Conservation

One of the goals of the Northwest Power Act is to achieve cost-effective energy conservation. As in prior Plans the Council has identified significant conservation opportunities. This section assesses how much cost-effective conservation is available, its benefits and risks and what kinds of acquisition approaches will be needed to capture this resource. The Council believes it will be a challenge to secure the benefits of conservation identified here. Bonneville, utility and public benefits charge administrator[1] intervention and investment will be required.

This chapter reviews the conservation potential in the region; describes the analysis of different conservation deployment strategies and proposes an annual conservation acquisition target. It goes on to describe specific acquisition approaches for the target conservation measures in the residential, commercial, irrigation and industrial sectores.

How Much Conservation Remains To Be Developed?

Table X-1 shows the amount of cost-effective and realistically achievable conservation savings potential by sector and end-use under the Council's medium wholesale electric price forecast. As can be see in Table X-1, the Council has identified just over 2800 average megawatts of conservation resources that could be developed during the next 20 years under these conditions.[2] This is enough energy to replace the output of about 18 single-unit combined cycle combustion turbine power plants, at about half the cost.[3] Almost 20 percent of this potential is in new and existing residential lighting. The next largest single source of potential savings, about 12 percent of the total, is in the non-aluminum industrial sector. The remaining large sources of potential savings are spread across residential water heating and laundry equipment and new and existing lighting and HVAC equipment in the commercial buildings.

Table X-1 also shows average real levelized cost and the benefit-to-cost ratio of the region's remaining conservation potential by major end-use. The weighted average real levelized cost of this conservation is 2.4 cents per kilowatt-hour (2000$).[4] In aggregate, these resources have a benefit-to-cost ratio of 2.5-to-1.0.[5] Note that some measures, such residential clothes washers, can have high-levelized cost while still providing high benefit-to-cost ratios. This seemingly counter-intuitive result can occur for several reasons. It may be that a measure, such as a high efficiency air conditioner or heat pump, produces most of its savings at times when wholesale power market prices are high and therefore they are more valuable to the region. Alternatively, this phenomenon can occur when a measure produces very large non-energy benefits such as the water savings from more energy efficient residential clothes washers.

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[1] Oregon and Montana have established a "public benefit charge" to fund investments in conservation, renewable resource and low-income weatherization. The Energy Trust of Oregon and NorthWestern Energy administer these funds.

[2] This is the total amount of conservation achievable, given sufficient economic and political resources, over a 20-year period in the medium forecast.

[3] Based on a 305 MW single-unit combined-cycle gas-fired plant (270 MW baseload + 35 MW duct-firing) seeing service in 2005. For the 2005-2019 periods, under average conditions, such a plant would operate at an average capacity of 156 MW with a levelized cost of $45.20/MWh (year 2000$).

[4] These levelized costs do not include the 10-percent credit given to conservation in the Northwest Power Act.

[5] 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.

Table X - 1			
Achievable Conservation Potential - Medium Forecast and Natural Gas Prices with Average Hydro generation Output			
Sector and End-Use	Cost-Effective Savings Potential (MWa in 2025)	Average Real Levelized Cost (Cents/kWh)	Benefit-to-Cost Ratio
Residential Refrigerators	5	2.0	2.2
Residential Clothes Washers	135	5.2	2.6
Residential Dishwashers	10	2.1	2.6
Residential Water Heaters	80	2.2	2.3
Residential Heat Pump Water Heaters	195	4.3	1.1
Residential Hot Water Heat Recovery	20	4.4	1.1
Residential Compact Fluorescent Lights	535	1.7	2.3
Residential New Space Conditioning - Shell	40	2.5	2.0
Residential Existing Space Conditioning - Shell	95	2.6	1.9
Residential HVAC System Efficiency Upgrades	65	4.3	1.2
Residential HVAC System Conversions	70	2.9	2.1
Residential HVAC System Commissioning	20	3.1	1.9
Commercial New & Replacement Equipment	85	2.2	1.8
Commercial New & Replacement HVAC	150	3	1.5
Commercial New & Replacement Infrastructure	20	2.1	2.0
Commercial New & Replacement Lighting	245	1.2	9.1
Commercial New & Replacement Shell	15	1.6	2.0
Commercial Retrofit Equipment	110	3.7	2.1
Commercial Retrofit HVAC	120	3.3	1.3
Commercial Retrofit Infrastructure	110	2.8	2.0
Commercial Retrofit Lighting	115	1.8	2.2
Commercial Retrofit Shell	10	2.9	1.3
New & Replacement AC/DC Power Converters	155	0.9	4.4
Industrial Non-Aluminum	350	1.7	2.2
Agriculture Irrigation	80	1.6	3.2
Total	2835	2.4	2.5

The amount of conservation that is cost-effective to develop depends upon, among other things, how fast the demand for electricity grows, future alternative resource costs and year-to-year variations in market prices.[6] It also depends upon whether more or less conservation in the region's resource portfolio can reduce the risk associated with possible future volatility in wholesale market prices, changes in technology, potential carbon controls and other risks. In order to assess whether 2,800 average megawatts (or some other amount) of conservation resource is more likely to provide the Northwest consumers with the lowest cost power system at an acceptable level of risk the Council

[6] For example, if economic growth follows the Council's medium-low forecast, the region will need to add approximately 100 average megawatts of new resources each year. However, if regional economic growth is at the Council's medium-high forecast, nearly 400 average megawatts of new resources will be needed each year.

tested a broad range of conservation deployment strategies in its portfolio analysis process. The following section discusses the results of the Council's assessment of conservation role in the region's portfolio of future resources.

Regional conservation strategies

The goal of each Council power plan has been to find the mix of conservation and new generating power supplies that produce the lowest total present-value cost of meeting the region's energy service needs across a wide range of future conditions. Historically, the region has used the fact that conservation can be acquired in relatively small increments and with short lead times to develop conservation in response to near-term resource needs and forecast of market prices. Figure 7-1 shows the year-to-year changes in annual amount of conservation acquired by Bonneville and the region's utilities. As can be seen from this figure, the pace of conservation development by has varied widely, sometimes swinging by more than plus or minus 60 average megawatts from one year to the next.

In scoping the issues for analysis in its Fifth Power Plan, the Council raised the question as to whether stabilizing the region's annual investments in energy efficiency would provide economic value.[7] Could a relatively stable amount of annual investments in conservation prove to be more economically efficient level of investment? Does conservation have value as a "hedge" against more volatile electricity market prices? Alternatively, should the region continued to use conservation as a flexible resource to follow short-term market conditions, now that future market prices are expected to be even more volatile than in the past? To address these questions, the Council tested four alternative conservation resource deployment strategies with its portfolio analysis model.

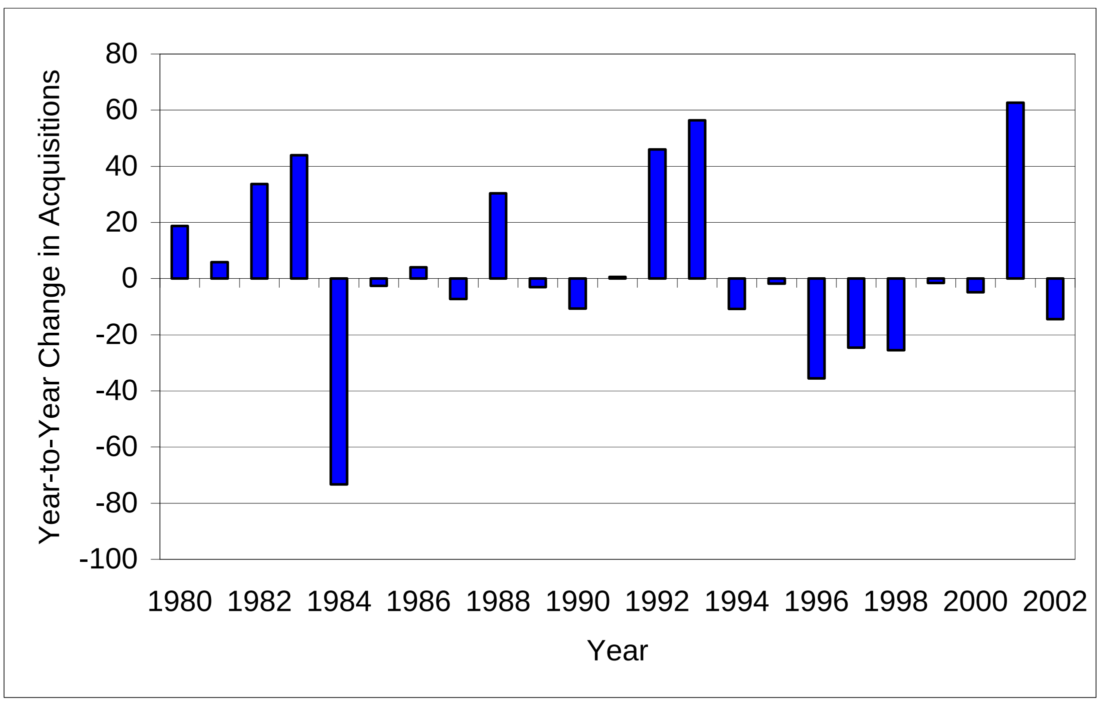

Figure 7-1 Year-to-Year Changes in Utility Conservation Acquisitions

[7] *Issues for the Fifth Plan*, Council Document 2002-1, February 6, 2002.

PUT UNITS (MWa) ON Y AXIS

The first deployment strategy tested was designed to mimic recent patterns of conservation development. Under this "Business as Usual" conservation deployment strategy it was assumed that the region would develop an average of roughly 50 average megawatts of conservation resources annually for a total of 1,000 average megawatts over the next 20 years. This pace of development is approximately the average annual conservation savings from Bonneville and utility programs for the five-year period between 1996 and 2000.

The second conservation portfolio management strategy tested by the Council was a "Follow-the-Market" strategy. In this strategy the amount of conservation resources deployed was based on recent historical market prices and resource needs. A different wholesale market price forecast was generated for each quarter (three month) interval of the 20-year planning period. Each forecast was based on the historical wholesale market prices during the prior five years (60 months). When forecast future prices were expected to be higher, more conservation was developed because more expensive conservation appeared to be cost-effective. When forecast of future market prices were lower, less conservation was developed because fewer measures appeared to be "cost-effective." Under this portfolio management decision rule the amount of conservation developed varied quarterly because resource development "followed-the-market." Use of this decision rule developed approximately 2200 average megawatts of conservation "on average" across the 750 futures tested. It also reduced both net present value system cost and net present value system risk relative to the Business as Usual strategy. .

The third conservation deployment strategy tested by the Council was designed to determine whether net present value system cost and/or system risks could be reduced still further. Under this strategy, termed the Minimum Cost/Risk strategy, the portfolio model evaluated developing varying amounts of additional conservation as potential hedge against future market price volatility. The amount that it could choose could vary somewhat from year to year in response to forecast market conditions. The model would increase the amount of conservation developed until doing so no longer reduced cost and risk. The amount of conservation it could do was capped by the amount in the supply curve. This approach resulted in the deployment of 400 - 500 average megawatts of additional conservation compared to the "follow-the-market" strategy at a lower net present value system cost and risk. The cost of the additional conservation is more than offset by savings during periods of higher electricity prices. PUT NPV$ HERE OR DELTA FROM FOLLOW THE MARKET. In addition to lower system cost and risk, this additional conservation reduces the amount of carbon dioxide production during the 20-year planning period. The reduction in estimated net present value system costs shown in this table reflects the avoidance of possible future carbon emissions penalties associated with the thermal resources that would otherwise be deployed. The deployment of 400-500 average megawatts of additional conservation results in about 18 million tons less carbon production across the entire WECC than does the "follow-the-market" strategy.

A fourth deployment strategy, referred to as "Sustained Orderly Development" was designed to represent a practical conservation deployment strategy that stabilizes annual regional investment in conservation. Under this decision rule, the model tested different levels of constant annual conservation development. In this case, conservation would be developed at an average of roughly 1XX average megawatts of conservation resources annually over the next 20 years. This results in approximately the same amount of conservation development over the planning period as the Minimum Cost/Risk strategy, but with less variation in the annual increments.

The least risk portfolio produced using the Sustained Orderly Development strategy has dispatchable conservation added at a constant rate of XX average megawatts per year and lost opportunity conservation added at YY average megawatts per year. While this conservation resource development policy is not as good as deploying conservation per the Minimum Cost/Risk its net present value system costs are comparable. The "Sustained Orderly Development" portfolio resulted in a mean net present value system cost that was just over $xxx million higher than the portfolios developed under the Minimum Cost/Risk strategy. And, because this decision rule is not as responsive to variations in market prices it increased net present value system risk by about $yyy million.

However, the Council portfolio analysis model does not include any costs associated with "ramping" conservation acquisition programs up and down. Although available data do not indicate that significant changes in annual acquisition levels increase the cost of developing conservation, it is clear that such changes do disrupt program operations. In particular, program evaluations have found that it is difficult to acquire conservation in large industrial and commercial facilities without having a long-term relationship with such customers. Therefore, the Council believes that difference in net present value system cost between the Minimum Cost/Risk strategy and the "Sustained Orderly Development" strategy is not material.

Figure 7-2 compares the net present value system cost and risk for the "best" portfolios produced by all four conservation deployment strategies discussed above. The "best" portfolios are those that have the lowest net present value cost for a given level of risk. . As can be seen from this figure, by far the worse performing strategy, in the upper right corner of the graph, is that which developed only develop a modest amount (50 MWa per year) of conservation. On the other hand, deploying conservation in the amounts and on the schedule resulting from the application of a Minimum Cost/Risk strategy premium produces the least cost portfolios for a given level of risk. However, the portfolios resulting from following a Sustained Orderly Development strategy of regional conservation deployment are nearly equivalent in terms of both costs and risks. Developing conservation in response to forecast of future market prices, the "Follow-the-Market" decision rule, without adjusting for the inherent uncertainty in those forecasts has greater likelihood of producing a higher system cost and system risk.

Replace with updated plot.

Figure 7-2 Net Present Value System Cost and System Risk of Alternative Conservation Deployment Portfolio Management Policies

Regional Conservation Target

Based on the forgoing analysis the Council recommends that regional target for develop 1XX average megawatts of conservation annually over the next five years. The Council believes that stabilizing the regional investment in conservation at this level has a much greater probability of producing a more affordable and reliable power system than alternative development strategies.[8] The Council recognizes that the 1XX average megawatts annual conservation target it is

[8] Figure 7-2 shows that the portfolios with the highest costs and risk are those with the least conservation. Unfortunately, they are also reflective of actual regional experience between 1997 and 2000 while the level of conservation developed in the portfolios with the lowest cost and risk and that called for in this Plan, has only been achieved once in the past twenty-four years.

recommending represents a significant increase over recent levels of development. However, the Council's analysis of the potential regional costs and risks associated developing lesser amounts of conservation demonstrates that failure to achieve this target exposes the region to substantially higher costs and risks.

Figure 7-3 shows the Council's recommended targets by sector and resource type. It is important to note that the Council recommends that in total, conservation resource development should be split equally between "lost opportunity" and "non-lost opportunity" resources.

The Council estimates that the Total Resource Cost of these acquisitions is approximately $380 million annually. The Council believes that this cost should be shared between the region's consumers and the regional power system. Over the last decade, the Bonneville and the region's utilities, working with the Northwest Energy Efficiency Alliance have been able to secure about 100 average megawatts per year at an average cost of just over $1.7 million (2000$) per average megawatt. Assuming that Bonneville and the region's utilities can "ramp up" their programs to capture an additional 50 average megawatts a year at their historical cost would require annual power system conservation investments in the range of $250 million per year.

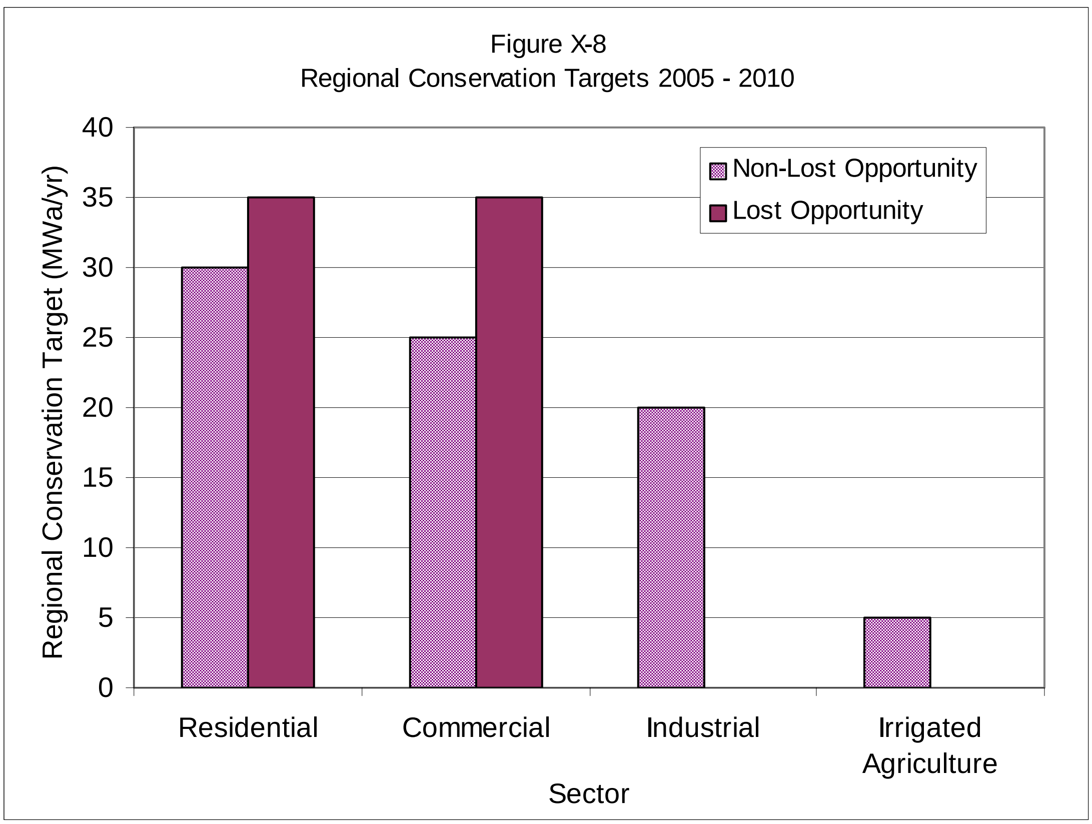

Figure 7-3 Regional Conservation Targets 2005 - 2010

Conservation Implementation Strategies

Acquiring cost-effective conservation in a timely and cost-efficient manner requires thoughtful development of mechanisms and coordination among many local, regional and national players.

This power plan cannot identify every action required to meet the conservation targets. However, the specific characteristics of the targeted conservation measures and practices, market dynamics, past experience and other factors suggest acquisition approaches that promise to be fruitful and effective. This section outlines major acquisition approaches and levels of effort that the Council recommends be pursued by entities in the region to secure the benefits from capturing the region's cost-effective conservation potential. It also sets forth some guidance on specific issues that the Council believes must be addressed in order to achieve its annual target of 1XX average megawatts of conservation savings.

Focus on "Lost Opportunity" Resources –

It appears that one of the principle factors behind the finding that developing additional conservation as a "hedge" against future market price volatility is that more "lost opportunity" resources are developed.[9] As described in the discussion of the results of the portfolio analysis, capturing these lost opportunity conservation resources reduces both net present value system cost and risk. If the region does not develop these resources when they are available, this value cannot be secured. These resources represent half of the Council's annual conservation target. Therefore, the region needs to focus on capturing these resources. This will very likely require significant new initiatives, including local acquisition programs, market transformation ventures and regional coordination.

Additional Regional Coordination and Program Administration Will Be Required

The Council believes coordinated efforts will be an increasingly necessary ingredient to successful development of the remaining conservation potential. The boundaries between direct acquisition approaches, market transformation, infrastructure support, and codes and standards are blurry. In fact, for much of the conservation resource, efforts are needed on all these fronts to take emerging efficiency measures from idea to common practice or minimum standard. Of increasing importance is improved coordination between local utilities, public benefits charge administrators, the Alliance, Bonneville, the states and others to assure efforts are targeted where they have the most impact on the resource development and where synergies of approach and combined efforts can be taken advantage of.

In addition, a significant share of the savings identified by the Council can be best acquired through regionally administered programs or require a regional scope to achieve economy of scale or market impacts. However, at present there is no regional organization chartered and/or funded to develop and administer such programs. In the past Bonneville has played this role.[10] However, it is not clear that Bonneville could or should continue to provide this function in the future. The Council intends to work with Alliance, Bonneville, the region's utilities and system benefits charge administrators and regulators develop solution to this problem.

Aggressive Action by the Power System Is Necessary

As in most previous Council Power Plans, this Plan does not attempt to quantify the portion of the achievable conservation that might be developed by consumers acting independently of utility or

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9 A lost-opportunity resource is a conservation measure that, due to physical or institutional characteristics, will lose its cost-effectiveness unless actions are taken now to develop it or hold it for future use. For example, some efficiency measures can only be implemented cost-effectively when a building is being constructed or undergoing major renovation. If they aren't done then, the opportunity to capture those savings is lost.

10 For example, Bonneville administer the Manufactured Housing Acquisition Program (MAP) on behalf of all of the region's public and investor-owned utilities.

system benefits administrator programs. There are several reasons for this. First, to the extent feasible the Council has attempted to account for existing market penetration of consumer investments in energy efficiency and the effects of know future codes and standards. These have already been subtracted from estimates of future potential.

Second, the Council is charged with determining which mix of resources will provide the region with most economically efficient and reliable electric power system and services. Allocating the targets (and the cost of meeting them) between the region's consumers and its electric ratepayers does not change the total cost of acquiring these savings. More importunately, since these two groups are comprised of the same individuals, from a regional perspective it makes no difference who pays -- the total bill is the same.

Third, this Plan's conservation target is achievable, yet aggressive. In order to achieve these targets, the region will need to make significant investments in conservation resources. While these conservation resources are less expensive than other resource options, their costs are front-loaded. This is especially true for "lost-opportunity" conservation resources because these resources have measure lives that typically exceed the 20-year planning period.[11] Only 315 average megawatts of the 2XXX average megawatts targeted by this Plan have real-levelized cost below 1.0 cent per kilowatt-hour. Even these conservation resources have "payback" periods exceeding those typically demanded by commercial and industrial customers. Given these facts, the Council is convinced that this Plan's conservation targets cannot be achieved without broad-based and aggressive programs. While these programs should be designed to target measures that would not otherwise be adopted and focus on consumers that would not likely adopt energy efficient technologies, those considerations should not drive program design.

Efficient Programs Are Not Necessarily Those With the Lowest (First Year) Cost

As noted in the previous discussion, conservation resource costs are "front-loaded." Therefore, measuring how effective local or regional conservation acquisition programs are based on their cost per first year savings is, at the very least, misleading and at worst, misguided. Lost-opportunity resources comprise fifty percent of the Council's conservation target. These resources, as noted above, are by definition "long-lived." Moreover, because the region has been successful in improving energy codes, federal efficiency standards and building practices a significant share of the remaining lost-opportunity potential is more costly than "average." These two factors create a conflict between getting conservation "cheap" and achieving the Council's lost-opportunity targets.

To illustrate this conflict consider the following example. High efficiency clothes washers represent 295 average megawatts of resource potential. Their real levelized cost is 4.2 cents per kilowatt-hour and they have a benefit-to-cost ratio of 2.85. The "first year cost" of savings from high efficiency clothes washers is $3.8 million per average megawatt. Compact fluorescent lamps (CFLs) represent 530 average megawatts of non-lost opportunity resource potential. They have a real levelized cost of just over 1.7 cents per kilowatt-hour and a benefit-to-cost ratio of 2.6. The "first year cost" of CFL savings is $2.4 million per average megawatt. If a conservation program operator "capped" its "willingness to pay" at $1.0 million per average megawatt it might forego securing one or both of these resources. Alternatively, to limit its costs, it might offer incentives to consumers that are so small that only those consumers who would have purchased the efficient clothes washer or CFLs end

[11] The "first year cost" of a measure with a real-levelized cost of just 1.0 cents per kilowatt-hour and a 20 year lifetime is over 17 cents per kilowatt-hour. At a retail electric rate of 5.0 cents per kilowatt-hour this measure would have a simple payback of over 3.5 years.

up participating in its program. As a result, the program produces no "incremental savings" beyond what the market would have done on its own.

This is not to say that the conservation should not be acquired at as low a cost to the power system as possible. While everyone benefits from cost-effective conservation, the end-user participants benefit most directly. Given that retail rates have risen significantly in recent years, end users have a greater incentive to share in the cost of the conservation. But the Council's goal is to achieve the 1XX average megawatt target. Whether the region's consumer's pay for more or less of the cost of doing so through their electric rates, while important, is a secondary goal.

A Mix of Mechanisms Will Need to Be Employed –

There are several acquisition approaches that have been used successfully in the region and around the country to develop cost-effective conservation not captured through market forces. Key among these are: direct acquisition programs run by local electric utilities, public benefit charge (PBC) administrators or regional entities; market transformation ventures; infrastructure development; state building codes; national and state appliance and equipment standards; and state and federal tax credits. The Council believes a suite of mechanisms should continue to be the foundation used to tap the conservation resource.

It is the nature of the conservation resource, the kinds of measures and practices, and the inherent advantages of different acquisition approaches that suggest how much of the conservation potential should be pursued, by what entities and using which methods. Most of the successful conservation development over the past two decades has been through a combination of approaches over time. Typically pilot projects demonstrate a new technology. Direct acquisition programs are used initially to influence leading decision makers to adopt the technology. Market transformation ventures are used to bring the technology to be part of standard practice. Then, in some cases, codes or standards can be upgraded to require the new measures.

Direct Acquisition Programs

Direct acquisition programs are typically programs run by local utilities, system benefits charge administrators, regional organizations, BPA and others that offer some kind of incentive to get decision makers to make energy-efficient choices. Incentives often take the form of rebates, loans, or purchased energy savings agreements. Direct acquisition programs are relatively expensive compared to other approaches because the incentive can be a significant fraction of the measure cost and substantial administrative costs are required. Historic program costs ranging from 1 to 5 million dollars per average megawatt of savings. However, in many cases, direct acquisition programs are the only mechanism available or are a necessary first step to get new measures and practices into the market place. Acquisition programs can be local or regional. Many retrofit programs for residential and commercial building are best run as local efforts. On the other hand, for measures where there are just a few suppliers or vendors in the region, a regional approach to direct acquisition will be more cost-efficient.

Market Transformation Ventures

Market transformation ventures are regional and national efforts to get energy-efficient products and services adopted by the marketplace sooner and more thoroughly than they would be otherwise. The Northwest Energy Efficiency Alliance (Alliance) is the key entity in the region pursuing this approach. The Alliance has developed an impressive track record of improving the adoption of efficiency measures and practices in most of the markets it has ventured into racking up sizeable low-cost energy savings of about 100 MWa at a cost of $1 million per MWa or less.[12] The Council envisions continued market transformation efforts will yield similarly impressive results at similarly low costs.

Conservation Infrastructure Development

Often, the delivery of new energy-efficient products and services requires development of, or intervention in, the infrastructure that proposes to deliver those products or services. Conservation infrastructure includes education, training, development of common specifications for efficient practices or equipment, certification programs, market research, program evaluation and other activities that support quick, widespread adoption of energy efficiency that delivers savings. Infrastructure development is often best approached at a regional or national level if the product or service is one that crosses the boundaries of local utilities. The Alliance, Bonneville, the states, the federal government and some national organizations have fostered infrastructure development in the past. For example, the federal government's Energy-Star program identifies products that meet minimum efficiency levels for common household appliances. Both market transformation ventures and direct acquisition programs can use the federal designation to promote products in regional and local markets.

In the past, some infrastructure development has been supported through the Alliance. But limited Alliance budgets, combined with increasing need for regional infrastructure has orphaned some efforts. The Council believes more effort should be directed to regional infrastructure in the next five years to speed the development and lower the cost of capturing all cost-effective savings.

Building Codes

Residential and commercial energy codes are adopted at the state and local level to require minimum levels of efficiency in many of the energy-using aspects of new homes and commercial buildings. Energy codes are typically part of the building code and typically lag behind leading-edge efficiency practices. Once adopted as the minimum standard, codes generally lead to decreasing measure costs. However, not all cost-effective conservation can be captured by buildings codes. Code improvement is a continual process and regional efforts need to continue.

Appliances and Equipment Standards

The federal government, and some state governments adopt minimum efficiency standards for certain appliances and equipment. Federal laws dictate that certain appliances fall under federal jurisdiction and timelines for minimum efficiency standards. Other appliances and equipment are not under federal jurisdiction but might be subject to state or local standards. Significant efforts should continue be placed on improving appliance standards.

Tax Credits

State and national tax credits have been used effectively to promote efficient equipment and practices beyond what is required in federal standards and state codes. State laws differ and may limit the ability of a state to offer tax credits. However, in instances like Oregon's Business Energy Tax Credit, these mechanisms have been very effective.

[12] Retrospective Assessment Of The Northwest Energy Efficiency Alliance, Final Report, by Daniel M. Violette, Michael Ozog, and Kevin Cooney, Available at http://www.nwalliance.org/resources/reports/120.pdf

The Council considered the mechanisms above, the kinds of measures and practices that comprise the conservation assessment, and the state of development of each in order to get a general idea of what level of effort to apply to each of these approaches to tap the conservation potential identified in this plan. Suggested approaches are based on the characteristics of the potential conservation including whether it is lost-opportunity or retrofit, it's size, cost, and non-energy benefits, characteristics of the market and delivery channels used disseminate the measures, local, state, regional and national programs already in place, and if and when a measure or practice might be subject to codes or standards.

Residential Sector Conservation

Table 7-3 shows the achievable savings, real levelized cost, benefit-to-cost ratio, total resource capital cost per average kilowatt and the share of sector savings for each of the major sources of residential sector potential. As can be seen from this table, the residential sector conservation potential is highly concentrated among just three measures. Nearly 70 percent of the realistically achievable residential sector conservation potential comes from three measures, compact florescent lighting, heat pump water heaters and high efficiency clothes washers. Moreover, of the remaining 30 percent, 10 percent comes from improving the efficiency of heat pumps and converting existing electric furnaces to high efficiency heat pumps and 6 percent comes from high efficiency water heater tanks. The remaining 14 percent of the sector's potential savings is spread among 12 other major measure types.

Table 7-3 Sources and Total Resource Cost Economics of Residential Sector Realistically Achievable Conservation Potential

Measure	Realistically Achievable Potential (MWa)	Weighted Levelized Cost (Cents/kWh)	Bene-fit/Cost Ratio	Weighted[13] Total Resource Capital Cost ($/KWa)	Share of Sector Realistically Achievable Potential
Energy Star Heat Pump Conversions	70	4.3	2.1	$ 4,520	5%
Energy Star Heat Pump Upgrades	60	2.9	2.1	$ 3,170	5%
PTCS Duct Sealing	10	3.1	2.3	$ 3,640	1%
PTCS Duct Sealing and System Commissioning	5	3.0	2.2	$ 3,520	0%
PTCS Duct Sealing, Commissioning and Controls	10	3.2	2.3	$ 3,860	1%
Energy Star - Manufactured Homes	20	2.3	2.1	$ 4,240	2%
Energy Star - Multifamily Homes	5	2.3	1.1	$ 4,620	0%
Energy Star - Single Family Homes	20	2.7	1.1	$ 5,490	2%
Weatherization - Manufactured Home	20	4.0	1.1	$ 5,490	2%
Weatherization - Multifamily	30	2.5	1.1	$ 4,480	2%
Weatherization - Single Family	40	1.9	2.4	$ 3,500	3%
Energy Star Lighting	530	1.7	2.3	$ 1,370	42%
Energy Star Refrigerators	5	2.0	2.3	$ 2,330	0%
CEE Tier 2 Clothes Washers	140	5.2	1.1	$ 4,820	11%
Energy Star Dishwashers	10	1.6	2.6	$ 1,480	1%
Efficient Water Heater Tanks	80	2.2	2.3	$ 1,810	6%
Heat Pump Water Heaters	200	4.3	1.1	$ 4,240	16%
Hot Water Heat Recovery	20	4.4	1.1	$ 7,620	2%
Total	1,275	2.9	**1.9**	$ 2,960	100%

Table 7-4 shows that the annual residential sector conservation target is just under 65 average megawatts. The estimated total resource cost of acquiring these savings is just under $190 million per year. Roughly 45 percent of this target is comprised of lost-opportunity resources. Of the remaining 55 percent that are dispatchable conservation resource, the bulk (75%) of the savings come from Energy Star Lighting (compact fluorescent lamps). The fact that the bulk of the residential sector savings potential is concentrated in just a few measures reduces the number of mechanisms that may be required to capture this potential at any particular point in time. However, The Council believes that over the course of the next 20 years, nearly the full array of mechanisms and approaches will still be required to accomplish this sector's savings.

13 This is the entire incremental capital cost of the measure plus program administrative cost. Since utilities and system benefit charge administrators rarely pay 100 percent of a measure's cost, their cost will be below this value.

Table 7-4 Annual Residential Sector Lost Opportunity and Dispatchable Conservation Resource Targets

Measure	Lost Opportunity Conservation Target (MWa/yr)	Dispatchable Conservation Target (MWa/yr)	Lost Opportunity Annual Total Resource Cost (millions)	Dispatchable Annual Total Resource Cost (millions)
Energy Star Heat Pump Conversions	3.5	-	$ 15.8	$ -
Energy Star Heat Pump Upgrades	3.0	-	$ 9.5	$ -
PTCS Duct Sealing	-	0.5	$ -	$ 1.8
PTCS Duct Sealing and System Commissioning	-	0.3	$ -	$ 0.9
PTCS Duct Sealing, Commissioning and Controls	-	0.5	$ -	$ 1.9
Energy Star - Manufactured Homes	1.1	-	$ 4.8	$ -
Energy Star - Multifamily Homes	0.1	-	$ 0.3	$ -
Energy Star - Single Family Homes	0.8	-	$ 4.2	$ -
Weatherization - Manufactured Home	-	1.0	$ -	$ 5.5
Weatherization - Multifamily	-	1.5	$ -	$ 6.7
Weatherization - Single Family	-	2.0	$ -	$ 7.0
Energy Star Lighting	-	26.5	$ -	$ 36.3
Energy Star Refrigerators	0.3	-	$ 0.6	$ -
CEE Tier 2 Clothes Washers	7.0	-	$ 33.7	$ -
Energy Star Dishwashers	0.5	-	$ 0.7	$ -
Efficient Water Heater Tanks	4.0	-	$ 7.2	$ -
Heat Pump Water Heaters	10.0	-	$ 42.4	$ -
Hot Water Heat Recovery	1.0	-	$ 7.6	$ -
Total	**31**	**32**	**$ 127**	**$ 60**

Lost Opportunity Resources

While most of the lost-opportunity resources are probably best targeted by regional or national market transformation ventures, several can benefit from complimentary local acquisition program in the near-to intermediate term. For example, the two largest lost-opportunity resources are high efficiency clothes washers and heat pump water heaters. The minimum permissible efficiency of clothes washers is set by federally preemptive appliance standards. These standards were last updated in 2001. The first "phase" of the 2001 standards took effect in January of 2004 and the second "phase" of those standards will take effect in January of 2007. By law, the US Department of Energy cannot revise the standard more than once every five years. This means that the first year a new clothes washer standard could take effect is 2012. Therefore, between now and then, a regional market transformation venture complimented by local acquisition programs and state tax credits that focus on the most efficient washers is needed to capture this resource. In addition, the region should continue to actively participate in the federal appliance standards rulemaking process to ensure that the higher efficiency standards are adopted in a timely manner.

In contrast, securing the lost opportunity savings available from heat pump water heaters will require a quite different mix of mechanisms. The principle barriers to widespread application of this technology are that prior generations of heat pump water heaters were unreliable, too expensive or both and they lacked a national distribution network. As a result of federal research and demonstration efforts, the current generation of heat pump water heaters are now much more reliable. However, they still have an incremental cost (over a standard electric water heater) of about $800-900 and are not available through existing plumbing supply distribution networks. In order to overcome these barriers, a regional scale demonstration program coupled with either a regional or national market transformation venture are required.

The regional demonstration program is needed to convince contractors and consumers that this technology is as reliable as a standard electric water heater. This program needs to be of sufficient scale and duration to create a national (or regional) market for heat pump water heaters that is large enough to gain both economies of scale for manufacturers as well as to develop the regional distribution network. The Council believes that the Northwest Energy Efficiency Alliance (Alliance), working with both its regional partners and other national and regional organizations,[14] is the logical entity to lead the development of this resource.

During the initial stages of this venture it is highly probable that either significant local acquisition program incentives or manufacturer incentives will be required to defray a portion of the incremental cost of heat pump water heaters. The Council does not believe that the Alliance's could realistically mount a successful market transformation venture for heat pump water heaters within its current budget constrains. For example, if the Alliance were to negotiate an agreement with manufacturers to cover 50% of the incremental capital cost of acquiring the savings from heat pump water heaters the annual cost of a successful program could be in the range of $10 to $15 million. This represents 50 to 75 percent of the Alliance's current annual budget for all of its activities. While these "acquisition payment" could be provided by local utilities, the Council believes that providing the Alliance with the ability to negotiate a single region wide payment to heat pump water heater manufacturers for all units installed in the region (as was done in the Manufactured Housing Acquisition Program) represents a more efficient mechanism for acquiring these savings.

The next two largest lost opportunity resources are high efficient hot water tanks and the installation of high efficiency heat pumps in both new homes and the conversion of existing homes with other forms of electric heat to high efficiency heat pumps when the existing heating system is replaced. As is the case with clothes washers, the federal standards for both of these standards were recently revised. New standards for electric hot water heaters took effect in January of 2001 and new standards for air source heat pumps will go into effect in January of 2006. Local acquisition programs have successfully targeted high efficiency water heaters. The Council recommends that these programs be enhanced and expanded to ensure that a greater proportion of electric water heater tanks installed in both new and existing homes are high efficiency tanks.[15]

Capturing the savings from the installation of more efficient air source heat pumps involves more than selecting a higher efficiency unit. The Council's savings estimate also assumes that the heat pump and the ductwork through which it distributes warm or cool air have been installed properly. In fact, the bulk of the savings from this measure are actually derived from better installation practices and sealing the "leaks" in ductwork. Local acquisition programs designed to capture this resource must therefore focus on improving the installation practices of contractors and their

[14] Ideally, a national market transformation venture should be implemented involving the Consortium for Energy Efficiency, the New England Energy Efficiency Partnerships, the Mid-West Energy Efficiency Alliance and other organizations so as to maximize the scale of the market demand for this product.

[15] The minimum "Energy Factor" (EF) for a high efficiency tank varies with tank capacity. The larger the tank the lower the minimum EF. For a tank with a rated capacity of 50 gallons the Council recommends a minimum EF of 0.93.

technicians. This will require support of training and quality control/quality assurance programs in addition to direct program incentives.

In new construction, the Alliance, working with its regional partners, recently embarked on an Energy Star new homes program that requires the proper installation of more efficient heat pumps and verification that the ductwork is indeed "tight." Local utility and system benefit charge administrator acquisition programs should compliment this venture. Local programs should also target heat pump installations in non-Energy Star new homes as well as be designed secure savings from the proper installation of high efficiency heat pumps and "duct sealing" in existing homes that are replacing their heating systems. The savings from "duct sealing" in both new and existing homes could be secured at a later date. However, failure to seal the duct system when the heat pump is installed dramatically reduces the heat pump's efficiency and also increases the cost of this measure since the home would have to be revisited.

The remaining lost opportunity conservation potential can be achieved by increasing the market share of high efficiency refrigerators, freezers and dishwashers and by increasing the efficiency of new electrically heated site built and manufactured homes. Current Alliance, utility and system benefits administrator programs aimed at increasing the market share of Energy Star refrigerators, freezers and dishwashers should be continued. In addition, the region should support revisions to the federal minimum standards for these appliances.

Under the Council's medium load growth forecast, approximately two average megawatts of savings are achievable each year through improvements in the thermal efficiency of new single family, multifamily and manufactured homes. As mentioned above, the Alliance recently commenced an Energy Star new site built homes market transformation venture that attempts to capture the portion of these savings. In its initial stages this venture does not focus on multifamily construction. The Council believes that since a high percentage of multifamily buildings are electrically heated, the Alliance should develop and implement a market transformation strategy that targets these dwellings. The Council also recommends that local utility and system benefit administrator programs be designed to compliment the Alliance initiatives. To the extent possible these programs should encourage the installation of high efficiency appliances, lighting and building thermal shell measures as part of an overall package.

Since the early 1990's the region's manufactured home suppliers in cooperation with the state's energy agencies, Bonneville and the region's utilities have supported the sales of high efficiency manufactured homes under the Super Good Cents® brand name. The industry has voluntarily underwritten the entire cost of the independent third party inspection and certification program operated by the region's state energy agencies for the past 10 years. Under an agreement with the US Environmental Protection Agency, these homes are now being co-branded as meeting the Energy Star® certification requirements. Super Good Cents®/Energy Star® homes now represent just under two-thirds of all new manufactured homes sited in the region.

While by any metric this program continues to be a national model for what can be achieved through market transformation, its current specifications do not require homes to include all measures that are regionally cost-effective nor has it penetrated 85 percent of the market. It must accomplish both of these tasks in order to capture the lost opportunity savings identified in Table 7-4. Therefore, the Council recommends that the state agencies and region's manufacturers adopt a revised set of specifications. The Council also recommends that utilities and system benefit administrators expand their support of this program so that it can achieve a greater market share. Enhance support for the program should be guided by an analysis of the market and other barriers that must be overcome to increase the market penetration rate of Super Good Cents®/Energy Star® manufactured homes.

The remaining lost opportunity resource identified by the Council is a recently developed technology to recapture the waste heat contained in shower water as is drains out of the shower. This technology works by a principle called “gravity film adhesion”. Warm water exiting through a vertical drain line does not “free fall” through the center of the pipe, but rather “adheres” to the side of the pipe, warming the pipe as it flows downward. The heat given off by this exiting shower water can be recaptured by wrapping copper tubing around the shower drain line and running the incoming cold water supply to the shower through the tubing. This pre-heats the cold water supply and reduces the amount of hot water needed to provide a comfortable shower.

A limited number of “gravity film heat exchange” (GFX) devices have been installed in the region. In order to work effectively these devices need to be installed where the shower drain line has at least a four-foot vertical drop. This limits their practical application to multifamily structures and two-story or basement homes. The Council has assumed that only one quarter of the new multifamily and single family residences built over the next twenty years could realistically install these devices. However, if state energy codes were to require that GFX devices be installed in all new homes and multifamily buildings (where physically feasible) then the regional savings from this measure could be four times larger or roughly 80 average megawatts.

In order to capture this potential savings from GFX devices will require a regional demonstration of the technology to familiarized builders, plumbers and code officials with its installation and operation. The Council believes that the Alliance is best positioned to identify the barriers to widespread market acceptance of this technology. Once the Alliance has completed the necessary market research it should design and implement a strategy to expand the market share GFX devices with the end goal of incorporating them into state energy or plumbing codes. In addition, the Council believes that local utility and system benefits charge administrator acquisition programs will need to target this device as part of their the Energy Star® new homes programs.

Dispatchable Residential Resources

Just over 80 percent of energy savings potential identified in the residential sector that can be scheduled for development nearly anytime during the next twenty years. The Council’s 1XX average megawatt target requires that the replacement of existing incandescent light bulbs with compact fluorescent lamps or fixtures (CFLs) be done in roughly equal increments, adding more than 25 average megawatts of conservation resources annually. Research conducted by the Alliance indicates that the average household has about 30 “sockets” that use a standard “Edison” base. Based on estimated historical sales of CFLs in this region the Council believes that about 10 percent of these “sockets” now contain CFLs. With recent (and continuing) improvements in CFL technology, virtually all of the remaining sockets with incandescent bulbs could be retrofitted with CFLs over the next twenty years.

Although the cost of CFLs has dropped dramatically over the past five years, they still cost at least three to four times as much as standard incandescent bulbs. Specialty bulbs, such as multi-wattage/output and those with dimming capability are significantly more expensive than their incandescent equivalents. Consequently, the Council believes that current Alliance market transformation ventures as well as complimentary utility and system benefits administrator acquisition programs are still needed to accomplish regionwide re-lamping.

The Council recognizes that the region may wish to schedule the dispatch of this resource during periods when market prices are high or drought conditions limit resource availability. While delaying the deployment of this resource until "the time is right" may seem at first appealing, the Council does not recommend this approach during the next five years. First, the savings from CFLs account for nearly 20 percent of the Council's annual 1XX average megawatt target. Any reduction in the savings from this measure will have to be compensated for by increased savings from other measures. Since the Council has not identified any alternative "dispatchable resources" of comparable size and cost (1.7 cents/kWh) any such substitution would likely come at a higher cost. Second, the Council believes that sustained and aggressive programs will be needed just to achieve the Council's annual CFL savings target. Recent evaluation found that about 80% of the lamps sold are immediately installed.16 Therefore, achieving the Council's target will likely necessitate the distribution of roughly 9 million CFLs annually, or about the same number as were distributed across the region in 2001 during the West Coast Energy Crisis.

The remaining residential sector dispatchable conservation resources are available through the weatherization of existing single family, multifamily and manufactured (mobile) homes. The bulk of these savings comes from installing higher levels of insulation and replacing existing windows with new Energy Star® products. In addition, cost-effective savings in existing homes with forced air furnaces and heat pumps can be captured by sealing the leaks in their air ducts and by making sure the heat pump as the proper refrigerant charge and system air flow.17 The Council believes that utility and public benefits charge administrator conservation acquisition programs should be the primary mechanism employed to capture these resources. These weatherization programs have a demonstrated track record. However, such programs need to be revised to incorporate duct sealing and heat pump maintenance in the package of efficiency improvements considered for installation in each home.

Table 7-5 provides a summary of the Council's recommendations regarding the mix of resource development mechanisms needed to achieve the residential sector's conservation targets. A primary (P) and secondary (S) resource development mechanism is shown for each of the major sources of residential sector conservation. Specific major mechanisms, such as market transformation, regional programs and local acquisition programs are also divided into several subcategories. Within these subcategories Table 7-5 also indicates the type of action (e.g., acquisition payment, product specification or research and development) the Council believes may be needed to develop this sector's conservation potential.

The Council estimates that Bonneville, the region's utilities and public benefits charge administrators will need to budget between $100 and $125 million annually to acquire the 60 - 65 average megawatts of residential sector conservation called for in this Plan. Of this amount approximately 75 to 85 percent will be needed for local acquisition programs, 15 to 25 percent for

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[15]Findings and Report - Retrospective Assessment of the Northwest Energy Efficiency Alliance, Final Report. Prepared for the Northwest Energy Efficiency Alliance Ad Hoc Retrospective Committee by Summit Blue Consulting and Status Consulting. Portland, Oregon. December 8, 2003.

[17] These measures were not included in the Fourth Power Plan's estimate of conservation opportunities.

regional programs, market transformation initiatives, research and development and specifications. The actual split between regional and local budgets should be determined based on whether regional or local acquisition payments offer a more efficient and effective method of securing savings from heat pump water heaters and Energy Star appliances.

Table 7-5 Summary of Council Recommended Residential Sector Conservation Resource Development Mechanisms

Measure	Acquisition Mechanism									
	Market Transformation					Regional Program			Local Program	
	Code & Standards	MT Venture	National Product Specification	Regional Product Specification	Regional RD&D	Administration	Infrastructure	Acquisition Payments	Administration	Acquisition Payments
Heat Pump Conversions	S	S		Y	S				P	P
Heat Pump Upgrades	S	S		Y	S				P	P
PTCS Duct Sealing	S			Y		S	P		P	P
PTCS Duct Sealing and System Commissioning				Y		S	P		P	P
PTCS Duct Sealing, Commissioning and Controls				Y	S	S	P		P	P
Energy Star - Manufactured Homes	S	P		Y		P		M		S
Energy Star - Multifamily Homes	P	P		Y		P			S	S
Energy Star - Single Family Homes	P	P		Y		P			S	S
Weatherization - Manufactured Home				Y					P	S
Weatherization - Multifamily				Y					P	S
Weatherization - Single Family				Y					P	S
CFLs		S	Y			P				S
Refrigerators	S	S	Y							S
Clothes Washers	S	S	Y							S
Dishwashers	P	S	Y							S
Efficient Water Heater Tanks	S									P
Heat Pump Water Heaters	S	P	Y	Y	P	S		Y		M
Hot Water Heat Recovery	S	P	M	Y	P					S
P-Primary or Near Term			**S - Secondary or Long Term**			**YES = Needed**		**M=May Be Needed**		

Commercial Sector

Several characteristics of the commercial conservation potential are notable. First, about two-thirds of the conservation potential identified is in lost-opportunity resources that must be captured when buildings are constructed or remodeled and when new or replacement equipment is purchased. These factors point to a relatively larger role for market transformation activities and regionally-coordinated acquisition approaches compared to the residential sector.

The conservation potential identified in the commercial sector has several characteristics that suggest a relatively large role for regionally-based approaches. First, a large fraction of the savings potential, about 60 percent, is in lost-opportunity measures. Second, a large fraction of the savings potential requires changing practices or services as opposed to simply installing new technology. This practice-oriented characteristic will require significant amounts of education, training and marketing. Third, codes and standards can play an important role in some of the measures where savings result primarily from more efficient equipment such as better AC to DC power converters and commercial refrigeration appliances. Because many of those products are used throughout the country, and the world, the cost of improving efficiency can be shared with others from outside the region, reducing the cost of acquisition. Fourth, only part of the savings potential in new buildings is suitable for adoption in building energy codes. Consequently, the region will need to maintain long-term efforts to improve building design, construction and commissioning practices. In addition, commercial markets for energy efficient products and practices typically span across utility boundaries and state lines. This is true for the vendors, designers, installers, and distributors that need to be influenced as well as commercial-sector business owners that operate chains, franchises or multiple establishments.

The Council recommends, about 50 to 60 average megawatts per year of commercial sector conservation be targeted for development. Region-wide lost-opportunity conservation targets should be in the range of 30 to 35 average megawatts per year. Discretionary targets should be in the range of 20 to 25 average megawatts per year. While there is a relatively important role for regionally-administered efforts, in the commercial sector, incentive payments and direct-acquisition approaches through local utilities and public benefits charge administrators will continue to play a key role and will require the largest share of financial requirements. Based on a the kinds of measures and programs identified and estimated programs costs, the Council estimates that majority of annual utility system expenditures would be earmarked for direct acquisition approaches. But, a significant fraction of annual expenditures on commercial conservation, about $20 million per year should be directed toward regionally-coordinated and administered efforts. Coordinated approaches are needed among the utilities, administrators, Bonneville, local, state and federal governments, trade allies, retailers, distributors, manufacturers and entrepreneurs. The need for coordinated and strategic efforts adds to administrative costs, but will provide leverage across markets, minimize duplication of efforts and improve the effectiveness of conservation programs.

Lost-Opportunity Commercial Resources

About 60 percent of the commercial-sector conservation potential is in lost opportunity resources under the medium forecast. The Council forecasts that under medium growth, typically 50 to 60 million square feet per year of new floor space are added in the region and another 20 million square feet undergo renovations significant enough to require compliance with more stringent energy codes. This is something on the order of 3000 new commercial buildings per year and significant renovations on another 2500 existing buildings. The Council recommends that the region gear up to be capturing 30 to 35 average megawatts per year of commercial sector lost-opportunity conservation.

These opportunities would benefit from strategic intervention in markets and efficiency efforts focused upstream of the consumer. Many of the lost-opportunity resources will require market transformation activities and regional infrastructure development. Furthermore, significant near-term effort is needed to ramp up conservation activities for commercial sector lost-opportunity resources to levels where most opportunities can be tapped. Of the lost-opportunity conservation potential identified, about one-third is in new appliances and equipment that can be tapped eventually through efficiency standards. But near-term investments are needed to support development and adoption of the standards and to get efficient products in place absent standards.

The other two-thirds of lost-opportunity potential is in new building design, new and replacement lighting systems and new and replacement HVAC systems and controls. These opportunities require a multi-faceted approach to acquisition including market transformation, education, training, design assistance and pursuit of better building codes and standards. Eventually lighting codes can be upgraded to capture some of this potential. But the majority of savings potential will require near-term market transformation, development of regional infrastructure including training, education, marketing, and market research plus incentives and rebates for consumers, manufacturers or vendors. Table 7-5 shows the size and cost characteristics of commercial lost-opportunity measures.

Table 7-5 - Commercial Sector Lost-Opportunity Measures

Measure	Realistically Achievable Potential in 2025 (MWa)	Weighted Levelized Cost (Cents/kWh)	Benefit Cost Ratio	Weighted Total Resource Capital Cost ($/kWa)	Share of Sector Realistically Achievable Potential
Efficient AC/DC Power Converters	156	0.9	4.4	$399	14%
Integrated Building Design	155	2.3	4.7	$2,739	14%
Lighting Equipment	125	0.3	12.3	$211	11%
Packaged Refrigeration Equipment	68	1.9	1.9	$1,299	6%
Low-Pressure Distribution	47	2.7	1.6	$4,641	4%
Skylight Day Lighting	34	3.4	1.6	$3,420	3%
Premium Fume Hood	16	3.7	1.0	$4,137	1%
Municipal Sewage Treatment	15	1.4	2.4	$687	1%
Roof Insulation	12	1.5	2.1	$2,458	1%
Premium HVAC Equipment	9.2	4.3	1.2	$4,060	1%
Electrically Commutated Fan Motors	9.1	2.4	1.8	$2,925	1%
Controls Commissioning	8.5	3.7	1.1	$3,248	1%
Municipal Water Supply	4.3	4.0	1.1	$1,375	0%
Variable Speed Chillers	3.5	3.1	1.6	$5,029	0%
LED Exit Signs	2.9	2.5	1.3	$1,792	0%
High-Performance Glass	0.9	2.8	0.7	$4,073	0%
Perimeter Day Lighting	0.9	6.3	0.9	$7,441	0%
LED Traffic Lights	0.2	2.6	1.4	$1,200	0%
Total	667	1.7	5.0	**$1,760**	59%

Six lost-opportunity measures above account for nearly 90 percent of the savings from lost-opportunity measures identified. Table 7-6 shows characteristics of these and the remaining commercial sector lost-opportunity measures and Council estimates for annual targets and expenditures over the next five years. These include rough estimates of funding required for regionally-administered aspects of programs. Regionally administered programs include market transformation, development and implementation of codes and standards, establishing regional specifications for measures or practices, developing regional infrastructure, research and development, and in two cases regional acquisition payments. The table also identifies that most of these measures require additional direct acquisition payments by utilities and public benefits charge administrators. But, the Council has not estimated annual direct acquisition payments of utilities and public benefits charge administrators because of the large range of approaches. The Council estimates that about $19 million will be needed annually for regionally-administered programs in addition to utility and public benefits charge administrator program incentives.

Acquisition approaches for the remaining lost-opportunity measures are discussed briefly following Table 7-6.

Table 7-6 Commercial-Sector Lost-Opportunity Measures

				Approximate Average Annual Expenditure for Regionally-Administered Programs ($million)						
Measure	Average Annual Target (MWa)	Average Annual Total Capital and Program Cost ($million)	Utility & PUBLIC BENEFITS CHARGE Acquisition Payments	Total	Codes & Standards	Market Transformation Ventures	Regional or National Product Specifications	Regional RD&D	Regional Infrastructure Development	Regional Acquisition Payments
Efficient AC/DC Power Converters	7.8	$3.1	Yes	$0.95	$0.10	$0.50	$0.15			$0.20
Integrated Building Design	7.8	$21.3	Yes	$7.10		$3.50	$0.30	$0.50	$2.80	
Lighting Equipment	6.2	$1.3	Yes	$1.92	$0.20	$0.66	$0.20	$0.20	$0.66	
Packaged Refrigeration Equipment	3.4	$4.4	Yes	$2.99	$0.10	$0.25	$0.15	$0.05	$0.25	$2.19
Low-Pressure Distribution	2.3	$10.9	Yes	$1.15	$0.10	$0.50	$0.15	$0.30	$0.10	
Skylight Day Lighting	1.7	$5.9	Yes	$0.85	$0.10	$0.30	$0.15	$0.20	$0.10	
Premium Fume Hood	0.8	$3.4	Yes	$0.35	$0.10	$0.20		$0.05		
Municipal Sewage Treatment	0.7	$0.5	Yes	$0.25		$0.10		$0.05	$0.10	
Roof Insulation	0.6	$1.5	Yes							
Premium HVAC Equipment	0.5	$1.9	Yes	$0.20			$0.10	$0.10		
Electrically Commutated Fan Motors	0.5	$1.3	No	$0.30	$0.20				$0.10	
Controls Commissioning	0.4	$1.4	Yes	$0.50	$0.10	$0.05	$0.10		$0.25	
Municipal Water Supply	0.2	$0.3	Yes							
Variable Speed Chillers	0.2	$0.9	Yes	$0.20					$0.20	
LED Exit Signs	0.1	$0.3	Yes							
High-Performance Glass	0.0	$0.2	Yes	$0.60		$0.50		$0.10		
Perimeter Day Lighting	0.0	$0.3	Yes	$0.30	$0.20			$0.10		
LED Traffic Lights	0.0	$0.0	Yes							
Evaporative Assist Cooling	0.0	$0.0	Yes	$1.00	$0.10	$0.50	$0.10	$0.20	$0.10	
Total	33.4	$58.7		$18.7	$1.3	$7.1	$1.4	$1.9	$4.7	$2.4

Efficient Power Supplies

This efficiency opportunity could reduce regional loads in the commercial and residential sectors by about 150 average megawatts in 2025 under medium load growth . The levelized cost of he savings is expected to be about 1.0 cent per kWh when fully deployed at high production levels. The benefit cost ratio is about four to one. Initially, program costs will be higher as production volumes are presently low and program costs could equal the capital costs of better power supplies. Eventually, appliance standards could capture the bulk of the savings at very low cost to society. These are a lost-opportunity measures. There are many distinct markets for power supplies depending on how they are incorporated into devices, how products are specified and marketed and the structure and location of the manufacturers.

The large potential savings at low cost of efficient AC to DC power converters has recently spurred some national and international efforts aimed at capturing the resource. Initial efforts include standardized test procedures to measure performance of power supplies, design guideline specifications for power supplies in personal computers advanced by Intel, a design competition for efficient power supplies taking place in 2004 with winners to be announced in March 2005, voluntary Energy Star specifications targeted for later in 2004 and efficiency labeling being considered for Energy-Star computers in 2005 which may include power supply specifications or overall computer performance specifications which encourage the use of efficient power supplies in computers. Finally, the state of California is considering mandatory efficiency standards for external power supplies in January of 2006, and more stringent standards in 2008. But additional efforts are needed in the Northwest to realize the full potential of the more efficient technology.

This efficiency opportunity suffers from classic barriers. The markets for both internal and external power supplies are highly competitive based primarily on first cost. The buyers of these devices are predominantly product manufacturers whereas the costs of operation fall on end users and are individually small, providing for little customer-driven demand for efficiency. But, because there are so many of these devices embedded in appliances and buildings, the savings to the power system are large and low cost. To overcome the barriers programs should aim at manufacturers, bulk purchasers and ultimately state level efficiency standards. What is needed is:

- Utility and Alliance participation in an emerging national buy-down program for desktop computers that contain highly efficient power supplies
- Development and adoption of buy down programs or manufacturer incentives for other high-volume products using power supplies like televisions, VCRs, and computer monitors
- States should adopt mandatory standards for external power supplies consistent with standards that are under consideration in California
- Participation of utilities and efficiency advocates in government labeling and standards discussions and continual improvement in qualifying specifications
- Utility or market transformation programs for high volume purchasers, like government procurement offices, to purchase winning products from the 2004 efficient power supply design competition
- Research and field measurements to better understand the total energy use of plug loads in homes and businesses

Regional and national market transformation efforts are needed in the near term as first steps toward acquisition. Simultaneous efforts will be needed to develop and adopt efficiency standards where applicable. A multi-year effort will be needed and should identify and focus on sub markets that offer significant savings and promising opportunities for effective intervention. The Council expects efforts to improve internal power supplies, which are integral to specific appliances like televisions and video cassette recorders, to require focused efforts for each product class and that these efforts will require cooperative funding of utilities and market-transformation entities from across the country. The Council expects such efforts may cost the region about $1 million per year over the next ten years.

New Building Integrated Design:

The Council estimates that roughly one-third of new commercial floor space could benefit form integrated building design. Estimated achievable conservation potential under the medium forecast is about 150 average megawatts in 2025 at a levelized cost of about 2.3 cents per kWh and benefits that are about 5 times costs. Annual conservation targets are about 8 average megawatts per year under medium growth. Total capital and program costs are estimated at about $18 million per year. Integrated building design expands the building design team to include owners, developers, architects, major sub-contractors, occupants and commissioning agents and involves them at the very start of a project. The early collaboration of interested parties lays the foundation for creating a high-performance buildings. Successful programs require training and education of design practitioners, early identification of projects, marketing, and professional services for coordination, facilitation, design and review. It is a change in the design process, as much as the application of efficiency technologies. As a result, the opportunities can not readily be captured by codes and standards.

The cost of acquiring savings in new buildings through integrated building design programs is probably equally split between the improving the design process and the incremental costs of more efficient technology. Although it is often the case that the net capital costs of measures is zero due to results of the integrated design process like system downsizing.

There are many energy efficiency activities going on today in support of integrated building design. These include the Alliance-supported Better Bricks project and advisor services, support of the day lighting labs, commissioning and building operator certification, training programs and research assistance. The Alliance is also pursuing a target market strategy, that includes integrated design, and is currently focusing on new schools, health care, and grocery stores. These should be continued, and modified. The target market strategy should be expanded to other segments of the new building industry going forward. Several regional utilities have new building programs or green building programs that promote integrated building design concepts and fund or offset costs of a design process that optimizes for energy efficiency. But the penetration of integrated building design practices is low, on the order of 5 percent of new floor space.

At the national level, participation in the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system is growing rapidly with over 1000 projects in the registration process. LEED projects can earn points toward a rating in categories of energy efficiency, sustainable sites, water efficiency, materials and resources, indoor environmental quality and design process. While LEED projects do not necessarily employ integrated design processes for energy efficiency, the wide recognition of the rating is appealing to many design teams and owners alike. It is one of the most successful programs at developing interest in better-designed buildings within the new building community. As such it offers an opportunity to engage designers and owners of new buildings and to focus on and improve energy efficiency aspects of new buildings through integrated design. Efforts are underway to improve the energy-efficiency aspects of the LEED rating system. These should be continued. Several utilities in the region and around the country are using LEED as a framework for new building programs and enhancing the energy efficiency aspects of LEED projects. There is an effort afoot

Also at the national level are the advanced building guidelines for high-performance buildings being developed by the New Buildings Institute. These guidelines and strategies, dubbed E-Benchmark, focus on improving the design process for commercial buildings as well as on specific technologies and practices that improve energy performance. They are designed to be compatible with LEED, and could be a framework for local efficiency programs to foster higher energy performance in buildings.

Changing design practice will take time and continual efforts. Needed activities include

- Continued training and education of design practitioners
- Developing and deploying strategies to identify and capture integrated design opportunities as they arise so opportunities are not lost
- Building the demand for high performance buildings among owners and occupants
- Design team collaboration incentives, funding for energy modeling and design charettes and offsetting LEED registration costs
- Incentive payments for adoption of some technologies
- Adopting appropriate integrated design efficiency strategies into building codes
- Integration of operation and maintenance and commissioning practices
- Obtaining and analyzing performance data for high-performance buildings
- Continued research and development of high-performance design practices and technologies

New Building Lighting Equipment

Advances in commercial lighting technology continue to improve system efficacy which is the light output of lamps and fixtures per unit of energy input. About 125 average megawatts of savings is available by 2025 in new and replacement lighting systems in addition to lighting savings accounted for under integrated building design above. About one dozen specific technologies and applications are included in this bundle. These measures tend to have low incremental cost in new and replacement lighting situations because higher system efficacy allows for fewer lamps, ballasts and fixtures and because of low incremental labor costs. The total resource cost is further reduced because of lower re-lamping and maintenance costs. The low cost characteristics combined with high customer benefits of lower maintenance costs and better quality and color, mean customers will eventually pick up a large share of the costs of these measures. But first, practitioners must get familiar with the technologies and their application to assure high-quality and long-lasting efficient lighting solutions. Because these are low cost lost-opportunity resources they are high priority. The goal is to apply these measures to all new buildings and all replace-on-burnout opportunities.

Northwest utilities, public benefits charge administrators have operated lighting programs for new commercial buildings for about a decade. These have included a range of rebates and design assistance focused at owners, vendors, specifiers and customers. Such efforts should continue and be expanded in the future to target all lost-opportunities. In addition, the region now sponsors lighting design labs in Seattle and Portland. These facilities offer expertise, training, workshops and opportunities for designers and owners to mock-up lighting system configurations to see the results.

As the region moves to the newer technologies and applications, education and training of practitioners will be needed. The region would benefit from common specifications for typical systems to simplify applications. This includes continued support for the lighting design labs and maintaining a cadre of well-informed lighting design specialists. Market research and target marketing is needed to identify and capture new and replacement lighting opportunities as they arise and to identify niche markets such as retail task lighting, warehouses and schools. In addition, building customer demand for the maintenance savings, and non-energy benefits of these systems will promote rapid deployment of the new measures. There are significant benefits to be gained from regional cooperation.. The Council estimates that over the next five years, about $2.2 million per year is needed for regionally-administered expenditures in addition to local utility and public benefits charge acquisition expenditures. The regionally-administered efforts should be focused on capturing these lighting measures in new and replacement markets including market transformation ventures, regional infrastructure support, market research and marketing, development of regional and national production specifications, and modifications of building codes and equipment standards.

Day Lighting in New Commercial Buildings:

The Council estimates about 77 average megawatts of conservation potential from day lighting applications through skylights and perimeter day lighting in new buildings beyond what is required in code. About 42 average megawatts is part of the integrated building design measures and another 35 average megawatts is in stand-alone applications. Annual targets for both approaches are 3.5 to 4 average megawatts per year once fully ramped up. Levelized costs for day lighting are about 3.5 cents per kWh and annual capital costs are about $6 million per year in addition to costs estimated under integrated design.

The region has recently established four labs that specialize in day lighting in Seattle, Portland, Eugene and Boise. These work to raise awareness and understanding of the benefits of day lighting designs in commercial buildings. The Alliance contributes to funding the labs and their experts so that Northwest architects and other building professionals can use consulting and modeling services to decide how to best incorporate day lighting into a building design and investigate the use of window glazing, electric lighting and controls.

The Council recommends a combination of regionally-administered efforts and local utility and public benefits charge administrator incentives to capture the savings from day lighting in new buildings. Significant utility and public benefits charge administrator support of day lighting is needed in the form of direct incentives. In addition, the Council recommends about $0.85 million annually is needed over the next five years for regionally-based efforts including:

- A market transformation venture focused around the owners and developers in building types where day lighting is most appropriate such as large one-story retail, warehouses, schools and certain office applications
- Research on integration issues including HVAC interaction specific to Northwest climates and daylight patterns
- Continued and expanded support for advisor service, labs, and training that is incremental to amounts in Integrated Design

- Development of Northwest-specific day lighting specifications and design protocols
- Integration of day lighting into building codes

Packaged Refrigeration Units

By 2025, loads could be reduced by about 68 average megawatts through more efficient packaged refrigeration devices such as ice-makers, reach-in refrigerators and freezers, vending machines, and glass-door beverage merchandisers. Annual acquisition targets are about 3.4 MWa per year and about $4.4 million in capital and program cost. Costs are expected to fall as the technologies are embedded in the products, just as cost fell for efficient residential refrigerators. The Council estimates the levelized cost of these savings is about 1.9 cents per kWh.

Ongoing efforts include Energy Star rated products, voluntary purchasing guidelines developed by the Federal Energy Management Program (FEMP) and two levels of voluntary standards developed by the Consortium of Energy Efficiency and used in some utility programs. In addition, the state of California has adopted minimum efficiency standards for ice makers, reach-in refrigerators, freezers and beverage merchandisers. California is considering more stringent standards for these appliances and expanding the standards to include walk-in refrigerators and water coolers. Market transformation efforts for efficient vending machines, undertaken with Coke and Pepsi at the national level, are on the verge of being fruitful. These two companies control the lion's share of the market and are considering specifications that would produce most of the savings from vending machines.

Efforts should focus on market transformation projects at the state regional and national levels due to the regional and national markets for these products. Ultimately standards can be adopted by the Northwest states to assure minimum efficiency levels in most products. The Council recommends that the states adopt the same testing procedures and minimum performance standards as California. This would allow standards to come into play sooner and at lower cost than developing state standards whole cloth. Following California would make for a large west-coast market for these products.

However, the efficiency levels under consideration in California, and proposed by the Council for the Northwest states, are not the most-efficient products on the market. Efforts are also needed to develop a broader range of products that exceed the minimum efficiencies of state standards and to build demand for those products. To promote that goal, acquisition incentives are needed for products that surpass the California standards to stimulate demand and build the case for improving standards over time. These efforts could include rebates and incentives to manufacturers, vendors or perhaps end users for Energy Star products and products that meet the more stringent Tier-2 performance levels suggested by the Consortium for Energy Efficiency (CEE). In addition, regionally-based market transformation efforts are needed to work with trade associations & food service consultants, to develop market channels, tailor marketing and incentives to chains and multi-unit purchasers, and to pursue continuous improvements in voluntary standards and national and regional efficient-product specifications.

Overnight capital and program costs are in the range of $4 to $5 million per year. Costs are expected to decrease sharply as manufacturers incorporate efficiency measures in more of the stock produced. In the near-term, the lion's share of costs are for direct acquisition. The Council recommends that these efforts be regionally based and be focused upstream of consumers for better leverage. The Council estimates that if incentives were 50% of expected incremental equipment costs, program costs would be on the order of $3 million per year with $2 million of that in direct incentives and the remainder focused on market transformation efforts, development of standards, regional and national specification setting, market research and marketing

Low-Pressure Distribution Systems

Total savings potential is about 100 average megawatts by 2025, half through integrated building design and half as stand alone applications. Levelized costs are estimated at 2.7 cents per kWh and the benefit-cost ratio is estimated at 1.6. The measure applies primarily to offices but there are some applications in education, health and "other" sub sectors. Two measures are modeled, under floor air distribution systems and dedicated outside air systems. Both are relatively new techniques in the US but are gaining in acceptance. Both show large savings potential of 1.0 to 1.5 kWh per square foot where applicable, lower in schools.

Overnight capital and program costs are in the range of $11 million per year. These measures are best approached as design practice changes through market transformation efforts. Regionally administered program costs are estimated at $1.2 million per year over the next five years. Initial efforts should focus on:

- Demonstration projects including engineering, and evaluation and case studies
- Develop ASHRAE aspects for standards & design protocols
- Research and development to refine designs, collect and review performance data, and tailor to Northwest climates.
- Training and marketing
- Regional specification setting
- Incorporation of efficient design and construction practices into codes

Electrically Commutated Fan Motors

The measure has been adopted in the Seattle building codes but should be adopted in statewide codes in Washington, Oregon, Idaho and Montana.

Light Emitting Diode (LED) Exit Signs

This technology should also be adopted in state codes where they are not currently required.

Evaporative Assist Cooling

The Council has not included savings target for this measure in the draft plan. But the savings potential is significant because of the dry summer climate in much of the region and because the relatively poor performance of stock economizers available in new roof top cooling equipment. In the near term the Council recommends a significant research and pilot project for evaporative-assist cooling.

Premium Fume Hoods, Premium HVAC Equipment, New Building System Commissioning Measures, Variable Speed Chillers, High-Performance Glazing

These measures will require regional market transformation or regional infrastructure development with significant utility incentives in the early stages to buy down equipment costs, subsidize design costs.

Dispatchable Commercial Resources

About 40 percent of commercial-sector achievable conservation is in retrofit measures. The Council recommends that the region gear up to be capture 20 to 25 average megawatts per year of commercial sector dispatchable conservation. Like lost-opportunity measures, retrofit measures require a combination of acquisition approaches. About one quarter of the savings potential is from lighting measures, and it is a relatively low-cost. The remainder are from a wide variety of measures and practices on various building types and end uses. Measure levelized costs are generally higher, and benefit-cost ratios generally lower than for commercial-sector lost-opportunity measures. But total capital and program costs per kWh are similar. Table 7-7 lists the characteristics of retrofit measures in order of total savings potential.

Table 7-7 - Commercial Sector Retrofit Measures

Measure	**Realistically Achievable Potential in 2025 (MWa)**	**Weighted Levelized Cost (Cents/kWh)**	**Benefit Cost Ratio**	**Weighted Total Resource Capital Cost ($/kWa)**	**Share of Sector Realistically Achievable Potential**
Lighting Equipment	114	1.8	2.2	$2,678	10%
Small HVAC Optimization & Repair	75	3.2	1.4	$1,773	7%
Network Computer Power Management	62	2.6	1.3	$953	5%
Municipal Sewage Treatment	43	1.4	2.4	$687	4%
LED Exit Signs	41	2.5	1.3	$1,792	4%
Large HVAC Optimization & Repair	38	3.7	1.2	$2,995	3%
Grocery Refrigeration Upgrade	34	1.9	1.9	$1,660	3%
Municipal Water Supply	18	4.0	1.1	$1,375	2%
Office Plug Load Sensor	13	3.1	1.2	$2,664	1%
LED Traffic Lights	10	2.6	1.4	$1,200	1%
High-Performance Glass	9	2.9	1.3	$4,156	1%
Adjustable Speed Drives	3	4.3	1.1	$7,545	0%
Total	462	2.5	1.7	$1,964	41%

Regionally-administered programs are important for retrofit measures, but play a relatively smaller role than utility and public benefits charge administrator direct acquisition approaches. Table 7-8 shows characteristics of the commercial sector lost-opportunity measures and Council estimates for annual targets and expenditures over the next five years. The Council estimates that nearly $7 million will be needed annually for regionally-administered programs for retrofit commercial conservation. Total annual capital costs are estimated at over $45 million annually. Utility and public benefits charge administrator incentives would be some fraction of that cost since most programs do not have to pay full cost for measures.

Table 7-8 - Commercial-Sector Retrofit Measures - Annual Targets

				Approximate Average Annual Expenditure for Regionally-Administered Programs ($million)						
Measure	**Average Annual Target (MWa)**	**Average Annual Total Capital and Program Cost ($million)**	**Utility & PUBLIC BENEFITS CHARGE Acquisition Payments**	**Total**	**Codes & Standards**	**Market Transformation Ventures**	**Regional or National Product Specifications**	**Regional RD&D**	**Regional Infrastructure Development**	**Regional Acquisition Payments**
Lighting Equipment	5.7	$15.3	Yes	$0.86		$0.33	$0.10	$0.10	$0.33	
Small HVAC Optimization & Repair	3.8	$6.7	Yes	$1.50		$0.30	$0.20	$0.50	$0.50	
Network Computer Power Management	3.1	$3.0	Yes	$0.55		$0.30			$0.25	
Municipal Sewage Treatment	2.1	$1.5	Yes	$1.10		$0.70		$0.30	$0.10	
LED Exit Signs	2.1	$3.7	Yes							
Large HVAC Optimization & Repair	1.9	$5.7	Yes	$1.80		$1.00	$0.30	$0.25	$0.25	
Grocery Refrigeration Upgrade	1.7	$2.9	Yes	$0.45			$0.10		$0.10	$0.25
Municipal Water Supply	0.9	$1.3	Yes	$0.20				$0.10	$0.10	
Office Plug Load Sensor	0.7	$1.8	Yes	$0.35		$0.20		$0.05	$0.10	
LED Traffic Lights	0.5	$0.6	Yes							
High-Performance Glass	0.4	$1.8	Yes							
Adjustable Speed Drives	0.2	$1.3	Yes							
Total	23.1	$45.4		$6.81		$2.83	$0.70	$1.30	$1.73	$0.25

Lighting Equipment

The lighting measures in this bundle are similar to their lost-opportunity counter parts. The main differences being the cost of retrofit applications higher due to labor costs and the savings are somewhat higher due to less efficient baseline systems. The measures suffer from the same barriers, primarily lack of awareness, training, equipment availability. As such the retrofit lighting measures would benefit from the regionally-administered programs recommended for lost-opportunity lighting measures. This includes education and training of practitioners, common specifications for typical retrofits, continued support for the lighting design labs and maintaining a cadre of well-informed lighting design specialists. The Council estimates that over the next five years, about $0.9 million per year is needed for regionally-administered expenditures in addition to local utility and public benefits charge acquisition expenditures. Regional utilities and public benefits charge administrators have operated commercial retrofit lighting programs for more than a decade with good results. These programs should continue and should focus on delivering the new technologies and applications.

Small HVAC Optimization & Repair

Small roof top HVAC systems carry the lion's share of cooling and heating loads in the Northwest. The Council estimates about 75 average megawatts of savings potential is available by 2025, most of it in reduced cooling energy. Levelized costs are about 3.2 cents per kWh and the benefit-cost ratio about 1.4. But this is a difficult market. There are many small customers, many vendors of repair service, and several different approaches to improve efficiency. Several pilot scale projects have been tried in recent years, at the Alliance and at several regional utilities, with mixed success on performance and cost. The Council believes the cost-effective savings potential is large and continued efforts are warranted to capture it. Currently three approaches are being tested in the region and in California. One addresses maintenance and repair protocols at the site. A second approach aims at replacing old economizers and controllers with a premium economizer package tailored to Northwest climates. A third approach addresses new equipment by promoting advanced system performance specifications for manufactures of new equipment.

In light of the uncertainty about what approach will perform best, the Council believes that first research is needed on the best approach to take and on field performance of fixes. Then pending results of that research, the region should embark on a strategy to capture the savings as effectively as possible. Near-term regionally-administered actions include, research, development of a strategy, and building regional infrastructure to support that strategy. A possible market transformation venture would be to encourage a manufacturer to develop and market an economizer product that is designed to perform well in the Pacific Northwest and California. The Council estimates up to $1.5 million per year is needed in regionally-administered efforts over the next five years.

Network Computer Power Management

Approximately 62 average megawatts of electricity could be saved at a levelized cost of 2.6 cents per kWh through automated control on network personal computers (PC). An Alliance project aimed at this target has been largely successful in getting a viable product to market. Capturing the remaining potential may require some amount of utility and public benefits charge administrator incentives, particularly if penetration rates are to be increased. In addition, there may be opportunities to develop a market transformation venture aimed at corporate information technology managers, or expanding the concept to other network-addressable devices commonly used in commerce. The Council estimates that $0.6 million per year is needed for infrastructure development, marketing and training as well as further market transformation.

Municipal Sewage Treatment

Between existing and forecast new sewage treatment plant capacity, the Council estimates approximately 58 average megawatts could be saved by optimizing plant operations through relatively simple controls at a levelized cost of 1.4 cents per kWh and a benefit-cost ratio of 2.4. An Alliance project aimed at this target has been largely successful in getting a viable optimization service and some new technology to market. Capturing the remaining potential may require some amount of utility and public benefits charge administrator incentives, particularly if penetration rates are to be increased.

In addition, there may be further opportunities for improving the energy efficiency of treatment regimes through new technological developments that would aid in controlling the biological process of treatment. Such an effort would require about $1 million per year over the next five year in research and market transformation venture capital.

Municipal Water Supply

The estimated 22 average megawatts of electric savings in municipal water supply systems needs to be confirmed through research and developed if it proves to be cost-effective and practicable. Near-term efforts should include a research and confirmation agenda with pilots projects that the Council expects will cost in the range of $0.2 million per year over the next five years. Depending on the outcome of the research and verification, utility and public benefits charge administrator programs would most likely be the vehicle for captring the savings. Such a project may benefit from some regionally-administered marketing, training, and infrastructure development.

LED Exit Signs

This is a proven technology with good product availability, significant labor savings, but small per unit savings. However, the Council estimates there are many exit signs in existing buildings that do not yet use efficient technologies. Overall about 40 average megawatts are available at levelized costs of 2.5 cents per kWh and a benefit-cost ratio of about 1.4. Acquisition of this measure is most suitable through utility and public benefits charge administrator programs to buy down the replacement cost of the more efficient signage.

Large HVAC Optimization & Repair

Optimizing the performance of existing buildings, with complex HVAC systems, through commissioning HVAC and lighting controls could save the region nearly 40 average megawatts at a levelized cost of 3.7 cents per kWh and a benefit-cost ratio of about 1.2. Capturing these savings requires a cadre of trained experts armed with analytical tools to optimize these complex energy systems. The Alliance has embarked on a market transformation pilot project dubbed Building Performance Systems that aims at developing a market structure that promotes and supports enhanced building operating performance. In partnership with the region's utilities, public benefits administrators, building owners/managers and service providers, key activities for this project include infrastructure development, a building performance services test, and a large-scale pilot. In addition, the Alliance supports building operator certification, the Building Commissioning Association and other regional training and educational infrastructure that supports acquiring these savings. These efforts should be continued along with utility and public benefits charge administrator program incentives. The Council estimates that annually regionally-administered program expenditures on the order of $1.8 million per year are needed to tap this measure in addition to locally-administered incentives and programs.

Grocery Refrigeration Upgrade

Retrofitting the refrigeration systems of existing grocery stores to improve efficiency could save the region about 34 average megawatts by 2025 at a levelized cost of 1.9 cents per kWh and a benefit-cost ratio of 1.9. These savings come from over one dozen individual measures that include simple and fairly complex retrofits such as high-efficiency case doors, anti-sweat heater controls, efficient motors in cases, floating head pressure control, and strip curtains and automatic door closers for walk-in coolers. This retrofit market overlaps many utility and Public Benefits Charge service territories and would benefit from common specifications for energy efficiency measures. Some training and education of service providers is needed as well as some regional marketing. The Council estimates that locally-administered efforts would require about $0.45 million per year. But the brunt of expenditures and incentives should be locally-administered through utility and public benefits charge administrators.

High-Performance Glass

There remain a significant number of electrically-heated buildings with single-glazed windows. Some of these are viable to retrofit with new high-performance glazing that will reduce both heating and cooling loads. The Council estimates about 9 average megawatts could be saved by 2025 by retrofitting the windows in these buildings and selecting new glazing to minimize heating and cooling energy use. Window retrofits on gas-heated buildings with electric cooling do not appear to be cost-effective. This measure is primarily a locally-administered program that will require some design assistance in selecting appropriate glazing as well as providing incentives to do the retrofits.

Office Plug Load Sensor, LED Traffic Lights, and Adjustable Speed Drives:

These measures together could reduce 2025 energy loads by nearly 30 average megawatts. The measures are best captured through locally-administered programs.

Irrigated Agriculture Sector

Lost Opportunity Resources

The Council did not identify any potential lost opportunity conservation resources in the Irrigated Agriculture Sector. However, this does not mean that all new irrigation systems are being designed to capture all cost-effective energy efficiency opportunities. While competitive economic and environmental pressures certainly encourage the use of more energy and water efficient irrigation systems, farmers, due to capital or other constraints, do not always install the most efficient systems. Utility, public benefits charge administrators and federal and state agricultural extension service education and technical assistance programs are still needed to help farmers and irrigation system hardware vendors design energy efficient systems.

Dispatchable Resources

The Council believes that utility and public benefits charge administrator acquisition programs are best suited to capture the five average megawatts of savings targeted per year in existing irrigation systems. Over the course of the past two decades Bonneville, along with many of its utility customers with significant irrigation loads have operated irrigation system efficiency improvement programs. These programs will need to be significantly expanded to attain the Council's regional target.

Industrial Sector

The Council believes that the 20 average megawatts of energy savings per year target for the industries in the region is best accomplished through closing coordinated utility and public benefits charge administrator acquisition programs and regional market transformation programs.

Several excellent industrial market transformation projects have been operated by the Alliance. These include projects that impact compressed air and motor management systems commonly used across many industries. The Alliance has also targeted specific technologies used in Northwest industries including pneumatic conveyors common in the wood products industry, refrigeration systems for cold storage warehouses, sewage treatment and others. Utilities and SBC administrators have developed programs that support these market transformation efforts. Bonneville and the region's utilities have developed programs that purchase energy savings from industrial customers, that rebate specific technologies, or that develop customer-specific programs tailored to meet the needs of both parties. These approaches should continue.

Industrial conservation measures generally have relatively short lifetimes because of the rapid rate of change in production facilities. So few conservation measures qualify as lost-opportunity measures because they exceed the life of the planning period. But in practice, many of the opportunities to improve efficiency in the industrial sector are associated with changes in production techniques, products produced, plant modernization, or changes required for improving product quality, quality control and even safety or environmental compliance. Taking advantage of these opportunities to improve energy efficiency is important. The Council believes these windows of potential influence should be considered as lost-opportunities because in a practical sense, the associated savings are not available if not captured during the natural process of industrial change and modernization.

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. Stable funding of utility acquisition investments is needed so that industrial customers can coordinate their capital budgeting process with utility financial support. Regional market transformation initiatives that focus on changing industrial energy management practices are also needed to ensure that efficiency investment opportunities are integrated into corporate productivity goals.

The Council, Bonneville, the Alliance, utilities, and SBC administrators should work with the regions industries, industrial trade associations and industrial service providers to develop and implement a strategy to tap industrial conservation over the next decade.###

SIDE BAR: Lowering the Utility System Cost of Conservation Acquisition
Get it as cheap as possible. Non-energy benefits. Rate structures. Decoupling. Coordination. Targeting

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Demand Response

Demand response is a change in demand for electricity corresponding to a change in the power system's cost of electricity. The problem is that while the region's electricity supply is generally responsive to conditions in wholesale power markets, its electricity demand is not. This situation has a number of adverse effects. It's widely recognized as one of the factors contributing to the high and volatile electricity prices experienced on the West Coast in 2000-2001. This chapter describes the analysis of the potential benefits of demand response and proposes steps to confirm and secure this resource for the region.

Potential Value of Demand Response

The region has not tried to stimulate demand response to any significant extent in the past. In some respects demand response is like conservation was 20 or 25 years ago; it seems to be a promising resource, but our experience is too limited to make confident estimates of the size and cost of the resource and the value it could provide the region.

We have approached the question of the potential value of demand response in several ways. The first was to look at its avoided cost – what costs are avoided by having demand response available. It is cost-effective to pay for demand reductions up to the marginal cost of serving demand. But since avoided costs vary with circumstances, no single value is appropriate for all utilities and all times. As pointed out earlier the short term avoided costs, which include the variable costs of operation of existing generators, can be much lower than long term avoided costs, which also include the cost of construction of new generating plants.[1] This plan focuses on the latter category, long run avoided costs, and the following discussion includes construction costs in estimates of avoided cost.

To start a regional examination of this issue, Council staff have estimated avoided costs using three contrasting approaches (see Appendix X for detailed description of these estimates). The first two approaches focus on the costs of meeting peak loads of a few hours' duration ("capacity problems"). Each approach has shortcomings; they should be seen as initial cuts at the problem rather than final solutions.

[1] In some cases costs of construction of distribution and/or transmission could also be avoided by demand response. These costs are location specific and are not included in the avoided cost estimates described here. If it were possible to include distribution and transmission in the calculations avoided costs would be higher.

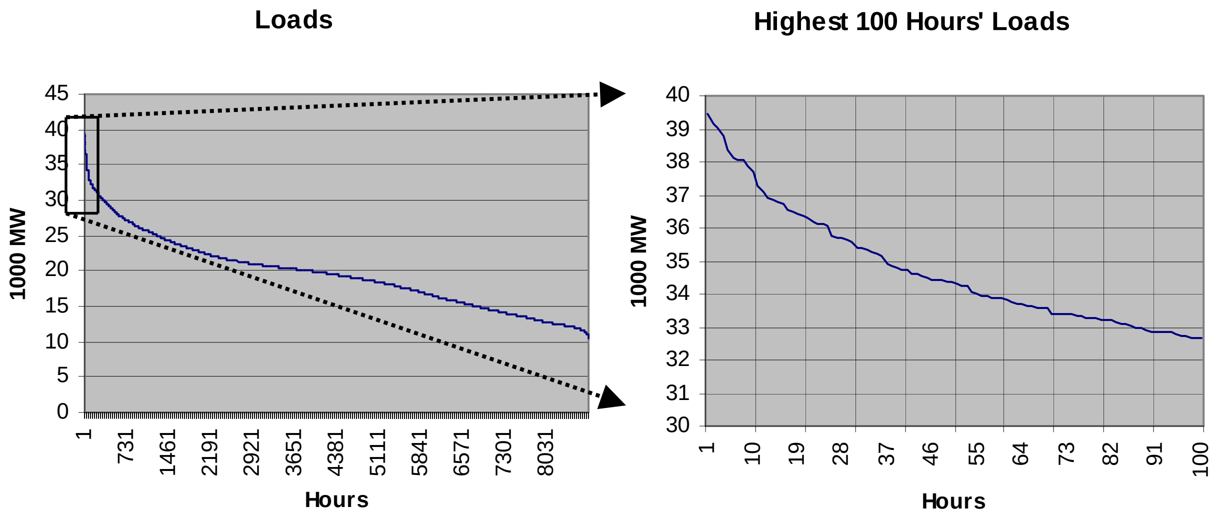

Figure XX

Approach 1. The first approach is to estimate the avoided cost of serving the peak loads of a power system served entirely by its own thermal generation, with loads distributed through the year similarly to the Pacific Northwest's loads. By arranging hourly loads from highest to lowest, a "load duration curve" is created -- shown on the left in Figure XX. The highest 100 hours are highlighted in the segment on the load duration curve shown on the right in the figure. The load in the highest hour is about 39,500 megawatts, while the load in the 10th highest hour is about 37,800 megawatts. In other words, about 1,700 megawatt of generating capacity are needed to meet loads that occur no more than 10 hours in an average year. The cost of building and operating a peaking generator for only 10 hours a year would be $6,489/megawatt-hour ($6.49/kilowatt-hour) for duct burner attachments on combined cycle combustion turbines, and $11,442/megawatt-hour ($11.44/kilowatt-hour) for simple cycle combustion turbines[2].

Per megawatt-hour costs decline as the number of hours per year of operation increase. Based on Figure XX, about 6,000 megawatt of generating capacity are needed to satisfy loads that occur 100 hours or less per year. A generator running for only 100 hours per year would cost $677/megawatt-hour ($0.68/kilowatt-hour) for duct burners and $1,179 ($1.18/kilowatt-hour) for simple cycle combustion turbines (about one tenth the cost of running 10 hours per year).

These figures mean that the avoided cost (i.e. value) of an incremental megawatt-hour of load reduction declines as we achieve more of it. If demand response allows us to avoid serving the highest 10 hours of load, we save at least[3] $6,489 to $11,442 per incremental megawatt-hour, depending on the generator technology. But if the power system is able to achieve enough demand response to avoid serving the highest 100 hours of load, the minimum avoided cost drops to the $677 to $1,179/megawatt-hour range.

Approach 1 neglects a number of significant features of the Pacific Northwest's power system: There is a large component of hydroelectric generation in the region's power system, which can

[2] Assumed costs for new generators are taken from the Council's new resource database.
[3] Most of this load is served even fewer than 10 hours per year and therefore has an avoided cost that is even higher.

generally meet peak loads more cheaply than a thermal system. Further, there are large transmission links with California and the Southwest, which facilitate sharing of generators, including peakers, with other regions and should generally reduce the cost of meeting peak loads. The Western power system includes a number of older, less efficient power plants that could be displaced by new peaking generators, with the operating cost savings offsetting part of the investment in the new units. The region also faces significant variation in the energy supplied by the hydroelectric system from one year to another, which changes the economics of thermal peaking generators (in poor water years the new peaking units may run many more hours than usual).

Approach 2. To reflect these features more realistically, the second estimation approach used AURORA©, an electric price forecasting model, to simulate the West Coast electricity system. This model takes account of interaction between hydro and thermal generators, trade among the various regions, and the operational interaction among plants of different generating efficiencies. The cost of a power system built to provide a given level of service was compared to the cost of a power system that could avoid serving about 5 percent of its load during the most expensive hours (about 250 hours in an average year). The difference is the avoided cost of service in those hours, or the value of demand response in those hours. Our estimate of avoided cost using this approach is $1,029/megawatt-hour in an average water year. In drier-than-average water years the marginal generators would run more hours, reducing the cost/megawatt-hour of their production. Critical water conditions resulted in an estimated avoided cost of $519/megawatt-hour. In wetter than average years they would run fewer hours, resulting in a higher cost/megawatt-hour.

While this approach captures the interaction between new and existing generators and trade between regions, it fails to reflect fully the flexibility in meeting peak loads that the hydroelectric system provides. Further, the analysis does not capture the unpredictability of loads and output from the hydroelectric system.

Approach 3. Portfolio analysis in support of this plan also demonstrates the potential for substantial benefits from including demand response in the region's power plans. The available demand response assumed in each case of the analysis is shown in Table XX. Compared to a portfolio with no demand response, the "base" portfolio makes 2,000 megawatts of demand response available over a twelve year period. This very rough estimate is based on estimates of price elasticity from time-of-day and real-time pricing experience elsewhere in the nation. We have further estimated that demand response could be maintained for a fixed cost of $5,000/MW for the first year and $1,000/MW for each year thereafter and could be dispatched for a cost of $150 per megawatt hour. In the case where there is no demand response, the portfolio model deploys additional combined cycle and single cycle combustion turbines while reducing somewhat the amount of wind generation.

Table XX: Available Demand Response by Case in Portfolio Analysis (megawatts)

	12/03	**12/07**	**12/09**	**12/11**	**12/13**	**12/15**	**12/17**	**12/19**

No DR	0	0	0	0	0	0	0	0
Base Portfolio	0	500	750	1000	1250	1500	1750	2000

The portfolio analysis concluded that available demand response makes it possible to reduce expected cost, risk or both. As Table XXX shows, the expected cost of the least cost portfolio declines from $17,519 million with no demand response, to $17,490 million with base case demand response assumptions. As the table also shows, including demand response in the portfolio allows a reduction in the lowest possible expected risk from $29,384 million to $28,820 million.

The "Risk ~ 29,800" category at the right of Table XXX lets us focus on changes in expected cost, while holding risk essentially constant. Introducing demand response at the base level allows the reduction of expected costs by $319 million, with no increase in expected risk.

Table XXX: Expected Costs, Risks of Demand Response Portfolios (\$Millions, Net Present Value)

	Least-cost Portfolio		Least-risk Portfolio		Risk ~ 29,800	
	Expected Cost	Expected Risk	Expected Cost	Expected Risk	Expected Cost	Expected Risk
No DR	17519	31661	18440	29384	18184	29781
Base DR	17490	30696	18478	28820	17865	29744

Confirming and realizing the potential

The results described above are dependent on the assumptions. Can 2000 megawatts of demand response be developed and done so at the costs we have estimated? What is the avoided cost? While this analysis clearly indicates that the potential benefit of demand response is very significant, there are a number of steps that the region needs to take to confirm and realize that potential:

Preserve, Refine and Expand Options

The need for demand response may have seemed to decline since the spring and summer of 2001, but if the events of the last few years have taught any lessons, one should be that conditions can change, and quickly. Maintaining and expanding the responsiveness of the region's demand to changing conditions is a cheap and attractive complement to building new generation capacity. Utilities should be able to offer programs to more participants. Participants should be able to identify more actions that will reduce load, given adequate incentive. We have a chance to build on recent experience and be able to respond quickly the next time conditions warrant.

Refine Buyback Programs to Reduce Transaction Costs

Much of the demand response enlisted in the 2000-2001 experience was the result of one-to-one negotiation, which was effective but relatively costly on a per-transaction basis. Utilities should be able to streamline some or all of these transactions (e.g. establishing many contract terms in advance, converting some negotiated deals to offers such as the Demand Exchange, etc.). Simplifying transactions will reduce the cost of making deals for both utilities and customers, which will make more deals and more load response possible.

Fully Incorporate Demand Response into Utilities' Integrated Resource Plans

As mentioned earlier, the greatest part of the potential benefit of demand response is due not to the avoidance of operating peaking generators, but to the avoidance of building them. After a generator is built, demand response allows the system to avoid only the operating cost of the generator. Before the generator is built, demand response can avoid not only the operating cost, but the construction cost as well. Depending on the hours of operation of the new unit, the total avoided cost of construction and operation may be five to 20 times the avoided cost of operation alone.

To take full advantage of the potential savings from demand response, planners need to take it into account from the beginning of their planning process, before they've committed to building new peakers. Regulators should require utilities to incorporate demand response fully into utilities' integrated resource plans.

Refine Estimates of the Size of the Resource

In order to fully incorporate demand response into resource plans, planners must have an estimate, in which they have confidence, of the size of the resource. Estimation of the size of the demand response resource presents many of the same problems as sizing the conservation resource, and more. Nevertheless it is necessary if planners are ever to rely on a significant amount of demand response instead of building new generation. This requires that load serving entities develop inventories of demand response capability, both long-term and short term, in their service territories.

Agree on Cost-Effectiveness Methodology

All the approaches we have used to estimate the value of demand response have significant limitations. Nevertheless, all the approaches lead to estimates of avoided costs that are several times the average rates paid by retail customers for electricity, and well above the incentives offered by regional utilities in their demand response programs in 2000-2001.

Another element of a cost-effectiveness methodology is the allocation of cost of metering and communication equipment necessary to demand response mechanisms. This equipment provides other benefits, such as automatic meter reading, to utilities and customers, and its cost is continuing to decrease. Cost-effectiveness evaluations should use the net cost of this equipment, after other benefits have been taken into account, to compare to demand response benefits.

Utilities, regulators, the Council and others from the region should work to develop a method of evaluating cost-effectiveness of demand response that gains general support.

Use Demand Response for Ancillary Services

Demand response is an alternative to generation in the provision of ancillary services, particularly reserves, and should be able to compete with generation to provide these services. The control and operation of the transmission system may well change in the next few years, and if a formal ancillary services market is part of that change, demand response should be able to participate on an equal basis with generation.

Transmission operators and their regulators should work to make this participation possible.

Resolve Regulatory Issues

The region's regulators will need to be involved in the regional discussion of avoided cost methodology, of course, since they will need to approve utilities' acquisitions of demand response. But there are other regulatory issues that need to be resolved as well.

For example, to the extent that states move toward giving customers the ability to choose their electricity, the effect could be to reduce access to demand response. Assume, for example, that

Supplier 1 serves industrial customers, whose loads are mostly constant, while Supplier 2 serves residential and commercial customers, whose loads exhibit daily and seasonal peaks. Supplier 1 needs little peaking generation to serve its load, while Supplier 2 needs significant peaking resources.

There is a potential regional benefit in Supplier 2 being able to obtain voluntary load reductions (demand response) not only from its own customers, but from Supplier 1's customers as well. Such transactions are likely to involve all three parties (i.e. the customer and both suppliers), and could need explicit approval from regulators. It would be unfortunate if suppliers, regulators and customers can't overcome any extra complexity to complete transactions that are in the regional interest.

The region's regulators will need to be alert to such issues and to be prepared to resolve them to remove obstacles to the fullest appropriate use of demand response.

Explore Ways to Make Price Mechanisms More Acceptable

Some of the advantages of price mechanisms over the alternative means of stimulating demand response were discussed earlier. Price mechanisms avoid transaction costs. They can reach more customers. They provide appropriate incentives when prices are low as well as when they are high. They can provide appropriate incentives for every hour of the year.

However, there are significant obstacles that hinder the adoption of price mechanisms. These obstacles may prove to be intractable, at least for now, but serious efforts are needed to identify ways to make price mechanisms more practical and acceptable. Such options as two-part real-time prices and time-of-use prices with critical peak prices deserve close examination and testing.

The Council, utilities, regulators and others should engage in a serious consideration of alternative forms of price mechanisms to meet valid concerns while achieving some of the advantages of these mechanisms.

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