## Ex Ante Review Findings

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

| | |
|---|---|
| **IOU** | Pacific Gas and Electric Company |
| **Application ID** | NC0117606-X063 |
| **Application Date** | 3/10/2011 |
| **Program ID** | Not provided |
| **Program Name** | New Construction and Savings by Design |
| **Program Year** | 2011 |
| **Itron Project ID** | TBD |
| **IOU Ex Ante Savings Date** | Not provided |
| **ED Measure Name** | Central chiller plant upgrades |
| **Project Description** | Installed three, 150 ton high efficiency VFD chillers in repurposed lab space |
| **Date of ED Review(s)** | 3/16/2012, 4/15/2012 |
| **Primary Reviewer and Firm** | Dale Tutaj/DNV KEMA<br>Steven Gates, James J. Hirsch & Assoc. |
| **Review Supervisor and Firm** | Joseph Ball/Itron |
| **Type of Review (Desk, On-site, Full M&V, Tool)** | Desk review |
| **ED Recommendation** | Revised savings of 417,113 kWh and 57 kW approved.<br><br>Incremental project cost of $333,869 not approved, pending additional information regarding the incremental cost of the screw chillers only, exclusive of other HVAC costs associated with the increased capacity of the data center. |

## Measure Description

This project was originally described as the conversion of office space into lab space, together with associated IT and networking equipment. The increased loads necessitated the installation of new chillers with redundancy, and other associated HVAC equipment.

A request for additional clarification revealed that the project actually consists of the expansion of a data center. While the expansion will require both new air handlers and chillers, only the chillers are included in this project. High-efficiency air-cooled VFD screw chillers are proposed in place of screw chillers minimally compliant with Title 24. The two existing air-cooled chillers are replaced with three new 150 ton chillers. The third new chiller is redundant; however because the proposed chillers are most efficient when operated at part load, all three chillers will run simultaneously.

Energy savings are expected to arise from:

1. Improved part load efficiency due to VFD technology
2. Improved part load efficiency due to better chiller design; most notably the ability to take maximum advantage of low outdoor ambient temperatures.

Proposed savings were 78 kW and 685,545 kWh annually, at an incremental cost of $659,800. Issues were found with both the projected energy savings, and the incremental cost.

## Summary of Review

Documents provided for review include the following:

- Syska_Hennesy_Initial_Analysis.xlsx contains bin analysis of energy savings. Loads are hard coded, but savings calculations are live.
- Final_Chiller_Calcs.xls contains baseline part load performance curve calculations, bin analysis for energy savings. Plant Load is hardcoded but other calculations are live.
- XXXXX Bldg K - YORK YVAA Chiller Performance.pdf is the new chiller manufacturer's performance specifications
- ProjectScopeDescription_[redacted].doc provides a description of the project and savings assumptions.
- Application_BuildingK_Chiller_PG2 .pdf is part of the program application.
- Application_BuildingK_Chiller_PG1.pdf is part of the program application

- 12MonthUsage_[redacted].pdf contains monthly gas and electric usage for 2011 for three service accounts.
- Various correspondences between contractors, the site contact, and utility discussing project details.

Since this project is a data center expansion, PG&E's "Energy Efficiency Baselines for Data Centers, October 2009" should be the governing document regarding the baseline. This document distinguishes between "small" data centers having a cooling load of less than 360 tons, vs. larger data centers. For a small data center, the baseline is defined to be direct-expansion air-cooled computer room air conditioners (CRACs). For larger data centers, the baseline is computer room air handlers (CRAHs), supplied by water-cooled chillers.

This project qualifies as a small data center, so the baseline would normally be air-cooled CRACs. However, the existing data center used CRAHs with air-cooled chillers. The expansion also proposes to use CRAHs with air-cooled chillers to take advantage of the existing infrastructure. The proposed baseline is then a hybrid of the small and large data center baselines. For this unusual case, ED recommends the hybrid baseline; CRAHs supplied by air-cooled chillers.

The baseline chillers are air-cooled screws with slide valves, minimally compliant with Title 24 at 1.256 kW/ton at AHRI conditions. The proposed chillers are high-efficiency air-cooled screw chillers with VFD compressor control at 1.11 kW/ton. In addition, part load performance is improved due to the use of a variable speed compressor in lieu of slide valves. The chiller is also capable of taking maximum advantage the efficiency gain that can be obtained when operating at low ambient temperatures; more conventional chillers must modulate condenser fans at low ambient temperatures, negating much of the potential efficiency gain.

Savings calculations were documented in the spreadsheet "Final_Chiller_Calcs.xls". The initial ED review(s) identified several issues with these calculations, including:

1. T-24 baseline for air-cooled chillers under ARI 550/590 test procedure is listed as 1.256 kW/ton, which is inconsistent with the baseline in the savings calculations of 1.1 kW/on.
2. Tab “Summary of Results” – This tab lists the baseline project cost as $340,200, and the proposed cost to be $1,000,000, for an incremental cost of $649,800. But the project only consists of high-efficiency air-cooled chillers with an efficiency of 1.1 kW/ton, compared to minimally compliant chillers. ED disagreed that the use of high efficiency chillers could triple the project cost.
3. Tab “Chiller Curve Comparisons” – The “Part Load Ratings” used to derive the York part-load curve were incorrect. These data were taken from the document “[redacted] Bldg K - YORK YVAA Chiller Performance.pdf”, “Part Load Rating Data” table at the bottom

of page 1. These data are for the integrated part-load value (IPLV), and assume the outdoor temperature drops as the load drops. For example, at 25% load, the outdoor temperature is 55°F; the resulting 0.4 kW/ton is mostly a function of the low 55°F, NOT the VFD. The part-load curve should be derived for a constant CHW and CW temperature; the EIR_FT curve should compensate for varying condenser temperature. Note that the data in this document is insufficient for establishing the three performance curves CAP_FT, EIR_FT and EIR_FPLR (a bi-quadratic requires at least 6 data points, and ideally at least twice that; a PLR curve requires at least two more data points in addition to the full-load point; for a minimum of 8 data points). The manufacturer would have to provide the data necessary.

4. Tab "Energy Savings Analysis" – These calculations are not correct. The spreadsheet presents a temperature bin calculation ranging from 95°F maximum to 25°F minimum, but the kW consumption in every temperature bin is exactly the same; 219 kW for the baseline chillers and 140 kW for the proposed chillers.

The project team responded by submitting a new spreadsheet, "[redacted] Bldg K CH Calc Rev 2.xlsx"; indicating that the previously submitted spreadsheet was the wrong one. Calculations in this spreadsheet appear correct, and predict energy savings of 57 kW and 417,113 kWh.

Baseline and proposed project costs are $416,131 and $750,000; for an incremental cost of $333,869. This incremental cost still appears high; excluding installation costs this figure implies that that efficient chillers cost roughly twice as much as T24-compliant chillers.

The baseline project cost is based on R.S. Means data. The proposed project cost is based on an email from the project contractor "SJCK Chillers - Project Valuation.msg". This email lists the "HVAC and Controls" cost at $750,000. Note however that the contractor's project covers the entire data center expansion, including air handlers, additional piping, pumps, and controls. Therefore, the incremental cost of the efficient chillers would be considerably less than stated.

## Review Conclusion

Resubmitted energy savings calculations appear reasonable. The incremental project cost does not appear to be reasonable.

## Summary of ED Requested Action by the IOU

1. Provide itemized project cost estimates, vendor proposals, and assumptions when available.

**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)** | New construction | New Construction |
| **Project Cost Basis (Full Cost, Incremental Cost)** | Incremental cost | "HVAC and Controls" cost of $750,000 is compared to R.S. Means cost of a chiller plant, $416,131. However the HVAC and Controls cost appears to include the cost of air handlers, piping, pumps, etc.<br><br>The incremental cost should be based on only the uninstalled cost of the chillers. |
| **RUL (Early retirement projects only, otherwise N/A (not applicable))** | N/A | N/A |
| **EUL** | Not provided | Review of 2008 DEER documentation indicates an EUL of 20 years for high efficiency chillers in non-res, HVAC applications |
| **First Year kWh Savings** | 417,113 | Accept |
| **First Year Peak kW Savings** | 57.0 | Accept |
| **First Year Therms Savings** | 0 | 0 |
| **kWh Savings (RUL Period)** | N/A | N/A |
| **Peak kW Savings (RUL Period)** | N/A | N/A |

| Description | IOU Proposed Ex Ante Data | ED Recommendations |
|---|---|---|
| **Therms Impact (RUL Period)** | N/A | N/A |
| **kWh Savings (EUL thru RUL Period)** | | |
| **Peak kW Savings (EUL thru RUL Period)** | | |
| **Therms Savings (EUL thru RUL Period)** | N/A | N/A |
| **Annual Non-IOU Fuel Impact (RUL Period)** | N/A | N/A |
| **Annual Non-IOU Fuel Impact (EUL thru RUL Period)** | N/A | N/A |
| **Net-to-Gross Ratio** | Not provided | None at this time. |

**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: New construction, major renovation |
| | ED Assessment:<br>New construction is appropriate |
| | ED Recommendation:<br>No changes |
| **Project Cost Basis** (for early retirement projects only, include RUL through EUL cost basis treatment) | IOU Proposal:<br>$750,000 for HVAC and Controls. Baseline cost of $416,131 based on R.S. Means data. |
| | ED Assessment:<br>Project cost appears to include unrelated items such as additional data center CRAH units, piping, pumps, etc. |
| | ED recommendation:<br>Unless the proposed chillers require additional controls, the incremental cost should be based on the uninstalled cost of the proposed vs. baseline chillers. This cost should be provided once available. |
| **RUL** (required for early retirement projects only, otherwise n/a) | IOU Proposal:<br>N/A |
| | ED Assessment:<br>N/A |
| | ED recommendation:<br>N/A |
| **EUL** | IOU Proposal:<br>N/A |
| | ED Assessment:<br>Review of 2008 DEER documentation indicates an EUL of 20 years for high efficiency chillers in non-res, HVAC applications |
| | ED Recommendation:<br>20 years based on 2008 DEER |
| **Savings Assumptions** | IOU Proposal:<br>Savings were projected based on bin-analysis |
| | ED Assessment:<br>The load profile was flat throughout the year, which is reasonable for a data |

| Reviewed Parameter | Analysis |
|---|---|
| | center. |
| | ED Recommendation:<br>Accept |
| **Calculation Methods/Tool review** | IOU Proposal:<br>Savings were projected using a bin analysis |
| | ED Assessment:<br>Resubmitted savings calculations are reasonable. |
| | ED Recommendation:<br>Accept. |
| **Pre- or Post-Installation M&V Plan** | IOU Proposal:<br>M&V plan was not provided but post-installation data collected from BMS were provided. |
| | ED Assessment:<br>Post-installation data were adequate. |
| | ED Recommendation: None. |
| **Net-to-Gross Review** | IOU Proposal: Not provided |
| | ED Assessment:<br>Project already completed when selected. Post-installation data for loads was gathered by BMS and reviewed. |
| | ED Recommendation: NTG interview recommended. |