



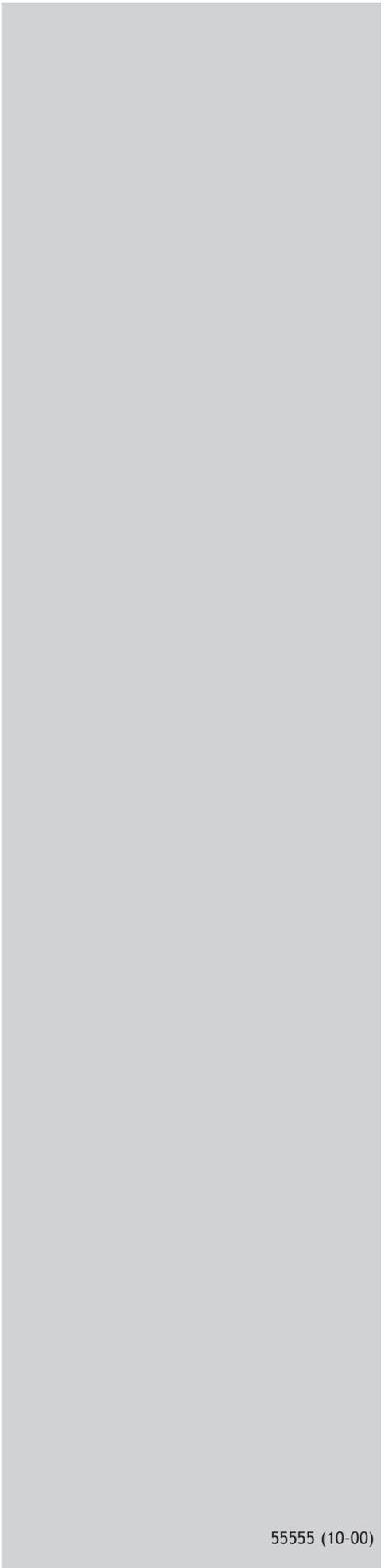
Cost-effectiveness of the Energy Smart Design Program (1991-1999)

Evaluation Unit
Energy Management Services Division

October 2000



Seattle City Light



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Energy Smart Design Program (1991-1999)**

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Introduction

Program Description

Seattle City Light operated the Energy Smart Design Program (ESD) in conjunction with the Bonneville Power Administration from 1988 through the end of the 1999 federal government fiscal year. To receive partial BPA funding for a project, the Seattle City Light customer contract had to be signed by December 31, 1996, and installation completed in the 1999 federal fiscal year. Seattle City Light has funded all projects contracted in 1997 and subsequent years.

In the first three years of the program, technical and financial assistance was provided to commercial building owners for designing energy efficient new and remodeled buildings. The building owners could install the conservation measures identified in these designs. Beginning in 1991, the ESD program was expanded to include financial assistance to customers for installing conservation measures in new, remodeled, and existing commercial buildings. In the first program option, Energy Rebate, fixed rebates were offered for the most common lighting, motor, and heating, ventilating, and air conditioning (HVAC) measures. Under the Site-based Incentive option, incentives were offered for conservation measures not on the rebate list.

The ESD program underwent additional changes in 1993, with two types of financial incentives offered to customers for installing conservation measures in their buildings. In the first option, Standard Incentives were available for lighting, motors, and HVAC measures. Customers could also participate in the Custom Incentive option for building envelope measures, energy management control systems, and other measures not funded in the Standard Incentives option.

Study Objectives

Electricity savings in the ESD program are the largest share of savings achieved to date for City Light's commercial and industrial customers. Through 1999, the ESD program savings are 61% of the total savings for these customers (Tachibana et al., 1999). Given the importance of these savings for conservation efforts at Seattle City Light, an earlier report (Coates, 1998) examined the program's economic worth for the years 1991-1997 from the point-of-view of the Pacific Northwest region, the City Light service area, City Light as a business, and the customer. The cost-effectiveness measure in the analysis was levelized program cost. In that study, low levelized costs, ranging from 6 to 35 mills, were found from the service area, utility, and customer perspectives. These low levelized costs were primarily due to Bonneville Power Administration reimbursements to City Light for administrative costs and customer incentives. A higher levelized cost, 43 mills, was found from the regional perspective as this perspective includes both utility and customer costs for the conservation measures.

The present report updates the earlier report (Coates, 1998) by using two cost-effectiveness measures to examine the program cost-effectiveness for the years 1991-1999. The cost-effectiveness measures in the analysis were levelized program cost

and the benefit-cost ratio. Both cost-effectiveness measures relate the program delivery and administrative costs for the conservation measures to the electrical energy savings achieved.

The ESD program design is structured so that City Light and the customer share the costs for installing the energy conservation measures in the customer's building. This sharing is based on the estimated annual energy savings for the conservation measure, the funding rate for the measure (e.g., \$0.14 per kWh for lighting fixtures), and the maximum amount that City Light will pay for a conservation measure. For the ESD program, City Light's funding is based the measure's annual energy savings times the funding rate, with the overall funding limited to 70% of the measure cost. Giving this cost sharing, an additional study purpose was to determine how the measure installation costs were shared between City Light and the customer, and whether the amount of sharing had changed over the years of program operation.

In the next section, the methods are presented for determining the sharing of the measure installation costs by City Light and the customer and for calculating the levelized costs and benefit-cost ratios from the four economic perspectives. Following the method discussion, the cost-effectiveness results for the ESD program are presented.

Method

The cost-effectiveness tests used for the Energy Smart Design Program were levelized program cost and the benefit-cost ratio. Levelized program cost is the present value of the program costs divided by the present value of the lifetime energy savings. In other words, the benefit in the levelized cost calculation is the discounted present value of the **kWh energy savings**. The benefit-cost ratio is the present dollar value of the benefits (i.e., energy savings) over the lifetime of the conservation measures divided by the present value of the costs. In other words, the benefits in the benefit-cost ratio are the discounted present value of the **dollar savings** from the conservation measures. Both the levelized costs and the benefit-cost ratios were calculated from four economic perspectives: the Pacific Northwest region, City Light service area, City Light as a business, and customers who participated in the Energy Smart Design Program. Additional details on the cost-effectiveness analyses are given below.

Program Benefits

For each of the economic perspectives in the cost-effectiveness analyses (Table 1), the program benefits were the projected kilowatt-hour energy savings for Energy Smart Design participants. The savings were adjusted upward by 5.2% to account for transmission and distribution savings that are due to the conservation savings. The projected savings were obtained from the Commercial/Industrial Management Tracking System, which is maintained in City Light's Energy Management Services Division. The measure life for the savings was assumed to be 15 years (Xenergy et al., 1996). The economic analysis also used a 3% real discount rate in discounting the energy

savings to a present value. The 3% rate is the long-term discount rate used in economic analyses at Seattle City Light.

For the benefit-cost ratio analyses, the energy savings were valued at the Marginal Value of Energy. This value is the marginal cost to the utility of purchased power on the Mid-Columbia market and the estimated cost of environmental externalities (e.g., cost of air, water, and other pollution from purchasing energy). For the customer, the energy savings in the benefit-cost analysis are valued at the discounted value of electricity bill savings over the measure life.

Program Costs

All costs for the cost-effectiveness analyses were adjusted to 1999 dollars with the Consumer Price Index for the 1991-1999 period. Table 1 shows the method used in calculating the various costs for the analyses. From the regional perspective, the costs were the sum of the installation costs for the conservation measures and the administrative costs for Seattle City Light. Administrative costs for the Bonneville Power Administration were not available. From the City Light service area perspective, the costs were calculated by subtracting Bonneville Power Administration incentive and administrative reimbursements to City Light from the total regional costs. The service area calculation was also used for the City Light as a business perspective, except that the conservation measures costs for the customers were excluded from the calculation. In the fourth economic perspective, the costs were the customers' share of the measure costs.

The costs used in the cost-effectiveness analyses were obtained from two sources. The costs of the conservation measures and City Light's incentive payments to customers were obtained from the Commercial/Industrial Management Tracking System. The Evaluation Unit's Accomplishments Report (Tachibana et al., 1999) was the source of the Bonneville Power Administration reimbursements to City Light and the utility's administrative costs.

**Table 1.
Benefits and Costs for the Economic Analyses**

Perspective	Benefits	Costs
Regional	Projected energy savings for program participants	Conservation measures and City Light's administrative costs
Seattle City Light service area	Projected energy savings for program participants	Conservation measures and City Light's administrative costs minus Bonneville Power Administration reimbursements
Seattle City Light	Projected energy savings for program participants	City Light's Incentive payments to customers and administrative costs minus BPA reimbursements
Customers	Projected energy savings for program participants	Customers' share of the conservation measures cost

The costs for the conservation measures and City Light's incentive payments were also used in determining the sharing of the installation costs by City Light and the customer. The customer share was calculated by subtracting City Light's incentive payments from the installation costs.

Results

Levelized Costs

Table 2 shows the Energy Smart Design Program energy savings and the associated administrative and program delivery costs during the years 1991 through 1999. In this table, the savings and costs are unadjusted; that is, they have not been adjusted to present values as was done in the cost-effectiveness analyses. As shown in the table, the energy savings for all Energy Smart Design projects during the 1991-1999 period total 343,205,091 kilowatt-hours (39.2 average megawatts). These savings, which result from installing conservation measures in the buildings, cost \$155,634,081 for the measures and \$20,406,999 for City Light's administrative costs.

Table 2.
Costs and Energy Savings
for the Energy Smart Design Program

City Light Incentive Payments ¹	BPA Payments to City Light	Customer Measure Costs	City Light Administrative Costs	Measure Installation Costs	Energy Savings (kWh) ²
\$60,919,264	\$51,326,446	\$94,714,817	\$20,406,999	\$155,634,081	343,205,091

¹ All costs in Table 2 are in 1999 dollars.

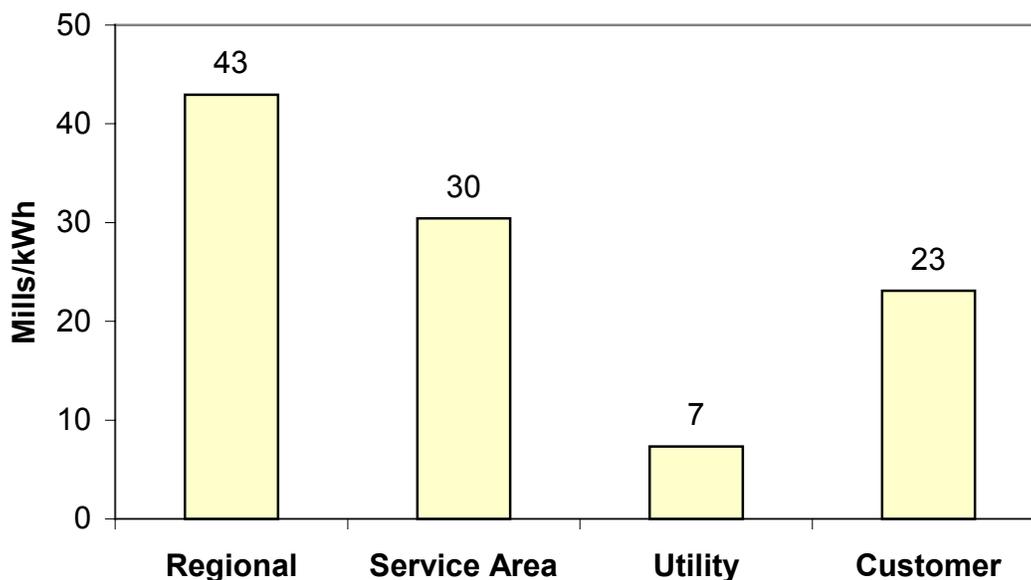
² The Energy Smart Design Program has claimed additional savings of 9,574 mWh. These savings result from customers taking conservation actions on their own following technical assistance from City Light staff. These savings are not used in the cost-effectiveness report.

Table 3.
Levelized Program Costs (mills/kWh)³

Period	Regional	Service Area	Utility	Customer
1991-1999	43.0	30.4	7.3	23.1

Table 3 and Figure 1 display the levelized costs for the Energy Smart Design Program by the four economic perspectives. As shown in the table, the total levelized regional cost was 43.0 mills per kilowatt-hour. Because of Bonneville Power Administration’s reimbursements to City Light for incentive payments, this cost is higher than the levelized costs for the other three economic perspectives. The levelized costs for the customer and service area perspectives were similar, at 23.1 and 30.4 mills per kilowatt-hour respectively.⁴ The levelized cost from the utility perspective was quite low, 7.3 mills per kilowatt-hour.

Figure 1.
Levelized Program Costs by Economic Perspective



³ The total number of projects, that is, measure groups such as lighting installed in a building, was 1,875.

⁴ The levelized cost for customers was also calculated using a 10% discount rate. Using this rate, which is often required by customers in making investments, the levelized cost for customers was 36 mills/kWh.

Figure 2.
Regional Levelized Costs by Measure Type

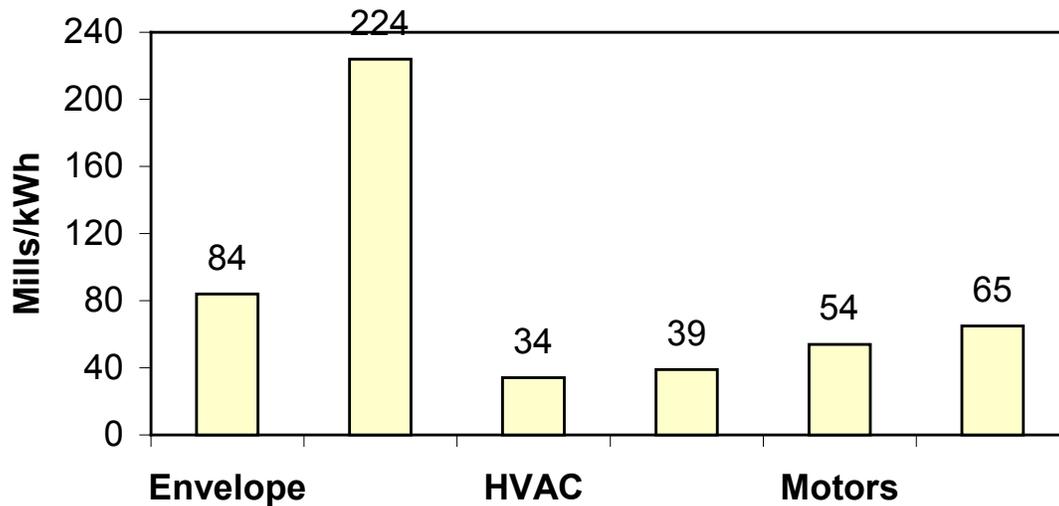


Table 4.
Levelized Program Costs by Measure Type and Economic Perspective

Measure Type ⁵	Regional	Service Area	Utility	Customer
Bldg. Envelope	84	63	10	53
Hot Water	224	180	22	159
HVAC	34	22	6	16
Lighting	39	30	5	25
Motors	54	30	12	17
Refrigeration	65	43	11	31

As noted above, Seattle City Light has provided funding for all projects contracted since January 1, 1997. Given this situation, an additional levelized cost was calculated assuming that BPA had provided no reimbursements throughout the nine-year period and all program costs were borne by City Light. In this instance, the levelized cost rose from 7.3 mills per kilowatt-hour to 19.9 mills.

⁵ For each measure type, the number of cases are: building envelope (n=19); hot water (n=10); HVAC (n=355); lighting (n=1,291); motors (n=121); and refrigeration (n=37).

Table 4 shows the levelized costs by measure type and the economic perspectives. Figure 2 (see page 6) has the levelized costs for the regional perspective only. Relative to the average levelized cost, lower costs across the regional, service area, and customer perspectives were found for lighting and HVAC measures. From the regional perspective, the levelized costs were 39 mills for lighting and 34 mills for HVAC. These two measures are the ones installed most frequently through the ESD program. Thus, the program has emphasized those measures which are the most cost-effective.

There were two measures that had substantially higher than average levelized costs for the regional, service area, and customer perspectives. The regional levelized costs for these measures, building envelope and hot water, were, respectively, 84 and 224 mills. The two measures were not installed frequently with the number of installations being 19 and 10.

An additional study purpose was to determine the percentage of the conservation measures installation costs that were paid by customers. Figure 3 shows a rolling percentage of the customer's share of the installation costs from 1991 through 1999. As shown in the figure, the customer has always borne a larger share of the installation costs than has Seattle City Light, with the share typically being between 50% and 60% of the installation costs. As of December, 1999, customers had paid 60% of the installation costs during the nine-year period.

Benefit-Cost Ratios

The benefit-cost ratios from the four economic perspectives are shown in Figure 4. These results generally parallel the levelized cost findings, as positive benefit-cost ratios were found from the point-of-view of the Pacific Northwest region, City Light service area, the utility, and the customer. Except for the utility benefit-cost ratio, the ratios are modestly positive, ranging from 1.1 to 1.6.⁶ For the utility, a large benefit-cost ratio, 6.4, was found.⁷ This large ratio is primarily due to the Bonneville Power Administration reimbursements to City Light for the ESD program.

Discussion

A study was conducted on the cost-effectiveness of energy conservation measures installed in commercial buildings through the Energy Smart Design Program over a nine-year period, 1991-1999. The levelized costs were calculated from four economic perspectives: the Pacific Northwest region, the Seattle City Light service area, City Light as a business, and the customer.

⁶ The benefit-cost ratio for customers was also calculated using a 10% discount rate. With this rate, the customer benefit-cost ratio was mildly negative at .91.

⁷ If City Light had paid all of the customer incentives during the nine-year period covered in this evaluation, the utility benefit-cost ratio would be 2.5

Seattle City Light and the Customer

The cost-effectiveness analyses showed that the ESD program is a positive economic value from the perspectives of Seattle City Light and the customer. For all program participants, low levelized costs for conservation measures installed through the ESD program were found from the service area (30.4 mills), utility (7.3 mills), and customer (23.1 mills) perspectives. Positive benefit-cost ratios were also found for the three perspectives as the ratios ranged from 1.5 to 6.6.

Figure 3.
Customer Share of Installation Costs by Year

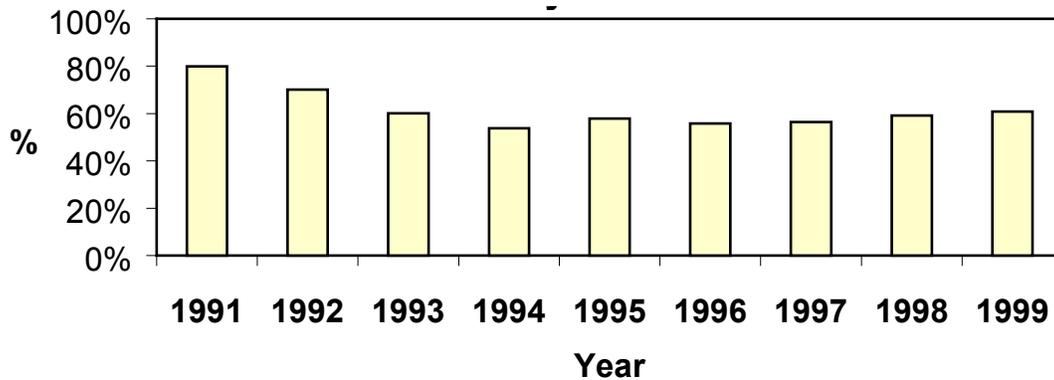
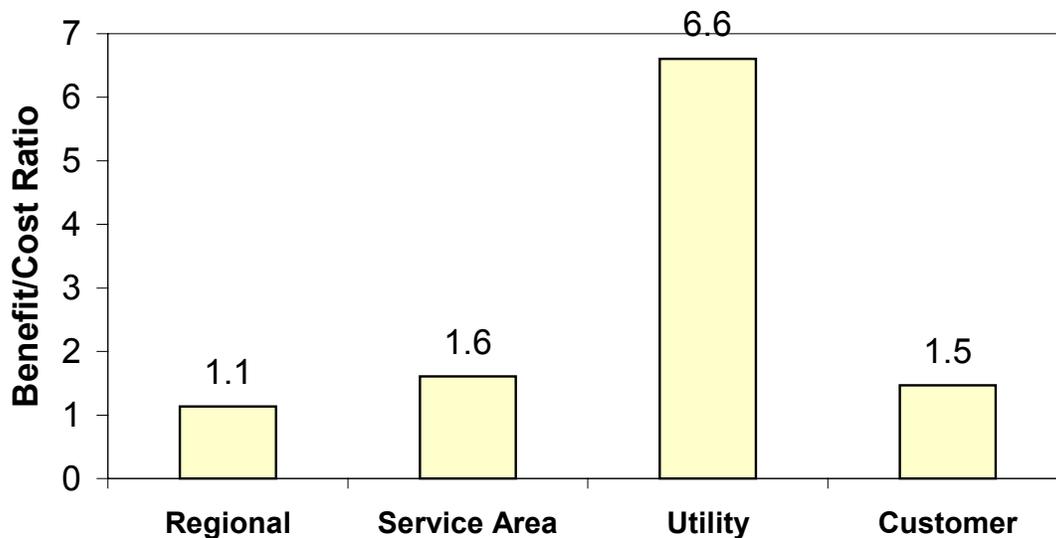


Figure 4.
Benefit-Cost Ratios by Economic Perspective



These low levelized costs and positive benefit-cost ratios for the three perspectives were primarily due to Bonneville Power Administration reimbursements to City Light for administrative costs and for incentives to customers for installing the conservation measures. For both City Light and the customers, these reimbursements and incentives markedly reduced their costs, thus resulting in low levelized costs for them. If City Light had paid all of the incentive costs for the customers during the 1991-1999 period, the utility levelized cost would be substantially higher, 19.9 mills, and the benefit-cost ratio would be lower, 2.5.

The Bonneville Power Administration no longer provides reimbursements to City Light for measure incentives and administrative costs. Given this situation, the most appropriate indicator of cost-effectiveness for the ESD program is now a service area perspective in which City Light pays the financial incentives for installing conservation measures in commercial buildings. The cost-effectiveness level for this perspective over the nine-year period is 43.0 mills, 19.9 mills for City Light and 23.1 mills for the customer. This cost-effectiveness level is the same as the regional level perspective presented in the current report.

The higher levelized cost for City Light's customers than for the utility are due to the customer paying a higher share of the measure costs. Over the nine years of the ESD program, the percentage of the measure costs paid by customers was 60%. This percentage of payment by the customers is somewhat higher than that found at other utilities. In the Eto et al. (1994) study of 20 utilities, the customers paid 44% of the installation costs.

One way for Seattle City Light to reduce the customer's share of the installation costs would be to increase the utility's incentive payments for the conservation measures. Currently, these payments are set at 14 cents per kilowatt-hour saved for lighting fixtures and from 23 to 28 cents per kilowatt-hour saved for the most common types of HVAC equipment. Cost analyses could be done to determine measure payment levels for customers that would bring the customer and utility shares for measure costs into greater balance.

Higher incentive payments for customers would have beneficial effects for both City Light and the customer. For City Light, higher payments would undoubtedly increase both the number of customers who take part in the ESD program and the programmatic energy savings. With higher savings, it would be easier for program staff to meet the annual savings goals for ESD. For customers, higher incentive payments would, from their perspective, improve the program's cost-effectiveness. This improved cost-effectiveness would be reflected in higher benefit-cost ratios in cost-effectiveness analyses and shorter payback periods for the conservation measures.

Pacific Northwest Region

A somewhat higher levelized cost, 43.0 mills per kilowatt-hour, was found from the regional perspective, as this perspective includes City Light's administrative costs and both utility and customer costs for the conservation measures. This levelized program cost is consistent with the findings from other levelized cost analyses for commercial conservation programs. In an analysis of the energy savings and costs for 1991-1992 participants in the ESD program, Xenergy et al. (1996) found that the total regional cost for the program was 50.4 mills (1999

dollars). In a second study, Eto et al. (1994)⁸ compiled energy savings and costs for 20 utility-sponsored lighting efficiency programs in the commercial sector.

They found that the average total resource cost for the 20 programs, which were implemented during the years 1988 to 1992, was 54.5 mills (1999 dollars).

Additional evidence for the program's cost-effectiveness was found when the program's levelized costs were compared to the cost-effectiveness screen used for the ESD program and City Light's marginal values of energy. In the first comparison, the program's regional cost-effectiveness was compared to the cost-effectiveness screen used by Seattle City Light and the Bonneville Power Administration for measures proposed for funding through the ESD program.⁹ This screening level, 56 mills, indicates that the ESD program is cost-effective when compared to the cost-effectiveness screen.

In the second comparison, the program's levelized costs were compared to City Light's marginal values of energy. Crane (1999) developed marginal values of energy over the planning horizon, 1999 to 2020, which include both mid-Columbia (i.e., dams on the Columbia River) energy costs and the value of environmental benefits (e.g., carbon dioxide reduction) from installing energy conservation measures in the buildings. The marginal values for low and high load costing periods were, respectively, 52.3 and 45.7 mills per kilowatt-hour (1999 dollars).¹⁰ These marginal values are somewhat above the regional levelized cost, 43.4 mills, for the ESD program. Thus, the ESD program is also cost-effective when compared to City Light's marginal costs for energy (Crane, 1999).

⁸ This study is also reported in Vine et al, ACEEE Summer Study Conference, volume 8, 1994.

⁹ This screening level was used by Seattle City Light from 1991 through 1999. Program operators are not currently using the cost-effectiveness screen.

¹⁰ Recent data on mid-Columbia energy costs indicates that current marginal values of energy may be higher than those presented by Crane (1999). The mid-Columbia energy costs for the year 2000 in City Light's latest price forecast are 26.9 mills per kilowatt-hour (1999 dollars). These costs are about 10 mills above the mid-Columbia costs per kilowatt-hour used in Crane's work.

Overall, the ESD program is cost-effective when compared to the program's cost-effectiveness screen and City Light's marginal values of energy. **Given that the program's cost-effectiveness level is just below these two comparison points, it may be worthwhile for the Commercial/Industrial Section to consider further improving the program's cost-effectiveness.** One way to improve the cost-effectiveness would be to reduce the cost-effectiveness screen. For example, the cost-effectiveness screen could be reduced to 50 mills. With this screening level, the overall program cost-effectiveness would probably drop below 40 mills.

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