Phase I Ex Ante Review Findings

Table 1-1: Project Information

IOU	Pacific Gas and Electric Company
Application ID	NC0122507
Application Date	11/16/2012
Program ID	PGE21031
Program Name	Commercial Calculated Incentives (NRNC)
Program Year	2012
Itron Project ID	X241
IOU Ex Ante Savings Date	TBD
ED Measure Name	New Data Center
Project Description	A new data center space is being constructed in an existing building on 6 of the 8 floors. The data center area (Bldg F) is 16,926 ft^2. Building G is a 153,969 ft^2 cold shell. This project covers mechanical improvements (a high-efficiency chiller, a waterside economizer, & high temperature differential/variable-speed CRAH units) that will allow this data center to operate while consuming less energy than a standard efficiency baseline data center.
Date of ED Review(s)	1/9/2013 & 6/6/2013
Primary Reviewer and Firm	Dale Tutaj//DNV KEMA
Review Supervisor and Firm	Doug Maddox / JJ Hirsch & Assoc
Type of Review (Desk, On-site, Full M&V, Tool)	Desk
ED Recommendation	Conditionally approved, pending post-install M&V and IOU true-up

Measure Description

The measures involved with this project are listed below:

High Efficiency Chiller: The chillers used on this project use variable-speed compressors and operate more efficiently than baseline, minimum-efficiency chillers.

Waterside Economizer: A water-to-water heat exchanger allows the chillers to be turned off during periods of low ambient wet bulb temperature. When the economizer is operating, the loads can be met without requiring mechanical cooling.

Efficient CRAH Units: The CRAH units on this project have variable-speed fan motors, allowing the fans to deliver only the amount of air required. Additionally, the air distribution is designed for a high temperature differential across the servers, allowing more cooling work to be done with less air movement.

Summary of Review

The following email correspondences were reviewed:

1 - FW PGE incentive applicaion for XXXXXX .msg
2 - RE PGE incentive applicaion for XXXXXX msg
3 - RE XXXXXXBldg F Contacts.msg
4 - RE XXXXXXKick Off Meeting msg
5 - XXXXXXBuilding F Kick-Off Follow Up.msg
5 - RE XXXXXXBuilding F Kick-Off Follow Up.msg
6 - RE XXXXXXBuilding F Kick-Off Follow Up.msg
7 - RE XXXXXXData Center Loading Schedule msg
8 - FW XXXXXXPGE meeting - 122111 msg
9 - RE XXXXXXPGE meeting - 122111.msg
10 - XXXXXXNeed Update Please.msg
11 - RE XXXXXX- Utility Incentive msg
12 - XXXXXX information.msg
13 - FW XXXXXXBldg. F [redacted] SBD (CMT 11697).msg
RE 15498 - XXXXXXBldg G lab msg
RE New App Reviewer Assignment Syska 122951 - XXXXXXBldg G lab EEGA2915.msg

The following files were reviewed:

App A_XXXXXXBuilding F and G Analysis – Spreadsheet_11-8-2012.xlsx

- App B_XXXXXXBuilding F and G Analysis – Incremental Cost Estimates.pdf. This document contains incremental costs as follows:
  - 1st and 2nd high efficiency chillers: Add for high efficiency chillers $54,000 with tax and O&P $60,495
  - 3rd standard efficiency chiller $200,000, 3rd cooling tower $130,000, chilled water pump $15,000, condenser water pump $12,000, piping, valves, misc materials $60,000, insulation $10,000, controls $50,000, VFD for tower and pumps (3) $25,000, rigging $10,000 with tax, O&P, and labor $617,457
  - 3rd high efficiency chiller $225,000, 3rd cooling tower $130,000, chilled water pump $15,000, condenser water pump $12,000, piping, valves, misc materials $60,000, insulation $10,000, controls $50,000, VFD for tower and pumps (3) $25,000, rigging $10,000, with tax, O&P and labor $644,770

  - Water side economizer 48,000, pipe $8,300, isolation valves and flanges $3,000, install control valves $5,000, rigging $1,000, pipe insulation $2,200, controls $10,000, with tax, O&P and labor $170,589
  - Incremental cost estimate for standard CRAH Units $15,593.19 and high efficiency CRAH units$20,835.33
- App C_XXXXXXBuilding F and G Analysis - SimCalc2 Recommendation Summaries.pdf. This document is the SimCalc Nonresidential New Construction Program Recommendation Summary. Building F has 8 floors and totals [redacted]. The standard and proposed lighting watts are 160.48 kW and 135.2 kW, respectively. Total lighting energy usage is 81,387.9 kWh. Building G has 8 floors and totals 153,969 ft^2. The standard and proposed lighting watts are 130.887 kW and 111.5 kW, respectively. Total lighting energy usage is 62,152.6 kWh
- 19520-Normal Load Tab 20110530.pdf **and** 19520-Normal Load Tab 20120211.pdf provide connected electric building load data for office and lab spaces in building G and F.
- 230514 VFD Drives Submittal.pdf is a submittal schedule for VFDs for CHWP P1 and 2, CWP P1 and 2, EF P1, CT P 1A and B
- 232123.001 Pumps.pdf provides the Pump Submittal
- 235700.001 Heat Exchanger Submittal.pdf
- 236416-Centrifugal Water Chiller Submittal.pdf for chillers 1 and 2
- 238126-Chiller Plant chilled fan coils.pdf contains submittal comments
- Data Center Implemental Cost Analysis.pdf contains the mechanical contractors cost estimates for the CRAC units and economizer, high efficiency chiller
- XX app Bld G Lab. pdf.pdf is the 2012 program application
- XXXXX CT 092211.pdf is the purchase order for the cooling tower.
- Incremental Cost Estimate for 1st + 2nd Hi-Efficiency Chillers.pdf
- M00.06_Bldg G.pdf is the building G plans
- Project Summary for XXXXXXBldg G Lab.doc contains a summary of the project and description of the documents provided to ED for review
- Tab 2 Chillers.pdf is the chiller submittal for buildings F & G

This project involves the installation of a new central plant with high efficiency chillers, water side economizer and (17) 20 hp, 24000 CFM high efficient CRAH units. The project is considered new construction as it is being installed in a cold shell existing construction. The following equipment will be installed: Three (3) 837 ton, high efficiency chillers, three (3) 950 ton capacity cooling towers, and VFDs on cooling tower fans and chilled water pumps.

Missing information, as discussed in the sections below are the explanation of the assumed power density of 200 W/ft^2, M&V plans, baseline chiller capacity, areas being serviced by the chiller, control sequence, and chiller specifications.

Several points were discussed with the contractor for this project as part of the parallel review. Additional documentation was also provided, as follows:

- CH-1 & 2 Final Submittal from Design Team.pdf
- Mechanical Schedule from Latest CD Drawing Set (11-29-2011).pdf

- Latest Controls Sequence form Design Team and Customer.pdf
- NC0122507 Custom Review Comments Memo - 02-07-13.pdf
- Chiller Specs and Part Load Performance (Original from PG&E).PDF
- App A_XXXXXXBuilding G Analysis Spreadsheet.xlsx
- App B_XXXXXXBuilding G Analysis Incremental Cost Estimates.pdf
- XXXXXXData Center Report.pdf

The items discussed are as follows:

1. Provide reference or explanation of the 200W/ft2 power density assumption.

   Response: This estimate was provided by the design team and is to be used until the space is fully loaded and the actual loading can be determined.

2. Discuss the controls/EMS system's trending and readout capabilities and if actual chiller loads could be used to update the savings estimates.

   Response: The plant is equipped with a SCADA system that monitors power usage.

3. Describe the baseline 600 ton chiller capacity with the cooling load at 98°F is 971.8 tons.

   Response: The baseline was established using the Energy Efficiency Baselines for Data Centers document dated November 30, 2011.

4. Explain or adjust savings calculation to account for why the free cooling effect of the MUAH does not reduce the chiller load in the baseline calculations.

   Response: Free cooling is not directly addressed in the baseline document. Currently the savings calculation does not account for free cooling in baseline or post cases.

   ED response: It appears that the free cooling is used in the post case (see App A_XXXXXX Building F and G Analysis – Spreadsheet_11-8-2012.xlsx Actual Tab, Cells P5:P15). The baseline case does not account from free cooling. After further discussion, it is acceptable to claim free cooling savings.

   New issue identified: the space was designed to receive 0.037 cfm/ft^2 of outside air. The baseline document specifies 0.15cfm/ft^2 should be used for the baseline. The 0.15 cfm/ft^2 is the minimum required ventilation rate for data centers, categorized as the "all others" occupancy type. This flow rate should be used for both baseline and post cases.

   Response: The flow rate of 0.15 CFM/ft^2 has been used, and savings have been revised.

5. Describe the areas the chilled water plant supplies. Some documents reference Building G and Building F. The floor area in the analysis file is only 16,916 ft2 but the build areas are much larger than that.

   ED Response: chilled water plant serves three areas (chiller room, data center, and cafeteria), but the savings are only being claimed for the data center. The savings should

account for areas serviced by the central plant. Since the cafeteria load may be weather-sensitive, savings should account for that. For trend data true-up savings estimates, a weather regression should be used for determining if savings need to be normalized to typical meteorological year (TMY).

Response: The kitchen MAHU is scheduled to run only when the kitchen hoods are turned on, typically from 5:00am to 3:00pm, Monday through Friday. For this reason the calculations for the MAHU are done separately. Because the chiller efficiencies are relatively stable throughout the outside air temperature range, the effects of the MAHU on the chiller efficiency is negligible for both the baseline and actual calculations; and since the kitchen. MAHU is off for the majority of the annual hours, the kitchen unit's load is not included in the chiller efficiency calculations, since it would significantly increase calculation complexity with minimal effect on accuracy.

6. Discuss the controls sequence and if the Hartman loop will be incorporated. Several emails reference the Hartman Loop, stating that it is unclear how it will affect the system but it will be incorporated during the verification of this project.

   Response: Some inconsistencies were noted between the control sequence and the savings calculations. The calculations show shared load between the second cooling tower and chiller, however current sequence is that the second stage is activated only when the chiller reaches the first chiller reaches 90% of capacity. However, the Hartman Loop is installed but is awaiting approval from the customers IT department. Once the Hartman Loop is operational the sequencing will be different than current operations. So there is no value to adjusting the savings calculations until the Hartman Loop is operational and trending data from the SCADA system can be used to determine loading, energy consumption and energy savings.

Review Conclusion

Ex ante savings are conditionally approved, pending post-install M&V and inspection report findings and IOU true-up.

Summary of ED Requested Action by the IOU

Perform post-install IR, M&V, and savings true-up. Then submit documents and findings to ED for final ex ante savings approval.

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	Incremental cost
RUL (Early retirement projects only, otherwise N/A (not applicable))	N/A	N/A
EUL	N/A	DEER 2008 EUL values should be used. For high efficiency chillers use 20 years, for water side economizer use 15 years, and for high temperature differential/variable-speed CRAH units with VAV box/VSD fan use15 years
First Year kWh Savings	6,931,637 kWh	TBD kWh
First Year Peak kW Savings	701.3 kW	TBD kW
First Year Therms Savings	-	-
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 (EUL thru RUL Period)	6,931,637 kWh	TBD kWh
Peak kW Savings (EUL thru RUL Period)	701.3 kW	TBD kW
Therms Savings (EUL thru RUL Period)	-	-

Comment [JCB1]: According to PG&E this value has increased to over 7 million kWh What are the most current values we received from the IOU for kWh and kW?

Description	IOU Proposed Ex Ante Data	ED Recommendations
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	TBD

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: "Energy Efficiency Baselines for Data Center" document dated November 30,2011 highlight baselines as follows: • Water-cooled chiller, part load-efficiency kW/ton provided in document • CW pumps at 19W/gpm @ design conditions • CW flow rate 3 gpm/ton • CHW pumps at 22W/gpm • CHW flow rate 2.4 gpm/ton • MUA supply air flow rate 0.15 cfm/ft^{2}at 55°F • Chiller capacity 600 tons, based on design load 1.2 safety factor • Minimum number of chillers, and cooling tower pumps n+1 = 2
	ED Assessment: This document provides the appropriate baseline as T24 does not cover data centers. The 12kV connected loads for Building G lab loads are 4,009 kVa, resulting in the large data center category. The baseline cooling system water cooled chilled water plant serving uniformly-sized chilled water CRAHs equipped with constant-speed fans. According to the (App A_XXXXXX Towers Building F and G Analysis Spreadsheet_11-8-2012 xlsx) the baseline chiller load is 971.8 tons at 98°F outside air conditions. The baseline chiller is 600 tons and does not appear to be 120% of the design load.
	ED Recommendation: In general baseline assumptions are valid and the correct document is referenced. However, waiting further information to assess the baseline chiller capacity.
Project Cost Basis (for early retirement projects only, include RUL through EUL cost basis treatment)	IOU Proposal: Incremental cost is estimated for all equipment. The mechanical contractor provided standard and high efficiency equipment costs.
	ED Assessment: The incremental cost should be used for new construction projects. The cost estimate sources should be provided
	ED recommendation: The cost basis is appropriate.
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: DEER 2008 provides EULs for high efficiency chillers and

Reviewed Parameter	Analysis
	water side economizers, 20 and 15 years, respectively. High temperature differential/variable-speed CRAH units are not included in DEER 2008 however the VAV box/VSD fan EUL can be used 15 years
	ED Recommendation: Use DEER 2008 values
Savings Assumptions	IOU Proposal: The chiller load is based on a power density of 200 W/ft^2.
	ED Assessment: Using an assumed power density may be a reasonable approach for determining the chiller load, however, the source for the value used was not provided.
	ED Recommendation: If the actual chiller load from EMS or control systems trending or readouts are available, they should be used to revise the energy savings estimates. If this is not available, the source of the power density should be provided.
Calculation Methods/Tool review	IOU Proposal: A simple engineering calculation spreadsheet is used. Chiller baseline performance curve is based on the 2013 Data Center Baseline Report. The load is determined by the floor space, and an assumed load in W/ft^2. The CHW flow rate and CW flow rate is calculated by an assumed flow rate per ton of cooling load. The chiller, pumps, fans power is summed for each hour bin.
	ED Assessment: The load is not weather dependant for data center loads so a building simulation is not required.
	Recommendation: a simple engineering spreadsheet calculation is sufficient for determining energy savings for this project.
Pre- or Post-Installation M&V Plan	IOU Proposal: No M&V plans or data is provided for this project.
	ED Assessment: The energy savings estimates could be improved or verified using post-install M&V. As the chiller load is not weather sensitive, a short data collection period or instantaneous readings may be sufficient. Chiller load (tons), chiller performance (kW/ton), chilled water flow and temperature, chilled water pumps, condenser water pumps, cooling tower fans, CRAH fan power (kW), supply and return temperatures. Extra monitoring time may be needed to capture weather sensitive CT fan kW, VFD speed, supply and return temperature, as well as condenser water pump data. 15 minute interval data over a range of outside air conditions should be collected. The economizer operation is a major component of savings, the transition that occurs between chiller cooling and economizer cooling should be identified.

Reviewed Parameter	Analysis
	The water-side condenser operation should be captured during M&V activities.
	ED Recommendation: Post M&V activities should be conducted to improve the energy savings estimates.
Net-to-Gross Review	IOU Proposal: Not provided
	ED Assessment: Not assessed
	ED Recommendation: TBD