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IMPACT EVALUATION OF AN ENERGY $AVINGS PLAN PROJECT AT LENROC COMPANY/MOORMAN MANUFACTURING

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SUMMARY

This impact evaluation of an energy conservation measure (ECM) that was recently installed at Lenroc Company/Moorman Manufacturing (Lenroc/Moorman) 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 Lenroc/Moorman 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 (Lenroc/Moorman's Abstract, Proposal, and Completion Report). The ECM itself consists of installing two heat exchangers to recover waste heat from a process water line to preheat incoming process air. The air and water are used in a proprietary process to produce biuret, a cattle feed supplement derived from urea.

Energy savings resulting from this ECM are expected to be 339,400 kWh/yr. On a per ton basis, this ECM will save 56.6 kWh/ton of biuret. The ECM cost $15,754 to install, and Lenroc/Moorman received payments of $9,452 from Bonneville and $3,933 from Grant County PUD for the acquisition of energy savings for a net cost to Lenroc/Moorman of $2,369. Without the acquisition payments from Bonneville and Grant County PUD, this ECM would not have been implemented. The levelized cost of these energy savings to Bonneville will be 2.3 mills/kWh over the ECM's expected 15-year life, and the levelized cost to the region will be 4.0 mills/kWh.

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CONTENTS

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 Lenroc Company/Moorman Manufacturing (Lenroc/Moorman) in Ephrata, Washington. The ECM at Lenroc/Moorman 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 Lenroc/Moorman project, the acquisition payment offered under the program was equal to the lesser of 10¢/kWh saved in the first year or 80% of 75% of eligible project costs (a net of 60% of eligible costs), up to a limit of $250,000. Because Public Utility District No. 2 of Grant County (Grant County PUD) purchases only 2% of its power from Bonneville, its customers are eligible for only 75% of the acquisition payment offered under the E$P to firms served by utilities that obtain all of their power from Bonneville. To compensate, Grant County PUD offered an additional acquisition payment of 25% of project costs to Lenroc/Moorman. Thus, the acquisition payments for this project totalled 85% of project costs.

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

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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 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 the heat recovery heat exchangers at Lenroc/Moorman, four techniques were selected from the general methodology: engineering analysis, financial analysis, site visit and interview, and review of Lenroc/Moorman's submittals. On-site submetering by PNL was not necessary because the metering performed by Lenroc/Moorman in accordance with E$P program requirements is adequate to determine the project's impact. Because Lenroc/Moorman was not interviewed during the process evaluation of the E$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 Lenroc/Moorman on November 21, 1991, to view the ECM firsthand and to conduct a technical interview with the plant's Assistant Manager.

1.2 PROJECT DESCRIPTION

Lenroc Company operates a plant that is owned by Moorman Manufacturing to produce biuret, a cattle feed supplement. Biuret is produced from urea in a proprietary process involving water, electricity, and air. Aqua ammonia is a byproduct of this process that Lenroc/Moorman also sells. The plant operates continuously for about eight months per year (typically 244 days) and is idle the other four months.

In the energy conservation project at Lenroc/Moorman, two cross-flow heat exchangers were installed to recover waste heat from a process water line before the water is cooled in a cooling tower. The recovered heat is used to preheat process air that is further heated by electric resistance duct heaters and supplemented by steam from an electric boiler. The two heat exchangers are in series, but they do not both operate at all times. One heat exchanger operates only 70% of the time, while the other is always in operation while the plant is producing.

To participate in the E$P Program, Lenroc/Moorman submitted three documents to Bonneville: an Abstract, a Proposal, and a Completion Report. The Abstract and Proposal described the ECM and laid out Lenroc/Moorman'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 Lenroc/Moorman 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 for this ECM was $15,754. Bonneville paid $9,452 for the energy saved, and in addition, Grant County PUD paid $3,933. The net cost to Lenroc/Moorman was $2,369. Lenroc/Moorman's cost of electricity is extremely low, approximately 0.6¢/kWh.

1.3 SUMMARY OF PROJECT IMPACTS

This E$P project, or ECM, is expected to save 339,400 kilowatt-hours annually.

Over the assumed 15-year life of this ECM, levelized costs to Bonneville will be 2.3 mills/kWh (1 mill = 1/1000 of a dollar), and cost to the region will be 4.0 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 2.2 mills/kWh and the cost to the region will be 3.9 mills/kWh.

Without the acquisition payments from Bonneville and Grant County PUD, this ECM did not meet Lenroc/Moorman's funding criteria; however, it did meet the criteria with the acquisition payments. Therefore, we conclude that the ECM would not have been installed in the absence of the E$P.

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

In this project, heat is recovered from process water on its way to a cooling tower, and the recovered heat is used to preheat process air before it enters a duct heater. To determine the energy savings, it is only necessary (and most convenient) to measure the amount of heat that is recovered fro. the process water and to assume that the heat recovered from the water replaces heat that would have otherwise been provided by the duct heater. Accordingly, for its Completion Report, Lenroc/Moorman measured water flow and inlet and outlet temperatures of the liquid side of the heat exchangers. Heat recovery was then calculated by the equation

heat recovery = (temperature change)*(mass flow)*(specific heat).

Three correction factors were applied to the general equation above. First, heat exchanger efficiency was assumed to be 97%. Second, allowance was made for an 8°F temperature drop that is inherent in the piping system. And third, allowance was made for the fact that one heat exchanger operates continuously while the other operates for only 70% of the time.

From the measured data and the equation above, this ECM will save 339,400 kWh/year. The plant produces 4,200 tons of biuret yearly, so each ton produced consumes 80.8 fewer kilowatt-hours, a savings of approximately 3.4%.

The cover sheet of the Completion Report for this project states that annual savings will be 237,600 kWh, which is 30% lower than the savings listed in this impact evaluation. According to the calculations presented in the

text of the Completion Report, the savings from this project will be 339,400 kWh/yr, which is the figure used in this impact evaluation. The reason that the calculations and the cover sheet do not match is because Grant County PUD and Lenroc/Moorman jointly agreed to reduce the savings estimate by 30% to be conservative in the Completion Report. We feel that the larger savings estimate is justified and, therefore, used it in this evaluation.

Fuel Switching

Electricity is the sole source of energy for this plant, so no fuel switching resulted from installing this ECM.

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?*

This ECM resulted in slightly lower production costs for Lenroc/Moorman, but no increases in output are expected. The plant only operates eight months per year because this is sufficient to meet all of the market demand for biuret. There is, therefore, no reason to increase output in the foreseeable future. Lenroc/Moorman is the only biuret plant in the country, so no other plants are affected by this ECM.

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 this ECM allows biuret to be produced with less electricity and because production levels are expected to remain stable, all of the energy savings from this ECM (339,400 kWh/year) will be reflected in lower loads at the serving utility, Grant County PUD.

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, Grant County PUD, and Lenroc/Moorman 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 was 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, 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, capital costs, etc.) and the energy savings, and must assume a discount rate and ECM life. With energy savings of 339,400 kWh/yr, the project's levelized cost from Bonneville's perspective will be 2.3 mills/kWh (see Appendix A). Bonneville's levelized cost decreases to 2.2 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, Grant County PUD, and Lenroc/Moorman are combined. The acquisition payments paid by Bonneville and Grant County PUD are included as costs to Bonneville and to the utility, and as a reduction in cost to Lenroc/Moorman. This approach is taken because the acquisition payments have federal income tax consequences to the company and, therefore, are not a net zero cost to the region.

The levelized costs to the region for acquiring annual energy savings of 339,400 kWh is 4.0 mills/kWh saved. Including transmission and distribution losses, the levelized cost decreases to 3.9 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?*

Lenroc/Moorman uses simple payback to select plant improvement projects, with a desired payback of four years or less. When this project was proposed to Bonneville, it was expected to cost $16,219 and result in electrical savings of $1,315 per year for a simple payback of about 12 years. Lenroc/Moorman expected to receive acquisition payments of $9,731 from Bonneville and $4,055 from Grant County PUD, which would have reduced the simple payback to less than two years, well within Lenroc/Moorman's implementation criterion of four-year simple payback. Without the additional acquisition payment from Grant County PUD, simple payback would have been about five years.

Considering the facts presented above, we conclude that this project would not have been implemented without the acquisition payments from Bonneville and Grant County PUD and that all of the project's impact can be attributed to the E$P. Further, the supplement from Grant County PUD in concert with the E$P was a significant factor in Lenroc/Moorman's decision to implement the project.

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 (althougn no administrative costs are included in this analysis of the ECM at Lenroc/Moorman Corporation).

Levelized Cost to Region - The sum of annualized costs to Bonneville, Grant County PUD, and Lenroc/Moorman per unit of energy saved by the energy conservation measure. This would include the same costs to Bonneville and Grant County PUD 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

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

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
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 payments from Bonneville and Grant County PUD are treated as costs to Bonneville and to Grant County PUD, and at the same time, a cash inflow to Lenroc/Moorman rather than a net zero cost. This is done because Lenroc/Moorman will incur a tax liability from the acquisition payments, thus a net cost to the region.

A.4 BONNEVILLE LEVELIZED COST CALCULATIONS

Input: one-time expenses

Acquisition payment paid (year 0)	= $9,452
Administrative costs (year 0)	= $0
Tax rate	= 0%
Energy savings (annual)	= 339,400 kWh
Output: levelized cost	= 2.3 mills/kWh

A.5 GRANT COUNTY PUD LEVELIZED COST CALCULATIONS

Input: one-time expenses

Acquisition payment paid (year 0) = $3,933

Administrative costs (year 0) = $0

Tax rate = 0%

Energy savings (annual) = 339,400 kWh

Output: levelized cost = 1.0 mills/kWh

A.6 REGIONAL LEVELIZED COST CALCULATIONS (BONNEVILLE + LENROC/MOORMAN)

A. Lenroc/Moorman

Input: initial capital

Equipment = $15,754

One-time expenses (revenues)

Acquisition payments received = ($13,385) (Bonneville and Grant County PUD combined)

Annual recurring expenses (revenues and savings)

None

Tax rate = 20%

Project Life = 15 years

Depreciation = 5 years

Energy savings (annual) = 339,400 kWh

Output: levelized cost = 0.7 mills/kwh

B. Regional levelized cost = Bonneville levelized cost + Grant County PUD levelized cost + Lenroc/Moorman levelized cost

= 2.3 mills/kWh + 1.0 + 0.7 mills/kWh

= 4.0 mills/kWh

A.7 LEVELIZED COSTS ALLOWING FOR TRANSMISSION AND DISTRIBUTION LOSSES

Input: transmission and distribution losses = 7.5%

Bonneville levelized cost = 2.3 mills/kWh/0.775 = 2.2 mills/kWh

Regional levelized cost = 4.0 mills/kWh/1.075 = 3.9 mills/kWh

APPENDIX B

COVER SHEET FROM LENROC/MOORMAN'S COMPLETION REPORT

COVER SHEET FROM LENROC/MOORMAN'S COMPLETION REPORT

Directions: Complete Sections I through IV and submit with Project Abstract. Photocopy and complete Section V to submit with Project Proposal. Photocopy and complete Section VI to submit with the Completion Report.

I. SPONSOR INFORMATION

Name and Full Address of Sponsoring Entity

Bonneville Power Administration
Mr. Larry King
Room 561 U.S. Court House
W. 920 Riverside Avenue
Spokane, Washington 99201

II. PROJECT IDENTIFICATION

Title	Name and Title of Project Manager or Other Contact
HEAT RECOVERY	TIM HEPNER
Location of Proposed Project: NORTH RAILROAD AVENUE EPHRATA, WASHINGTON 98823	Area Code & Telephone No.: 509 754-52-66

Standard Industrial Classification Code (SIC)	Utility Service Area	Portion of kWh purchased from servicing Utility
Primary 2873 - Secondary 2048	Grant County	100 %

II. PROJECT SUMMARY

Brief Description of Proposed Project

Recover heat from distillation process and preheat purge air in another part of the plant facility.

IV. ESTIMATED ENERGY SAVINGS AND COSTS (submit with Project Abstract)

Average Annual Energy Savings	Total Project Costs	Incentive Estimate	Incentive Type	Ratio of Incentive Estimate to Total Project Costs
147,672 kWh/yr	$16,218.00	$9,731.00	__10¢ per kWh __80% of Project Costs	60 %

V. ESTIMATED ENERGY SAVINGS AND COSTS (submit with Project Proposal)

Average Annual Energy Savings	Total Project Costs	Incentive Limit	Incentive Type	Ratio of Incentive Limit to Total Project Costs
kWh/yr	$	$	__10¢ per kWh __80% of Project Costs	%

VI. MEASURED ENERGY SAVINGS AND COSTS (submit with Completion Report)

Average Annual Energy Savings	Total Project Costs	Ratio of Actual Savings to Estimated Savings
237,555 kWh/yr	$ 15,753.85	161 %

END

DATE FILMED

6/08/92