

**WORKPAPER DISPOSITION FOR  
Non-Residential HVAC Rooftop Quality Maintenance  
California Public Utilities Commission, Energy Division  
May 2, 2013**

Refer to Table 1 for a list of currently submitted IOU workpapers that cover Non-Residential HVAC Rooftop Quality Maintenance (QM) as part of statewide programs. Table 2 provides a comprehensive list of workpapers that cover all commercial HVAC maintenance measures. Many of the workpapers in Table 2 cover individual measures that are also part of the suite of treatments included in the QM workpapers listed in Table 1. All are covered in this disposition.

**Table 1 - Non-Residential HVAC Quality Maintenance Workpapers**

Workpaper ID	Workpaper Title	Date Submitted
<b>SDG&amp;E</b>		
n/a		
<b>SCE</b>		
SCE13HC037	Comprehensive Commercial HVAC Rooftop Unit Quality Maintenance	5/9/2012
<b>PG&amp;E</b>		
PGECOHC138	Non-Residential HVAC RTU Quality Maintenance	8/26/2012

**Workpaper Disposition:** Approved Pending the Following Revisions

1. Revise Ex Ante Claims Process: Commission staff prefers that ex ante claims be based on the actual service tasks completed as part of the QM process. Claim categories and savings should match those currently used to provide compensation to service providers. This disposition has developed treatment-based unit energy savings (UES) and Installation Rate (IR) values to meet that desired goal. IOUs have claimed that this poses an unacceptable problem. As such, treatment-based UES and IR values have been re-combined to provide single, mechanical system-based sets of values. As much as possible, claims categories match those in the original work papers.

ED prefers that ex ante claims are to be based upon the service provider incentive structure in three broad categories as outlined in Table 2. Note that a specific Service Incentive does not necessarily correspond directly to all Related Workpapers in the adjacent column. This table addresses both the statewide program and local and 3<sup>rd</sup> party programs. The treatment-based values in this disposition have been applied to both the statewide and local programs. The final disposition values provided here apply only to the statewide program with a treatment-based disposition applied to the local programs.

**Table 2 – Workpaper Listing by Measure Category**

Measure Category	Service Incentive	Related Workpapers
RCA and Coil Cleaning	• Coil Cleaning	WPSDGENRHC1010
	• Adjust Airflow	WPSDGENRHC1020
	• Refrigerant System Service	WPSDGENRHC1040
	• Condenser Coil Cleaning	SCE13HC037
	• Evaporator Coil Cleaning	PGECOHC138
	• Condenser Coil Combing	PGE3PHVC156 PGE3PHVC158
	• Refrigerant Charge and Airflow Service	PGE3PHVC160
Economizer Repair and Control Revision	• Economizer Functional Test	SCE13HC037 PGECOHC138
	• Integrate Economizer Wiring	
	• Replace Damper Motor	
	• Replace Controller/Sensor	
Thermostat Replacement and Reprogramming	• Renovate Linkage & other components	PGE3PHVC151 PGE3PHVC152
	• Functional Economizer Test	
	• Economizer Control Package	
	• Economizer Adjustment	
Thermostat Replacement and Reprogramming	• Replace T-stat	SCE13HC037 PGECOHC138 PGE3PHVC153 PGE3PHVC157
	• Adjust T-stat schedule	

2. Revise All UES Values to Use the Staff Recommended Values: UES values shall be obtained from the attached workbook - *20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx*.

Commission staff has developed these revised treatment values considering the following:

- Projected savings for many of the components of the Quality Maintenance programs remain difficult to obtain, requiring skilled maintenance technicians to realize anticipated program benefits. The use of incorrect maintenance techniques, test and repair equipment, and procedures can result in a decrease in cooling system efficiency and/or increase in system operation – both generating negative energy savings. These are not only undesired results, but act to offset benefits obtained at properly maintained sites.
- The original disposition, issued for SCE’s 2010-2012 workpaper, requested additional data collection to support the proposed “as-found” conditions. This data collection has not been completed as of the date of this disposition. Preliminary submittal of QM program data and an initial program evaluation suggests assumed baseline conditions in

the current workpapers are unrealistically pessimistic in both the relative occurrence of maintenance items and as well as their assumed “as found” set of conditions when found.

- Energy savings values shall be based on published DEER values where at all possible.
  - Note that economizer decommissioning is *not* an accepted measure.
  - No UES values are available for economizer and thermostat measures for SCG and SDG&E. UES values are based on current values from submitted workpapers. None have been submitted for SCG or SDG&E at the time of this disposition. Disposition values will be provided once covering workpapers are provided.
3. IOUs Shall Establish Consistent Savings Estimate Approach: For those treatments not currently addressed in DEER, staff requests that all IOUs use a common hourly simulation based approach to ex ante savings calculations similar to that used by PG&E. While staff does not insist on a particular simulation tool, the use of eQUEST and DEER baseline models is highly recommended as it provides staff with the ability to review all details of the assumptions and approaches used to develop ex ante savings. The use of modified DEER models, in particular, provides a vetted starting process in the analyses and removes many uncertainties in the estimation of demand impacts and seasonal accrual of energy impacts.

## **Background for Workpaper Dispositions**

### **Summary:**

Commission staff believes that the proposed ex ante values are overly optimistic. These concerns have been voiced in past workpaper reviews and project coordination reviews. They include baseline issues that are not fully supported, savings assumptions that remain in question and program implementation issues that have the potential to adversely affect program benefits. Commission staff understands the time and effort required to fully implement these programs, and this review is based on staff’s best evaluation of the programs’ current ability to deliver savings. The discussions below detail staff’s concerns and how those concerns impact ex ante savings estimates.

### **1. Baseline Assumptions Are Overly Pessimistic**

1. Relative occurrence of faults. A review of baseline assumptions used in the estimation of ex ante savings is believed to be overly pessimistic in the relative occurrence of faults. These concerns were outlined specifically in the disposition of the SCE 2010-2012 QM workpaper and in coordination meetings with PG&E. The assumed treatment weightings used to combine treatment savings values are provided in the HVAC QM Savings tab in the combined savings workbook – “20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx.” Refer to cells D4 through D12 in the “HVAC QM Savings” tab for the values staff has used for the expected incidence of treatment.

2. Economizer repair. Assumptions are made as to the failure damper position associated with economizer repairs. In general, the assumption is that the dampers are at some open position that equals or exceeds that need for ventilation air. A past survey by PG&E indicated that approximately 40% of failed economizers failed in a closed mode. This issue has been discussed with the IOUs in various coordination meetings via the HVAC Project Coordination effort. Based on these discussions, no additional data seems to exist on the economizer failure damper position, nor does the current data collection process collect this information directly. Until such time that direct data are obtained, the baseline assumption for failed economizers should either be the current minimum outdoor air setting (60% occurrence) or failed closed (40% occurrence). A failed-close damper leakage rate of 5% outside air is an acceptable baseline assumption.
3. Addition of Programmable Thermostats. The current baseline assumption for facilities with non-programmable thermostats is that connected HVAC systems operate continuously. The neglects building owner intervention or possible building-wide time-clock control. Until additional information is obtained that demonstrated otherwise, the baseline model should assume that 30% of all sites using non-programmable thermostats exhibit either manual control or time-clock control of units. Replacement of the existing thermostat with a programmable thermostat for those sites will result in unit cycling at set-back/set-up temperature settings during unoccupied periods as opposed to a deactivated system.

## **2. Repair Efficacy is Overly Optimistic**

Current workpapers base ex ante savings estimates on the assumption that technicians place the HVAC systems into proper working order. The system improvements are based on either ideal operating conditions or repairs associated with skilled repair technicians. Staff believes these end conditions are the programs' best available efficiency improvements – not necessarily those actually provided by the programs. As an example, SCE proof of concept report on their QM program showed both negative and positive savings for 33 units for which usable performance data were available. Some negative savings were obviously associated with an improperly assumed baseline, e.g. economizer repairs. Others were associated with refrigerant system repairs. Those, if done properly, should not have produced negative savings.

## **3. Treatment Weightings Used to Provide Combined UES and Savings Adjustment Values**

The assumed treatment weightings used to combine treatment savings values are provided in the *HVAC QM Savings* tab in the combined savings workbook – “20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx.” Treatment weighting used in this disposition are those provided under the heading **Staff QM** in the **Expected Incidence of Treatment** table (cells A2 through E12) of the “HVAC QM Savings” tab of the workbook. Values reported as recent (2012) claims by current programs are provided as examples in the table for comparison.

### **Supporting Documents**

The following attachments provide details on the assumptions and base values used to produce accepted UES values and their associated savings adjustments. Each attachment details the source of UES values and any modification to available values.

- Attachment A - Background for Refrigerant Charge Adjustment (RCA) Related UES Values. This attachment details the development of approved UES for refrigerant charge adjustment, condenser and evaporator coil cleaning, and air flow adjustment tasks.
- Attachment B - Background for Tstat Related UES Values. This attachment details the development of approved UES values for programmable thermostat and thermostat set point adjustment measures.
- Attachment C - Background for Economizer Related UES Values. This attachment details the development of approved UES values for economizer repair and economizer controls adjustment measures.

### **Attachment A - Background for RCA Related UES Values:**

Savings estimates for workpapers that include refrigerant charge and air-flow adjustment related claims differ significantly in their approaches to determining those claim values. Rather than examining each workpaper and approach separately, this disposition provides a single set of values based on those provided in the 2011 DEER.

It is important to note that current DEER UES values represent program end goals that could be obtained via a properly functioning maintenance program. Cooling system efficiency improvements used to generate these savings were obtained by a cadre of skilled technicians focused on maximizing system efficiency improvements. These same technicians currently serve as master technicians in the ongoing program EM&V effort. Commission staff believes that service technicians of this level of expertise operate in IOU-sponsored QM efforts, however staff also believes a significant quantity of service technicians do not possess a master's level of expertise and program benefits suffer as a result.

The general approach in establishing task-based UES values includes the following steps:

1. Start with UES values from the 2011 DEER for commercial RCA efforts. Again, these values are viewed as a realizable goal for all QM efforts.
2. Separate those values into task components of charge adjustment, condenser and evaporator coil cleaning and air flow adjustment.
3. Provide adjustments to the various components to account for proper application of DEER assumptions and installation rates that represent best estimates of the current state of programs in obtaining DEER values.

#### **1. DEER RCA Data**

The assumptions and data associated with the DEER values are well documented in the 2005 DEER Update Study. DEER UES values provide expected measure benefits for a system receiving ideal maintenance. The 2011 DEER UES values for RCA are listed in the "Base RCA –DEER" tab of the workbook "20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx."

#### **2. Estimation of Non-Charge Related Services Based on DEER Refrigerant Charge Measures**

QM workpapers recognize that RCA measure savings associated with DEER estimates include a mix of treatments. Potential treatments include RCA, condenser and evaporator coil cleaning, air flow adjustments and other fault corrections like removal of non-condensables or line restrictions in the refrigerant system. Unfortunately, the actual tasks performed that generated those savings were not published, nor were the incremental benefits of various treatments measured. The approach taken in IOU workpaper development efforts was to assume that efficiency improvements associated with minimal charge adjustments (less than 10% change in charge) were all a result of coil cleaning and air flow adjustments. While this approach has merit, there are no data to support this assumption.

Without better information, staff assumes the benefit of non-charge related coil cleaning and air flow adjustment to equal 25% of DEER charge adjustment UES values, or

$$\text{Non-Charge Adjustment UES Values} = \text{DEER RCA UES values} * 0.25 \quad (1)$$

There is no known evidence as to the relative impact from the three measures – condenser coil cleaning, evaporator coil cleaning and air flow adjustment - that generate non-charge adjustment savings. It is generally recognized that typical efficiency improvements associated with condenser coil cleaning are much larger than the other two. Given a paucity of direct measurements of field conditions, staff recommends the following apportioning of non-charge adjustment savings among the three possible measures:

- Condenser Coil Cleaning – 50% of the total
- Evaporator Coil Cleaning – 25% of the total
- Air Flow Adjustment – 25% of the total.

Note that the total non-charge adjustment UES values for coil cleaning and air flow adjustment apply to all treated units, even those whose threshold charge adjustment would not qualify for RCA savings. Based on these assumptions, UES values for condenser and evaporator coil cleaning and air flow adjustment are as follows:

$$\text{Condenser Coil Cleaning UES Values} = \text{DEER RCA UES values} * 0.125 \quad (2)$$

$$\text{Evaporator Coil Cleaning UES Values} = \text{DEER RCA UES values} * 0.0625 \quad (3)$$

$$\text{Air Flow Adjustment UES Values} = \text{DEER RCA UES values} * 0.0625 \quad (4)$$

The DEER RCA value multipliers are provided in Cell B2 of the respective UES value tabs for the various treatments in the workbook “*20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx*.” These tabs are *Cond Coil Cleaning* for condenser coil cleaning UES values, *Evap Coil Cleaning* for evaporator coil cleaning UES values, and *Air Flow Adjustment* for air flow adjustment UES values.

**Attachment B - Background for Revised Thermostat Measures UES Values:**

Savings estimates for workpapers that include thermostat measures vary among the various related workpapers. These differences are related to differing pre/post measure assumptions and the relative occurrence of those assumptions. In all cases, workpapers categorize thermostat measures into two general categories:

- Replacement of a non-programmable thermostat with a programmable unit and
- Revision of set-points for an existing programmable thermostat.

Non-residential QM workpapers PGECOHC138 and SCE13HC037 calculate expected savings based on defined specific remedies. Third party workpapers PGE3PHVC153 and PGE3PHVC157 use DEER values for measure ID D03-071 - Time Clocks (heating/cooling) for both treatments. In reviewing all associated workpapers, staff makes its disposition based upon the following:

1. Calculation methodologies provided in workpapers PGECOHC138 and SCE13HC037 are fundamentally sound and represent an approved overall approach. Savings estimates associated with these efforts serve as the basis for this disposition. However, staff asks that all future energy impacts be based on a single calculation approach. The approach used in workpaper PGECOHC138 is preferred as it is based on established DEER building models and energy calculation approaches.
2. The use of DEER values associated with measure ID D03-071 is not appropriate for use in workpapers PGE3PHVC153 and PGE3PHVC157 as the assumptions associated with this measure do not coincide with the expected treatment.
3. Staff believes that many of the assumptions used in calculating the benefits of thermostat measures are overly optimistic and significantly overstate savings. The disposition includes savings adjustments based on past discussions, data obtained from current programs, and general program observations (qualitative assessment only) from the ongoing EM&V effort via Work Order 32.

**1. IOU Proposed UES Values**

The thermostat measures are not in DEER. Because of this, data from the PGECOHC138 and SCE13HC037 workpapers are used to provide initial UES values. Program data and workpaper information is used to separate savings data into two general categories – replacement of a non-programmable thermostat with a programmable unit and re-programming of an existing programmable thermostat. The third party workpaper PGE3PHVC153 is a thermostat replacement measure. The third party workpaper PGE3PHVC157 is a thermostat reprogramming measure.

**PGE Unadjusted UES Values**

Workpaper PGECOHC138 provides only aggregate savings for both treatments (thermostat replacement and thermostat re-programming) weighted by assumed occurrence. Based on data

provided in the workpaper, thermostat savings occur for 29.38% of the systems. The savings associated with thermostat measures are based upon the full population of systems. As such, savings associated with a thermostat treatment (not the population as a whole) are:

$$\text{Total PGE Un-Adjusted UES}_{\text{Tstat}} = \text{Reported UES}/0.2938 \quad (1)$$

where the Reported UES values are those noted as Weighted Tstat Savings in the "PGE-ComHVACQMFromPGECOHC138" tab of the work book "20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx." The various headings provide kWh, kW and therm UES values. The workpaper or associated documents provide no mechanism for apportioning the overall UES values into thermostat replacement or reprogramming treatments. The only additional data available is that thermostat replacements are 90% of the treatments, while thermostat reprogramming is assumed to occur in the remaining 10% of the overall thermostat treatments.

Information from the SCE QM workpaper suggests that energy savings associated with thermostat replacement are essentially double that of thermostat re-programming. While we are hesitant to apply data from one calculation process to another, this seems to be a reasonable finding. Applying the two-to-one savings ratio between thermostat replacement and reprogramming to the PGE data:

$$\text{Total PGE Un-Adjusted UES}_{\text{Tstat Replace}} = \text{Reported UES} * 1.053 / 0.2938 \quad (2)$$

$$\text{Total PGE Un-Adjusted UES}_{\text{Tstat Reprog}} = \text{Reported UES} * 0.53 / 0.2938 \quad (3)$$

where:

Total PGE Un-Adjusted UES<sub>Tstat Replace</sub> are the unadjusted UES values from a thermostat replacement treatment and

Total PGE Un-Adjusted UES<sub>Tstat Reprog</sub> are the unadjusted UES values from a thermostat reprogramming treatment.

Equations 2 and 3 provide UES estimates for thermostat replacement and thermostat reprogramming from the overall weighted thermostat savings values. The multipliers used in Equations 2 and 3 are applied to the PGE Un-Adjusted UES values via multipliers in cells D6 for the thermostat replacement measure and cell D7 for the thermostat reprogramming measure in the "PGE Unadj Tstat" tab of the workbook "20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx."

#### SCE Unadjusted UES Values

Gross treatment UES values are provided in supporting documents to the SCE quality maintenance workpaper SCE13HC037. Additional weightings associated with the assumed occurrence of each treatment are available. This allows direct calculation of thermostat

replacement and reprogramming unadjusted UES values. The workpaper does not provide these values for specific building types. Instead, prototypical building types are developed with UES values associated with each prototype, then those prototypes are mapped to DEER building types along with their associated savings. The complete expansion of the mapping of prototypical results to DEER building type is found in the “SCE Unadj Tstat” tab of the workbook “20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx.”

## 2. UES Revisions:

Final UES values for thermostat measures are provided in the “Overall TStat Savings” tab of the workbook “20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx.”

As noted previously, Commission staff believes that the assumptions used to generate UES values are overly optimistic and/or are not being met by program implementation. As an example, the savings associated with the replacement of a non-programmable thermostat with a programmable one assumes that HVAC systems operate continuously because the existing thermostat has no time-clock control. There is no evidence that this case occurs and this ignores the likely possibility that an overriding time clock or manual operation prevents system operation during unoccupied periods. HVAC system availability is common in lease agreements. Overriding time clock controls are common in chain store establishments, education facilities, and many other building types. Other facilities, groceries and some medical facilities for example, while included in savings estimates, may require continuous space conditioning. Examples of the installation of programmable thermostats that were set up for continuous, fixed temperature space conditioning were observed as part of Work Order 32 EM&V efforts.

Thermostat re-programming has its own set of problems. Problem areas include changing fan operation from intermittent to continuous during occupied periods as part of program requirements. While this is necessary to meet code, it results in significant energy increases where the measure assumes an energy savings. Similar negative impacts can occur if thermostats are set by program rule to cycle the system at the set-up/set-back temperature settings during unoccupied periods when an owner has scheduled the system off without regard to unoccupied temperatures. The review of past thermostat claims identified a reprogramming claim for an unoccupied building that made these unnecessary changes. Savings estimates also ignore the possibility of overriding time-clock controls that would make unoccupied setting changes moot.

The overriding issue is that program assumptions used to develop UES values are not being used to constrain measure implementation. As such, measure implementation can, and does, provide either no savings or negative savings. This leads staff to apply the following gross savings adjustment (GSA) multipliers to un-adjusted savings:

$$GSA_{Tstat\ Replace} = * 0.25 \quad (4)$$

$$GSA_{Tstat\ Reprog} = * 0.50 \quad (5)$$

The 0.25 gross savings multiplier for the thermostat replacement measure is based on the assumption that uncontrolled HVAC system operation is uncommon. It also recognizes a potential negative impact when manual control that allows no night-time unit operation is replaced by automatic control that would allow night-time operation.

The 0.50 gross savings multiplier for thermostat reprogramming accounts for potential negative impacts associated with sites that currently operate with occupied fans at their intermittent, rather than continuous, settings. It also accounts for inappropriate thermostat set point changes like those noted for unoccupied buildings.

Final UES values equal un-adjusted values times the respective adjustment in the "Overall TStat Savings" tab of the workbook "*20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx*." Assumed savings multipliers provided in Equations 4 and 5 are clearly identified in the table at the top of the worksheet.

### **Attachment C - Background for Revised Economizer Measures UES Values:**

The workpaper categorizes economizer measures into three general treatments:

- Repair of a non-working economizer
- Revision of control set-points to those that provide additional economizer operation (higher control set-points), and
- Economizer decommissioning.

To develop approved savings values, staff utilized IOU data as described in Section 1, IOU Proposed UES Values, adjusted as described in Sections 2 and 3, Commission Staff UES Revisions – Economizer Repair and Additional Staff Adjustments – SCE Economizer Control Measures, respectively. Economizer decommissioning is not an acceptable measure, has been removed from the list of treatments, and has not been included in the UES values developed by staff. The measures “repair of non-working economizer” and “economizer control upgrades” are acceptable treatments. These measures are similar to DEER measures D03-058, which provides the basis of the workpaper UES values for the addition of an economizer, and D03-060 which represents an economizer repair and controls upgrade measure.

The DEER values are problematic for a number of reasons. The predominant issue has to do with the assumptions about the initial state of the unit under repair and the final state of the repaired economizer, in the case of the economizer repair measure. The same issues arise on the economizer controls upgrades. Many of these differences are based on reports of field activities incorporated into workpaper savings calculations but not available for inclusion into DEER analyses. A second issue is that the DEER values do not cover the range of building types appropriate for the QM programs. This is especially the case for the D03-060 economizer controls upgrade measure. In all, current DEER measure values are not usable as a base for UES values. In reviewing available DEER measures and all associated workpapers, staff makes its disposition based upon the following:

- Calculation methodologies provided in workpapers PGECOHVC138 and SCE13HC037 are adequate to establish initial gross UES values. Savings estimates associated with these efforts serve as the basis for this disposition. However, for future workpapers, staff expects all energy impacts to be based on a single calculation approach. The approach used in workpaper PGECOHVC138 is preferred as it is based on established DEER building models and energy calculation approaches. While savings values are accepted for this disposition, staff finds the bin-analysis methodology used in workpaper SCE13HC037 to be lacking and should be replaced with a simulation approach based on established building models consistent with those used in DEER evaluations.
- While the calculation methodologies used to determine measure savings are sound, staff finds that many of the assumptions used in those calculations are optimistic. This disposition will adjust savings based on discussions and data provided in the 2010-2012 dispositions and general

program observations (qualitative assessment only) of the ongoing EM&V effort via Work Order 32.

### 1. IOU Proposed UES Values

Data from the PGECOHC138 and SCE13HC037 workpapers are used to provide un-adjusted gross energy impacts. Program data and workpaper information is used to separate savings data into two general categories – repair of an existing economizer and economizer set-point controls re-programming.

#### PGE UES Values

Staff used the PGECOHC138 workpaper savings values as the starting point to develop final savings values. Based on data provided in the workpaper, economizer treatments are assumed to occur for 62.7% of the systems. Of those treatments, 30.7% (20.6% of all systems) are for controls upgrades and the remaining 59.3% (46.57% of all systems) are for economizer repairs.

$$\text{WP Aggregate UES}_{\text{Economizer}} = 0.4657 * \text{WP UES}_{\text{EconoRepair}} + 0.206 * \text{WP UES}_{\text{EconoControls}} \quad (1)$$

where

WP Aggregate UES<sub>Economizer</sub> = the UES values for economizer measures from workpaper PGECOHC138,

WP Aggregate UES<sub>EconoRepair</sub> = the UES values associated with economizer repair, and

WP Aggregate UES<sub>EconoControls</sub> = the UES values associated with economizer controls upgrades.

The UES values for economizer repair can be calculated from the total provided in the workpaper and controls upgrades EUS values from workpaper PGE3PHVC152 by,

$$\text{WP UES}_{\text{EconoRepair}} = (\text{WP Aggregate UES}_{\text{Economizer}} - 0.206 * \text{WP UES}_{\text{EconoControls}}) / 0.4657 \quad (2)$$

IOU-proposed UES values for all economizer treatments are provided in the PGE-*“ComHVACQMFromPGECOHC138”* tab in the *“20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx”* UES workbook. These UES values have a column heading of WEIGHTED ECONO SAVINGS for kWh, kW and therm UES values. UES values associated with the PGE3PHVC152 workpaper are provided in the *“PGE-AdjEconoCtrlFromPGE3PHVC152”* tab of the workbook. Disaggregated repair and controls UES values are provided in the *“Overall Econo Savings”* tab of the workbook. UES values are provided sequentially, with control upgrades following repairs. The repair/control measure is identified in column B of the sheet. The economizer repair values are calculated based on Equation 2 above, with the WP Aggregate UES<sub>Economizer</sub> values taken from values in the *“ComHVACQMFromPGECOHC138”* worksheet and WP UES<sub>EconoControls</sub> values taken from the *“PGE-AdjEconoCtrlFromPGE3PHVC152”* worksheet.

### SCE UES Values

Gross treatment UES values are provided in supporting documents to the SCE QM workpaper SCE13HC037. Data for economizer repairs are taken directly from the worksheets *SCE-Funcr-Econo.xls* for economizer repairs and *SCE-Econo-Adj-JP.xls* for economizer controls. The values used in this analysis are those that have not been weighted by assumed system efficiency degradation, but are for base efficiency systems. Staff believes the overall degradation assumes an excessively high number of degraded units and greater than anticipated efficiency degradation. In addition, UES estimates make assumptions about the fixed open damper position prior to repair that are not well supported. The workpaper does not provide these values for specific building types. Instead, prototypical building types are developed with UES values associated with each prototype. They are then applied to those building types associated with each prototypical building. Staff has performed the full expansions of this mapping to create SCE unadjusted savings for both economizer treatment. These expanded savings values are included in the "SCE Econo Savings" tab of the workbook "20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx."

## **2. Commission Staff UES Revisions – Economizer Repair:**

Energy Division staff adjustments to IOU UES estimates are made in the "Overall Econo Savings" tab of the "20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx" UES workbook. These adjustments are applied only to the economizer repair UES values. They include an energy savings multiplier of 0.5, as noted in cell I6 of the worksheet and a demand offset of -0.0238 kW/ton, as noted in cell H10.

The adjustments to economizer repairs are made to account for what Commission staff finds are inappropriate baseline assumptions used by the IOU in establishing UES values. The economizer repair UES values do not account for the possibility that the economizer failed state was a closed outside air damper prior to treatment. Commission staff noted a 2001 study by Felts<sup>1</sup> of 250 packaged systems that found that 40% of non-functional economizers were stuck closed (no outside air). The repair of these systems typically results in increased energy use and most certainly increase cooling system peak electric demand due to increased outside air supply. Commission staff addresses this by reducing the UES values for the economizer repair measure. This is done via the following assumptions:

- a. It is assumed that 25% of repaired economizers have a closed failed outside air damper mode. This is less than the 40% noted in the Felts report, but accounts for situations where outside air dampers are closed and economizers are deactivated by system owners for non-energy related reasons (most often odors associated with ventilation air). Those owners would not permit the repair of the economizer.

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<sup>1</sup> Don Felts, "Roof Top Unit Economizer Feasibility Study", Pacific Gas and Electric Company, 2001 with additional data details provided by Peter Jacobs.

- b. The negative energy impact associated with repairing systems where the outside air damper is failed closed equals the positive impact of a repaired system where the outside air damper failed at an open setting. This is likely to overstate impacts for cooler climate zones, but understate impacts for warmer climate zones, but additional details are unavailable at the time of this disposition.
- c. The peak electric demand associated,  $KW_{DEER2011}$  with direct expansion systems is included in the “coolingkWperTon2” tab of the workbook “20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx.” These values are taken from weighted results for a DEER lighting measure and represent the DEER-weighted value for typical DEER peak demand for cooling.
- d. An estimated 10% of the peak cooling load is a result of ventilation loads.

Given these assumptions, workpaper UES values for electric energy savings are adjusted as follows:

$$\text{Revised kWh Savings UES}_{\text{EconoRepair}} = \text{WP UES}_{\text{EconoRepair}} * 0.75 - \text{WP UES}_{\text{EconoRepair}} * 0.25, \text{ or} \quad (3)$$

$$\text{Revised kWh Savings UES}_{\text{EconoRepair}} = \text{WP UES}_{\text{EconoRepair}} * 0.50 \quad (4)$$

This is the source of the 0.5 multiplier on repair UES energy values provided in cell I6 of the “Overall Econo Savings” tab of the “20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx” UES workbook.

Workpaper UES values for electric demand savings are adjusted as follows:

$$\text{Revised kW Savings UES}_{\text{EconoRepair}} = \text{WP UES}_{\text{EconoRepair}} - KW_{DEER2011} * 0.1 \text{ vent load faction} * 0.25, \text{ or} \quad (5)$$

$$\text{Revised kW Savings UES}_{\text{EconoRepair}} = \text{WP UES}_{\text{EconoRepair}} - 0.025\text{kW/ton} * KW_{DEER2011} \quad (6)$$

This is the source of the -0.025 offset to IOU demand UES values as shown in cell H10 of the “Overall Econo Savings” tab of the “20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx” UES workbook.

### **3. Additional Staff Adjustments – SCE Economizer Control Measures:**

As discussed above, SCE did not develop savings values of economizer measures for each DEER building type. Instead, prototypical building types are developed with UES values associated with each prototype. They are then applied to those building types associated with each prototypical building. Additionally, staff believes that PG&E’s direct simulation method, as opposed to SCE’s bin method, of estimating savings of economizer measures is more appropriate. These two very different approaches to developing savings for economizer measures results in very different savings values between the two IOUs for identical measures, particularly for the economizer control measures. In an effort to align PG&E and SCE results, staff applied a multiplier to the economizer control measure results for a subset of the SCE results that were expanded to all DEER building

types. These multipliers are found in column M at the top of the “*HVAC QM Savings*” tab of the “*20132014-CommercialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx*” UES workbook.

## References

### Commercial HVAC Maintenance Savings Values



20132014-Commercia  
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