

Ex Ante Review Findings

Table 1-1: Project Information

IOU	Pacific Gas and Electric (PG&E)
Application ID	2K12128938
Application Date	April 11, 2011
Program ID	PGE21011
Program Name	Commercial Calculated Incentives
Program Year	2011
Itron Project ID	X260
IOU Ex Ante Savings Date	TBD
ED Measure Name	Evaporative Coolers
Project Description	Evaporative Cooler retrofits for existing rooftop units at twelve (12) separate large retail stores
Date of ED Review(s)	01/28/2013
Primary Reviewer and Firm	Chris Williams / DNV KEMA
Review Supervisor and Firm	Kunal Desai / Itron Inc
Type of Review (Desk, On-site, Full M&V, Tool)	Desk Review
ED Recommendation	Ex ante project savings estimates are conditionally approved pending post-implementation M&V data collection and savings true-up and workbook reference amendments. Post-implementation M&V data collection and savings workbook true-up includes additional requirements laid out in the review intended to substantiate key input assumptions used in the AESC savings calculation workbooks

Measure and Baseline Descriptions

The retrofit project proposes to install Integrated Comfort Dual Cool evaporative coolers on a total of 92 existing rooftop units (RTU) serving twelve big box retail stores located throughout the PG&E service territory. This project is the third phase of the evaporative cooler retrofits.

These big box retail stores vary in size ranging from 102,640 to 212,242 square feet, and in operating hours from 12 to 24 hour daily operation. Individual store RTUs proposed for retrofit are either 10 or 20 tons in cooling capacity (i.e., a single store will have either 10 ton or 20 ton units proposed for retrofit, but not a mix of both) and each store has either 6 or 10 units proposed to be retrofitted with the Dual Cool evaporative coolers.

The Dual Cool evaporative coolers save energy by increasing the effective efficiency of the RTU compression cycle by pre-cooling incoming condenser air and also by pre-cooling and effectively decreasing the cooling load of the incoming outside air that mixes with the unit's make-up air. PA-approved energy savings for all 12 sites totals 726,200 kWh and 762 kW with an estimated project cost of \$569,000. Individual site project costs are either \$42,000 or \$55,000 for each site. The proposed net incentive (energy + demand savings) totals \$185,130 using incentive rates of \$0.15 per kWh and \$100 per kW.

Summary of Review

Documents provided for the Phase I review include the following:

- Multi-site PA review package with pre-installation verification for a sample of the 12 sites
- Individual site 12-month (or longer) electric usage
- PA savings summary and application summary workbooks documenting individual site savings, incentives, project cost, and basic site information (square footage, operating hours, estimated project start/completion dates, number and type of units proposed for retrofit)
- Multi-site project application form
- Individual site savings calculation workbooks, adjusted by AESC to more closely match specific site operations and also to incorporate findings from a Emerging Technology (ET) program conducted by AESC on behalf of PG&E
- (Provided during parallel review) PG&E Emerging Technology Program project # ET12PGE3181 report, *Evaporative Retrofit Components for Roof Top Packaged Air-conditioning Units*. (the ET Report)

The Phase I review focused on the documentation listed above, specifically on the individual site savings calculation workbook tool which contained individual site baseline information and savings assumptions. The ET Report was also an important source for critical assumptions referenced in the savings calculation workbook.

Baseline information for the stores is input in to the individual site calculation workbooks; baseline conditions include store size, climate zone, unit size (in tons), number of retrofitted units and total units, percent outside air brought in to the mixed air plenum, total fan power, supply air temperature, and economizer availability (i.e., on/off). All of the RTUs have economizers (or at least dampers and actuators); however, per the technical reviewer (AESC) the economizers may or may not be currently functional. The economizers whose functionality have been verified in the field have the economizer spreadsheet input set to “on”, while those that have not been verified have had the economizer set to “off”. The final installation requirements should include the provision to verify whether each RTU’s economizer is functional or not. “Superstore” sites have additional user-dependent inputs for their air handling units (AHUs) that provide make-up air. These inputs include number of AHUs, size (tonnage), total flow rate (CFM), and percent outside air.

The PA review report documents a pre-installation inspection on a sample of sites that confirms the RTU/AHU equipment capacities, quantities, and current operation.

The energy savings calculation workbooks generate hourly RTU load models and compares baseline consumption with the proposed consumption. The workbooks implicitly assume that the RTUs operate based on outdoor air temperature and potentially condition store spaces 24 hours per day. Individual store and unit fan controls and schedules should be verified during the post-implementation review. The proposed consumption is altered from the baseline by simulating the effectiveness the evaporative coolers have on pre-cooling the incoming condenser air and incoming outside air that is mixed with the make-up air. The effectiveness of the pre-cooling is generated as an effectiveness factor percentage – 40% for the incoming outside air that is mixed with the make-up air and 80% for the incoming condenser air. These effectiveness factors were taken directly from the averaged results of the ET Report for the same evaporative cooling technology. The load models, specifically the kW/sf and compressor load regression models, were generated and calibrated with monitored data from a “Div1” and “Superstore” retail store in climate zone 12 territory (The phase 3 project sites are in climate zone 2, 12, and 13). Other regression curves (e.g., capacity curves, part load and full load efficiency curves) were apparently generated using plant equipment specifications from those stores as well, and are presumed to be applicable to the phase 3 project stores because of the similar vintage, store layout, and application of the equipment in the chain retail stores.

The raw monitored data that was used to generate the linearly regressed compressor load (in the “Div1” workbooks) and RTU kW load (in the “Superstore” workbooks), dependent on outside air temperature and normalized to store square footage, was not available for review. It should be noted that these linear regressions need to conform to the following criteria to be acceptably accurate:

- An F test for the overall model fit must have a p-value less than 0.05 (i.e., the overall fit is statistically significant at the 5% significance level)

- All included variables in the model must have a p-value less than 0.2.
- At least one of the variables in the model must have a p-value less than 0.05
- The R-Square for the regression must be at least 0.5.

It should also be noted that the “Div1” calculation workbooks do not contain references to the RTU and AHUs specifications and efficiency curves; only the “superstore” workbooks contain those information. Including these information (i.e., the “RTU-EERs” and “AHU-EERs” spreadsheets) in the “Div1” calculation workbook would be useful for the ex ante review if there are future projects that involve only “Div1” stores.

The “Div1” and “superstore” workbooks use slightly different combinations of full load and part load efficiency data points (pulled from the “superstore” RTU specifications) in order to develop the workbook’s regression curve coefficients. The “Div1” workbooks also add a 10% efficiency penalty to the kW/ton data points. The reason for the difference between the “Div1” and “superstore” efficiency regression curves is not explained in their workbooks; the final installation report should modify the calculation workbooks to explain these inconsistencies.

The PA review package had a minor set of additional requirements that included inspection for a sample of the 12 sites and requirement for the customer to provide a copy of the paid invoice for the all stores involved in the phase 3 retrofit. The ET Report recommends additional criteria to be met in order to substantiate the savings estimated for the Dual Cool evaporative technology. The criteria are based on the ET Report’s field observations which suggest that the effectiveness of the evaporative cooling equipment and persistence of the estimated annual savings are very dependent on the commissioning and proper operation and maintenance of the retrofitted equipment. Some of these recommendations include:

- A quality maintenance program must be provided that supports the (Dual Cool) unit for at least 3 years
- A commissioning test must be performed for each installation that measures power consumption, outside air dry and wet bulb temperature, after condenser coil dry and wet bulb temperature, and the temperature of the outside air pre-cooler in order to demonstrate the system is working optimally as part of the installation report. Measuring these points will verify the evaporation effectiveness factors used in the calculation workbooks.
- The “cut-in” point for the Dual Cool evaporative coolers should be at a minimum of 70 °F so that the benefits of the lower condensing temperature are captured without incurring too much water pump power penalties, water consumption, or algae growth (reduced performance).

Review Conclusion

Ex ante project savings estimates are conditionally approved pending post-implementation M&V data collection and savings true-up and workbook reference amendments. Post-implementation M&V data collection and savings workbook true-up includes additional requirements laid out in the review intended to substantiate key input assumptions used in the AESC savings calculation workbooks.

Summary of ED Requested Action by the IOU

1. Provide additional information to substantiate the inconsistencies between the “Div1” and “superstore” regression coefficient values on the “Regression” spreadsheet. Specifically, the source of the 10% efficiency (kW/ton) penalty in the “Div1” workbooks and the floor-area-normalized RTU kW and compressor load regression coefficients. Additionally, provide statistical fit results for the regressions to verify that they conform to the conditions described in the review summary above;
2. To expand completeness of the individual AESC calculation workbooks, recommend copying over pertinent spreadsheets (e.g., “RTU-EERs”, “AHU-EERs”, “DB”, “WB” spreadsheets) from the “superstore” workbook in to the “Div1” workbook. Future projects that utilize these AESC-developed workbooks will have applicable references and template worksheets for altering the RTU/AHU specifications depending on the customer;
3. Provide a post-implementation commissioning report that substantiates the key parameters involved in the calculation workbooks. The commissioning should report back power consumption, outside air dry and wet bulb temperature, after condenser coil dry and wet bulb temperature, and the temperature of the outside air pre-cooler in order to true-up the evaporation effectiveness factors (condenser pre-cooling and OAT pre-cooling), the Dual Cool “cut in” temperature, and percent outside air intake (“OAT %”). Develop a post-implementation M&V plan based on the commissioning report recommendation and submit the plan for ED review. The results of the post-implementation M&V will be applied to the savings workbooks to true-up the ex ante savings estimates;
4. Provide evidence that the customer is participating in a quality maintenance program that provides support to the retrofitted units for at least 3 years;
5. Provide verification of each RTU’s economizer status to ensure that each store’s savings spreadsheet is properly utilizing the economizer input. Additionally, verify the minimum percent outside air value used for each store’s (i.e., for each RTU proposed to be retrofitted) savings workbook. If the actual RTU damper position is different from what is reflected in the savings workbooks, revise the workbooks’ “OAT [%]” input during the post-implementation review.

6. As part of the post-implementation review, verify individual store and unit fan controls, setpoints, and schedules to ensure the savings workbooks correctly model each store's RTU schedule and operation. The savings workbooks should incorporate any site specific RTU/AHU schedules that are not already reflected in the workbook inputs. The post-implementation review will also include true-up of the savings estimates using the savings workbooks
7. Provide a source and estimate for the effective useful life (EUL) of the evaporative cooling equipment;
8. After installation and commissioning provide site specific project costs disaggregated by individual unit (i.e., 10 ton and 20 ton retrofit costs), if possible.

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)	Add-on Measure. Project baseline is existing equipment	Add-on Measure baseline acceptable
Project Cost Basis (Full Cost, Incremental Cost)	\$569,000; This is the total phase 3 project cost across all 12 physical sites. Disaggregated cost by site is also included	This is a retrofit project; full cost
RUL (Early retirement projects only, otherwise N/A (not applicable))	N/A	N/A
EUL	Not provided	TBD
First Year kWh Savings	726,200	TBD
First Year Peak kW Savings	762	TBD
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 (EUL thru RUL Period)	726,200	TBD
Peak kW Savings (EUL thru RUL Period)	762	TBD
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	A NTG interview may be warranted

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: Add on Measure. Baseline equipment is existing equipment. The measures are retrofit measures
	ED Assessment: The chosen baseline is appropriate
	ED Recommendation: None
Project Cost Basis (for early retirement projects only, include RUL through EUL cost basis treatment)	IOU Proposal: Full cost (measure equipment cost + labor cost)
	ED Assessment: Retrofit (add-on) measures should use full cost basis
	ED recommendation: When project is complete, provide project cost documentation in the form of vendor invoices for equipment, labor, and materials, categorized by individual site and retrofitted unit, if possible.
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: Assessment will be completed after the IOU submits EUL estimates and ED reviews
	ED Recommendation: TBD
Savings Assumptions	IOU Proposal: Savings assumptions include: <ul style="list-style-type: none"> • Baseline equipment operation and performance specifications • Evaporation effectiveness factors of 40% and 80% for OAT pre-cooling and condenser pre-cooling, respectively
	ED Assessment: Savings assumptions do not account for internal loads, equipment schedules, or solar heat gain. Hourly cooling demand is based solely on hourly outdoor air temperatures. This method is reasonable considering the building type and schedules of these large big box retail stores (most are 24 hours; some are 12-18 hours but are only closed for stocking purposes)
	ED Recommendation: See the Summary of ED-Requested Action by the IOU section for relevant requests regarding post-installation savings assumption true-up.
Calculation Methods/Tool review	IOU Proposal: Uses a spreadsheet hourly load model tool developed by AESC and adjusted using pre/post meter data and regression models from the ET Report. The data used are from a “Div1” and “superstore” site, both located in climate zone 12, and both are of the same retail chain as the stores in this project. The AESC-developed load model tool was specifically developed for this Dual Cool evaporative cooling technology.

Reviewed Parameter	Analysis
	<p>ED Assessment: The calculation method and tool used for this project’s savings estimates are appropriate. Further adjustments can be made to the tool after the required post-installation M&V plan is completed.</p> <p>ED Recommendation: See the Summary of ED-Requested Action by the IOU section for relevant requests regarding post-installation savings assumption true-up.</p>
<p>Pre- or Post-Installation M&V Plan</p>	<p>IOU Proposal: Pre-installation M&V amounted to equipment verification for three of the twelve sites and collection of equipment specifications for the twelve sites. The ET Report also informed baseline energy consumption using regression models that had been calibrated to two weeks of monitored data from a “Div1” and “superstore” site, both in climate zone 12.</p> <p>Post-installation M&V plans include site inspection for a sample of sites and a requirement for the IOU to submit a copy of the paid invoice for all the involved stores. Post-installation measurement efforts for this project phase are not planned. The “div1” and “superstore” calculation workbooks use 5 months of post-installation monitored data from the retail chain’s “Div1” and “superstore” climate zone 12 sites that participated in the ET Report.</p> <p>ED Assessment: The post-installation regression models calibrated to the 5 months of monitored data for the “Div1” and “superstore” retail building types provides a substantial effort for post M&V; however, this evaporative cooling technology requires specific commissioning in order to optimize the operation of each retrofitted unit. The commissioning process may involve some inherent spot-measuring tasks that can also be used to true-up the calculation workbook parameter inputs.</p> <p>ED Recommendation: See the Summary of ED-Requested Action by the IOU section for relevant requests regarding post-implementation M&V and savings assumption true-up. After revising the post-implementation M&V plan with the recommendations in this review, resubmit the plan for ED review.</p>
<p>Net-to-Gross Review</p>	<p>IOU Proposal: Not provided</p> <p>ED Assessment: Assessment not completed</p> <p>ED Recommendation: A NTG interview may be warranted</p>