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IMPACT EVALUATION OF AN ENERGY $AVINGS PLAN PROJECT AT COLUMBIA HARBOR LUMBER COMPANY

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Pacific Northwest Laboratory
Richland, Washington 99352

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EXECUTIVE SUMMARY

This impact evaluation of an energy conservation measure (ECM) that was recently installed at Columbia Harbor Lumber Company (Columbia Harbor Lumber), Chehalis, Washington, 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 Columbia Harbor Lumber as a result of the E$P and to determine how much the savings cost Bonneville and the region.

The impact of the ECM was evaluated with a combination of engineering analysis, financial analysis, interviews, and submittal reviews (Columbia Harbor Lumber's Completion Report and Proposal). The ECM itself consists of an adjustable speed drive for controlling the speed of nine fans on a lumber drying kiln.

Energy savings resulting from this ECM are expected to be 286,500 kWh/yr. On a per unit of output basis, this ECM will save 0.053 kWh/board foot, a 48% reduction. The ECM cost $24,086 to install, and Columbia Harbor Lumber received payment of $19,269 from Bonneville for the acquisition of energy savings. In all likelihood, this ECM would have been installed even without the acquisition payment from Bonneville. The levelized cost of these energy savings to Bonneville will be 5.6 mills/kWh over the ECM's expected 15-year life, and the levelized cost to the region will be 7.4 mills/kWh.

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IMPACT EVALUATION OF AN ENERGY $AVINGS PLAN PROJECT AT COLUMBIA HARBOR LUMBER CORPORATION

1.0 INTRODUCTION

This letter report describes Pacific Northwest Laboratory's (PNL's)[a] evaluation of the impact of an energy conservation measure (ECM) installed at Columbia Harbor Lumber Company (Columbia Harbor Lumber) in Chehalis, Washington. The ECM at Columbia Harbor Lumber 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 acquire electrical energy savings in the industrial sector of the Pacific Northwest. For the Columbia Harbor Lumber project, the acquisition payment offered under the program was equal to the lesser of 10¢/kWh saved in the first year or 80% of eligible project costs, up to a limit of $250,000.

The general objective of the impact evaluation was to determine how much electrical energy is saved by the ECM 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 measure in terms of kilowatt-hours and kilowatt-hours per unit of plant output? Also, did any fuel switching result from implementing this ECM?

2. If the ECM 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?

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

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

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

5. How much of the ECM'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 considered 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 an adjustable speed drive (ASD) on a new lumber kiln at Columbia Harbor Lumber, four techniques were selected from the general methodology: engineering analysis, financial analysis, site visit and interview, and review of Columbia Harbor Lumber's submittals. On-site submetering by PNL was not necessary because the metering performed by Columbia Harbor Lumber in accordance with E$P program requirements is adequate to determine the project's impact. Because Columbia Harbor Lumber was not interviewed during the process evaluation of the E$P program, no process evaluation results are available for this project. However, questions pertinent to the impact evaluation that are ordinarily asked during a process evaluation interview were included in the impact evaluation interview.

Representatives from PNL visited Columbia Harbor Lumber on November 14, 1991, to view the ECM firsthand and to conduct a technical interview with the plant's General Manager. The following day, a telephone interview was conducted with the Secretary/Treasurer of Columbia Harbor Lumber's parent company (Patrick Lumber) to discuss financial aspects of the ECM.

1.2 PROJECT DESCRIPTION

Columbia Harbor Lumber is a mill that performs two services for other firms: it dries and/or performs machining operations on better grades of rough-cut and final-cut lumber. Columbia Harbor Lumber does not actually own the lumber it processes. The plant consists chiefly of four lumber drying kilns and two machining centers.

In the energy conservation project at Columbia Harbor Lumber, an adjustable speed drive was installed as part of a new lumber kiln. The kiln involved in this project is the largest one at the plant, with annual drying capacity of approximately 7.0 million board feet (bd ft) per year. The kiln itself was installed to replace two older kilns that are now out of service. The ASD is used to control the speed of nine 15-horsepower motors driving large fans that circulate warm air through the kiln. All of the fans run at the same speed at any instant in time, so a single controller is used to regulate all of them simultaneously.

The energy savings from this project result from running the fans at less than full speed during part of the drying cycle of each charge (or batch) of lumber. Without the ASD, the fans would run at full speed during each entire drying cycle and unnecessarily consume electricity. With the ASD controlling the fan motors, however, fan speed can be matched to drying requirements as needed during a cycle. Energy consumption is reduced because air flow can be reduced during much of a typical drying cycle.

Another benefit of installing an ASD on this kiln is that it allows improved control of the drying process. This improved control results in improved lumber quality and reduced cycle time for each charge.

To participate in the E$P Program, Columbia Harbor Lumber submitted three documents to Bonneville: an Abstract, a Proposal, and a Completion Report. The Abstract briefly described the ECM and provided rough estimates of project costs and energy savings. The Proposal described the ECM in greater detail and presented more precisely Columbia Harbor Lumber's expectations with regard to costs and benefits. Included was a calculation of the ECM's expected simple payback. A Completion Report was submitted to

Bonneville after the ECM was installed and Columbia Harbor Lumber had verified the resulting energy savings. This document listed the actual costs of the ECM along with a calculation of the energy savings that had been achieved.

The total cost to Columbia Harbor Lumber for this ECM was $24,086, and Bonneville paid $19,269 (80% of eligible project costs) for the energy saved. Columbia Harbor Lumber pays approximately 2.4¢/kWh for electricity.

1.3 SUMMARY OF PROJECT IMPACTS

This E$P project, or ECM, is expected to save 286,500 kilowatt-hours annually.

Over the assumed 15-year life of this ECM, levelized costs to Bonneville will be 5.6 mills/kWh (1 mill = 1/1000 of a dollar), and cost to the region will be 7.4 mills/kWh. These costs are in real dollars and do not include additional savings that accrue if transmission and distribution losses are considered. The levelized cost to Bonneville including transmission and distribution losses will be 5.2 mills/kWh and the cost to the region will be 6.9 mills/kWh.

For the reasons cited in Section 2.5, we conclude that this energy conservation measure would have been installed in the absence of the E$P Program.

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 ECM in terms of kilowatt-hours and kilowatt-hours per unit of plant output? Also, did any fuel switching result from implementing this ECM?*

Energy Savings

Determining the energy savings for this ECM is complicated by the fact that the kiln on which the ASD was installed never existed without the ASD. Therefore, there are no historical energy consumption data to use as a baseline against which to compare post-ECM energy consumption to determine energy savings. In its Completion Report, Columbia Harbor Lumber calculated baseline energy consumption by measuring fan power at full air flow (which corresponds to 80% motor speed) at 175°F and then used the fan laws and typical drying cycle data to develop a figure for baseline consumption. Specifically, the measured power was adjusted via the fan laws to estimate how much power is used at each temperature during each of the commonly used drying cycles. By this method, baseline energy consumption was calculated to be 688,900 kWh/yr for 41.9 charges of lumber.

Another complication in determining energy savings by this ECM is that kiln operation varies significantly with different types of lumber, different charge sizes, and different moisture content of lumber at the beginning of the drying process. All of these factors vary from charge to charge, and none of them can be predicted with much certainty. Columbia Harbor Lumber's energy savings calculations were based on estimates of the long-run values of these factors (e.g., lumber mix is 39.5% Douglas fir clear grade, 21.4% Douglas fir shop grade, 10.7% hemlock shop grade, and 28.4% hemlock common grade; typical charge size is 150,000 bd ft; and 41.9 charges/yr). Using these estimates, the baseline energy consumption for the kiln is 0.11 kWh/bd ft.

After establishing baseline energy consumption, the kiln was metered for four days while drying a charge of hemlock common grade lumber. With the ASD operating, the kiln required 5,500 kWh to dry the charge. This figure was then scaled up by the ratios of drying cycle lengths to estimate post-ECM energy consumption for each of the other wood species. The drying cycle for a charge of hemlock common grade is 118 hours, the cycle for Douglas fir clear grade is 230 hours, the cycle for hemlock shop grade is 242 hours, and the cycle for Douglas fir shop grade is 326 hours. For example, the post-ECM energy consumption for hemlock shop grade was therefore estimated to be 242/118 * 5500 = 11,280 kWh per charge.

During the impact evaluation, a minor discrepancy was found in the Completion Report concerning the drying cycle length for Douglas fir shop grade lumber. After consulting with Columbia Harbor Lumber, PNL used the corrected value of 280 hours (instead of 326) for the length of time to dry a charge with the ASD operating. Because of this discrepancy, the number of charges for the baseline should have been 41.9 charges per year. After making this correction and the one described below, PNL calculated annual energy savings to be 286,500 kWh, which is about 3% less than the 294,900 kWh/yr savings stated in Columbia Harbor Lumber's Completion Report.

The baseline energy consumption calculated in the Completion Report was based on 41.0 charges per year. The energy consumption with the adjustable speed drive was based on 43.9 charges per year. The difference, 2.9 charges per year, represents an estimate of the increased annual number of charges that result from improved drying control achievable with the adjustable speed drive. Considering this increase in throughput, the annual energy savings presented in the Completion Report is 294,900 kWh. After gaining operating experience with the new ASD-equipped kiln, Columbia Harbor Lumber now expects to process five more charges per year than the number assumed in the (corrected) baseline calculations, for a total of 46.9 charges per year (41.9 + 5.0 = 46.9). For purposes of this impact evaluation, PNL calculated energy consumption based on 46.9 charges per year. Using this figure, energy savings are expected to be 286,500 kWh/yr, or 0.053 kWh/bd ft (0.11 kWh/bd ft - 0.057 kWh/bd ft = 0.053 kWh/bd ft) for the expected lumber mix.

Fuel Switching

Because this ECM consisted of installing an adjustable speed drive on a group of electric motors, fuel switching was not an option. Therefore, no fuel switching occurred.

2.2 IMPACTS TO THE FIRM

2. *If the ECM 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 ECM did indeed improve the productivity of the production process by reducing the cycle time required for each charge of lumber. As a consequence of reduced cycle times, Columbia Harbor Lumber expects to increase throughput of the kiln by about five charges per year, an increase of approximately 12% above the pre-ECM baseline. Even with increased throughput there is a net electricity savings from the ECM of 42%. Specific energy consumption drops from 0.11 kWh/bd ft to 0.057 kWh/bd ft, a reduction in energy consumption by half (48%).

Columbia Harbor Lumber has no other plants in the region that perform this type of lumber drying, so no impacts will occur at other plants.

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 ECM?*

Because there are no cogeneration or other complicating factors in this project, all of the energy savings from this ECM will be reflected in reduced load at the utility, Lewis County Public Utility District. Including the increase in energy consumption from increasing the kiln's throughput, the net impact to the servicing utility from this ECM will be a 286,500 kWh/year reduction in electrical load.

2.4 LEVELIZED COSTS

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

Levelized annual costs are used to compare the attractiveness of various projects or investment 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 A for complete definition 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 optimize the ranking of these options. The objective of using levelized costs to evaluate these energy conservation measures is to determine the financial impact of each ECM to Bonneville ($/kWh saved) and to the region (Bonneville and Columbia Harbor Lumber combined).

In the industrial sector, it is not possible to accurately predict the life of an ECM because any number of external factors could cause the ECM to have longer or shorter life than expected when it is installed. To allow comparisons of levelized costs among projects installed under the E$P, all ECMs are assumed to have a life of 15 years. Even though some ECMs will have longer or shorter lives, for purposes of impact evaluations, 15 years is considered a conservative but likely life for typical ECMs 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 paid, capital costs, etc.) and the energy savings, and must assume a discount rate and ECM life. With energy savings of 286,500 kWh/yr, the project's levelized cost from Bonneville's perspective will be 5.6 mills/kWh (see Appendix A). Bonneville's levelized cost decreases to 5.2 mills/kWh when transmission and distribution losses are considered. Transmission and distribution losses increase the energy savings at the source by 7.5%.

The levelized costs calculated in this impact evaluation include the acquisition payment by Bonneville but ignore any administrative or evaluation

costs for the program. Data are not available to calculate these costs on a project-by-project basis, but they will be included in an impact evaluation report on the overall program.

2.4.2 Regional Perspective

To calculate the levelized cost to the region, the costs to Bonneville and Columbia Harbor Lumber are combined. The acquisition payment by Bonneville is included as a cost to Bonneville and as a reduction in cost to Columbia Harbor Lumber. 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.

The levelized costs to the region for acquiring annual energy savings of 286,500 kWh is 7.4 mills/kWh saved. Including transmission and distribution losses, the levelized cost decreases to 6.9 mills/kWh saved.

2.5 IMPACT ATTRIBUTABLE TO E$P

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

Columbia Harbor Lumber uses simple payback to select plant improvement projects, but it does not have a predetermined threshold that a project must meet for implementation. When this project was proposed to Bonneville, it was expected to cost $24,086 and result in electrical savings of $5,949 (usage and demand savings combined) per year for a simple payback of about 4 years based solely on energy savings.

However, according to an executive at Columbia Harbor Lumber, the firm's primary reason for installing this ASD was not to obtain energy savings, but to achieve better control of the drying process. Improved control was expected to result in shorter cycle times and improved lumber quality. Two of the managers at Columbia Harbor Lumber stated that the ASD would have been installed even without the acquisition payment from Bonneville. In fact, the new kiln had already been designed with an ASD before Columbia Harbor Lumber was even aware of the acquisition payment available from Bonneville's E$P Program.

Considering the facts presented above, it is evident that this project would have been implemented without the acquisition payment from Bonneville and that none of the project's impact can be attributed to the E$P.

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.

APPENDIX A

FINANCIAL EVALUATION DETAILS

APPENDIX A

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 - The annualized costs to Bonneville, direct and indirect, per unit of energy saved by the conservation measure. Costs included are the acquisition payment and the program administrative costs (although no administrative costs are included in this analysis of the ECM at Columbia Harbor Lumber Corporation).

Levelized Cost to Region - The sum of annualized costs to Bonneville and Columbia Harbor Lumber per unit of energy saved by the energy conservation measure. 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 ECM are not considered in this analysis.

A.2 LEVELIZED COST FORMULA

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

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

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%.

2. Equal annual energy savings--savings (kilowatt-hours) per year--is constant over the 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 Columbia Harbor Lumber rather than a net zero cost. This is done because Columbia Harbor Lumber will incur a tax liability from the acquisition payment, thus a net cost to the region.

A.4 BONNEVILLE LEVELIZED COST CALCULATIONS

Input: one-time expenses

Acquisition payment paid (year 0)	= $19,269
Administrative costs (year 0)	= $0
Tax rate	= 0%
Energy savings (annual)	= 286,500 kWh
Output: levelized cost	= 5.6 mills/kWh

A.5 REGIONAL LEVELIZED COST CALCULATIONS (BONNEVILLE + COLUMBIA HARBOR LUMBER)

A. Columbia Harbor Lumber

Input: initial capital

Equipment = $24,086

One-time expenses (revenues)

Acquisition payment received = ($19,269)

Annual recurring expenses (revenues and savings)

None

Tax rate = 30%

Project Life = 15 years

Depreciation = 5 years

Energy savings (annual) = 286,500 kWh

Output: levelized cost = 1.8 mills/kwh

B. Regional levelized cost = Bonneville levelized cost + Columbia Harbor Lumber levelized cost

= 5.6 mills/kWh + 1.8 mills/kWh

= 7.4 mills/kWh

A.6 LEVELIZED COSTS ALLOWING FOR TRANSMISSION AND DISTRIBUTION LOSSES

Input: transmission and distribution losses = 7.5%

Bonneville levelized cost = 5.6 mills/kWh/1.075 = 5.2 mills/kWh

Regional levelized cost = 7.4 mills/kWh/1.075 = 6.9 mills/kWh

APPENDIX B

COVER SHEET FROM COLUMBIA HARBOR LUMBER'S PROPOSAL

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COVER SHEET FROM COLUMBIA HARBOR LUMBER'S PROPOSAL

Cover Sheet

Complete sections I-VI of Exhibit A of the second edition of the Notice of Program Interest. December 11, 1990

I. SPONSOR INFORMATION:

Columbia Harbor Lumber Company
1591 N. National Avenue
Chehalis, Wa 98532

II. PROJECT IDENTIFICATION:

Lumber Dry Kiln

LOCATION OF PROJECT:

1591 N. National Avenue
Chehalis, Wa 98532

NAME AND TITLE OF PROJECT MANAGER:

Les Oliver, Secretary/Treasurer
(503) 222-9671

STANDARD INDUSTRIAL CLASSIFICATION CODE (SIC):

2421

UTILITY SERVICE AREA/PORTION OF kWh PURCHASED FROM SERVICING UTILITY:

Lewis County PUD/100%

III. PROJECT SUMMARY:

Incorporate variable frequency fan motor control on nine 15 hp kiln fan motors.

IV. ESTIMATED ENERGY SAVINGS & COSTS:

AVERAGE ANNUAL ENERGY SAVINGS:	TOTAL PROJECT COSTS:
211,690 kWh/yr	$24,086

INCENTIVE ESTIMATE & TYPE:

$19,269 (80% of project cost)

END

DATE
FILMED
6/08/92