PNUCC

Bringing the *Power* of good ideas *Together.*

Memorandum

To: Board of Directors

From: Steve Kern, System Planning Committee Chair

Date: May 31, 2011

Subject: Report Completed – Sorting out Demand-Side Management

---

PNUCC's System Planning Committee has spent time over the past two years studying the characteristics of the power supply options for meeting future load growth. Our initial work on resource characteristics led us to the topic of demand-side management. We hope this report, *Sorting Out Regional Demand-Side Management*, provides you with a clearer understanding of this multifaceted resource.

Demand-side management has been prominent in utility integrated resource plans for decades, but for planners and operators, it is something of an enigma. We don't build it in any traditional sense, we don't see it physically operating, and the output isn't measurable in real time. We can't dispatch it, and we don't know exactly when it is there and when it isn't.

Even naming this resource poses a challenge. Is it conservation or energy efficiency? Or does the term demand-side management more clearly describe resource-development activities that depend on customer participation. As you can see from the title of our paper, we decided it did.

The System Planning Committee's demand-side management study aims to help system planners, operators, and policymakers better understand the resource. We explored the vocabulary, mechanisms for estimating potential, and tracking programs and savings, and we identified key players in the region's demand-side management community. As one of our committee members said, "I'm going to have all of my staff read this paper so they have a basic understanding of how DSM impacts our planning."

Cost and public policy are driving an ever-greater reliance on demand-side management. The success of the Smart Grid, for example, will require more effort on the part of the customer than we have ever witnessed before. We invite you to share the knowledge we have accumulated over the past year as we explored the many aspects of demand-side management.

Sorting out Regional Demand-Side Management

PNUCC

System Planning Committee

May 2011

Acknowledgements

This paper was developed and reviewed by members of the
PNUCC System Planning Committee.

Electronic copies of this report are available on the
PNUCC Website
www.PNUCC.org

101 SW Main Street, Suite 1605
Portland, OR 97204

Sorting Out Regional Demand-Side Management

Table of Contents

Overview

Demand-side management is an increasingly important resource for meeting our high-tech population's thirst for electricity. Demand-side management creates a reduction in energy consumption or change in the pattern of energy use and encompasses energy efficiency/conservation as well as demand response efforts to control demand. It is both mandated by many states and sought by utilities in its own right and it brings with it a host of challenges and opportunities different from that of traditional resources, such as a natural-gas generator.

Utilities are using a variety of tools to change the pattern of customer energy consumption to spread the need over a wider timeframe and decrease peaks, or to reduce consumption all together. These tools include agreements with customers. An example may be an agreement to run irrigation pumps during the time of day when more energy is available. It also includes energy-saving actions like replacing an inefficient plasma television with a more efficient LCD model, as well as other paths to reduce energy consumption. At this time most of the demand-side management efforts in the Northwest fall under the energy efficiency category and this will be the primary focus of this paper.

Although the idea of saving energy is simple, the act of developing and promoting energy savings, gaining customer participation and accounting for megawatts saved is complex. Comparing and communicating energy savings in a meaningful way requires an understanding of energy conservation concepts and vocabulary that are outlined in this paper. The audience for this paper is power managers and decision makers.

History

Awareness of energy conservation was jumpstarted in the 1970's during the energy crisis in which the United States and other countries were exposed to skyrocketing fuel costs and a shortage of oil. And entities around the region have been participating in demand-side management ever since.

In 1980 the Northwest Power Act was passed in the face of possible energy shortages. Among other purposes the Act was designed to promote energy conservation in the Pacific Northwest and "to assure the Pacific Northwest an adequate, efficient, economical and reliable power supply", and "facilitating the orderly planning of the region's power system". The Act also established the Northwest Power and Conservation Council to facilitate meeting these goals.

Deregulation in the mid 1990s led to concerns that energy efficiency efforts would be deemed "stranded assets" and utilities would not be able to recover program costs. Regional discussions lead to the formation of the Northwest Energy Efficiency Alliance (NEEA) as a non-profit organization funded by utilities and BPA to promote energy efficiency and market transformation.

Under Washington State's *Energy Independence Act* of 2006 voters approved the *Initiative 937* (I-937) requiring utilities who serve 25,000 or more customers to set and meet conservation targets. The initiative states that qualifying utilities are to use methods consistent with those used by the Northwest Power and Conservation Council to identify achievable and cost-effective conservation potential over the next ten years. It also calls for these estimates to be updated every 2 years.

At the federal level the *Energy Independence and Security Act of 2007* set several new standards that promote energy efficiency and renewable resources. Among these are new standards for lighting as well as residential and commercial appliance standards.

According to the Northwest Power and Conservation Council's 6th Power Plan the region has saved just shy of 4,000 average megawatts from the first estimated energy efficiency efforts through 2008. They further explain that this effort amounts to $1.8 billion in savings for the consumer. And they estimate another 6,000 to 7,000 MWa of energy can be saved over the course of the next 20 years.

In 2009 the country prepared for possible federal climate change legislation through a proposed emissions trading bill which would create a new niche for demand-sided management. Although this particular bill did not pass, the national momentum exists for climate change legislation in the near future. These events and the dynamic energy resources mix in the Northwest have spurred great energy savings. The effort utilities are exhibiting today is unparalleled in our region's history.

Efforts

The list below illustrates the variety of forms demand-side management efforts can take. Each form reflects a unique level of involvement from customers and the electric utility, as well as other entities. Definitions and examples are included to clarify each form of demand-side management for this paper, although the meanings of some of these terms are not universally agreed upon. Utilities include a few or many of these forms of demand-side management in their resource plans depending on their needs and the availability and cost effectiveness of the program in their area.

- **Energy Efficiency** – A reduction in electrical power consumption as a result of increases in the efficiency of energy use, or production. In this paper the terms **conservation and energy efficiency are used interchangeably.**

- **Transmission and Distribution Efficiency** – Infrastructure upgrades to utilities' transmission and distribution systems that save energy by minimizing losses.
- **Market Transformation Efforts** – A strategic process of intervening in a market to accelerate the adoption of all cost-effective energy efficiency
- **Demand Response** – Control of demand through customer/utility agreements that result in a temporary change in consumers' use of electricity in times of system stress.
- **Fuel Conversion** – Consumers' efforts to make a permanent change from electricity to natural-gas or other fuel source to meet a specific energy need, such as residential heating.
- **Fuel Switching** – Consumers' efforts to make a temporary change from electricity to another fuel source to meet a specific energy need.
- **Energy Storage** – Technologies for changing energy into a form that is convenient for use at a later time when a specific energy demand is greater. Energy storage may take a variety of forms such as hydro pump-storage or batteries.

These efforts are often broken into sectors by customer type; residential, commercial, industrial and agricultural, each offering a unique opportunity for savings. And because the success of demand-side management often rests squarely on the shoulders of the customer, the opportunities for savings are as unique and diverse as each utility's customer base.

Terminology

There is a great deal of variability in defining and tracking demand-side management efforts and the terms we use to describe them have different interpretations in our region. Listed below are the terms and their meanings used in this paper to define the scope of demand-side management efforts.

<u>Measure</u> – A measure defines a particular method by which materials, equipment or activities result in energy savings. For example, wrapping a water heater is an energy efficiency measure. The duration over which the measure continues to save energy is the **measure life**.

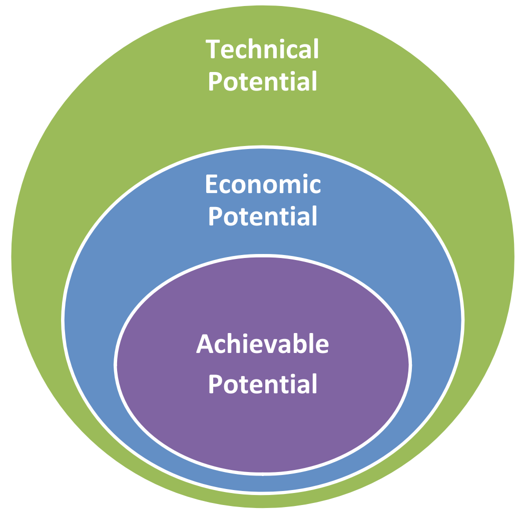
<u>Program</u> – A company's commitment to attaining energy savings from specific measures is an energy conservation program. For example, a utility may implement a program to wrap water heaters and invest in community outreach to attain these savings. This program has duration, or **program life**, over which the utility continues to attain new energy savings by wrapping more water heaters.

Challenges

To begin, accounting for demand-side management efforts require our best guess at estimating something that doesn't exist. We are estimating the amount of electricity we didn't use during a given time. Now that we have touched on this esoteric aspect, let's put the idea of measuring the-lack-of-athing aside and focus on the challenge of translating utilities' vast energy conservation efforts into something more tangible.

Demand-side resources come in many forms and offer savings that reflect their specific attributes, creating opportunities and challenges. The challenges have been divided into three categories; Estimating Potential, Achievability, and Tracking. These concepts highlight the inherent uncertainty in estimating, achieving and tracking energy savings and will help you frame the questions you need to ask to gain a sense of the role and benefits of demand-side efforts.

Estimating Potential



Layers of Potential – Regional entities use a variety of terms to describe the notion of the energy savings opportunities available in their area through demand-side management efforts. To get our arms around this, the three terms below describe how some entities view the layers of potential available savings.

- Technical potential savings are all energy savings available in an area.
- Economic potential are the savings available in an area that are cost-effective (see cost-effectiveness below).
- Achievable potential are all cost-effective energy savings that can be captured without running into other market barriers.

Evaluation – Evaluations are used to refine or confirm the planning assumptions for savings. They test the assumptions made in planning about how much saving can be captured from a measure when actually installed/implemented in the real world.

Cost Effectiveness – Demand-side management (i.e. energy efficiency and demand response) are assessed for cost-effectiveness to determine if the outcome warrants the cost. Considering that energy efficiency reduces the need for new generating resources and may offer carbon reductions it is often a cost-effective path for utilities to take to fill a need.

Not all entities determine the cost-effectiveness of a measure the same way. When the Council assesses cost-effectiveness for the 6th Power Plan they compare "all the costs of a measure with all of its benefits, regardless of who pays those costs or who receives the benefits." Others assess cost-effectiveness relative to the impact it has on their utility and ultimately their customers. For example, if achieving energy savings through a conservation measure is less expensive than having to purchase the energy on the wholesale market, the measure is deemed cost-effective.

Source of Savings Estimate – In the Northwest there are several entities that assess the potential energy savings from demand-side management.

- Electric power utilities – Many have departments for energy efficiency and other demand-side management efforts. They participate in every facet of the process including research and development, estimating energy savings, customer outreach, program implementation, tracking and much more.
- Northwest Power and Conservation Council – Developed a calculation to estimate a utility's share of conservation effort in the region based on load to assist utilities that do not have the resources to assess their own conservation. They do note, however, that the mix of available conservation opportunities is unique to each utility and vastly more complex than a simple ratio based on load.
- Regional Technical Forum – Members are appointed by the Northwest Power and Conservation Council and are tasked with developing standards to verify and evaluate conservation savings.
- Bonneville Power Administration – Has funding mechanisms in place that reimburse customers for qualifying energy efficiency efforts. The latest Energy Efficiency Implementation Manual developed in April of 2011 outlines a variety of ways to assess potential energy efficiency savings. These include deemed measures based on historic savings, custom programs tailored to take advantage of specific and non-deemed savings opportunities, and savings acquired through third parties, such as the Energy Trust of Oregon, who specialize in acquiring energy efficiency savings on the behalf of utilities and others.

<u>Time of Savings</u> – The time over which energy savings occurs can vary greatly from measure to measure creating yet another challenge for estimating and tracking demand-side management. Energy saving measures may be specific to a time of year. For example, a measure that upgrades irrigation pumps to gain efficiency may only save energy in the summer months. Some utilities capture the seasonal shape of their saving estimates and some do not. Resources that are controllable may be used to shave peak demand, while others may save energy day in and day out contributing to an average decrease in the need for energy.

Peak demand is becoming more important in our region, as are measures that provide a reduction in peak demand. Some measures that reduce average energy use also reduce peak demand. Others are designed specifically to reduce electricity consumption during times when the system is stressed. Some utilities' efforts capture these savings and others report that their programs obtain savings during peak hours, but the benefits are not tracked. An increase in wind generation in our region is prompting utilities to look into controllable resources that can be used toward balancing some of the fluctuations in wind.

<u>Forecasted Savings Based on Historic Demand</u> – Another complexity develops when forecasting conservation savings based on historic demand that may or may not include previously acquired conservation savings. If not for these past savings the demand would have been higher, which changes the potential savings available. In addition prior conservation efforts impact the potential measures that can be implemented today. How are historic savings treated in the forecast of demand?

Technologies – Some bright stars for future demand-side management are emerging technologies and although their potential is great we don't fully grasp what role they will play next week, or next decade. We also don't know the extent of customer involvement that will be required. A great example of this is Smart Grid. We all know the name, but we have yet to fully realize the extent of how it will be used and the savings it will provide.

Achievability

Geographic Availability – The potential to develop conservation programs and the associated resource costs are not evenly distributed across the region. There are many customer, environmental, technological and financial attributes in a given area that affect the success of conservation programs. In addition to the proportion of residential, commercial, industrial, and agricultural customers other factors influence the availability and feasibility of savings programs. These include geographic customer distribution, socioeconomic factors, resource costs, temperature variations and the mix of fuel types.

Customer Participation Risks – Customer participation is crucial and the amount of customer involvement required to achieve savings differs greatly amongst measures. Human behavior directly and indirectly impacts conservation penetration. Program participation ranges from replacing a light bulb which takes very little effort or money, to remodeling the heating system in your house. Participation, behavioral trends, legislation, and over all energy consumption all influence the amount of cost-effective conservation available for different measures.

Lost Opportunity – Some forms of energy efficiency can only be cost-effectively acquired during a specific window of opportunity. An example is a home built with materials that offer greater insulation than required by code. If not acted on during construction the opportunity to capture these savings is lost.

Ramp Rate – The speed at which a program is implemented over time determines the ramp rate. Typically programs that are cost effective and have few barriers have a high initial ramp rate. Changes in ramp rate can greatly affect the forecast of potential available savings for an area.

Customer Role – Many utilities and other regional entities have measures that target customer behavior, such as a plea to customers to turn off lights and televisions when not in use. This is termed behavioral conservation and it offers great possibilities and great uncertainty as it relies fully on customer's behavior change and is not a one-time event. It often requires the customer to repeat the energy saving action on a regular basis.

Energy Saved Depends on Energy Use –The amount of energy saved for a particular measure depends on how much energy is used. For example, a compact fluorescent light will save more energy when placed in a fixture that remains on all day and night than it will in a fixture that is only on for a few hours. This fact appears simple but adds yet another layer of complexity when accounting for energy that is not used.

Tracking

Tracking Programs over Time

- **Existing (historic) savings** – Programs that are already in place and the savings are ongoing (a water heater tank wrapped yesterday and the savings are felt today).
- **New savings from existing programs** – Programs that are in place, but the effort to capture the savings is still underway and new savings are being acquired (a new water heater tank wrapped tomorrow from yesterday's program).
- **New savings from new programs** – Planned programs that have yet to be implemented to capture the expected savings.

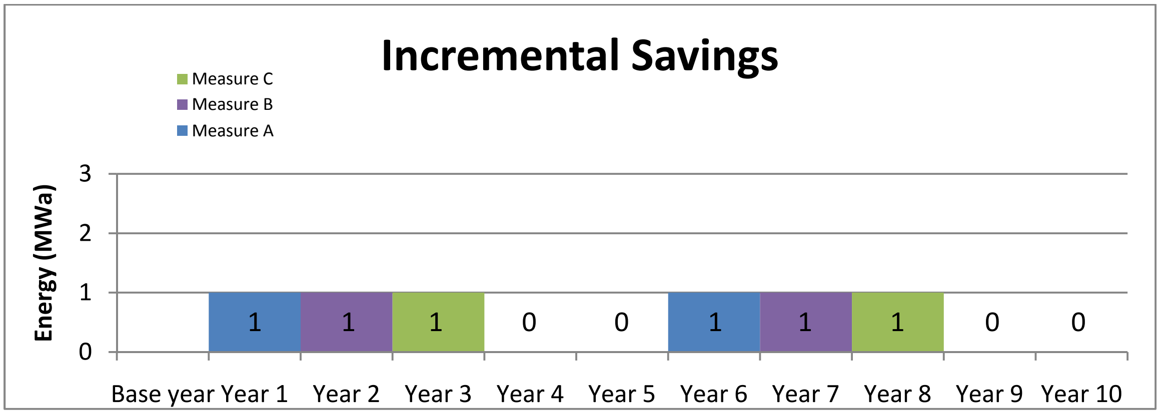
Base

- **Base year** – Established as the point of reference in time from which future year's savings will be estimated. A fixed base year compares gains in energy efficiency by year with the base year's condition. A sliding base year compares efficiency gains of each year to those of the previous year.
- **Baseline** – A historic level of assumed savings used as a reference point for estimating future savings. This starting point can be determined in a variety of ways and should be aligned before conservation comparisons can be made. Codes and standards may, or may not be included in the baseline. The implementation of a future code or standard may change the baseline.

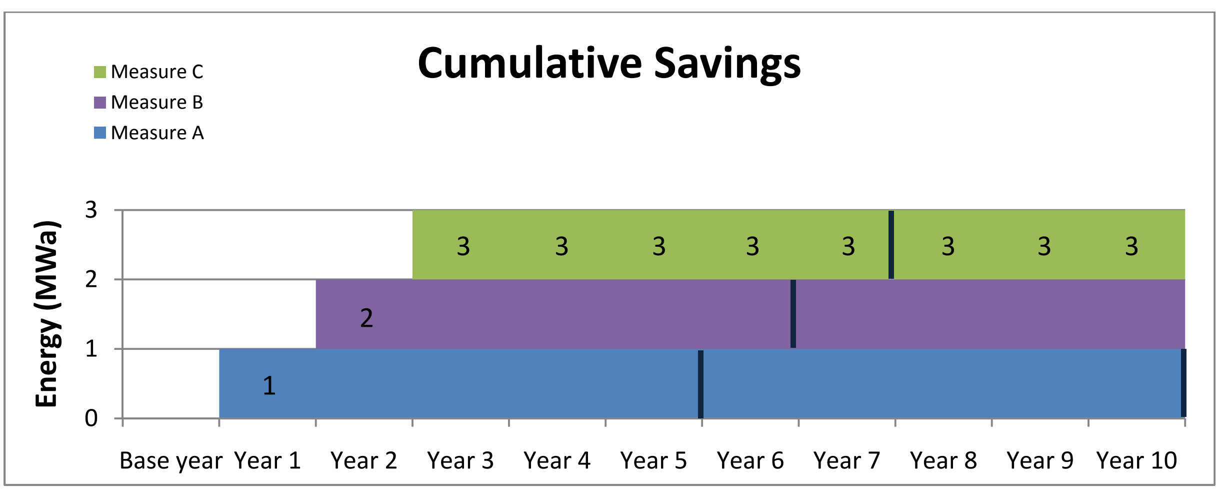
Persistence – Savings that extend beyond the life of a measure and do not require additional effort to recapture are said to persist. In some cases savings persist because the energy saving action is only available once, such as an energy efficient building material used in making a home. In other cases when it is time to recapture savings codes and standards may have increased the minimum efficiency available. For example if an old water heater that is wrapped breaks, it will be replaced with a newer model that is more efficient and doesn't have to be wrapped and the savings persist.

Incremental vs. Cumulative Savings – The varieties of measures that make up energy conservation have a wide range of attributes creating accounting challenges not encountered in any other types of power resource. Conservation must be handled carefully when adding savings estimates over time for long term planning. Consider the graphs below to illustrate incremental and cumulative savings over time as well as a potential double-counting pitfall. In these simplistic scenarios three conservation measures, each saving 1MWa per year and having a measure life of 5 years, are brought on-line in succession. In these scenarios, at the end of each 5 year measure life a new measure is implemented to recapture the savings.

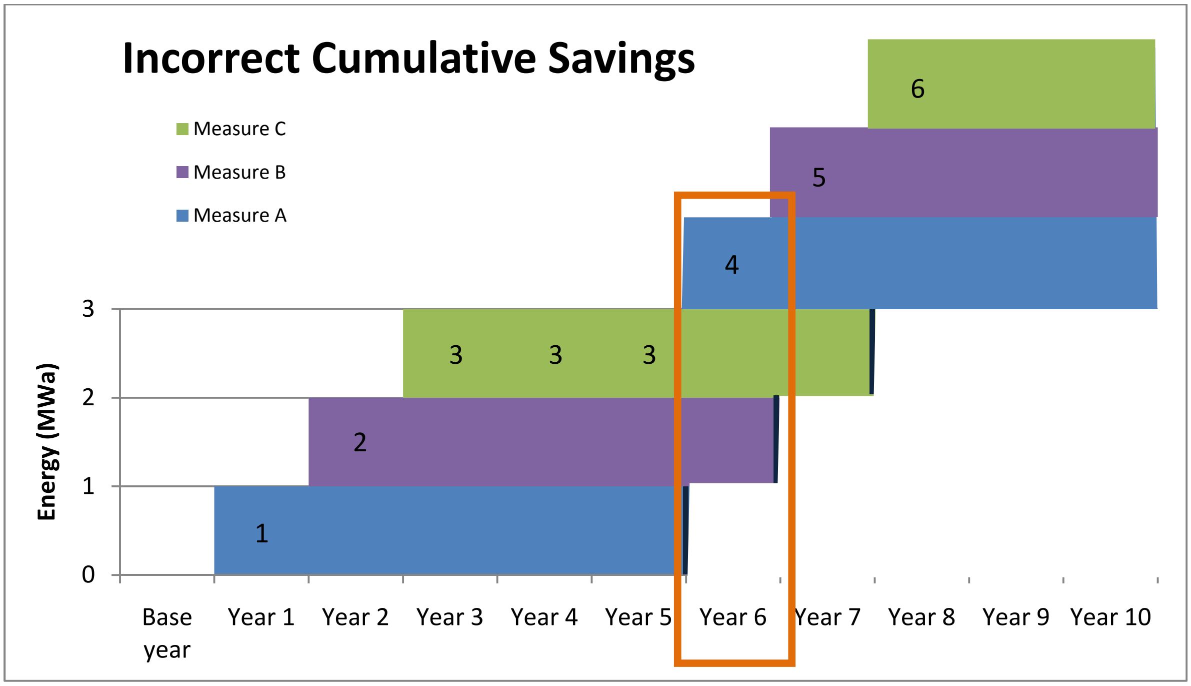
- **Incremental Savings** – The graph below illustrates energy conservation savings as an annual snapshot. This captures only the new savings increment acquired in first that a measure. Savings are reacquired at the end of the 5 year measure life.



- **Cumulative Savings** – The graph below illustrates the total average megawatts saved each year relative to the base year. This is simplified when a measure's savings are assumed to persist beyond the life of the measure and do not require future utility effort to recapture these savings. For example in year 6 the savings accounted for must either a) be reduced to reflect the end of the first segment of *Measure A* before the second segment starts, or b) include the savings from the continuation of A in the baseline to show a new level of historic savings before adding the next segment of *Measure A*. In this case each measure saves one average megawatt per year and the savings are accounted for as shown below.



- **Caution:** If the measure savings do not persist and must be recaptured the baseline savings must be adjusted to incorporate the initial savings before beginning the next segment. There is **potential for double counting** beginning in year 6 and beyond as the measures are re-established. If not accounted for correctly the savings could be misconstrued as shown by the 4MWa in year 6 below.



Questions to ask include the following. What savings are included in the baseline? What point in time do the savings estimates begin (base year)? Do measures persist through time? How are price affects handled? Is the savings measured from the customer side or the generation side?

Deemed Measure – A measure for which energy savings can be estimated on a per-unit basis stemming from a history of measured results and an ability to replicate energy savings.

Site Savings – When tallying energy efficiency the amount of power saved is relative to location. Energy savings counted at the point of consumption is comprised of the energy that would have been consumed if not for the conservation effort. When measured at the point of generation, however, the savings is larger. It includes the energy saved at the consumer end as well as the energy that would have been lost through transmission.

Monitoring and Verification – Many entities around the region participate individually in monitoring and verification of demand-side management measures. The goal is to line up the estimated savings with actual benefits that are realized from the measures.

Accounting for Codes and Standards – Building codes and appliance efficiency standards present a unique opportunity to capture a bulk of energy savings in a behind-the-scenes way that doesn't require a consumer's active participation. **Building codes and appliance standards** establish a minimum level of energy efficiency for a building practice or material or for electrical appliances. They are enacted at the federal or state level. Accounting for these savings presents a challenge, particularly when many entities play a role in the adoption of a new code or standard. When a utility effort drives the adoption of a code or standard how are the utilities' commitments of time, effort and money accounted for?

Key Northwest Players

Energy conservation is promoted in a variety of ways and through many entities. The success of this resource is dependent on customers and regional entities. Below are some of the key participants in our region's energy savings efforts.

Bonneville Power Administration

- Collects funds from its public utility customers to be used for conservation, oversees utility conservation efforts and allocates reimbursement of funds to utilities for programs that meet "the full set of requirements necessary for reimbursement"

Consumers - Industrial, Commercial and Residential

- Customer participation is essential
- Affects all demand side aspects of energy efficiency including achievable savings, ramp rate, and penetration rate
- Some efforts are tailored around savings opportunities specific to each business

Electric Utilities

- Utility conducted programs to capture savings including energy efficiency and demand side management
- Utility funded conservation efforts carried out through a third party entity

Energy Trust of Oregon

- Implements energy efficiency and conservation programs on behalf of the independently owned electric and gas utilities in Oregon
- Non-profit organization funded by electric utility customers through their utility bill

Federal Regulation

- Establishes federally regulated appliance efficiency standard
- Creates federal incentive programs

Non-Participants

- Savings that occurs from customers that adopt conservation savings outside of a specific conservation program. These savings are not captured through or funded by utility or regulatory agency programs.

Northwest Energy Efficiency Alliance (NEEA)

- Creates energy savings through market transformation by promoting behavior changes on both the customer side and the supply side
- Funds training and support for building code compliance

Northwest Power and Conservation Council

- **Regional Technical Forum (RTF)** – assesses energy conservation measures and establishes standardized methods for achieving the conservation savings
- Promotes Codes and standards at the federal level
- **Power Plan** – Estimates regional target for conservation savings

State Entities

- Establishes state regulated appliance efficiency standards
- Sets energy codes and standard for public buildings
- Creates state incentive program

Bibliography

1. Bonneville Power Administration (BPA), Energy Efficiency Implementation Manual, April 2011, (166 pages)

2. Congressional Resource Service (Report for Congress), Energy Independence and Security Act of 2007: A Summary of Major Provisions, December 2007 (27 pages)

3. North Carolina State University – website, Database of State Incentives for Renewables & Efficiencies (DSIRE). http://www.dsireusa.org/Index.cfm?RE=0&EE=1

4. Northwest Energy Efficiency Alliance (NEEA), Market Transformation and the Northwest Energy Efficiency Alliance – A Brief History, March 2008, (10 pages)

5. Northwest Power and Conservation Council, Sixth Northwest Conservation and Electric Power Plan, February, 2010 (314 pages)

6. Pacific Northwest Electric Power Planning and Conservation Act, December 1980, (58 pages)

7. Regional Technical Forum (RTF), Charter of the Regional Technical Forum of the Pacific Northwest Electric Power and Conservation Planning Council, 1995, (11 pages)

8. State of Washington, Community – Trade and Economic Development, 2008 Washington State Utility Resource Plans, December 2008 (95 pages)

9. U.S. Energy Information Administration (EIA), Annual Electric Power Industry Report – Form EIA-861, 2007 (12 pages)