NW Energy Coalition

Efficiency Works!

The Power of Efficiency:

Pacific Northwest Energy Conservation Potential Through 2020

April 2009

The NW Energy Coalition is an alliance of more than 100 environmental, civic, and human service organizations, progressive utilities, and businesses in Oregon, Washington, Idaho, Montana, Alaska and British Columbia. We promote development of renewable energy and energy conservation, consumer protection, low-income energy assistance, and fish and wildlife restoration on the Columbia and Snake rivers.

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Overview

Energy efficiency can and will play an increasingly critical role in the region's efforts to meet growing energy needs and reduce greenhouse gas emissions (GHG). However, current energy efficiency efforts are not capturing all the available cost effective conservation. Instead, the region requires more aggressive conservation policies and targets that encompass load growth planning ***and*** help mitigate climate change.

The NW Energy Coalition in 2008 launched an energy efficiency campaign called *Efficiency Works!* to make cost effective electricity and natural gas savings the region's No. 1 strategy for reducing greenhouse gas emissions from the utility sector and ensuring we meet future demand without costly, climate-polluting fossil fuel power plants. The Coalition contracted with Ecotope, Inc. to assess the region's potential for meeting load growth through 2020 while significantly reducing greenhouse gas emissions. The key findings of this report are:

- **With new and emerging technologies and more integrated building design, there is enough cost effective energy efficiency – approximately 5,200 average megawatts - to meet all the region's growing needs for electricity through 2020.** Technologies included in this analysis include LED and advanced lighting technologies which will become cost effective within the decade, high efficiency variable speed heat pumps only recently introduced from Asia and integrated design approaches to building design and ventilation.
- **Using a well-established levelized cost number for natural gas ($0.80/therm) there is enough cost-effective end-use natural gas energy efficiency to meet about half of projected growth through 2020.** Most of these savings occur through more extensive weatherization programs, more efficient domestic water heaters and--in the commercial sector--integrated building design that result in measures such as improved ventilation system management using CO_2 sensors.
- With the addition of a $50/ton carbon adder – well within the range of $16 - $64 per ton of CO_2 assumed by such regional processes as the Western Climate Initiative – cost-effective electric energy conservation potential is increased by 20% to an excess of 6,000 average megawatts. This has the effect of meeting all the region's load growth and creates the opportunity to address other policy priorities such as cutting back on certain high carbon producing generators or replacing the energy forgone by the removal of selected dams for salmon survival.
- Using a slightly higher carbon adder for natural gas - $57/ton – increases the available conservation potential for natural gas only slightly, only an additional 40 million therms. Total natural gas load growth through 2020 is projected at 1 billion therms.
- Increased energy efficiency does far more for the region than provide an affordable, clean energy future. It also stimulates job growth, keeps local dollars in the region and often also conserves water.

Investing in energy efficiency is a win-win strategy to address climate change in the Pacific Northwest. These investments can act as a catalyst for progress on the interdependent issues of economic development, energy security, and climate protection.

Introduction

Over the past 30 years, energy efficiency has proven to be a low-cost, low-risk investment for meeting the region's growing demand for electricity and avoiding the need to build costly new generating resources. Since 1978, regional energy efficiency measures have produced nearly 3,700 aMW of savings – more than enough to meet the needs of three cities the size of Seattle. It would take approximately six to seven coal plants to produce an equivalent amount of energy (NPCC, 2007).

Traditionally, energy efficiency targets in the region have focused on meeting a portion of the region's load growth. This report looks at the potential for energy efficiency to meet all load growth through 2020, boosting the economy as well as substantially reducing GHG emissions.

Electricity and natural gas use continues to grow. For example, without more energy conservation than currently planned, regional electric load growth from 2005 through 2025 is projected to be 1.36% per year[1]. (NPCC 2005) The growth rate for natural gas end-uses is even greater: through 2012 and beyond, it is projected to grow by an annual average rate of 1.9%.

With growing energy use, greenhouse gas emissions also rise. Regional policy makers at all levels have established aggressive targets for reducing GHG emissions. For example, the Western Climate Initiative sets a medium-term goal of 15% below 2005 levels by 2020 (WCI 2008). Meeting these goals will require the region to fundamentally recalibrate energy efficiency targets.

For the purposes of this analysis, the WCI 2015 and 2020 emission targets are used as a starting point to determine the load reductions necessary to meet the GHG reduction targets in the Pacific Northwest and to assess energy efficiency as the number one resource for achieving these load reductions. As a base case for the analysis, the current electric energy efficiency potential was summarized from the Northwest Power and Conservation Council's Fifth Plan (NPCC 2005) and an aggregate of current natural gas potential was developed from the region's six largest natural gas utilities.

To assess optimized regional energy efficiency potential the analysis was developed based on:

- New technologies not accounted for in current plans;
- the anticipated increasing cost of carbon;
- distribution system efficiencies; and,
- other factors that increase the technical and cost-effective potential of energy efficiency.

The report also summarizes regional assessments of combined heat and power (CHP), Smart Grid technologies, and additional benefits such as job creation and non-energy savings associated with energy efficiency.

[1] The current economic downturn may reduce near-term forecasts but overall the growth level in the Pacific Northwest is likely to be consistent over the longer term of this analysis.

Growing Regional Energy Use: Electricity and Natural Gas

Over the near (5+ years) and mid (10-15 years) term, the Pacific Northwest is projected to experience increasing demand for both electricity and natural gas. Electric load growth from 2005 through 2025 is projected to be 1.36% annually (NPCC 2005) above the 120 – 140 aMW of efficiency acquired per year as assumed in the Council's 5th Plan. Increases have not been uniform, however, with some parts of the region, such as southern Idaho, having recently undergone expanded growth. Through 2015, Idaho electric demand is expected to increase 1.87% annually (Idaho Energy Plan 2007) while other parts of the Northwest are growing at slower rates.

For the time frame between 2000 and 2025 electricity use is projected to increase as follows: (NPCC 2005):

- Western Oregon and Washington west of the Cascades – 1.06%
- Eastern Oregon, Washington and Northern Idaho – 0.42%
- Southern Idaho – 1.5%
- Montana (PNW portion)[2] – 0.63%

Although the closing of most of the region's aluminum smelters since 2001 slowed load growth, the increasing demand illustrated above reflects increases in commercial sector employment and residential population levels. (NPCC 5th Power Plan Biennial Report, 2007).

Natural gas end use demand is expected to grow at an annual average rate of 1.9% through 2012 and beyond.[3] The differences in regional distribution are somewhat more pronounced compared to the electric growth. For example, Intermountain Gas, serving southern Idaho is experiencing and projecting 5% annual growth through 2012 (Intermountain Gas 2008; Idaho Energy Plan 2007). In contrast, Puget Sound Energy, mainly serving the Puget Sound region, is expecting 1.5% demand growth through 2025 (PSE 2007) primarily due to an expanding economy and population as well as fuel switching in the residential sector (NWGA 2007). Newly constructed houses are increasingly built with natural gas space and water heat while existing houses are switching from electric to gas equipment.

The current economic downturn may reduce the near-term forecasts but, absent increased energy efficiency, the overall growth level in the Pacific Northwest is likely to be consistent with projections for both electricity and natural gas.

The trend of increasing demand for both electricity and natural gas is depicted in Figure 1. The graph adds back in the 5th Plan's energy efficiency acquisitions of 120 – 140 aMW per years, so the rate of growth is larger by that amount than the 1.36% referenced above. It is important to note that the bars in the graph are not at equal time steps but instead provide

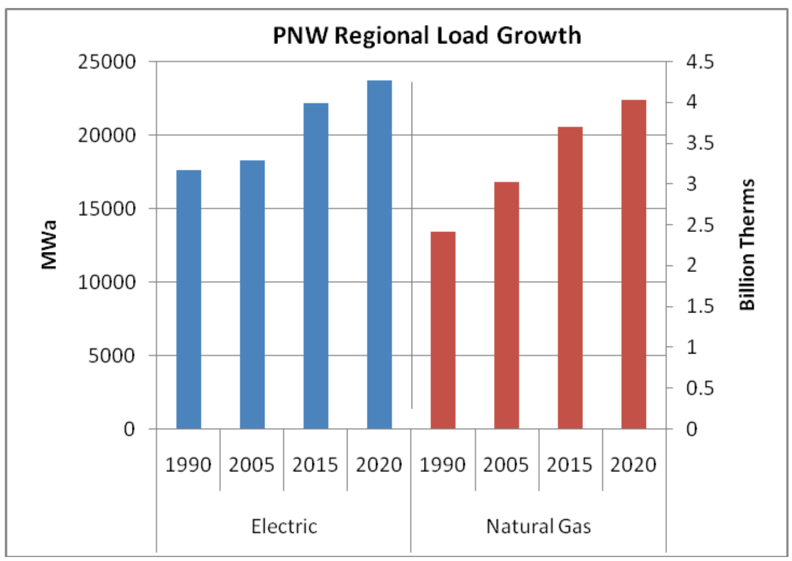
[2] This planning area is served primarily by NorthWestern Energy and several rural electric cooperatives. The NPCC uses this area to develop their power plans.

[3] Calculated from six natural gas IRPs and the Northwest Gas Association 2007 Outlook.

snapshots for the years discussed in this report. Of note is the smaller increase in electric demand from 1990 to 2005. This is explained by several factors:

- The high prices during the Western energy crisis of 2000-2001 curtailed demand for an otherwise increasing load. In particular, industrial users were impacted more heavily than other sectors.
- Industrial gas consumption was lower in 2005 over 2000 due to price increases.
- More expensive gas and electricity resulted in some facilities implementing energy conservation measures and the closure of others, thus permanently changing the region's industrial natural gas use base (NWGA 2007).
- The addition of a mild recession in 2001-2002 also kept demand lower (NPCC Biennial Report, 2007). Combined with higher prices, this resulted in overall lower growth from 1990 to 2005 than had been expected.

Figure 1: Pacific Northwest Regional Electric and Natural Gas Load Growth

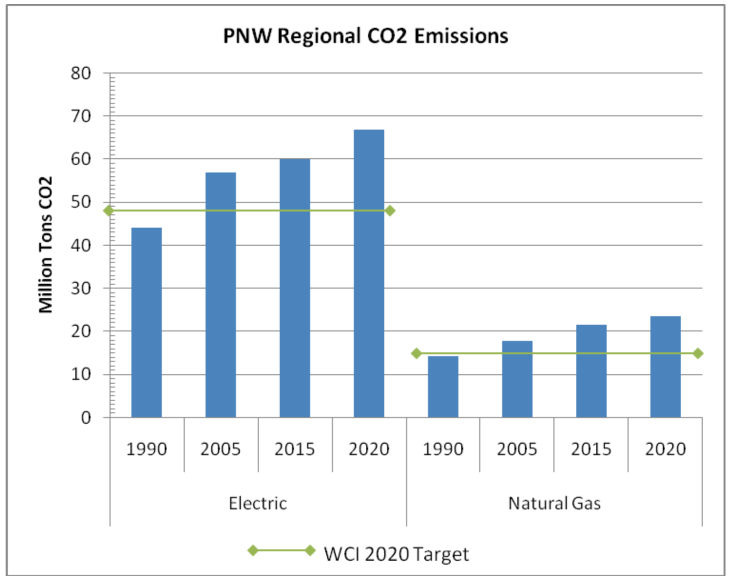


Source: Ecotope, Inc. 2008

Growing Regional GHG Emissions

Continuing at its current pace, in the absence of increased energy efficiency, the region's electricity and natural gas use will produce more greenhouse gas emissions. The amount of CO_2 emissions due to electricity generation and gas end use is shown in Figure 2. While the portion due to natural gas is smaller than electricity, it is growing more rapidly. For example, Figure 2 shows 2015 natural gas CO_2 emissions will be 53% above 1990 levels and 2020 emissions will be 67% above. In contrast, electricity generation emissions will be 36% above 1990 levels in 2015 and 52% above in 2020.

Figure 2: Pacific Northwest Regional Electric and Natural Gas CO_2 Emissions



Source: Ecotope, Inc. 2008

The growing load and emissions become a considerable issue when viewed against the plans made by various local, state, regional, and federal entities to meet the climate change challenge. At the state level, both Oregon's and Washington's legislatures have mandated goals for reducing GHG emissions and Montana's Climate Action Plan includes a recommended goal. Oregon's goal is the most aggressive, setting a target of 10% below 1990 levels by 2020. Washington is targeting 1990 levels by 2020 – the same level recommended in Montana's plan. Many municipalities and counties have their own targets. To address climate on a larger scale, the Western Climate Initiative, consisting of 11 member states and provinces, including Montana, Washington, and Oregon, set a target of reducing GHG emissions to 15% below 2005 levels by 2020. Idaho is currently an observer to the WCI, but not a participant.

The WCI states are proposing a regional cap-and-trade program that sets a cap on total GHG emissions. The cap is reduced periodically until the 2020 level is met.. Market forces then act to redistribute emission allowances to achieve reductions in the most cost-effective way. The end result for utilities will be an effective price to continue to emit CO_2. The WCI target is shown in Figure 2 for both electricity and natural gas. To help meet the electric sector emissions target, the region will need to at least meet load growth through energy efficiency. To reduce emissions associated with natural gas end uses, the most cost effective option is to use less of it through energy efficiency.

Role of Energy Efficiency in Reducing Emissions

Load Growth and Emissions

The electric and natural gas projections in the figures above clearly show the relationship between load growth and increasing emissions. At a point where most of the region is taking on the challenge of reducing emissions to at least 15% below 2005 levels by 2020, load growth is projected to make this challenge much more difficult. Instead of decreasing, Pacific Northwest utility sector emissions are projected to actually increase by nearly 15.9 million tons between 2005 and 2020. Clearly a "business-as-usual" approach including current electric energy conservation targets and plans for adding renewable resources will not prevent *increases* in regional CO_2 emissions, let alone meet the WCI goals.

In 2007, the Northwest Power and Conservation Council (NPCC) calculated the carbon footprint of the Northwest Power System and analyzed several scenarios to determine alternatives for meeting the emission reduction targets of the WCI and the states of Washington and Oregon (NPCC Carbon Footprint, 2007). These scenarios included the recommended resource portfolio of the 5th Power Plan (base case), a low-conservation scenario where base case conservation targets are not met, and a high-renewables scenario based on state renewable energy portfolio standards. Table 1 presents the potential emissions for each of the three scenarios.

Table 1: Projected CO_2 Production and Effects of Alternative Scenarios

Scenarios	Forecast 2024 Emission Rates ($MMtCO_2$)	Change from Base Case
Base Case (5th Power Plan Portfolio)	67	N/A
Low Conservation	71	+4.4
High Renewables	63	-4.2
Source: Adapted from NPCC Carbon Footprint 2007		

The key findings of the NPCC study indicated that although current rates of conservation programs and renewable portfolio standards mandating acquisition of low carbon resources may help reduce CO_2 emissions, it is unlikely that these activities will maintain current levels of emissions, let alone reduce them to the levels outlined in current climate policies. To put this in perspective, the NPCC estimates that the 2024 forecasted regional CO_2 emissions under the base case scenario will exceed 1990 levels by an amount of CO_2 equivalent to eight typical coal-fired plants. Further, adding significant levels of renewables only reduces emissions by 4.2 million tons of CO_2 by 2024, compared to the 17 million ton reduction necessary to meet the WCI target by 2020, a difference of 12.6 million tons of CO_2.

The gap between natural gas emissions and targets is similarly divergent. Current natural gas end use emissions are projected at 23.5 million tons of CO_2 in 2020, 8.5 million tons greater than the WCI target of approximately 15 million tons.

The NPCC carbon footprint study underlines the need to significantly accelerate regional energy efficiency measures to reduce load growth and thereby reduce CO_2 production from generating resources. Recent national and global assessments of energy demand also point to the critical role that energy efficiency will play in making steep cuts in global energy demand, and thereby global emissions. A 2007 McKinsey Global Institute report projects that by using energy more productively we could cut growth in global energy demand by 50%. On a national level the US could reduce GHG emissions by 7 to 28% below 2005 levels (McKinsey 2008).

The Western Governor's Association's Energy Efficiency Task Force conducted an independent analysis to assess the potential electricity savings of aggressive energy efficiency efforts in Western states (WGA 2006). While recognizing that some Western states are already making serious efficiency gains through utility conservation programs, building energy codes, tax credits, etc., the study determined that more can and should be done. According to the study, adopting "best practice" energy efficiency policies and programs in all western states could:

- eliminate 75% of projected load growth during 2005-2020;
- reduce overall electricity consumption in 2020 by 20% relative to a scenario without energy efficiency initiatives; and,
- yield tremendous economic and environmental benefits.

In June of 2006 the WGA adopted a resolution based on the recommendations of the study to develop an additional 30,000 megawatts of clean energy by 2015; increase energy efficiency 20 percent by 2020; and ensure secure, reliable transmission for the next 25 years.

The Role of Energy Efficiency in Meeting Climate Goals

Due to a high proportion of hydropower and newly added wind power and other non-hydro renewable resources, the overall carbon intensity of the Pacific Northwest power system is much lower than the overall Western Interconnected Power System—0.52 lb/kWh vs. 0.90 lb/kWh in 2005 (NPCC Carbon Footprint, 2007). However, in 2006 a full 30% of the regional electrical generation source fuel is carbon based (coal and natural gas). Figure 3 presents the region's current electrical generation source fuel.[4] Since the region has

Figure 3: 2006 Pacific Northwest Electrical Generation

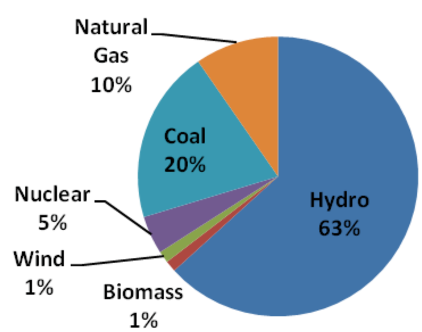
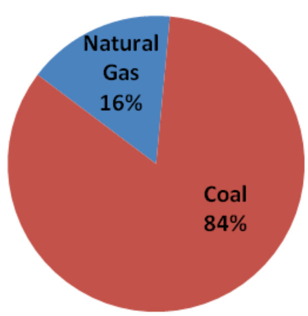


Figure 4: 2006 Pacific Northwest Electrical Generation CO_2 Emissions



[4] http://www.nwcouncil.org/energy/powersupply/Existing%20Projects%20101008_web.xls

already tapped hydro resources, new electric load growth is met at the margin of our resource mix that is partly carbon based, hence efficiency gains directly impact emissions.

Although coal represents only 20% of regional generation in 2006, it accounts for 84% of the total CO_2 emissions (See Figure 4). The cost of carbon emissions facing utilities in the future will likely make coal too expensive, thus favoring wind turbine and natural gas plant construction. Energy efficiency will supplant the most expensive source of energy – meaning that energy efficiency gains can be used to take current coal fired power plants offline only if a high enough price (≈$50/ton) for carbon is imposed. Otherwise, energy efficiency will supplant cleaner natural gas, which would likely be the highest cost resource absent carbon pricing. Removing coal first – the most polluting resources first – is the quickest way toward reaching emission targets.

Energy Efficiency Helps Keep Future Costs Down

Energy efficiency is integral to the economic aspect of the climate stabilization puzzle. Energy efficiency has long been the least-cost energy resource, especially when compared to new generating resources (both carbon based and renewable based). Energy efficiency will save consumers money and in addition, by altering the demand-supply balance, energy efficiency can stabilize energy prices and serve to offset higher energy prices resulting from a cap-and-trade system. The Western Climate Initiative anticipates that complementary policies (e.g., energy efficiency programs, codes that require energy efficient buildings, and a carbon tax) will enable participant states to meet GHG reduction targets at a net cost savings (WCI 2008). In all cases, more efficient energy use helps protect customers of the region's utilities from the volatility of energy costs, while protecting the utilities from the volatility of future fuel costs.

Once CO_2 is regulated, it is highly probable that the costs of GHG abatement will increase over time. Fortunately, energy efficiency resources can be leveraged relatively quickly. This will reduce upward pressure on electric rates and provide efficiency benefits to all utility customers.

Like any energy resource, efficiency requires investment to achieve. Good program design can help maximize the long-term benefits of conservation investments and thus minimize any utility rate increases required to implement the efficiency program. To illustrate: it costs much more to retrofit existing buildings than to build efficiency gains into buildings during the design and construction phase. These "lost opportunities" increase the cost of GHG mitigation. As a result, state climate action plans are counting on energy efficiency, stricter building codes, and standards to achieve at least a third of their GHG reductions.

Pacific Northwest Energy Efficiency – Past, Present and Future

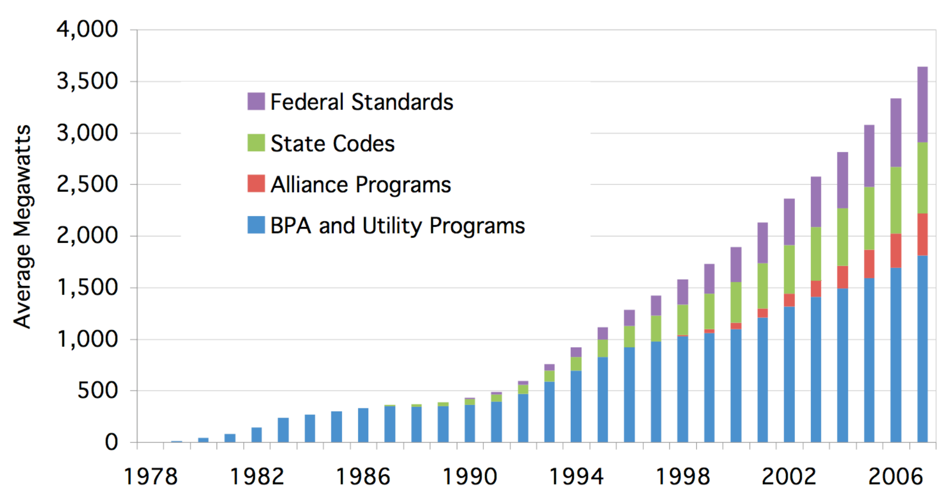
The Track Record

The Pacific Northwest has a long and successful track record of growing its economy with less electricity. As illustrated in Figure 5, since 1978 the Pacific Northwest has produced almost 3,700 aMW of energy savings -- about half of regional load growth -- through a combination of Bonneville Power Administration and utility programs, market transformation programs, state energy codes, and federal efficiency standards (NPCC RTF presentation, 2008). These efficiency gains saved the region's consumers nearly $1.6 billion in 2007 and lowered the region's carbon emissions by an estimated 14.1 million tons (NPCC Presentation to NEEA Task Force, 2008).

In contrast to electricity conservation, end-use natural gas efficiency efforts are a relatively new area of focus for combined and gas-only utilities, so the region has far less experience and data upon which to base projections for future gas savings. However, early efforts have produced promising results. For instance, residential and commercial natural gas consumption was 1.5% lower in 2005 than in 2000 despite a 13% increase in the number of customers. The reduced usage per-person reflects improvements in appliance efficiency, conservation measures, and improved codes and standards (NWGA 2007).

Figure 5: Pacific Northwest Energy Efficiency Achievements

(Electric Power Sector)

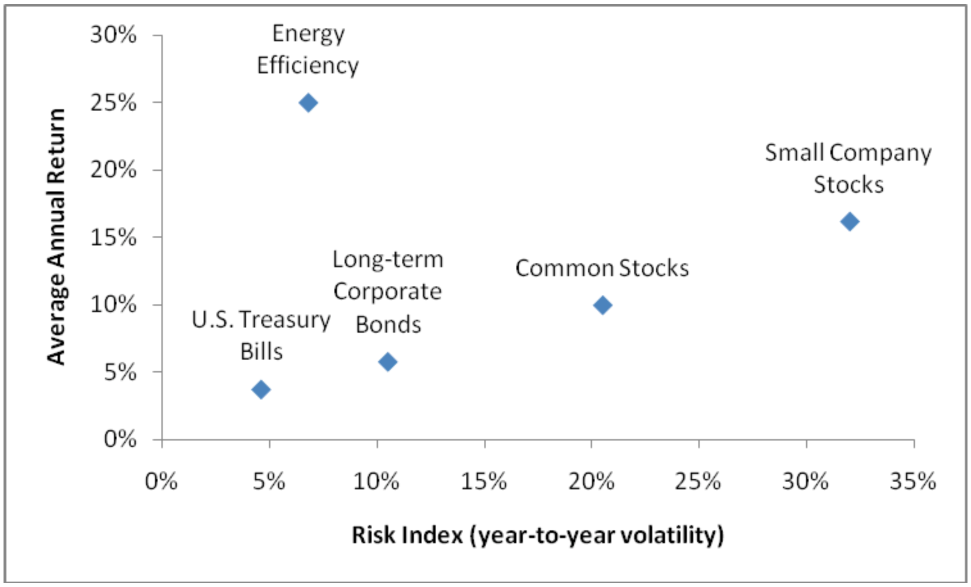


Investments in energy efficiency reside at an advantageous intersection of low-risk and high return. Figure 6 illustrates the investment risks and returns of energy efficiency compared to other investments such as stocks, U.S. T-Bills, and long-term corporate bonds. For instance, a 2006 modeling study on natural gas prices in the Pacific West[5] by the ACEEE shows a net payback in five years of investments in both electric and natural gas conservation measures.

[5] Washington, Oregon, and California

Interestingly, efficiency measures aimed at electric use not only lower electricity demand and cost, but also provide additional benefit to the market price of natural gas by reducing the electric generation using gas as a feedstock (Prindle 2006). Efficiency investments are increasingly beneficial to insulate businesses and consumers from volatile gas markets and climbing gas prices. Note that average U.S. wellhead prices have more than doubled from a low of $2.95 per 1000 cubic feet in 2002 to $7.33 in 2005 (EIA 2008).

Figure 6: Efficiency Investment Risks and Returns



Source: ACEEE 2008

Current Plans for Regional Energy Efficiency

In this section, current regional electric and natural gas assessments are summarized based on the 5th Power Plan and an aggregate of recent natural gas Integrated Resource Plans (IRPs). The following section explores how current estimates can be augmented and defines an optimized level of efficiency gains relevant to projected increases in demand and emissions.

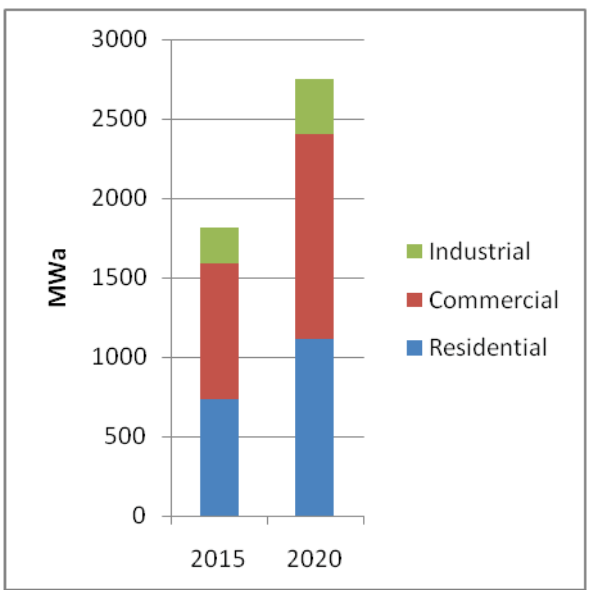
The amount of energy use that conservation can replace is quantified as the energy efficiency potential. There are three versions of this quantity: technical, achievable, and economic.

- **Technical potential** represents the total energy savings that can be accomplished without the influence of market barriers (cost and others) and customer awareness. Technical potential comprises all of the different technologies and programs that exist to reduce energy use. Technical potential is also forecast into the future in an attempt to account for new and emerging technologies.
- **Achievable potential** acts to decrease the amount of technical potential. The achievable potential accounts for gaps in market penetration of various measures. In its 5th Power Plan, the NPCC uses 85% of technical potential as the amount of achievable potential.
- **Economic potential** is the amount of achievable potential deemed cost-effective. This amount is set by the avoided cost of electricity or gas, among other factors. For gas, the avoided cost is mainly the wholesale cost at which utilities purchase gas

from a pipeline and the cost of its carbon emissions. However, in the utility IRPs reviewed for this report, different utilities used a range of cost assumptions from roughly $0.4/therm to $0.9/therm. The lower end of the range is consistently below the wholesale cost of gas resulting in an underestimation of the economic potential (EIA 2008) and includes no cost for carbon emissions. Recently, the Energy Trust of Oregon, which manages conservation programs for some Oregon gas utilities, raised its avoided cost to $0.8/therm, aligning more closely with current actual market prices. For electricity, the avoided cost is the cost to build and operate the new generating facility. This includes the price of construction and the expected cost of fuel in the case of gas or coal and associated emissions. The NPCC adds two other factors in calculating avoided costs. First, it applies a generic 10% adder, required by the Northwest Power Planning and Conservation Act (§3(4)), reflecting the non-quantifiable benefits of conservation vs. supply-side resources. Secondly, the Council raises the avoided cost to reflect the risk-mitigation value of conservation during higher-than-average-cost futures. Clearly then, the higher the avoided cost, the more economic conservation potential.

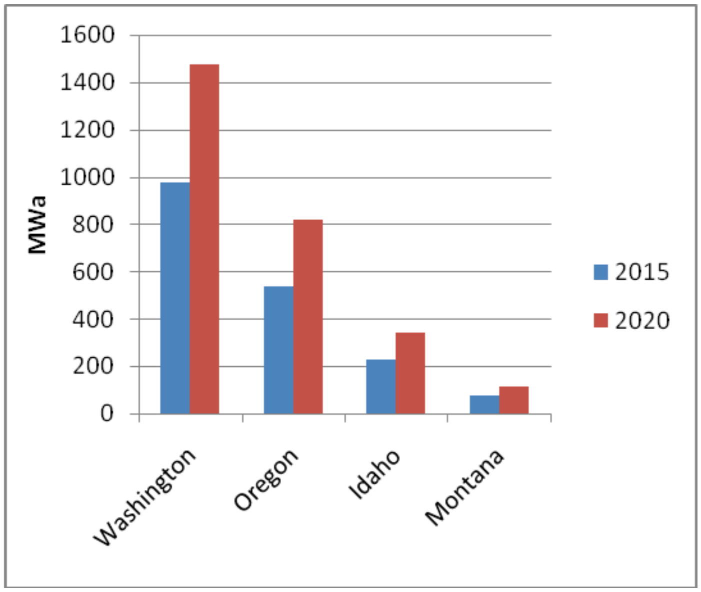
Figure 7 presents the regional base electric energy efficiency potential estimated in 2005 by the NPCC in the 5th Power Plan. Figure 8 presents similar information broken out by state.

Figure 7: Regional Base Electric Energy Efficiency Potential



Source: Ecotope, Inc. 2008

Figure 8: State Base Electric Energy Efficiency Potential



Source: Ecotope, Inc. 2008

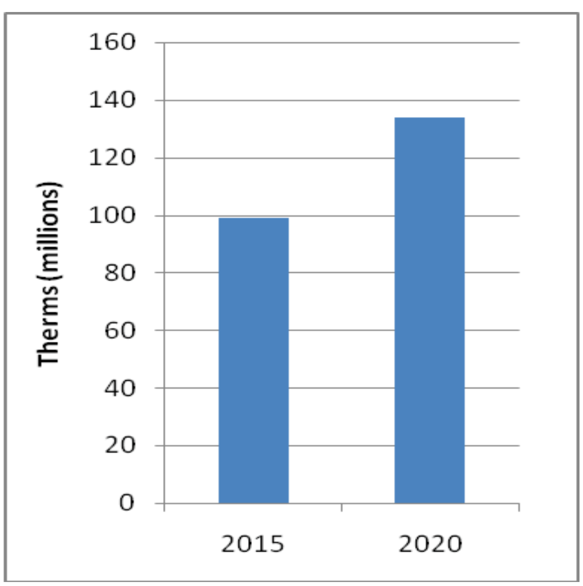
The 5th Power Plan identifies over 4,600 aMW of technical potential and about 2,500 aMW of achievable, cost-effective potential (NPCC 2005). The planning horizon for the 5th Power Plan was 2005-2025; the estimates presented in Figure 7 and Figure 8 are adjusted to align with the 2015 and 2020 emission targets used by the WCI.

Since the 5th Power Plan, the region as a whole has met these targets, with several utilities exceeding the targets by up to 25% (NPCC RTF Meeting, 2008). The additional conservation that has been achieved so far, above and beyond the NPCC's targets, demonstrates that a higher level of conservation is possible.

> "Considering all of the energy savings realized since 1977, Seattle City Light has saved over 7 billion kWh, which is enough electricity to power 340,000 homes for two years. In "nominal" dollars — dollars not adjusted for inflation — customer bill savings have totaled $245 million. (These) achievements are even more impressive given that Seattle's electricity rates are among the lowest in the country and therefore do not always give customers the strongest motivation to save energy."
>
> *Seattle City Light 2008-2012 Conservation Action Plan*

For natural gas, there are six major utilities, all investor-owned, which deliver the vast majority of gas to the region. They are: Cascade Natural Gas, Puget Sound Energy, Avista, Northwest Natural Gas, Intermountain Gas, and NorthWestern Energy. Unlike electricity generation there is no regional organization equivalent to the Northwest Power and Conservation Council to provide an overall picture of gas consumption and conservation. Instead, this report generates the overall picture by combining the relevant statistics from the six utility IRPs. (Note that gas transported to customers who purchased the gas on the open market and gas used to generate electricity are not included in the analysis.) **Error! Reference source not found.**9 shows the total regional natural gas efficiency potential as identified by the utilities in the region. The core customer demand in 2006 was approximately 3 billion Therms. Transportation to other customers brings the total regional consumption to 4.3 billion Therms.

Figure 9: Regional Base Natural Gas Efficiency Potential



Source: Ecotope, Inc. 2008

Energy Efficiency: Optimized Potential to Meet Load Growth Through 2020 and Reduce Emissions

The analysis conducted for this report demonstrates that greater levels of conservation in the Pacific Northwest are available and attainable. To provide more of the region's energy needs through conservation, this report proposes an optimized, more aggressive energy efficiency scenario to the current baseline plans — referred to in this report as the "optimized" scenario. The analysis to construct the optimized scenario consisted of:

1. Applying technologies and programs developed in various regional utility IRPs broadly across the region;
2. Accounting for new and emerging technologies; and,
3. Assessing the appropriate amount of money to devote to energy efficiency resources.

All three of these steps contribute significantly to the amount of conservation available.

Step one acknowledges that while there are numerous cost effective efficiency measures currently available to utilities, only a portion (sometimes a small portion) are being implemented. Some utilities have long-term, strong commitments to energy efficiency and thus more complete demand side management (DSM) programs, whereas others are only just beginning to implement pilot projects. Even though such conservation programs as low flow showerheads or compact florescent lighting are clearly cost effective to both utilities and customers and provide additional benefits including saving water, not every utility in the region has come close to fully implementing all of them. No new technology advancements need to be made beyond current measures for this step to be effective. Utilities need only to fully implement basic, proven programs. In particular, the natural gas utilities have been slow in implementing DSM programs. In addition, there has been little effort to acquire electricity-saving measures in homes heated with natural gas, except for a few dual-fuel utilities. The natural gas share of energy efficiency potential stands to benefit the most in this step. What is needed to realize this share of the savings potential is more effective marketing and program design to increase participation levels and help customers take advantage of savings opportunities. In addition, some states and local governments offer incentives and others do not. More consistency in offerings and promotion of these programs will greatly increase efficiency acquisition.

Step two takes the base case energy efficiency measures applied to the region as a whole and adds to them with new and emerging technologies. New technologies are ones currently on the market but those which have not yet been widely considered by planners as part of the available energy efficiency resource. They include LED and advanced lighting technologies which may not be cost effective for several years, high efficiency variable speed heat pumps only recently introduced from Asia, and integrated design approaches to building design and ventilation. Emerging technologies will introduce completely new products to the market, drastically improve on old ones, or reduce the price of current technologies. For instance, super insulating windows, with a U-value of 0.25 or less are an enormous improvement over current windows. Next, improvements to LEDs are expected to dramatically reduce the cost of this energy saving lighting technology in the next ten years and are currently being tested in the Pacific Northwest Laboratory facility in Portland under the USDOE Caliper Testing Program.

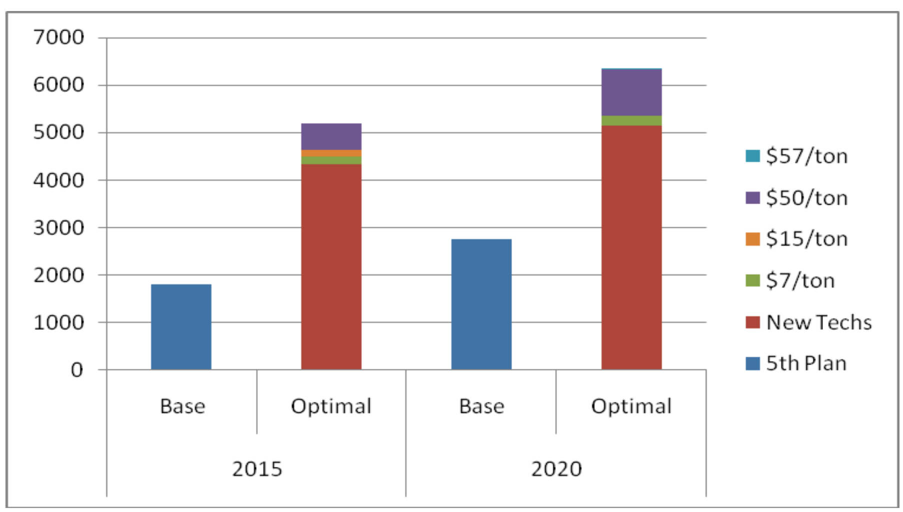
Part three of constructing the optimized scenario addresses the question of how much conservation is available for a given level of spending. The first two steps determine how much technical potential exists while this third step determines how much of it the region will seek to use. Traditionally, the dollar amount used is an avoided cost equivalent to acquiring a new electricity generating resource or acquiring more natural gas supply. The avoided cost is the fundamental economic quantity that utilities use to evaluate their programs. Ensuring that avoided costs accurately and fully reflect the financial risks of fossil fuel resources as well as all environmental externalities results in higher avoided costs – and increased economic energy efficiency potential. Currently, in a number of planning contexts (WCI, state, etc.), CO_2 emissions are being given a price. Adding this "carbon adder" to the avoided cost makes more energy efficiency cost effective.

Optimized Energy Efficiency Scenario

In this analysis, the methodology explained previously was used to develop an optimized energy efficiency scenario for the region to meet load growth and climate change mitigation targets. The figures in this section present scenarios for the electric and gas sector on both a regional and state level. The specific details used to arrive at these numbers are discussed further on in the report.

For the electric utility sector, accounting for new and emerging technologies made the largest changes. As depicted in Figure 10, the impact of these changes is to increase the conservation potential of the region in 2020 from approximately 2,500 a MW in the 5th Power Plan to approximately 5,200 – enough to meet the region's predicted load growth.[6] This conservation can be done through the implementation of new technologies and programs alone.

Figure 10: Regional Optimized Electric Efficiency Potential

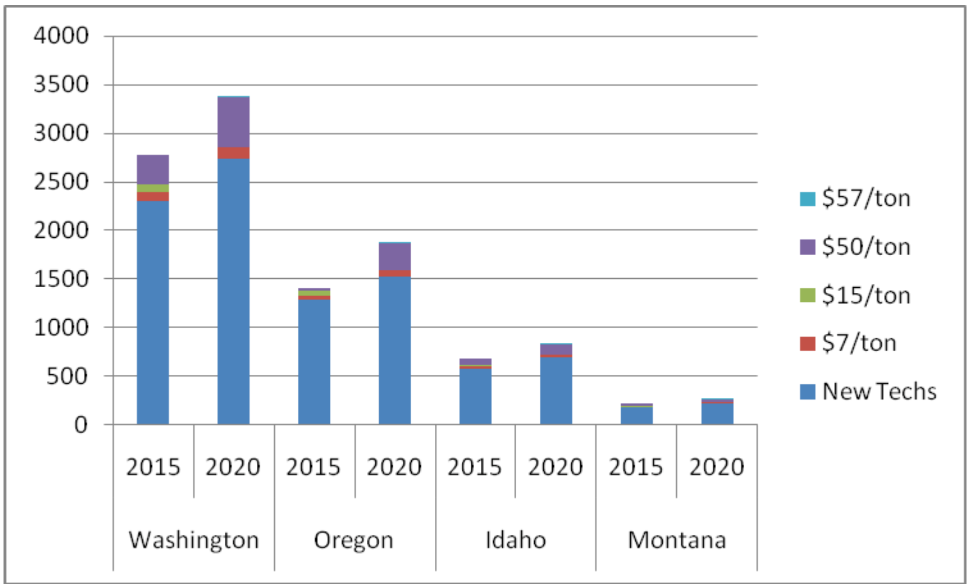


Source: Ecotope, Inc. 2008

[6] The analysis uses the 5th Power Plan's median load forecast. The base conservation (5th Plan levels) is included in the estimates. The "New Techs" bar in Figure 10 includes the conservation amount from the 5th Plan plus conservation from new technologies.

If, as suggested above, the financial risks associated with new fossil fuel generating resources are included in avoided costs in the form of a carbon adder, substantially more energy efficiency becomes cost effective as shown in Figure 10. With the addition of a $50/ton carbon adder, conservation potential is increased by an additional 20% to an excess of 6,000 aMW.[7] This would have the effect of meeting virtually all the load growth in the region, while creating the opportunity for the region to address other policy priorities, whether cutting back on certain high carbon generators or replacing the energy from dams removed for salmon survival. Figure 11 presents this optimized, more aggressive electric efficiency potential by state.

Figure 11: State-by-State Optimized Electric Efficiency Potential



Source: Ecotope, Inc. 2008

Placing a price on carbon emissions as is being done in the proposed regulatory and policy planning environment will have a positive effect on the amount of energy efficiency available to the region. A carbon adder acts to increase the cost of burning fossil fuels and hence the avoided cost. A higher avoided cost expands the pool of cost effective energy efficiency measures. The report considers three different carbon adders, a low cost case, a WCI forecast case, and a case setting the cost of carbon at a level high enough to reduce emissions to 15% below 2005 levels in 2020.

First, a number of utility IRPs as well as the NPCC are considering $7/ton CO_2 emitted as a minimum case for future planning. The low case will have a minimal effect on the avoided cost and overall efficiency potential. The associated costs for natural gas end use and for electricity generation based on gas and coal plants are shown in Table 2.

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[7] The WCI Design Report, Appendix B, page 36, Table B-30, reports scenario analysis results showing a possible range of $16-$64 per ton of CO_2.

Second, the WCI conducted one forecast scenario for a broad regulatory scope with no offsets, which estimates $57 per ton in 2020 (WCI 2008). Under the WCI cap-and-trade regime, CO_2 costs escalate with time so the effective adder in 2015 will be less, close to $15/ton.

Third, this report determined that an amount approaching $50/ton CO_2 is needed to meet reduction targets. With this adder, all load growth is met and then coal-fired capacity is taken offline to lower CO_2 emissions.

Table 2: Carbon Adders Used to Estimate Efficiency Potential

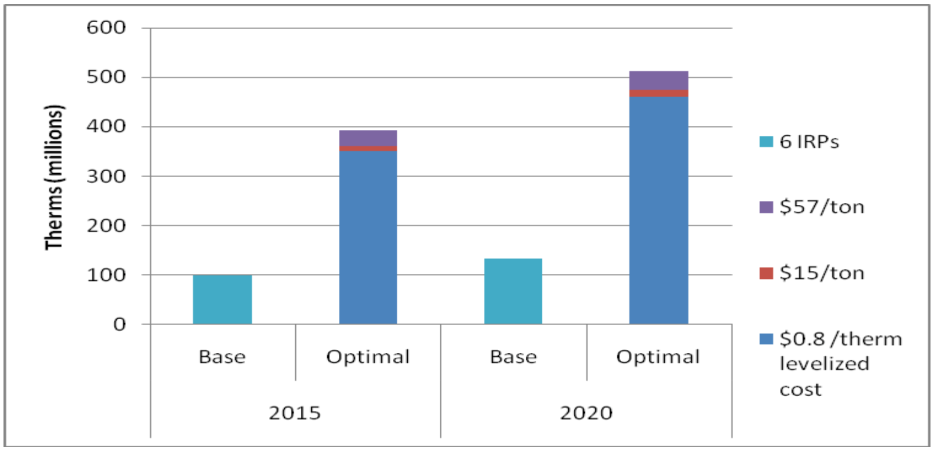
Carbon Adder	Avoided Cost Increase		
	Natural Gas End-Use ($/therm)	Gas Turbine ($/kWh) on Margin	Coal Plant ($/kWh) on Margin
$7 / ton	0.04	0.003	0.008
$15 / ton	0.09	0.006	0.018
$50 / ton	0.29	0.020	0.058
$57 / ton	0.33	0.023	0.066

In Figure 10 and Figure 11, the amount of electric energy conservation potential includes all of the measures on the supply curve up to the avoided cost. For the 5th Power Plan, the avoided cost was near five cents per kWh. This differs from the average cost of the entire conservation package, which was a little more than 3 cents per kWh. In the analysis and supply curve with new technologies (presented in detail in subsequent sections), the avoided cost is set at 5.7[8] cents per kWh, which reflects a slight increase in avoided costs. The labels for $7, $15, $50, and $57 per ton indicate the effects a carbon adder at that level would have on the avoided cost and hence the amount of potential available. The base year used for the graphs is 2005.

The picture for the natural gas utility sector is different. Load growth through 2020 is predicted to be considerable, nearly 1 billion Therms (the equivalent of roughly 100% of what Puget Sound Energy currently sells). The amount of known and anticipated technical conservation potential is not enough to meet the region's load growth. Still, the optimized scenario depicted in Figure 12 marks a significant improvement over the currently projected conservation. Using a levelized cost of $0.80 per therm shows that starting in 2005, there are 460 million Therms of available efficiency by 2020. Two carbon adders, both from the WCI, were considered for natural gas. The largest adder, $57/ton, makes the total available over 500 million Therms. Figure 13 shows the optimized natural gas potential by state.

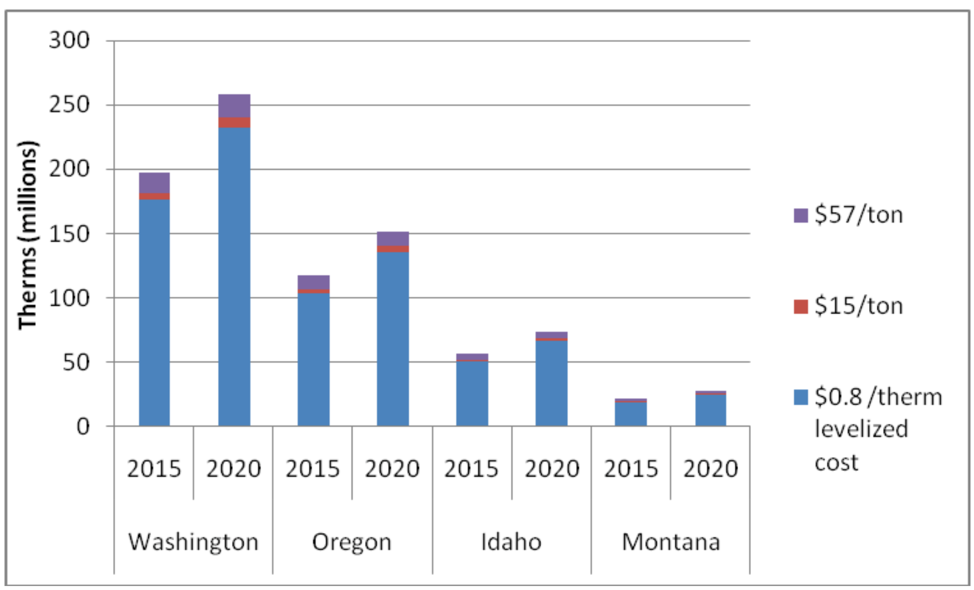
[8] The avoided cost of 5.7 cents/kWh number was based on information from late 2008 as the most likely avoided cost for a mix of mostly gas and coal. Since then, we've learned that the Power Council's 6th plan may have an avoided cost of 10 cents per kWh, essentially what new wind turbine and gas turbine construction looks like at the margin. Assuming higher avoided costs would yield 6300 aMW of conservation potential.

Figure 12: Regional Optimized Natural Gas Efficiency Potential



Source: Ecotope, Inc. 2008

Figure 13: State-by-State Optimized Natural Gas Efficiency Potential



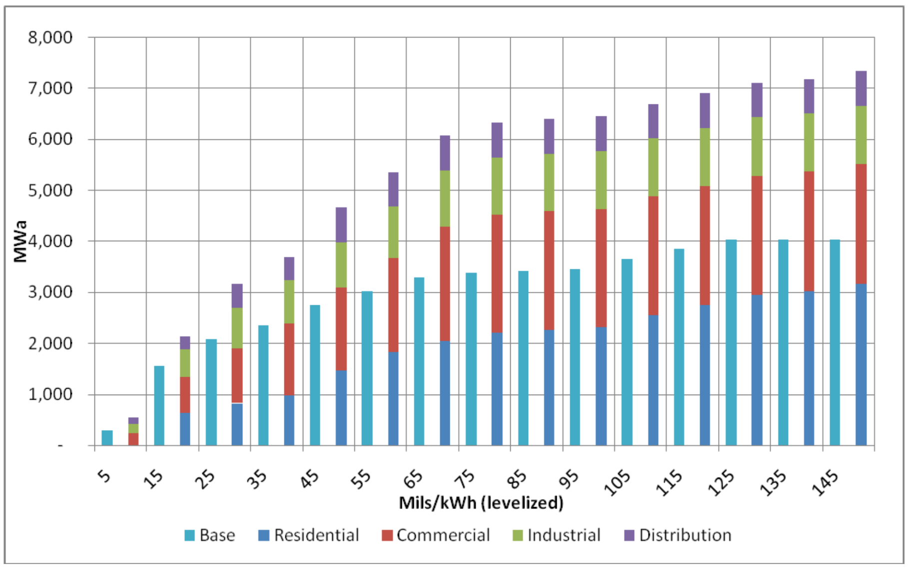
Source: Ecotope, Inc. 2008

Increasing the Supply Curve

The optimized energy efficiency potential presented in the discussion above is based on the supply curves and efficiency measures discussed in this section. Supply curves are defined as the summation of conservation resources available at a particular cost. The supply curve is organized in ascending values so the analyst can easily assess the amount of conservation available at each particular avoided cost. The conservation supply curves developed for the region's electricity conservation assessments have been a long-standing approach to resource planning in the Pacific Northwest. These supply curves were developed originally by the Northwest Power Planning Council in 1982, and have been used ever since as a primary planning tool. Figure 14 shows both the supply curve for conservation from the 5th Power Plan and this report's optimized, more aggressive scenario made as part of this analysis. For this evaluation, the 5th Power Plan was used as the base case with new technologies and conservation techniques then added. The 5th Power Plan always uses optimum conservation packages based on avoided costs and other resource requirements projected using the planning tools. The actual cut off points for conservation are set by those assumptions.

In this analysis, new measures have been added in various categories. The optimum conservation mix has also been changed based on the increased value of electricity and natural gas as avoided cost and on the potential for a carbon adder of $7 to $57 per ton generated.

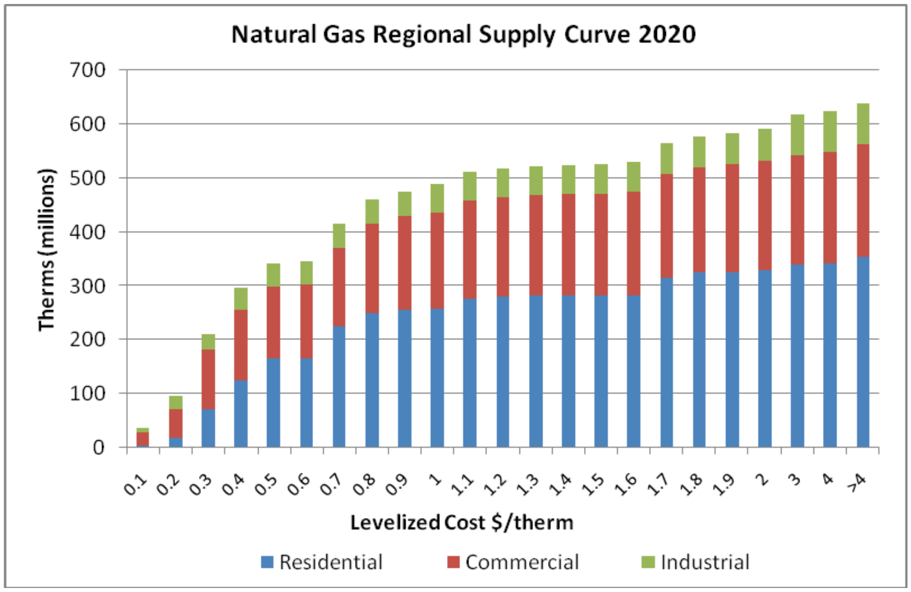
Figure 14: Regional Electrical Efficiency Supply Curve for 2020



Source: Ecotope, Inc. 2008

In contrast to the electric sector, historically there has not been an effort to develop regional conservation assessments for the natural gas sector. As previously mentioned, the approach used in this report was to analyze the six major gas utilities to produce a regional picture. The analysis showed that the gas utilities were not uniformly considering a number of energy conservation measures. Consequently, this report picked the supply curve data used by the Energy Trust of Oregon (ETO) as a best practice and applied it to the region as a whole (see figure 15). The ETO has an extensive list of technologies and programs which were used to develop a more complete regional supply curve for gas conservation potential.

Figure 15: Regional Natural Gas Efficiency Supply Curve for 2020



Source: Ecotope, Inc. 2008

Residential Sector

The analysis of the residential sector built substantially on the analysis in the 5th Power Plan and included many options that were more expensive and thus not included in their original supply curve (e.g., ground source heat pumps and solar hot water heaters. Heat pump water heaters have also been included in 50% of the electric water heating in the region. Other measures include: replacement windows as a conservation measure in which utilities would be asked to replace windows especially in multifamily construction; several Energy Star appliances where federal standards have resulted in improved efficiency and costs for higher performing appliances (e.g. refrigerators, washers) since the original analysis was conducted; and advanced lighting based on LEDs, which is included as a potential improvement in the post-2015 residential market.

In the residential gas analysis, the efficiency potential across the region was dramatically increased by more extensive use of weatherization and efficient domestic water heaters combined with the higher avoided costs used by ETO.

Commercial Sector

The commercial sector is more complicated in that the optimized, more aggressive scenario is based not on new technologies in and of themselves, but rather on integrated and green building design, and specific measures to implement and ensure that these techniques result in energy efficient buildings. Generally, these measures apply to both gas and electric commercial building end uses.

In the analysis for this report, the baseline for new construction for the region in 2006 and 2007 was reviewed. In this review, the potential for integrated design was estimated by reviewing buildings that had noticeable improvements in their design and operation. This was done in three sectors: offices, schools, and retail buildings which represent approximately 60% of the new construction area.

The measures include:

- Better and improved ventilation system management using CO_2 sensors (an important addition to the gas supply curves).
- Demand-only ventilation systems.
- Careful management of ventilation air and indoor air quality.
- Improved lighting systems using additional high efficiency components not currently being used in these sectors, especially high performance fluorescent technologies.
- Improved and integrated controls that are developed by the engineers as part of the integrated design.
- Commissioning beyond the levels currently required including retro-commissioning or ongoing review especially during the initial building start-up.

In addition to these measures, several specific measures were reviewed and added for application to some commercial sectors. These include ground source heat pumps in HVAC design, and high performance windows beyond those that represent a 25% improvement over current code or practice.

Industrial Sector

The industrial sector analysis in the 5th Power Plan was fairly minimal and focused on several very effective conservation measures that transcend almost any specific industry. These measures include: high performance motors, high performance compressors for air, refrigeration, and high performance lighting. Several of the IRPs that were reviewed included an alternative method for evaluating industrial conservation in which individual sectors were reviewed. Measures applied to those sectors were related to the production systems in those industries, which has the effect of increasing the industrial conservation potential by up to four times. Even with relatively modest changes and avoided costs, these IRP's suggested approximately a tripling of conservation potential. Using the measures included in the Energy Trust of Oregon conservation assessment and the IRPs of Cascade Natural and Northwest Natural Gas, the 5th Power Plan was extended to include that technique. As with the commercial sector, this analysis applied equally well to both the electric and gas industrial customers.

In addition, an Operations & Maintenance measure was added that represents about a 10% increase in savings and is based on ongoing utility involvement in specific measures and management techniques that could sustain, extend, and improve industrial process or equipment efficiency for the duration of the life of a particular production line or plant. This is potentially a fairly modest cost and may be extremely cost-effective. However, the need for integrated energy and efficiency management in the industrial sector, while widely reviewed, remains an emerging conservation opportunity. Using a 10% adder for this would be a conservative estimate but would require an ongoing involvement in the industrial sector (similar to the Seattle programs) across the region's utilities.

Distribution Efficiency

Finally, the distribution systems for the electric utilities have been reviewed extensively in the last five years. This has resulted in a series of potential measures that could optimize the electric grid and the distribution of electricity throughout the region. All of these have been done under the rubric of voltage reduction or voltage management. Several measures are available for substations and feeder stations that could reduce the overall energy requirement of the distribution system and result in a 1% - 3% savings overall. In addition, more expensive measures that address transformers at the end of the distribution system, and more importantly voltage management at the individual customer level, would add appreciably to this savings. The analysis for the optimized potential in this report uses an R. W. Beck study (R. W. Beck 2007) to assign energy savings estimate costs for these conservation voltage measures. They represent approximately 13% of the optimized conservation potential in this report (680 aMW of the total 5,200 aMW potential). This is a very appreciable improvement and involves changes only in the efficiency of the distribution system.

Combined Heat and Power

In this report, the value of combined heat and power (CHP) is reviewed within the context of the region's energy efficiency and climate protection goals. CHP refers to onsite cogeneration of electricity and thermal energy in a single integrated system (ACEEE 1999).

Because CHP captures and uses waste heat from the generating process onsite, it can be a way to increase efficiency in industrial and commercial applications. Aggregate efficiencies typically reduce overall energy use by 10-25%. In theory, the potential efficiency gains of cogeneration could be large, especially when compared to centralized gas or coal fired generation. However, the split of costs and benefits between the host, a gas utility and an electric utility create serious institutional barriers. In addition, until carbon is monetized through some sort of carbon regulation, the significant emissions savings from CHP cannot be part of the benefit equation. Without active intervention by states or utilities, CHP remains an area of unrealized potential.

In 2004, Energy and Environmental Analysis, Inc. (EEA) conducted the most recent comprehensive market assessment of CHP in the Pacific Northwest (Washington, Oregon, Alaska, and Idaho). EEA estimated that between 2,000 and 6,100 MW of cost-effective CHP potential may be available in the 2004-2025 timeframe (EEA 2004). According to the 2004 study, increased CHP market penetration will produce economic benefits (annual benefits of $318 -$885 million), energy savings (54 – 167 trillion Btu/year), and a potential reduction in pollutant emissions for the region (CO2 reductions of 6-22 million tons/year). However, the EEA analysis is somewhat outdated, so it is difficult to assess the current relevance of the EEA projections.

Some regional utilities have conducted more recent assessments of CHP in relation to market changes and their unique planning constraints. Seattle City Light's 2006 IRP notes that until recently some industry observers believed there was significant potential to develop new CHP projects and that this development would occur as the need for new resources grew. However, due to sharp increases in natural gas prices and high initial costs, vigorous expansion of CHP has not occurred and was not included in Seattle City Light's 2006 IRP.

Based on a review of emerging CHP analyses in energy planning documents across the region and nationally, the economic and environmental viability of CHP is in flux. In the typical utility environment where natural gas-fired electricity is on the margin, the benefits of CHP pencil out. However, until carbon savings become a tangible benefit through regulation, and in the face of high fuel price volatility combined with stressed capital markets, the benefits of CHP become less certain to the host industry. Considering this ambiguity, this report does not include CHP efficiency potential in the analysis of optimized efficiency potential for the region.

The future relevance of CHP will need to be analyzed on a regional level within the evolving planning environment. Detailed analysis will be required to understand the complex influences of volatile fuel prices, cap-and-trade initiatives such as the WCI, dramatically expanding levels of end use energy efficiency potential, the impact of renewable portfolio standards, and fuel switching options. This type of high-context analysis may reveal a clearer indication of the efficiency and emission reduction potential of CHP in the Pacific Northwest region.

Smart Grid

Optimizing the region's electrical power system with smart devices and systems will help facilitate the transition to a clean energy future. Just in its infancy, the "smart grid" connects smart buildings, smart appliances, etc., via two-way, Web-based communications. Smart grid technologies will help the Pacific Northwest meet increasing energy needs with energy efficiency and renewables by facilitating clean energy integration and allowing utilities, homeowners, and businesses to control and shape power demand based on real-time price information and grid reliability needs.

Basically, the smart grid uses smart meters that "talk" with the utility and relay information and instructions to the homeowner and the home's appliances. At the simplest level, this can reduce meter-reading costs and quickly locate outages. But its real value is in controlling appliances when the grid is stressed and providing usage feedback to customers. Within the next 10 years, most energy-intensive appliances—including furnace thermostats, water heaters, refrigerators, freezers, etc.,—will be manufactured with chips that will connect them to the meter through a wireless home or business network. In addition to facilitating communication and remote control, the smart grid allows the use of electric vehicles' batteries to store power.

Smart grid technologies include[9]:

- **Distributed Resources –** distributed generation interconnection, energy storage integration.
- **Power Grid Management –** real-time monitoring, transmission-distribution, demand response automation, communications networks.
- **Customer Power Management –** smart meters, smart buildings/equipment, smart appliances, voltage regulation.

Although, in aggregate it is difficult to quantify the efficiency potential of a smart grid, some technologies have been assessed, including integrated building controls (smart buildings/ equipment) and distribution efficiency (transmission-distribution management, voltage regulation, and smart meters). Together, these specific smart technologies represent a significant portion of the regional optimized efficiency potential presented in this report: approximately 800 aMW of the 5,200 aMW estimated energy efficiency potential.

[9] List of technologies taken from a special report by Climate Solutions (Mazza 2005)

Additional Benefits

Leveraging energy efficiency potential to meet regional demand and reduce emissions also stimulates job growth and saves water and sewer costs. These non-energy benefits increase the cost-effectiveness of individual energy efficiency measures and further position energy efficiency as a cost-effective, integrated strategy for addressing climate change, economic development, and energy independence.

Oregon's Residential and Business Energy Tax Credits (RETC & BETC) programs have high impact in 2007 - 2008:

- Energy costs down by $297.2 million
- Economic output up by $575.7 million
- 1,706 new jobs
- Wages up by $41.1 million
- State and local tax revenues up $22.4 million
- CO_2 emissions down 2.4 million tons

The "green jobs" generated by energy efficiency investments typically involve retrofit construction, green building design services, and smart grid technologies. Research shows a direct relationship between investment in these industries and job creation. A study of Seattle's energy efficient job creation potential showed that for every $1 million invested in energy efficiency retrofit programs, 7.37 full time employees are created (SCL 2008). Another study focusing on clean energy jobs in Oregon and Washington projects medium-growth job estimates for green building design services at 12,937 by 2025, with an additional 2,669 jobs in the smart grid industry (Clean Edge & Climate Solutions 2008). In an accelerated growth scenario the job estimates reach 16,834 and 7,212, respectively.

Energy efficiency technologies such as low-flow showerheads and efficient clothes washers minimize water and sewer requirements as well as energy (NPCC 2005). A 2006 report to the Western Governors' Association predicts that a Best Practices scenario of aggressive adoption of "best practice" policies and programs in all 18 member states would save 1.8 trillion gallons of water during 2005–2020 (WGA 2006). The water savings identified in the report would result from the greater use of energy and water saving devices and from reduced power plant operation. The water savings would also provide reductions in energy required for water treatment, pumping, distribution, and heating (WGA 2006).

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