimates for other demand-side strategies such as combined heat and power and customer-sited renewables, which are not covered by this report. Therefore, the treatment of the efficiency potential was not as detailed as in the VELCO study, where efficiency was considered side-by-side with other alternatives, including combined heat and power, distributed generation, and transmission system upgrades. These were analyzed through an integrated transmission resource planning process, to support an ultimate decision by the Vermont Public Service Commission on the appropriate solution.

5.4 Potential Type

To provide a realistic and credible alternative to supply-side investments, a potential study should put forth an estimate of the efficiency potential that is achievable with current best-practice programming. The analysis must generate high confidence that the estimated potential is feasible and practicable to acquire in the required timeframe if efficiency is to be truly comparable to wires-based infrastructure investment. The timing of savings is particularly relevant in assessing reliability impacts and the feasibility of supply upgrade deferral. Therefore, funds are best spent assessing achievable and program potential, rather than economic potential, since these convey what can actually be accomplished and the economics associated with capturing efficiency. Note that an achievable potential estimate (which represents the maximum portion of the economic potential that can be acquired given market barriers) may raise questions about the uncertainty of the estimate and the confidence with which the efficiency resource can be relied upon to generate the necessary savings. This also generates additional demands on the methodology as discussed below.

The ACEEE study presents both an economic potential estimate and a "policy potential" estimate, the latter corresponding in definition to program potential as used in this report. The economic potential was determined using a detailed bottom-up analysis (described in more detail below). The VELCO study presents a program potential that represents a substantial portion of the achievable potential.

Ideally, the potential estimate for a study assessing the alternatives to supply-side investment is supported by program design information developed from the experience of other jurisdictions. The program potential in the ACEEE study is based on an expansion of legislatively mandated efficiency programs to levels less than or equal to those already occurring in other states. Because the location of efficiency savings is critical to specific upgrade components, the analysis was segmented into small geographic areas and relied heavily on onsite data collection from some of the biggest end users to refine estimates. Also, to increase the level of certainty that impacts can be captured reliably and in a timely fashion, penetration rates were developed that reflect a high level of confidence, as opposed to typical best estimates for maximum achievable levels in which confidence may be lower.

5.5 Level of Detail and Data Requirements

Generally speaking, a higher level of rigor is necessary when assessing efficiency as an alternative to supply-side investments, which requires a greater level of detail than in the previously described scenario outlined in Chapter 4. That discussion notes that the level of detail required in the analysis and the available data are closely linked, and both of these influence the overall cost of performing the study.

Both of the two studies considered here evaluated efficiency potential at the level of individual efficiency measures. For the commercial and industrial part of the VELCO study, this meant that the energy use by each

Schedule RAV-E2

major end-use (e.g., lighting, space heating, water heating) for each building type (e.g., office, retail, grocery) needed to be known. While this information is often difficult to locate, in this case building-type data were provided by the utility. Site-specific information is usually preferable in this scenario, as it increases the confidence in the end result. This end-use data was collected for major end users. To further improve the accuracy of the data used in the analysis, the project included onsite surveys for a sample of individual non-residential customers (see sidebar). This greater level of accuracy for disaggregated inputs at the building type and end use level becomes especially critical when evaluating the potential for small geographic areas. While a statewide or regional study can rely to a large extent on averages, for very small areas a few building types or customers may comprise a disproportionate share of the opportunities or load. For example, in the VELCO areas studied, a few ski resorts account for a large portion of the winter peak, and fully understanding their opportunities and expansion plans was critical to the ultimate outcome of the study.

Another difference between a potential study designed to make the case for efficiency and one aimed at assessing the alternatives to supply-side investments is the potential benefit of tailoring the analysis more closely to the specific situation. In the case of the VELCO analysis, the additional effort necessary to develop a set of efficiency measures specifically selected to address the winter peak was justified by the value of a more precise estimate. This is an example of pursuing additional detail in areas of the analysis where it will provide the greatest value. Because of the relatively high saturation of electric space heat and water heating, additional effort was spent characterizing fuel switching measures. A further example of this is the emphasis on estimating the peak demand impacts of efficiency measures in the VELCO study, explained in greater detail in the next section.

5.6 Methodology

In contrast to the studies presented in Chapter 4, the ACEEE and VELCO potential estimates rely at least in part on a more detailed "bottom-up" methodology. Also, because one of the studies addresses a very specific system need, additional measures of cost-effectiveness are appropriate to facilitate comparisons with the alternatives.

Field Verification of Baseline Conditions

For the VELCO potential study, site visits were conducted to determine both the distribution of end-use technologies already in place (e.g., age and type of fluorescent lighting fixtures) and the available opportunities for efficiency investments (e.g., percentage of lighting fixtures that are screw-based). Because this potential study was conducted to support an analysis of transmission alternatives, the site visits played an important role in strengthening the confidence in the results.

5.6.1 A Detailed Look at Supply-Side Alternatives: Bottom-Up Potential Estimates

Section 3.4.5 introduced the concept of bottom-up and top-down analyses of efficiency potential and Section 4.6.1 described the application of a simple top-down analysis to produce high-level efficiency potential estimates. A bottom-up approach provides greater detail and is particularly well-suited to analysis of the residential sector for two reasons. First, good data on the number of households and their characteristics are generally available (often from the U.S. Census). Second, the efficiency opportunities in the residential sector are far more homogeneous than in the commercial sector. For example, each residence typically has one heating system, one refrigerator, one dishwasher, etc.

A bottom-up calculation of the efficiency potential for an individual measure takes the following form:

Measure Savings = Per Unit Savings
× # of Households or Customers
× Applicability Factor
× Feasibility Factor
× Turnover Factor
× Net Penetration Rate

where:

- **Applicability factor** is the number of units per customer eligible for a certain measure. Depending on the measure, it may range from less than one (say, the fraction of households with a dishwasher) to greater than one (say, the number of incandescent light bulbs per household)

- **Feasibility factor** is the fraction of the units that can technically be replaced with an efficient alternative from an engineering point of view. This factor accounts for the fact that certain pieces of equipment cannot possibly be replaced by more efficient units, due to such factors as temperature, location, infrastructure, etc.

- **Turnover factor** is the portion of existing units that will be naturally replaced each year due to failure, remodeling, or renovation. It is usually calculated as one divided by the equipment average service life, under the assumption that if equipment lasts for 10 years, one- tenth of the units in existence will be replaced each year. For measures where saturation is changing significantly over time (for example, central air conditioning in moderate northern climates, or plasma TVs) the use of the reciprocal of measure life may not be appropriate. In this case, efforts to collect actual annual sales data should be made. This factor is not used in the retrofit market, where inefficient equipment is replaced before its natural life is over. Nor is it used for new construction analyses, where all new equipment is eligible for efficiency upgrade at the time of purchase.

- **Net penetration rate** is the difference between the anticipated adoption rate of the efficiency measures after intervention and the "business as usual" adoption rate absent efficiency intervention. In the case of technical or economic potential, the theoretical efficiency-case penetration is generally 100 percent. For achievable and program potential analyses, it is the percentage of eligible measures that can reasonably be expected to occur assuming gradual, real-world adoption of the efficient technology. The penetration rates should account for the fact that not everyone will automatically replace their inefficient technology as soon as a program starts, and that programs usually ramp up over time, as market acceptance of the efficient technology increases. The baseline penetration rate should account for the natural measure adoption (people who would buy the efficient technology in the absence of any program intervention). For market transformation programs, penetration rates will typically be modeled for a time period exceeding the duration of the program to account for post-program market effects attributed to the program. See Section 4.6.1 for more detail on modeling penetration rates.

Both the VELCO and ACEEE studies included bottom-up analyses: the residential (and partially the commercial and industrial) sectors in the VELCO study,[3] and the estimate of economic potential in ACEEE report. In the VELCO study, the authors used the formula above to estimate achievable efficiency potential for a range of measures. When using a bottom-up approach, it is important to check the results against the disaggregated load forecast to ensure that credible results are obtained. For example, if one has an overly high estimate of the number of households with electric heat, relying only on a bottom-up approach could result in estimated potential that exceeds the total existing heating consumption for all customers. For the VELCO study, this was addressed by calibrating the end-use disaggregation data to overall forecast data.

In the ACEEE analysis, the bottom-up approach was used only for the economic potential. As in the VELCO study, a simple formula was used to estimate the total savings potential from each measure based on per-measure savings, the size of the eligible population, and the percent turnover. Recall that an economic potential estimate for retrofit opportunities typically reflects a snapshot at one point in time, rather than the distribution of savings over time that one would estimate from an actual program.

5.6.2 Ability to Displace Supply-Side Investments: Assessing Demand Impacts

Electricity usage is characterized by two factors: the total amount of energy consumed over a period of time and the intensity of this consumption. The first, usually referred to as "energy," is measured in kilowatt-hours (or alternatively, megawatt- or gigawatt-hours).[4] Energy is the basis for energy transactions; one consumes kWh and pays a per-kWh charge. The intensity of the electric usage is termed “peak load,” or “demand.” It is measured in kilowatts, megawatts, or gigawatts. A good analogy is that demand refers to the size of a pipe and energy to the amount of water flowing through the pipe. The amount of generation or transmission capacity in a network is primarily driven by the peak load. Therefore, a potential estimate that addresses the ability of efficiency to displace a supply-side investment must address the ability of efficiency to reduce the peak load. This must include consideration of the timing of the system peak load, both daily and seasonally.

Most potential estimates are initially based on the calculation of energy savings for two reasons. First, the monetary savings from an efficiency measure are most directly related to the amount of energy saved, and second, energy is easier to measure than demand, as timing and diversity between individual loads is not as critical. There are a variety of methods for estimating the peak demand reduction from an efficiency measure, described in more detail in Appendix C.

The VELCO study assessed the ability of efficiency to address a transmission shortage during winter peak loads. Therefore, the demand reduction calculation considered savings from measures that reduce load during the winter peak. For example, air conditioning measures do not contribute to winter peak savings, although they might contribute substantial energy savings over the course of the year. The demand reduction calculation in the VELCO study used hourly load-shape information for a variety of end-uses and building types, based on simulation modeling of large numbers of prototypical buildings. These load-shapes were analyzed to determine the percentage of all energy consumed during the periods of interest, from which coincidence and diversity factors were developed. Other approaches include direct metering studies, or impact evaluations of past efficiency program efforts.

5.6.3 Supply-Side Alternatives for the Utility: Additional Cost-Effectiveness Tests

Regardless of a potential study’s objective, the TRC and SCT provide important indicators of the economic effects of pursuing efficiency. In some cases, such as when conducting a potential study to assess alternatives to supply-side investments, additional cost-effectiveness tests provide important context for decision-makers. In the VELCO case, the utility responsible for the potential new transmission line needed to understand the relative costs and benefits of the different supply-side and demand-side alternatives. The effect of these choices on its ratepayers was also an important concern. The utility therefore implemented the utility cost test and RIM test. Because it excludes the benefits that accrue to the end-use customers (primarily from energy savings), the RIM test usually results in lower cost-effectiveness than the TRC or SCT. In addition, investment in efficiency may result in higher utility *rates* (i.e., price per kWh or therm) for the average customer, even though average total energy *bills* (i.e., total dollar spending on energy) will go down.[5]

5.7 Presentation of Results

A potential study that identifies alternatives to supply-side investments still generates the same set of outputs as do potential studies for other objectives. On the other hand, a different results presentation may be more informative or useful for the decision-makers. If multiple cost-effectiveness tests are conducted, a clear explanation of their differences and a side-by-side comparison of the results will highlight the trade-offs between, for example, the societal and ratepayer perspectives. Additional comparisons may be drawn between the efficiency case and the supply-side alternative if data on the latter are available. Although they have not yet been made public, preliminary strategies for conveying the results of the VELCO study have focused on comparing the costs of the transmission alternative to various alternative resource configurations (ARCs) that include differing combinations of efficiency and distributed generation. The example table below indicates the types of data of primary interest to the intended audience.

Schedule RAV-E2

Table 5-1. Sample Table Comparing Transmission Alternatives in VELCO Territory

	Transmission	ARC1 (100% Efficiency Plus DR)	ARC2 (Generation)	ARC3 (50% Efficiency + Generation)
NPV Societal Costs	$x million	$x million	$x million	$x million
Firm MW, 2016	xxx	xxx	xxx	xxx
Capital Required 2008-2016 (000's)	$xxx,xxx	$xxx,xxx	$xxx,xxx	$xxx,xxx
Illustrative Retail Rate, 2016 (cents/ kWh)	xx	xx	xx	xx

Table is presented for illustrative purposes only without results. Actual study data are not yet available.

In this case, a comparison of the energy impacts was secondary, as the efficiency case was designed to provide comparable peak energy "supply" as the supply-side alternative. Note the importance of economic outputs of the study, and the need to ensure comparability with the outputs from other modeling or planning efforts such as those focused on the costs and benefits of investment in new generation, as modeled in the ARC2 scenario.

An additional consideration when assessing alternatives to supply-side investments is the need to interface with the utility planning process. Often, utilities conduct modeling to evaluate the effects of different investments on the energy system. These models may require more detail than typically generated by a potential study. In particular, utility modeling is usually based on an hour-by-hour simulation of the energy system over an entire year, but an hourly distribution of efficiency measure savings is rarely available. One approach is to use the same load-shape information that facilitates peak demand reduction calculations to determine the annual hourly distribution, which ensures consistency between the peak load calculation and the hourly outputs. If this is done, care must be taken to ensure that hourly loadshapes for each end-use and building type are calibrated to overall system hourly loads.

5.8 Conclusion

The following table summarizes the key attributes of the two example studies presented in this chapter.

Table 5-2. Summary of Example Potential Studies: Identifying Alternatives to Supply-Side Investment

	VELCO "Southern Loop"	ACEEE Texas
Scope	Electric potential in small geographic area	Electric potential in Texas
Potential Type	Achievable program potential in targeted geographic area	Economic and program
Objective	Determine whether the construction of a transmission line could be deferred or replaced with aggressive efficiency	Determine the potential for efficiency as an alternative to new coal plants
Audience	The VELCO decision-makers	Legislature and action groups
Data Sources	Primary (site audits), Census, and state forecasts	Census, EIA, ERCOT, commercial economic data
Analytical Methodology	Bottom-up for residential, top-down for commercial and industrial	Bottom-up for economic potential, top-down for program potential
Program Design/Penetrations	Assumed aggressive pursuit of efficiency opportunities and high percentages of retrofit and new construction opportunities over 10 years, plus staggered implementation of retrofits measures in two sub-regions	Develops savings factors for the proposed policies from a variety of sources
Cost-Effectiveness Tests	SCT	Modified participant for economic, N/A for program
Results	Efficiency could: • Provide yearly savings of more than 30 MW and 150 GWh on the Southern Loop • Yield nearly $70 million in net utility benefits	Efficiency could: • Meet 107% of growth in summer peak demand • Reduce energy consumption by 22% in 15 years

Schedule RAV-E2

5.9 Notes

1. These ranges should be viewed as approximate. They are based on a sample of studies and are not intended to define the absolute limit of these parameters.

2. The cited report is part of testimony to be filed with the Vermont Public Service Board in relation to the Southern Loop project. It had not yet been filed at the time of this Guide's publication. Preliminary information regarding the consideration of efficiency as an alternative to transmission investments can be found in *Southern Loop Utility Search Conference Background Report,* produced for CVPS and VELCO and available at <www.velco.com/Files/Southern%20Loop/VTsoloop%20rpt%20final.pdf>. When filed, the testimony will be available on the Public Service Board Web site, <www.state.vt.us/psb>.

3. The VELCO study used a combination of top-down and bottom-up analyses for the commercial and industrial sector. The top-down portion was implemented with greater detail and customer-specific information than the analyses described in Chapter 4. The more detailed approach includes a calculation of savings potential for each measure, using a formula similar to that used in the residential bottom-up analysis. The main difference is the use of a factor for percentage of energy saved in place of a per-unit energy savings quantity.

4. In non-electric efficiency potential studies, the units of energy might be gallons of oil, therms of natural gas, or pounds of steam.

5. This rate versus bill distinction is an important part of the policy considerations for efficiency programming, as it raises issues of the distributional effects of efficiency policies and spending. A discussion of these issues and potential policy approaches to addressing them is beyond the scope of this paper. Please refer to the *National Action Plan for Energy Efficiency* (2006) for additional information.

6: Applying the Concepts: Detailed Planning and Program Design

This chapter discusses potential studies in situations where the policy decision to invest in efficiency has already be made. For this study application, it is assumed that there is no need to build a case for supporting efficiency, as the decision to invest in energy efficiency has already been made. Instead, these studies focus on how much to spend on efficiency and how that money can best be spent. The types of studies described in this chapter tend to focus more on the disaggregated results (e.g., is there more opportunity in lighting or HVAC?) than other types of potential studies. The cost is typically $75,000–$500,000, with the associated time-to-completion between 4 and 12 months. The large ranges with this application are mostly due to variations in study design. This application can be used to evaluate both small programs and large portfolios of programs, with the latter being more expensive and time-consuming.[1]

6.1 Key Questions

The following questions will help entities ensure that a detailed planning and program potential study is the appropriate application:

- Has the decision to invest in efficiency already been made?
- Are data needed primarily to aid in decisions about which market sectors, targeted geographic areas, end uses, measures, and programs should be tapped to realize efficiency potential?
- Are study findings intended primarily for energy efficiency planners who will incorporate the results into portfolio decisions?
- What is the history of efficiency programming in this area? What effect does this history have on the assumptions we make about program potential?
- Should the study focus on one particular end use, customer segment, or set of measures? Are data available that can give reasonable disaggregated results?

6.2 Objective and Audience

Previous chapters presented potential studies as tools used when attempting to answer the question of whether or not efficiency programming should be pursued, whether for general policy reasons or to address specific energy system needs. This chapter presents a third scenario, one where the decision to invest in efficiency has been made and the questions are how the investment should be made and to what extent. A potential study with this objective might provide guidance on the best ways to structure efficiency programs, the relative costs and benefits of different approaches to acquiring a given efficiency resource, or the efficiency potential given a particular program structure and budget. It also might focus on specific sets of measures or customer types that are applicable to a specific program, rather than considering all possible technologies and markets. For example, a study might specifically look at commercial lighting opportunities. These studies likely have a narrower audience than those discussed previously, with utilities, efficiency program administrators, and public utility commissions the most interested parties.

6.3 Example Application: California Potential Study

California is one of the nation's most energy-efficient states, having kept per capita energy use flat for over two decades (Goldstein, 2007). Sustained energy efficiency efforts have been a key contributor to this accomplishment, yet the state continues to seek additional efficiency opportunities. Several years ago, the four large investor-owned utilities (IOUs) in California commissioned

Schedule RAV-E2

Questions for the Analyst

- After deciding that the objective of a potential study is to inform the planning and program design process, the project manager should ask the analyst the following questions to help guide the contracting process. Raising these issues early can ensure that key assumptions and data inputs are incorporated into the analysis, and that the final "deliverable" meets the project manager's requirements for cost, scope, and rigor.
- What is the main purpose of the study? To which specific program areas or markets is it targeted?
- How will the study be used, and by what audience? What level of disaggregation of results is important to ensure its usefulness?
  - What data are available?
  - Does the contracting firm have access to proprietary data?
  - What local utility data are available?
  - Are available data of sufficient detail and quality to provide disaggregated results?
  - Is there a need to do primary onsite data collection? If so, what are the most important markets and technologies to collect data for?
- What are the trade-offs between statistical precision and level-of-effort in the primary data collection process?
- What demand-side resources should the analyst include? Efficiency only? Demand response? Combined heat and power? Fuel switching? Onsite distributed generation? Renewables?
- Should the analysis be tied to specific program designs? What level of detail on program budgets is required?
- What is the basis for estimated market penetrations of efficiency?
  - How are baseline assumptions developed?
  - Are they consistent with the underlying forecast?
- Should the analyst focus on maximum achievable potential for different markets, or focus on the achievable levels given specific program designs and funding levels? What are the most important pieces of information needed?
- Are the costs and benefits of efficiency carefully accounted for and presented in cost-effectiveness tests? Are discount rates and other assumptions clearly stated and reasonable?
- What specific results are necessary?
  - How can results be presented to be most compelling to the target audience?
  - What level of disaggregation should be presented?
  - Should sensitivity analyses be conducted to provide a range of results given different assumptions?

a series of studies to assess energy efficiency potential in the wake of the energy crisis in 2000 and 2001. This chapter describes one study from this series that addressed energy efficiency (both electric and natural gas) in the residential sector (KEMA-XENERGY, 2003a).

6.4 Potential Type

The California study was conducted because "policymakers are most interested in knowing the amount of savings or resource reduction that could occur in response to a particular set of programs or policies" (p. 1-6). Although the study presents a sequence of analyses to estimate the technical, economic, and maximum achievable potentials, the end product is a set of program potential estimates that provide a range of results based on variation in program funding and energy price forecasts. This is the key difference between the program potential and the maximum achievable potential estimates in this case. By modeling the interaction between program spending, energy costs, and the adoption of efficiency measures, the study is able to assess program potential for a number of scenarios.

6.5 Level of Detail and Data Requirements

Studies that are intended primarily for program design purposes may be similar to studies done to build the case for efficiency or to analyze efficiency as an alternative to supply-side investment. There are two key differences when supporting detailed program planning. First, the level of accuracy of *disaggregated* results is much more important. Second, the level of effort put into program budgeting and measure penetration rates is higher and must explicitly recognize the specific detailed program designs contemplated. The latter is discussed more fully below.

Planners may contemplate programs that target very specific markets (e.g., an "efficient schools" program or an air conditioner program). Obviously, this means that, for example, estimates of schools' potential need to be reasonably accurate. When building a case for efficiency, if the distribution of opportunities between, say, schools and offices is somewhat inaccurate it may not matter, so long as overall results reflect the entire area studied. Similarly, if only air conditioners are promoted, having precision on the actual distribution of different size air conditioners and annual sales of AC units is obviously more critical. As a result, while some program planning potential studies are limited in scope, they generally require more detailed data and better disaggregation.

For example, the California study is limited to existing residential construction; new homes are not included. The analysis includes a relatively limited set of measures that were commercially available at the time and most likely to be included in potential new programs under consideration, rather than a comprehensive list of existing and emerging technologies.

The long history of efficiency programs in California generated a comparatively rich data set from which the study authors drew information to inform their analysis. In particular, the California Energy Commission has a long history of conducting research and evaluation of energy consumption and efficiency programs. While this will not necessarily be the case in other jurisdictions, one is more likely to conduct this type of potential study where efficiency programming already exists. In areas with relatively little experience, proven program designs may be implemented without the need to conduct detailed potential estimates. Where more detailed data are necessary but not available, primary research may be indicated.

6.6 Methodology

Previous chapters describe both top-down and bottom-up methodologies and address the variety of cost-effectiveness tests applied to potential estimates. This section addresses issues of program budget estimates and their role in cost-effectiveness screening. In addition, the connection between program spending and assumptions of penetrations warrants additional focus.

Though energy efficiency almost always provides positive net benefits to both society and program administrators, it costs money to make it happen. The costs of efficiency programs can be divided into measure costs related directly to efficiency measures and non-measure costs that are necessary and important to efficiency programs but do not directly lead to measure adoptions. Accounting for measure costs depends on the perspective taken in the cost-effectiveness tests. If a societal or total resource cost test is used, the measure costs include the incremental cost of efficiency measures and any installation costs, regardless of who

Schedule RAV-E2

pays them. When using a utility or ratepayer test, the measure costs are limited to the program measure costs, and do not include participant contributions. Non-measure costs consist of spending on administrative, staffing, marketing, data tracking, monitoring, and evaluation activities.

For a high-level study, non-measure cost estimates are often determined by applying cost adders to the modeled measure or financial incentive costs, based on typical ratios of program non-measure costs (for things such as administration, etc.) to measure costs or incentives. For a more detailed study that supports program planning and design, more detailed budgets should be derived. There are a range of budget categories to consider, including staffing, outside engineering assistance, annual evaluation costs, etc.

The California study estimates administrative costs for a range of efficiency scenarios. While specific details are not given, the administrative cost estimate is constructed using a formula that includes both a fixed component and a component that varies with the program savings estimate. This is likely to be a better representation than a simple cost adder. Other example studies discussed earlier in this Guide, including the VELCO study, relied on non-measure cost estimates built up from individual line items for staffing, contractors, marketing, and other components.

For higher level studies, one may apply typical penetration rates across broad categories of measures, or estimate program costs across all markets that generally reflect typical categories of programs. However, for estimating the actual program potential for a given program, specific penetrations by measure and customer type should be estimated based on the actual program strategies. Similarly, specific program budgets should be built up based on estimates of costs for each major budget item.

6.7 Presentation of Results

Again, the results from a potential study that contributes to program planning and design are no different than the results of other potential studies. If supported by a greater level of detail in the inputs, the study can provide decision-makers with more detailed results, even to the level of building type, end-use, or individual efficiency measures. In support of summary results tables, appendices to the California study provide detailed tables listing the savings estimates for each efficiency measure under each program scenario, one of which is shown in part below. These data can facilitate discussion regarding program design by indicating which measures are likely to generate the largest savings.

Figure 6-1. Savings Estimates for Select Measures

Utility and CEC Forecast Climate Zone	Segment SF=Sing Fam MF=Mult Fam MH=Mobl Hom	End Use	Total GWh	GWh Potentials						
				Technical	Economic	Max Ach	100% Ach	50% Ach	Curr Ach	Nat Oc
PG&E-CZ01	SF pre-7	Air Conditioning	35.0	49.9%	19.3%	7.1%	2.4%	1.6%	1.1%	0.1%
PG&E-CZ01	SF pre-79	Clothes Drying	107.6	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PG&E-CZ01	SF pre-79	Clothes Washing	25.0	40.2%	40.2%	12.7%	9.8%	7.2%	4.9%	0.4%
PG&E-CZ01	SF pre-79	Dishwashing	37.6	8.4%	8.4%	2.8%	2.1%	1.6%	1.2%	0.1%
PG&E-CZ01	SF pre-79	Freezer	40.8	7.7%	7.7%	2.0%	0.2%	0.1%	0.0%	0.0%
PG&E-CZ01	SF pre-79	Lighting	324.1	32.5%	30.4%	23.1%	21.1%	12.8%	6.3%	1.1%
PG&E-CZ01	SF pre-79	Other	192.5							
PG&E-CZ01	SF pre-79	Pool Pump	31.3	43.5%	43.5%	14.2%	8.4%	6.3%	4.4%	0.5%
PG&E-CZ01	SF pre-79	Refrigerator	167.3	43.5%	34.8%	27.5%	7.0%	5.2%	3.9%	1.5%
PG&E-CZ01	SF pre-79	Space Heating	165.6	30.4%	18.1%	12.9%	9.2%	6.5%	4.3%	1.1%
PG&E-CZ01	SF pre-79	Water Heating	30.7	56.3%	14.1%	4.7%	3.8%	3.5%	3.1%	4.6%
PG&E-CZ01	SF post-78	Air Conditioning	56.3	62.8%	30.0%	7.9%	3.1%	2.1%	1.3%	0.2%
PG&E-CZ01	SF post-78	Clothes Drying	111.3	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PG&E-CZ01	SF post-78	Clothes Washing	25.9	40.2%	40.2%	12.7%	9.8%	7.2%	4.9%	0.4%
PG&E-CZ01	SF post-78	Dishwashing	38.9	8.4%	8.4%	2.8%	2.1%	1.6%	1.2%	0.1%
PG&E-CZ01	SF post-78	Freezer	42.2	7.7%	7.7%	2.0%	0.2%	0.1%	0.0%	0.0%
PG&E-CZ01	SF post-78	Lighting	311.8	34.9%	32.7%	24.9%	22.6%	13.7%	6.7%	1.2%

Source: KEMA-Xenergy, 2003b.

6.8 Conclusion

The following table summarizes the key attributes of the example study presented in this chapter.

6.9 Notes

1. These ranges should be viewed as approximate. They are based on a sample of studies and are not intended to define the absolute limit of these parameters.

Table 6-1. Summary of Example Potential Study: Detailed Planning and Program Design

	KEMA California
Scope	Electric and natural gas potential in residential sector existing buildings
Potential Type	Technical, economic, maximum achievable, and program
Objective	Develop a comprehensive efficiency plan
Audience	City Public Service (a utility serving the San Antonio area)
Data Sources	California Energy Commission, other state-specific reports
Analytical Methodology	Bottom-up for all potential types
Program Design/Penetrations	Detailed "adoption model" to estimate penetrations based on incentives and energy costs
Cost-Effectiveness Tests	TRC
Results	Efficiency could: • Achieve 15,643 MW (36%) and 19,710 GWh (28%) in technical potential • Achieve 3,564 MW (23%) and 15,084 GWh (21%) in economic potential • Achieve 1,773 MW (11%) and 9,826 GWh (14%) with maximum achievable funding levels • Achieve 907 MW (6%) and 6,327 GWh (9%) with a 100% budget increase • Achieve 611 MW (4%) and 4,149 GWh (6%) with a 50% budget increase • Achieve 385 MW (2%) and 2,413 GWh (3%) with unchanged budget

7: Conclusion

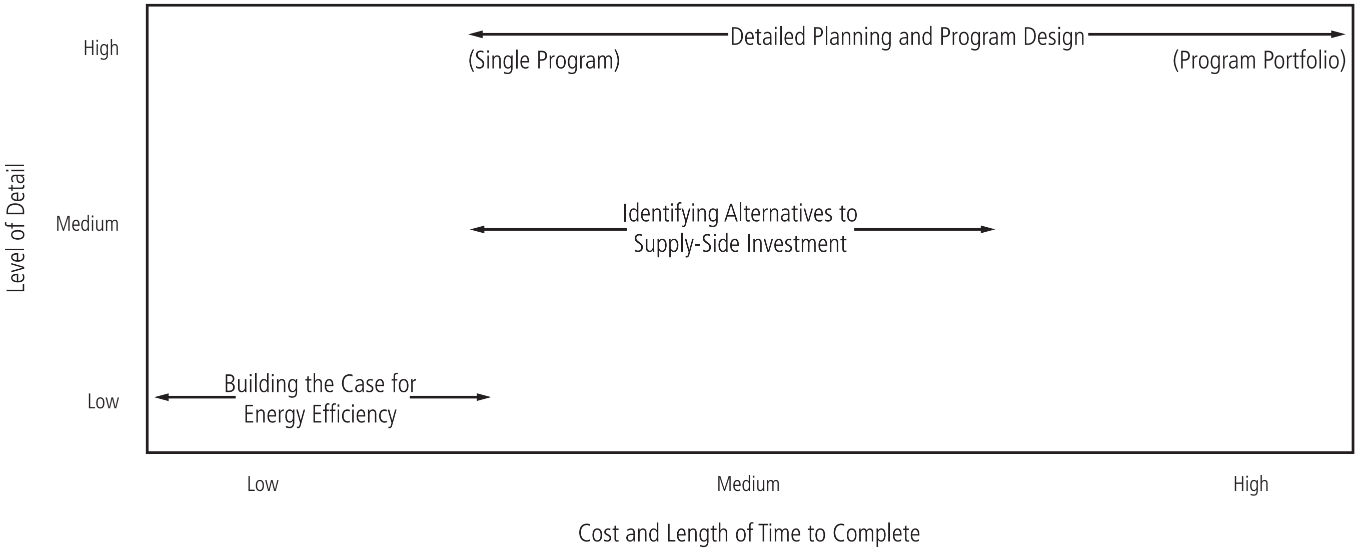
The objective of this Guide is to provide decision-makers with sufficient information to understand the process of conducting a potential study and the important inputs and methodological considerations involved. The Guide presents this information in the form of several completed potential studies that cover a range of scenarios, objectives, and applications. The figure below, repeated from Chapter 2, summarizes the relationship between cost, level of detail, and the scenarios. While there are certain to be some exceptions, the general trend is a useful heuristic for decision-makers commissioning a study.

This Guide identifies a number of important considerations in conducting a potential study. These are:

- Because data availability is often the limiting factor for an analysis, structure the methodology and level of detail based on the best available data. Consider primary data collection when the study objectives warrant the additional expense and complexity.
- Select the appropriate potential type(s) to analyze. For most applications, an achievable or program potential is likely to provide the most useful information for decision-makers and stakeholders.
- Select the appropriate cost-effectiveness tests to apply to efficiency investment. Presenting results from multiple tests, while adding complexity to the analysis, provides important information on the distribution of the costs and benefits of efficiency investments among consumers, utilities, and public entities.

For additional detail on the methodology of potential studies, please refer to Appendix C, Detailed Methodology Discussion.

Figure 7-1. Considerations for Conducting Potential Studies



Appendix A: National Action Plan for Energy Efficiency Leadership Group

Co-Chairs

Marsha Smith
Commissioner, Idaho Public Utilities Commission
President, National Association of Regulatory Utility Commissioners

James E. Rogers
Chairman, President, and C.E.O.
Duke Energy

Leadership Group

Barry Abramson
Senior Vice President
Servidyne Systems, LLC

Tracy Babbidge
Director, Air Planning
Connecticut Department of Environmental Protection

Angela S. Beehler
Director of Energy Regulation
Wal-Mart Stores, Inc.

Jeff Bladen
General Manager, Market Strategy
PJM Interconnection

Sheila Boeckman
Manager of Business Operations and Development
Waverly Light and Power

Bruce Braine
Vice President, Strategic Policy Analysis
American Electric Power

Cheryl Buley
Commissioner
New York State Public Service Commission

Jeff Burks
Director of Environmental Sustainability
PNM Resources

Kateri Callahan
President
Alliance to Save Energy

Jorge Carrasco
Superintendent
Seattle City Light

Lonnie Carter
President and C.E.O.
Santee Cooper

Gary Connett
Manager of Resource Planning and Member Services
Great River Energy

Larry Downes
Chairman and C.E.O.
New Jersey Natural Gas (New Jersey Resources Corporation)

Roger Duncan
Deputy General Manager, Distributed Energy Services
Austin Energy

Angelo Esposito
Senior Vice President, Energy Services and Technology
New York Power Authority

Jeanne Fox
President
New Jersey Board of Public Utilities

Anne George
Commissioner
Connecticut Department of Public Utility Control

Dian Grueneich
Commissioner
California Public Utilities Commission

Blair Hamilton
Policy Director
Vermont Energy Investment Corporation

Leonard Haynes
Executive Vice President, Supply Technologies, Renewables, and Demand Side Planning
Southern Company

Mary Healey
Consumer Counsel for the State of Connecticut
Connecticut Consumer Counsel

Joe Hoagland
Vice President, Energy Efficiency and Demand Response
Tennessee Valley Authority

Sandy Hochstetter
Vice President, Strategic Affairs
Arkansas Electric Cooperative Corporation

Helen Howes
Vice President, Environment, Health and Safety
Exelon

Bruce Johnson
Director, Energy Management
Keyspan

Mary Kenkel
Consultant, Alliance One
Duke Energy

Ruth Kiselewich
Director, Conservation Programs
Baltimore Gas and Electric

Rick Leuthauser
Manager of Energy Efficiency
MidAmerican Energy Company

Harris McDowell
Senator
Delaware General Assembly

Mark McGahey
Manager
Tristate Generation and Transmission Association, Inc.

Ed Melendreras
Vice President, Sales and Marketing
Entergy Corporation

Janine Migden-Ostrander
Consumers' Counsel
Office of the Ohio Consumers' Counsel

Michael Moehn
Vice President, Corporate Planning
Ameren Services

Fred Moore
Director Manufacturing & Technology, Energy
The Dow Chemical Company

Richard Morgan
Commissioner
District of Columbia Public Service Commission

Brock Nicholson
Deputy Director
Division of Air Quality
North Carolina Air Office

Pat Oshie
Commissioner
Washington Utilities and Transportation Commission

Douglas Petitt
Vice President, Government Affairs
Vectren Corporation

Bill Prindle
Deputy Director
American Council for an Energy-Efficient Economy

Phyllis Reha
Commissioner
Minnesota Public Utilities Commission

Roland Risser
Director, Customer Energy Efficiency
Pacific Gas and Electric

Gene Rodrigues
Director, Energy Efficiency
Southern California Edison

Art Rosenfeld
Commissioner
California Energy Commission

Gina Rye
Energy Manager
Food Lion

Jan Schori
General Manager
Sacramento Municipal Utility District

Ted Schultz
Vice President, Energy Efficiency
Duke Energy

Larry Shirley
Division Director
North Carolina Energy Office

Tim Stout
Vice President, Energy Efficiency
National Grid

Deb Sundin
Director, Business Product Marketing
Xcel Energy

Paul Suskie
Chairman
Arkansas Public Service Commission

Dub Taylor
Director
Texas State Energy Conservation Office

Paul von Paumgartten
Director, Energy and Environmental Affairs
Johnson Controls

Brenna Walraven
Executive Director, National Property Management
USAA Realty Company

Devra Wang
Director, California Energy Program
Natural Resources Defense Council

J. Mack Wathen
Vice President, Regulatory Affairs
Pepco Holdings, Inc.

Mike Weedall
Vice President, Energy Efficiency
Bonneville Power Administration

Zac Yanez
Program Manager
Puget Sound

Henry Yoshimura
Manager, Demand Response
ISO New England Inc.

Dan Zaweski
Assistant Vice President of Energy Efficiency and Distributed Generation
Long Island Power Authority

Observers

Keith Bissell
Attorney
Gas Technology Institute

Rex Boynton
President
North American Technician Excellence

James W. (Jay) Brew
Counsel
Steel Manufacturers Association

Roger Cooper
Executive Vice President, Policy and Planning
American Gas Association

Dan Delurey
Executive Director
Demand Response Coordinating Committee

Reid Detchon
Executive Director
Energy Future Coalition

Roger Fragua
Deputy Director
Council of Energy Resource Tribes

Jeff Genzer
General Counsel
National Association of State Energy Officials

Donald Gilligan
President
National Association of Energy Service Companies

Chuck Gray
Executive Director
National Association of Regulatory Utility Commissioners

Steve Hauser
President
GridWise Alliance

William Hederman
Member, IEEE-USA Energy Policy Committee
Institute of Electrical and Electronics Engineers

Marc Hoffman
Executive Director
Consortium for Energy Efficiency

John Holt
Senior Manager of Generation and Fuel
National Rural Electric Cooperative Association

Eric Hsieh
Manager of Government Relations
National Electrical Manufacturers Association

Lisa Jacobson
Executive Director
Business Council for Sustainable Energy

Kate Marks
Energy Program Manager
National Conference of State Legislatures

Joseph Mattingly
Vice President, Secretary and General Counsel
Gas Appliance Manufacturers Association

Kenneth Mentzer
President and C.E.O.
North American Insulation Manufacturers Association

Diane Munns
Executive Director, Retail Energy
Edison Electric Institute

Michelle New
Director, Grants and Research
National Association of State Energy Officials

Ellen Petrill
Director, Public/Private Partnerships
Electric Power Research Institute

Alan Richardson
President and C.E.O.
American Public Power Association

Andrew Spahn
Executive Director
National Council on Electricity Policy

Rick Tempchin
Director, Retail Distribution Policy
Edison Electric Institute

Mark Wolfe
Executive Director
Energy Programs Consortium

Facilitators

U.S. Department of Energy

U.S. Environmental Protection Agency

Appendix B: Glossary

Achievable potential: The amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g., providing end-users with payments for the entire incremental cost of more efficiency equipment). This is often referred to as maximum achievable potential.

Applicability factor: The number of units per customer eligible for a certain measure.

Cost-effectiveness: A measure of the relevant economic effects resulting from the implementation of an energy efficiency measure. If the benefits outweigh the cost, the measure is said to be cost-effective.

Economic potential: Refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources.

End-use: A category of equipment or service that consumes energy (e.g., lighting, refrigeration, heating, process heat).

Energy efficiency: The use of less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way.

Feasibility factor: The fraction of the units that can technically be replaced with an efficient alternative from an engineering point of view.

Lost-opportunity: Refers to an efficiency measure or efficiency program that seeks to encourage the selection of higher-efficiency equipment or building practices than would typically be chosen at the time of a purchase or design decision.

Measure: Installation of equipment, subsystems, or systems, or modification of equipment, subsystems, systems, or operations on the customer side of the meter, in order to improve energy efficiency.

Net penetration rate: The difference between the anticipated adoption rate of the efficiency measures after intervention and the "business as usual" adoption rate absent efficiency intervention.

Participant cost test: A cost-effectiveness test that focuses on either "typical" or aggregate participating customer(s), comparing quantifiable benefits and costs.

Portfolio: Either (a) a collection of similar programs addressing the same market, technology, or mechanisms or (b) the set of all programs conducted by one organization.

Potential study: A quantitative analysis of the amount of energy savings that either exists, is cost-effective, or could potentially be realized through the implementation of energy efficient programs and policies.

Program: A group of projects with similar characteristics and installed in similar applications.

Program administrator cost test: A cost-effectiveness test that evaluates the impacts of the efficiency initiatives on the administrator or energy system (sometimes referred to as the utility cost test or energy systems test).

Program potential: Refers to the efficiency potential possible given specific program funding levels and designs. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable."

Project: An activity or course of action involving one or more energy efficiency measures, at a single facility or site.

Ratepayer impact measure (RIM) test: A cost-effectiveness test that evaluates the impacts on customer rates.

Retrofit: Refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher efficiency units (also called "early-retirement") or the installation of additional controls, equipment, or

Schedule RAV-E2

materials in existing facilities for purposes of reducing energy consumption (e.g., increased insulation, lighting occupancy controls, economizer ventilation systems).

Spillover: Reductions in energy consumption and/or demand caused by the presence of the energy efficiency program, beyond the program-related gross savings of the participants. There can be participant and/or non-participant spillover.

Societal cost test (SCT): A cost-effectiveness test that is a variation of the total resource cost test that includes monetized effects of externalities (e.g., emissions impacts) benefits.

Technical potential: The theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures.

Total resource cost (TRC) test: A cost-effectiveness test that assesses the impacts of a portfolio of energy efficiency initiatives on the economy at large. The test compares the present value of costs of efficiency for all members of society (including costs to participants and program administrators) compared to the present value of benefits, including avoided energy supply and demand costs.

Turnover factor: The portion of existing units that will be naturally replaced each year due to failure, remodeling, or renovation.

Appendix C: Detailed Methodology Discussion

This appendix provides a summary of a typical analytical framework for conducting a potential study as well as additional discussion of the individual components. This is not intended to provide sufficient detail to direct readers to conduct their own studies, but rather to inform them of the types of issues that arise during a study so that they may participate meaningfully in discussions of methodology, data sources, etc. It should also be noted that this is an example of a typical analytical approach. Numerous variations on this method can and do exist, and will generally be developed in consideration of data, budget, and time available.

C.1 Forecasts and Disaggregation

Broadly speaking, the objective of a potential study is to estimate future energy savings opportunities resulting from the presence of some program or policy to promote efficiency. That is, the potential estimate is relative to some scenario that represents business as usual. Therefore, the first step in any potential study is to predict the future in the absence of intervention to promote additional efficiency investments. This baseline scenario forecast provides the context for the comparison of the efficient scenario. The baseline can be characterized in terms of annual kWh consumed, peak demand of the system (whatever its boundaries) in MW, tons of pollutants emitted, or other metric. In practice, the first two metrics are most typically used.

It is critical to understand what the baseline forecast represents. For example, many jurisdictions have some efficiency programming already. Do the forecasts include expansion of the existing program, ignore it altogether, or somewhere in between? Furthermore, does the forecast include assumptions about "natural efficiency" (the proportion of all equipment purchases that will flow to efficient products in the absence of any programmatic incentives) or changes in building codes or other energy use standards (e.g., national ENERGY STAR requirements)?

The effect of economic growth and new construction on the forecast should also be understood. Electricity demand and consumption typically grow over time because there are both new consumers (represented by new households, commercial buildings, and industrial facilities) and growth in existing consumers' consumption. Understanding the relative contribution of these two factors to the baseline forecast provides important input to assumptions made later in the analysis, particularly in determining the number of opportunities for different types of efficiency investment.

Care should also be taken to ensure that, if forecasts for different sectors are derived from different sources, they are harmonized to the extent possible. For example, the underlying economic or demographic assumptions behind a forecast of residential energy growth should match those used to determine industrial energy consumption. Another potential pitfall concerns different treatment of some industries or building types by different data sources.[1] A detailed discussion of this issue is beyond the scope of this paper; suffice it to say that the user should try to understand the underlying assumptions and limitations in their input data, as with any analytical effort.

Disaggregating the baseline forecast typically presents challenges. Good state- or utility-level energy use data are typically not readily available. Utilities may have data sets that provide some information on their customer population such as building size or industry classification, but many do not. Refer to Section 3.3.2 for a more detailed discussion of some of the primary data sources on energy consumption in the United States.

In some cases, utilities or states have undertaken end-use surveys, particularly in the residential sector. Such information is highly valuable for potential studies. Even if the survey is several years old, there may be sufficient information to adjust for changes in technology, economy, and demographics since the data were collected. For studies that require a robust, detailed understanding of energy use by building type or end-use, field visits and/or site surveys—which can add substantial cost to the overall effort—may be needed to acquire the necessary information.

C.2 Measure Characterization

Measure characterization is the determination of parameters for individual or bundles of technologies, services, or design practices that define the costs, savings, and lifetimes for different measures. Measure characterization will typically rely on research about existing technologies available in the market and their performance, as well as engineering calculations and cost estimation. Typical steps include:

- Determination of an efficiency measure, including defining the baseline efficiency or practice as well as that of the efficient scenario.
- Calculation of the annual energy savings and peak demand impact coincident with the utility system. This generally will be specific to individual customer types, reflecting differences in operating hours, load shapes, existing efficiency levels, etc.
- Determination of the pattern of savings over time. This is dependent on the energy-use load shape of the measure. Because energy reductions are more valuable at some times than others (e.g., during business hours on a hot summer day versus during the night in the winter for electric systems), modeling the hourly occurrence of savings is important to estimating the benefits from efficiency. Ideally, hourly data by building type and measure will be used. If potential study results are integrated with power production models, hourly data will typically be necessary. If not, aggregated data for seasonal on- and off-peak periods may suffice, along with "coincidence factors," which estimate the portion of customer peak demand savings that will be coincident with the time of the utility system peak. Often development of this data requires building simulation modeling or reliance on secondary research.
- Determination of differences in operation and maintenance costs of efficient versus baseline measures. For example, if efficient equipment lasts longer than baseline equipment, savings in avoided replacement parts may occur.
- Determination of non-energy costs and benefits, such as savings in water, waste reduction, improvements in productivity, etc., related to adoption of efficient systems.
- Determination of the measure cost. For "lost opportunity" measures such as in new construction and planned replacement of failing equipment, this will typically be the incremental cost of efficient equipment as compared to baseline equipment. For discretionary early retirement measures that replace functioning equipment or other retrofit measures such as building shell improvements, costs will typically represent the total labor and equipment costs of new systems.
- Determination of the average service life of the efficient alternative.
- Determination of shifts in savings and capital investments over time. For example, initial savings from equipment retrofit measures represent the difference in efficiency between the efficient equipment and the old, inefficient existing equipment at a facility. However, this old equipment would naturally be replaced at some point in the absence of an efficiency initiative with new equipment at the standard efficiency available at that time. As a result, the long-term savings from early retirement measures are often much less than the initial savings. Similarly, the retrofit defers the need for new capital investment to replace the old equipment at the normal replacement time. The

present value of this permanent shift in capital expenditures must be taken into account to properly assess the cost-effectiveness of these measures.

C.3 Applying Data Parameters

While the disaggregated forecast and measure-level data provide many of the inputs to a potential estimate (along with specific penetration rates, described above), an analytical approach to combine all these data and take account of the many moving parts is necessary. In general, there are two main approaches to calculating the potential of an efficiency measure: top-down and bottom-up.

A bottom-up approach first starts with the savings and costs associated with replacing one piece of equipment with its efficient counterpart, and then multiplies these numbers by the number of measures expected to be installed throughout the life of the program. Often, a bottom-up approach is preferred for residential analysis because of the greater amount of data available and homogeneity of the buildings. While this approach does not rely as directly on a disaggregation of the energy use forecast, when using a bottom-up approach it is important to calibrate results to the disaggregated data to ensure that credible results are obtained. For example, if one has an overly high estimate of the number of households with electric heat, relying only on a bottom-up approach could result in estimated potential that exceeds the total existing heating consumption of all customers. A bottom-up approach requires the same basic factors as a top-down approach, with a couple of key differences:

- The applicability factor is not expressed as the percentage of eligible kWh sales, but rather as the number of customers eligible for a certain measure. Depending on the measure, it may range from less than one (say, the fraction of customers with a dishwasher) to greater than one (say, the number of incandescent light bulbs per customer).
- The savings factor is not needed, since a bottom-up approach already starts with the energy and demand saved by a given measure.

The resulting formula is:

Measure Savings = Per Unit Savings
× # of Households or Customers
× Applicability Factor
× Feasibility Factor
× Turnover Factor
× Net Penetration Rate

C.4 Industrial Efficiency Potential

Developing a potential analysis for industrial energy consumers can be more complicated than for the residential and commercial sectors due to the relative heterogeneity of energy consumption patterns and end-uses across different industries. Industrial efficiency potential estimates can be developed using either a top-down or a bottom-up approach, depending on data availability, the variability in facility type included in the study, and other factors.

Whereas industry-level data on energy consumption may be difficult to come by, it is often relatively easy to gather economic data at the industry level within an area of interest. Therefore, a useful approach starts with these data and develops industry-specific energy use estimates using average energy intensities for each industry. Expressed in kWh per dollar value of output, sales volume, or other economic measure, these factors are available from the Energy Information Administration's Manufacturing Energy Consumption Survey (see Section 3.3.2). Depending on the level of rigor required, these factors may be verified and/or adjusted by surveying a sample of local industries to determine if local conditions result in substantially different energy intensities from the published averages. Given that most regions have a small number of industries responsible for a large fraction of industrial energy use, this type of survey need not be exhaustive to provide a valuable increase in accuracy.

Once industry-level energy use forecasts are in hand, a top-down approach using published factors for the potential energy savings available in different industries—applied to industry-sector-specific economic forecasts—is a relatively straightforward way to assess the potential available in the area of interest. An example of this approach is found in a study of energy efficiency potential in New York State (NYSERDA, 2003). The potential savings in each industry from this study may be transferred to other states or regions and applied to the distribution of industrial energy use there. This was recently done in a high-level potential study for Texas (Optimal Energy, 2007).

A bottom-up approach requires more detailed data regarding the average saturation of key energy-using equipment in industrial facilities, such as motors, mechanical equipment, refrigeration, etc. Assuming sufficient data are available or are captured through onsite visits, this approach would proceed in the same fashion as described above. For a targeted study, resources can be focused on accurately characterizing one or a small number of industries in the area of interest through site visits or surveys. When applying this approach to industrial facilities, it is important to note the heterogeneity in the energy savings of various efficiency measures across industries. For example, whereas the average energy savings in residential applications are relatively consistent (say, for a more efficient refrigerator), industrial equipment operates under widely variable conditions in different facilities. A motor may be in use 250 hours per year or 7,500. Any industrial potential estimate must acknowledge this variability, include mechanisms to address it, and clearly state the assumptions that result.

C.5 Understanding Interactions Between Efficiency Opportunities

While Section 3.4 provides a general overview of typical analytical methods for quantifying overall efficiency potential, care must be taken to recognize the dynamic nature of real-world efficiency adoption and interactions among different efficiency resources. Three major factors must be explicitly addressed in any analysis:

- Acknowledging and accounting for the changing building and equipment stock over time and its effect on future efficiency opportunities.
- Identifying and adjusting for mutually exclusive efficiency opportunities.
- Estimating the interactions among different efficiency measures.

Without explicitly adjusting for the above three items, significant errors can occur in analysis that result in double counting or other large overestimation of potential. The first issue recognizes that as one assumes adoption of aggressive efficiency, the baseline stock of equipment becomes different so that future years' efficiency opportunities are diminished. For example, in the extreme case of a technical or economic potential study, all retrofit opportunities are assumed to be captured immediately. Under this scenario, in the short term no remaining opportunities to improve efficiency at the time of natural replacement exist because they have all been captured through retrofit. In the case of achievable potential, keeping track of the changes to existing equipment over time becomes more critical, as some percentage of opportunities may be captured through retrofit programs while others will be targeted at the time of natural replacement.

The second issue is important because many technologies analyzed may be mutually exclusive. For example, an office can replace an existing tank-type water heater with either: 1) a high efficiency tank-type water heater; 2) a separate storage tank with water heated through a heat exchanger off a central boiler; and 3) a point-of-use heater. However, all three would not simultaneously be installed. Therefore, while each technology's individual efficiency potential is initially calculated, the aggregate efficiency potential must parse out how much adoption will occur from each technology in consideration of the others to avoid double counting.

Finally, the cumulative efficiency potential will necessarily be less than the sum of the individual potential for each measure. This is the result of interactions between systems. For example, adoption of efficient windows or insulation will lower the cooling and heating loads in building. As a result, once these are installed the efficiency potential from an efficient air conditioner or boiler will be lower, as will its cost-effectiveness. Therefore, once individual measure potential is estimated, an iterative process must be undergone to properly reflect interactions to determine ultimate total potential for a given market segment, customer class, or total sector.

C.6 Program Budgets

Though energy efficiency almost always provides positive net benefits to both society and program administrators, it costs money to make it happen. The budgets associated with energy efficiency are important components of all of the economic tests. The degree of detail that goes into determining budgets for an achievable or program potential study is driven by the level of detail desired and the study's uses.

For a high-level study, program budget estimates are often determined by applying cost adders to the modeled measure or financial incentive costs, based on typical ratios of program non-measure costs (for things such as administration, marketing, data tracking, monitoring and evaluation, etc.) to measure costs or incentives. Ideally, when using adders, distinct adders should be applied to different programs, and adders should vary over time. For example, a market transformation program that focuses on upstream efforts at manufacturers and distributors may have proportionally much higher non-measure costs than an industrial retrofit program that focuses on distinct, site-specific opportunities. Similarly, some programs may have very high adders in early years for training and marketing, with significant drops over time as participation increases and start-up costs go away. As with any economic analysis, all dollars should be consistent between budgets, avoided costs, measure costs, and other inputs in terms of whether they are real or nominal, and the years dollars they are expressed in.

For a more detailed study, especially where the potential study may or will be used as a starting point for initiative planning, more detailed budgets should be derived. While incentive costs will be driven by estimates of installed measure costs and the incentive design (e.g., 50 percent of incremental costs for new construction), there are a range of budget categories to consider. Program budgets should be built up by line item, based on expected needs of things like staffing, outside engineering assistance, annual evaluation costs, etc. Some typical budget line items that should be considered include, but are not limited to:

- **Administrative management:** The portion of upper-level management costs that will be assigned to any individual or portfolio of initiatives.
- **Program management:** This labor cost is incurred by overseeing implementation of any initiative, whether using in-house or outsourced staff.
- **Project management:** Represents labor spent in working directly with customers or supporting contractors, architects, or engineers; managing efficiency projects; and providing coordination services and in-house documentation.
- **Business development:** Labor costs associated with face-to-face sales efforts in bringing participants and partners into the initiatives.
- **Planning:** Costs of establishing initiative strategies and ongoing program design and analysis.
- **Technical assistance:** Providing customers with analysis of individual efficiency opportunities, including opportunity identification and quantification of benefits, costs, and performance issues. May be provided by a combination of in-house and outsourced staff.
- **Administrative:** Costs for day-to-day administration plus allocated costs for office management, accounting, payroll, fulfillment (e.g., cutting incentive checks).
- **Subcontractors:** Could range from outsourced labor for any of the above, to subcontractors representing the entire workforce for a particular initiative.
- **Measurement and verification:** Costs to verify claimed energy efficiency savings. Typically includes in-house quality assurance/control activities as well as pre- and post-installation inspections of customer sites.

- **Tracking:** The development, maintenance, and use of a data tracking system for customer interaction, claimed energy savings (both by customer and in aggregate), associated costs, and management and regulatory reporting.

- **Marketing and advertising:** Ranges from radio and/or television advertisements, to developing articles to be published in local newspapers or trade journals, to the development and maintenance of a Web site and program materials. Often includes labor to directly market to various entities.

- **Technical assistance/design assistance/commissioning/retro-commissioning incentives:** Project-based incentives separate from direct measure incentives to support market-based design and technical service costs.

- **Evaluation:** The costs of performing third-party evaluations of programs. This may include process, market, and impact evaluations.

- **Performance incentives and lost revenue:** Some jurisdictions provide performance incentives to program administrators to encourage exemplary performance. Others provide compensation to utilities for revenue losses from efficiency programs. Where these costs are a required part of implementing programs, they should be included in budgets, depending on the economic tests being performed. In economic tests from a societal perspective, performance incentives and lost revenue are not resource costs in that they are simply transfer payments—typically from ratepayers to shareholders or some other entity.

C.7 Cost-Effectiveness Screening

Once all of the data are available to determine the energy savings and costs associated with a forecast set of efficiency investments, the analyst can determine the overall effects of efficiency investments or policies. As described in Section 3.4, economic effects are of particular interest to decision-makers. The process of assessing the economic effects of efficiency investments is typically referred to as "cost-effectiveness screening." This refers to the comparison of the benefits of the investment to its cost. Efficiency measures should pass the "cost-effectiveness screen" of having positive net benefits (i.e., benefits greater than costs), based on whatever economic tests are applied.

Screening is conducted using one or more of the tests described in Section 3.4.3. To calculate the economic benefits from individual measures, benefits in individual years are calculated, added together, and discounted to provide a present value. Accurate estimates ensure that energy savings are not counted beyond the predicted lifetime of a measure and adjust savings when the baseline changes or "shifts" (as discussed above). The major component of economic benefits generally result from the direct energy and demand savings, and are calculated by multiplying the savings in each year by that year's avoided costs for energy and demand (if applicable). Additional benefits can include non-energy economic benefits such as reductions in maintenance or replacements costs as well as water and other resource savings. Efficiency measures provide savings across multiple years, while costs are typically assumed to be borne in the installation year, so all benefits and costs should be expressed in terms of their present-value in a common year. In the case of economic potential estimates, measures that do not pass the cost-effectiveness screen will be eliminated from the analysis results. These economic results are then used in the application of the range of economic tests.

Numerous models exist to perform these economic screens. Some analysts have their own proprietary databases or spreadsheets, while others rely on commercially available software. Each platform has strengths and weaknesses, typically as a result of its development to support a particular project or projects. A detailed review of these models is beyond the scope of this Guide. Nevertheless, just as with other aspects of the analysis, the policy-maker should understand the key limitations of any model used as part of a potential study and any potential biases introduced as a result (e.g., whether the model tends to overestimate or underestimate the potential, or the cost of achieving that potential).

C.8 Notes

1. For example, municipal wastewater treatment plants are sometimes categorized as an industrial load and sometimes as commercial.

Appendix D: Data Sources

This appendix lists some common data sources used for potential studies, and a short description of each.

Title	Description	URL Address
Database for Energy Efficient Resources (DEER)	Sponsored by the California Energy Commission and the California Public Utilities commission, this database provides a list of measures, with their associate costs, savings, and expected lifetime. Note that these data are based on California information, and may have to be adjusted for use in other regions.	<www.energy.ca.gov/deer/>
Commercial Building Energy Consumption Survey (CBECS)	CBECS is a survey conducted by the Energy Information Administration (EIA) every 4 years. It collects and quantifies "information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures." This has data for the nine census divisions, and is mostly used to find the applicability of a given measure (e.g., the percent of buildings that have air conditioning).	<www.eia.doe.gov/emeu/cbecs/>
Residential Energy Consumption Survey (RECS)	This is the residential counterpart to CBECS, though in addition to the nine census divisions, it also has data for the four most populous states–California, Florida, New York, and Texas. It also tends to have better consumption data by end-use than CBECS.	<www.eia.doe.gov/emeu/recs/>
Manufacturing Energy Consumption Survey (MECS)	The manufacturing counterpart to CBECS and RECS. The basic unit of data for MECS is the manufacturing establishment, and MECS provides consumption information on 48 industry groups and 21 industry subsectors.	<www.eia.doe.gov/emeu/mecs/contents.html>
Annual Energy Outlook	Released annually by the EIA, this report gives electric load forecasts by end-use for the nine census divisions.	<www.eia.doe.gov/oiaf/aeo/index.html>
eShapes	eShapes data, owned by ITron, are based on audit data for more than 20,000 buildings across the country. They consist of hourly electricity consumption data for various sectors and end-uses. These data are used to find what time of the day and year energy savings occur, and the coincidence factor for demand savings.	<www.itron.com/pages/products_detail.asp?ID=itr_000491.xml&pgtype=&subID=fb>
Economy.com	Economy.com provides a wide range of economy data and forecasts that can be used to help develop an accurate prediction for future load growth.	<www.economy.com/default.asp>

Title	Description	URL Address
Utility Information	Often, the utilities in the region of interest can provide valuable information on the size of the electric load, load forecast, electric consumption by sector, and more. Also, some utilities fund separate organizations to perform market research. For example, California's Pacific Gas and Electric Company started the Food Service Technology Center to test the performance and efficiency of commercial kitchen equipment.	Food Service Technology Center: <www.fishnick.com/>
Lawrence Berkeley National Laboratory (LBNL)	LBNL is a federal laboratory that performs much research on new energy systems and environmental solutions. It releases many helpful reports on emerging technology, which can be used for measure characterizations.	<www.lbl.gov/>
Consortium for Energy Efficiency (CEE)	CEE is a nonprofit corporation dedicated to promoting the manufacture and purchase of energy efficient products and services. It performs market research and sets reasonable high-efficiency standards for a range of different products and appliances.	<www.cee1.org/>
Industry data	Often it is possible to get relevant measure data directly from the industry group or manufacturer. Examples include the National Electrical Manufacturers Association (NEMA) and the American Refrigeration Institute (ARI). Also, equipment catalogs and information sheets are often good sources for cost and consumption data.	NEMA: <www.nema.org/> ARI: <www.ari.org/>
Census	The Energy Consumption Surveys contain good data at the census division level, but if you need data at the state or county level, you can go to the U.S. Census. While the Census does not contain energy consumption data, it can tell you the number of households or businesses in a region.	<www.census.gov/>

Appendix E: Example Potential Studies

This appendix provides a list of past potential studies, with brief descriptions.

Title/Description		Purpose	URL Address
Midwest	**Examining the Potential for Energy Efficiency to Address the Natural Gas Crisis in the Midwest.** The results of this study suggest that a modestly aggressive, but pragmatically achievable, energy efficiency campaign (achieving about a 5% reduction in both electricity and natural gas customer use over 5 years) could produce tens of billions of dollars in net cost savings for residential, commercial, and industrial customers in the Midwest.	This study was conducted to examine efficiency to mitigate the effects of rising gas prices in the Midwest, which uses natural gas at a much higher rate than the rest of America. Thus this case builds a case for efficiency, but also examines how much gas usage can be offset by efficiency efforts.	<www.aceee.org/pubs/u051.htm>
Northeast	**Economically Achievable Energy Efficiency Potential in New England.** This report provides an overview of areas where energy efficiency could potentially be increased in the six New England states.	This is a meta-study, designed to give policy-makers direction on how to implement and direct energy efficiency efforts.	<www.neep.org/files/Updated_Achievable_Potential_2005.pdf>
	Electric Energy Efficiency and Renewable Energy in New England: An Assessment of Existing Policies and Prospects for the Future. This report applies analytical tools, such as economic and environmental modeling, to demonstrate the value of consumer-funded energy efficiency programs and renewable portfolio standards and addresses market and regulatory barriers.	This study was conducted to "contribute to a growing body of work applying analytical tools to show the value of consumer funded energy efficiency programs and renewable portfolio standards with new rigor."	<www.neep.org/html/NEEP_C&IReview.pdf>

Schedule RAV-E2

Title/Description		Purpose	URL Address
Northeast	**NEEP Initiative Review: Commercial/Industrial Sectors Qualitative Assessment and Initiative Ranking for the Residential Sector.** Shtick Consulting. Submitted to Northeast Energy Efficiency Partnerships, Inc., October 1, 2004.	This is a qualitative assessment of commercial and industrial initiatives based on a quantitative study done by Optimal Energy, Inc. and Vermont Energy Corporation. It was conducted to provide feedback for specific efficiency initiatives.	<www.neep.org/html/NEEP_C&IReview.pdf>
Southeast	**Powering the South, A Clean & Affordable Energy Plan for the Southern United States.** This report shows that a clean generation mix can meet the region's power demands and reduce pollution without raising the average regional cost of electricity and lists the policy initiatives that can make the changes.	This report was developed mainly for the purpose of building a case for clean energy. It estimates potential not only for efficiency, but also for renewables and combined heat and power, with the aim of offering a comprehensive energy plan for the Southeast.	<www.crest.org/articles/static/1/binaries/pts_repp_book.pdf>
Southwest	**The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest.** This report for the Southwest Energy Efficiency Project examines the potential for, and benefits from, increasing the efficiency of electricity use in the southwest states of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming.	This report builds a case for efficiency, analyzing the achievable potential and macro-economic benefits, but also examines specific savings opportunities and proposes a range of policy recommendations.	<www.swenergy.org/nml/index.html>

Title/Description		Purpose	URL Address
Southwest (continued)	**A Balanced Energy Plan for the Interior West.** This report shows how energy efficiency, renewable energy, and combined heat and power resources can be integrated into the region's existing power system to meet growing electric demands in a way that is cost-effective, reliable, and reduces risk and improves environmental quality for the interior west region of Arizona, Colorado, Montana, New Mexico, Nevada, Utah, and Wyoming.	This report first makes a case for efficiency and renewables, analyzing the economic and environmental costs of the status quo, and then proposes a specific "balanced energy plan" for the interior west region that would essential eliminate load growth.	<http://westernresources.org/energy/bep.html>
California	**California's Secret Energy Surplus: The Potential for Energy Efficiency.** This study focuses on assessing electric energy potential in California through the assessment of technical, economic, and achievable potential savings over the next 10 years.	This study was commissioned to expand previous studies to cover all sectors and vintages in California for a 10-year horizon.	<http://docs.cpuc.ca.gov/published/report/30114.pdf>
	California Statewide Residential Sector Energy Efficiency Potential Study. Presents a sequence of analyses to estimate the technical, economic, and maximum achievable potentials, as well as a set of program potential estimates that provide a range of results based on variation in program funding and energy price forecasts.	Conducted for policymakers interested in knowing the amount of savings or resource reduction that could occur in response to a particular set of programs or policies.	<www.env-ne.org/Publications/CT_EE_MaxAchievablePotential%20Final%20Report June%202004.pdf>

Title/Description		Purpose	URL Address
Connecticut	**Independent Assessment of Conservation and Energy Efficiency Potential for Connecticut and the Southwest Connecticut Region.** This study estimates the maximum achievable cost-effective potential for electric energy and peak demand savings from energy efficiency measures in the geographic region of Connecticut served by United Illuminating Company and Connecticut Light and Power Company.	This study gives an estimate of the total potential in Connecticut, but it focuses on the 52 towns and, in particular, 16 critically constrained areas in southwest Connecticut. The study concludes that there is significant potential in the areas it examines.	<www.env-ne.org/Publications/CT_EE_MaxAchievablePotential%20Final%20Report June%202004.pdf>
Florida	**Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands.** Estimates the capacity for energy efficiency using building energy simulations.	Provides the state with an achievable efficiency estimate and a suite of policy options to consider towards realizing this potential.	<www.aceee.org/pubs/e072.htm>
Georgia	**Assessment of Energy Efficiency Potential in Georgia.** This report presents a profile of energy use in Georgia; the potential for, and public benefits of, energy efficiency; and a public policy review.	This report was written primarily to build the case for efficiency, as there were no existing programs in Georgia when the report was released.	<www.gefa.org/Modules/ShowDocument.aspx?documentid=46>
Iowa	**The Potential for Energy Efficiency in Iowa.** This report uses existing programs, surveys, savings calculators, and economics simulation to estimate the potential for energy savings in Iowa.	The purpose of this study was to provide an initial estimate of the potential, to build the case for efficiency.	<www.ornl.gov/sci/btc/apps/Restructuring/IowaEEPotential.pdf>

Schedule RAV-E2

Title/Description		Purpose	URL Address
Massachusetts	**The Remaining Electric Energy Efficiency Opportunities in Massachusetts.** This report addresses the remaining electric energy efficiency opportunities in the residential, commercial, and industrial sectors in Massachusetts.	This study focuses on program designs, examining how various funding levels will affect the savings of various building and end-use sectors.	<www.mass.gov/Eoca/docs/doer/pub_info/e3o.pdf>
Nevada	**Nevada Energy Efficiency Strategy.** Nevada has taken a number of steps to increase energy efficiency. This report provides 14 policy options for further increasing the efficiency of electricity and natural gas and reducing peak power demand.	This study focuses on policy and program design.	<www.swenergy.org/pubs/Nevada_Energy_Efficiency_Strategy.pdf>
New Jersey	**New Jersey Energy Efficiency and Distributed Generation Market Assessment.** This study estimates mid- and long-term potential for energy and peak-demand savings from energy efficiency measures and for distributed generation in New Jersey.	This study was conducted to analyze the achievable and business-as-usual cases to see whether New Jersey is meeting its efficiency targets, and to make recommendations for future policies.	<www.policy.rutgers.edu/ceeep/images/Kema%20Report.pdf>
New York	**Energy Efficiency and Renewable Energy Resource Development Potential In New York State. Final Report Volume One: Summary Report.** This study examines the long-range potential for energy efficiency and renewable energy technologies to displace fossil-fueled electricity generation in New York by looking at the potential available from existing and emerging efficiency technologies and practices and by estimating renewable electricity generation potential.	This study was commissioned to estimate the technical and maximum achievable potentials in New York State, including the potential from renewables and combined heat and power.	<www.nyserda.org/sep/EE&ERpotentialVolume1.pdf>

Title/Description		Purpose	URL Address
Oregon	**Energy Efficiency and Conservation for the Residential, Commercial, Industrial, and Agricultural Sectors.** This report is designed to inform the project development and selection process for a list of potential energy efficiency and renewable energy measures that could provide electricity savings for Oregon consumers.	The stated goal of this projected was "to provide the Energy Trust of Oregon, Inc. with a list of potential energy efficiency and renewable energy measures that could provide electricity savings for Oregon consumers."	<www.energytrust.org/library/reports/Resource_Assesment/ETOResourceAssessFinal.pdf>
	Natural Gas Efficiency and Conservation Measure Resource Assessment for the Residential and Commercial Sectors. This is a resource assessment to evaluate potential natural gas conservation measures that can be applied to the residential and commercial building stock serviced by Northwest Natural Gas.	The purpose of this study was to evaluate potential natural gas efficiency measures, to find out if they are technically feasible and cost-effective.	<www.energytrust.org/library/reports/Resource_Assesment/GasRptFinal_SS103103.pdf>
Texas	**Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's Growing Electricity Needs.** Presents both economic and program potential estimates. The economic potential was determined using a detailed bottom-up analysis.	Prepared in response to announced plans to construct several large coal-fired power plants to meet future peak loads in Texas.	<http://aceee.org/pubs/e073.pdf>
	Power to Save: An Alternative Path to Meet Electric Needs in Texas. Estimates the potential for efficiency and other demand-side strategies by relying on the results of other studies in similar or nearby regions.	Commissioned by national nonprofit groups with an interest in energy efficiency and climate change.	<www.ceres.org/pub/docs/Ceres_texas_power.pdf>

Schedule RAV-E2

Title/Description		Purpose	URL Address
Vermont	**Assessment of Energy Efficiency and Customer-Sited Generation Investments in the Southern Loop.** A detailed analysis of program potential given aggressive efficiency programming.	Prepared in relation to efforts to build a new transmission line serving a small geographic region in Southern Vermont.	<www.velco.com/Templates/default.asp?pageId=48>

Schedule RAV-E2

Appendix F: References

American Council for an Energy-Efficient Economy [ACEEE] (2007). *Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's Growing Electricity Needs*. Report No. E073.

California Public Utilities Commission [CPUC] (2001). *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects*.

Goldstein, D.B. (2007). *Saving Energy, Growing Jobs*. Berkeley: Bay Tree Publishing.

KEMA-XENERGY, Inc. (2003a). *California Statewide Residential Sector Energy Efficiency Potential Study*. Study ID #SW063, Vol. 1.

KEMA-XENERGY, Inc. (2003b). *California Statewide Residential Sector Energy Efficiency Potential Study*. Study ID #SW063, Vol. 2.

Nadel, S., A. Shipley, and R.N. Elliott (2004). *The Technical, Economic and Achievable Potential for Energy Efficiency in the U.S.—A Meta-Analysis of Recent Studies*. Washington, DC: American Council for an Energy-Efficient Economy [ACEEE].

National Action Plan for Energy Efficiency (2006). *The National Action Plan for Energy Efficiency*. <www.epa.gov/cleanenergy/pdf/napee/napee_report.pdf>

National Action Plan for Energy Efficiency (2007). *Guide to Resource Planning with Energy Efficiency*. Prepared by Snuller Price, Energy and Environmental Economics, Inc.

New York State Energy Research and Development Authority [NYSERDA] (2003). Energy Efficiency and Renewable Energy Resource Development Potential in New York State—Final Report, Volume One: Summary Report.

Northeast Energy Efficiency Partnerships [NEEP] (2005). *Economically Achievable Energy Efficiency Potential in New England*. Optimal Energy.

Optimal Energy, Inc. (2007). *Power to Save: An Alternative Path to Meet Electric Needs in Texas*. Report commissioned by the Natural Resources Defense Council and Ceres.

Optimal Energy, Inc. (forthcoming). *Assessment of Energy Efficiency and Customer-Sited Generation Investments in the Southern Loop*. Prepared for Vermont Electric Power Company.

Southwest Energy Efficiency Project [SWEEP] (2002). *The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest*. Report for the Hewlett Foundation Energy Series.

Schedule RAV-E2

Funding and printing for this report was provided by the U.S. Department of Energy and U.S. Environmental Protection Agency in their capacity as co-sponsors for the National Action Plan for Energy Efficiency.

Recycled/Recyclable—Printed with Vegetable Oil Based Inks on 100% (Minimum 50% Postconsumer) Recycled Paper

Schedule RAV-E2