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LETTER REPORT

IMPACT EVALUATION OF AN ENERGY SAVINGS PLAN
PROJECT AT LAMB-WESTON, INC.

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EXECUTIVE SUMMARY

This impact evaluation of an energy conservation measure (ECM) that was recently installed at Lamb-Weston, Inc. (Lamb-Weston) was conducted for the Bonneville Power Administration (Bonneville) as part of an evaluation of its Energy Savings Plan (ESP) Program. The Program awards cash incentives 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 Lamb-Weston as a result of the ESP 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, submittal reviews (Lamb-Weston's Completion Report, Proposal, and Abstract), and process evaluation reviews. The ECM itself consists of a heat recovery heat exchanger added to the hot drain of a potato blancher to reclaim heat that would otherwise be discarded at Lamb-Weston's Plant 1 in Quincy, Washington. At this facility, Lamb-Weston makes frozen French fried potatoes for institutional and consumer markets.

Energy savings resulting from this ECM are expected to be 4,037,101 kWh per year. The ECM cost \$67,020 to install and Lamb-Weston received an incentive from Bonneville of \$40,212. The levelized cost of these energy savings to Bonneville will be 0.83 mills/kWh over the ECM's expected 15-year life, and the levelized cost to the region will be 1.50 mills/kWh.

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1.0 INTRODUCTION

This letter report describes Pacific Northwest Laboratory's (PNL's) evaluation of the impact of an energy conservation measure (ECM) installed at Lamb-Weston, Inc. (Lamb-Weston) in Quincy, Washington. The ECM at Lamb-Weston is one of a group of nine energy conservation projects to have its impact evaluated by PNL. All nine of the projects have or will receive incentives from the Bonneville Power Administration (Bonneville) under its Energy Savings Plan (ESP) Program for energy conservation in the industrial sector.

The ESP Program is being offered so that when the need arises, Bonneville will already have developed and tested an industrial energy conservation program that can then be expanded into a full-scale acquisition effort. For the Lamb-Weston project, the incentive offered under the program was equal to the lesser of 5¢ per first year's kilowatt-hours saved 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 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 kWh and KWh per unit of plant output? Also, did any fuel switching result from implementing this ECM?
2. If the ECM resulted in improved 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 servicing utility in terms of electrical energy consumption (in kWh) 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 ESP?

1.1 APPROACH FOR IMPACT EVALUATION

Before selecting individual energy conservation projects for impact evaluation, PNL developed a general impact evaluation methodology. The major finding of the methodology development process 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 the heat-recovery heat exchanger (HRHE) at Lamb-Weston, five techniques were selected from the general methodology: engineering analysis, financial analysis, site visit and interview, review of sponsor's (Lamb-Weston's) submittals, and review of process evaluation results. On-site submetering by PNL was not necessary because the metering performed by Lamb-Weston to verify energy savings in accordance with ESP program requirements is adequate to determine the project's impact.

As part of the process evaluation of the ESP Program, ERC Environmental and Energy Services Company conducted an interview with Lamb-Weston on July 25, 1989. The results of this interview were reviewed as part of the impact evaluation because some of the information obtained in the interview applies to both the process and impact evaluations. Representatives from PNL visited Lamb-Weston on February 15, 1990, to view the ECM firsthand and to conduct technical interviews with the plant's Technical Services Manager and an industrial engineer.

1.2 PROJECT DESCRIPTION

Lamb-Weston is a potato processor that produces a variety of fried and frozen potato products at three plants in Quincy, Washington, as well as elsewhere in the region. This ECM was installed in Quincy's Plant 1 where French fries in a number of shapes and sizes are produced.

One of the steps in producing French fries is to blanch the sliced potatoes in water at 170°F. To maintain adequate water quality in the blancher, a certain amount of hot water is constantly discarded and replaced by fresh, heated water. Prior to installation of this ECM, the discarded hot

water was dumped directly into the gutter and cold water at 62°F was heated by the plant's electric boiler to replace the discarded water.

This ECM consists of a heat recovery heat exchanger (HRHE) to preheat the cold makeup water by recovering heat from the waste water. Using waste water at 170°F, the makeup water is preheated to 140°F on its way to the steam heat exchanger, thereby saving the electrical energy that would otherwise be required to heat the makeup water from 62°F to 140°F. Makeup water flow varies from 50 to 75 gallons per minute (GPM) depending on the sugar content of the potatoes being processed, an average of 58 GPM over the course of a year.

Along with the HRHE that was added to the blancher, a 7.5 horsepower pump was also installed to move the waste water through the heat exchanger. The pump was not metered during the savings verification, but calculations show that its energy consumption is negligible (about 1/2%) compared to the savings from the heat exchanger. Therefore, the pump's energy consumption is ignored in the impact evaluation.

As required by the ESP Program, Lamb-Weston submitted three documents to Bonneville: an Abstract, a Proposal, and a Completion Report. The Abstract described the ECM in general terms and laid out Lamb Weston's expectations with regard to costs and benefits. Included was a calculation of the ECM's expected simple payback. The Proposal described the ECM in greater detail and included a revised cost estimate. A Completion Report was submitted to Bonneville after the ECM was installed and Lamb-Weston had verified the resulting energy savings. This document listed the actual costs of the ECM along with a calculation of the savings that had been achieved.

Lamb-Weston paid \$67,020 for the ECM and received an incentive of \$40,212 from Bonneville.

1.3 SUMMARY OF PROJECT IMPACTS

This ESP project is expected to save 4,037,101 kWh per year for a levelized cost to Bonneville of 0.83 mills/kWh (1 mill = 1/1000 of a dollar) over an assumed life of 15 years. The levelized cost to the region will be

1.50 mills/kWh. No assessment of the energy savings per unit of output can be made because the plant's output figures are proprietary.

No changes in plant output or shifts in production are expected to result from this ECM, so all of the reduction in energy consumption will be realized by the local utility. This ECM would not have been installed without the incentive from Bonneville, so all of its impact can be attributed to the ESP.

2.0 IMPACT EVALUATION

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

2.1 ENERGY SAVINGS AND FUEL SWITCHING

1. How much electrical energy is saved annually by the ECM in terms of kWh and kWh per unit of plant output? Also, did any fuel switching result from implementing this ECM?

Energy savings for this ECM were verified by measuring the temperature rise and water flow of the fresh makeup water as it flowed through the heat exchanger. After correcting for boiler efficiency, the energy that is recovered from the waste water and added to the makeup water in the heat exchanger equals the electrical energy that is not consumed by the boiler, and hence represents electrical savings for the process. Lamb-Weston measured water temperature and flow for a 15-day period in November 1989. The data were recorded on circular charts and averaged daily; average temperatures and flow were calculated for the 15-day period. The average makeup water inlet temperature was found to be 62.2°F and the outlet temperature 140.5°F, for an average temperature rise of 78.3°F. In calculating energy savings in its Completion Report, Lamb-Weston used the measured water flow of 49.7 gallons per minute (GPM).

While 49.7 GPM is typical for November, over the course of a year the makeup water flow varies from 45 GPM to 75 GPM, and it averages approximately 58 GPM. Therefore, this report uses the annual average of 58 GPM in calculating the annual energy consumption. Another difference between this report and the Completion Report is that no allowance was made for boiler system efficiency (estimated at 95% in the Abstract) in the Completion Report, even though Lamb-Weston's prior submittals had considered this factor. Because of these differences in calculations, this evaluation shows about 18% greater energy savings than the Completion Report.

Annual energy savings in Btu are calculated by the equation
 $58 \text{ gal/min} \times 345,600 \text{ min/year} \times 8.34 \text{ lb/gal} \times 78.3 \text{ }^{\circ}\text{F} \times$
 $\text{Btu/}^{\circ}\text{F-lb} = 13.09 \text{ million Btu/year.}$

Electricity savings are then calculated as

$13.09 \text{ million Btu/year} \div 3,413 \text{ Btu/kWh} \div 0.95 = 4,037,101$
kWh/year.

The savings of 4,037,101 kWh per year represent about 2% of the total electrical consumption at the plant. Because the plant's output is considered proprietary information, it is not possible to determine how much electricity is saved per ton of product. Fuel switching is not considered a realistic option for this plant because its price of electricity is so low (less than 0.7¢ per kWh).

2.2 IMPACTS TO THE FIRM

2. If the ECM resulted in improved 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?

Lamb-Weston has potato processing plants throughout the region, many of them capable of producing identical products. Even though this ECM will improve the productivity of the process at Plant 1, the savings are so small compared to other costs (in particular the cost of transporting potatoes to this plant instead of closer ones) that Lamb-Weston will not be shifting production from its other plants to this one. Nor will the output of this plant be increased due to a competitive advantage relative to other firms--the savings are just too small to have such an effect. Because no changes in output will result from this ECM, however, it will cause a net reduction in energy consumption at the plant.

2.3 IMPACTS TO THE UTILITY

3. What is the net impact to the servicing utility in terms of electrical energy consumption (in kWh) 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, Grant County Public Utility District. Because operating the blancher does not contribute to the peak demand of the plant (this occurs during start up), no reduction in demand will be realized at the utility. The net impact to the servicing utility from this ECM will be a 4-million-kWh/year reduction in electricity 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 will be incurred over the life of the project, accounting for the time value of money. (See the Appendix 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 and options for new generation capacity and to optimize the ranking of these options. The objectives of using levelized costs to evaluate these energy conservation measures are as follows:

- to determine the financial impact of each ECM to Bonneville (\$/kWh saved)
- to determine the financial impact to the region (Bonneville and Lamb-Weston combined).

2.4.1 Bonneville Perspective

To determine the levelized costs to Bonneville and to the region, we must know the project costs (incentive paid, capital costs, etc.) and the energy savings, and assume a discount rate and ECM life. The incentive from Bonneville was \$40,212, and the energy savings expected from this ECM are

4,037,101 kWh per year for 15 years. With energy savings of this magnitude, the project's levelized cost from Bonneville's perspective is 0.83 mills/kWh.

This levelized cost is significantly lower than any costs reported thus far for ESP projects. The reason for such low costs can be traced to the relatively low electric rates charged by Lamb-Weston's local utility. Only projects that result in extremely high electricity savings relative to their costs are pursued when electricity is so inexpensive. This project's incentive was limited by the provision of the ESP Program that limits incentives to no more than 80% of project costs. While other projects have been receiving incentives of 5¢ or 10¢ per kWh, Lamb-Weston's incentive cost Bonneville less than 1¢ per kWh saved.

Bonneville's levelized cost decreases to 0.77 mills/kWh saved when transmission and distribution losses are considered. Transmission and distribution losses increase the energy savings at the source by 7.5%.

All costs are shown in real dollar terms (without inflation effects). These results include the incentive paid by Bonneville but ignore any program 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 the final impact evaluation report on the overall program.

2.4.2 Regional Perspective

To calculate the project's levelized cost to the region, the costs to Bonneville and Lamb-Weston are combined. The incentive paid by Bonneville is included as a cost to Bonneville and as a reduction in cost to Lamb-Weston. This approach was taken because the incentives have federal income tax consequences to the firm and, therefore, are not a net zero cost to the region. The incentive paid by Bonneville is included as a reduction in cost to Lamb-Weston with no effect on Bonneville's cost. Using this approach, Lamb-Weston's levelized cost for the ECM is 0.668 mills/kWh saved.

The levelized cost to the region for acquiring annual energy savings of 4,037,101 kWh is 1.50 mills/kWh saved. Including transmission and distribution losses, the levelized cost decreases to 1.40 mills/kWh saved.

2.5 IMPACT ATTRIBUTABLE TO ESP

5. How much of the ECM's impact can be attributed to the ESP?

Determining whether Lamb-Weston would have implemented this ECM without the incentive from Bonneville requires an understanding of the company's capital budgeting process and its criteria for investment. It also requires one to analyze the ECM from Lamb-Weston's perspective prior to actually making the decision to install the ECM (i.e., from the data presented in the Proposal).

During process and impact evaluation interviews, representatives of the firm stated that they typically pursue cost-saving projects that result in simple payback of less than 2 years and that they prefer to achieve payback in less than 1 year. Lamb-Weston's Proposal for this project showed an estimated cost of \$80,000 and annual savings of 3,900,000 kWh. Allowing for 95% efficiency of the boiler system (as stated in the project Abstract), the project was expected to save \$24,180 per year. With no incentive from Bonneville, the simple payback for the project was expected to be 3.31 years, which clearly does not meet Lamb-Weston's criteria for funding. The expected incentive from Bonneville was \$48,000, which reduces the simple payback period to 1.3 years, well within Lamb-Weston's funding criteria.

As it turned out, the actual cost of this ECM was \$67,020, energy savings are about 4 million kWh per year, and the incentive from Bonneville was \$40,212. The actual simple payback period for the project is 1.1 years.

Another factor to consider in determining whether or not this ECM would have been installed in the absence of the ESP is technical risk. Because Lamb-Weston had already installed a very similar system at its Plant 2 in Quincy (where the economics for heat recovery are more favorable) and because that system is considered very successful by the firm, technical risk for this project was minimal from Lamb-Weston's perspective.

Based on Lamb-Weston's responses during the process and impact evaluation interviews, its financial evaluation of the project, and its level of technical risk, we conclude that Lamb-Weston would not have installed this ECM without the incentive offered by Bonneville. Therefore, all of the energy savings achieved by this project can be attributed to the ESP.

APPENDIX

FINANCIAL EVALUATION DETAILS

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FINANCIAL EVALUATION DETAILS

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 incentive paid and the program administrative costs (although no administrative costs are included in this analysis of this ECM at Lamb-Weston).

Levelized Cost to Region - The sum of annualized costs to Bonneville and the firm 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 on-going incremental production costs to the firm.

LEVELIZED COST FORMULA

$$LC = \{ [PVC I + PVIC I + (PVOM + PVPT + PVOTE) * (1-itf) - PVD * itf] / (1-itf) \} * (CRF/AES)$$

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).

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 (kWh) 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 incentive from Bonneville is treated as a cost to Bonneville and, at the same time, a cash inflow to the firm rather than a net zero cost. This is done because the firm will incur a tax liability due to the incentive, and thus a net cost to the region.

BONNEVILLE LEVELIZED COST CALCULATIONS

Input: one-time expenses

Incentive paid (year 0) = \$40,212

Administrative costs (year 0) = \$0

Tax rate = 0%

Energy savings (annual) = 4,037,101 kWh

Output: levelized cost = 0.83 mills/kWh saved.

REGIONAL LEVELIZED COST CALCULATIONS (BONNEVILLE + LAMB-WESTON)

A. Lamb-Weston

Input: initial capital

Equipment = \$67,020 (including installation)

One-time expenses (revenues)

Incentive received = (\$40,212)
Proposal and Abstract preparation costs = \$1250
Annual recurring expenses (O&M)
Maintenance = \$ nil
Tax rate = 34%
Depreciation = 5 year
Energy savings (annual) = 4,037,101 kWh
Output: levelized cost = 0.67 mills/kwh saved

- B. Regional levelized cost = Bonneville levelized cost + Lamb-Weston levelized cost
= 0.83 mills/kWh + 0.67 mills/kWh
= 1.50 mills/kWh saved

LEVELIZED COSTS ALLOWING FOR TRANSMISSION AND DISTRIBUTION LOSSES

Input: transmission and distribution losses = 7.5%
Bonneville levelized cost = 0.83 mills/kWh $\div$ 1.075 = 0.77 mills/kWh
Regional levelized cost = (0.83 mills/kWh + 0.67 mills/kWh) $\div$ 1.075
= 1.40 mills/kWh