

Phase I Ex Ante Review Findings

Table 1-1: Project Information

IOU	Pacific Gas and Electric Company
Application ID	HEEP 87
Application Date	2/5/2013 (Program Participation Agreement)
Program ID	PGE2206
Program Name	Healthcare Energy Efficiency Program (HEEP)
Program Year	2013
Itron Project ID	X309
IOU Ex Ante Savings Date	Not provided
ED Measure Name	Multiple HVAC measures
Project Description	<p>This is a [REDACTED] facility constructed in 1986. There are a total of five EEMs, as follows:</p> <ul style="list-style-type: none"> • EEM 1, Install variable frequency drives (VFD)s on secondary chilled water pumps and implement chilled-water reset • EEM 2, Install high efficiency heating hot water boilers. • EEM 3 Install premium-efficiency supply fan motors with VFDs on air handling units • EEM 4, Install high efficiency chillers. • EEM 5, Replace existing cooling tower with increased capacity and VFD fan controls.
Date of ED Review(s)	3/12/2013
Primary Reviewer and Firm	Dale Tutaj//DNV KEMA

Review Supervisor and Firm	Joseph Ball/Itron
Type of Review (Desk, On-site, Full M&V, Tool)	Desk
ED Recommendation	RUL period savings are conditionally approved. EUL through RUL period savings need to be calculated using T-24 baseline. Also, upon completion of the project, revise the eQuest model to true up the savings based on post field findings.

Measure Description

The measures involved with this project are listed below:

- EEM 1: Install variable frequency drives (VFDs) on two 15 hp secondary chilled water pumps and implement chilled-water reset.
- EEM 2: Installed high efficiency heating hot water boilers. Boilers use an estimated 80 to 90% of the sites natural gas usage. Two (2) 4,500 MBH units with 80% thermal efficiency were replaced with two (2) high efficiency 2,000 MBH units with a thermal efficiency of 88%. The RUL was not provided.
- EEM 3: Install premium-efficiency supply fan motors with VFDs on air handling units (AHUs). The administration building and adjoining spaces are served by ten (AHU) with constant volume supply fans. The fans are serving variable-air-volume (VAV) boxes. The VAV boxes are under-utilized with constant speed fans. The RUL was not provided.
- EEM 4: Install high efficiency chillers. There are two (2) constant speed 300 ton chillers. One unit is redundant. The new units will be two (2) 250 ton VFD chillers. The reduced capacity is to match the load. The existing chillers are used as the baseline in savings calculations. The RUL was not provided.
- EEM 5: Replaced two (2) 280 ton cooling towers controlled by two-speed fans with two (2) new, expanded capacity cooling towers whose fans are controlled with VFDs. The existing cooling towers are used as the baseline in savings calculations. No RUL was provided for the exiting cooling towers.

These measures result in an ex ante total annual energy savings of 515,734 kWh, and 17,336 therms with a peak demand reduction of 32.6kW

Summary of Review

The following documents were reviewed:

- HEEP-87 - Calculation Summary_1.29.2012.xlsx, this document contains a summary by measure of the energy savings, cost, and incentive.
- HEEP-87_ [REDACTED] _PPA_01.30.2012_signed.pdf, this document is the program participant agreement, dated 2/5/2013.
- HEEP-87_ [REDACTED] _AuditReport_01.31.2013.pdf is a comprehensive audit report..

eQuest Files were also provided:

- For Engineering Review - (Healthcare Energy Efficiency Program (HEEP) Pre Installation Report [REDACTED]).msg
- RE For Engineering Review - (Healthcare Energy Efficiency Program (HEEP) Pre Installation Report [REDACTED]).msg
- RE HEEP 87 project comments.msg

Several additional documents were provided as a result of the parallel review process, as follows:

- EnergyEfficiencyOIR-Post-2008_DR_ED_366_EEGA_2733Supp01.doc
- HEEP-87 - Calculation Summary_05.07.2013.xlsx
- HEEP-87 [REDACTED] Energy Model Calibration.pdf
- EnergyEfficiencyOIR-Post-2008_DR_ED_366_EEGA_2733.doc
- Revised eQuest files. This includes a monthly calibrated model with local weather for the associated utility billing period used to calibrate the model.

The measures for this project are all eligible according to the Nonresidential Retrofit – Demand Response Procedures Manual.

This project involves 5 measures. Savings were estimated using a whole building energy model and the base case was simulated using existing equipment’s efficiencies. The details of the proposed measures are enumerated as follows:

- EEM 1, Install variable frequency drives (VFDs) on two 15 hp secondary chilled water pumps and implement chilled-water reset. This is an add-on measure; therefore estimating the savings with existing condition as baseline is appropriate for this measure.
- EEM 2, Install two high efficiency heating hot water boilers that were replacing two pre-existing inefficient boilers. Existing boiler efficiency was used in the base case to estimate the savings for this measure. However, discussion with the implementer revealed that the existing boilers are nearing the end of their service life, but the implementer wasn’t able confirm the exact number of years life left with the existing boilers. So, the savings should be estimated in two categories for this measure; RUL period savings using existing boiler efficiency as baseline and EUL-RUL period savings using T-20 boiler efficiency as baseline. Submit evidence of early retirement. For valid program-induced replacements, the remaining useful life must be more than one year.
- EEM 3, Replace ten constant volume air handling units (AHUs) with premium-efficiency supply fan motors and VFDs. Existing constant speed AHUs were used as baseline to estimate the savings of this measure. According to the implementer, the pre-existing air handlers had some RUL left in them, so the savings estimated using existing air handling systems as baseline are appropriate for the RUL period. However, for the EUL through RUL period normal baseline should be applied where the proposed air handling units (AHUs) should be compared with 2008 Title-24 standard air handling system to estimate the savings. According to 2008 Title-24, Individual VAV fans with motors 10 horsepower or larger shall be driven by a mechanical or electrical variable speed drives.

Because the capacities of the proposed AHUs are more than 10 hp, the VFD controls savings will be zeroed out for the EUL-RUL period. However, there may be some savings associated with the premium efficiency fan motors.

- EEM 4, Replace two existing constant speed 300-ton chillers with two high efficiency 250 ton variable speed chillers. One of the chillers is redundant. The capacity reduction was achievable because the existing system was oversized. Since the existing chillers had some service life remaining, using the existing chiller efficiency as baseline was appropriate for estimating savings for the RUL period. For the RUL through EUL period, T-24 chiller efficiencies applicable as of January 1, 2014 should be used as baseline
- EEM 5 Replace two 280 ton cooling towers with two-speed fan controls with two new cooling towers and VFDs on fans and expanded capacity. The VFD fan control will allow for savings of the cooling tower fans during cold conditions. The increased cooling tower capacity will result in lower condenser water return to the chiller resulting in reduced loading of the chiller. The existing cooling tower utilizes two 15 hp two-speed fans. The new cooling tower has two 7.5 hp fans with VFDs. For this capacity expansion baseline, T-24 efficiency should be used. ED's reviewer thoroughly examined the Title-24 2008 standard document and found that the T-24 mandates for VFD control for cooling tower fans equal or above 7.5 hp capacity. **As both the proposed cooling tower fans are 7.5 hp each, savings from the VFD will not be eligible for savings.** T-24 requires that approach temperatures should be 10F or lower. The post case approach temperature is 11F, and therefore no savings will be achieved. The pumping performance in T-24 is 38.2 gpm/hp, therefore if pumping performance exceeds this, savings will be achieved. Missing information and any observed issues were resolved during the parallel review process with the IOU and the third party implementer. The primary modification needed was a change with the eQuest modeled savings. The original application savings were 552,400 kWh, and 21,800 therms with a peak demand reduction of 31.1 kW. These values were revised to include a monthly calibration with utility billing data and local weather. The IOU-revised savings are 524,600 kWh, and 17,300 therms with a peak demand reduction of 85.90 kW. However, these savings correspond to the utility billing year of 2012, which was an atypical climatic year. Therefore, the calibrated model needs to be run with climate zone weather. This was completed as part of the ED's review along with the modification to cooling tower 1A's baseline control type. The cooling tower CT1A was modeled with a single speed control whereas it should have been modeled with two-speed control according to the project scope provided by the implementer. So, the ED reviewer changed the cooling tower fan control strategy from single-speed to two speed control and re-simulated the model. These changes result in a savings of 515,734 kWh, 32.6 kW, and 17,336 therms. It is unclear why the kW savings are significantly lower than the calibrated model with 2012 weather data. It is likely that

this is based on the max kW values for baseline and post cases. Peak kW savings should be based on 1991 Climate zone 3 consecutive peak days of July 22- 24.

Review Conclusion

The ED revised RUL period savings of 515,734 kWh, 32.6 kW, and 17,336 therms are conditionally approved. EUL through RUL period savings need to be estimated using the appropriate T-24 baseline. Upon completion of this project post M&V activities need to be performed to true-up energy savings.

Summary of ED Requested Action by the IOU

Upon completion of this project, post M&V activities should be conducted.

The ED requests that IOU undertake the following actions and submit additional documentation either by June 24, 2013 or 14 days from submittal date of this review:

1. Estimate of RUL for all equipment in years.
2. Provide calculated savings for EUL through RUL period. For the second baseline (EEMs 2-5) the calibrated model should use T-24 as baseline. Also, the T-24 chiller and T-20 boiler efficiencies should be used. For the VFD controls on the cooling tower fan motors, no savings will be achieved during this period (EUL – RUL). Provide the eQuest model (with .inp, .pd2, .sim, and 8760 files)
3. Provide a post-install M&V plan that includes:
 - Chiller water pumps and secondary pumps, power, flow rate.
 - Supply fan motors with VFDs on AHUs power, & airflow, actual spot-measured VFD speeds
 - Chiller power, supply temperature, return temperature,
 - Cooling tower fan power, approach temperature, fan VFD speed, fan kW, condenser water temperature.

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)	Early Replacement	EEM 1, Add-on measure EEMs 2-5, Early Replacement
Project Cost Basis (Full Cost, Incremental Cost)	\$383,250, Full Cost	Both Full & Incremental Measure Costs apply for EEMs 2-5. Only full costs apply for EEM1
RUL (Early retirement projects only, otherwise N/A (not applicable))	Not provided	There may be RUL in the existing equipment, but estimates were not provided
EUL	Not provided	According to DEER 2008 high efficiency chillers and high efficiency boilers both have an EUL 20 years; while packaged cooling towers VAV boxes and VSD fans have an EUL of 15 years
First Year kWh Savings	524,600	515,734, pending post-install M&V and IOU true-up
First Year Peak kW Savings	85.9	32.6, pending post-install M&V and IOU true-up
First Year Therms Savings	17,300	17,336, pending post-install M&V and IOU true-up
kWh Savings (RUL Period)	524,600	515,734, pending post-install M&V and IOU true-up
Peak kW Savings (RUL Period)	85.9	32.6, pending post-install M&V and IOU true-up

Description	IOU Proposed Ex Ante Data	ED Recommendations
Therms Impact (RUL Period)	17,300	17,336, pending post-install M&V and IOU true-up
kWh Savings (EUL thru RUL Period)	Not Provided	TBD
Peak kW Savings (EUL thru RUL Period)	Not Provided	TBD
Therms Savings (EUL thru RUL Period)	Not Provided	TBD
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	Assessment not completed

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: The baseline efficiency levels are the existing equipment performance. No EUL through RUL period savings provided.
	ED Assessment: The in situ baseline equipment is appropriate for early replacement and add-on measures. However, the EUL through RUL period savings need to be calculated using T-24 and T-20 as the baseline. For EEM1 there will not be a dual baseline. EEM5 is not eligible for savings during the after RUL period.
	ED Recommendation: EEM 1, Add-on Measure, EEM 2-5, Early replacement
Project Cost Basis (for early retirement projects only, include RUL through EUL cost basis treatment)	IOU Proposal: Full cost, a total project cost is listed as \$383,250 in the Comprehensive Energy Audit, based on discussions with the customer selected contractor.
	ED Assessment: Both full and incremental costs are appropriate for this project as follows: EEM1 – Full Cost EEM2-5 – Both Full and Incremental Costs
	ED recommendation: The contractor estimated costs are appropriate. Upon completion of this project submit the itemized invoices showing breakdown of material, labor & shipping costs for all measures.
RUL (required for early retirement projects only, otherwise n/a)	IOU Proposal: Not provided
	ED Assessment: The 3P implementers indicated that the existing equipment had some service life remaining, but an estimate was not provided. So, RUL couldn't be assessed. An estimate needs to be provided to determine the EUL through RUL savings.
	ED recommendation: Provide RULs of all replaced equipment.
EUL	IOU Proposal: Not provided
	ED Assessment: EUL for these measures can be determined from DEER 2008 EULs.
	ED Recommendation: HE chillers & boilers EUL is 20 years, EUL for cooling towers VAV boxes and VSD fans is 15 years.
Savings Assumptions	IOU Proposal: the existing building schedule is used with existing equipment

Reviewed Parameter	Analysis
	<p>operation used as the baseline. The utility billing data is used to calibrate the whole building model. The calibration results of NMBE and CV (RMSE) are -2.7%, 7.5%, -1.0% and 9% for kWh and therm utility bills, respectively.</p> <p>During the parallel review process, the following changes were made to from the baseline model:</p> <ul style="list-style-type: none"> ▪ CHW Loop Pump, added VFD with minimum speed of 20% and VFD loss of 0.05%, and pump kW of 11.19 kW, ▪ Chilled Water Loop cool setpoint was fixed and changed to OA reset, with head set point control valve reset, ▪ Chiller capacity was changed from 360 tons to 300 tons with variable speed. The electric input ratio was changed from 0.18 to 0.178, ▪ Boiler capacity was changed from 4,500 Mbtuh to 2,000 Mbtuh with heat input ratio of 1.25 improved to 1.136 ▪ Cooling tower capacity was increased from 375 tons to 470 tons, with variable speed fans installed. The designed approach temperature was 13F changed to 11F. ▪ For the VAV system, VFDs were installed from constant volume baseline, with a minimum fan ratio of 0.3. <p>ED Assessment: Using the utility bills for calibration is appropriate. The results should fit the CPUC Guidelines (consistent with ASHRAE Guideline 14-2002 standard of 5.3.2.4 (f)). The computer model shall have an NMBE of 5% and a CV (RMSE) of 15% relative to monthly calibration. The assumptions used for each measure are reasonable.</p> <p>ED Recommendation: None</p>
<p>Calculation Methods/Tool review</p>	<p>IOU Proposal: A whole building energy model was developed to identify building loads. The model was calibrated using monthly utility data. The calibrated model was run with baseline conditions and post conditions using local weather data.</p> <p>ED Assessment: The whole building model is appropriate for these measures. By using the monthly utility data calibrated model approach; the calibrated model needs to be run with the appropriate CZ weather data.</p> <p>ED Recommendation: The post-retrofit operational parameters such as equipment efficiency, schedule, set points, and all other operation parameters</p>

Reviewed Parameter	Analysis
	should be used to true up savings, in the post-retrofit eQuest model.
Pre- or Post-Installation M&V Plan	IOU Proposal: No pre or post M&V plans were provided for review.
	<p>ED Assessment: Post installation end-use data should be used to true up energy savings upon completion of this project. Temperature set points and schedules should be verified. Additionally metered data should be collected for several weeks to calibrate the model. Data to collect should include a minimum of two weeks of data at an interval of 15 minutes, and cover a representative range of operating conditions (schedules and weather conditions):</p> <ul style="list-style-type: none"> ▪ Chiller water pumps and secondary pumps, power, flow rate. ▪ Supply fan motors with VFDs on AHUs power, & airflow, actual spot-measured VFD speeds ▪ Chiller power, supply temperature, return temperature, ▪ Cooling tower fan power, approach temperature, fan VFD speed, fan kW, condenser water temperature.
	ED Recommendation: Post M&V needs to be conducted to true-up energy savings estimates.
Net-to-Gross Review	IOU Proposal: Not provided
	ED Assessment: Not assessed
	ED Recommendation: TBD