Phase III Ex Ante Review Findings

Table 1-1: Project Information

IOU	Pacific Gas and Electric
Application ID	2K1211087C
Application Date	Not provided (but prior to 02/05/2013)
Program ID	PGE21262
Program Name	UC/CSU/CCC Partnership Program
Program Year	2012
Itron Project ID	X205
IOU Ex Ante Savings Date	Not available
ED Measure Name	Smart Grid Controls (Phase C)
Project Description	This proposed control upgrade project at nine buildings in an university campus has following measures: i) Advanced Scheduling Controls ii) Modified Temperature Setpoints iii) Minimum Outside Air Reset iv) Demand Control Ventilation (DCV) This is Phase C of the three phase comprehensive control upgrade project at the university campus.
Date of ED Review(s)	05/24/2013 07/08/2013
Primary Reviewer and Firm	C.D. Nayak / DNV KEMA
Review Supervisor and Firm	Amit Kanungo/ DNV KEMA
Type of Review (Desk, On-site, Full M&V, Tool)	Desk Review
ED Recommendation	The project is conditionally approved for EEM-1, EEM-3, and EEM-4. Table-II of this report provides the list of buildings selected by the customer for various measure implementations. However, ED believes that the savings expected from EEM-3 and EEM-4 is complementary in nature, and the final claimed savings

	should consider either EEM-3 or EEM-4. If the implementer decides to implement EEM-4, as required by the 2008 Compliance Manual, then the resulting savings will automatically include EEM-3 as well. On the other hand, if the implementer decides to implement EEM-3 alone, that final claimed after the project completion should only be for EEM-3. The implementer needs to demonstrate the operation of the implemented measures before the measure final energy savings are approved.

Measure Description

This control upgrade project is located at nine buildings in a university campus. It appears from the project documents that the existing pneumatic control systems at these buildings will be replaced with DDC, which will enable added control measures on the existing HVAC equipment. It seems that there are about [redacted] buildings in the university campus, and control retrofit measures are being implemented in these buildings progressively in different phases. Phase C, which includes nine buildings, is in this incentive application. The pre-installation inspection by IOU's technical reviewer was completed on 9/14/2012.

The following four measures have been described in the project document:

1. Advanced Scheduling Controls: The proposed advanced zone controls will enable building systems to be shut down when there is no scheduled occupancy. Currently, the level of zone control in these buildings requires multiple systems to be ON even if only one office space out of the entire building is occupied.
2. Modified Temperature Setpoints: Setpoint savings are the result of reduced space temperature setpoint during the heating season from 70-72 ^{o}F to 68 ^{o}F
3. Minimum Outside Air Reset – Currently there is no control to modify the percentage of minimum outside air. The new controls will enable the reduction of outside air, and the proposed measure will reduce the OA intake depending on the occupancy. The minimum OA flow rate (for both heating and cooling) will reduce from 30% to 15%.
4. Demand Control Ventilation – The proposed CO_2 sensors on the return ducts will be used to modulate the ventilation rate.

Presently, the campus does not have an energy management system (EMS) that ties the entire campus together to enable remote access to program set points, scheduling, etc. The proposed EMS will enable real-time changes to temperature set-points, and scheduling to match building occupancy to zone level instead of building level as in base case. In the proposed case, the buildings selected under this incentive application will have more number of zones. The project

file documents the existing and post-retrofit building schedules, heating setpoints, and minimum OA percentage.

Summary of Review

Documents provided for this Phase III review include the following:

- Project scope, existing and proposed HVAC system details, schedules, and setpoints, and minimum OA percentage.
- eQUEST energy models
- Projected measure cost
- Building operating schedule
- EUL and RUL details

ED reviewed the hourly output of the energy models and found that even though the boilers are shut down during May 31st to Oct 31st in actual operation, the building model shows that space heating occurs during this period. ED reviewer discussed this issue with the IOU reviewer on 6/12/2013 and the IOU reviewer agreed to revise the eQUEST model, consistent with the actual boiler operation hours.

ED reviewer noted that Title-24 both "requires" and "permits" DCV under two different sections depending upon the building usage. However, in both cases the, the standard say that the areas must be served by multiple zone systems that are continuously occupied during normal business hours with occupant density greater than 25 people per 1000 ft²(40 sq. ft. per person). ED interviewed the customer and found that the design occupancy in these building are about 20 sq. ft. per person, though may not be for all spaces in these building. Thus, all buildings included in this application meet the occupant density requirement mandated in Title-24, and therefore, qualify for the proposed DCV (EEM-4).

ED compared the eQUEST input files and the hourly output results for EEM-3 and 4 to verify the changes made in EEM-4 over EEM-3, however, could not determine the differences in the system operation and OA damper position as a result of DCV implementation. The ED reviewer believes that expected savings from EEM-3 and EEM-4 are complementary in nature, and therefore, it suggested that the IOU reviewer should consider either EEM-3 or EEM-4, and provide ED the updated project scope. The ED reviewer had a meeting with the IOU reviewer on 6/12/2013 and follow-up discussions afterwards. The ED reviewer noted that Title 24 calls for detailed onsite verification during design, construction, and commissioning phases to realize the savings under the proposed DCV, and this requires the integration with existing economizers, and OA percentage setpoint. Therefore, the implementer should provide the detailed procedure for checking location, testing, and integration with economizers. The final project document should provide the upper and lower limit of the installed CO_2 sensors, the new control sequence

of the economizers, and the minimum ventilation rates for each building after EEM-4 is implemented. Further, the ED reviewer noted that from the project documents received earlier, it appears that the proposed CO_2 sensors will be installed on the return ducts. ED feels that 2008 Non-residential Compliance Manual does not allow CO_2 sensors on the return air ducts.

Based on the meeting held on 6/12/2013 and afterwards, the IOU reviewer will check if the implementer is ready to execute EEM-4 per the check list provided in 2008 Compliance Manual for DCV implementation during design, submittal, construction, and acceptance phases (refer page 4-30, Section 4.3.7). If the implementer decides not to go for DCV (EEM-4), then the final revised eQUEST model's parametric runs will select only EEM-3 with the actual implemented minimum OA damper position. However, if the implementer decides to implement the DCV, then IOU reviewer will take out EEM-3 from the EQUEST model's parametric runs, because once DCV is implemented, that will automatically decide the minimum OA damper position to meet the minimum ventilation rate, hence, a separate run for EEM-3 is not necessary. This way, the projected savings of EEM-3 are already embedded in EEM-4 savings (which, ED believes, might go of up little as EEM-3 is taken out of the parametric runs). Lastly, ED recommends that the final energy models should be trued-up with the actual site information collected during the post-field verification. Furthermore, the final submittals in the post-installation phase should provide the list of HVAC system operation changes under EEM-4 or EEM-3.

As the available project documents do not provide any specific information on the existing building control system's age, the ED reviewer interviewed the campus contact to obtain the age and functionality of the existing building EMS.

From Table-I and Table-II given below, the proposed control system upgrade projects at only four buildings ([redacted]) will be treated as Early Replacement and the projects at the remaining buildings will be treated as Normal Replacement.

ED reviewer examined both the current 2008 Title-24 and the old Title-24 standard documents to assess the eligibility of the proposed measures and determined that irrespective of the baseline types, EEM 2 will not be eligible for incentive, because this is considered as the minimum basic control feature per Title-24, and considered mandatory even when the pre-existing EMSs were installed at each of the buildings (listed in Tables I & II below). Therefore, the proposed savings from EEM 2 do not qualify for IOU incentives. Note: Table II identifies which of the campus buildings will be receiving each of the four HVAC measures (EEMs 1-4).

The IOU reviewer informed the ED reviewer that the proposed EEM-1 will create more number of zones in the affected buildings and thus, exceeds the minimum requirement provided in 2008 Title 24 for isolation areas (refer to Section 122 (g) for Isolation Area Devices). ED acknowledges that this will provide tighter zone controls over the pre-existing condition, and therefore, EEM-1 is eligible for IOU incentive.

Table-I, EMS Vintages

Building	Age of existing control systems
[redacted]	1992, took 18 months for project completion
[redacted]	2000 – only had local thermostats,
[redacted]	2005
[redacted]	1992
[redacted]	Original EMS - 1992, got updated in 2005, and all pneumatics and sensors were replaced in 2005
[redacted]	Original EMS - 1992, and was replaced in 2010. The modification introduced PLC based controller. In 2013, the EMS is moving from Wonderware to Tridium (JACE – field controller) (ADR programming)
[redacted]	1992, and now moving to Tridium
[redacted]	1992
[redacted]	1992

Table-II, Building Vintages & Applicable EEMs

Building / Vintage	Age of Pre-Existing EMS	EMS RUL	EEM1-Scheduling	EEM-2 Temperature Setpoint Modification	EEM-2 Minimize Outside Air	EEM-4 Demand Control Ventilation
[redacted]	1994	0	X	X	X	
[redacted]	2000	2	X			
[redacted]	2005	7	X			
[redacted]	1992	0	X	X	X	X
[redacted]	2005	7	X	X	X	X
[redacted]	2010	12	X			
[redacted]	1992	0	X	X	X	X
[redacted]	1992	0	X	X	X	X
[redacted]	1992	0	X	X		X

Review Conclusion

The project is conditionally approved for EEM1, EEM3, and EEM4 for all buildings selected for individual measures (refer to Table II). The IOU should provide additional details as detailed in Summary of Review, above.

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)	Existing operating conditions were taken as the baseline. Therefore, early replacement is baseline.	Based on the information collected from the facility personnel, the proposed EMS replacement in only four buildings fall under early replacement, and the projects at remaining buildings should be treated as normal replacement.
Project Cost Basis (Full Cost, Incremental Cost)	Full cost. The project document anticipates the total project cost at $727,593, which is based on the quote received from the vendor.	Full cost applies for early replacement measures, and incremental cost applies for normal replacement measures.
RUL (Early retirement projects only, otherwise N/A (not applicable))	The project document provides the RUL information. The buildings included in the application were built between 1953 – 1979. It appears that the existing building control systems are 10 – 15 years old.	Tables-I and II (above) provide the vintage summary of the existing EMS, building, and their RUL.
EUL	Per DEER 2008, EUL for the Energy Management System is 15 years.	EUL information is adequate and correct.
First Year kWh Savings	N/A, PG&E only provides natural gas to the campus.	N/A
First Year Peak kW Savings	N/A, PG&E only provides natural gas to the campus.	TBD

Description	IOU Proposed Ex Ante Data	ED Recommendations
First Year Therms Savings	20,650 (as documented in "PGE EAR 2K1211087C_Lincus Response_04012013.docx ") Scheduling controls– 10,268, revised temperature setpoints – 4,817, Minimum OA reduction – 3,859, DCV – 1,707	EEM-2 is not eligible for savings estimation. TBD.
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)	N/A, PG&E only provides natural gas to the campus.	N/A
Peak kW Savings (EUL thru RUL Period)	N/A, PG&E only provides natural gas to the campus.	N/A
Therms Savings (EUL thru RUL Period)	20,650	EEM-2 is not eligible for savings estimation. TBD.
Annual Non-IOU Fuel Impact (RUL Period)	N/A	TBD
Annual Non-IOU Fuel Impact (EUL thru RUL Period)	N/A	TBD
Net-to-Gross Ratio	Not provided	0.58

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 operating conditions were taken as the baseline. Therefore, early replacement is baseline.
	ED Assessment: Based on the information collected from the facility personnel, the proposed EMS replacement in only four buildings fall under early replacement, and the projects at remaining buildings should be treated as normal replacement.
	ED Recommendation: No change
Project Cost Basis (for early retirement projects only, include RUL through EUL cost basis treatment)	IOU Proposal: Full cost. The project document anticipates the total project cost at $727,593, which is based on the quote received from the vendor.
	ED Assessment: Full cost applies for early replacement measures, and incremental cost applies for normal replacement measures.
	ED recommendation: No change.
RUL (required for early retirement projects only, otherwise n/a)	IOU Proposal: The project document provides the RUL information. The buildings included in the application were built between 1953 – 1979. It appears that the existing building control systems are 10 – 15 years old.
	ED Assessment: Tables-I and II provide the vintage summary of the existing EMS, building, and their RUL.
	ED recommendation: No change
EUL	IOU Proposal: Per DEER 2008, EUL for the Energy Management System is 15 years.
	ED Assessment: EUL information is adequate and correct.
	ED Recommendation: No change.
Savings Assumptions	IOU Proposal: Per the project document, following information are available: "Most of the building inputs and loads in the energy models are default eQUEST values. This includes building construction components, lighting loads, miscellaneous loads, domestic hot water equipment and loads, and chilled water equipment and loads. These items would not have a great effect on the energy savings calculations performed by eQuest, and these inputs remained constant in the baseline and proposed models. The boiler efficiency used in the model was 84%,

Reviewed Parameter	Analysis
	which was documented in a commissioning report from then the boiler was installed."
	ED Assessment: ED reviewed the energy models for air-side and water-side equipment details, AHUs configurations, economizer type, and control, fan speed control, heating and cooling supply air temperatures, heating and cooling controls, boiler and chiller inputs, CHW and HHW loop details, etc.
	ED Recommendation: IOU should provide the list of assumptions made in the final models in the post-installation phase.
Calculation Methods/Tool review	IOU Proposal: The measure savings were calculated with building eQUEST models. The project documented the details of the existing boiler plant. There are three natural gas boiler; Boiler #1 is rated for 45,000 lbs/hr and has a rated efficiency at 84%, Boiler #2 is identical to Boiler #1, and acts as redundant to Boiler #1, Boiler #3 is rated for 20,700 lbs/hr, and runs when campus load is low. All boilers are shut down from May 31st through Oct 31st. Per the available documents, three energy models were developed for this savings estimation. The first model is titled "XXXX Baseline - EEM1 - EEM2.pd2" and encompasses the baseline as well as the scheduling and temperature setpoint changes made. The second model is titled "XXXX - EEM3.pd2" and shows the savings for the reduced minimum outside air requirement. This model was created from the inputs of the last energy efficiency measure created in the first file, therefore including the measures already simulated in the first model. The third model is titled "XXXX – EEM4.pd2" and shows the savings for adding DCV for critical zones of the proposed buildings. This model was created from the inputs to the third model, therefore including all measures already simulated in the first and second models.
	ED Assessment: The tool used for determining the measure savings is appropriate. However, it appears that as there are no individual gas meters for each building, the eQUEST models seem not calibrated against the actual building level usage. Furthermore, because the energy modeling with eQUEST takes care of the interactive effective between gas and electricity usage, the absence of building cooling system/parameter verification will affect both baseline and proposed heating usage.

Reviewed Parameter	Analysis
	ED reviewed the hourly output of the energy models and found that even though the boilers are shut down during May 31st to Oct 31st, the building model uses space heating. Therefore, the campus consultant should review the models and revise as necessary. ED compared input and hourly output results for EEM-3 and 4 to verify the changes made in EEM-4 over EEM-3, however, could not determine the differences in the system operation and OA damper position as a result of DCV implementation.
	ED Recommendation: ED recommends that the final energy models should be trued-up with the actual site information collected during the post-field verification. Furthermore, the final submittals in the post-installation phase should provide the list of HVAC system operation changes under EEM-4 over EEM-3, and input parameter changes that result EEM-4 savings.
Pre- or Post-Installation M&V Plan	IOU Proposal: No pre-installation M&V was done. Only the pre-existing HVAC operation schedules, heating setpoints, and minimum OA percentages collected through the on-site verification were utilized. The project document also suggests that the IOU proposes physically verifying the temperature setpoints, operating schedules, and controls setpoints in the new Tridium DDC system during the post-inspection.
	ED Assessment: The available information for the pre-existing and post-installation verifications are adequate. ED feels that EEM-3 and 4 are very closely connected, and the available project document does not provide adequate details as how savings will be realized under EEM-4 after EEM-3 is implemented and its associated savings are captured. The final project document should provide the upper and lower limit of the installed CO_2 sensors, the new control sequence of the economizers, and the minimum ventilation rates for each building after EEM-4 is implemented.
	ED Recommendation: ED feels that no pre- and post-installation M&V are required. The building models should be trued-up with the actual observations to be collected during the post-field verification.
Net-to-Gross Review	IOU Proposal: Not available
	ED Assessment: PROJECT HISTORY: The original idea of changing the HVAC system was conceived in 2005, and a feasibility study was conducted at that time. The old system included DDC thermostats that weren't working well, or what they controlled wasn't working well,

Reviewed Parameter	Analysis
	and the system was narrow in its capabilities. Several factors were necessary to make this project economically feasible, of which the PG&E incentive was one, along with a DOE Smart Grid grant for approximately $4 million and municipal incentives of approximately $150k. Energy efficiency projects tend to take second order to the prioritized hierarchy of deferred maintenance projects on campus, of which there is a $167 million backlog. The existing equipment might have lasted for an additional 5 years, but was obsolete and in need of replacement both in terms of age and in terms of limited capabilities. In some cases the thermostats being replaced were not working well, or what they controlled was not working well. The campus must meet university-level requirements regarding AB32 goals and must achieve LEED certification on new buildings, as well as respond to direct requests and expectations on the part of the campus community regarding prioritizing environmentally conscious choices. PROJECT FINANCING: Several factors were necessary to make this project economically feasible, of which the PG&E incentive was one, along with a DOE Smart Grid grant for approximately $4 million and municipal utility incentives of approximately $150k. The final decision to proceed with the project was made once the DOE grant and municipal incentives were known to be in place, but while the amount of PG&E incentive funding was not yet known. In general, the university looks for projects with a 7 year payback or less, based on debt service and energy savings relative to a 15 year loan. Capital is available in the form of loans through the UC Regents office. NTG SUMMARY: The only important program factor was the availability of the rebate (10/10). The likelihood of completing the project without the rebate was 2/10. However the IOU incentive was not essential in meeting financial criteria, as it was dwarfed by DOE rebates. Important non-program factors included remote maintenance (9/10), improved product quality (9/10), the age/condition of the old equipment (9/10), and corporate policy/guidelines (8/10).
	ED Recommendation: NTGR = 0.58