## Phase 1 Ex Ante Findings

**Table** Error! No text of specified style in document.**-1: Project Information**

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|---|---|
| **IOU** | Pacific Gas and Electric |
| **Application ID** | IRCx-036 |
| **Application Date** | Not provided |
| **Program ID** | PGE2228 |
| **Program Name** | Industrial Recommissioning |
| **Program Year** | 2013 |
| **Itron Project ID** | X337 |
| **IOU Ex Ante Savings Date** | TBD |
| **ED Measure Name** | Process Optimization |
| **Project Description** | Manufacturing process optimization by implementing control strategy for conveyor and packaging motors for two bottling production lines |
| **Date of ED Review(s)** | May 1, 2013 |
| **Primary Reviewer and Firm** | Chris Williams, DNV KEMA |
| **Review Supervisor and Firm** | Amit Kanungo, DNV KEMA |
| **Type of Review (Desk, On-site, Full M&V, Tool)** | Desk |
| **ED Recommendation** | The ex-ante savings are conditionally approved at the following ED-revised values: **1,372,905 kWh; 163.5 kW**. |
| **ED Project Manager** | [redacted] / California Public Utilities Commission, Energy Division |
| **ED Policy Authorization** | |

## Measure Description

The measure is a motor control system that would shut off production line motors when not in use. The control system consists of sensors and control equipment that continuously detects manufactured bottles along either of the two packaging lines. The controls activate and deactivate segments of the production line's motors as needed. This reduces the idle run time of the many conveyor and packaging motors by running the motors only when there is a product load on a given production line. The control system will also have an emergency shutdown mechanism to override the automated controls.

Energy savings are estimated to be 1,982,223 kWh and demand savings are estimated to be 240.2 kW. Incentive rates of $0.09/kWh and $100/kW were used to estimate a project incentive of $202,420.07. Full project costs were estimated to be $450,000; this includes all installation costs.

## Summary of Review

The IOU has submitted the following documents to the ED for the phase I ex ante review:

- Project implementation (investigation) report documenting the project summary (including party contacts), measure and baseline description, pre- and post-M&V plan, and project agreement forms;
- Project calculations and supporting data including pre-M&V power and current (amps) measurements and motor inventory;

The review focused on these two documents to assess the eligibility of the measure and the reasonableness of the baseline establishment, savings approach, and post-M&V plan.

The baseline motor schedule was developed by first identifying and creating an inventory of conveyor and packaging (non-conveyor) motors that would be considered for controlled shut-down. This inventory was provided to the implementation team, Nexant, by the customer and included the location, function, and rated amperage of the motors. The list totaled 541 motors, where 262 and 279 motors are used for the bulk and case packaging, respectively.

*Baseline Electric Demand*

Power measurements (amperage, voltage, power factor, true power) were taken for a sample (23) of non-conveyor motors. This sample covered three of the four non-conveyor motor types and around 65% of the non-conveyor motors listed in the motor inventory. The measurements were taken while the motors were idling so that the unloaded motor power demand could be determined to use in estimating baseline power demand. These average power readings were then applied to other un-sampled non-conveyor motors serving "similar" functions on the separate, but identical, packaging line.

Conveyor motors were largely inaccessible for true power measurements. As an alternative to power measurements, a portable multi-meter was used to measure current draw (amps) for a

sample of conveyor motors while unloaded and idling. All of the conveyor motors identified to be controlled have a rated amperage of 2.3 amps and a rated voltage (phase-to-phase) of 480 volts. Since the conveyor motors have varying loads depending on where they are located on the production line, a sample of 40 conveyor motors were selected (by the customer) throughout the production line and current (amps) readings were taken while the motors were idling. It appears that only one phase of the motor had the current measured and this measurement was taken to be the average current draw among all three phases. It also appears that the supply voltage was assumed to be 480 volts phase-to-phase. Since the measured idling motor load is largely affected by these two values (average motor voltage and amperage), extra scrutiny should be taken toward these values to ensure the assumptions are not applied liberally.

The savings method uses the measured current readings along with a load factor profile (by power factor) obtained for a similarly rated motor from the DOE MotorMaster+ database. Three points from the profile are utilized (50%, 75%, and 100% load); the 100% load point is used to calculate the rated kW at full load (i.e., at the rated 2.3 amps). The other two points are utilized to establish an assumed linear relationship between load and power factor. This linear relationship assumption generally holds for load factors higher than 50%, but the relationship becomes increasingly nonlinear as motor load decreases. In this instance, based on the measured line current readings, the idling current load was generally more than half of the rated full load current; hence the linear relationship can be reasonably assumed. The iterative Goal Seek Excel tool is then used to find load factor values (and consequentially calculates for the power factor) that satisfy the assumed linear equations. Finally, using the calculated power factors, the assumed 480 volt supply voltage, and the measured phase current, motor power (kW) is calculated for the 40 sampled idling conveyor motors.

The savings approach described in the project implementation report continues by determining the (normal) distribution of calculated power factor values among the sampled motor set, and finds that the distribution is fairly packed (83%) within one standard deviation (0.078) of the mean power factor. Because of this relatively tight distribution of power factor calculations, the implementer considered it reasonable to extend the average (mean) amperage measurements and power factor calculations to the other conveyor motors of the same size (horsepower and rated amperage). This approach calculates the baseline (idling) power demand of the conveyor motors.

While the report discusses the savings method as above, the calculation workbook deviates from this approach by using the rated current (2.3 amps) instead of the average measured current of the 40 idling conveyor motors. It appears that this may have been an error or oversight in the savings calculation workbook. To align the calculated savings with the report's methodology, the average calculated power of the idling motors should be used, because it contains both the average measured current and the average calculated power factor. Addressing this issue significantly reduces the estimated baseline idling power demand of the conveyor motors. For

example, the idling equipment baseline kW for the 2.3 rated amp motors in the "Cases" packaging line reduces from 220.3 kW to 142.4 kW.

*Process Operation*

The facility operates continuously, 24 hours a day. Packaging line operating hours, and more importantly the lines' idling hours, were estimated by analyzing the bulk and case production line data provided by the customer. The data tabulated the annual number of bottles packaged by each packaging line (cases and bulk) based on shop number. Based on these annual production numbers of each packaging line and the observation that the packaging lines cannot run simultaneously, percentages of idling times for each packaging line were estimated. This calculation assumed that the "packaging time per bottle" is the same between the bulk and case production lines so that total annual bottles packaged by the case and bulk lines could be compared to estimate idling times. The percentages of idling times were then applied to the facility's total annual operating time of 7,884 hours, or 90% of 8,760 hours. It was assumed by the customer that the facility's packaging lines are utilized 90% of the year; the remaining 10% time was estimated to be downtime for repairs and maintenance. The motor controls system intends on shutting off the production line motors during their idling periods instead of having them run unloaded. These idling times are multiplied by the baseline idling power demands of the case and bulk motors to calculate for the project's energy savings.

## Review Conclusion

Overall, ED agrees with the project's in-situ baseline, process operation assumptions, the savings methodology, and post-M&V plan. To comment on the M&V plan, it is not entirely clear whether the average idling measurements of the selected sample of motors is sufficiently representative of the baseline. ED has suggested revising the proposed M&V plan to address this uncertainty.

ED identified a discrepancy in the idling equipment baseline power demand. The IOU-submitted savings calculations use the rated amperage (2.3 amps) for the conveyor motors instead of the average of the current measurements. Based on the project implementation report and the ex ante review, the intent of the idling equipment baseline power demand calculation for the conveyor motors was to use the mean value of the current measurements and power factor calculations. The revised calculations for the bulk and case conveyor motors (the 2.3 rated amp motors) use the average of the calculated kW at the measured current and calculated power factor.

The ex ante savings are recommended to be conditionally approved at the following values in order to address a discrepancy in the IOU-submitted savings calculations: **1,372,905 kWh; 163.5 kW**.

## Summary of ED Requested Action by the IOU

Upon post-install M&V and IOU savings true-up, ED requests that the IOU undertake the recommended steps:

1. ED suggests expanding the current M&V plan proposed by Nexant to take further advantage of the energy monitoring system (EMS) being installed as part of the implementation of the motor control system. It is anticipated that the motor control center (MCC) will have the ability to override the automated shutoff of idling motors so that it should be possible to operate a packaging line in the override mode i.e., baseline conditions. The energy monitoring system can also be set to trend the entire production line and record energy consumption and demand. ED recommends that the MCC override the automated controls and operate in baseline conditions for a week and automated conditions for a week while trending the entire production line. The difference in demand and energy consumption can be normalized to production. If the plant packages different types of bottles with varying weights or sizes, then idling power will vary and the M&V period will have to be longer to include as many packaging variations as feasible. Variations in this M&V approach could be adopted; the main advantage of this approach is that it utilizes the new controls and EMS so that the entire production line (bulk and case) can be monitored in baseline and automated conditions.
2. Track production of the case and bulk packaging lines during the trending period and normalize to compare to percent-in-use and percent-off times to the baseline percentages. If significantly different (more than 20%), then adjust baseline calculation as necessary. This comparison will be used to confirm baseline idling times for each production line, and to confirm the assumption that the packaging time per bottle (the metric used to calculate percent-in-use and percent-idle times) is roughly the same for the bulk and case packaging lines;
3. Submit itemized invoices to verify actual project costs;
4. Provide an EUL estimate for the motor control system;
5. Provide documentation that indicates that a maintenance and/or repair plan (in-house or contracted) is in place for the motor control system, as a means for persistence verification.

**Table 1-2: Project Overview**

| Description | IOU Proposed Ex Ante Data | ED Recommendations |
|---|---|---|
| **Project Baseline Type (Early Replacement, Normal Replacement, Capacity Expansion, New Construction, System Optimization, Add-on Measures)** | System Optimization | System Optimization |
| **Project Cost Basis (Full Cost, Incremental Cost)** | Full Cost | Full Cost |
| **RUL (Early retirement projects only, otherwise N/A (not applicable)** | N/A | N/A |
| **EUL** | Not provided | TBD |
| **First Year kWh Savings** | 1,982,223 | 1,372,905 recommended for pre-implementation estimate |
| **First Year Peak kW Savings** | 240.2 | 163.5 recommended for pre-implementation estimate |
| **First Year Therms Savings** | N/A | N/A |
| **kWh Savings (RUL Period)** | N/A | N/A |
| **Peak kW Savings (RUL Period)** | N/A | N/A |
| **Therms Impact (RUL Period)** | N/A | N/A |
| **kWh Savings (RUL thru EUL Period)** | N/A | N/A |
| **Peak kW Savings (RUL thru EUL Period)** | N/A | N/A |
| **Therms Savings (RUL thru EUL Period)** | N/A | N/A |
| **Annual Non-IOU Fuel Impact (RUL Period)** | N/A | N/A |
| **Annual Non-IOU Fuel Impact (RUL thru EUL Period)** | N/A | N/A |
| **Net-to-Gross Ratio** | Not provided | Not assessed |

**Table 1-3: Detailed Review Findings**

| Reviewed Parameter | Analysis |
|---|---|
| **Project Gross Savings Baseline** (for early retirement projects only, include RUL through EUL baseline) | IOU Proposal: Existing equipment (conveyor and non-conveyor motors) while their respective production lines (case or bulk) are idling; annual production data from the customer to estimate split of idling times between the production lines |
| | ED Assessment: The project baseline was estimated using reasonable assumptions |
| | ED Recommendation: None |
| **Project Cost Basis** (for early retirement projects only, include RUL through EUL cost basis treatment) | IOU Proposal: Full cost |
| | ED Assessment: Since this is a system optimization project, full cost is appropriate |
| | ED recommendation: None |
| **RUL** (required for early retirement projects only, otherwise n/a) | IOU Proposal: N/A |
| | ED Assessment: N/A |
| | ED recommendation: N/A |
| **EUL** | IOU Proposal: Not provided |
| | ED Assessment: TBD |
| | ED Recommendation: Provide an EUL estimate as part of the post-implementation M&V process |
| **Savings Assumptions** | IOU Proposal: Non-conveyor motors: Full power "spot" measurements for a sample of motors while their respective production lines were idle<br><br>Conveyor motors: Current (amps) measurements of a sample of motors while their respective production lines were idle; assumed a linear load factor profile based on power factor to determine motor power based on measured current and rated current at full load.<br><br>Production line operation: Annual production data (total bottles packaged annually by the bulk and case production lines) used to split the assumed total annual production time of 7,884 hours (8,760 hours with 10% downtime for maintenance and repair) in to % idle times for the bulk and case production lines |
| | ED Assessment: This approach offers a decent estimate but assumes that the production time per bottle is the same between the bulk and case production lines. Since the production lines carry relatively similar idling motor loads, error in this assumption would not greatly affect the resulting savings. Another influence on savings is the assumed facility operation of 8,760 hours with 10% downtime for maintenance and repair. This has not been planned for verification. |
| | ED Recommendation: During post-install M&V & saving true-up use the proposed energy monitoring system and production data during the proposed |

| Reviewed Parameter | Analysis |
|---|---|
| | trending period to verify the baseline idling times used for each production line, and adjust the energy savings. |
| **Calculation Methods/Tool review** | IOU Proposal: Spreadsheet analysis and calculations |
| | ED Assessment: The calculation method used to estimate savings is appropriate for this type of project and measure |
| | ED Recommendation: None |
| **Pre- or Post-Installation M&V Plan** | IOU Proposal: For post-installation verification, power or current (amps) trend data will be collected for one week using the energy monitoring system proposed to be installed as part of this motor control system implementation. The trend data will be used to verify that the idle production lines' motors are powered off. |
| | ED Assessment: The M&V plan is appropriate for this type of project and measure; however, it is not entirely clear whether the average idling measurements of the selected sample of motors is sufficiently representative of the baseline. |
| | ED Recommendation: See the ED Requested Actions. |
| **Net-to-Gross Review** | IOU Proposal: None provided |
| | ED Assessment: TBD |
| | ED Recommendation: TBD |