Energy Efficiency: A Cost-Effective Strategy to Meet Regional Climate Goals in the Pacific Northwest

Poppy Storm, Ben Larson, and David Baylon, Ecotope Inc.

ABSTRACT

In the Pacific Northwest, energy efficiency has played a significant role over the past 30 years in meeting load growth and averting the need to build costly new generating resources. With increasing interest in climate protection, national and international studies have highlighted the key role energy efficiency will play in reducing greenhouse gas (GHG) emissions. Energy efficiency is a proven, low-cost, low-risk investment for meeting the region's growing demand for electricity and natural gas. This paper presents Ecotope's assessment of energy efficiency as a resource to meet the region's energy needs while substantially reducing GHG emissions in the Pacific Northwest.

Regional energy-efficiency targets have traditionally focused on meeting a portion of the load growth in the Pacific Northwest states—Washington, Oregon, Idaho, and Montana. With the region's ever-increasing energy demand, energy efficiency programs are faced with a moving target and must cut into existing demand to ensure we achieve our climate goals. This paper takes a carbon-reduction oriented approach to assess cost-effective energy efficiency potential in the Pacific Northwest electric and natural gas utilities. The Western Climate Initiative's 2015 and 2020 emissions targets are used as a starting point to determine the load reductions necessary to meet these targets in the Pacific Northwest and to assess energy efficiency as the primary resource for realizing these load reductions. Achieving these efficiency levels would not only eliminate the need for new electric-generating capacity, but could also eliminate the need for some of the highest-carbon-producing resources in the current electric supply.

Introduction

Climate and energy-efficiency policies can work in synergy: energy efficiency can help reduce greenhouse gas emissions, and the well-branded concept of climate change can motivate energy efficiency gains. However, simply 'reducing emissions' is not the endgame. Dramatically reducing emissions low enough to meet regional carbon reduction targets is the endgame. In the four states of the Pacific Northwest region—Washington, Oregon, Idaho, and Montana—meeting Western Climate Initiative[1] 2020 targets would require a regional carbon reduction of 17 million tons in the electric sector alone. Meeting this objective requires a deep understanding of the scale of the task at hand as well as transformational energy efficiency strategies that fully leverage the synergy between climate and energy efficiency policies. This paper assesses the magnitude of energy efficiency necessary to meet regional carbon reduction goals, the amount of cost-effective energy efficiency available to meet these goals, and the

[1] The Western Climate Initiative (WCI) is a collaboration of most of the western U.S. states as both participants and observers. From the Pacific Northwest, Washington, Oregon, and Montana are participant members, while Idaho is an observer. The WCI also includes a number of members in Canada and northern Mexico. The WCI is centered around a regional cap-and-trade program. For more information on the WCI see http://www.westernclimateinitiative.org/.

relationship between the cost of carbon and energy efficiency potential. The paper also explores strategies for achieving this energy efficiency potential in the Pacific Northwest within a meaningful timeframe, including emerging technologies, services, and mindsets as well as innovative program and energy code design.

In the Pacific Northwest, energy efficiency has played a significant role over the past 30 years in meeting load growth and averting the need to build costly new generating resources. Since 1978, regional energy-efficiency measures have produced nearly 3,700 aMW—the equivalent of approximately six to seven coal plants—of savings, compared to the current load on the system of 21,000 aMW. This represents a 15% savings over the 24,700 aMW capacity required without energy conservation (NPCC 2007).

With increasing interest in climate protection, recent national and international studies have highlighted the key role energy efficiency will play in reducing greenhouse gas (GHG) emissions. International experts indicate that to avert global warming, global emissions must make a quick and steep decline to 50-85% below 1990 levels by 2050 (Stern 2007). In the Pacific Northwest alone, this amounts to a reduction of 35 to 50 million tons of CO_2 from electric power emissions in 2005, and 10 to 15 million tons from natural gas emissions. For natural gas emissions, this represents the amount of gas used by more than two million typical houses in western Oregon and Washington.

Traditionally, energy efficiency targets in the Pacific Northwest have focused largely on meeting the region's electric load growth. More climate-oriented energy efficiency policy must *reduce* current demand, not just limit increasing demand. With society's ever-increasing demand for energy, just meeting our resource needs will not ensure that we reduce emissions enough to stabilize the climate. 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, 10-to-20-year trajectory of this analysis (NPCC 2005).

Regional policymakers at all levels established aggressive targets for reducing GHG emissions via the Western Climate Initiative (WCI), the Western Governors' Association (WGA), and state, county, and municipal climate action plans. The WCI sets a medium-term goal of 15% below 2005 levels by 2020 (WCI 2008). The state of Washington has established an emissions level limit of 1990 levels by 2020, while Oregon has set the limit at 10% below 1990 levels by 2020 (NPCC Carbon Footprint 2007). Meeting these goals will require the region to fundamentally recalibrate energy-efficiency targets and achieve all cost-effective energy efficiency potential. Increasing our energy productivity will also reduce energy costs to residents and help businesses remain competitive in a carbon-constrained economy. However, 2020 is quickly approaching and strategies for reaching these goals must focus on defining an accelerated path to achieving deep energy efficiency gains.

This paper takes a carbon-reduction oriented approach to assess energy-efficiency potential in the Pacific Northwest electric and natural gas utility sectors. The WCI 2015 and 2020 emission targets are used as a starting point to determine the load reductions necessary to meet these targets in the Pacific Northwest and to assess whether energy efficiency can be the primary means of achieving these load reductions. These efficiency levels would not only eliminate the need for new electric-generating capacity, but would also eliminate the need for some of the highest-carbon-producing resources in the current electric supply—namely coal and natural gas generating resources which constitute approximately 30% of the region's electric generation. In this analysis, the focus is on the potential role of energy efficiency in reducing fossil-fuel-based generation. In a region with a high proportion of hydro power, a carbon-reduction scenario biased toward aggressive energy efficiency goals could preclude the need for coal-to-natural-gas fuel switching, or even excessive development of expensive renewables such as wind and solar.

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),[2] and an aggregate of current natural gas savings potential was developed from the region's six largest natural gas utilities. An updated assessment of optimized energy efficiency potential was also developed that considers new technologies not accounted for in the Fifth Plan; the increasing cost of carbon; distribution system efficiencies; and other factors that increase the technical and cost-effective potential of energy efficiency.

Regional Greenhouse Gas Reduction Targets

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. Without additional energy efficiency measures, electric load growth from 2005 through 2025 is projected to be 1.36% annually (NPCC 2005). Although there have been recent declines in industrial sector demand (mainly due to the closing of most of the region's aluminum smelters since 2001), commercial sector employment and residential population increases continue to drive demand upwards (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 dominant drivers are an expanding economy and population, as well as fuel switching in the residential sector (NGA 2007). Newly-constructed houses are increasingly built with natural gas space and water heat, while existing houses are switching from electric to gas equipment.

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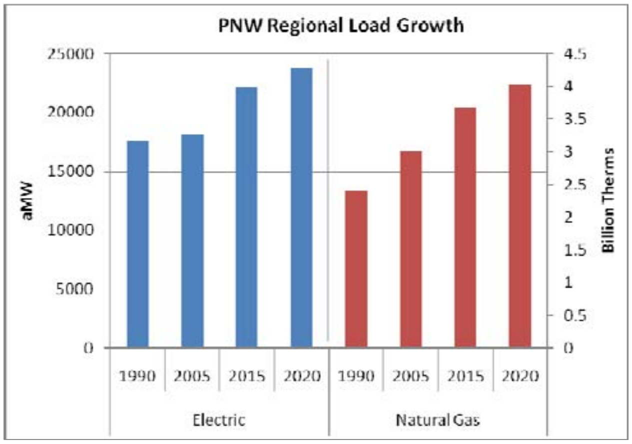
[2] The Northwest Power and Conservation Council (NPCC) is a regional energy planning organization created by Congress to develop and maintain a regional power plan, and a fish and wildlife program to balance the Northwest's environment and energy needs. Every five years the NPCC develops an updated 20-year electric power plan intended to guarantee adequate and reliable energy at the lowest economic and environmental cost to the Northwest. See http://www.nwcouncil.org/about/background.htm for a background of the Northwest Power and Conservation Council and its role in energy and conservation planning in the Pacific Northwest.

[3] Calculated from six natural gas Integrated Resource Plans (IRPs) and the Northwest Gas Association 2007 Outlook.

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

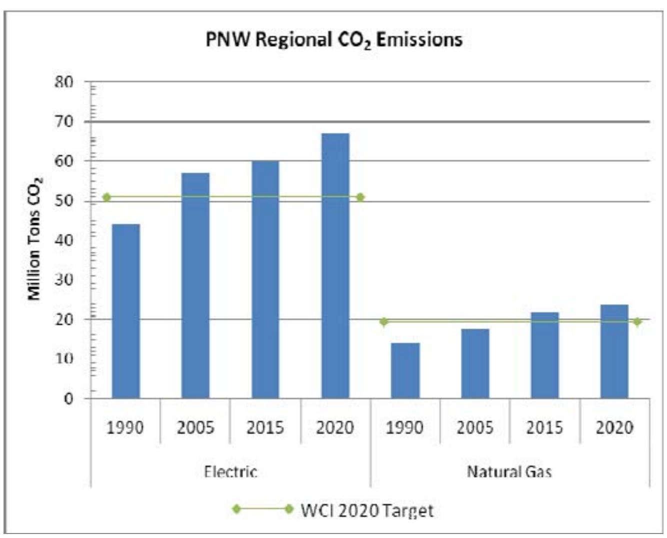


Source: Ecotope Inc. 2008

Both past and future demand for electricity and natural gas are depicted in Figure 1. The trend of increasing demand is clear. Note the bars in the graph are not at equal time steps, but instead provide snapshots for the key years discussed in this paper. Of note is the smaller increase in electric demand from 1990 to 2005. The high prices during the Western energy crisis of 2000-2001 curtailed demand for an otherwise increasing load.

Continuing at its current pace (in the absence of higher levels of demand-side efficiency measures), the region's electricity and natural gas use will emit increasing amounts of greenhouse gases into the atmosphere. 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

Increasing electric and natural gas demand and emissions pose a significant challenge to the plans made by various local, state, regional, and federal entities to meet the climate change challenge. Oregon's and Washington's legislatures have mandated goals for reducing greenhouse gas 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. Municipalities and counties also have their own targets. To address climate change 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 which limits the total amount of GHG emissions. 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.

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.

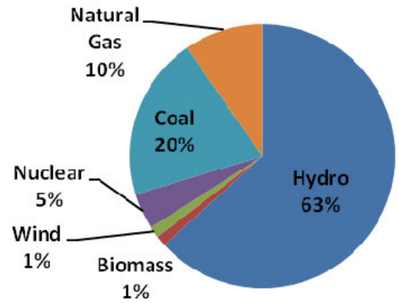
In 2007, the NPCC calculated the carbon footprint of the Northwest Power System and analyzed several scenarios to determine alternatives for meeting the emission reduction targets of the WCI and the states of Washington and Oregon (NPCC Carbon Footprint 2007). The key findings of the study indicate that although current conservation rates and renewable portfolio standards mandating acquisition of low-carbon resources may help reduce CO_2 emissions, it is unlikely that these activities will maintain emissions at current levels, let alone reduce them to the levels targeted 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. Adding significant levels of renewables only reduces emissions by 4.4 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.

Clearly a 'business-as-usual' approach will not prevent increases in regional CO_2 emissions, let alone cause reductions consistent with the WCI goals. 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 compared to the approximately 15 million tons that would be necessary to meet the WCI 2020 target.

Energy Efficiency: Key to Meeting Climate Goals

Due to a high proportion of hydropower, aggressive conservation development, 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 versus 0.90 lb/kWh in 2005 (NPCC Carbon Footprint 2007). However, in 2006 a full 30% of the regional electrical generation source fuel was carbon-based (coal and natural gas). Figure 3 presents the region's current electrical generation source fuel. Since regional demand has already exceeded available hydro resources, new load is met at the margin by a resource mix that is partly carbon-based and includes natural gas, wind, and efficiency. Reducing electric energy demand directly reduces carbon emissions generated at the margin.

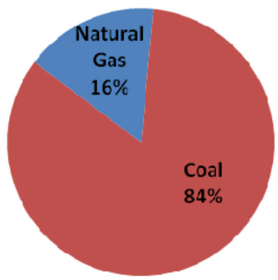
Figure 3. Pacific Northwest Electrical Generation Source Fuel



Source: NPCC 2005

Although coal represents only 20% of regional generation in 2006, it accounts for 84% of the total CO_2 emissions (see Figure 4.). The carbon emission fees being considered by regional agencies and bodies will most likely make coal less competitive with energy efficiency and gas turbines (NPCC 2010). Therefore, energy efficiency gains can be used to take current coal-fired power plants offline. Removing these most polluting resources first is the quickest way toward reaching emission targets. As shown later in this paper, the potential impact of energy efficiency programs could more than offset coal's 20% share of regional generating resources.

Figure 4. 2006 Pacific Northwest Electrical Generation CO_2 Emissions



Source: NPCC 2005

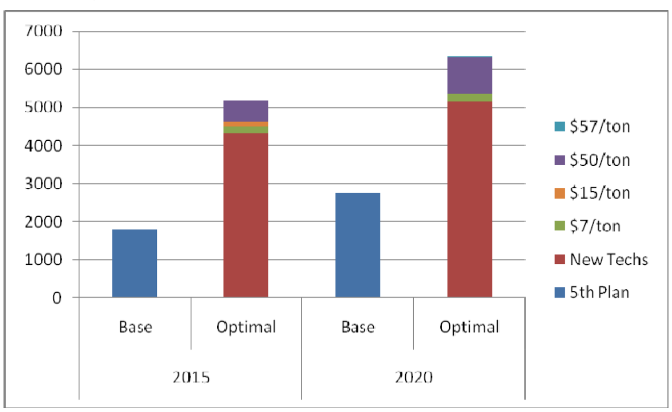
Optimized Potential to Meet Load Growth and Reduce Emissions

More energy efficiency than what is identified in the 5th Power Plan is needed to meet the Pacific Northwest's growing electricity and natural gas demand while simultaneously helping achieve the region's greenhouse gas reduction targets. Importantly, these greater levels of conservation are available and attainable. To provide more of the region's energy needs through conservation, this paper proposes an optimized, more aggressive energy efficiency scenario to the baseline plans of the 5th Power Plan.[4] There are three broad steps used in constructing this optimized scenario: apply technologies and programs developed in various regional utility Integrated Resource Plans (IRPs) broadly across the region; account for new and emerging technologies; and assess the appropriate amount of money to devote to energy efficiency resources. This methodology 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 regional scenarios for the electric and gas sector. The specific details used to arrive at these numbers are discussed later in the paper.

For the electric utility sector, accounting for new and emerging technologies had the most significant effect on available conservation. As depicted in Figure 6, the impact of these changes is to increase the conservation potential of the region in 2020, from approximately 2,800 aMW in the 5th Power Plan, to approximately 5,200 – enough to meet the region's predicted load growth.[5] This conservation can be done through the implementation of new technologies and programs alone. However, a 'business-as-usual' approach won't meet these objectives. We need fast, aggressive efforts to capture this conservation as soon as possible.

If the financial risks associated with new fossil-fuel-generating resources are included in avoided costs as a 'carbon adder,' a substantial amount of additional energy efficiency becomes cost effective, as shown in Figure 6. The carbon adder takes into account the cost of carbon in a regulatory environment that places a price on carbon via various scenarios such as cap-and-trade or a carbon tax. With the addition of a $50 per ton carbon adder, conservation potential is increased by an additional 20% to an excess of 6,000 aMW.[6] This would have the effect of meeting virtually all the load growth in the region *and* creating the opportunity for the region to address other policy priorities, such as removing some high-carbon generating capacity.

Figure 6. Regional 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 increase the amount of price-competitive energy efficiency

[4] Since the analysis in this paper was completed, the 6th Power Plan has been released. The targets identified in the plan closely align to the analysis included in this paper. See http://www.nwppc.org/energy/powerplan/6/default.htm for more information on the 6th Power Plan.
[5] The analysis uses the 5th Power Plan's median load forecast. The new conservation is included in the conservation estimates used here and forms the base conservation measures in Figure 6.
[6] 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.

available to the region. A carbon adder acts to increase the cost of burning fossil fuels and hence the avoided cost. In turn, the higher avoided cost will allow the once too expensive efficiency measures to become cost-effective. This paper considers four different carbon adders shown in Table 1:

- **$7/ton, low-cost case**. A number of utility IRPs, as well as the NPCC, are considering $7/ton CO_2 emitted as a minimum case for conservation planning. The low case will have a minimal effect on the avoided cost and overall efficiency potential.
- **$15/ton WCI 15-year forecast**. Under the WCI cap-and-trade regime, CO_2 costs escalate with time, so the adder in 2015 will be less than in 2020 ($15/ton).
- **$50/ton, minimum to meet 2020 WCI target**. For this case, Ecotope sets the cost of carbon at a level high enough to reduce emissions to 15% below 2005 levels in 2020. This increase helps develop a larger portfolio of efficiency measures for the region. With this adder, all load growth is met and coal-fired capacity is then taken offline to lower CO_2 emissions.
- **$57/ton, WCI estimate with no offsets**. The WCI conducted one forecast scenario for a broad regulatory scope with no offsets which estimates $57/ ton in 2020 (WCI 2008). This is the level the WCI forecasts as a potential price point via a 20-year operation of cap-and-trade on carbon emissions.

The associated costs of these carbon adders for natural gas end use and for electricity generation based on gas and coal plants are shown in Table 1.

Table 1. Carbon Adders Used to Estimate Efficiency Potential

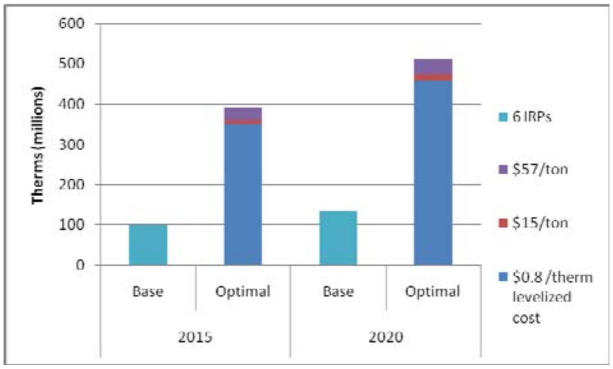
Carbon Adder	**Avoided Cost Increase**		
	Natural Gas End-Use ($/therm)	Gas Turbine ($/kWh) on Margin	Coal Plant ($/kWh) on Margin
$7/ton	$0.04	$0.003	$0.008
$15/ton	$0.09	$0.006	$0.018
$50/ton	$0.29	$0.020	$0.058
$57/ton	$0.33	$0.023	$0.066

Source: Ecotope, Inc. 2008

In Figure 6, the amount of potential includes all measures with costs less than the avoided cost. For the 5th Power Plan, the avoided cost was near $0.05 per kWh. In our analysis with new technologies, the avoided cost is set at $0.057 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 picture for the natural gas utility sector is different. Load growth through 2020 is predicted to be considerable, nearly 1 billion Therms. The amount of known and anticipated technical potential is not enough to meet the region's load growth. Still, the optimized scenario depicted in Figure 7 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 7. Regional Optimized Natural Gas Efficiency Potential

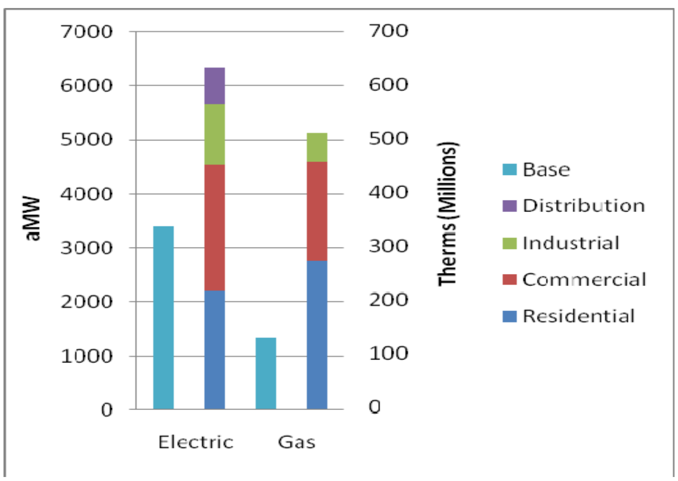


Source: Ecotope Inc. 2008

Optimized Efficiency Measures

The result of the carbon adders is that an array of efficiency measures is cost-effective in end-use sectors used in the regional planning approach. Figure 8 shows the relationship between the increased conservation targets and the base efficiency forecasts from the 5th Power Plan and the gas utilities' aggregated base from their individual IRPs. Several of the main conservation initiatives implied by this carbon adder are described below. For this analysis the $50/ton adder is used.

Figure 8. 2020 Efficiency Resources Using a $50/Ton Carbon Adder



Source: Ecotope Inc. 2008

Residential sector. The analysis of the residential sector built substantially on the 5th Power Plan to include options that were previously excluded as being too expensive (e.g., ground source heat pumps and solar hot water heaters). In addition, heat pump water heaters have been included in 50% of the electric water heating in the region. Other measures include: replacement windows, especially in multifamily construction; several EnergyStar™ appliances where federal standards have resulted in improved efficiency and costs for higher-performing appliances (e.g., refrigerators, washers); and advanced lighting based on LEDs 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. A further key increase was due to using the higher avoided cost of gas set forth by the Energy Trust of Oregon (ETO)[7] as opposed to the lower amount set forth by individual utilities in their IRPs.

Commercial sector. The commercial sector is more complicated in that the optimized, more aggressive scenario is based not on new technologies, 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, the baseline for new construction for the region in 2006 and 2007 was reviewed. 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: (a) improved ventilation system management and demand-only ventilation using CO_2 sensors (an important addition to the gas analysis); (b) careful management of ventilation air and indoor air quality; (c) improved lighting systems not currently being used in these sectors, especially high-performance fluorescent technologies; (d) improved and integrated controls that are developed by engineers as part of the integrated design; and (e) commissioning beyond the levels currently required, including retro-commissioning or ongoing review, especially during the initial building startup. Additionally, several specific measures, including ground source heat pumps in HVAC design and high performance windows beyond those representing a 25% improvement over current code or practice, were added for application to some commercial sectors.

Industrial sector. The industrial sector analysis in the 5th Power Plan was minimal and focused on several very effective conservation measures that transcend almost any specific industry. These measures include high-performance motors, high-performance air compressors, refrigeration, and high-performance lighting. Several of the IRPs that were reviewed included an alternative method for evaluating industrial conservation in which individual industries 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 IRPs suggested approximately a tripling of conservation potential. Using the measures included in the ETO 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. It is based on continuing 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.

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[7] The Energy Trust of Oregon (ETO) is an independent, nonprofit organization funded by the Oregon public benefits charge. ETO is responsible for implementing the conservation programs of Oregon's two largest utilities. For more information on ETO go to http://energytrust.org/.

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 which 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 to 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 paper uses a regional 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 paper (680 aMW of the total 5,200 aMW potential). This is an appreciable improvement involving only changes in the efficiency of the distribution system.

Conclusions

Energy efficiency will play a fundamental role in the region's efforts to meet load growth and reduce GHG emissions. These investments can act as a catalyst for progress on the interdependent issues of economic development, energy security, and climate protection. However, current targets will not meet the load reductions required to attain regional GHG goals. Meeting these goals will require conservation achievements that go beyond load growth planning and encompass the load reductions necessary to meet the requirements of climate change mitigation. The analysis presented in this paper confirms energy efficiency's potential to meet a significant amount of these reduction goals in a cost-effective way.

The prospect of leveraging the region's energy-efficiency potential to dramatically reduce emissions, take coal-fired resources offline, and meet regional carbon reduction goals is an encouraging proposition. From a strategic, analytical, and research perspective, the task at hand is to determine how to turn this potential into reality.

The Pacific Northwest conservation industry has been very successful at achieving efficiency through a combination of effective regional planning, measure development, and efficiency programs. We need to not only continue this 'more and better' tradition, but also add another component of engagement that envisions and promotes the development of transformational and integrated policies at all levels of the energy efficiency 'ecology' in the Pacific Northwest. Additional research could provide a holistic assessment of this ecology to identify opportunities for transitioning regional efficiency planning from an electricity-centric to a fuel-blind context more appropriate to integrating climate and efficiency policies. This research could also explore the relationships among regional planning bodies, utilities, municipal governments, NGOs, and consultants. For example, many city governments and planning departments are developing and implementing some of the most innovative and transformational energy efficiency and climate oriented programs. And yet, municipal governments often are not closely tied in to regional or utility level planning. New policies that examine how these different sectors can work together and contribute complementary capacities will integrate climate and efficiency efforts more effectively.

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