Guidebook for Potential Studies in the Northwest

October 2010

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1 Introduction

This guide provides information related to energy efficiency potential studies, specifically for utilities in the Pacific Northwest. The first section is a discussion of what a potential study is and the data required to develop one. Next, an overview of how the Northwest Power and Conservation Council (Council) models potential for the Northwest region is provided. Then, a brief description of the Council's Target Calculator and a new tool called the Utility Potential Calculator are provided. The final section describes components of a typical Action Plan that can be used as a starting point for taking action on the results of a potential study. The Appendix contains a list of references and links to data sources and energy efficiency reference material. A Glossary is also included to define common energy efficiency terms.

2 Basics of Potential Studies

Energy efficiency potential studies provide estimates of the amount and cost of energy savings that are available in a given area over a selected timeframe. At the very basic level, the annual energy savings potential (kWh) of a particular device (e.g., efficient showerhead or light bulb) is multiplied by the number of locations where these could be installed, and the result is the overall potential for that device (Figure 1).

Figure 1
Energy Efficiency Savings Potential Assessment

A potential study expands on this concept to include multiple devices, or measures applied across sectors to the entire service territory. Therefore, a potential study requires significant data collection to define customer characteristics (e.g., house types, age of construction, etc) and energy efficiency measures (e.g., cost, savings, and load shape information) and utility data (e.g., load forecasts, discount rates). The numerous data points are brought together to produce estimates of energy and capacity savings potential.

Types of Potential

In developing a potential study, several different types or levels of efficiency potential are often identified: technical, economic, and achievable. Technical potential is the theoretical maximum efficiency in the service territory. Achievable potential is a subset of technical potential based on physical barriers, market conditions, customer acceptance and other constraints that reduce the technical potential savings from an energy efficient device. Economic potential is a subset of the achievable potential that has been screened for cost effectiveness through various benefit-cost tests. When these three factors are applied, the result is called the achievable economic potential.

- Technical – Amount of energy efficiency potential that is available regardless of cost or other constraints such as willingness to adopt measures. It represents the theoretical maximum amount of energy efficiency if these constraints are not considered.

- Achievable – Amount of potential that can be achieved through a given set of program conditions. Achievable potential takes into account many of the realistic barriers to adopting energy efficiency measures. These barriers include the willingness of consumers to adopt a measure and the physical limitations of ramping up a program over time. The level of achievable potential can increase or decrease depending on the given incentive level of the measure.

- Economic – Amount of potential that passes an economic cost/benefit test. This generally means that the present value of the benefits exceeds the present value of the measure costs over its lifetime. Sometimes, the levelized cost of an efficiency measure is compared with levelized market prices or an alternative conventional supply-side energy resource (avoided cost). However, because a measure's levelized cost does not reflect the value of its savings based on time of day or season of the year it produces these savings, cost-effectiveness is better determined by comparing a measures' cost with the value of its savings using a benefit-to-cost ratio.

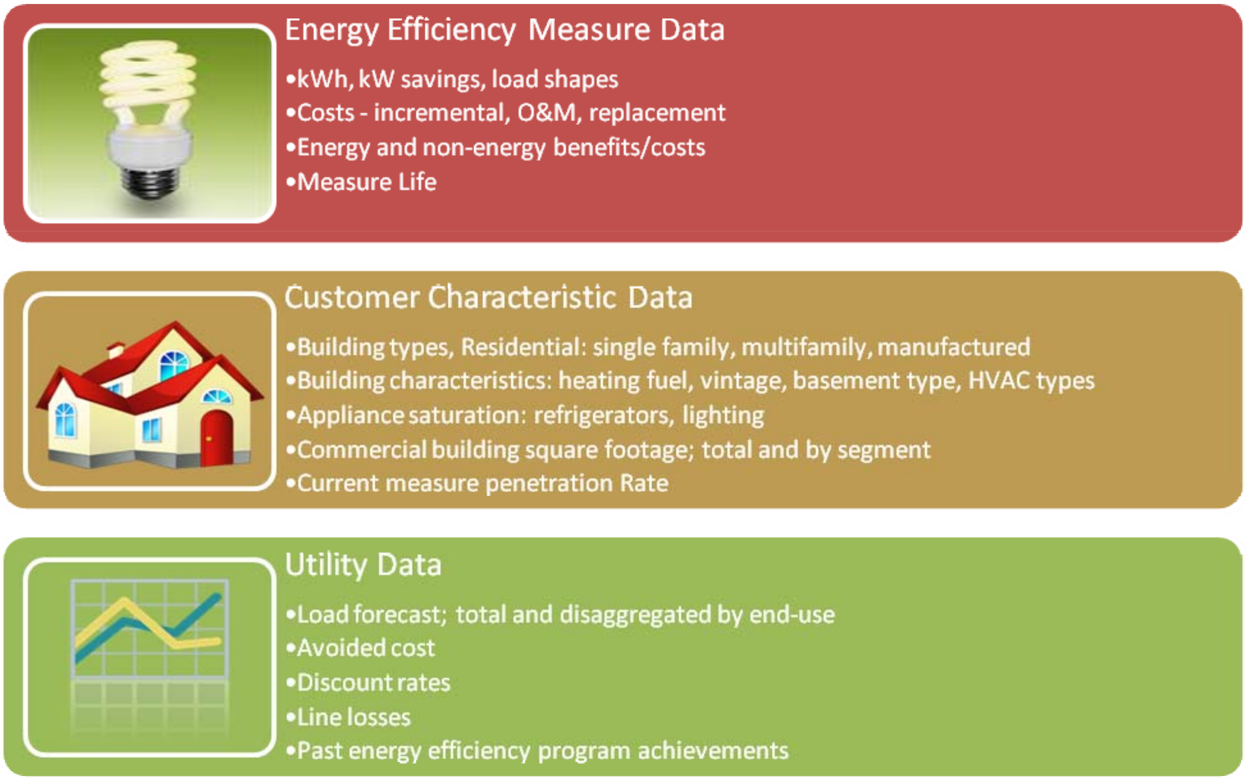
Some potential studies include variations of achievable potential. For example, "program achievable potential" can refer to achievable potential given a set of program conditions, including incentive levels. Maximum achievable potential is the amount of energy savings that can realistically be achieved assuming the most aggressive program approach (for example, offering 100% of the incremental cost of all measures)[1]. Scenarios can be developed to provide a range of program potential estimates given a range of program or portfolio design.

Basic Data Requirements

In order to perform a potential study, information and data about the electricity end-users (utility customers) must be obtained or developed. The data needed for a potential study generally fall into three categories as illustrated in Figure 2 below: energy efficiency measure data, electricity end-user characteristics, and utility data.

[1] By definition, in order for a measure to be cost-effective it must produce savings at a lower cost to the utility than the next cheapest alternative resource. As a result, a utility can pay up to just less than the cost of alternative resources for energy efficiency even if this exceeds the incremental measure cost including program administration. Therefore, when assessing maximum achievable potential, utilities should consider that they could pay more than some measure's cost to ensure they are installed.

Figure 2
Overview of Potential Study Data Requirements



The characterization of efficiency measures includes measure savings (kWh), demand savings (kW), measure costs ($), and expected useful measure life (years). Other features such as end-use or measure load shape, operation and maintenance costs, and non-energy benefits are also important for measure definition. Energy efficiency measure data are often available from national or regional sources, which can be used directly or updated if more localized information is available. Measure characterization is usually accomplished through the use of existing databases where savings, costs, and measure lives are well-defined. Utilities conducting comprehensive potential assessments may develop their own measure data through end-use metering of efficiency measures, building load modeling, and research.

Customer characteristics data are another important component of a potential study. One of the best ways to obtain these data is through original research, especially end-use surveys. An end-use survey may provide all the detailed housing and commercial building data requirements. Defining service territory data is often referred to as characterizing the baseline.
If end-use surveys are not practicable, customer characteristics can be estimated using regional or neighboring utility surveys or databases. Other sources include county databases, multiple listing services, paid-for database subscriptions, online databases, or other sources. In addition to end-use data, baseline saturation data for applicable energy efficiency measures is needed. This information can be obtained through the customer surveys and from records of past energy efficiency program accomplishments.
The third category is referred to as utility data. These are data specific to the utility and include current and forecasted loads, growth rates, avoided cost information, and line losses. It is helpful

to understand the overall consumption by the utility customers, as well as a forecast of future loads. These baseline consumption forecasts can be an overall projection, a sector-level forecast, or an end-use forecast. It is important to understand how much, if any, energy efficiency is assumed as part of the load forecast so that efficiency potential estimates are not double-counted. In practice, this task is often quite difficult to accomplish because very few utilities employ end-use level load forecasting models. These forecasting models permit a direct comparison between the level of efficiency assumed for an appliance or building and the assumptions used in the potential study. More commonly, utilities use "econometric" load forecasting models which do not disaggregate energy use down to individual end uses or even buildings. The forecast should also reflect the planning period chosen for the study. Common planning period choices are 10, 15, and 20 years.

The avoided cost of electricity is the dollar value per MWh, of the conserved electricity, and accounts for the benefit value in cost effectiveness tests. It is often based on the cost of a new generating resource, a forecast of market prices for power or a forecast of market price plus an adder which accounts for the risk and cost reduction that higher cost conservation provides. In the Council's Sixth Power Plan the avoided cost for energy efficiency is the wholesale market price plus a risk-mitigation premium[2]. The Council's Sixth Power Plan identified a risk mitigation premium of $35/MWh for retrofit conservation measures, and a $50/MWh for lost opportunity conservation measures. Lost opportunity measures are those that require a major equipment purchase or new construction.[3] If an efficient measure is not installed at the time it is being replaced or built, the efficiency opportunity is "lost". For this reason, the lost opportunity measures are given more value.

Basic Modeling Methodology

There are two general analytical approaches to estimating conservation potential: a bottom-up approach, and a top-down approach. The bottom-up approach is the primary method used by the Council and is the one generally described in this manual. The key factor is the number of kWh saved annually from the installation of an individual energy efficient measure. The savings from each measure is multiplied by the total number of potential measures expected to be installed over the life of the program. Each individual total measure savings is aggregated into total potential.

The top-down approach starts with the load forecast over the study period. These load forecasts are then disaggregated by end-use. Energy savings by measure, end-use, program, or sector are then expressed as a percent of the total energy consumption.

The two approaches, described above, are frequently combined. For example, a bottom-up approach is often presented not only as energy savings but also as a percent of the baseline consumption. Conversely, the top down approach often results in reporting energy savings data for specific measures or programs.

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[2] Conservation risk premiums are derived from the Council's portfolio model. Refer to the Council's Sixth Power Plan for a description of the portfolio model.

[3] Additional discussion of the derivation of the Council's "risk premium/market price adder" appears in Appendix E and Appendix J of the Sixth Plan.

Different approaches can also be used for different sectors. For example, the residential sector potential could be developed using a bottom-up approach through an end-use survey. However, the same study might use a top-down approach for the industrial sector. In some cases, the industrial sector requires the top-down approach due to the variation in measure savings and rigorous data requirements of a bottom-up approach. However, utilities with a few large industrial customers may be better served by taking a bottom-up approach that is plant-specific for the largest customers.

Estimating Technical Potential

The technical potential is the sum of all measure savings and possible applications of the measure across the service territory. Estimating the technical potential begins with determining the amount of savings expected to be produced by an energy efficiency measure. Then, the number of "applicable units" must be estimated. "Applicable units" refers to the number of units that could technically be installed in a service territory. This includes accounting for units that may already be in place. A sample formula for calculating technical potential for a residential measure is shown below:

Measure Savings = (Per Unit Savings) x (# of households) x (Applicability) x (1- Saturation)

The "Applicability" value is highly dependent on the measure and the housing stock. For example, a duct sealing measure is only be applicable to homes with electric space heating equipment that use forced-air distribution systems, such as heat pumps or electric furnaces. Technical potential should consider the interaction of measures, the order of measure adoption or stacking effect and measure overlap. For example, if high efficiency lighting system is installed in a commercial building, it reduces air conditioning loads and increases heating loads. The total savings estimate must account *interaction* of all three end uses. In addition, the measure-by-measure savings sometimes depend on which measure is installed first (i.e., stacking). For example, the savings from adding floor insulation depends on whether a home's attic and walls are already insulated. Finally, sometimes two different measures target the same technical potential, so adjustments must be made so as not double count savings (i.e. measure overlap). Total technical potential is often significantly more than the amount of economic and achievable potential. Economic potential refers to the fraction of technical potential that is cost-effective. Achievable potential refers to the fraction of technical or economic potential that can be achieved through all mechanisms (e.g., programs, codes and standards, market transformation, etc.) over the entire planning period.

Estimating Economic Potential

To find cost-effectiveness potential, energy efficiency measures must pass economic screening. Generally, potential studies use a total resource cost (TRC) perspective to screen measures for cost effectiveness. A total resource cost perspective considers all costs and benefits for each energy efficiency measure regardless of to whom they occur. Costs and benefits include capital, labor, operation and maintenance, periodic replacement of the measure, fuel, disposal, program administration, distribution and transmission impacts, and quantifiable non-energy costs or benefits. The total resource cost is the cost-effectiveness test used by the Council.

Another common cost-effectiveness test is the utility cost test (UCT) (also known as the program administrator cost test). This test considers only those costs and benefits that accrue to the utility and includes only those savings that are attributable to the utility's programs, i.e., "net savings." Application of the UCT in an assessment of the economic potential can be problematic because it requires that "free-ridership" and "spillover" effects of the anticipated programs targeting each efficiency measure be estimated prior to program implementation. In addition, energy efficiency measures with significant non-energy benefits, but smaller energy benefits may past the TRC but not pass the UCT screening.

There are a variety of other cost effectiveness tests. Both the California Standard Practice Manual[4] and the National Action Plan for Energy Efficiency's "Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers"[5] provide good definitions and calculation procedures for the various cost effectiveness tests.

Estimating Achievable Potential

Achievability criteria can be applied either to technical potential or to economic potential. The Council applies achievability criteria prior to the economic cost-effectiveness tests. The Council uses an 85% achievability factor for all non-lost opportunity measures, and just over 65% achievability for lost-opportunity measures. The Council published a white paper describing the basis for using these values[6]. Since it is impossible to predict the future, the decision to adopt an achievability factor is a judgment call. However, its selection should take into account historical accomplishments as well as the fact that not all of technical potential must be captured solely by utility programs. As the Council's analysis shows, over the extended periods covered by potential studies, changes in codes and standards and other factors also contribute to improvements in efficiency.

There are many different types of achievability factors and many ways to apply them. In addition, the achievability can be evaluated through different scenarios (e.g., high, medium, low). Scenarios can be based on the level of incentives offered or other program design factors.

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[4] California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects. July 2002. http://drrc.lbl.gov/pubs/CA-SPManual-7-02.pdf

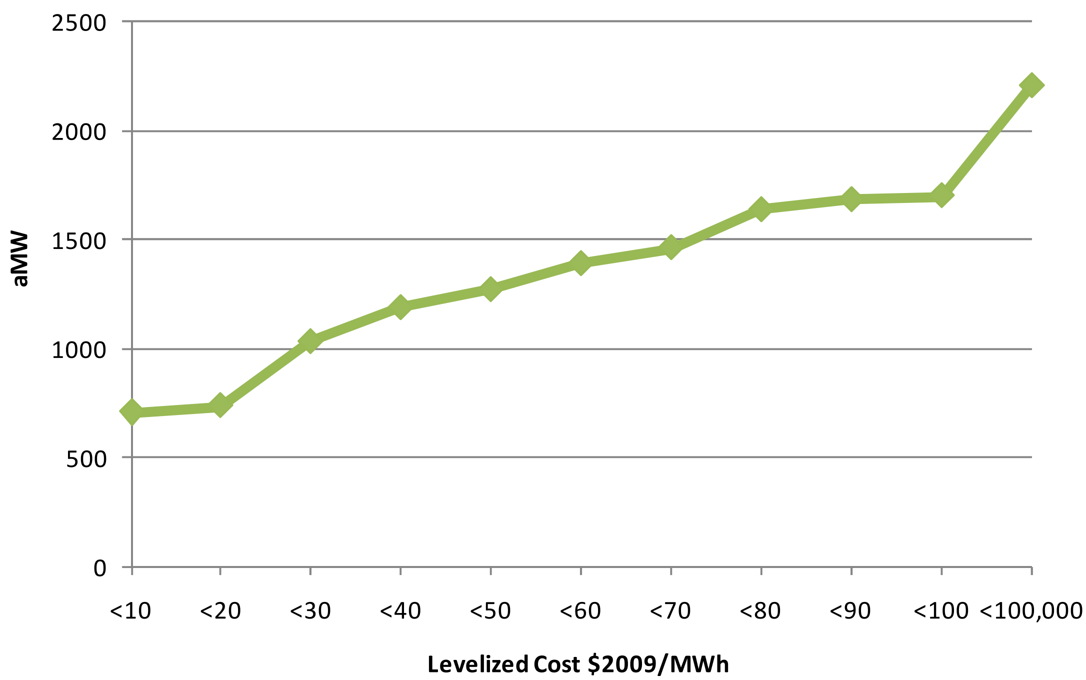
[5] http://www.epa.gov/cleanenergy/energy-programs/napee/resources/guides.html

[6] Read more about how the Council determines achievability rates here: "Achievable Savings: A Retrospective Look at the Northwest Power and Conservation Council's Conservation Planning Assumptions." August 2007. http://www.nwcouncil.org/library/2007/2007-13.htm.

Supply Curves

Each type of potential can be summarized in supply curves where potential (kWh, MWh, GWh or aMW) is graphed against the levelized cost ($/MWh or ¢/kWh). Figure 3 illustrates a conservation supply curve. The x-axis shows the costs in levelized terms. Measure costs are standardized allowing for the comparison of measures with different lives. The y-axis shows the amount of potential (aMW) for each price level. The aMW amounts are cumulative numbers, so for example, the 1000 aMW at <$30/MWh means that there is a total of 1000 aMW from a variety of measures at a cost of under $30/MWh. The supply curve facilitates comparison or demand-side resources to supply-side resources, and is often used in conjunction with Integrated Resource Plans (IRPs).

Figure 3
Supply Curve – Technical Potential



Levelized Cost

The levelized cost of each measure is the discounted present value cost of the measure annualized over its life divided by the annual energy savings. When developing or reviewing levelized costs it is important to understand what is included. The most basic levelized cost includes the net incremental capital cost of the measure. More elaborate definitions include the changes in maintenance costs or savings, non energy benefits/costs, and any other costs associated with implementing the measure during its lifetime. This definition, called the Total Resource Cost or TRC Levelized cost, is used by the Council.

Levelized Cost

$$\text{Levelized Cost} = \text{Discounted Present Value Cost of Measure Annualized Over Life (\$)} \div \text{Annual Energy Savings (kWh)}$$

Developing a Comprehensive Potential Study and Data Requirements

Developing a comprehensive energy efficiency potential study requires significant effort, time, and other resources. Utilities often hire consulting firms to assist with the development of these comprehensive studies. According to the NAPEE Guide for Conducting Energy Efficiency Potential Studies[7], the cost for performing a comprehensive potential study can range from $75,000 to $500,000. Appendix A of this report contains a listing of other reports and documents that may be useful for learning more about conducting comprehensive potential assessments. Table 1 provides a list of many possible inputs and considerations for conducting full potential studies.

Table 1
Energy Efficiency Potential Study Data Requirements

Energy Efficiency Measure Data	Define technology, measure, or practice over baseline measure	Energy Savings, kWh, kW, shape of savings over time	Costs $ Incremental capital, O&M, periodic replacement	Non-Energy Benefits, greenhouse gas emissions[8] avoided, water savings, detergent or other savings Measure Life		Measure Life
Utility Data	Current and forecasted energy loads and consumption		Discount Rates	Transmission and Distribution line losses		Inflation Rate
Avoided Cost	Local and Bulk transmission and distribution $/kW		Value of greenhouse gases $/ton	Value of non-energy savings such as water, detergents, etc.		Energy $/kWh
Residential Building Characteristics	Building Type: Single Family, multi-family, manufactured,	Residency Type: owned, rented, seasonal	Building Vintage	Single Family Home basement Type	Heating fuel, heat system types and efficiencies	Cooling system types and efficiencies
	Building Size (sq ft) window size (sq ft)		Existing weatherization efficiency		New Building characteristics	Thermostat type
Residential Appliance Saturation	Efficiency of Large appliances, refrigerators, freezers, dishwashers, clothes washers and dryers		Efficiency and number of Light sockets (for each lighting application) or lighting density (watts/sq ft)		Home electronics and controls	Plug-in Hybrid Cars
	Water Heater fuel and		Desktop and Laptop			

[7] 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>

[8] For more on Marginal Carbon Dioxide Production in the Pacific Northwest power system refer to: http://www.nwcouncil.org/library/2008/2008-08.pdf, June 13, 2008

Table 1
Energy Efficiency Potential Study Data Requirements

	efficiency	computers		Efficient Heating Systems	
Commercial Building Characteristics	Building Type: Restaurant, retail, office, warehouse, hospital, schools, health buildings, universities, hospitality, theatres, museums, public buildings, other, etc)	Heating and Cooling System	Heating Fuel	Size (sq ft) – total and by sub-sector	Vintage (Year of construction)
Commercial Appliance Saturation	Commercial clothes washers and dryers (hospitals, Multi-family, Laundromat, restaurants)	Refrigeration Equipment	Server Rooms, computers	Interior and Exterior Lighting types or lighting power density (watts/sq ft)	
Infrastructure	Parking garage lighting characteristics	Street and Roadway Lighting	Exit Signs	Traffic Signals	Municipal waste and waste water
Industrial	Custom characteristics may include: motors, refrigeration, process management, pumps, variable speed devices, fans, lighting, heating venting and cooling, compressed air, rewind systems, fruit storage, etc				
Agriculture	Dairy farm: dairy pumps	Crop Types and irrigation system types	Irrigation: pumps, sprinklers, gaskets, nozzles, drains, hubs, pressure regulators		
Codes and Standards	County, city, state, or federal codes and standards	Future codes and standards, timelines for phasing out older technologies	Proposed codes and standards		
Past Program Data	Annual efficiency achievements (aMW)	Annual efficiency costs ($) by program and measure	Baseline saturation of measures		

Outline of Representative Methodology

A utility interested in a comprehensive potential study may consider the following steps (not necessarily in sequential order):

1. Develop load forecast
    a. Overall utility load forecast (identify whether or not conservation is included in the load forecast)
    b. Load forecast by sector
    c. Load forecast by sector and end use
2. Conduct Customer Surveys
    a. Housing characteristics
    b. Consumption patterns and appliance data
    c. Space and water heating fuel use
    d. Baseline saturations
3. Identify Non-Residential Characteristics
    a. Commercial building floor area
    b. Commercial building segmentation
    c. Industrial segmentation (consumption by sub-sector)
    d. Agriculture load and type
4. Characterize Energy Efficiency Measures
    a. Compile a list of energy efficiency measures to include
    b. Research published sources and databases of efficiency measures
    c. Meter and subsequently collect utility-specific data to define measure savings
    d. Determine if/when codes or standards apply to each measure
    e. Adjust measure savings for several factors including[9]:
        i. Take-Back – Customers either uninstall the energy efficiency measure or change their behavior so that the technology is used more frequently than it would have had the technology not been energy efficient. The impact is a reduction in savings.
        ii. Failure – The technology fails, breaks, or is destroyed.
        iii. Installation – Technology is stored rather than installed. This reflects efficient products sold by retailers, but not installed immediately.
        iv. Space Conditioning Interaction – Technologies that increase or decrease electricity use in electrically heated buildings.

[9] These adjustment factors become quantified through program evaluations and may not be available at the onset of a potential assessment. For the PNW, many of the deemed savings values developed by the RTF include some or all of these adjustments.

5. Determine Avoided energy and capacity cost (opportunity cost for conservation) and develop a forecast, or determine method to include potential supply curves in Integrated Resource Planning
6. Project service territory characteristics for the length of the study period
    a. Building stock growth rates
    b. Appliance saturation (light fixtures, electric heat, etc)
    c. Building characteristics such as size, number of windows, etc
7. Calibration of baseline end use assumptions
    a. Disaggregation of baseline consumption by end-use
    b. End-use forecast model
8. Combine these data in a model to calculate energy efficiency technical potential
    a. Make sure there is no double-counting of measure savings or costs.
    b. Account for codes and standards changes
    c. Adjust for interactions among efficiency measures
9. Conduct cost-effectiveness tests using measure data and avoided cost data (economic potential), or utilize results in resource plan.
10. Apply achievability rates (achievable potential). This can also be applied before the cost-effectiveness test.
11. Develop various scenarios to account for risk, exogenous factors, and differing implementation strategies
12. Present results in terms of costs, annual savings, total cumulative savings, peak savings, end-use savings, supply curves, and by measure
13. Document methodology, data sources, inputs, results, and conclusions
14. Create an action plan to acquire energy efficiency resources

Additional Resources

For additional resources on energy efficiency potential assessment methodology, see the documentation listed below:

Guide for Conducting Energy Efficiency Potential Studies, National Action Plan for Energy Efficiency. http://www.epa.gov/solar/documents/potential_guide.pdf
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.

California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects. July 2002. http://drrc.lbl.gov/pubs/CA-SPManual-7-02.pdf
This manual describes the primary cost effectiveness tests used to evaluate DSM programs. It identifies the cost and benefit components and cost-effectiveness calculation procedures from four major perspectives: Participant, Ratepayer Impact Measure (RIM), Program Administrator Cost (PAC), and Total Resource Cost (TRC). A fifth perspective, the Societal, is treated as a variation on the Total Resource Cost test.

Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy Makers, National Action Plan for Energy Efficiency. http://www.epa.gov/cleanenergy/documents/utility_data_guidance.pdf
This document outlines the need to align utility practices with increasing customer requirements for energy use and cost data. This guidance document summarizes current data practices, outlines the business and policy cases for action, and presents both basic and advanced approaches for providing consistent, standardized electronic energy consumption and cost data to business customers.

The Technical, Economic and Achievable Potential for Energy-Efficiency in the U.S. – A Meta-Analysis of Recent Studies, American Council for an Energy-Efficient Economy. January 2004. http://www.aceee.org/conf/04ss/rnemeta.pdf
This analysis summarizes, compares, and contrasts the results of 11 studies on the potential for energy efficiency in the U.S. in order to discern overarching findings. The study concludes with several recommendations for future energy efficiency potential work.

Examples of energy efficiency potential studies are included below:

Energy Efficiency and Conservation Measure Resource Assessment for the years 2008-2027, Energy Trust of Oregon. February 26, 2009. http://www.energytrust.org/library/reports/090226_EE_ConservMeasure_ResourceAsses.pdf
This study assesses the energy efficiency and renewable energy measures that could provide electricity and natural gas demand-side savings for Oregon consumers by 2027 within the Energy Trust service territory.

Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027). May 4, 2004. http://www.pse.com/SiteCollectionDocuments/2007IRP/Appendices/K1-Demand-sideAnalysisReport.pdf

This study estimates the potentials for electric and natural gas demand-side management (DSM) resources in Puget Sound Energy's (PSE's) service area from 2008 to 2027. The study was commissioned by PSE as part of its biennial integrated resource planning (IRP) process. The study includes both electricity and natural gas energy efficiency potentials. In addition, it includes small-scale generation, demand response, fuel conversion, distributed generation and emerging technologies.

California Statewide Residential Sector Energy Efficiency Potential Study, Pacific Gas & Electric. April 2003. http://docs.cpuc.ca.gov/published/report/30114.pdf
This study assesses electric and natural gas energy-efficiency potential in existing residential buildings within the service territories of the four major investor-owned utilities in California: PG&E, Southern California Edison Company, Southern California Gas Company, and San Diego Gas and Electric Company (SDG&E).

B.C. Hydro Conservation Potential Review, 2006.
http://www.bchydro.com/about/company_information/reports/electricity_conservation.html

This study is the most comprehensive of its type carried out in North America and examines the benefits and feasibility of energy efficient technologies, alternative energies and fuel switching, behavior and lifestyle choices.

The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest, Southwest Energy Efficiency Project. November 2002.
http://www.swenergy.org/nml/index.html
This study 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. The study models two scenarios, a "business as usual" Base Scenario and a High Efficiency Scenario that gradually increases the efficiency of electricity use in homes and workplaces during 2003-2020. This study looks in particular at environmental (avoided emissions) and macroeconomic effects (jobs) of aggressive energy efficiency programs.

Energy Efficiency in Maryland's Electricity Future, September 2007.
http://www.aceee.org/getfile.cfm?publicationid=91

This report lays out the role that improving energy efficiency can play in meeting these new energy and environmental challenges. For this discussion, energy efficiency improvement is defined as reducing the energy required for a given unit of physical work or economic output. Efficiency gains are distinct from load management (short-term reductions in use during peak demand periods) or reductions in energy use from reduced economic activity.

Industrial Efficiency Data Catalogue, Northwest Power and Conservation Council. June 2009.
http://www.nwcouncil.org/dropbox/

This data catalogue includes a compilation of published and unpublished resource assessments, market and technology reports, datasets, case studies and guidebooks focused on industrial energy efficiency and energy management. The catalogue was used to develop the Industrial Supply Curve for the Council's Sixth Power Plan. This collection is meant to serve as a resource for the Council and its stakeholders to use when referencing the Industrial Energy Efficiency Supply Curve and in performing their own related work. This collection does not claim to be a complete listing of updated or valuable sources - the literature is very extensive and rapidly growing. It does, however, represent an updated list of references that the Council found to be helpful in developing its assessment of conservation potential in the Northwest.

3 Council Methodology

The Northwest Power and Conservation Council (Council) was formed by the Northwest states in 1981 in accordance with the Northwest Electric Power Planning and Conservation Act (Act). The Act charges the Council with creating a power plan for the region and reviewing/revising it every five years. Technologies that allow for more efficient production of electrical services are considered the equivalent of generating additional electricity. The Act designates efficiency improvements as the highest priority resource for meeting electricity demands and gives it a 10 percent cost advantage. The Council adopted its Sixth Power Plan in February 2010.

For the conservation portion of the Plan, the Council conducts a region-wide potential assessment. Conservation supply curves are and the primary results of this assessment and are used in the Council's "Resource Portfolio Model (RPM)" where thousands of power supply scenarios are analyzed based on 750 different forecasts of future conditions.

Council Methodology Overview

The methodology for developing the Council's supply curves are described in the Power Plan itself. For the *Sixth Power Plan*, the conservation methodology is described in *Chapter 4: Conservation Supply Curve Assumptions*, and *Appendix E: Conservation Supply Curve Development*[10]. This section provides a brief summary of this methodology.

The Council's methodology for evaluation of conservation resources involves four major steps:

1) develop estimates of technical potential and the cost of conservation including its contribution to energy and capacity needs
2) identify the amount of achievable potential and create supply curves for lost-opportunity and non-lost opportunity conservation
3) identify the time-based shape of the savings in the supply curves
4) the supply curves are compared against supply-side resources in the portfolio model which determines the avoided cost of conservation and the amount to pursue.
5) identify development characteristics of the cost-effective conservation potential including programmatic approaches and timing constraints
6) identify conservation development strategies

<u>Council Technical Potential and Costs</u>

The Council uses the bottom-up approach for estimating potential savings as described earlier. The first step is to develop conservation supply curves based on engineering analysis. This step entails evaluating the cost of all conservation measures, including capital, financing, operating and period replacement costs.

[10] http://www.nwcouncil.org/energy/powerplan/6/default.htm

Measure energy and capacity savings are estimated, including the monthly and daily load shape of the savings. Non-energy benefits and costs, such as water savings or changes in natural gas use associated with of each measure are estimated[11] to the extent they can be identified and calculated. This results in a summary of all the costs and savings for technically feasible measures. From these estimates the Council calculates several key parameters including levelized life-cycle cost and benefit-cost ratios. The fraction of forecast building, appliance or equipment stock the measures apply to, whether the measure is a lost-opportunity[12], and savings interactions from application of multiple measures are also determined.

Regional characteristics are assembled through numerous sources, including customer characteristics data from utility surveys. The Northwest Energy Efficiency Alliance (NEEA) conducts a significant number of market research studies that provide the basis for significant region-specific data. Various city, county, and state resources are also utilized to build up the data required to define the regional housing and commercial building characteristics. These data are used to determine the fraction of the region's building stock apply to the measures.
The Council develops energy efficiency measure data through the Regional Technical Forum, which provides detailed analysis and review of savings, costs, and lifetimes of energy efficiency measures appropriate for the Northwest region. In addition, the Council looks to other regions and the federal rulemaking process for new measures and possible changes to energy efficiency requirements.
The present value of each measure's benefits is compared to the present value of its life cycle costs (see Figure 4). Benefits include energy and capacity cost savings, local distribution system cost savings and the 10 percent credit given conservation in the Northwest Power Act and any quantifiable non-energy benefits. The costs include the sum of the installed cost of the measure, and operation and maintenance costs (or savings) associated with ensuring the measure's proper functioning over its expected life.[13]

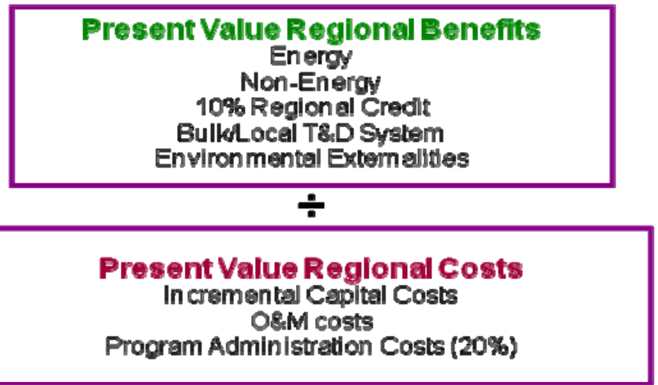
The Council uses the Total Resource Cost test to determine the cost-effectiveness of all resources. In order to implement this test in its RPM, the Council calculates a "TRC Net Levelized Cost" to compare the cost of conservation to the costs of power purchases and new resource development. The TRC Net Levelized cost is computed based on all costs minus all benefits regardless of which sponsor incurs the cost or accrues the benefits. TRC Net Levelized Cost includes all applicable costs and all benefits. In addition to energy system costs and benefits, TRC Net Levelized Cost includes non-energy, other-fuel, O&M, periodic-replacement and risk-mitigation benefits and costs. The TRC Net Levelized Cost corresponds to TRC B/C ratios with regard to the costs and benefits included. Benefits are subtracted from costs and then levelized over the life of the program.

[11] For example, when an efficient light bulb is installed, there is a corresponding increase in heating load that needs to be made up by heating system. If that heating system is natural gas, these costs are deducted from the benefits.

[12] Lost-opportunity resources can only be captured during a limited window of opportunity, such as when a building is built or an industrial process is upgraded.

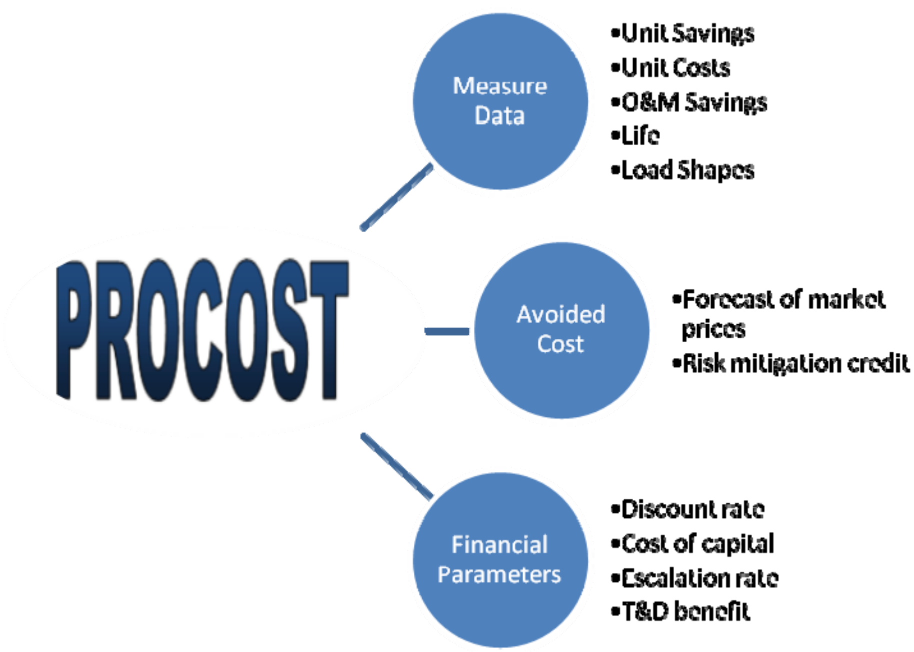
[13]For more on cost-effectiveness tests and why the Council uses the TRC, see the following paper: http://www.nwcouncil.org/energy/crac/meetings/2009/03/Council_CostEffectiveness_Issues.pdf

Figure 4
Total Resource Cost Test



The Council has developed a cost-effectiveness model called ProCost which serves as the basis for energy efficiency measure cost-effectiveness assessment. The basic input structure of ProCost is shown in Figure 5. The results of ProCost include all present value cost, savings, and cost-effectiveness information for each measure and program. ProCost is used to develop the TRC Net Levelized cost values for the supply curves and the shape of the savings over time.

Figure 5
Overview of Council's ProCost Model



<u>Council Achievability Rates</u>

The Council applies achievability rates[14] to the amount of technical potential available. These achievability rates indicate that not all of the potential is likely to be accomplished during the 20-year planning period. The percent of achievable savings is a function of the type of measure and

[14] Read more about how the Council determines achievability rates here: "Achievable Savings: A Retrospective Look at the Northwest Power and Conservation Council's Conservation Planning Assumptions." August 2007. http://www.nwcouncil.org/library/2007/2007-13.htm.

the time period. The Council uses 85% achievability rates for measures that can be implemented at any time (non-lost opportunity). For measures that are implemented only at certain times during the planning period determined by the end-life of the technology (lost opportunity), the Council applies various "ramp rates" to the measures, to ramp up over time to the maximum 85% of the total. Once achievability rates are applied to the technical potential, the resulting potential is called achievable potential.
The Council's portfolio analysis model uses two conservation supply curves, one for non-lost opportunity (discretionary)[15] measures and one for lost-opportunity measures. The portfolio model then evaluates conservation along with other regional resources. The portfolio model determines the amount of conservation that is cost-effective to develop in each of the 750 futures considered in the Council's planning process.

Portfolio Model and Avoided Costs

The supply curves are developed and provided to the portfolio model. These conservation resources are compared against supply-side resources in the portfolio model to determine the amount of conservation that can be economically developed. Part of this result is the reference avoided cost of conservation, or the cost below which conservation is considered cost effective.

Because significant quantities of conservation are available at costs below most forecasts of future market prices, the portfolio model would deploy all of the low-cost conservation immediately, unless the pace of conservation deployment is constrained to achievable rates. Therefore in addition to the 85% achievability rate, the Council sets a maximum annual deployment rate, or infrastructure maximum. This represents the upper limit of annual conservation resource development based on implementation capacity.

Programmatic Approaches and Timing

The Council has always constrained the pace of conservation deployment through the use of "ramp rates". However, in the development of the Sixth Plan conservation supply curves the Council assigned "ramp rates" to individual measures or measure bundles to build up to the aggregate non-lost opportunity and lost-opportunity supply curves. The ramp rates reflect near-term penetration rates of individual measures or suites of measures. For example, measures involving emerging technology might start out at low penetration rates and gradually increase to the 85 percent penetration. Simple measures with well established delivery channels (e.g., efficient showerheads) be fully implemented in several years. Whereas retrofit measures in complex markets might take 20 years to reach full penetration.

Conservation Development Strategies

The Council includes an Action Plan in the Power Plans. The action plan where it relates to conservation includes development strategies and identifies resources needed to implement the

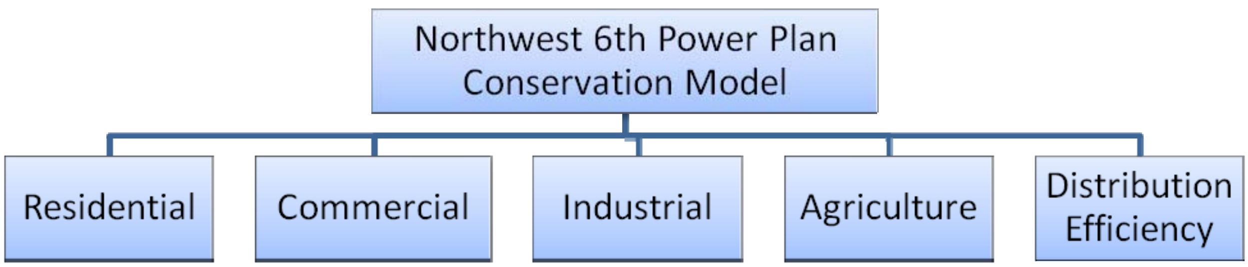
[15] Non-lost opportunity measures are also called "discretionary" or "retrofit", indicating that they can be implemented at any time during the planning period.

strategies. These strategies include recommendations for research and demonstration of new and emerging conservation measures.

Council Potential Model Details by Sector

The Council in its Sixth Power Plan built up the energy efficiency potential through five distinct sectors: residential, commercial, industrial, agricultural and distribution efficiency (see Figure 6). Although the Council refers to a single "model," estimates of energy efficiency potential are composed of many related Excel spreadsheets. Supply curves are segmented by sector and are publicly available online:
http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm

Figure 6
Council's Sixth Plan Conservation Model Overview



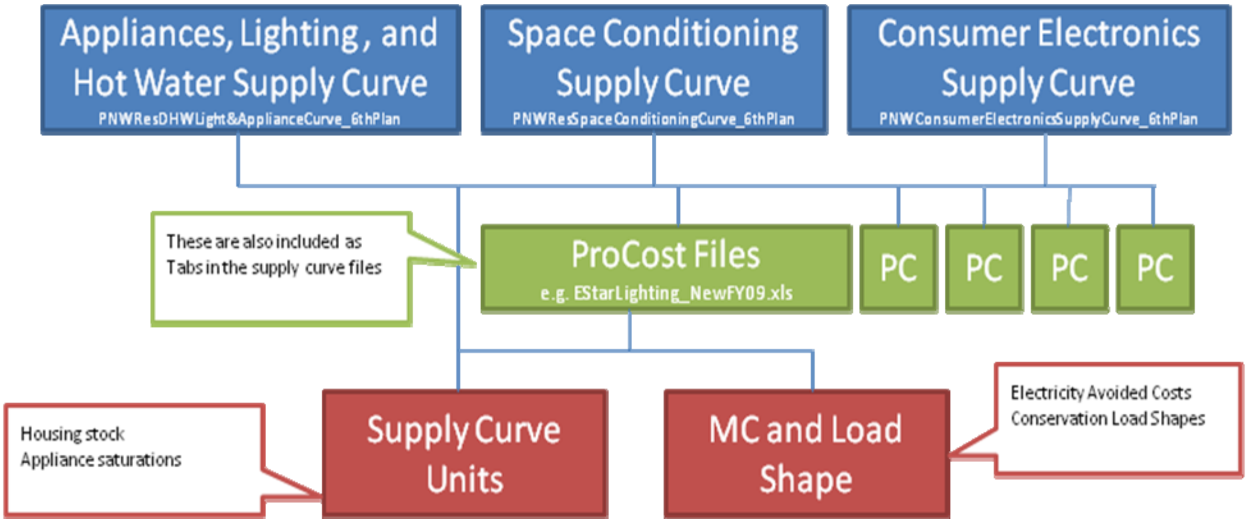
Since these models are publicly available, anyone can download and customize them for a specific service territory. However, due to the size and complexity of the models, this customization effort would require significant technical expertise and advanced Excel expertise. In general, the service territory characteristics such as housing types or commercial building segmentation can be more easily customized than data relating to measure characteristics and cost-effectiveness. The following sections provide an overview of the computational structure of the Council's model and suggestions on how to change key model parameters.

Residential

In the residential sector, the Council largely bases conservation estimates on the region's housing stock (i.e., number of households). The primary factors affecting the housing stock are the breakdown of housing by type (single family, multi-family, manufactured housing), vintage (pre-1980, new construction, etc), foundation type (full basement, crawlspace, on slab), climate zone, residential heating type and appliance saturation data.

As shown in Figure 7, residential measures are bundled into three main files: 1) Appliances, Lighting, and Hot Water, 2) Space Conditioning and 3) Consumer Electronics. Individual measure ProCost information is available in separate ProCost files and also built into separate tabs in each supply curve file. There is a load shape file (*MC_AND_LOADSHAPE_6P.xls*) and technical performance data file for measures like Energy Star appliances that feed the ProCost worksheet tabs. The Council combines cost effectiveness calculations from ProCost with information about the housing stock contained in the supply curve units file (*PNWResSectorSupplyCurveUnits_6thPlan.xls*) to generate supply curves. A diagram of the Council's residential model is below:

Figure 7
Residential Model Structure



Customizing the Residential Model

For those interested in customizing the model for local service territory use should start with the "curve" files (represented by the blue boxes in Figure 7). Each of these three files contains a worksheet called "Applicability Table". Some key variables that could be customized are located in columns "H" through "L". These variables include the number of units, maximum market penetration, current market saturation and remaining technical potential. An excerpt from the worksheet is shown in Figure 8.

Figure 8
Excerpt from "Applicability Table" Worksheet

C	H	I	J	K	L
Category	**Total Technically Available Units**	**Maximum Technically Applicable Market Penetration**	**Current Market Saturation**	**Remaining Technical Potential (Fraction of Units)**	**Remaining Technical Potential (Units)**
Showerhead	7,389,910	85%	5%	80%	5,911,928
Lighting - Existing	5,797,587	85%	70%	15%	869,638
Lighting - New	1,455,576	85%	70%	15%	218,336

These variables could be directly modified here or traced back to the "Supply Curve Units" file for background on the origin of these values. Also in this worksheet are the ramp rates for the measure categories, which could also be adjusted as needed.

A more difficult level of customization would be the cost and cost-effectiveness of the measures. This would require making changes to the ProCost files (represented by the green boxes in Figure 7). In the residential model, the ProCost files are embedded in the Supply Curve files also, but making changes would still require running the ProCost macro. ProCost also requires an associated file called *MC_AND_LOADSHAPE_6P.xls* to open to be able to run. This file contains electricity and natural gas price forecasts, conservation load shapes, and numerous other worksheets that link to ProCost.

ProCost is relatively complicated to learn and run, and these instructions are beyond the scope of this handbook. The Council staff or several consultants in the region can provide training if needed.

Commercial

For the commercial sector, each measure type, such as lighting, duct sealing or roof insulation, has its own separate ProCost measure file. Supply curves of most measures are determined by the total building square footage in commercial sub-sectors (e.g. hospital, university, large office, small office, etc). There are several exceptions, such as wastewater treatment or traffic signals, which do not rely on square footage and are predominantly based on population and applicability assumptions.

Individual measure file organization is fundamental to understanding the commercial model. The ProCost files can be identified by "PC" followed by the name of the measure. For example, *PC-Windows-6P-D10.xls* is the commercial windows measure supply curve developed for the Sixth Plan. Each supply curve Excel file contains a difference measure, but is similar in layout. There are three main categories of worksheets in each file structured around the input and output to the ProCost calculator.

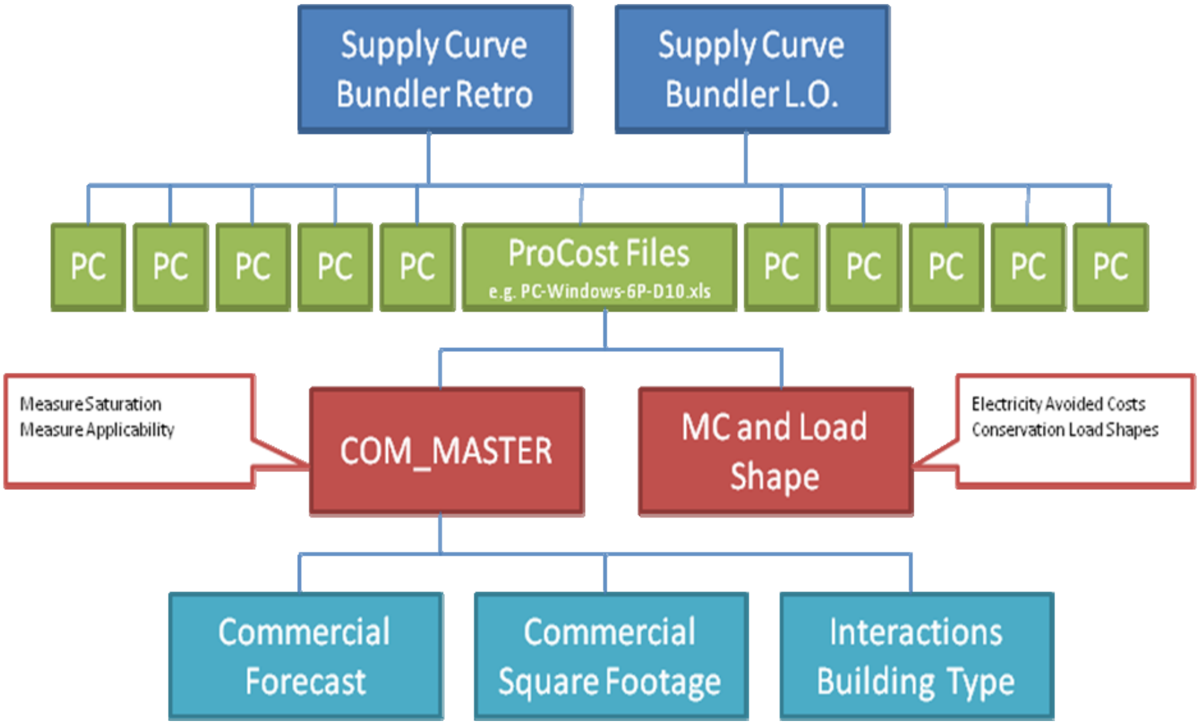
- The first is the MData and MMap worksheets, which hold most of the cost and savings data for each measure.
- The second is the ProData worksheet, which takes data from the MData and MMap worksheets and feeds the ProCost model. The ProCost model returns cost effectiveness values to the lower portions of the ProData worksheet.
- The third and last is the supply curve worksheets, which calculates total savings potential for the measure. The supply curve worksheets combine results of the ProCost calculations along with commercial space forecasts and achievability rates from ComMaster. Usually, there are several supply curve worksheets for new, retrofit and natural replacement [16] cases.

The measure workbooks reference several other key files. The *ComMaster.xls* file includes measure applicability, baseline penetration, applicable vintage cohort, achievability, fuel saturations and equipment saturations and other key characteristics common to all commercial measures. The *ComFloorAreaForecast.xls* file contains commercial stock estimates for occupancy type, state and vintage. The load shape file (*MC_AND_LOADSHAPE_6P.xls*) contains avoided cost information, load shapes and avoided CO_2 emissions.

Figure 9 is a diagram of the Council commercial structure. Notice how the commercial forecast and ComMaster files feed each supply curve file, which are then rolled up into bundle files. Therefore, changing values in these files requires re-running the ProCost model.

[16] The natural replacement mode applies to subsystems and equipment within buildings that are replaced on burnout, at the end of their useful life, or at the time of remodel of the building or system within a building. Natural replacement measures are considered Lost Opportunity.

Figure 9
Commercial Model Structure



Customizing the Commercial Model

The Council's commercial model is more complex than the residential portion, which reflects the more complex nature of the commercial sector. The supply curve tab of each ProCost file is a good place to begin for those interested in customizing the Council's commercial model. The top block in each supply curve worksheet is the floor area by sub-sector projected out for the 20-year study period. Since the commercial model is largely based on floor area by sub segment, it is important to determine these data for a local service territory. Once these values are updated, the new supply curve for that measure is generated. All applicability and achievability rates are applied to the new floor area data.

Industrial

The Council's industrial sector analysis covers most of the region's non-DSI industries plus refrigerated warehouse storage. The industrial model is structured differently than in other sectors; it utilizes a top-down rather than a bottom-up approach. First, data were collected on electricity use by industry and by state. The consumption estimates were then disaggregated by major process end use. Next, the energy conservation measures (ECMs) are applied to end use estimates as a percent savings with associated costs. Finally, factors for measure applicability, measure interaction, and achievability rates over time are applied.

The industrial assessment includes an Excel workbook which contains industrial load data, measure data, conservation supply curves and documentation. Another Excel workbook converts measure costs and savings data to conservation supply curves for input to the portfolio model. These two workbooks are:

- PC-Industrial-D10.xls
- Industrial-Tool-D10.xls

The supply curve file (PC-Industrial) includes a separate ProCost input tab for each industry (e.g., Mechanical Pulp, Frozen Food, etc.). Each industry worksheet contains a list of applicable measures with their corresponding savings and cost assumptions. For example, both refineries and cold storage include a measure called "transformers." The council model calculates the potential for transformer improvement in each industry tab, then rolls them up together to estimate a total potential.

Customizing the Industrial Model

The Industrial_Tool.xls file contains the background information for the measures as well as applicability information by subsector.
For those interested in customizing the industrial potential, the best way to begin is to update the forecasted industrial load at the end of the study period. This can be done at the top of the "Program Summary" worksheet *Industrial_Tool.xls* file. Then, load must be changed in each sub-segment tab. For example, the first one is the MechPulp (Mechanical Pulp) worksheet. At the top there is a "MWh:" box to with the regional value for the total mechanical pulp sector consumption. Simply change this number to reflect the local service territory consumption, and do the same for all sub-sectors.

Agriculture

Agriculture has three main measure categories, each with its own supply curve file: irrigation hardware improvements, irrigation scheduling and daily farm operation. Contained within each supply curve file is the ProCost model for determining cost effectiveness. For irrigation measures, the model determines how many acres of land are applicable to each technological or scheduling improvement. For dairy production, the model determines the total weight of milk produced using input assumptions for Northwest states.

Customizing the Agriculture Model

The Agriculture model is set up in a similar manner as the Residential model. A good starting point for customizing this model is on the "Applicability Table" worksheet of each supply curve file (e.g., *DairySupplyCurve6thPlan.xls*).

Distribution Efficiency

Distribution efficiency is the newest component of the Council's model. The primary measure is voltage reduction through the regional power distribution network, but there are several other measures that address line losses. Conservation potential is estimated using the number of substations and total load. The main file (*PC-Distribution-6P-D2_rev.xls*) contains the ProCost data, measure information and supply curve.

Customizing the Distribution Efficiency Model

One possible place to start for customizing the distribution efficiency portion is the "SC-Retro" worksheet of the supply curve file. Cells A13 through A17 could be modified by multiplying these values by your share of regional load. More detailed customization can be done by tracing these values to the source worksheets, and then modifying these data for a local service territory.

4 Options for Estimating Utility Potential

In the Northwest there are several ways to obtain energy efficiency potential estimates:

- Council's Target Calculator[17]
- Utility Potential Calculator (UPC)
- Custom Utility Potential Study [18]
- Customize the Council Model [19]

The Council's target calculator provides a potential estimate based on a utility share of the region's load. This is a quick way to get a high level potential estimate, but no customization is available. The Utility Potential Calculator is a new tool that is based on the Sixth Power Plan and provides more options for customizing to a specific service area. The final two options (full potential and Council models) provide the most flexibility and customization options, but also require significant effort and expertise. These approaches can be distinguished by the level of customization available as indicated in Figure 10.

Figure 10
Potential Study Tool Comparison

	Utility Location	Residential Load	Commercial Load	Industrial Load	Housing Stock	Appliance Saturation	Heat Type	Building Vintages	Commercial Stock	Industry Types	Demolition/Growth Rates	Avoided Cost	Technical Measure Data	Ramp Rates	Utility Data*
Target Calculator	x	x	x	x											
UPC	x	x	x	x	x	x	x	x	x	x	x				
Full Potential Study	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Council Models	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

*Including finace rates, line losses, admin cost

[17] This would satisfy the first option for setting conservation targets for Washington State I-937 utilities
[18] This is the third option for setting conservation targets for Washington State I-937 utilities
[19] This could be used to satisfy the second or third options for setting conservation targets for Washington State I-937 utilities

This section includes a brief description of how to use the Council's simplified calculator (currently called "UtilityTargetCalc_v2_01_6thPlan.xls") and the Utility Potential Calculator (UPC). The other two more detailed methods were covered in previous sections.

The Council's Target Calculator

At the request of the Washington Department of Commerce (formerly Commerce, Trade, and Economic Development), the Northwest Power and Conservation Council created a Utility Target Calculator to give utilities a simple means to compute "their share" of the regional's total conservation target. The Council clearly states that the Excel calculator is an "approximation" of the level of conservation utilities should target in order to be consistent with the Council's regional goals and does not formally assign individual utility targets. Nevertheless, the results of this calculator can be used as rough guidance for utility conservation program planning until a utility completes their own conservation potential study or other methods become available. The I-937 rules in Washington also states that it may be used to determine public utility conservation targets.

In the target calculator file (http://www.nwcouncil.org/energy/UtilityTarget.htm), users must select their utility service area and are given three options to calculate their share of conservation potential. All three options are based on the 2007 utility retail load relative to regional load.

- Option 1 calculates potential based on utility share of total regional retail sales and is best suited for larger utilities whose residential, commercial and industrial sectors reasonably profile resemble those of the region as a whole.
- Option 2 calculates potential based on utility share of total regional retail sales by sector and is best suited for any utility that does not have significant irrigated agriculture load.
- Option 3 is used for utilities who do have agriculture load and requires that the user enter manually enter the utility's 2005 retail sales in the irrigated agriculture sector.

Additionally, the Target Calculator file includes a rough guide for allocating budget funds to meet calculated targets.

Utility Potential Calculator - UPC

BPA, with support from EES Consulting, has developed a Utility Potential Calculator (UPC) using the Council's Sixth Power Plan Conservation data. The tool is designed to allow regional utilities to estimate their conservation potential using the framework of the Council's detailed model, rather than estimating a conservation target using their relative share of regional load. The model uses the Council's methodology, structure and data files, but considerably simplifies the input requirements. The UPC is a tool that goes beyond the Target Calculator and enables users to modify a variety of input variables to match their service territory but is much simpler than conducting a comprehensive potential study.

UPC avoids the significant volume of the Council's file structure by excluding inputs that would require re-running the ProCost calculator. It takes a limited set of user inputs that represent the housing, commercial, industrial and agricultural stock of a specific utility. For example, using high-efficiency spray heads as a representative measure, the UPC allows users to change the number of restaurants that could have efficient spray head washer installed, but not the kW savings potential or avoided energy of specific spray head models. Thus, UPC functions as a lightweight standalone model that benefits from the Council's detail, but is not hindered by numerous files, links and references. This is accomplished by leaving the Council's measure characteristics unchanged, but enabling the user to adjust the local service territory characteristics.

In the UPC file, there are five input tabs (worksheets) with one tab for each sector (residential, commercial, etc). The user can modify housing stock, commercial building stock, agricultural acres and industrial load on each tab. Some information is required, such as total residential units or industrial load by sub sector. Beyond these required values, users are given the option to further breakdown inputs for their utility's service region or use the Council's regional averages.

Residential

In the residential sector, users input characteristics of the housing stock in their service territory: total housing units, housing type, foundation, heating type, vintage and appliance saturations. Additionally, cooling, heating and solar zones and growth and demolition rates are required. Regional average values are listed for reference and can be used for comparison or as a place-holder until local data are obtained. The input screen for the residential sector of the UPC is displayed in Figure 11. Note that users can change characteristics for both existing homes and new construction.

Figure 11
UPC Residential Input Screen

RESIDENTIAL

Heating Zone	Cooling Zone	Solar Zone
1	2	2

Residental Households	Total Population
78,251	177,630

Housing Stock	Existing Homes	New Homes	Regional %
House Type			
Single Family	72%	72%	72%
Multi-Family	22%	22%	18%
Manufactured Homes	7%	7%	10%
Housing Vintage			
Pre-1980	70%	70%	57%
1980 - 1993	10%	10%	14%
Post 1993	21%	21%	28%
Heat Fuel Type			
Natural Gas Homes	24%	24%	37%
Electric Homes	74%	74%	53%
Other Fuel Homes	3%	3%	10%
Electric Heat System Type			
Forced Air Furnace	9%	9%	34%
Heat Pump	20%	20%	20%
Zonal (Baseboard)	71%	71%	44%
Electric Other	0%	0%	2%
Single Family Foundation Type			
Crawlspace	64%	64%	64%
Full Basement	23%	23%	23%
Slab on Grade	13%	13%	13%

Housing Appliances	Existing	New	Regional %
Water Heating			
Electric	82%	82%	64%
Natural Gas	18%	18%	36%
Appliance Saturation			
Refrigerator	112%	112%	112%
Freezer	57%	57%	57%
Clothes Washer	85%	85%	87%
Electric Dryer	82%	82%	82%
Dishwasher	67%	67%	67%
Electric Oven	82%	82%	82%
Room AC	11%	11%	11%
Central AC	50%	50%	50%

Demolition	Annual Rate	Regional Rate
Single Family	-0.23%	-0.23%
Multi-Family	-0.23%	-0.23%
Manufactured Homes	-1.07%	-1.07%

Growth Rate	Annual Rate	Regional Rate
	1.4%	1.4%

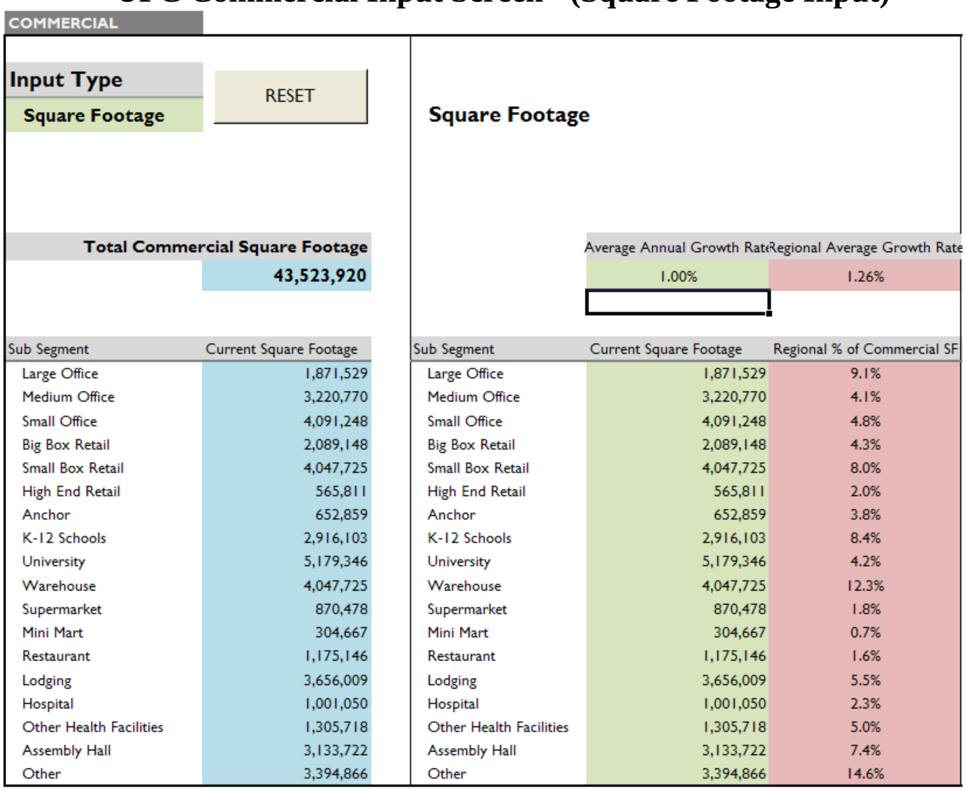
The UPC model uses these characteristics to segment the housing stock into different bins. For example, each bin has a specific combination of characteristics, such as a single family house built before 1980 with forced air furnace heat and a crawlspace. These different bins determine the available units for each of the Council's residential measures.

Commercial

For the Commercial sector, the UPC model requires characteristics of a utility's commercial stock and uses the information to determine the applicable commercial square footage for each measure. The Council's commercial potential estimates are based primarily on the applicable square footage available for new construction, retrofit, or natural replacement measures. To estimate the conservation potential at the utility level, the UPC determines the ratio between the commercial square footage in their service territory and the square footage in the entire region. Therefore, the most accurate way to input data is by directly entering square footage data for each commercial sub-sector.

The UPC provides three other options if local square footage data are not available: 1) annual consumption (kWh) by subsector, 2) number of buildings by subsector, or 3) number of employees by subsector. These characteristics can be entered and the model will use conversion factors to generate square footage in each commercial sub-sector. Annual load or number of buildings by can be entered and the UPC converts to square footage using EUI (kWh/sq ft) or average square footage by building type. These default conversion factors should also be reviewed and verified.

Figure 12
UPC Commercial Input Screen - (Square Footage Input)


COMMERCIAL

Input Type: Square Footage — RESET

Total Commercial Square Footage: 43,523,920

Sub Segment	Current Square Footage
Large Office	1,871,529
Medium Office	3,220,770
Small Office	4,091,248
Big Box Retail	2,089,148
Small Box Retail	4,047,725
High End Retail	565,811
Anchor	652,859
K-12 Schools	2,916,103
University	5,179,346
Warehouse	4,047,725
Supermarket	870,478
Mini Mart	304,667
Restaurant	1,175,146
Lodging	3,656,009
Hospital	1,001,050
Other Health Facilities	1,305,718
Assembly Hall	3,133,722
Other	3,394,866

Square Footage

Average Annual Growth Rate	Regional Average Growth Rate
1.00%	1.26%

Sub Segment	Current Square Footage	Regional % of Commercial SF
Large Office	1,871,529	9.1%
Medium Office	3,220,770	4.1%
Small Office	4,091,248	4.8%
Big Box Retail	2,089,148	4.3%
Small Box Retail	4,047,725	8.0%
High End Retail	565,811	2.0%
Anchor	652,859	3.8%
K-12 Schools	2,916,103	8.4%
University	5,179,346	4.2%
Warehouse	4,047,725	12.3%
Supermarket	870,478	1.8%
Mini Mart	304,667	0.7%
Restaurant	1,175,146	1.6%
Lodging	3,656,009	5.5%
Hospital	1,001,050	2.3%
Other Health Facilities	1,305,718	5.0%
Assembly Hall	3,133,722	7.4%
Other	3,394,866	14.6%

Industrial

The industrial sector in the UPC is based directly on The Council's *Industrial Tool* spreadsheet. This is the first power plan to include process data for industrial potential, so it is used it directly by inserting it into the Industrial section of the UPC model. The key information required is the annual industrial sector consumption, both total and by subsector.

Figure 13
UPC Industrial Input Screen

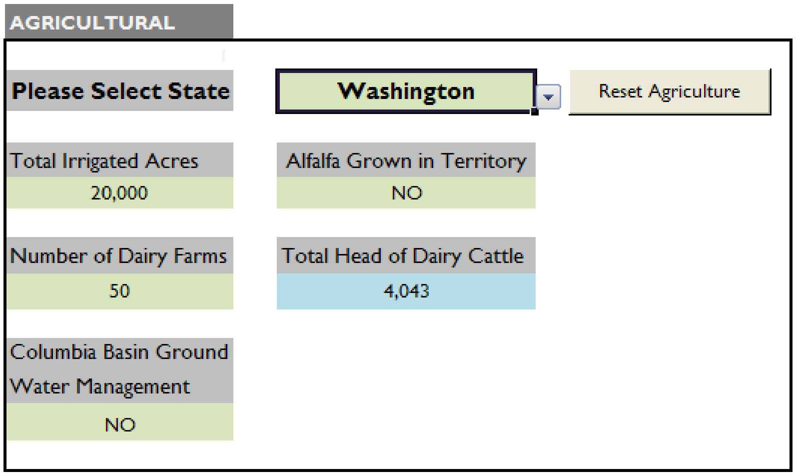
INDUSTRIAL

Annual Base Load in 2009	MWh	Annual Growth Rate (Regional Average)
Mechanical Pulp	0	0.81%
Kraft Pulp	0	0.97%
Paper	438,745	0.19%
Foundries	0	0.60%
Frozen Food	3,090	-0.35%
Other Food	10,800	0.37%
Sugar	0	-0.07%
Lumber	16,689	-0.51%
Panel	7,640	-0.32%
Wood	83,266	0.61%
Electric Fabrication	0	0.49%
Silicon	0	-1.04%
Metal Fabrication	25,079	1.00%
Equipment	1,356	-1.90%
Cold Storage	11,523	2.12%
Fruit Storage	0	2.19%
Refinery	0	-0.94%
Chemical	0	0.51%
Miscellaneous Manufacturing	129,368	1.04%
		Reset Growth Rates
Total	727,556	

Agricultural

Measures are broadly divided into irrigation hardware improvements, irrigation scheduling, and dairy farming. For irrigation measures, users enter the total number of irrigated acres in their service territory and Columbia Basin data (if applicable). Measures for dairy farming use pounds of milk as measure units, so users input the number of dairy farms in their territory. The UPC calculates the total lbs of milk applicable to dairy measures using different assumptions in each state.

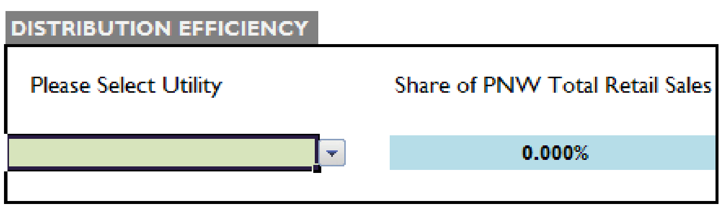
Figure 14
UPC Agriculture Input Screen



Distribution Efficiency

Potential in the DE sector is calculated using the percentage of a utility's share of regional non-industrial retail sales. This is the same methodology as The Council's Target Calculator.

Figure 15
UPC Distribution Efficiency Input Screen



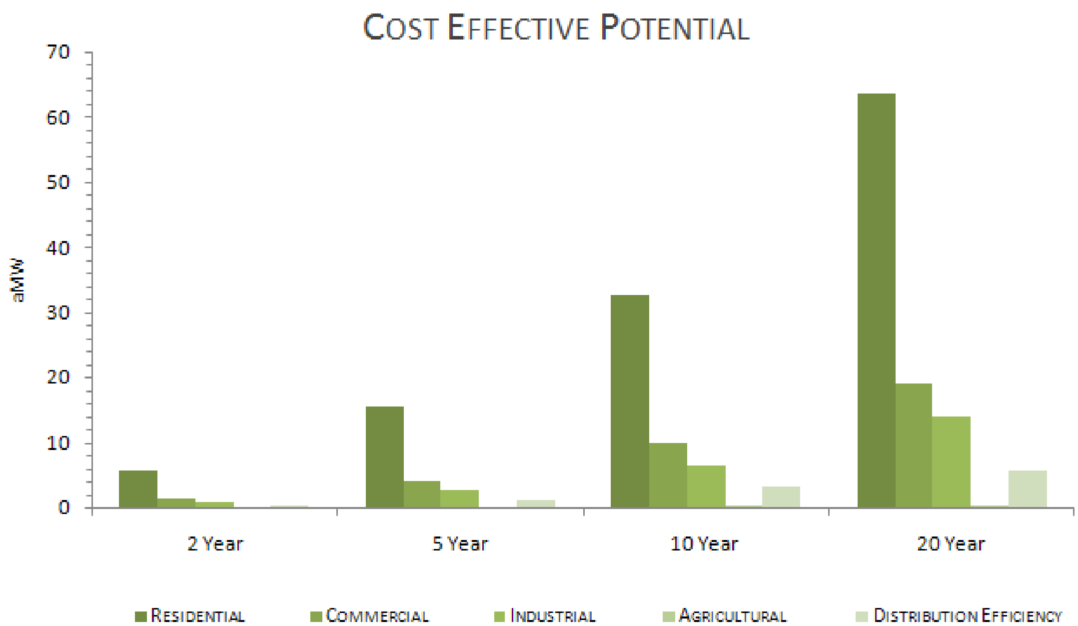
Results

As the input data are entered into the UPC the results are updated. Results can be found on two separate worksheets, one for savings and one for estimated costs. Figure 16 shows and example of the energy savings results page.

Figure 16
Example Results

Achievable Savings

	Cost Effective - aMW			
	2 Year	5 Year	10 Year	20 Year
Residential	5.65	15.55	32.59	63.68
Commercial	1.26	4.05	9.85	19.06
Industrial	0.84	2.70	6.42	13.85
Agricultural	0.05	0.13	0.27	0.27
Distribution Efficiency	0.22	1.10	3.23	5.70
TOTAL	**8.02**	**23.54**	**52.35**	**102.56**



5 Action Plan

Estimating conservation potential is a first step towards meeting resource needs with energy efficiency. The next major step is developing an action plan. The action plan takes the results of a potential study and defines the steps and resources need to achieve the energy efficiency goals established by utility. The basic components of an action plan are listed below:

1. Review and Understand Potential Estimates
    a. Compare with past conservation achievement
    b. Compare potential areas with existing programs
    c. Identify gaps in current program offering
    d. Understand cost estimates
    e. Understand timing of measure and program implementation
2. Identify conservation goals
    a. Determine the level of total conservation to pursue
    b. Establish commitment for this new goal
    c. Ramp rates?
    d. Determine how savings will be achieved (incentives, market transformation, codes and standards)
3. Develop program plans
    a. Program plans are needed to:
        i. Document existing programs
        ii. Revise existing programs
        iii. Establish new programs
        iv. Adopt 3rd party programs (e.g., BPA Grocery Program)
    b. Components of a program plan
        i. Program goals and objectives
        ii. Detailed utility program costs (Incentives, marketing, etc.)
        iii. Savings estimates by measure
        iv. Cost estimates by measure
        v. Expected number of units
        vi. Cost effectiveness (measure, program, portfolio level)
        vii. Marketing plan
        viii. Delivery strategies including vendor collaboration
        ix. Incentive design
        x. Incentive processing
        xi. Evaluation plan
        xii. Measurement and verification of savings
4. Commit the resources to achieve the goals

   a. Establish internal budgets to meet the goals
      i. Consider funding market transformation or assisting with code changes
      ii. Optimize BPA programs
      iii. Leverage government tax credits
   b. Staffing
      i. Commit to adequate staffing levels
      ii. Identify staffing needs
         1. Run programs in-house
         2. Manage contractors to run programs
5. Implement new or revised programs
   a. Program launch date
   b. Prepare all utility staff that may be impacted (e.g., those answering telephones, etc.)
6. Establish measurement and verification protocols
   a. How will the savings be verified?
   b. How will the program's progress and success be evaluated?
7. Tracking and Reporting
   a. How will the program results be tracked and recorded?
   b. Determine the reporting metrics such as level of detail and report frequency

Achieving a prescribed level of conservation and energy efficiency as an alternative to supply-side resources requires careful planning and implementation. Considering the steps outlined above will enable a utility to provide quality programs that provide verified savings to offset the need for market purchases or new resources.

Appendix A Documentation

This section lists several links to energy efficiency data and reports including: program planning and evaluation, estimation methodology, national and regional survey data, measure data, and other helpful resources.

1) EPA NATIONAL ACTION PLAN VISION FOR 2025

The Vision for the National Action Plan for Energy Efficiency (Action Plan) establishes a goal of achieving all cost-effective energy efficiency by 2025, presents 10 implementation goals for states, utilities, and other stakeholders to consider to achieve this goal, describes what 2025 might look like if the goal is achieved. Specific documents in the plan are outlined below:
Website: http://www.epa.gov/cleanenergy/energy-programs/napee/resources/vision2025.html

UNDERSTANDING COST-EFFECTIVENESS OF ENERGY EFFICIENCY PROGRAMS: BEST PRACTICES, TECHNICAL METHODS, AND EMERGING ISSUES FOR POLICY-MAKERS
Reviews cost-effectiveness tests for energy efficiency, including discussing each perspective represented by the five standard cost-effectiveness tests and clarifying key terms.
Website: http://www.epa.gov/cleanenergy/documents/cost-effectiveness.pdf

UTILITY BEST PRACTICES GUIDANCE FOR PROVIDING BUSINESS CUSTOMERS WITH ENERGY USE AND COST DATA
This guidance document summarizes current data practices, outlines the business and policy cases for action, and presents both basic and advanced approaches for providing consistent, standardized electronic energy consumption and cost data to business customers.
Website: http://www.epa.gov/cleanenergy/documents/utility_data_guidance.pdf

ALIGNING UTILITY INCENTIVES WITH ENERGY EFFICIENCY INVESTMENT
This report describes the financial effects on a utility of its spending on energy efficiency programs, how those effects could constitute barriers to more aggressive and sustained utility investment in energy efficiency, and how adoption of various policy mechanisms can reduce or eliminate these barriers.
Website: http://www.epa.gov/cleanenergy/documents/incentives.pdf

GUIDE TO RESOURCE PLANNING WITH ENERGY EFFICIENCY
The Guide details how to integrate energy efficiency into resource planning and use a variety of methods to help ensure that energy efficiency programs provide a resource as dependable and valuable to utilities and their customers as any supply-side resource. The Guide organizes the planning process into ten important steps, each with their own associated technical issues, best practices, and information resources.
Website: http://www.epa.gov/cleanenergy/documents/resource_planning.pdf

GUIDE FOR CONDUCTING ENERGY EFFICIENCY POTENTIAL STUDIES

The Guide for Conducting Energy Efficiency Potential Studies 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 were made to best achieve the studies' objectives. It also provides an overview of the main analytical steps in conducting a potential.
Website: http://www.epa.gov/cleanenergy/documents/potential_guide.pdf

2) ENERGY INFORMATION ADMINISTRATION DATA (EIA)

COMMERCIAL BUILDING ENERGY CONSUMPTION SURVEY (CBECS)
CBECS is a survey conducted by the 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."
Website: http://www.eia.doe.gov/emeu/cbecs/
Floor space and heat types can be found at:
http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set7/2003html/b34.html

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. Website: http://www.eia.doe.gov/emeu/recs/
Specific housing characteristics can be found at:
http://www.eia.doe.gov/emeu/recs/recs2001_hc/2001tblhp.html

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.
Website: http://www.eia.doe.gov/emeu/mecs/contents.html
End-Use consumption data can be found at:
http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/excel/table6.1_02.xls

3) NORTHWEST POWER AND CONSERVATION COUNCIL DATA

NWPCC CONSERVATION CALCULATOR
NWPCC provides utilities with a simple means to compute "their share" of the Northwest Power and Conservation Council 5th Plan's regional conservation target. This calculator is intended to provide utilities with an "approximation" of the level of conservation they should target in order to be consistent with the Council's regional goals.
Website: www.nwcouncil.org/energy/UtilityTargetCalc_v1_7.xls

SIXTH PLAN CONSERVATION SUPPLY CURVES
Draft of supply curve data for residential, commercial, industrial, agricultural and distribution system measures under Northwest Power and Conservation Council Sixth power plan.
Website: www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm

4) NORTHWEST ENERGY EFFICIENCY ALLIANCE

The Northwest Energy Efficiency Alliance (NEEA) creates and manages cost-effective market transformation efforts in the states of Idaho, Montana, Oregon and Washington. In partnership with local utilities and public service administrators, NEEA's work encourages marketplace adoption of energy-saving technologies and services, as well as supports regional education and marketing platforms. NEEA's efforts target the residential, commercial, and industrial sectors. In addition NEEA focuses on developing new energy-efficient technologies and providing marketing and training resources across sectors.

EVALUATION REPORTS
Document the effects of our project efforts. This information allows projects to be managed adaptively to achieve their goals in a changing market as well as improve future efforts.
Website: http://www.nwalliance.org/research/evaluationreports.aspx

MARKET RESEARCH REPORTS
Explore opportunities for new market transformation projects.
Website: http://www.nwalliance.org/research/marketresearchreports.aspx

5) CALIFORNIA MEASUREMENT ADVISORY COUNCIL (CALMAC)

The CALMAC database includes publications for energy efficiency program evaluation. Sample program evaluations are provided for California utilities and regions.
Website: http://www.calmac.org/default.asp

6) AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY (ACEEE)

The ACEEE site provides several resources such as standards, technology studies, climate impacts, state and national energy policy, tax incentives, market transformation and energy markets.
Website: http://www.aceee.org/energy/reports.htm#sepa

7) DATABASE FOR ENERGY EFFICIENT RESOURCES (DEER)

The Database for Energy Efficient Resources (DEER) contains information on selected energy-efficient technologies and measures. The DEER provides estimates of the energy-savings potential for these technologies in residential and nonresidential applications. The database contains information on typical measures -- those commonly installed in the marketplace -- and data on the costs and benefits of more energy-efficient measures. Energy-efficient measures

provide the same energy services using less energy, but they usually cost slightly more. The site is maintained by the California Public Utilities Commission.
Website: http://www.deeresources.com/

8) Miscellaneous Resources

City Data

Aggregated data for residential and commercial building types, home heating fuel and residential building vintage by county and city.
Website: www.city-data.com

Pacific Northwest Regional Economic Analysis Project

Web-based program used to create graphic trends analysis of local economic indicators and generate shift-share analysis of local employment growth. Data is compiled by the Regional Economic Measurement Division (REMD) of the Bureau of Economic Analysis (BEA).
Website: www.pnreap.org/Washington/

Washington State Office of Financial Management

The Office of Financial Management provides vital information, fiscal services and policy support data, including population, industry, employment indicators for Washington State.
Website: www.ofm.wa.gov

Local Sources

Smaller localized data sources may be available to provide some components needed for your potential study. Examples include:

- County databases
- Local real estate offices or web sites
- Chambers of Commerce
- Yellow pages or other business directories
- Neighboring or overlapping utility companies (e.g., water utilities, natural gas utilities)
- Local equipment vendors

Fee-Based Databases

There are a variety of for-fee databases that can be purchased (either subscription or one-time use). A couple of these databases include:

- INFOUSA – Contains square footage information for commercial buildings
  - Web site: http://www.infousa.com/
- FWDODGE

Appendix B Glossary

Average Megawatt (aMW): Average hourly usage of electricity, as measured in megawatts, across all hours of a given day, month or year.
Achievable Potential: A measure of conservation potential that takes into account how many measures will realistically be implemented. For lost opportunity measures, there is only a certain % of expired units or new construction for a specified time frame. The Council uses 85 and 65 % achievability rates for retrofit and lost opportunity measure respectively. Sometimes achievable potential is a % of economic potential and sometimes achievable potential is defined as a % of technical potential.
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. Costs and benefits are usually calculated as a present value over the life of the measure.
Economic Potential: Refers to the portion of technical conservation potential that passes a cost effectiveness test.
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.
Incremental Cost: The extra cost incurred for an extra unit of output. Within energy efficiency, incremental cost is usually the cost to improve a measure technology from baseline and can be incurred by the consumer, the utility, or a combination of both. See also *measure cost*.
Levelized Cost: Levelized cost is a measure of resource costs over the lifetime of the resource. Evaluating costs with consideration of the resource life standardizes costs and allows for a straight comparison.
Load: Load refers to the amount of electric power delivered or required at any specific point on a system. This can be for a customer, a piece of equipment or the total demand in an electric system.
Lost Opportunity: Refers to measures that are installed as new construction or at the end of the life of the unit. Examples include weatherization, heat pump upgrades, appliances, or premium HVAC in commercial buildings.
MW (megawatt): 1,000 kilowatts of electricity. The generating capacity of utility plants is expressed in megawatts.
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.
Measure Cost: The cost of an energy efficiency measure. Measure cost is sometimes referred to as *incremental measure cost* or *incremental cost*. The cost of the measure should correspond to the savings of that measure, which may be incremental compared with a less efficient device. For example if the savings for a light bulb is 30 kWh per year, this savings refers to the consumption of a standard light bulb minus the consumption of the efficient bulb. Therefore, the measure cost is the cost of the efficient bulb minus the cost of the standard bulb.
Northwest Power and Conservation Council "The Council": The Council develops and maintains a regional power plan and a fish and wildlife program to balance the Northwest's environment and energy needs. Their three tasks are to: develop a 20-year electric power plan that will guarantee adequate and reliable energy at the lowest economic and environmental cost to the Northwest; develop a program to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River Basin; and educate and involve the public in the Council's decision-making processes.

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.

Retrofit: Retrofit measures are those that are replaced at anytime during the unit's life. Examples include lighting, shower heads, pre-rinse spray heads, or refrigerator decommissioning.
Technical Potential: Technical potential is the theoretical maximum of all conservation potential regardless of cost-effectiveness or achievability.
Total Resource Cost Test (TRC): This test is used to determine whether or not conservation measures are cost-effective. A measure passes the TRC if the present value of all benefits (no matter who receives them) divided by the present value of all costs (no matter who incurs them) is equal to or greater than one.
Utility Cost Test (UCT): Also referred to as the Program Administrator Cost Test. A cost-effectiveness test that evaluates the impacts of the efficiency programs on the utility. It uses only the costs that incur to the utility (or program administrator), and not those paid by customers or other parties.
SOURCE: US EPA and USA DOE (2008): *National Action Plan for Energy Efficiency Vision for 2025: A Framework for Change*. http://www.epa.gov/cleanrgy/documents/vision.pdf.