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IMPACT EVALUATION OF AN ENERGY $AVINGS PLAN PROJECT AT HOLNAM INCORPORATED

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May 1993

Prepared for
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Program Evaluation Section
Office of Energy Resources
Bonneville Power Administration
U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

SUMMARY

This impact evaluation of four energy conservation measures (ECMs) that were recently installed at Holnam Incorporated (Holnam) was conducted for the Bonneville Power Administration (Bonneville) as part of an evaluation of its Energy $avings Plan (E$P) Program. The Program makes acquisition payments to firms that install energy conservation measures in their industrial processes. The objective of this impact evaluation was to assess how much electrical energy is being saved at Holnam as a result of the E$P and to determine how much the savings cost Bonneville and the region.

The impact of the ECMs was evaluated with a combination of engineering analysis, financial analysis, site visit and interview, and review of previous program submittals (Holnam's Proposals and Completion Reports). The four ECMs were all electronic power control devices that replaced less efficient technologies for controlling power to the kiln drive motors, cooler grate drive motors, cooler fan motors, and kiln stack gas precipitators.

Energy savings from this project are expected to be 1,782,000 kWh/yr or 0.20 average megawatts. On a unit production basis, this project will save 3.4 kWh/ton of cement, based on Holnam's projected average annual future production rate. Energy consumption for the four applications is not directly proportional to production, however. The four ECMs cost a total of $248,232 to install, and Holnam received payment of $115,615 from Bonneville for the acquisition of energy savings. Program administrative costs incurred by Bonneville, Pacific Northwest Laboratory (PNL), and Seattle City Light (SCL) were estimated to be $29,362. The real levelized cost (1992 $) of these energy savings to Bonneville will be 6.2 mills/kWh over the project's expected 15-year life, and the real levelized cost (1992 $) to the region will be 14.1 mills/kWh.

Based on expected ECM installation costs and energy savings benefits alone, none of the four ECMs would have been implemented by Holnam without the E$P acquistion payment. The acquistion payment reduced the payback period for the four ECMs from 6 to 2 years, which made the project economically attractive to Holnam management. However, installation of the new power controls on

the kiln stack gas precipitators would probably have been implemented in 1992 anyway, because this ECM allowed Holnam to increase the total plant output and move toward its new production goal.

If costs and energy savings not attributable to the E$P (Holnam's costs and the energy savings associated with the precipitator controls) are excluded, Holnam's costs become $211,220 and the annual energy savings become 1,572,000 kWh. The corresponding real levelized costs (1992 $) to Bonneville and the region become 7.0 mills/kWh and 13.8 mills/kWh, respectively.

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IMPACT EVALUATION OF AN ENERGY $AVINGS PLAN PROJECT AT HOLNAM INCORPORATED

1.0 INTRODUCTION

This report describes Pacific Northwest Laboratory's (PNL's)[a] evaluation of the impact of four energy conservation measures (ECMs, also referred to collectively as a project in this report) installed at Holnam Incorporated (Holnam). Holnam is the parent company of Ideal Cement, which owns cement production plants at various U.S locations. The ECMs evaluated were located at their Seattle Plant. The project at Holnam is one of about thirty energy conservation projects to have its impact evaluated by PNL. All of the projects have received or will receive acquisition payments from the Bonneville Power Administration (Bonneville) under the Energy $avings Plan (E$P) Program.

The E$P is being offered to reduce electrical energy consumption in the industrial sector of the Pacific Northwest. For the Holnam project, the acquisition payment offered under the program was equal to the lesser of 15¢/kWh saved in the first year or 80% of eligible project costs, both multiplied by 75%. The 75% factor is applied to this project because Holnam's serving utility, Seattle City Light (SCL), does not obtain all of its power from Bonneville, and it is eligible to receive only 75% of the total project cost.

The general objective of the impact evaluation was to determine how much electrical energy is saved by the project and at what cost to Bonneville and to the region. In support of this general objective, answers were sought to the following questions:

1. How much electrical energy is saved annually by the energy conservation project in terms of kilowatt-hours, kilowatt-hours per unit of plant output, and average megawatts (aMW)? Also, did any fuel switching result from implementing this project?

(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

2. If the project improved the productivity of the process, did the firm then increase output of the process to take advantage of the productivity improvement? Did the change in output result in a net increase or decrease in energy used by the process? Did the change in output cause changes in output at the firm's other plants in the region?

3. What was the net impact to the serving utility in terms of electrical energy consumption (in kilowatt-hours) from implementing the project?

4. What are the levelized costs of the project from the perspectives of Bonneville and the region?

5. How much of the project's impact can be attributed to the E$P?

1.1 APPROACH FOR IMPACT EVALUATION

Before selecting individual energy conservation projects for impact evaluation, PNL developed a general impact evaluation methodology (Spanner et al. 1988). The major finding of the methodology development was that in the industrial sector, energy conservation projects must be evaluated on a case-by-case basis. Accordingly, the general methodology consists of a variety of impact evaluation techniques that can be applied to individual projects according to the specific circumstances.

To evaluate the impact of installing electronic power controllers at Holnam, four techniques were selected from the general methodology: engineering analysis, financial analysis (see Appendix), site visit and interview, and review of Holnam's submittals. Onsite submetering by PNL was not necessary because the metering performed by Holnam and SCL in accordance with E$P program requirements was adequate to determine the project's impact. Representatives from PNL visited Holnam on October 22, 1992, to view the project firsthand and to interview Holnam's electrical supervisor.

1.2 PROJECT DESCRIPTION

Holnam manufactures Portland cement via the wet process. Clay, limestone, sand, and iron are ground in a ball mill and mixed into a slurry that is about one-third water. The slurry is fed into a rotary kiln that sequentially evaporates free water, releases water combined with the dry components, decomposes the carbonates, and combines the oxides. The resulting mixture agglomerates into nodules (clinker) that are subsequently ground into cement.

Electronic power controllers were installed in the energy conservation project at Holnam. Each of the four ECMs is briefly described below.

An electronic adjustable speed drive replaced a saturable core reactor as the power controller for the kiln drive motors. Saturable core reactors vary the output power by dissipating part of the relatively constant input power as waste heat while the electronic adjustable speed drive allows power input to vary directly with shaft power requirements.

A silicon-controlled rectifier also replaced a saturable core reactor as the power controller for the kiln stack gas precipitators, with energy savings accruing similarly to that just described for the kiln drive motor application. In addition, the new precipitator controls are able to "recognize" a sharp rise in power demand, caused by arcing in the precipitators, and momentarily cut power to the precipitators to eliminate the short circuit. This saves wear and tear on the equipment as well as energy that would otherwise be "feeding" the short. More importantly, the electronic controls allow Holnam to operate the precipitators at a higher dust loading (corresponding to a higher production rate) that would otherwise not be possible due to the arcing problem.

An electronic adjustable speed drive replaced a thyristor drive controlling the power supplied to the two cooler grate motors. The thyristor provides only half-wave rectification of the ac power, which increases losses in the dc motor due to the "ripple effect." The new electronic adjustable speed drive provides full-wave rectification, significantly improving motor efficiency.

Four adjustable frequency drives were installed to control the cooler fan flow rate rather than using inlet vanes. Inlet vanes control flow rate by varying the pressure drop external to the cooler section. Thus, motor power is relatively constant. Flow control is achieved by varying the pressure drop through the vanes. In contrast, the adjustable frequency drives control the flow rate by varying the fan output and electrical input directly, thereby eliminating the additional pressure drop losses.

In general, it was not possible to determine energy savings simply by measuring before and after energy consumption, due to significant process changes affecting each of the ECMs. For example, increasing the production rate increased the dust loading and power demand by the precipitators. Relining the kiln with brick increased the kiln weight and power demand by the kiln drive motors. Increasing the bed depth on the cooler grates increased the pressure drop through the bed, increasing the power demand by the cooling fan motors. Finally, new bearings contributed to a decrease in the power demanded by the cooling grate motors.

Given these and other process changes, the general approach was to measure the before and after energy efficiencies of the power controllers and calculate energy savings based on the efficiency improvement and the power output from the controller after the ECM and other process changes were implemented. Energy savings associated with the cooler fan controls were estimated based on the theoretical reduction in fan power obtained by switching from inlet vane control to electronic power controls. The theoretical approach was required because the new cooler sections and fans never had inlet vanes (but would have if the electronic motor controls had not been installed).

Holnam submitted two types of documents to Bonneville for each ECM: Proposals and Completion Reports. The Proposals and Completion Reports were prepared by SCL, Holnam's serving utility. The Proposals described the ECMs and presented Holnam's cost and benefit expectations. Completion Reports were submitted to Bonneville after the ECMs were installed and Holnam had verified the resulting energy savings. These documents listed the actual costs of the ECMs along with calculations of the energy savings that had been achieved.

Energy savings estimates presented in the Proposals and/or Completion Reports were adjusted based on information gathered during the site visit and interview. Increased motor power demand and controller efficiency assumptions increased the estimated savings for the kiln drive motor by about 25%. A decrease in the precipitator power demand assumption decreased the estimated energy savings for this application by about 15%. Inlet vane control was assumed to require less energy, lowering the expected savings for implementing electronic controls by about 10%. Finally, the average annual power demanded by the cooler grate motors was increased to allow for bearing friction, increasing the expected energy savings from the new controller by 5%.

The total cost to Holnam for this project was $248,232, and Bonneville paid Holnam $115,615 for the energy saved. An additional $29,362 was spent by Bonneville, PNL, and SCL to administer and evaluate the project.

1.3 SUMMARY OF PROJECT IMPACTS

This E$P project (all four ECMs) is expected to save 1,782,000 kilowatt-hours annually (0.20 aMW). Over the assumed 15-year life of this project, levelized costs to Bonneville will be 6.2 mills/kWh (1 mill = 1/1000 of a dollar), and the levelized cost to the region will be 14.1 mills/kWh. These costs are in real 1992 dollars and do not include additional savings that accrue if transmission and distribution losses (estimated to be 7.5% on average) are considered. The levelized cost to Bonneville, including transmission and distribution losses, will be 5.8 mills/kWh, and the levelized cost to the region will be 13.1 mills/kWh.

This project did not meet Holnam's funding criteria based on the expected energy savings benefits alone, but did meet the criteria based on the expected energy savings and the expected Bonneville acquisition payment. However, in addition to the energy savings benefits, installation of the precipitator controls allowed Holnam to increase plant output towards its new production goal. Therefore, we conclude that three of the four ECMs would not have been installed in the absence of the E$P, but that the precipitator controls probably would have been installed in 1992 anyway.

If costs and energy savings not attributable to the E$P (Holnam's costs and the energy savings associated with the precipitator controls) are excluded, Holnam's costs are reduced to $211,220 and the annual energy savings are reduced to $1,572,000 kWh. These new figures result in real levelized costs (1992 $) to Bonneville and to the region of 7.0 mills/kWh and 13.8 mills/kWh, respectively. Including the impact of transmission and distribution energy savings, the real levelized costs (1992 $) to Bonneville and to the region become 6.5 mills/kWh and 12.8 mills/kWh, respectively.

2.0 IMPACT EVALUATION

The following section addresses the five major objectives of the impact evaluation as stated in the introduction.

2.1 ENERGY SAVINGS AND FUEL SWITCHING

1. *How much electrical energy is saved annually by the project in terms of kilowatt-hours, kilowatt-hours per unit of plant output, and average megawatt-hours? Also, did any fuel switching result from implementing this project?*

Energy Savings

Electronic power controllers were installed in the following four applications, as described in Section 1.2: 1) kiln drive motors, 2) kiln stack gas precipitators, 3) cooler grate drive motors, and 4) cooler fan motors. Specific energy savings calculations are described for each in the following paragraphs.

The Completion Report for the kiln drive motors indicated an expected annual savings of 892,317 kWh. This value was calculated based on the measured improvement in the controller efficiency from 0.68 (before retrofit) to 0.91 (after retrofit), a measured controller output power demand of 285.8 kW, and 8,400 operating hours per year. Discussions with the plant electrical supervisor indicated that the 0.91 value measured after the retrofit probably included transformer losses and that the actual controller efficiency was likely closer to 0.97. In addition, periodic amperage readings in the months following the retrofit indicated that the average instantaneous power demanded by the motors would be at least 300 kW. With these changes, annual energy savings were estimated to be about 1,100,000 kWh (0.13 aMW).

The Completion Report for the kiln stack gas precipitators indicated an expected annual savings of 243,246 kWh. This value was calculated based on measured improvement in the controller efficiency from 0.77 (before retrofit) to 0.97 (after retrofit), a measured controller output power demand of 108 kW, and 8,400 operating hours per year. Discussions with the plant electrical supervisor indicated that the post-retrofit measurements were taken with the precipitator running "wide open" without active controls. Actual power demand varied from 63 kW up to 110 kW and averaged about 90 kW. Average power demand was assumed to be 95 kW over the long run to allow for an expected increase in production level. With this change, annual energy savings were estimated to be about 210,000 kWh (0.024 aMW).

The Completion Report for the cooler grate drive motors indicated an expected annual savings of 30,322 kWh. This value was calculated based on a measured controller efficiency of 0.72 before the retrofit, an assumed controller efficiency of 0.95 after the retrofit, a measured controller input power demand of 11.3 kW, and 8,400 operating hours per year. Discussions with the plant electrical supervisor indicated that part of the reduction in energy demand occurring after retrofit could be attributed to an overhaul of the bearings in the drive mechanism. Future increases in bearing friction relative to the measurement period immediately after retrofit were assumed to increase demand by 5%, on average, over the course of a year. Thus, annual energy savings were estimated to be 32,000 kWh (0.0037 aMW).

The Completion Report for the cooler fan motors indicated an estimated annual savings of 480,482 kWh. This value was calculated based on fan power demand estimated to be 290 brake horsepower (BHP) with inlet vanes and 196 BHP with electronic motor controls during 8000 hours of normal operation and 359 BHP for either technology for 200 "high flow" hours per year. These figures were determined based on the expected flow rate and static pressure requirement per fan and vendor-supplied fan performance curves for inlet vane and electronic motor controls. Motor efficiency was assumed to be 95% with vane control and 92% (lower due to derated conditions) with electronic controls. Controller efficiency was assumed to be 95%. Review of the fan performance curves resulted in revised fan power demand estimates of 280 BHP with inlet vanes and 194 BHP with electronic controls. Total annual operating hours were adjusted to 8,400 to be consistent with the other ECMs. The result was an annual energy savings estimate of 440,000 kWh (0.050 aMW).

Fan motor power consumption with the electronic controls was measured after the retrofit to be about 150 kW, depending on clinker bed depth and static pressure drop. This is significantly less than the predicted values noted above, which may be attributed to operating at lower static pressure than was presumed for the theoretical calculations. Nevertheless, energy savings were based on the theoretical comparison between vanes and electronic controls because actual measured consumption with vanes was not possible and may also have been significantly less than the theoretical calculations indicated.

In summary, the sum of the annual energy savings estimates presented in the four Completion Reports (1,646,367 kWh) was revised to a total of 1,782,000 kWh (0.20 aMW). This is equivalent to saving 3.4 kWh/ton of cement, based on Holnam's planned production rate. Table 2.1 summarizes the ECM energy savings estimates from the Completion Reports and this impact evaluation.

TABLE 2.1. Energy Savings Estimates for Each ECM

	Energy Savings, kWh/yr	
ECM	Completion Report	Impact Evaluation
Kiln drive motors	892,317	1,100,000
Kiln stack gas precipitators	243,246	210,000
Cooler grate drive motors	30,322	32,000
Cooler fan motors	480,482	440,000
Total	1,646,367	1,782,000

Fuel Switching

Three of the electronic controllers installed in this project were applied to electrically-driven motors and the fourth controller was applied to the electrostatic precipitators. Each application requires electrical energy. Therefore, no fuel switching occurred.

2.2 IMPACTS TO THE FIRM

2. If the project improved the productivity of the process, did the firm then increase output of the process to take advantage of the

productivity improvement? Did the change in output result in a net increase or decrease in energy used by the process? Did the change in output cause changes in output at the firm's other plants in the region?

Installation of this project improved the productivity of the production process by reducing electrical consumption per ton of cement. Although Holnam has increased production since the project was completed, the production decision was based on the current and projected market for cement rather than the change in production cost associated with this project. Collectively, energy consumption for the four ECM applications is not strongly affected by the production rate, resulting in a net decrease in energy consumption even with the increase in production. Holnam has one other cement plant in the Pacific Northwest (Trident, Montana), but the two plants have independent regional markets and therefore make independent production decisions.

2.3 IMPACTS TO THE UTILITY

3. *What is the net impact to the serving utility in terms of electrical energy consumption (in kilowatt-hours) from implementing the project?*

Because this project had no cogeneration or other complicating factors, all of the energy savings from this project will be reflected in reduced load at the utility, SCL. The net impact to the serving utility from this project will be a 1,782,000 kWh/yr (0.20 aMW) reduction in electrical load.

2.4 LEVELIZED COSTS

4. *What are the levelized costs of the project from the perspectives of Bonneville and the region?*

Levelized costs are used to compare the attractiveness of various projects or resource acquisition alternatives. The levelized cost is the annual cost that would be incurred over the life of the project, accounting for the time value of money. (See Appendix for complete definitions and formula.) Levelized costs provide a single figure of merit for comparing energy conservation alternatives. In addition, levelized costs can be used to compare conservation projects with options for new generating capacity and to aid in the ranking of these options. The objective of using levelized costs to evaluate these energy conservation measures is to determine the relative cost of each project to Bonneville ($/kWh saved) and to the region (Bonneville, SCL, and Holnam combined).

In the industrial sector, it is not possible to accurately predict the life of a project because any number of external factors could cause the project to have a longer or shorter life than expected when it is installed. To allow comparisons of levelized costs among projects installed under the E$P, all projects are assumed by PNL to have a life of 15 years. Even though some projects will have longer or shorter lives, 15 years is considered a conservative but likely life for typical projects in the industrial sector.

2.4.1 Bonneville Perspective

To determine the levelized costs to Bonneville and to the region, we must know the project costs (acquisition payment, capital costs, etc.) and the energy savings, and must assume a discount rate and project life. With energy savings of 1,782,000 kWh/yr, the project's real levelized cost (1992 $) from Bonneville's perspective will be 6.2 mills/kWh (see Appendix). Bonneville's levelized cost decreases to 5.8 mills/kWh when transmission and distribution losses are considered. These losses increase the energy savings at the point of generation by 7.5%.

The levelized costs calculated in this impact evaluation include the acquisition payment by Bonneville as well as Bonneville and PNL administrative and evaluation costs.

2.4.2 Regional Perspective

To calculate the levelized cost to the region, the costs to Bonneville, SCL, and Holnam are combined. The acquisition payment by Bonneville is included as a cost to Bonneville and as a reduction in cost to Holnam. This approach is taken because the acquisition payment has federal income tax consequences to the company and, therefore, is not a net zero cost to the region. SCL's costs include the cost for preparing program submittals and for performing metering. Because SCL does not explicitly track its costs for participating in the E$P, the utility provided an approximate estimate of its costs.

3.0 REFERENCES

Spanner, G. E., D. R. Brown, D. R. Dixon, B. A. Garrett, R. W. Reilly, J. M. Roop, and S. A. Weakley. 1988. *Potential Techniques for Evaluating the Impact of Industrial Energy Conservation Projects under Bonneville's Energy $avings Plan*. Letter Report. PNL-6628, Pacific Northwest Laboratory, Richland, Washington.

The real levelized costs to the region for acquiring annual energy savings of 1,782,000 kWh is 14.1 mills/kWh saved. Including transmission and distribution losses, the levelized cost decreases to 13.1 mills/kWh saved.

2.5 IMPACT ATTRIBUTABLE TO E$P

5. *How much of the project's impact can be attributed to the E$P?*

Energy conservation projects at Holnam must have a simple payback period of approximately two years or less for implementation. When this project was proposed to Bonneville, it was expected to incur initial costs of about $237,000 and reduce annual electricity costs by about $36,200 for a simple payback of between 6 and 7 years based solely on energy savings. With an expected acquisition payment from Bonneville of about $154,000 at the time the projects were proposed, the simple payback period was reduced to a little more than 2 years.

Based on expected ECM installation costs and energy savings benefits alone, none of the four ECMs would have been implemented by Holnam without the E$P acquistion payment. The acquisition payment reduced the payback period for the four ECMs by about 4 years, which made the project economically attractive to Holnam management. However, installation of the new power controls on the kiln stack gas precipitators would probably have been implemented in 1992 anyway, because this ECM allowed Holnam to increase the total plant output and move toward its new production goal. Therefore, we conclude that only the impact associated with the kiln drive motors, cooler grate motors, and cooler fan motors can be attributed to the E$P.

If costs and energy savings not attributable to the E$P (Holnam's costs and the energy savings associated with the precipitator controls) are excluded, Holnam's costs are reduced to $211,220 and the annual energy savings are reduced to $1,572,000 kWh. These new figures result in real levelized costs (1992 $) to Bonneville and to the region of 7.0 mills/kWh and 13.8 mills/kWh, respectively. Including the impact of transmission and distribution energy savings, the real levelized costs (1992$) to Bonneville and to the region become 6.5 mills/kWh and 12.8 mills/kWh, respectively.

APPENDIX

FINANCIAL EVALUATION DETAILS

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FINANCIAL EVALUATION DETAILS

A.1 DEFINITIONS

Levelized Cost - A single figure of merit that expresses the cost per unit of benefit (in this case, energy savings) accounting for the time value of money. This annualized cost would be constant over the entire project life. An infinite number of cash flow scenarios (costs incurred at different times in the project life) could result in the same annualized cost.

Levelized Cost to Bonneville Power Administration (Bonneville) - The annualized costs to Bonneville, direct and indirect, per unit of energy saved by the conservation measure. Costs included are the acquisition payment, program administrative costs, and project evaluation costs.

Levelized Cost to the Region - The sum of annualized costs to Bonneville, SCL, and Holnam per unit of energy saved by the energy conservation project. This would include the same costs to Bonneville as above, plus the initial capital and ongoing incremental production costs to the firm. Any non-electrical savings that result from the project are not considered in this analysis.

A.2 LEVELIZED COST FORMULA

$$LC = \{[PVCI + PVICI + (PVOM + PVPT + PVOTE) \bullet (1-itf) - PVD \bullet itf] / (1-itf)\} \bullet (CRF/AES)$$

where LC = levelized cost (real $)

PVCI = present value of initial capital costs

PVICI = present value of interim capital costs

PVOM = present value of operating and maintenance (O&M) costs

PVPT = present value of property taxes

Annual Energy savings

With precipitator controls = 1,782,000 kWh

Without precipitator controls = 1,572,000 kWh

Output:

Levelized cost

With precipitator controls = 6.2 mills/kWh

Without precipitator controls = 7.0 mills/kWh

A.5 REGIONAL LEVELIZED COST CALCULATIONS (BONNEVILLE + Holnam)

A. Holnam

Input:

Equipment installation

With precipitator controls = $248,232

Without precipitator controls = $211,220

Administrative costs = included with installation

Acquisition payment received = $115,615

Tax rate = 34%

Project life = 15 years

Depreciation = 7 years

Annual Energy savings

With precipitator controls = 1,782,000 kWh

Without precipitator controls = 1,572,000 kWh

Output:

Levelized cost

With precipitator controls = 7.7 mills/kWh

Without precipitator controls = 6.6 mills/kWh

B. Seattle City Light

Input:

Administrative and evaluation costs = $3800

Tax rate = 0%

Annual Energy savings

With precipitator controls = 1,782,000 kWh

Without precipitator controls = 1,572,000 kWh

Output:

Levelized cost

With precipitator controls = 0.18 mills/kWh

Without precipitator controls = 0.20 mills/kWh

C. Regional levelized cost = Bonneville levelized cost + Holnam levelized cost + Seattle City Light levelized cost

= 6.2 mills/kWh + 7.7 mills/kWh + 0.18 mills/kWh

= 14.1 mills/kWh with precipitator controls

= 7.0 mills/kWh + 6.6 mills/kWh + 0.20 mills/kWh

= 13.8 mills/kWh without precipitator controls

A.6 LEVELIZED COSTS ALLOWING FOR TRANSMISSION AND DISTRIBUTION LOSSES

Input: transmission and distribution losses = 7.5%

Levelized costs with precipitator controls:

Bonneville = 6.2 mills/kWh/1.075 = 5.8 mills/kWh

Regional = 14.1 mills/kWh/1.075 = 13.1 mills/kWh

Levelized costs without precipitator controls

Bonneville = 7.0 mills/kWh/1.075 = 6.5 mills/kWh

Regional = 13.8 mills/kWh/1.075 = 12.8 mills/kWh

PVOTE = present value of one-time expenses

itf = combined state and federal income tax fraction

PVD = present value of depreciation

CRF = capital recovery factor (spreads the costs over the project life in real dollar terms)

AES = annual energy savings (kWh/yr).

A.3 GENERAL ASSUMPTIONS

The following general assumptions were made in the levelized cost calculations:

1. All cash flows are expressed in nominal terms (with inflation) and are discounted to present value at a nominal discount rate of 8.15% (combines a real discount rate of 3.0% and an inflation rate of 5.0%). The costs are annualized over the life of the project using the capital recovery factor at a real discount rate of 3.0%, resulting in real levelized costs.
2. Annual energy savings (kilowatt-hours/yr) are constant over the 15-year life of the project. This assumes no loss in efficiency of the equipment with time.
3. Transmission and distribution losses equal 7.5%, increasing the energy savings at the source by a corresponding 7.5%.
4. In the regional cost calculation, the acquisition payment from Bonneville is treated as a cost to Bonneville and, at the same time, a cash inflow to Holnam rather than a net zero cost. This is done because Holnam will incur a tax liability from the acquisition payment, thus a net cost to the region.
5. All cost data are expressed in 1992 dollars.

A.4 BONNEVILLE LEVELIZED COST CALCULATIONS

Input:

Acquisition payment paid	= $115,615
Administrative and evaluation costs	= $25,562
Tax rate	= 0%

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