Conservation Resources

OVERVIEW

This chapter provides an overview of the procedures and major assumptions used to derive the Council's estimates of conservation resources available in both the public and private utility service territories across the region. It describes the cost and availability and other key characteristics of the conservation potential. It also describes the Council's policy on conversion from electricity to natural gas as an electric efficiency measure.

In the Council's power plan, conservation is defined as the more efficient use of electricity. This means that less electricity is used to produce a given service at a given amenity level. Conservation resources are measures that ensure the efficient use of electricity for new and existing residential buildings, household appliances, new and existing commercial buildings, commercial-sector appliances, commercial infrastructure and industrial and irrigation processes. For example, buildings in which heat loss is reduced through insulating and air tightening require less electricity for heating. These conservation efficiencies mean that less electricity needs to be generated, saving operating costs and ultimately requiring less new power plant construction. Conservation also includes measures to reduce electrical losses in the region's generation, transmission and distribution system.

Conservation has been a central ingredient in the resource portfolios of previous plans for meeting future electrical energy needs. Each kilowatt-hour of electricity conserved means that one less kilowatt-hour needs to be generated. But conservation resources carry costs and risks, as do generation and demand response resources available to the region for development. The Council's uses a portfolio model to determine what resources to develop on what schedule in order to minimize power system costs and risks. (See Chapters 6 and 7 for a discussion of the portfolio analysis) Each of the resources considered by the portfolio model, including conservation, carry unique physical and financial characteristics that determine its value and risk to the system. The amounts of cost-effective conservation identified in this chapter are not presented as targets, but rather a summary of conservation resource characteristics. How much of this conservation resource to develop, at what pace, and under which development decision criteria is determined in the portfolio analysis. In the portfolio analysis, the costs and risks of developing conservation are evaluated relative to other resource alternatives considered in this plan. That analysis, presented in Chapter 7, leads to action plan targets for conservation acquisition.

In order for the portfolio model to identify how much conservation is appropriate to develop, the Council first estimates the amount, cost, and availability of conservation. The cost, amount and characteristics of the supply of conservation resources available to the region are described and reported in this chapter under specific medium-case assumptions. The amount of conservation available to develop depends on future growth patterns, economic cycles, and success of conservation programs, timing of codes and standards, power prices and a host of other factors. For example, more conservation would be available if the region grows at a faster pace than the medium-demand forecast. Less if the regions grows more slowly. Similarly, more would be cost-effective than reported in this chapter, if power prices are higher than the medium forecast used as a proxy for cost-effectiveness in this chapter.

This draft plan identifies over 4,600 average megawatts of technically available conservation potential in the medium-demand forecast by the end of the forecast period. About half of the potential is from lost-opportunity measures, which must be captured at the time new buildings are built or new appliances and equipment is purchased. The other half is discretionary with regard to timing. Discretionary conservation can be deployed any time within practical limits.

But not all of those 4,600 average megawatts of conservation potential are practicably achievable or economic to deploy. The Council's conservation resource assessment takes into account both the fraction of technical potential estimated to be ultimately achievable and the fraction estimated to be cost-effective under medium case assumptions.

The technically available conservation potential identified by the Council is reduced to reflect that a fraction of measures that can never be practicably achieved, even if the measures are free and cost-effective. Some customers will not adopt some measures, some equipment will not be replaced with more efficient equipment for a variety of reasons, and some new buildings and equipment will not meet energy codes and standards. To account for this, the Council estimates the fraction of the conservation potential is practicably achievable over the course of the twenty-year plan period and the pace at which the conservation programs can be accelerated or codes and standards adopted. The Council believes that program penetration can reach 85 percent over twenty years. But, early-year penetration rates for new programs will be lower because it takes time to ramp up programs. Specific ramp-up constraints, and year-to-year acceleration limits used in the portfolio analysis are described in Chapter 7. For the purpose of illustrating conservation potential in this chapter, the Council assumes 85 percent or 3,900 average megawatts, of the estimated 4,600 average megawatts of cost-effective conservation is achievable over the course of the twenty-year planning period.

Some of the conservation identified in the Council's resource assessment is relatively expensive. The portion of the 3,900 average megawatts of achievable conservation potential that will be cost-effective to develop depends on how future market prices unfold, how valuable the conservation resource is compared to other resources and the relative risk of conservation compared to other resources. The Council's portfolio analysis is used to determine best conservation development strategies given the uncertainties the region faces. But, for illustrative purposes in this chapter the Council reports amounts estimated to be cost-effective based on a medium-case forecast of power market prices at the Mid-Columbia trading hub for every hour over the next twenty years. Using this estimate of future wholesale electricity prices, about 2,800 average megawatts of the 3,900 achievable megawatts would be cost-effective.

These estimates for the fraction achievable and fraction that would be cost effective produce a single point estimate of 2,800 average megawatts of cost-effective and achievable conservation available to the region by 2025. This achievable and likely cost-effective conservation potential is available at an average levelized cost of about 2.4 cents per kilowatt-hour.[1] This is equivalent

[1] The energy savings potential and average cost estimates in this chapter include administrative costs and adjustments for transmission and distribution line losses. Levelized cost calculations are performed in constant (2000$) using a discount rate of 4 percent over a financing period of 15 years.

to the capability of more than eight new 400 megawatts coal-fired power plants at about two-thirds of the cost.[2]

Table 3-1, and Figure 3-1 show the distribution and estimated benefit cost ratios of the region's achievable and cost-effective conservation potential by major end-use and sector under the Council's medium forecasts of load growth, power and fuel prices, hydro conditions and resource development. Figure 3-2 shows the conservation supply curve by sector for all conservation identified in this assessment. Costs reported are the levelized costs of the conservation measures and expected program costs in (2000$).[3] Reported savings include reduced line losses.

[2] Based on a 400 megawatts coal-fired power plant seeing service in 2009. Under average conditions, such a plant would operate at an average capacity of 326 megawatts with a levelized cost of $36.68 per megawatt hour (year $2,000).

[3] These costs are not total resource costs. They do not include the value of deferred transmission or distribution system savings, quantifiable non-energy benefits, or operational and maintenance savings attributable to conservation measures. Total resource cost includes the net costs of conservation resources. The Council uses total resource costs, which are measure and program costs net of associated benefits when evaluating the relative costs of conservation and generating options to assure the fair comparison of conservation and generating resources.

Table 3-1: Achievable and Cost-Effective Conservation Potential

Sector and End-Use	Cost-Effective Savings Potential (MWa in 2025)[4]	Average Levelized Cost (Cents/kWh)[5]	Benefit/Cost Ratio[6]
Commercial New & Replacement Lighting	245	1.2	9.1
Agriculture - Irrigation	80	1.6	3.2
New & Replacement AC/DC Power Converters[7]	156	1.5	2.7
Residential Clothes Washers	135	5.2	2.6
Residential Dishwashers	10	1.6	2.6
Commercial New & Replacement Infrastructure[8]	11	1.4	2.4
Residential Compact Fluorescent Lights	535	1.7	2.3
Residential Water Heaters	80	2.2	2.3
Commercial Retrofit Lighting	114	1.8	2.2
Residential Refrigerators	5	2.1	2.2
Commercial Retrofit Equipment[9]	109	3.4	2.1
Residential HVAC System Conversions	70	4.3	2.1
Commercial New & Replacement Shell	13	1.6	2.0
Industrial Non-Aluminum	350	1.7	2.0
Residential New Space Conditioning - Shell	40	2.5	2.0
Residential Existing Space Conditioning - Shell	95	2.6	1.9
Residential HVAC System Commissioning	20	3.1	1.9
Commercial Retrofit Infrastructure[8]	105	2.2	1.8
Commercial New & Replacement Equipment[9]	84	2.2	1.8
Commercial New & Replacement HVAC	148	3.0	1.5
Commercial Retrofit HVAC	117	3.4	1.3
Commercial Retrofit Shell	9	2.9	1.3
Residential HVAC System Efficiency Upgrades	65	2.9	1.2
Residential Heat Pump Water Heaters	195	4.3	1.1
Residential Hot Water Heat Recovery	25	4.4	1.1
Total	**2,814**	**2.4**	**2.7**

[4] This is the total amount of conservation estimated to be cost-effective and achievable, given sufficient economic and political resources, over a 20-year period under the medium forecast of loads, fuel prices, water conditions, and resource development.
[5] These levelized costs do not include the 10-percent credit given to conservation in the Northwest Power Act.
[6] These "benefit-to-cost" (B/C) ratios are derived by dividing the present value benefits of each measure's energy, capacity, transmission and distribution and non-energy cost savings by the incremental present value cost (including program administration) of installing the measure.
[7] Measure occurs in residential, commercial and industrial sectors.
[8] Commercial infrastructure includes sewage treatment, municipal water supply, LED traffic lights, and LED exit signs.
[9] Commercial equipment includes refrigeration equipment and controls, computer and office equipment controls and laboratory fume hoods.

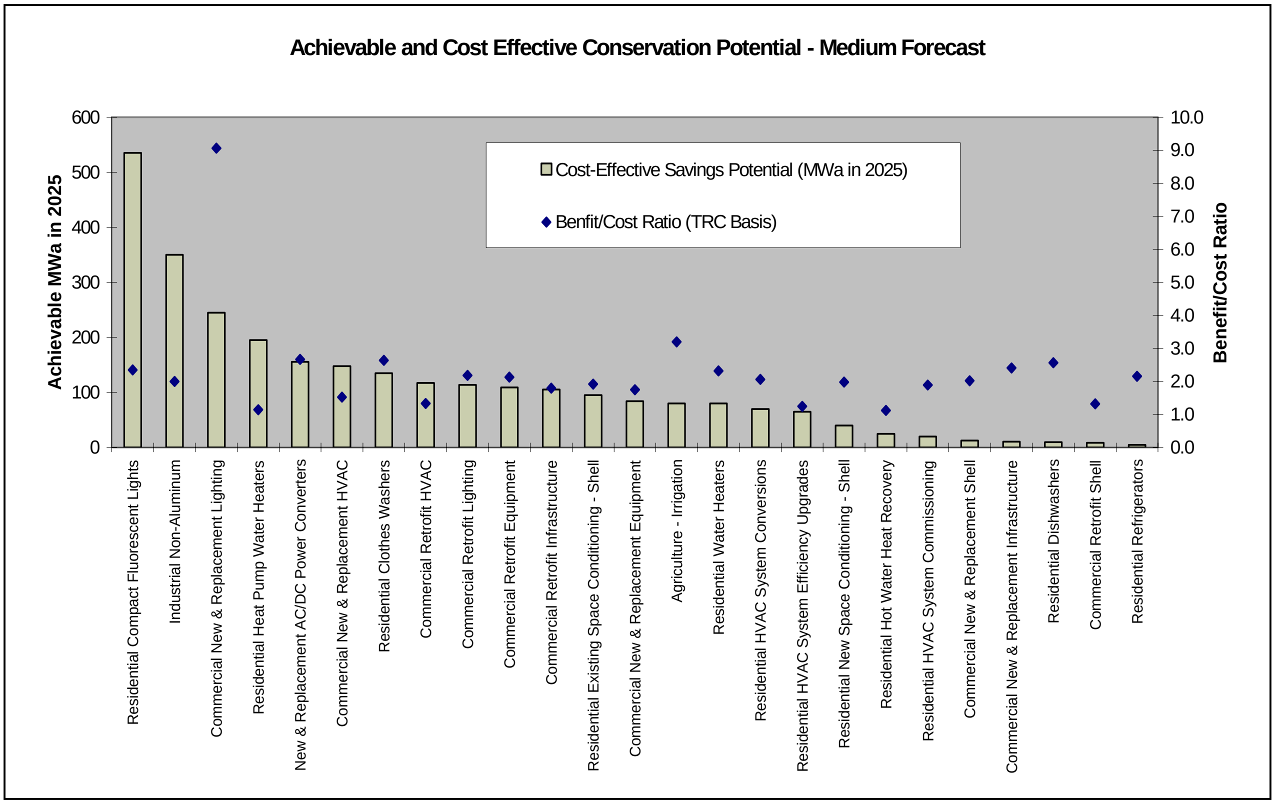

Figure 3-1: Achievable and Cost-Effective Conservation Potential

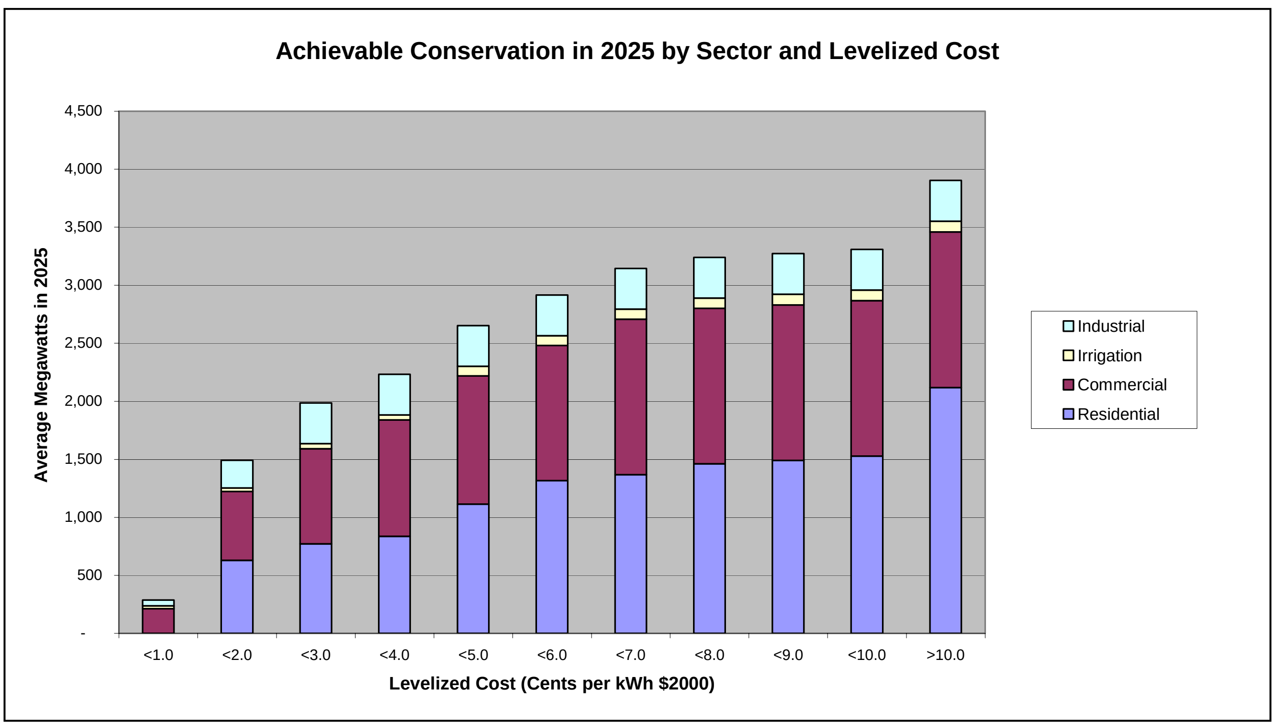

Figure 3-2: Achievable Conservation in 2025 by Sector and Levelized Cost

TWO DECADES OF CONSERVATION PROGRESS

Since the adoption of the Council's first power plan in 1983 the region has made significant progress in acquiring conservation. The Council's first power plan stated that the acquisition of cost-effective conservation should be used to reduce year 2002 loads by 5 to 17 percent depending upon the rate of economic growth experienced in the region. The plan called upon Bonneville and region's utilities to develop and implement a wide array of conservation programs. The plan also called upon the state and local governments to adopt more energy efficient building codes. It called upon the federal government to adopt national energy efficiency standards for appliances and to upgrade its existing efficiency standards for new manufactured homes.

In response to the Council's first power plan, the Bonneville Power Administration and the region's utilities initiated conservation programs across all economic sectors. Between 1980 and 2002, these programs acquired over an estimated 1,425 average megawatts of electricity savings. Since its formation in 1996, Bonneville and the region's utilities have sponsored the market transformation initiatives of the Northwest Energy Efficiency Alliance. Alliance programs have contributed another 110 average megawatts of savings, increasing the 1980-2002 regional total to 1,535 average megawatts. The average levelized cost of these savings to the region's power system was approximately 2.1 cents per kilowatt-hour (2000$), or approximately 60 percent of the expected cost of electricity from new generating resources. However, the region did not capture all the conservation identified in that first power plan. Nor has it captured all the cost-effective conservation identified in subsequent plans.

While progress toward adoption of more energy-efficient energy codes has proceeded at a slower pace, all of the Northwest states have now adopted energy codes that require new residential and commercial buildings and those buildings that undergo major renovations or remodeling to be constructed with significantly more efficiency measures. By 2002 buildings constructed to these codes were saving an estimated 475 average megawatts of electricity. The region will continue to accrue additional savings as future buildings are constructed in accordance with these codes.

At the federal level, new standards for residential water heaters and appliances such as refrigerators, freezers and clothes washers were first adopted in 1987. In 1992 Congress enacted federal standards for additional appliances, electric motors, certain commercial heating, ventilating, air conditioning equipment and lighting equipment. After much debate, in 1994 the Department of Housing and Urban Development (HUD) revised its federally pre-emptive energy efficiency standards for new manufactured homes for the first time in 20 years. Taken together these federal efficiency standards saved an estimated 450 average megawatts of electricity in 2002.

Figure 3-3 shows that cumulative conservation savings from Bonneville and utility programs, as well as state codes and federal standards from 1980 through 2002 total about 2,500 average megawatts. By 2002 the 2,500 average megawatts of conservation resources developed in the region were meeting between 10-12 percent of Northwest electric energy service needs. To place this in perspective, this is more electricity than was consumed in the entire state of Idaho during 2002.

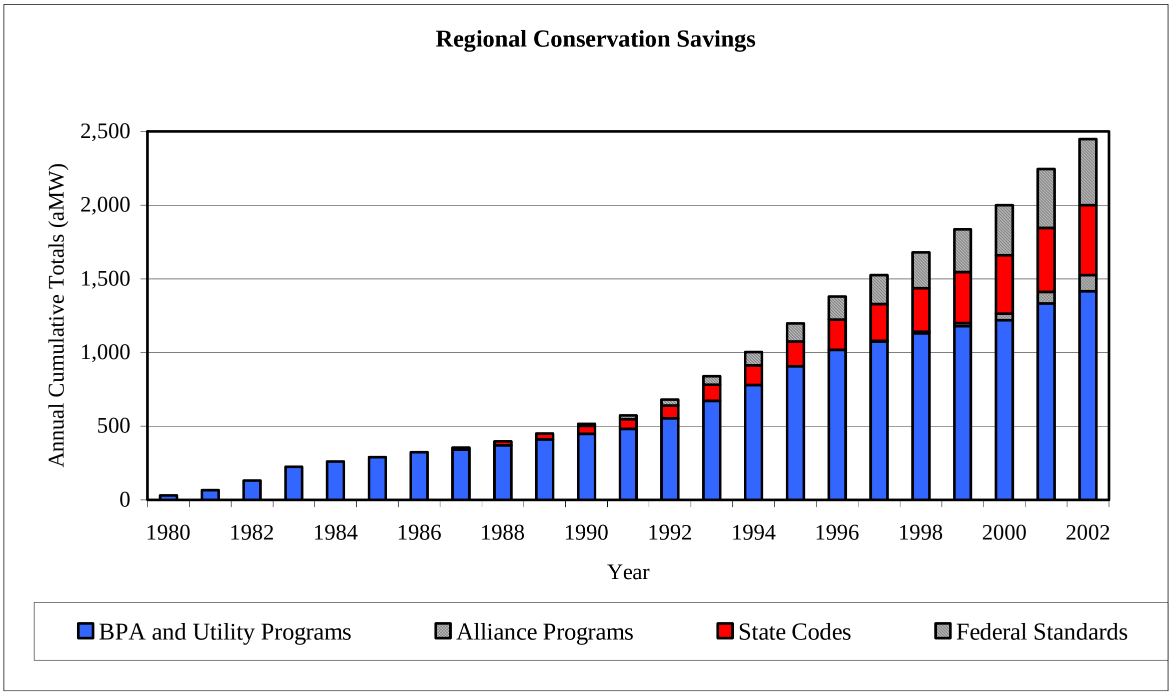

Figure 3-3: Regional Conservation Savings 1980 - 2002

MAJOR CHANGES IN CONSERVATION RESOURCE ESTIMATES

The Fourth Power Plan's conservation estimates were prepared in 1995. This new estimate of energy conservation potential takes into account significant changes that took place in the intervening years. These include: 1) conservation acquired since the Fourth Power Plan; 2) changes in avoided costs; 3) technology improvements; and 4) changes in baseline characteristics forecasts. Each of these changes is discussed in the following sections.

Conservation Acquisition Since the Adoption of the Fourth Power Plan

Since 1995 utility conservation programs, including regional market transformation activities, changes in federal and state codes and standards, have captured some of the cost-effective conservation potential identified for development in that plan.[10] Bonneville and utility programs acquired approximately 620 average megawatts of conservation resources between 1996 and 2002. In addition, the Northwest Energy Efficiency Alliance and its regional utility partners are increasing the market share of a wide array of higher-efficiency appliances, building practices, residential lighting and other measures. Figure 3-4 shows that by the year 2025 the Council estimates approximately 170 average megawatts of conservation will be captured by these existing market transformation efforts.

[10] Market transformation means efforts to improve the market viability and availability of specific conservation equipment or services so that they can achieve high levels of market penetration with little or no utility incentives. Because these markets typically cut across multiple utility service territories, market transformation efforts in the Northwest have been developed in conjunction with the region's utilities through the Northwest Energy Efficiency Alliance (NEEA).

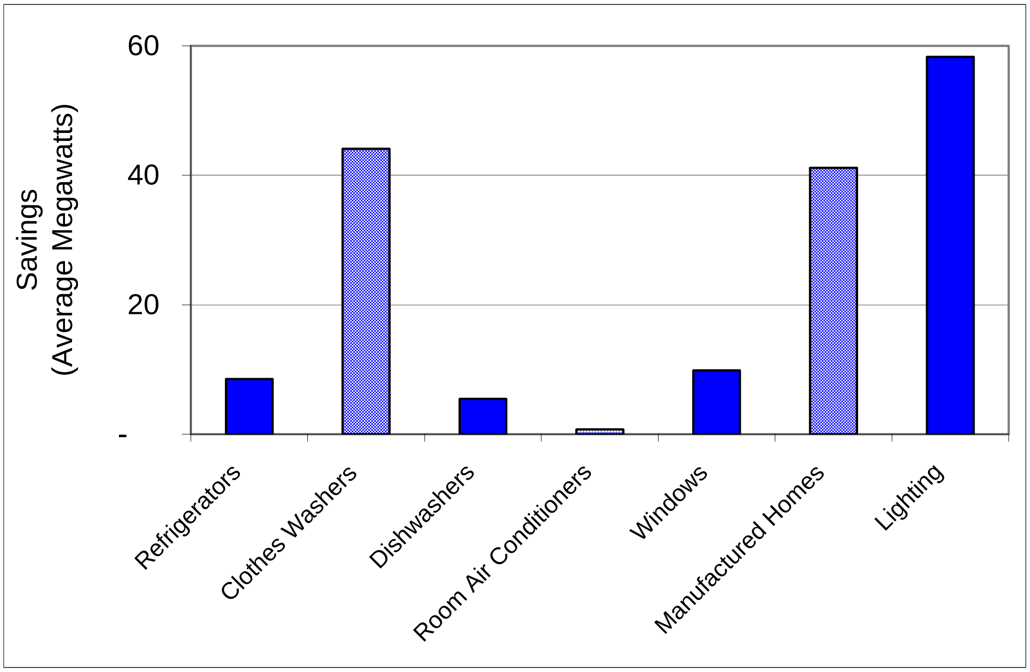

Figure 3-4: Future Load Reductions From Existing Market Transformation Efforts

Since 1995, revised federal standards for refrigerators, clothes washers, electric water heaters, heat pumps and central and room air conditioners have been adopted. Table 3-2 shows the magnitude of the improvement in efficiency required by these standards and their effective dates. Figure 3-5 shows the amount of savings attributable to each of these standards under the Council's medium load growth forecast. In aggregate, these standards are expected to save the region 730 average megawatts before the year 2025.

Table 3-2: Efficiency Improvements Required by Federal Appliance Efficiency Standards

COVERED APPLIANCE/EQUIPMENT	IMPROVEMENT OVER EXISTING STANDARD	EFFECTIVE DATE
Room Air Conditioners	10 - 25% depending on size	October 1, 2000
Refrigerators/Freezers	25 - 30%	July 1, 2001
Clothes Washers	20% 35%	January 1, 2004 January 1, 2007
Water Heaters	5%	January 20, 2004
Central Air Conditioners and Heat Pumps	30% for cooling 15% for heating	January 23, 2006

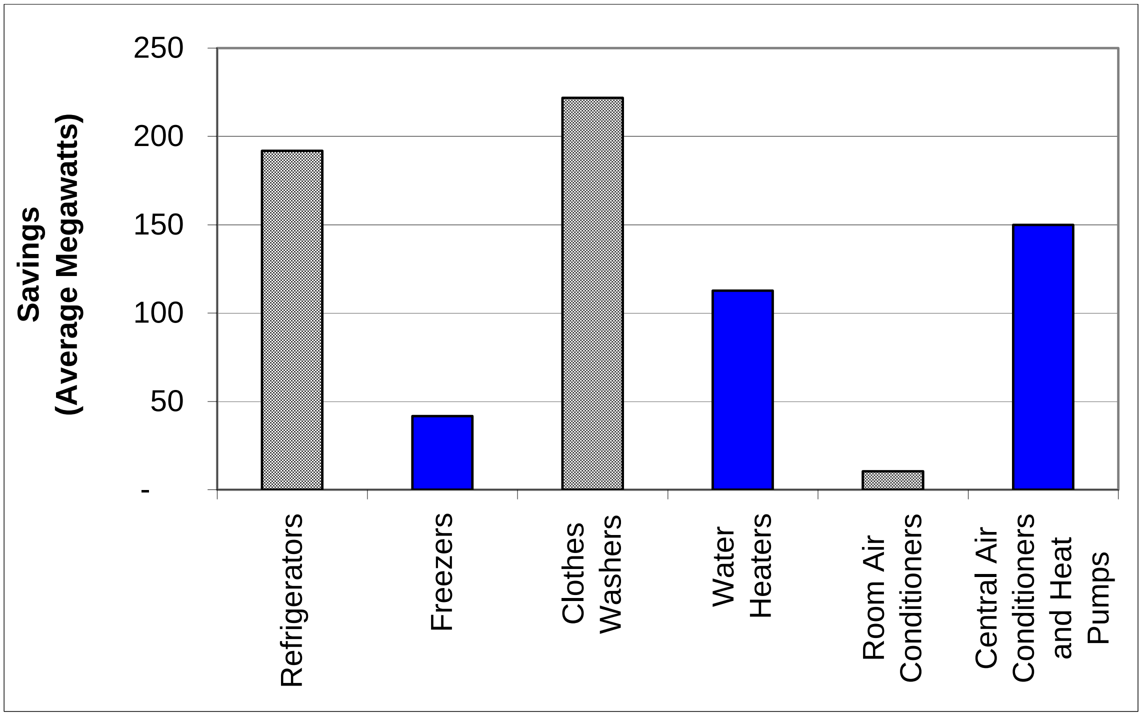

Figure 3-5: Forecast Regional Savings from Recently Revised Federal Appliance Efficiency Standards in 2025

In addition, Oregon, Washington, Seattle and Idaho have improved or adopted energy efficiency codes for commercial buildings since 1995. Oregon completed significant revisions, which took effect starting in 2003. Washington adopted modifications in 2001 and 2002. Seattle upgraded the its energy code in 2002. And Idaho adopted its first commercial building code, which took effect in 2003. The Council estimates that these changes, adopted since 1995, will reduce energy use in commercial buildings by about 100 average megawatts in 2025 under the medium growth forecast.

These forecast and historic savings have been incorporated into the Council's load forecast and removed from its conservation resource supply estimates. The 620 average megawatts of utility-acquired conservation secured from existing buildings, appliances and equipment reduces the remaining conservation potential from those applications. This is accounted for by a combination of reducing the remaining number of buildings or homes that are available for efficiency upgrades and reducing the level of savings in each. The efficiency gains from market transformation and codes and standards described earlier not only directly reduce the remaining potential but also reduce future expected load growth by an equivalent amount. This is accounted for by reducing the pace of expected load growth and by increasing the "baseline" efficiency used for the building, appliance or equipment affected by these codes and standards.

Changes in Avoided Costs

A second factor that has altered the amount of conservation remaining to be captured is the expected cost of new power supplies. In the Council's Fourth Power Plan, conservation resources with a real levelized cost of between 2.4 and 3.1 cents (2000$) per kilowatt-hour were considered regionally cost-effective. The "cost-effectiveness limit" used in this analysis is between 3.3 and 8.9 cents (2000$) per kilowatt-hour for a measure with a 20-year resource life, depending upon the daily and seasonal distribution of the savings.[11] Table 3-3 shows that under the Council's medium forecast, had the region's avoided cost of new generation remained under 3.0 cents per kilowatt-hour, approximately 765 average megawatts of conservation potential would not have been cost-effective.

Table 3-3: Changes To Conservation Resource Potential Due To Higher Avoided Cost

Sector & End Use	Average Megawatts
Residential Clothes Washers	135
Heat Pump Water Heaters	195
Hot Water Heat Recovery	35
Residential HVAC System Conversions	60
Residential HVAC System Commissioning & Repair	20
Commercial Lighting and HVAC Measures	270
Irrigated Agriculture	50
Total	**765**

Technology Improvements

Technological improvements since the adoption of the Fourth Power Plan have added cost-effective savings potential where none existed. Significant increases in the efficiency and/or reduction in the cost of more efficient refrigerators and freezers, clothes washers, dishwashers, lighting and windows have taken place over the past few years. The following two examples illustrate the significance of these changes.

The "most-efficient" clothes washers now available are 50 percent more efficient than the recently revised federal standard that is not scheduled to take effect until 2007. As a result, there are now 290 average megawatts of conservation potential available from the use of these more efficient clothes washers -- above and beyond a federal standard that will not take effect for three more years.

The average cost of compact fluorescent lamps (CFLs) assumed in the Fourth Power Plan was $12.55 per lamp. Today, CFLs can now be purchased for less than $3.00 per lamp. Moreover, current CFLs are significantly smaller in size and now include multiple output ("3-way") lamps, flood and spot lights and dimmable ballasts; thus they can now be used in nearly all residential lighting fixtures and applications. Due to their cost and physical characteristics, the Fourth Power Plan assumed that only three CFLs could be installed in the average residence. This draft plan assumes that nearly all fixtures with "screw in" incandescent lamps can be replaced with CFLs by 2025, increasing conservation potential from this one technology from 60 average megawatts to nearly 600 average megawatts.

[11] In this draft plan, the Council differentiates the marginal cost of supplying new power based on the time of day, the day of the week and the month of the year. As a result, the "cost-effectiveness" of a particular conservation measure depends on when it produces savings. See Appendix E: Conservation Cost-Effectiveness Methodology for further explanation.

Regional market transformation initiatives have produced results that justify including some new measures in the region's conservation portfolio. For example both developing the infrastructure to perform residential duct testing and sealing and developing lower-cost methods of reducing sewage treatment energy use are new measures in the assessment that sprang from regional market transformation efforts. Also in the "non-buildings" category, several new technologies have added to the stock of cost-effective conservation opportunities. These include better control of the power use of desktop computers, higher-efficiency commercial refrigerators, freezers and ice makers, LED traffic signals and exit signs and more efficient AC-to-DC power transformers used in hundreds of appliances from cell phone chargers to televisions. These new technologies have added nearly 1,300 average megawatts of conservation potential that was not considered or available in 1995.

The factors affecting the regional conservation potential estimates and their contributions are summarized in Table 3-4.

Table 3-4: Summary of Major Changes Affecting Regional Conservation Potential

Factor	**Affect on Conservation Potential in Medium Forecast (Average Megawatts)[12]**	
	Decrease	**Increase**
Utility Program Acquisitions	600	0
Regional Market Transformation Actions	170	0
New/Revised Federal Standards	730	0
Higher Avoided Cost	0	767
Technology Improvements	0	1240

Changes in the Load Forecast

In addition to these factors, changes in the load forecast can result in major changes in conservation resource potential. Five factors exerting the most influence are 1) the number of new residences heated with electricity; 2) the market share of electric water heating; 3) the electric heat saturation in commercial buildings; 4) the commercial building demolition rate; and 5) the rate of non-aluminum industrial load growth. Table 3-5 compares these factors for the draft Fifth Power Plan's medium forecast with the medium forecast from the Fourth Power Plan.

Table 3-5 shows that the most significant changes in the Council's estimate of regionally cost-effective conservation were due to differences in the underlying load forecast in the commercial and industrial sectors. Due to lower (relative to electricity) gas prices, more commercial buildings are expected to use natural gas heat. This lowered the commercial sector conservation potential. The Council also forecast fewer electrically heated dwellings and fewer electric water heaters by 2025. This also reduces the potential for conservation in the residential sector.

[12] Utility program acquisitions decrease the conservation resource potential available in existing buildings and equipment; the revised codes and standards impact conservation potential in new construction and lower avoided cost; and technology improvements affect both new and existing electricity applications.

The industrial sector growth is significantly lower than that in the Fourth Power Plan. DSI loads in 2025 are forecast to be 1,681 average megawatts lower than in the Fourth Power Plan. Under the medium forecast, non-DSI industrial loads are forecast to be 1,375 average megawatts lower. The Fourth Power Plan did not contain an estimate for conservation potential in the DSIs, so the reduction in future load from these industries had no impact on the regional conservation potential. On the other hand, the reduction in future non-DSI industrial loads has reduced the conservation potential in this sector.

The lower forecast for industrial electricity use is a result of anticipated changes in the region’s industrial mix. As Northwest electricity retail prices approach those experienced in other regions of the nation electricity-intensive industries such as pulp and paper and food processing are anticipated to comprise a smaller portion of the overall industrial sector load. This has reduced the total conservation potential available from non-DSI industrial loads.

Table 3-5: Major Changes in Medium Load Forecast Affecting Conservation Potential

Factor	Fourth Power Plan Value	Draft Fifth Plan Value	Impact on Conservation Potential
New Electrically Heated Dwellings	1.18 million	.813 million	Decrease Potential
Residential Water Heating Saturation	78%	64%	Decrease Potential
Commercial Sector Electric Heating	55% to 40% (over 20 years)	33% to 30% (over 20 years)	Decrease Potential
Commercial Sector Demolition Rate	High	Low	Decrease Potential
Non-Aluminum Industrial Load in 2015	7152 MWa	5919 MWa	Decrease Potential

ESTIMATING THE CONSERVATION RESOURCE

The following section summarizes the Council's estimates of conservation resources available to the region. The narrative is based on calculations from the Council's medium demand forecast. Conservation resources under these medium case conditions are summarized for each sector.

The evaluation of conservation resources involves four major steps. The steps are: 1) develop estimates of technical potential; 2) identify the amount of achievable and the cost of conservation including its contribution to energy and capacity needs, 3) identify development characteristics of the cost-effective conservation potential including programmatic approaches and timing constraints; and 4) identify conservation development strategies that optimize the value of conservation for the region based on its cost, savings, dispatchability and risk-minimization characteristics. These steps are described briefly in the sections below. Methods used in the second step, identifying the amount of cost-effective potential, are explained in further detail in Appendix D. While these methods are not significantly different than in the last plan, their application under new avoided costs leads to a significant increase in conservation potential and changes in the values of different conservation measures.

Step 1: Develop estimates of Technical Potential

The first step is to develop conservation supply curves based on engineering analysis. This step entails evaluating the leveled life-cycle cost of all conservation measures, determining what fraction of forecast building, appliance or equipment stock the measures apply to, whether the measure is a lost-opportunity, and savings interactions from application of multiple measures. Measure costs include capital, financing, operating and period replacement costs. Measure energy and capacity savings are estimated, including the monthly and daily shape of the savings. Non-energy benefits and costs, such as water savings or changes in natural gas use associated with of each measure are estimated to the extent they can be identified and calculated. This results in a summary of all the costs and savings for technically feasible measures. From these estimates the Council calculates several key parameters including levelized life-cycle cost and benefit-cost ratios.[13]

This technical conservation supply curve represents all the available conservation potential and its associated costs. However, it is not all practically achievable. "Achievable conservation," is defined as the net energy savings the Council anticipates after taking into account factors such as consumer resistance, quality control and unforeseen technical problems. Historically, the Council has assumed that 85 percent of the technically available conservation was achievable because it believed that the wide assortment of incentives and regulatory measures provided by the Northwest Power Act could persuade the region's electricity consumers to install a large percentage of the available and cost-effective conservation. The draft Fifth Power Plan continues to assume that 85 percent of the cost-effective conservation can be achieved.

Two supply curves are passed to the Council's portfolio analysis model. One curve is for discretionary conservation measures. The other describes lost-opportunity conservation measures. The Council's portfolio model then evaluates conservation and other resources available to meet the region's power needs and identifies resource development strategies for each. The achievable conservation supply curves made available to the portfolio analysis model includes some measures that are cost-effective and some that are not.

Step 2: Estimating Cost-Effective Conservation

The Council uses its portfolio model to determine how much conservation is cost-effective to develop. But in order to characterize the conservation potential for this assessment, the Council estimates which measures and programs represented in the achievable supply curve are regionally cost-effective. To do this, the present value of each measure's benefits is compared to the present value of its life cycle costs. Benefits include energy and capacity cost savings, local distribution cost savings and the 10 percent credit given conservation in the Northwest Power Act and any quantifiable non-energy benefits.[14]

[13] Levelized life-cycle cost is the present value of a resource's cost (including capital, financing and operating costs) converted into a stream of equal annual payments; unit levelized life-cycle costs (cents per kilowatt-hour) are obtained by dividing this payment by the annual kilowatt-hours saved or produced.

[14] To ensure that conservation and generating resources are compared fairly, the costs and savings of both types of resources must be evaluated at the same point of distribution in the electrical grid. Conservation savings and costs are evaluated at the point of use, such as in the house. In contrast, the costs and generation from a power plant are evaluated at the generator itself (busbar). Thus, to make conservation and the traditional forms of generation

The costs included in the Council's analyses are the sum of the total installed cost of the measure, and any operation and maintenance costs (or savings) associated with ensuring the measure's proper functioning over its expected life. The benefit-cost ratio of a measure is the sum of the present value benefits divided by the sum of the present value costs. Any measure that has a benefit-to-cost ratio of 1.0 or greater is deemed to be regionally cost effective. Those measures that pass this screening step are then grouped into "programs. The cost of this package of measures is then increased to account for program administrative expenses to estimate whether the overall package is regionally cost-effective.[15]

The Council incorporates detailed information on the benefits of conservation based on when the conservation produces savings. The Northwest's highest demand for electricity occurs during the coldest winter days, usually during the early morning or late afternoon. Electricity saved during these periods is more valuable than savings at night during spring when snow melt is filling the region's hydroelectric system and the demand for electricity is much lower. However, since the Northwest electric system is linked to the West Coast wholesale power market, the value of the conservation is no longer determined by solely by regional needs.

Part of the value of a kilowatt-hour saved is the value it would bring on the wholesale power market. This assessment uses the Mid-Columbia trading hub (Mid-C) prices from the AURORA forecasting model to represent the wholesale value of electricity saved and thereby gauge cost-effectiveness. Given the interconnected nature of the West, Mid-C wholesale power prices are expected to reflect the demand for summer air conditioning in California, Nevada and the remainder of the desert Southwest. Consequently, wholesale power prices are significantly higher during the peak air conditioning season in July and August than they are during the remainder of the year. Measures, like more efficient air conditioning, reflect the value of these higher prices.

In addition to its value in offsetting the need for generation, conservation also reduces the need to expand local power distribution system capacity and transmission system capacity. The values for this aspect of conservation range from zero for central air conditioning to 1.8 cents per kilowatt-hour for residential space heating depending on when the savings occur relative to system peaks. A more detailed discussion of the time value of conservation savings is in Appendix E: Conservation Cost-Effectiveness Methodology.

Step 3: Identify Development Characteristics

The value of conservation is also determined by how and when it can be developed. The conservation assessment identifies two key characteristics in this regard. First the conservation potential is characterized by whether its timing is discretionary. For conservation measures that are applied to existing buildings, timing is largely discretionary. Whereas for measures in new

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comparable, the costs of the generation plant must be adjusted to include transmission system losses and transmission costs.

[15] In addition to the direct capital and replacement costs of the conservation measures, administrative costs to run the program must be included in the overall cost. Administrative costs can vary significantly among programs and are usually ongoing annual costs. In prior power plans, the Council used 20 percent of the capital costs of a conservation program to represent administrative costs. The Council's estimate of 20 percent falls within the range of costs experienced in the region to date. Therefore, the average cost of all conservation programs is increased 20 percent before being compared to generating resources.

buildings, or equipment, the opportunity to adopt the measure occurs only as fast as new buildings or equipment are put in place. This limits the rate at which these measures can be adopted. However, it also limits the window of opportunity when efficiency upgrades can be captured. This latter category of conservation resources is therefore frequently referred to as “lost opportunity” resources. Furthermore, the conservation assessment identifies the rate at which conservation developments can be accelerated or decelerated. Each bundle of conservation potential has deployment limits.

These constraints include the rate at which programs can be brought online, referred to as the program acceleration or *ramp* rate, the maximum that can be developed in any three-month period, and the maximum ramp-up and ramp-down between quarters. Development of discretionary conservation is limited to a maximum of 30 average megawatts per quarter or 120 average megawatts per year. For lost-opportunity conservation, quarterly development is limited by the physical amount of lost-opportunities available in that quarter. This amount is tied to the growth rate in electricity demand so that in times of high growth, more lost-opportunity conservation is available for development. Less is available in times of low load growth. Lost-opportunity conservation is also constrained in the early years of the forecast period as new programs are brought on line. The maximum penetration of lost-opportunity conservation programs is 15 percent of available stock in 2005 and increases to 85 percent by 2016. The rate at which programs can slow down and the minimum level at which programs can remain viable are also important. The minimum viable level of the program, if above zero, determines the amount of savings that would accrue even though the region would prefer to delay the purchase of the resource during the surplus period. Each program also has an upper limit on its activity level and how quickly the activity level can be reduced (decelerated).

The Council based the ramp rate limits it assumed in its portfolio analysis model on an analysis of historical year-to-year changes in the level of utility conservation. Figure 3-6 shows that year-to-year swings in the amount of utility-acquired conservation in the region have ranged from a decrease of about 70 average megawatts to an increase of nearly 100 average megawatts with multiple “swings” in the 30 - 40 average megawatt range. The Council limited the changes to 80 average megawatts per year.

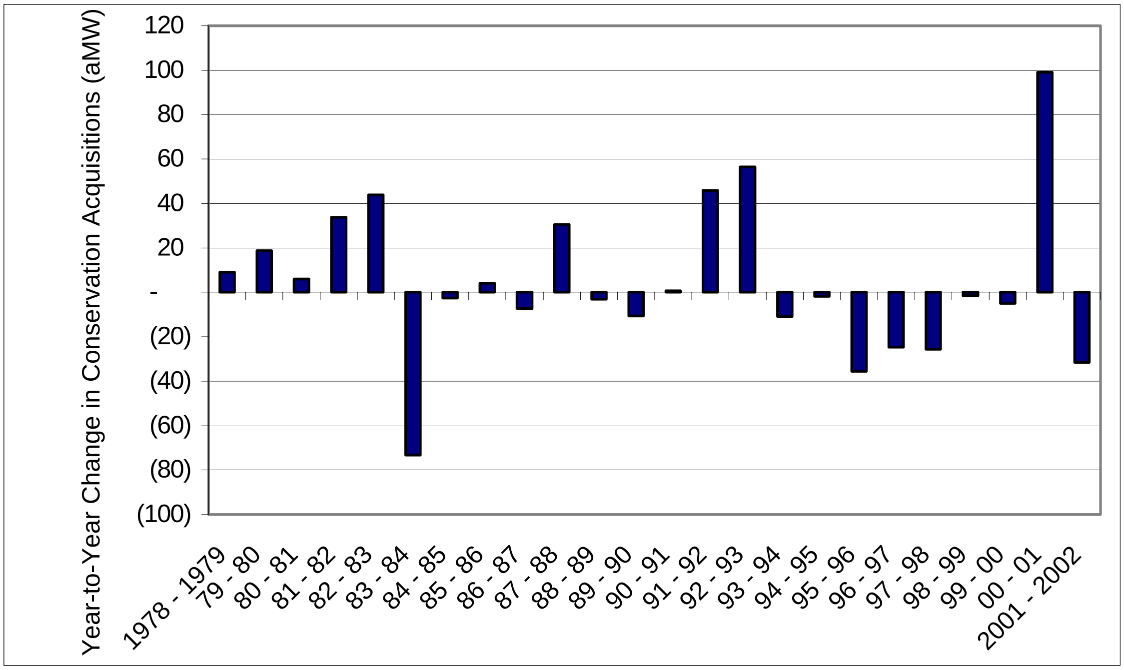

Figure 3-6: Year-to-Year Changes in Northwest Utility-Acquired Conservation

Step 4: Identify Optimal Conservation Development Strategies

The final step in determining the value of conservation savings to the Northwest involves evaluating conservation resources and other resources available for development as part of the regional electricity system. The cost and savings data, the shape of the savings, their capacity value, and the development timing characteristics of conservation are analyzed in the Council's portfolio analysis model. How much conservation to develop is determined by comparing conservation against other resources to find which conservation deployment strategy in combination with development of other resources provides the Northwest with electric service at the least cost while maintaining system reliability at an acceptable level of risk. The results of that analysis are in Chapter 7.

SUMMARY OF ACHIEVABLE CONSERVATION POTENTIAL BY ECONOMIC SECTOR

The following sections summarize the conservation available to the region. The discussion is broken down by economic sectors including residential, commercial, industrial, and agricultural. Cost-effective amounts in these tables are based on medium case forecasts and base-case estimated wholesale prices, not optimized results of the portfolio analysis. Details are available on line at the Council's web site.

A Note about Supply Curves

A supply curve depicts the amount of a product available across a range of prices. In the case of conservation, this translates into the number of average megawatts that can be conserved at various costs. More conservation is available at higher cost, up to a point. This section depicts much of the conservation resource in the form of supply curves. These can be for individual measures or groups of measures. The supply curves used in this draft plan do not distinguish between conservation resulting from specific programs or consumer response to the price of electricity. Regardless of how the costs of installing a conservation measure are shared, its total cost to the region is the same. The money used to purchase these savings is not available for investment in other resources and goods. If consumers contribute to the purchase of conservation resources, then the cost to the electricity system (i.e., utilities) will be less than the costs presented in this chapter. The costs presented here represent all costs to all participants. This is called total resource cost, or TRC.

Conservation supply curves are a function of the conservation measure's savings and cost. Each measure's savings and cost are used to derive a levelized cost, expressed in cents per kilowatt-hour. The absolute value (in terms of kilowatt-hours per year) of the savings produced by adding a conservation measure is a function of the existing level of efficiency. The less efficient the existing structure or equipment, the greater the savings obtained from installing the measure. In order to minimize the costs of efficiency improvements, conservation measures are applied in order from lowest-cost to highest.[16]

To ensure consistency between the conservation supply curves and the portfolio analysis model, financial assumptions used in the levelized cost calculation are the same as those used in the system models. The portfolio analysis model assumes that conservation will be financed for 15 years or the life of the conservation measure; whichever is shorter, at a real after-tax interest rate of 4 percent.[17]

Residential Sector

The residential sector consumed just over 6,700 average megawatts of electricity in the year 2000, or about 38 percent of the region’s non-DSI electricity consumption. Under the medium demand forecast residential loads are expected to grow by about 2,700 average megawatts or 1.36 percent per year from 2000 to 2025. If all of the realistically achievable conservation potential identified in this draft plan is acquired, 2025 residential sector loads could be cost-effectively reduced by 1,275 average megawatts.

Figure 3-7 shows the technical, economic and achievable conservation potential in the residential sector at levelized costs up to over 10 cents per kilowatt-hour. As can be seen from this chart the total economic potential in the residential sector is approximately 1,500 average megawatts by 2025 in the medium forecast. Of this amount the draft plan estimates that 1,275 average megawatts of conservation savings can be realistically achieved by 2025.

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[16] Least cost is defined in terms of a measure’s levelized life-cycle cost, stated in cents per kilowatt-hour. Levelized cost is used so that measures with different lifetimes and savings can be compared on a uniform basis.

[17] In practice, consumers and/or utilities may decide to pay cash or “expense” their conservation investments. While this increases the “up front” cost of the savings it avoids the interest cost associated with financing and therefore would produce a lower levelized cost than shown here.

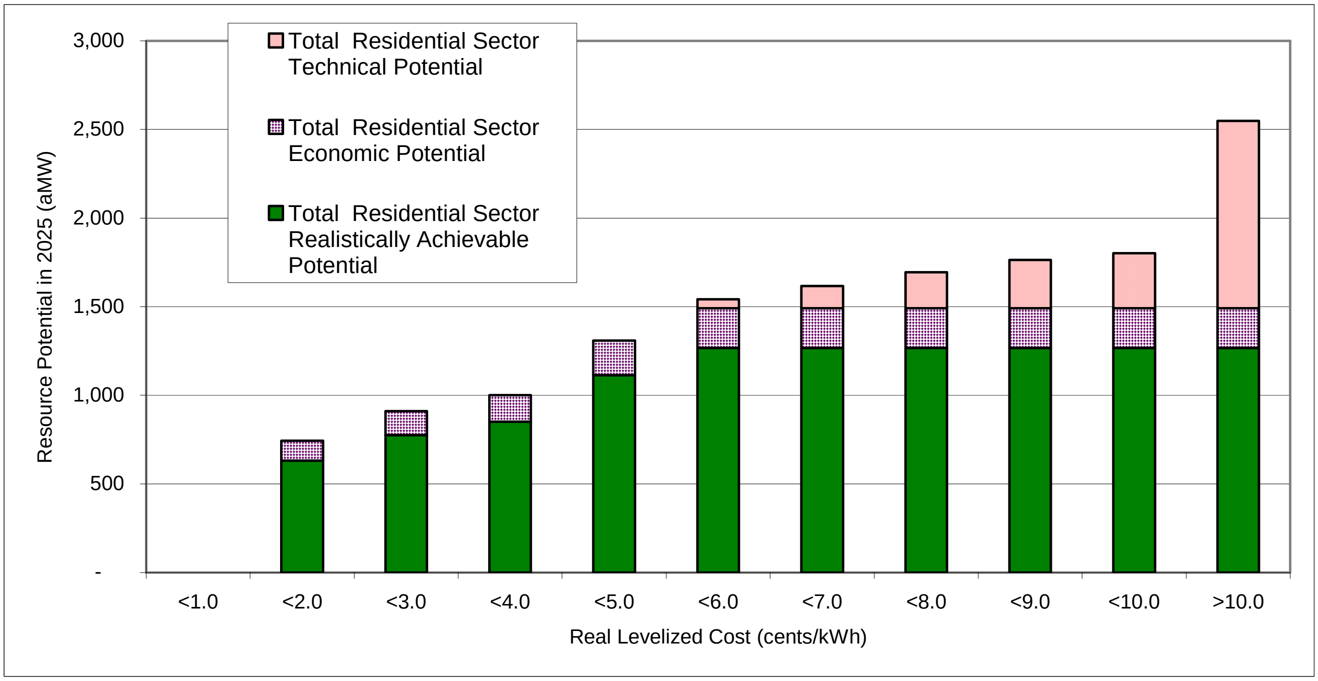

Figure 3-7: Residential Sector Technical, Economic and Achievable Conservation Potential by 2025 under Medium Forecast

Major residential sector conservation opportunities have been identified that will reduce the anticipated demand for space conditioning (i.e., heating and cooling), water heating, lighting, clothes and dish washing and refrigeration. Figure 3-8 shows the source of the savings among the major end uses of electricity in this sector. The largest resource potential (41 percent) is estimated to be available from improvements in residential lighting.

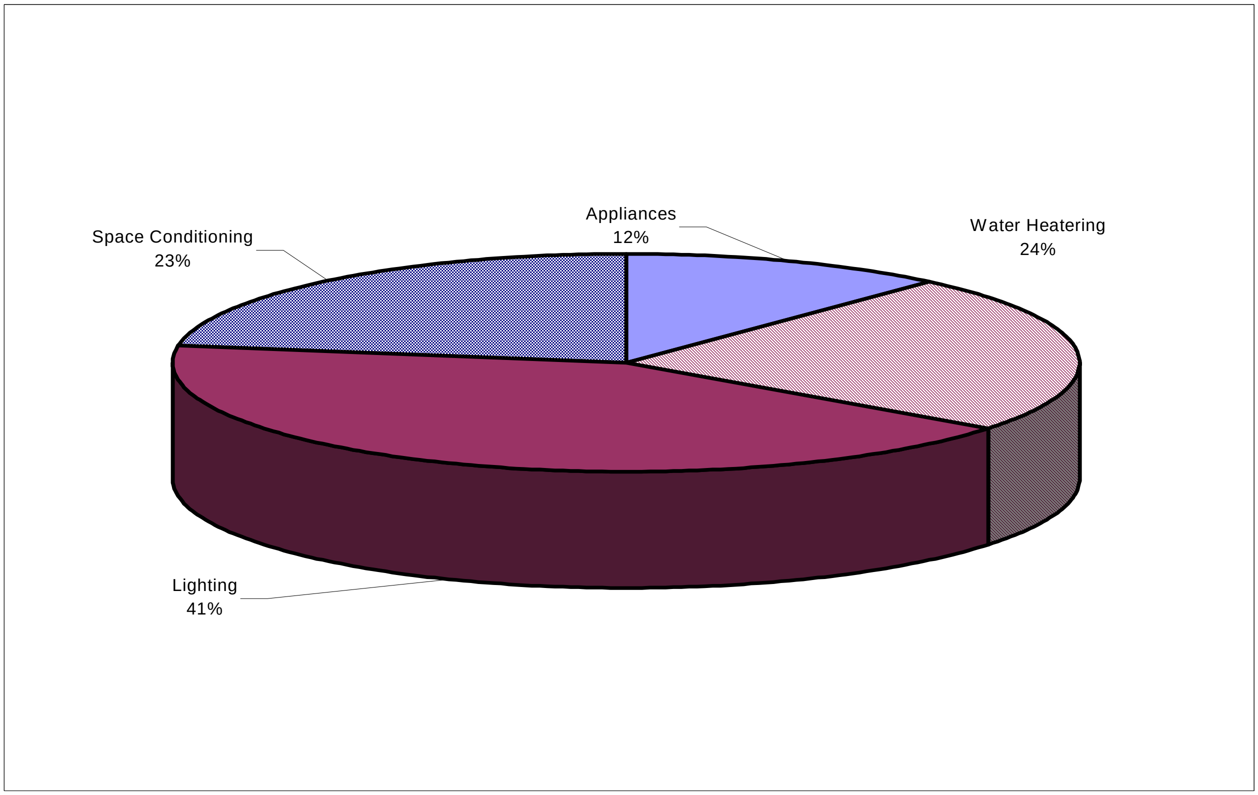

Figure 3-8: Residential Savings Potential by End Use

Improvements in water heating and space condition efficiency each constitute about one-fourth of the achievable potential. More efficient appliances comprise the remainder of this sector's potential. The following section discusses the major findings of the Council draft conservation assessment for this sector.

Residential Space Conditioning

Although thousands of the electrically heated homes in the region have been retrofitted and improved energy codes require that new homes be built more efficiently, not all cost-effective conservation opportunities in existing and new homes have been, or are being, captured. Figure 3-9 shows the technical, economic and achievable savings potential in residential space conditioning. This draft plan identifies cost-effective conservation savings in existing site-built and manufactured/mobile homes that could reduce year 2025 demand for electricity by 285 average megawatts. These savings are available at an average total resource cost of 3.1 cents per kilowatt-hour.

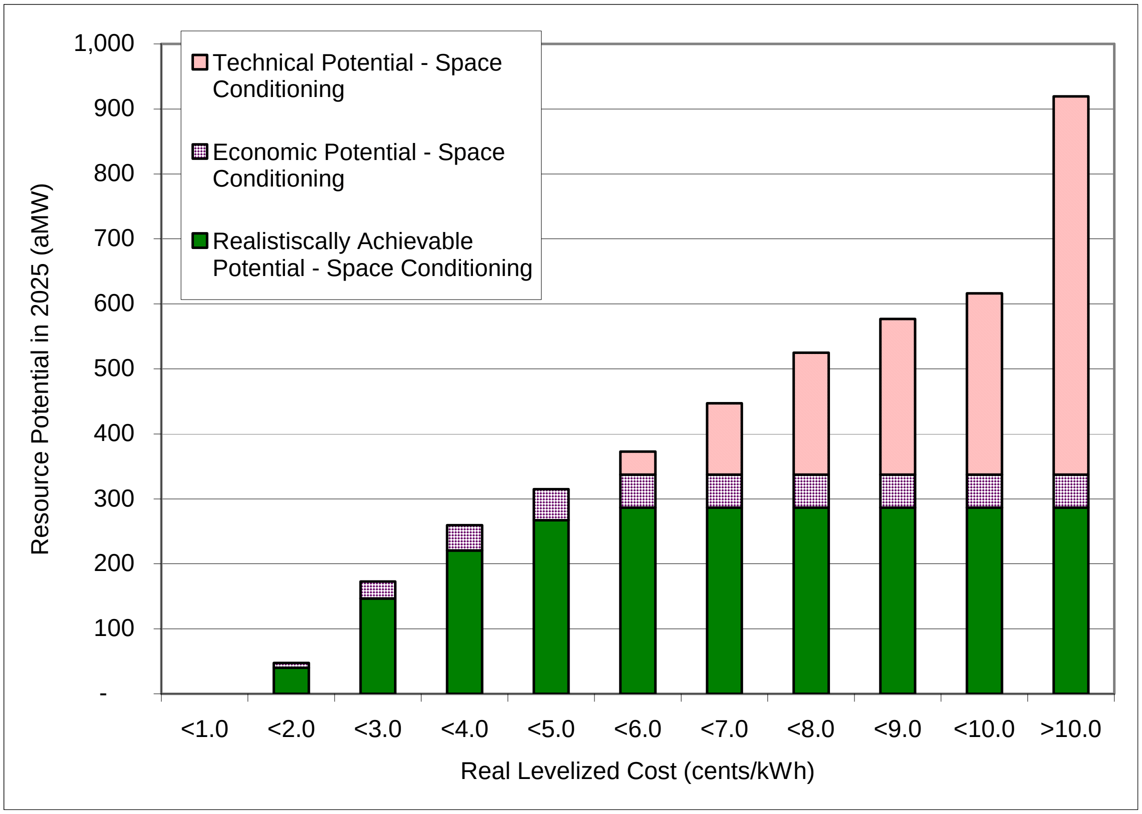

Figure 3-9: Residential Space Conditioning Conservation Resource Potential

Approximately one-third of the achievable space conditioning conservation potential can be acquired through weatherization of existing site-built and manufactured homes. Improving the efficiency of both existing and new heating systems through either converting them to heat pumps or installing a higher efficiency heat pump represents about half of the space conditioning conservation potential. Sealing duct work in homes with electric forced-air heating systems and "commissioning" heat pumps to ensure their refrigerant charge is correct and that they have adequate air flow across their heating coils each represent about 3 percent of the achievable potential. The remaining 12 percent of the potential comes from improvements in the efficiency of new site-built and manufactured homes.

This is the first Council plan to identify the conversion of existing forced-air and zonal (baseboard, wall & radiant) heating systems to high efficiency air-source heat pumps as a cost-effective conservation option. This plan, also for the first time, identifies cost-effective conservation savings opportunities from reducing the "leaks" in forced-air distribution system ductwork and from proper installation of air-source heat pumps. These options would not have been available had it not been for regional market transformation activities supported by the Northwest Energy Efficiency Alliance and its utility partners. However, while the transformation of this market may yet occur, it appears that in the near term local utility programs will need to target these measures in order to capture their savings.

Residential Lighting

The single largest residential sector conservation opportunity identified in this draft plan is the replacement of incandescent lamps with compact fluorescent lamps (CFLs). As noted previously, recent improvements in product quality (size, color rendition, "instant start," etc.) and dramatically lower product prices have increased the size of this conservation resource by nearly tenfold. Over the next 20 years the region could reduce lighting use in the residential sector by 530 average megawatts at a total resource cost of 1.7 cents per kilowatt-hour.

The Northwest has been quite successful in its efforts to deploy improved compact fluorescent lighting over the past several years. In the future, both regional market transformation efforts and continued local utility programs will be necessary to capture this large resource. Market transformation efforts should focus on improving product quality and features that promote consumer acceptance (color, multi-wattage, dimming capability, etc.) while utility programs can address the lack of awareness and higher incremental cost barriers faced by this technology.

Residential Appliances

Figure 3-10 shows that 150 average megawatts of cost-effective conservation is estimated to be achievable by 2025 from improvements in residential appliances. The average total resource cost of these savings is 4.9 cents per kilowatt-hour.

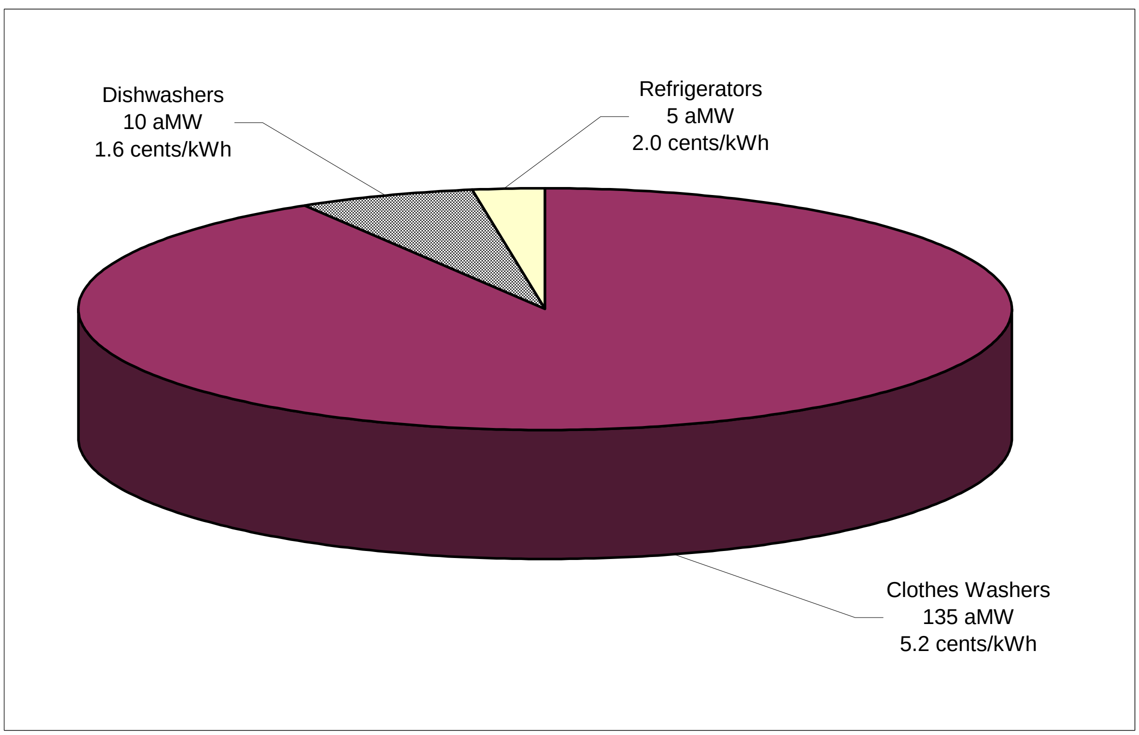

Figure 3-10: Realistically Achievable Conservation Potential in Residential Appliances

Savings from more efficient clothes washers represent over 90 percent of the savings available from the use of more efficient residential appliances. Despite the recent adoption of higher efficiency standards for residential clothes washers, advancements in technology have made even higher levels of efficiency cost-effective. New clothes washers are available that are 50 percent more efficient than the 2007 federal standard. While savings from clothes washers have a relatively high levelized cost (5.2 cents per kilowatt-hour) they are regionally cost-effective from a total resource cost perspective due in large part to their significant "non-energy" benefits. These washers require much less water and detergent. Therefore they save the region both water and wastewater treatment costs as well as energy costs.

The small amount of conservation potential available from improvements in residential refrigerators and freezers is due to the fact that a new federal standard took effect in 2001 that increased efficiency by approximately 30 percent. On average, a typical new refrigerator now uses less than 500 kilowatt-hours per year, down from over 1,000 kilowatt-hours less than a decade ago. Consequently, a 10 percent improvement in efficiency only nets about 50 kilowatt-hours per year of savings -- about the same as replacing one incandescent lamp with a CFL.

On the other hand, recent product offerings from some refrigerator manufacturers have increased the differential between the new federal standard and their products, with some models exceeding the federal standards efficiency by as much as 20 percent. While there are as yet too few models to determine whether this level efficiency is cost-effective, the Council intends to review this issue prior to issuance of its final Fifth Power Plan.

Residential Water Heating

Four major technologies were investigated to assess their ability to cost-effectively reduce residential water heating use. The new federal standards that took effect in January of 2004 require that a 50-gallon electric water heater achieve and Energy Factor (EF) of not less than 0.904. Despite the improvements required by the new federal standards, even higher levels of tank efficiency can produce cost-effective savings. Installation of better-insulated tanks instead of ones that just meet the new federal standard could produce regional savings of over 80 average megawatts by 2025 at a total resource cost of 2.2 cents per kilowatt-hour.

In addition to improvements in tank efficiency which only reduce "standby" losses, two other technologies are available that reduce the amount of electricity needed to heat the water in the tank. The first of these technologies employs a small heat pump to extract heat from the air and release it inside the tank. Current commercially available water heating heat pumps are capable of achieving over 240 percent improvements in the efficiency of water heating. Application of this technology, due to its high cost (4.3 cents per kilowatt-hour) and its larger physical size has been limited to not more than one-quarter of the region's single family and manufactured homes. However, even with this limitation, the use of heat pump water heaters could produce regional savings of 195 average megawatts by 2025.

Heat pump water heaters have been commercially available since the early 1980s. In fact the first Council plan anticipated that they would achieve significant market penetration by the year 2000. This has not proven to be the case. Consequently, the region needs to undertake a deliberate program to achieve the cost-effective savings available from this technology. This will likely require a demonstration project of that is both regional in nature and of significant scale. The primary problem facing the deployment of this technology is its current high incremental cost and the lack of a regional distribution network -- barriers that cannot be overcome by individual utility programs.

Solar water heating is the third technology option for reducing electricity use for residential water heating. While this technology clearly has promise, at its current price it was not identified providing a regionally cost-effective resource option. Figure 3-11 shows the major sources of residential water heating conservation potential.

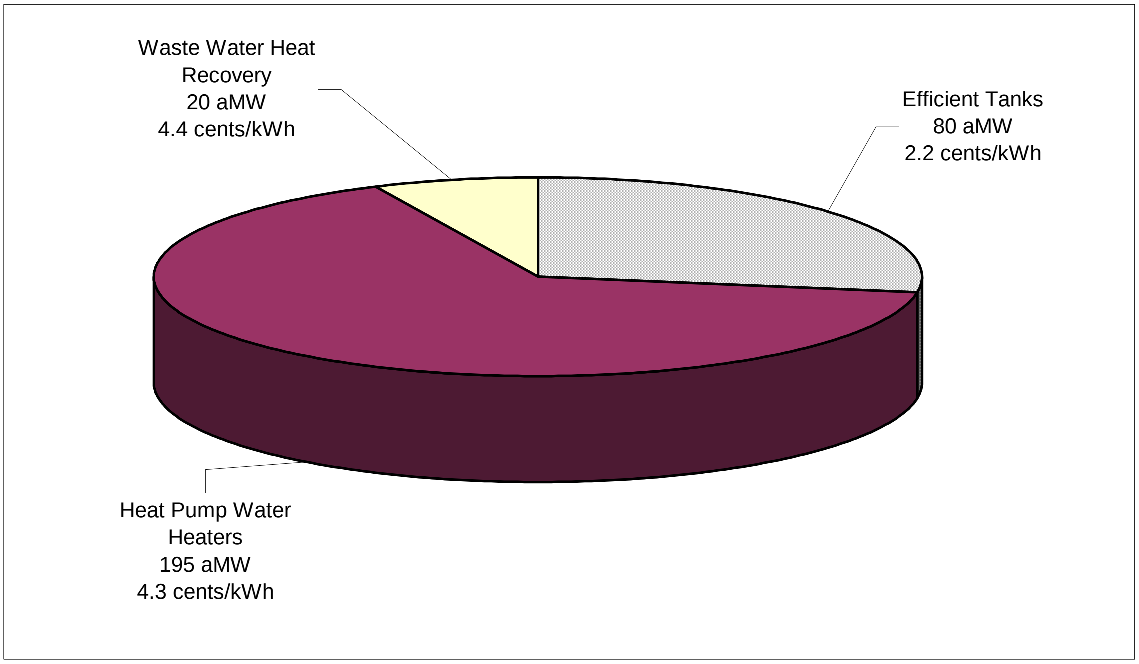

Figure 3-11: Realistically Achievable Conservation Potential in Residential Water Heating in 2025

The fourth technology that can cost-effectively reduce future residential water heating use recovers waste heat from shower drain water to pre-heat the shower's cold water supply. This recent technology innovation employs the fact that drain water adheres to the sides of a pipe as it falls downward. The phenomenon, referred as "gravity film adhesion," permits heat to be recovered from the shower drain water. By the year 2025 installation of this technology in new single family and multifamily dwellings could save the region 20 average megawatts at a total resource cost of 4.4 cents per kilowatt-hour.

The achievable potential for this measure could be significantly increased (perhaps by as much as fivefold) if it were adopted in state energy code requirements for new residential construction. In the near term, both regional market transformation efforts and local utility incentives will likely be required to capture this resource.

Dispatchable and Lost Opportunity Resources in the Residential Sector

Approximately half, 650 average megawatts, of the achievable resource potential in the residential sector is comprised of "dispatchable" conservation resources. These resources can be scheduled for development any time during the next twenty years. On the other hand, the remaining half, 625 average megawatts, of the achievable conservation resources in this sector must be acquired at the time of their construction, replacement or installation. Once programs are capturing 85 percent of lost-opportunities this amounts to between 30-35 average megawatts per year. Based on their total resource cost, the region (utilities and consumers) would need to allocate approximately $125 million annually to acquire these “lost-opportunity” resources. If the region were to acquire the dispatchable residential sector conservation resources in equal annual amounts (20-25 average megawatts) over the next twenty years the total resource cost of doing so would be approximately $60 million per year.

Commercial Sector

The commercial sector consumed just over 5,200 average megawatts of electricity in the year 2000, or about 30 percent of the region’s non-DSI electricity consumption. About 88 percent of this is used in buildings with the remaining amount used in infrastructure systems like water supply, sewage treatment, street and highway lighting, traffic signals, broadcasting and other non-building systems that are part of our economy. Under the medium forecast, commercial loads are expected to grow to by nearly 1,800 average megawatts or 1.18 percent per year from 2000 to 2025. If all of the realistically achievable conservation potential identified in this draft plan is acquired, 2025 commercial sector loads could be cost-effectively reduced by about 1,100 average megawatts under the medium forecast.

The draft commercial conservation assessment evaluated about 100 measures for possible inclusion in the supply curve. All told, nearly 1,600 average megawatts of technical conservation potential were identified in the medium forecast as shown in Figure 3-12. The assessment covered building systems, equipment and infrastructure. Nearly 90 percent of the conservation identified is cost-effective based on expected average wholesale market prices. Estimating that 85 percent of the conservation is practically achievable leaves a cost-effective and achievable resource of over 1,100 average megawatts that could be developed over the forecast period in the commercial sector. That is about 16 percent of medium forecast 2025 commercial sector loads. The average levelized cost of the cost-effective and achievable conservation is 2.1 cents per kilowatt-hours (2000$).

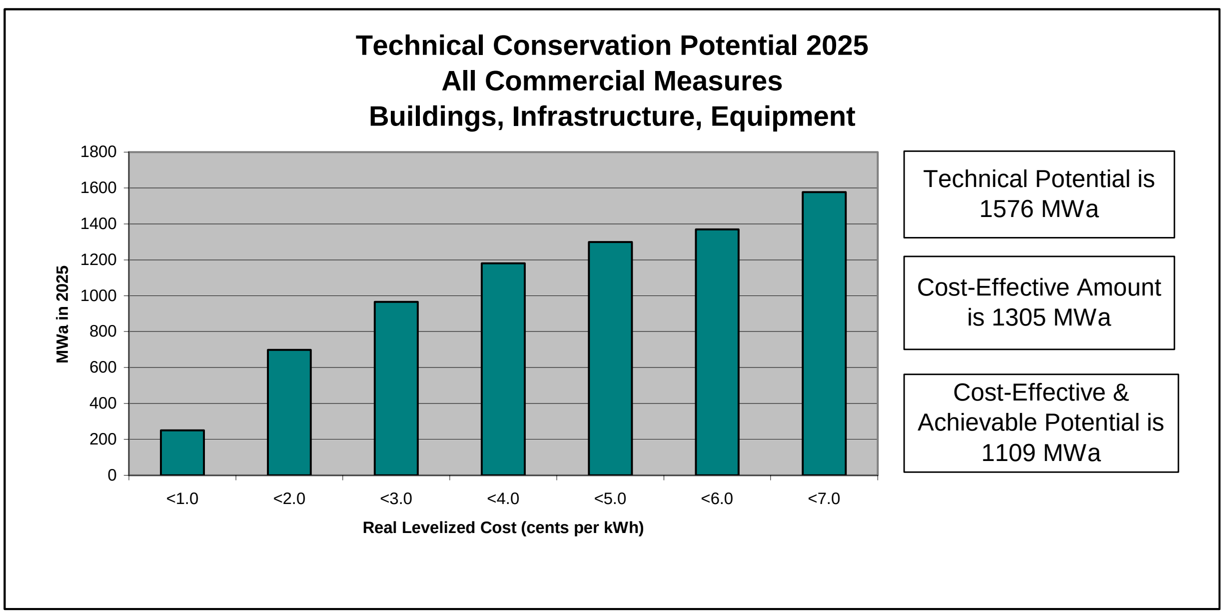

Figure 3-12: Commercial Sector Technical Conservation Potential

Figure 3-13 shows that about 60 percent of the cost-effective and achievable savings is lost-opportunity conservation. About two-thirds of the savings is in building lighting, heating, cooling, ventilation, and air-conditioning systems. The other third is divided between equipment and infrastructure systems.[18] Savings from commercial lighting measures the largest single end-use contributing to the savings potential. Tables 6 and 7 list the commercial sector measures lost-opportunity and retrofit measure bundles discussed in this section.

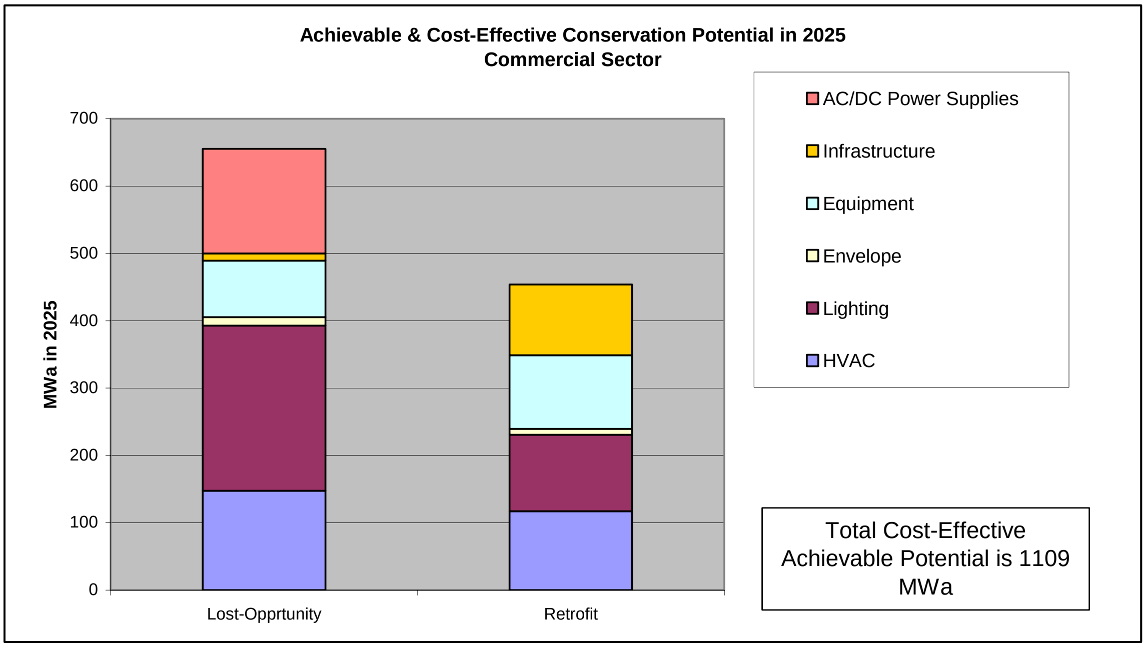

Figure 3-13: Commercial Lost-Opportunity and Retrofit Conservation

[18] Part of lost-opportunity potential, from more efficient AC/DC power supplies, occurs in the residential and industrial sectors.

Table 3-6: Commercial-Sector Retrofit Measures

Lost-Opportunity Measure	Realistically Achievable Potential in 2025 (MWa)	Weighted Levelized Cost (Cents/kWh)	Benefit/Cost Ratio
Efficient AC/DC Power Converters	156	1.5	2.7
Integrated Building Design	155	2.3	4.7
Lighting Equipment	125	0.3	12.3
Packaged Refrigeration Equipment	68	1.9	1.9
Low-Pressure Distribution	47	2.7	1.6
Skylight Day Lighting	34	3.4	1.6
Premium Fume Hood	16	3.7	1.0
Municipal Sewage Treatment	11	1.4	2.4
Roof Insulation	12	1.5	2.1
Premium HVAC Equipment	9	4.3	1.2
Electrically Commutated Fan Motors	9	2.4	1.8
Controls Commissioning	9	3.7	1.1
Variable Speed Chillers	4	3.1	1.6
High-Performance Glass	1	2.8	0.7
Perimeter Day Lighting	1	6.3	0.9
Evaporative Assist Cooling	0	0.0	0.0
Total	**655**	**1.8**	**4.7**

Table 3-7: Commercial-Sector Retrofit Measures

Retrofit Measure	Realistically Achievable Potential in 2025 (MWa)	Weighted Levelized Cost (Cents/kWh)	Benefit/Cost Ratio
Lighting Equipment	114	1.8	2.2
Small HVAC Optimization & Repair	75	3.2	1.4
Network Computer Power Management	61	2.8	1.3
Municipal Sewage Treatment	37	1.4	2.4
LED Exit Signs	36	2.3	1.6
Large HVAC Optimization & Repair	38	3.7	1.2
Grocery Refrigeration Upgrade	34	1.9	1.9
Municipal Water Supply	25	3.3	1.2
Office Plug Load Sensor	13	3.1	1.2
LED Traffic Lights	8	1.9	1.8
High-Performance Glass	9	2.9	1.3
Adjustable Speed Drives	3	4.3	1.1
Total	**454**	**2.5**	**1.7**

Commercial Retrofit Measures in Buildings

Most of the electricity used in the commercial sector is used to light buildings, provide comfortable controlled climates, and to operate equipment. Despite the performance of conservation programs over the last 20 years and improving codes and standards, there is still a great deal of viable conservation opportunity in building lighting and HVAC systems for both new and old buildings. Figure 3-14 is the supply curve for building-related conservation measures for retrofit conservation in the existing building stock. Of the nearly 400 average megawatts of achievable potential, nearly 300 average megawatts is cost-effective, with benefit-to-cost ratios greater than 1.0.

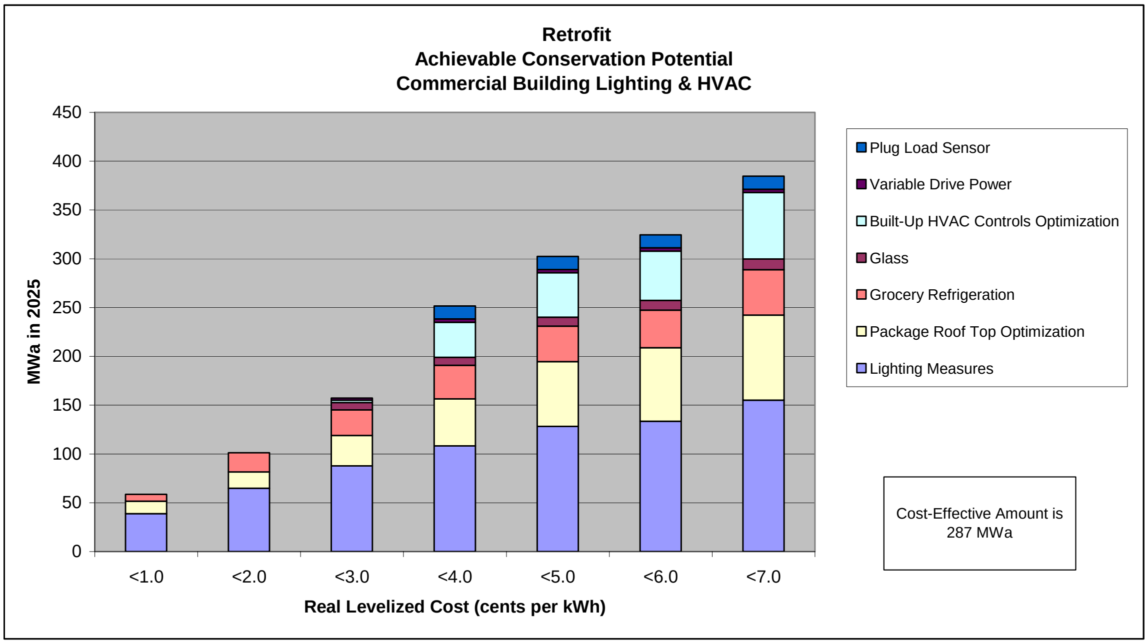

Figure 3-13: Retrofit Conservation in Commercial Buildings

Commercial Retrofit Lighting

Much of the retrofit potential is in lighting measures. Under medium case assumptions 114 average megawatts is cost-effective at an average cost of about 1.8 cents per kilowatt-hour and a benefit-cost ratio of 2.2. Since the Fourth Power Plan there has been continued evolution in commercial fluorescent lighting technology. Improved lamp phosphors, lamp barrier coatings, gas fills and ballast electronics have achieved impressive new levels of efficiency, color quality and longevity. Four-foot fluorescent lamps are the workhorse of commercial lighting. New high-performance fluorescent systems reach efficiencies of almost 100 lumens per watt. That's nearly double the efficacy of new systems commonly installed a decade ago. Improvements in high-ceiling applications yield significant new savings opportunities. There have also been significant strides made toward more efficient options for display lighting used in retail applications.

There are about 20 commercial lighting measures in the commercial sector assessment. These measures represent a cross section of lighting applications specific to building and lighting equipment types. Technologies include:

- High-performance T8 lamps paired with high-performance ballasts (HPT8) replacing T12 and first-generation T8 systems in the 4-foot and 8-foot fixture markets[19]
- Pulse-start metal halide fixtures replacing standard metal halide
- High-output linear fluorescents (T5HO and HPT8) replacing metal halide fixtures in high-ceiling applications
- Ceramic metal halide and halogen infrared lamps replacing incandescent display lighting in retail applications
- Compact fluorescent lamps and fixtures replacing incandescent and smaller standard metal halide fixtures

Technological improvements in high-performance T8 lamps paired with high-performance ballasts (HPT8) provide large savings over older T12 lamps and ballasts. And the new systems are cost-effective in many cases when replacing T8 lamps and ballasts installed as recently as the early 1990s. HPT8 systems can provide better quality light at a 50 percent savings over older T12 systems and a 20-30 percent savings over first-generation T8 lamps and ballasts.

Cost premiums for the new lamps are modest, about $1.00 per tube over standard T8 lamps. This premium is expected to remain in place due to the higher cost of the phosphor ingredients in the high-performance systems. But high-performance ballast costs are falling, and for at least one major manufacturer there is no ballast cost premium for high-performance ballasts. In many applications a two-lamp high performance T8 system can replace three- or four-lamp systems providing lower re-lamping costs over the life of the system due to fewer lamps required, and longer lamp life, even at higher lamp prices.

Increasing the penetration of high-performance T8 technology will not be easy. Presently there is a dizzying array of fluorescent lamp and ballast choices. Getting high quality lighting and energy savings will require careful system specification and application as well as efforts to get the products to market. Programs to help simplify choices and provide easy system design parameters would go a long way to improve the successful rollout of this technology.

Another significant new technology application is the use of high-output linear fluorescent fixtures instead of metal halide fixtures in high-ceiling applications like warehouses and big box retail stores. High-output linear fluorescent fixtures including HPT8 and T5HO systems offer efficiency improvement of about 50 percent over standard metal halide fixtures. The linear fluorescent systems also provide better color rendition, less light depreciation over time and the ability to restart instantly. The instant restart advantages allow the fluorescent systems to be used more easily in combination with occupancy or day lighting controls. But metal halide systems are still significantly less expensive on a first-cost basis.

The Northwest has been quite successful in its past efforts to retrofit commercial-sector lighting. In the future, both regional efforts and continued local utility programs will be necessary to capture this large resource. Market transformation efforts should focus on improving product availability and the education and training needed to assure quality retrofit applications. There are several commercial sector lighting markets that need to be addressed including retail display lighting, high-ceiling applications, and office lighting systems. Local acquisition programs can

[19] T8 and T12 refer to the diameter of the fluorescent tubes in eights of an inch. A T8 tube is one-inch in diameter.

address the lack of awareness and higher incremental cost barriers faced by these measures. Eventually, building codes can be improved to incorporate lower lighting power densities.

Optimizing Commercial Package Roof-Top HVAC Units

The second-largest slice of the commercial retrofit potential is in optimizing packaged rooftop HVAC units (75 average megawatts at a levelized cost of 3.2 cents per kilowatt hour and a benefit/cost ratio of 1.4). By far the single most common HVAC system in the commercial sector is the package rooftop system. These systems are typically fairly small unit sizes that provide gas heating and electric cooling and ventilation to portions of commercial buildings. Despite the fact that they are mass-produced and installed, these systems are notoriously problematic. Control and damper malfunctions are common and have been well documented by regional studies. The conservation potential in this category includes the following measures: economizer repair, coolant charge correction, coil cleaning, and demand-control ventilation. Much of the savings result from repairing economizers to perform up to their potential. Economizer operation reduces the need for operating air conditioning compressors by using outside air to cool spaces when possible. The Pacific Northwest climate is particularly well suited to this technique. Developing the savings from these measures will require significant research to verify savings and cost, training and education, development of protocols for diagnosis and repair, and significant acquisition incentives. It is a set of measures that may or may not be suitable for market transformation but would benefit greatly from region-wide cooperation on development and deployment strategies.

An emerging technology that may supersede these measures is the development and use of packaged evaporative-assist cooling units. Several manufacturers are developing such devices that could significantly improve cooling system performance for packaged rooftop units increasing the size of the potential in this category and possibly lowering its cost. These devices are particularly well suited to the Pacific Northwest climate with its warm dry summers. Savings from evaporative assist cooling have not been included in the resources assessment because the technology is not widely available for simple packaged systems. However, products are emerging and the region should proceed with some demonstration projects for this technology.

Other Commercial Building Retrofit Measures

The remainder of the retrofit supply curve includes several measures. Optimizing built-up HVAC control systems (38 average megawatts at 3.7 cents per kilowatt-hour and benefit/cost ratio 1.2) is one or the more expensive sets of measures in the assessment. This measure set includes diagnosis, repair and commissioning of buildings with complex HVAC systems. Grocery refrigeration (34 average megawatts cost-effective at 1.9 cents per kilowatt-hour and benefit/cost ratio 1.9) includes 17 specific measures for grocery store refrigeration systems. Retrofitting single-glazed windows in electrically-heated buildings (9 average megawatts at 2.9 cents per kilowatt-hour and benefit/cost ratio 1.3), installing occupancy sensor controls for certain office equipment (13 average megawatts at 3.1 cents per kilowatt-hour and benefit/cost ratio 1.2) and retrofitting variable-load fans and pumps with variable-speed drives or adjustable speed drives (3 average megawatts at 3.1 cents per kilowatt-hour and benefit/cost ratio 1.6) represent the remainder of the identified retrofit conservation potential. These measures are best developed primarily through direct acquisition incentives of local utilities and system benefit charge administrators and secondarily through market transformation ventures and infrastructure support.

New Commercial Buildings, Renovations, Remodels and System Replacements

By 2025 about 40 percent of the building stock will be buildings built after 2002 under medium case assumptions. Even though building codes have undergone tremendous improvements for efficiency, technology and building design practice present further opportunities for energy efficiency. In addition to new structures, this category contains many measures that apply to building energy systems that are replaced due to events including tenant remodels, full building renovations, conversion from one use to another and equipment burn out.

Conservation measures in this category are lost-opportunity measures in that they only occur at the time a new building is built or a system or piece of equipment is replaced. In this category measure costs and savings are incremental to what would be installed absent attention to efficiency. The baseline against which efficiency options are measured is the applicable building code, or if superior, standard practice. For example, if an entire office lighting system were replaced as part of a remodel, the baseline system would be 1.1 watts per square foot in code, not the 1.5 watts per square foot of the old system. But data from a recent survey show that common-practice in new office lighting systems is 1.0 watt per square foot. Common practice is more efficient than code. An efficient HPT8 system could be installed at 0.8 watts per square foot. The savings counted in this assessment are only the difference between the common-practice system and the efficient system or 0.2 watts per square foot in this example. Costs are the incremental costs of the more efficient equipment and any extra labor required.

Figure 3-15 represents the achievable conservation supply curve for lost-opportunity conservation in new buildings, renovations, remodels and system replacements. About 550 average megawatts are available, of which about 420 is cost-effective.

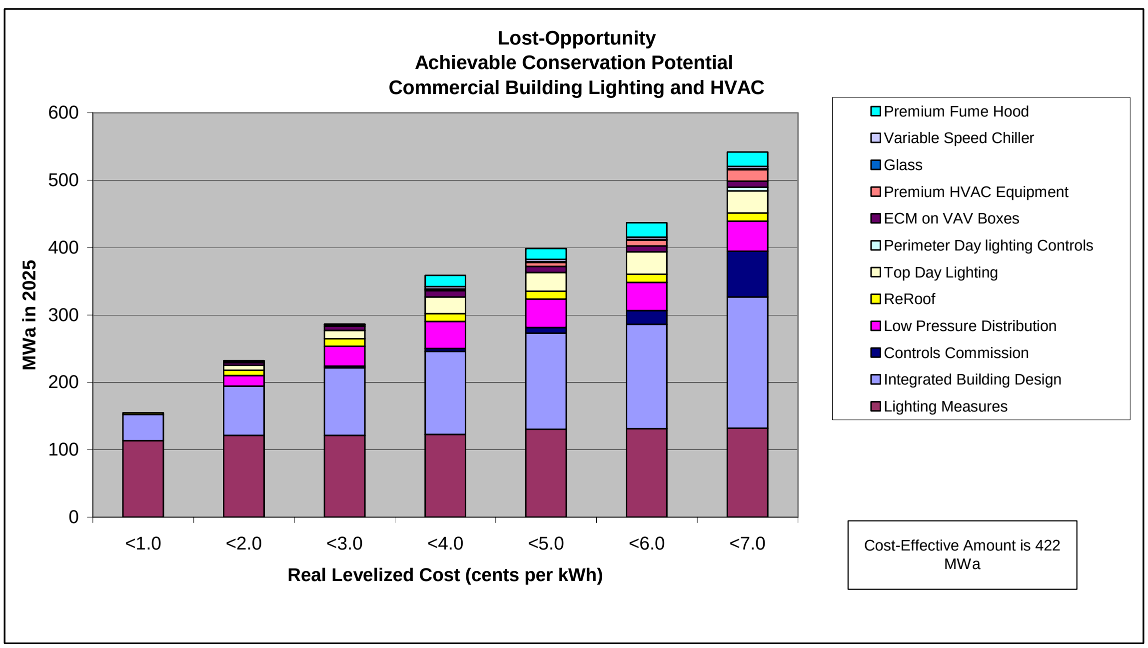

Figure 3-15: Lost-Opportunity Conservation in Commercial Buildings

New Commercial Building Lighting Measures

Many of the lighting measures in this curve are similar to their counterparts in the retrofit supply curve. But their costs and savings are lower. The new building lighting measure bundle contains 18 measures based on the same technologies used in the retrofit measures. But their application in new buildings is at lower cost than in the retrofit case. Savings are lower too, because the baseline from which savings are estimated is lower. There is a potential for 125 average megawatts at 0.3 cents per kilowatt-hour. Several hundred combinations of lighting technology, building type and space heat fuel characteristics comprise the measure bundle to capture the range of costs and interactive effects on space heating and cooling energy use from reduced lighting energy. The measures are applied only to the estimated fraction of new floor space that is not already at high-efficiency lighting power density levels. The low levelized cost of the new-building lighting measures is due in part to reduced re-lamping and maintenance costs of high-performance systems where fewer lamps can provide equivalent light and last longer.

New building lighting measures also include sky lighting in one-story retail stores, warehouses and schools (34 average megawatts at 3.4 cents per kilowatt-hour and benefit/cost ratio of 1.6) as well as a small amount of potential from perimeter day lighting control in some offices beyond the manual switching required in the predominant codes.

New building and replacement lighting measures are available now, but significant education, training, marketing are needed to develop these measures to their full potential. These measures are ripe for a combination of local incentives and market transformation ventures. Considerable regional cooperation and infrastructure are needed for education, training, marketing and specification setting because of the many options available to designers and lighting installers and a confusing array of products.

New Commercial Building System Commissioning Measures

Commissioning energy systems in new buildings is another significant source of savings in the new building supply curve. The estimate for such measures is 9 average megawatts at 3.7 cents per kilowatt-hour. Building commissioning is a systematic process of ensuring that the energy consuming systems in a building work together as intended and can be maintained to continue to do so. It involves a commissioning plan developed in the design-phase, specified functional testing of systems, and the development and implementation of operations and maintenance plans and training. The estimates of cost and savings of this measure have been modified from those in the Fourth Power Plan for several reasons. Foremost is a significant increase in estimated new building commissioning costs based on recent evaluation studies in and outside the region. Another factor is that the baseline assumes a significant amount of building commissioning is already taking place in new buildings as a result of changing design and construction practices as well as some elements of the building code in the Seattle area.

New Commercial Building Integrated Design

The largest measure bundle in the new building category is integrated building design. The potential is estimated to be 155 average megawatts at 2.3 cents per kilowatt-hour. This is a set of measures that, when applied in an integrated fashion at the design stage of new buildings provide synergies that increase savings or reduce costs when compared to the application of individual measures. For example, during the design process of a large new office building, the selection of glazing is an important step with complicated interactions between heat loss, solar heat gain, glazing area, external shading, orientation, day lighting considerations, and the sizing of the HVAC systems in the building. Savings due to energy-optimized glazing selection provide synergistic savings and reduced the size and cost of HVAC systems required to condition the building. In many cases capital costs of the bundle of integrated measures net to zero.

Integrated design is only viable as a measure for a fraction of the new building stock. It requires some additional design costs and design team interaction and is more likely to be adopted in projects that are developed by long-term owners. This assessment applies the measure to a fraction of new building floor area that ranges from 20 percent to 70 percent depending on building type.

The technologies in the integrated design bundle include many of the same lighting, HVAC and envelope technologies and commissioning reviewed and deployed individually in new buildings. But their savings are marginally higher because of synergies between measures and the ability to capture capital cost reduction from down-sized equipment, avoided systems and redirected capital. The savings are about evenly split between lighting and HVAC end uses.

Acquisition approaches for new building integrated design measures should be a combination of market transformation, regional infrastructure development, and local program assistance. In most cases, the key is to get energy considerations into the building design process at an early stage. Another element needed is developing demand among owners for efficient buildings. Identifying likely candidates and finding ways to intervene early enough in the design process to make a difference requires thoughtful and sometimes expensive marketing approaches. There are many submarkets for commercial building design depending on building type and ownership patterns. Because of these characteristics of the design market, achieving energy savings through design practice changes is best pursued at a regional level since designers operate across all utilities. Local utility incentives can be focused on extra design costs. The region has made some good progress along these lines in recent years through market transformation programs run by the Northwest Energy Efficiency Alliance. Continued and expanded efforts are needed.

Other New Commercial Building Measures

Many of the measures in this curve are available only in new buildings or when new equipment is purchased. The measures are briefly described below.

- Low-pressure distribution systems (47 average megawatts at 2.7 cents per kilowatt-hour) are an emerging design practice that includes raised floors, efficient diffusion of air and dedicated outdoor air systems to reduce the energy required to deliver heating, cooling and fresh air to buildings. These measures are probably best approached as design practice changes through market transformation efforts
- High-performance glazing (1 average megawatts at 3.7 cents per kilowatt-hour) represents glazing systems that are better than code and optimized for minimizing heating and cooling requirements. These measures are probably best approached as design practice changes through market transformation efforts

- Reroofing with extra insulation (12 average megawatts at 1.5 cents per kilowatt-hour) is a measure that is available only at the time of reroofing and is cost-effective for buildings heated with electricity. This is good measure for local utility programs
- Premium HVAC equipment (9 average megawatts at 4.3 cents per kilowatt-hour) primarily represents installing package rooftop HVAC equipment with higher cooling performance than specified in code. Regional and national market transformation efforts are needed in the near term combined with local utility incentives to capture these savings
- Variable speed chillers (4 average megawatts at 3.1 cents per kilowatt-hour) can be installed as replacement chillers in hospitals, large offices and other built-up HVAC systems. Their part-load efficiency is much improved over modular constant-speed chillers, and they are particularly useful in the mild Pacific Northwest climate. Regional and national market transformation efforts are needed in the near term combined with local utility incentives to capture these savings
- Premium fume hoods (16 average megawatts at 3.7 cents per kilowatt-hour) are new designs for laboratory safety exhaust hoods that require much less air flow and fan horsepower to perform their safety functions. These hoods can save 50 percent to 70 percent over hoods commonly in use today and dramatically reduce the amount of energy needed to condition make-up air. This measure is probably best approached through regional market transformation or regional infrastructure development with significant utility incentives in the early stages.

Commercial Infrastructure and Equipment

The Fifth Power Plan considers conservation potential in several areas not evaluated in previous plans. These are summarized in the infrastructure and equipment categories in Figure 3-16. This analysis yielded about 400 average megawatts of cost-effective and achievable conservation potential.

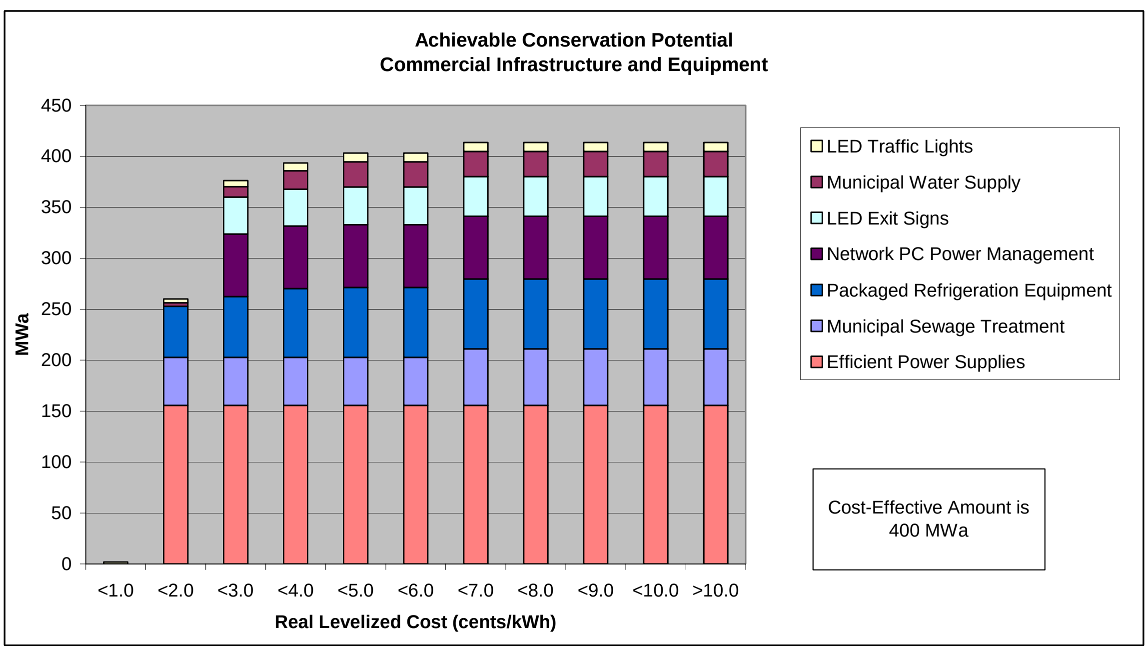

Figure 3-16: Achievable Conservation Potential in Commercial Infrastructure and Equipment

Figure 3-17 divides the commercial infrastructure and equipment into lost-opportunity and retrofit categories. About 60 percent is in lost-opportunity category.

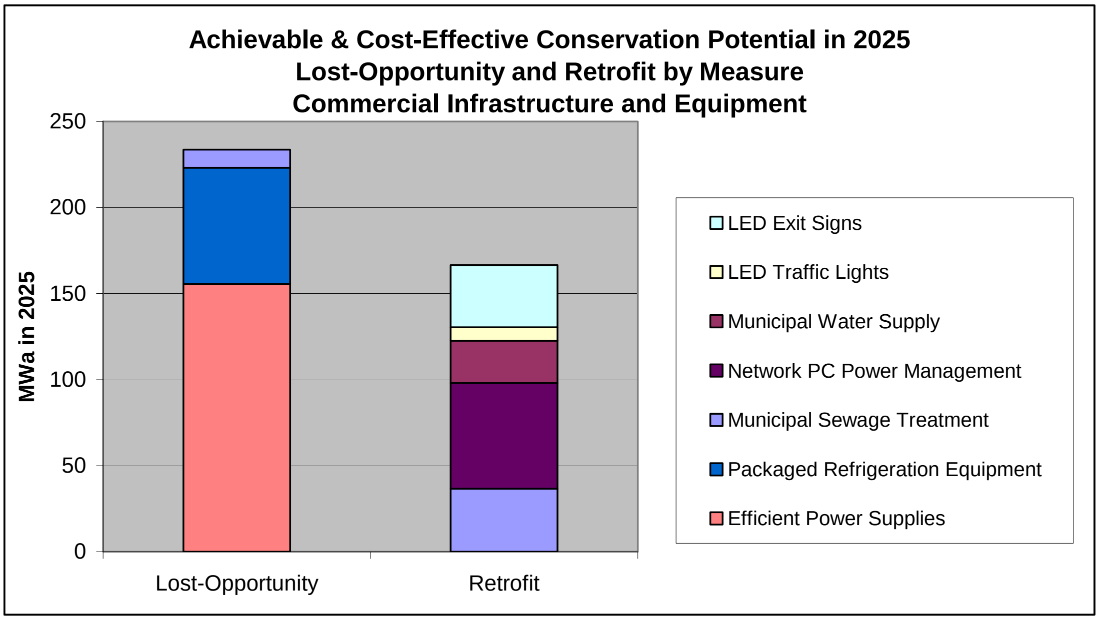

Figure 3-17: Achievable and Cost-Effective Potential in Infrastructure and Equipment

Lost Opportunity Measures in Commercial Infrastructure and Equipment

The lost-opportunity supply curve appears in Figure 3-18. The lost-opportunity conservation potential is dominated by efficient power supplies and efficient packaged refrigeration units.

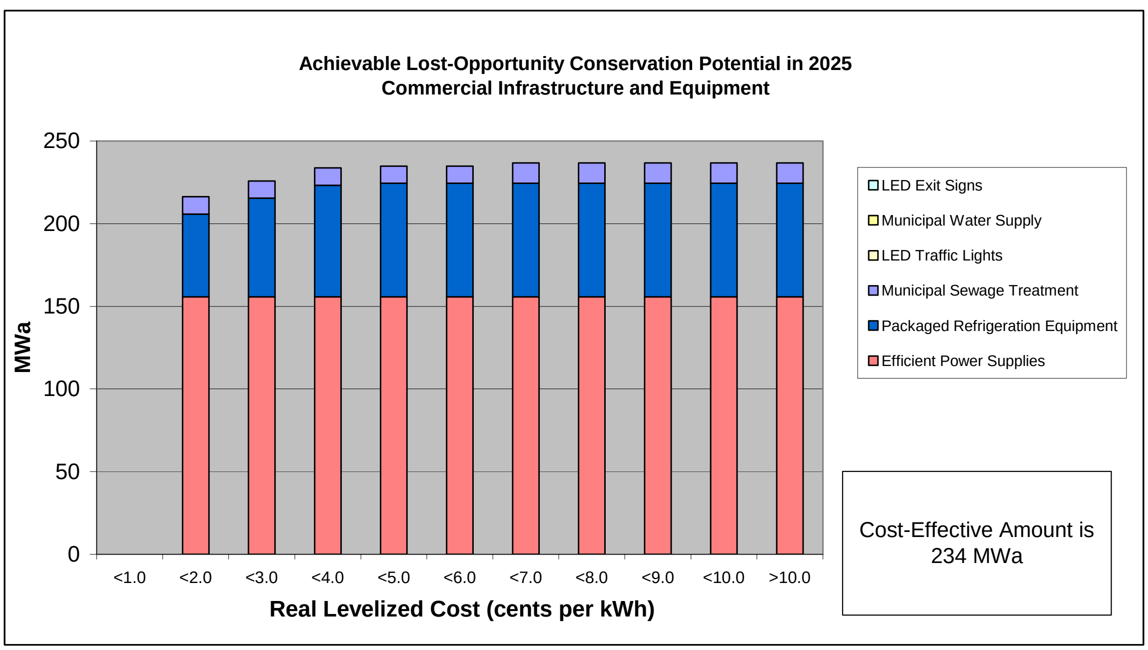

Figure 3-18: Lost Opportunity Potential in Infrastructure and Equipment

Efficient Power Supplies

Many electric and electronic devices in use in the Pacific Northwest operate on direct current (DC) power. There are approximately 100 million of these devices in the Northwest embedded in televisions, VCRs, computers, monitors, furnaces, answering machines, credit card machines, phone chargers and many other devices.

Within these devices, small transformers convert alternating current (AC) power to direct current (DC) power. There is an efficiency loss when power is converted from AC to DC. Efficiency of typical small transformers ranges 50 percent to 75 percent depending on the transformer and how heavily it is loaded. Improvements in the design of these small transformers and conversion to solid-state technology provide significant improvements. For example, the transformers in desktop computers typically operate in the 70 percent efficiency range at 30 percent load factor. New solid-state transformers can increase the efficiency to the 85 percent range. While savings at the individual appliance level are small (49 kilowatt-hour/year in the case of a personal computer), the huge number of these devices makes the total savings potential quite large -- 156 average megawatts at 1.5 cents per kilowatt-hour or less. The potential identified here is for all sectors of the economy, residential, commercial and industrial. The cost cited here is based on the incremental cost of an efficient power supply for a personal computer. These measures are good candidates for market transformation ventures and national standards.

Packaged Refrigeration Units

Efficient commercial refrigerators, freezers, icemakers, beverage machines and vending machines represent another set of measures not previously identified in any regional power plan. This is stand-alone equipment is used in restaurants, schools, hospitals and the lodging industry. Design and equipment advances made in the residential refrigeration market have not been realized in commercial units. The potential is large, and cost is low -- 68 average megawatts at 1.9 cents per kilowatt-hour. Savings from efficient units range around 50 percent and can go higher. In one recent research project, efficiency designers worked with a major manufacturer and reduced consumption a their solid-door reach-in refrigerator by 68 percent from 9 kilowatt-hour per day to 2.9 kilowatt-hour per day. The improvements were from brushless DC evaporator fan motors, changed face frame design, reduction of anti-sweat heater wattage, and changed refrigerant to R-404A. The net cost for these improvements was zero.

The estimated potential uses a baseline of the 2003 California standards and takes into account existing penetration of Energy-Star qualifying units. Cost estimates are based on several recent studies. Ultimately these measures are good candidates for state standards and market transformation projects at the state, regional and national levels. In the near term, acquisition incentives may be needed to stimulate demand.

Retrofit Measures for Commercial Infrastructure and Equipment

Figure 3-19 shows the retrofit supply curve for commercial infrastructure and equipment. About 180 average megawatts has been identified, most of which is cost-effective.

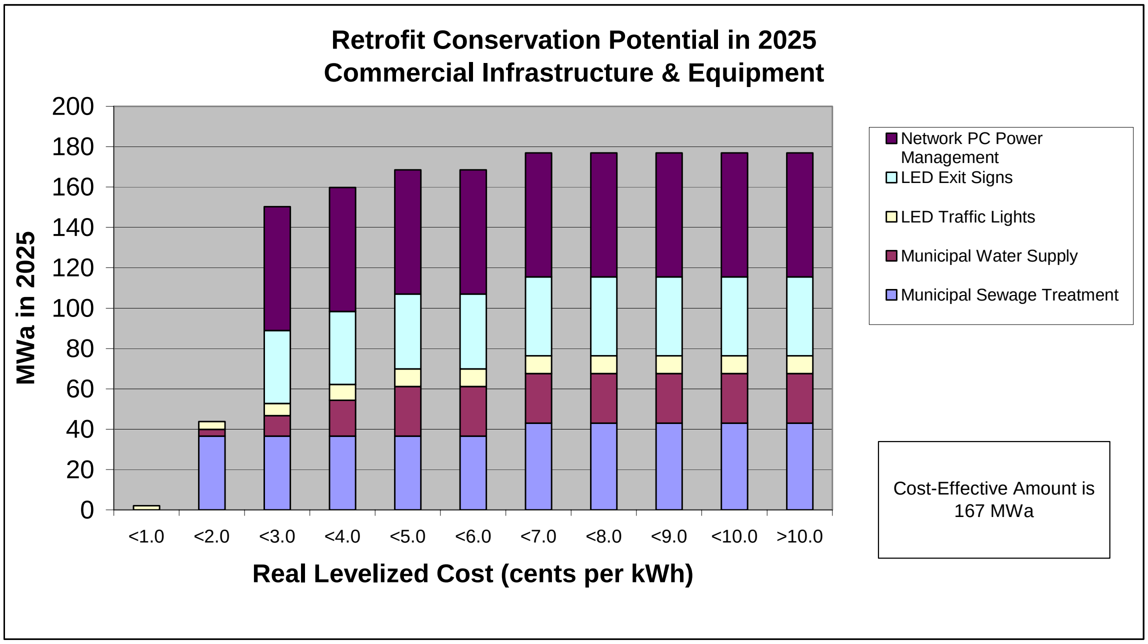

Figure 3-19: Retrofit Measures in Infrastructure and Equipment

Network Personal Computer Power Management

Network personal computer power management is the automatic control of systems that can turn computers and monitors off when not in use. This software allows companies to take full advantage of the energy-saving capabilities inherent in today's personal computers. The measure provides a network administrator the capability of monitoring energy use of networked computers and remotely powering down desktop computer systems when not in use. The potential is estimated to be 61 average megawatts at 2.8 cents per kilowatt-hour.

LED Exit Signs

Exit signs in new buildings are predominantly efficient using light-emitting diodes (LED), compact fluorescent (CFL) or electro-luminescent (EL) light sources. While an estimated 20 percent of exit signs in existing buildings use these technologies, the other 80 percent are still using incandescent signs. Exit signs are on all the time, and the savings from moving to one of the efficient technologies are significant: 100 to 250 kilowatt-hours per sign per year depending on the base case sign and the technology chosen. Six measures and applications were used to estimate costs and savings. There is also significant labor and lamp replacement savings over the life of the signs as the lamp life of the efficient models is much longer than the incandescent signs. The potential is 36 average megawatts at 2.3 cents per kilowatt-hour.

LED Traffic Lights

The application of green and red LEDs to the traffic signal market has been swift. Many signals across the region have already been changed out, but there are more to do. Red signals were the first to change due to their lower cost. Green LED signals are now cost-effective and being adopted in many jurisdictions. Ten measures by color and size were used to estimate costs and savings. The estimated remaining potential, 8 average megawatts at 1.9 cents per kilowatt-hour, is based on phone surveys of many municipal, county and state jurisdictions.

Municipal Sewage Treatment

This is another new measure in the power plan. Treating municipal sewage uses an estimated 300 average megawatts across the Pacific Northwest. The optimization of sewage treatment processes through improved process controls can yield significant energy, and maintenance savings particularly in small to mid-sized wastewater treatment plants. Savings are in reduced pumping and aeration costs. Appropriately adjusted controls can also deliver other benefits by helping plants comply with water quality regulations and better manage sludge accumulation, chlorination and de-chlorination, effluent, ammonia and odors. Costs and savings for this measure were estimated from a Northwest Energy Efficiency Alliance pilot program and work in California. Five applications of the technology in different sizes and for different treatment processes make up the supply curve. The levelized cost of this measure is greatly reduced by significant non-energy benefits. The estimated potential is 37 average megawatts at 1.4 cents per kilowatt-hour. The measure is best developed through a combination of market transformation and direct acquisition.

Municipal Water Supply

Supplying clean water to municipalities uses about 120 average megawatts of electric energy per year across the Northwest. Many of the same process controls used in wastewater management, plus improvements in leak detection technology, can be tapped to produce savings in municipal water supply. The estimated potential is 25 average megawatts at 3.3 cents per kilowatt-hour. The costs and savings of these measures are more uncertain than those for wastewater because the region has not run any pilot programs to demonstrate savings.

Irrigated Agriculture

Irrigated agriculture consumed approximately 650 average megawatts of electricity in the year 2000, or about four percent of the non-DSI electricity consumption in the region. This sector's loads are forecast to increase by approximately 30 average megawatts by 2025 or about 0.17 percent per year. If all of the realistically achievable conservation savings identified in this draft plan can be captured, irrigation loads can be cost-effectively reduced by about 11percent in 2025.

Figure 3-20 shows the technical, economic and achievable conservation potential in the irrigated agriculture sector at levelized costs up to over 10 cents per kilowatt-hour. As can be seen from this chart, the total economic potential in the residential sector is approximately 95 average megawatts by 2025 in the medium forecast. Of this amount the draft plan estimates that 80 average megawatts of conservation savings can be realistically achieved by 2025 at an average total resource cost of 2.7 cents per kilowatt-hour.

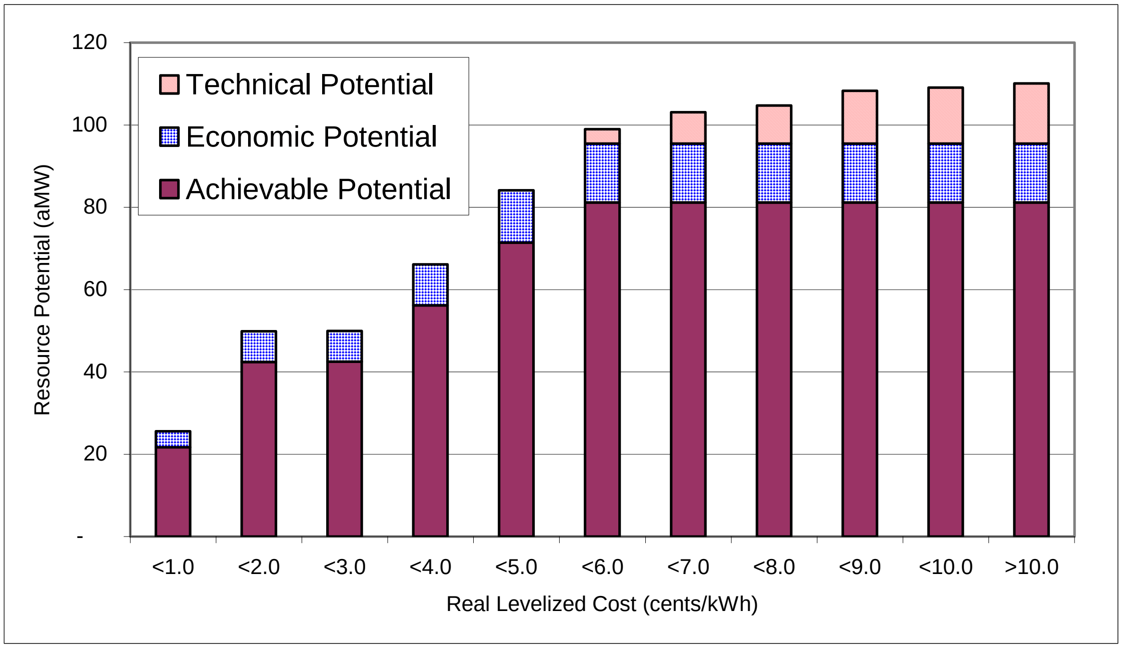

Figure 3-20: Energy Conservation Potential in Irrigated Agriculture

Between 1987 and 1997 the amount of irrigated land in the region increased just under 10 percent or about 760,000 acres. The greatest increases in irrigated acreage were in Oregon, followed by Idaho and Washington. Only in Montana did irrigated acreage remain roughly unchanged over the decade. However, despite the increase in irrigated land, electricity use in this sector actually decreased by about ten percent between 1994 and 1997. This was largely a result of conversion from high-pressure to low-pressure center-pivot irrigation systems.

Figure 3-21 shows the market share irrigated by center-pivot systems at three different operating pressures. As can be seen from a review of Figure 3-21, the decrease in high-pressure center-pivot market share has been offset in the market share of low-pressure center pivot systems. Low-pressure systems not only require significantly less energy for pumping than do high-pressure systems, they also reduce the amount of water evaporated into the air. This results from the fact that they spray water downward rather than upward and also apply it over a smaller area. With less evaporation more water can be applied to crops with the same number of kilowatt-hours or the same amount of water can be applied with fewer kilowatt-hours. Converting the remaining acreage of high- and medium-pressure center-pivot irrigation systems to low-pressure systems could collectively save 30 average megawatts for less than 1.4 cents per kilowatt-hour.

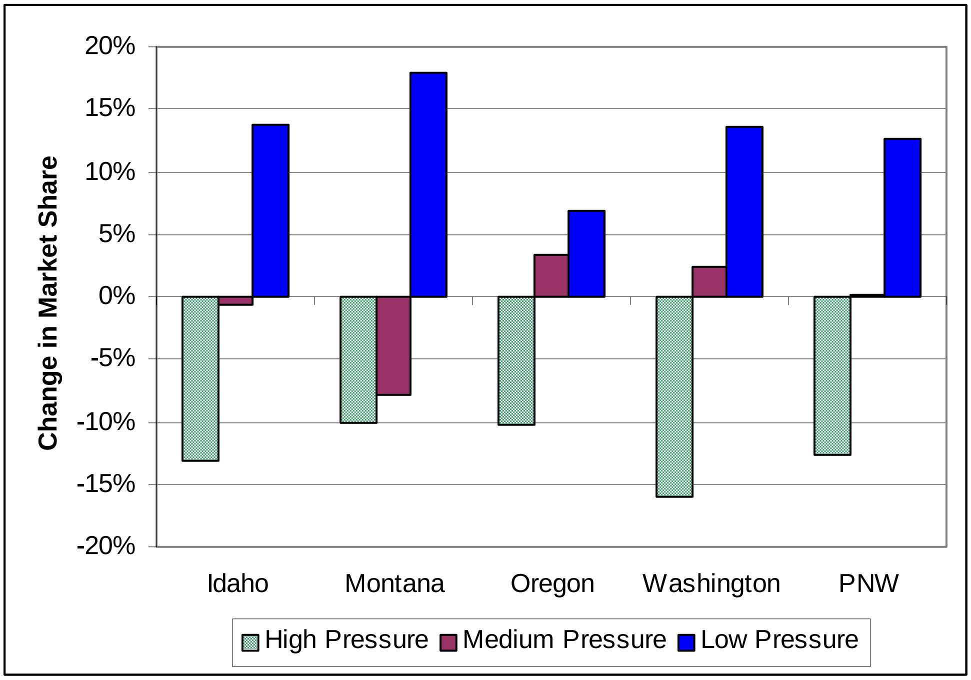

Figure 3-21: Change in Market Share of High- Medium- and Low-Pressure Center-Pivot Irrigation Systems 1994 to 1997

In addition to reducing system-operating pressures, improvements in the efficiency of irrigation are possible through the use of higher efficiency pumping and by reducing system friction losses and water leaks. As shown in Figure 3-22, the largest single source of cost-effective achievable potential in the irrigation sector comes from the replacement of existing pumps with higher efficiency ones, reducing leaks by replacing worn gaskets and installing new spray nozzles. Savings from this measure could total 35 average megawatts at a total resource cost of 3.3 cents per kilowatt-hour. An additional 15 average megawatts of savings are available at a total resource cost of 4.7 cents per kilowatt-hour through reductions in leakage and nozzle replacements on existing irrigation systems where existing pumping systems are already efficient.

Dispatchable and Lost-Opportunity Resources in the Irrigated Agriculture Sector

All 80 average megawatts of the achievable resource potential in the irrigated agriculture sector are "dispatchable" conservation resources. These resources can be scheduled for development any time during the next 20 years. If the region were to acquire the dispatchable agricultural sector conservation resources in equal annual amounts (4 average megawatts per year) over the next 20 years the total resource cost of doing so would be approximately $7 million per year. Most of these measures and practices are best acquired through a combination of local utility conservation acquisition programs combined with technical assistance to irrigators.

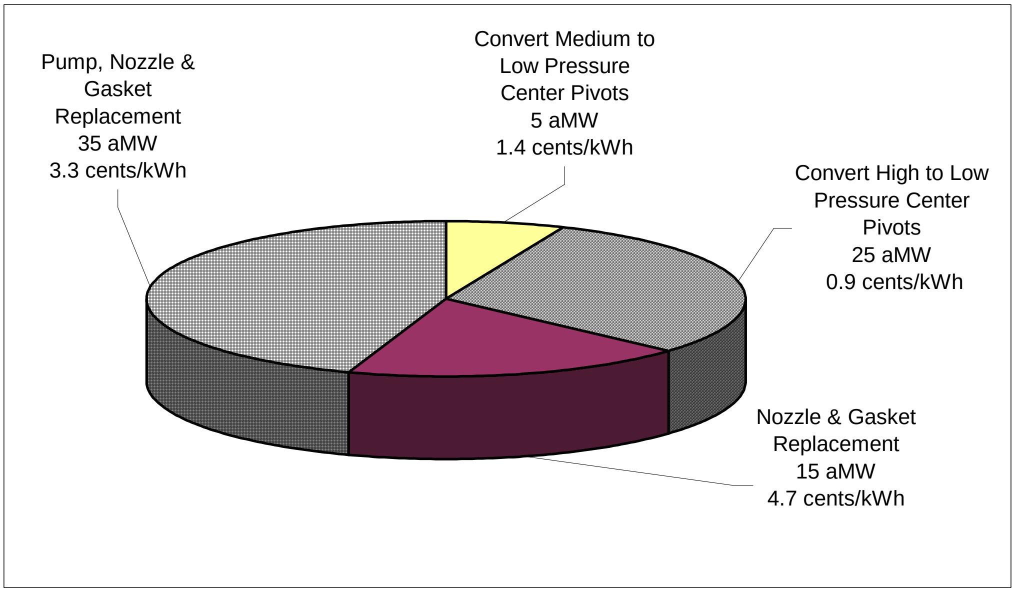

Figure 3-22: Achievable Conservation Resource Potential in Irrigated Agriculture

Industrial Sector

The non-DSI industrial sector consumed approximately 4,800 average megawatts of electricity in the year 2000, or about 27 percent of the non-DSI electricity consumption in the region. This sector's loads are forecast to increase by approximately 2,300 average megawatts by 2025 or about 1.58 percent per year. The Council estimates that, at a minimum, there is a 5 percent savings from this sector that is both cost-effective and achievable. That amount would be about 350 average megawatts on forecast 2025 non-DSI industrial electric loads.

The Council has not done any primary research on industrial potential for this Draft Fifth Power Plan. However, to formulate an estimate of savings from the non-DSI industrial sector, the Council reviewed industrial sector analyses recently completed for the Northwest Energy Efficiency Alliance and the Energy Trust of Oregon as well as a survey of business management practices regarding energy in major Northwest industries performed for the Alliance. The Council also reviewed recent utility reports of industrial-sector conservation achievements and reports of industrial conservation activity from the Energy Trust and industrial participation in the Oregon Business Energy tax Credit. These sources all corroborate that significant potential remains for industrial energy savings in the Pacific Northwest.

The study done for the Energy Trust of Oregon identified a technical savings potential of 32 percent over 10 years in the industrial sector in Oregon, distributed among some 26 specific measures or practices.[20] About 85 percent of the savings was estimated to be cost-effective given assumptions used by the Trust, with an average cost well below 1 cent per kilowatt-hour. Presuming 85 percent of the economic potential is practically achievable, overall savings potential identified is on the order of 23 percent of industrial electric use.

[20] "Energy Efficiency And Conservation Measure Resource Assessment For The Residential, Commercial, Industrial And Agricultural Sectors." Prepared for the Energy Trust of Oregon, Inc. by Ecotope, Inc., The American Council for an Energy Efficient Economy (ACEEE), and Tellus Institute, Inc., January, 2003.

The Alliance study found a regional technical potential of 682 average megawatts and an achievable potential of 545 average megawatts.[21] This analysis identified a series of measures and practices that are applicable across all industries. It also evaluated industry- and process-specific savings for five major Northwest industries: pulp and paper; wood products; food processing; transportation equipment; and microelectronics. The overall achievable savings potential in the Alliance study is about 13 percent of forecasted non-DSI industrial load assumed by the Alliance. Cost estimates by the Alliance ranged in the 1 to 2 cents per kilowatt-hour levelized cost. Both the Alliance study and the Trust study identify similar energy-saving opportunities that are briefly discussed below.

The study of business practices performed for the Alliance found that Northwest businesses are comparable to other businesses in the United States and around the world with regard to the use of management practices for energy and energy costs[22]. The study indicates industrial-sector businesses have much room for improvement in the way they manage energy and energy costs. Thirty Northwest businesses participating in the study were rated at one or two stars on a scale where five stars is the top rating and reflects “best practices.” Companies rated with two stars tend to be focused in cutting out obvious waste of energy, but don’t have consistent and systematic processes for continuing to generate improvements and sustain them.

As part of the Fourth Power Plan, the Council did an extensive review of industrial sector conservation supply estimates performed by others. Results of that analysis led the Council to believe an 8-percent reduction in non-industrial electric loads was achievable and cost-effective overall. Individual sector potential ranged from 5 to 11 percent. Prior Council estimates also cited industrial conservation potential in the range of 7 to 9 percent of electric consumption for the sector as a whole. These earlier estimates were based on several different methods of analysis. The 1983, 1986 and 1989 estimates were based on industrial customer response to surveys. The 1991 Council estimate was based on an end-use model and supplementary data from energy audits.

Industrial Energy Use

As shown in Table 3-8, according to market research done for the Alliance, motors and motor systems used approximately 2,500 average megawatts or just over half of the electricity consumed in the non-DSI industrial sector in 2000. Compressed air systems used another 10-percent while lighting represented around 5-percent of total sector electricity use.

[21] Industrial Sector Initiative, Northwest Energy Efficiency Alliance, Third Review Draft, May 22, 2004.
[22] One-2-Five® Energy Market Research Program Results, EnVinta Corporation for the Northwest Energy Efficiency Alliance, May 2004.

Table 3-8 - Major Uses of Electricity in the Non-DSI Industrial Sector

End Use	Estimated Load (aMW)	Share of 2000 Industrial Loads
Compressed Air	510	11%
Motor and Motor Systems	2500	52%
Refrigerated Warehouses	110	2%
Lighting	240	5%
Other	1476	31%
Total	4836	100%

Industrial Conservation Measures and Practices

In the industrial sector, substantial savings are available from measures that apply across facility and process types. These crosscutting measures include motors and motor-driven systems, lighting, compressed air, and electrical supply systems. Other measures are industry-, or process-specific. These include specific technologies or system optimization such as refrigeration optimization in food processing and storage, improved conveyance systems, ultra-violet and microwave drying, membrane technology in chemicals industries and carbon dioxide purging systems in controlled-atmosphere storage facilities.

Most of the electricity consumed by industry is used in electric motors that drive a variety of systems. Electric motors are used in pumps, fans and blowers, compressed air systems, material handling, conveyance, material processing, and refrigeration. There are three kinds of efficiency improvements possible in these systems. Taken together, these three approaches can yield savings on motors and the systems they drive in the range of 10 to 15 percent.

First, more efficient motors can be used. Motors are inherently efficient devices, and the implementation, in 1997, of the minimum-efficiency standards in Energy Policy Act of 1992 (EPAct) eliminated the least-efficient products from the new-motor market. More recently, the motor manufacturers trade association, National Electrical Manufacturer's Association (NEMA), in cooperation with the Consortium for Energy Efficiency agreed upon voluntary minimum standards for "premium" efficiency motors up to 500 horsepower. NEMA members are now promoting the use of these "premium" motors to their customers. Savings from premium motors are typically in the 1 to 4 percent range depending on size and motor loading.

Second, even greater savings can be realized through improvements in the efficiency of the systems that electric motors operate. These include both the selection of more efficient pumps, fans and compressors as well as significant savings from correctly sizing the equipment to meet operating demands. This frequently involves removing dampers and pressure-reducing valves, and reducing system pressure instead by slowing the fans or trimming pump impellers. In many cases, the motor that runs the system can then be downsized, moving its operating point into a range of greater efficiency. Typical savings are 6 percent for fan systems and 15-20 percent for pumping systems.

Third, motor and drive systems savings can be achieved through system optimization. This approach requires a systematic evaluation of the process system to determine the optimal flow and pressure requirements serviced by the motor system. These evaluations can be time-consuming and often require the use of external engineering contractors. However, the savings achieved through system optimization can be dramatic – often exceeding 50 percent of initial system electricity use.

Industrial lighting systems offer another crosscutting industrial efficiency opportunity. Industrial lighting systems can be fairly complex due to the application-specific nature of the designs, demanding performance requirements and sometimes-harsh operating environments. But the high-performance lighting technologies available in commercial building systems can provide cost-effective savings at industrial facilities as well. Up to 50 percent improvement in the efficacy of high-ceiling applications systems are particularly attractive measures. And 10 to 15 percent improvements are available from new high-performance T8 fluorescent systems over the standard T8 fluorescent systems used in industrial office space and low ceiling manufacturing areas. Conservatively, 15 to 20 percent of industrial lighting energy could be saved cost-effectively. This amounts to about 40 average megawatts. In addition to energy savings, substantial productivity and safety benefits have been documented to result from improved industrial lighting designs. Unfortunately, designers with industrial lighting experience are in short supply.

Compressed air systems are also used throughout industry, primarily to operate tools. These systems account for about 10 percent of non-DSI industrial electric use. These systems are convenient for plant workers and managers, but are notoriously inefficient and offer easy opportunities for cost-effective savings. There are many measures employed when optimizing compressed air systems, ranging from reducing leaks to the application of sophisticated sensors and controls on modular multiplexed compressor banks. Typical savings are in the 5 to 15 percent range.

Tuning up electric supply systems in industrial facilities is another cross cutting opportunity. Two measures have wide applicability. First, over- or under-voltage conditions and unbalanced phases can significantly reduce the efficiency of motors by up to 5 percent while also leading to premature equipment failure. Surveys have indicated that these conditions are far more common than previously recognized. Second, high-efficiency transformers are available to convert distribution voltage to plant voltage. Both load and no-load losses can be reduced by 40 to 50 percent, which translates into a one- to two-percent reduction in electric bills.

Finally, there is a wide array of process-specific and industry-specific conservation opportunities. Savings available in process modifications are often dramatic. One such emerging process change is a new approach to controlling carbon dioxide levels in controlled atmosphere storage facilities like fruit warehouses. Current systems use nitrogen gas to dilute the carbon dioxide emitted from stored fruit that reduces fruit quality. A new system under development and testing purges carbon dioxide gas instead and uses about one-tenth the electricity as the nitrogen dilution system.

The emergence of industry-specific processes improvements is difficult to predict. However, there are several well-understood opportunities that are noted here as examples because of their applicability in the Northwest. They include:

- Pumping system optimization in the pulp and paper industries

- Controls and process stabilization techniques in the pulp and paper industries. While all mills have process controls, the next generation of controls can provide value in process stabilization, improved quality control and assurance as well as improve up time in mills

- Advance clean-room design and system optimization techniques in electronics manufacturing plants which reduce the large HVAC loads required in clean rooms

- Refrigeration system optimization in food processing and storage industries

Developing Industrial Conservation

Successful development of industrial-sector energy efficiency depends on developing the infrastructure and relationships between program and plant staff. A network of consultants with appropriate technical expertise is needed. This expertise is available for motor management and compressed air programs. But for other measures, such as motor system optimization and industrial lighting design, where access to experienced engineers and designers is more critical, the identification and/or development of the support network will require time and effort. A mix of market transformation ventures, regional infrastructure development, and local program offerings from rebates to purchased savings will be needed to realize this source of low-cost energy efficiency potential.

COUNCIL POLICY ON FUEL SWITCHING

The appropriate role for the Council in promoting the direct use of natural gas for space and water heating has long been an issue in the region. The Council has analyzed the technical issues and the policy issues in a number of studies. The specific issues have changed somewhat over time and include: whether fuel conversions to natural gas should be considered conservation of electricity, whether incentives for electricity efficiency improvements will adversely affect natural gas markets, the cost-effectiveness and potential amount of fuel switching available to the region, whether fuel choice markets are working adequately or not, and the relative risks of price change for natural gas and electricity.

The Council policy on fuel choice has consistently been that fuel conversions, while they do reduce electricity use, are not conservation under the Northwest Power Act because they do not constitute a more efficient use of electricity. The Council has recognized, however that, if its conservation programs were to cause a reduction in the use of natural gas in favor of electricity, it would reduce the electricity savings expected from electricity conservation programs.

The Council's analysis has also recognized that in some cases it is more economically efficient to use natural gas directly for space and water heating than to use electricity generated by a gas-fired generator. However, this is very case specific and depends on a number of factors including the proximity of natural gas distribution lines, the size and structure of the house, the climate and heating requirements in the area, and the desire for air conditioning and suitability for heat pump applications. In general, although direct use of natural gas is more thermodynamically efficient (except for the case of heat pumps), it is more costly to purchase and install. Therefore, its economic advantage depends on the ability to save enough in energy costs to pay for the higher initial cost. One particularly attractive opportunity for conversion to natural gas is in homes that have natural gas space heating systems, but electric water heaters. In many of these cases, it would be cost effective for consumers to install natural gas water heaters.

The Council has not included programs in its power plans to encourage the direct use of natural gas, or the promote conversion of electric space and water heat to natural gas. This policy is consistent with the Council's view of its legal mandate. In addition, the Council's analysis has indicated that fuel choice markets are working well. Since the large electricity price increases around 1980, the electric space heating share has stopped growing in the region while the natural gas space heat share in existing homes increased from 26 to 37 percent. A survey of new residential buildings conducted in 2000 for the Northwest Energy Efficiency Alliance found that nearly all new single-family homes constructed where natural gas was available had gas-fired forced air heating systems. The survey also found an increased penetration of natural gas heating in the traditionally electric heat dominated multi-family market, especially in larger units and in Washington. Fuel conversion of existing houses to natural gas has been an active market as well, often promoted by dual fuel utilities.

The Council's policy on fuel choice is a market-based approach. The Council will leave the choice of heating fuels to individual consumers. But at the same time, the Council will work to facilitate appropriate fuel choice through information and promoting efficient pricing of electricity.

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