**Work Paper WPSDGENRHC0027**

**Revision 0**

**San Diego Gas & Electric**

**Energy Efficiency Engineering**

**Economizer Repair for Package AC**

### Core Measure Summary Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General Measure Information | | | | | | | | PT | | 1st Baseline Period | | | | 2nd Baseline Period | | | | TOU |
| Measure Name | Measure RunID | Solution Code | CZ | Building Type | Load Shape | EUL | Unit Definition | Program Type (NEW, ROB, RET) | Applicable Code | Gross Unit Annual Electricity Savings (kWh/unit) | User Entered kW Savings per unit (kW/unit) | Gas Savings (Therms) | 1st Baseline Useful Life | kWh Saving per unit (kWh/unit) | kW Savings per unit (kW/unit) | Gas Savings (Therms) | 2nd Baseline Useful Life | % TOU |
| Economizer Repair-DXGF | N/A | N/A | 06 | Assembly | DEER:HVAC\_Split-Package\_AC | 5.0 | Cap-tons | ROB | No | 3.23 | 0.00 | 0.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Economizer Repair-DXGF | N/A | N/A | 07 | Assembly | DEER:HVAC\_Split-Package\_AC | 5.0 | Cap-tons | ROB | No | 3.24 | 0.00 | 0.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Economizer Repair-DXGF | N/A | N/A | 10 | Assembly | DEER:HVAC\_Split-Package\_AC | 5.0 | Cap-tons | ROB | No | 1.72 | 0.00 | 0.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Economizer Repair-DXGF | N/A | N/A | 06 | Education - Primary School | DEER:HVAC\_Split-Package\_AC | 5.0 | Cap-tons | ROB | No | 31.85 | 0.00 | 0.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Economizer Repair-DXGF | N/A | N/A | 07 | Education - Primary School | DEER:HVAC\_Split-Package\_AC | 5.0 | Cap-tons | ROB | No | 36.50 | 0.00 | 0.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Economizer Repair-DXGF | N/A | N/A | 10 | Education - Primary School | DEER:HVAC\_Split-Package\_AC | 5.0 | Cap-tons | ROB | No | 24.23 | 0.00 | 0.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Note: **For the complete list of Measures, refer to the attached calculation spreadsheet**

### Costing and NTG Summary Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General Measure Information | | | | PT | | NTG | | | IR | 1st Baseline Period | 2nd Baseline Period | IMC | DIM |
| Measure Name | Solution Code | CZ | Unit Definition | Program Type (NEW, ROB, RET) | Applicable Code | NTG Non-Res. | NTG Res. | NTG Multi Family | Installation Rate | Gross Measure Cost per unit | Gross Measure Cost per unit | Incremental Measure Cost per unit | Delivery & Incentive Method |
| Economizer Repair-DXGF | N/A | 6 | Cap-tons | ROB | No | 0.85 |  |  | 1.00 | From Program | $0.00 | $200.10 | Financial Support / Direct Install |
| Economizer Repair-DXGF | N/A | 7 | Cap-tons | ROB | No | 0.85 |  |  | 1.00 | From Program | $0.00 | $230.00 | Financial Support / Direct Install |
| Economizer Repair-DXGF | N/A | 10 | Cap-tons | ROB | No | 0.85 |  |  | 1.00 | From Program | $0.00 | $207.92 | Financial Support / Direct Install |
| Economizer Repair-PKHP | N/A | 6 | Cap-tons | ROB | No | 0.85 |  |  | 1.00 | From Program | $0.00 | $200.10 | Financial Support / Direct Install |
| Economizer Repair-PKHP | N/A | 7 | Cap-tons | ROB | No | 0.85 |  |  | 1.00 | From Program | $0.00 | $230.00 | Financial Support / Direct Install |
| Economizer Repair-PKHP | N/A | 10 | Cap-tons | ROB | No | 0.85 |  |  | 1.00 | From Program | $0.00 | $207.92 | Financial Support / Direct Install |

Note: **For the complete list of Measures, refer to the attached calculation spreadsheet**

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision # | MM/DD/YY | Author/Affiliation | Summary of Changes |
| 0 | 06/30/2014 | Kyle Dunn (MWE2) | Original Workpaper for release, adapted from PGE3PHVC152 R0 |

# Section 1. General Measure & Baseline Data

## 1.1 Measure & Delivery Description

This workpaper addresses the savings associated by repairing common economizer problems to make the economizer functional, adjust the set point, and enable economizer operation with a higher changeover set point without compromising comfort. This workpaper is adapted from PG&E’s workpaper PGE3PHVC152 R0 [1]. Energy savings are achieved by repairing the economizer to take advantage of cooling with unconditioned outside air when the outside air is below a set point temperature and the system calls for cooling.

### 1.1a Measure Description

Measures in this workpaper include repairing an economizer on a packaged AC unit to 0.7 maximum outside air. The baseline assumption is dictated by the attached Energy Division Disposition (Disposition) titled “2013\_2014-ComHVACQMWorkpaperDisposition\_2May2013.docx” and is equated to an economizer failed at 0.245 maximum outside air.

Table 1 Measure Names

|  |  |
| --- | --- |
| Solution Code | Measure name |
| N/A | Economizer Repair-DXGF |
| N/A | Economizer Repair-PKHP |
| N/A | Economizer Repair-PVAV |

### 1.1b Delivery and Incentive Mechanism

The Delivery Mechanism for this measure is Financial Support – Downstream Deemed, and includes Program Types of Replace on Burnout (ROB).

### 1.1c Measure Requirements

***Terms and Conditions***

The customer facility is physically located within SDG&E service territory and that the customer receives electric services from SDG&E.

***Market Applicability***

This measure is applicable to non-residential customers with packaged rooftop HVAC equipment with dx cooling, gas heating, and an airside economizer in climate zones 06, 07, and 10. The measure is applicable in all SDG&E climate zones and for all building vintages. The intent of the incentive is to repair a non-functional economizer.

## 1.2 DEER Differences Analysis

The DEER2011[2] data for the DEER measure D03-058, Economizer – Packaged System, include: demand, electric, and gas energy savings of installing an Economizer on a package system. DEER measure D03-060, Economizer Maintenance include: demand, electric, and gas energy savings of repairing an Economizer to a more functional state. Neither DEER measure contain the appropriate information for energy savings for these measures as dictated by the ED Disposition for PG&E and SCE workpapers related to economizer maintenance. .

The DEER2011 the DEER measure D03-060, Economizer Maintenance includes the EUL for this Economizer Repair measure.

Table 2 DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | No |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | Yes |
| Deviation from DEER | Energy Savings, Measure Costs |
| DEER Version | DEER 2011, D11 v2.05 |
| DEER Run ID and Measure Name (Sample) | 2005-D03-060 |

## 1.3 Code Analysis

Table 3 Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| N/A | N/A | N/A |
| N/A | N/A | N/A |

**Title 20:** This measure does not fall under Title 20 of the California Energy Regulations

**Title 24:** This measure does not fall under Title 24 of the California Energy Regulations…

**Federal Standards:** This measure does not fall under Federal DOE or EPA Energy Regulations.

## 1.4 Measure Effective Useful Life

The Effective Useful Life (EUL) of an economizer repair measure, EUL ID: HVAC-RepEcono. This was taken from a DEER publication “DEER2014-EUL-table-update\_2014-02-15” [3]. DEER2014 documentation provides EUL and RUL information to be used for the 13-14 program cycle on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “Summary of EUL-RUL Analysis for the April 2008 Update to DEER” provides the RUL value as a flat 1/3 of the EUL value. Table 4 below identifies the value/methodology used for the measures in this work paper.

Table 4 DEER08 EUL Value/Methodology

|  |  |  |
| --- | --- | --- |
| Market | Enduse | DEER EUL ID |
| Non Residential | SpaceCool | HVAC-RepEcono |

## 1.5 Net-to-Gross Ratios for Different Program Strategies

The net-to-gross ratios (NTGR) were obtained from the “DEER2011\_NTGR\_2012-05-16.xls” [4] on the DEER website. The relevant NTGR for these measures are shown in Table 5 below.

Table 5 Net-to-Gross Ratio

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID |
| Com-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | All |

\*Denotes that the column is taken from the DEER NTG Table.

The installation rate (IR) is identified in the calculation attachment. This value is obtained from a spreadsheet created by the DEER team titled ““GrossSavingsAdjustments.xlsx” [5], and includes GSIA ID DEF-GSIA.

## Spillage rate will also be applied to measures however the values will not be tracked in the workpapers. The spillage rate will be tracked in an external table to be supplied to the Energy Division.

## 1.6 Time-of-Use Adjustment Factor

As directed by the CPUC in decision 06-06-063 dated June 29, 2006, time-of-use (TOU) adjustment factors are to be applied for residential A/C and commercial A/C (packaged and split-system direct-expansion cooling) measures only. Additionally, if a measure is assigned a DEER08 load shape, i.e. the load shape starts with “DEER:” the TOU assigned to that measure should also be zero.

Table 6 TOU Summary Table

|  |  |
| --- | --- |
| Measure | % |
| Economizer Repair | 0 |

# Section 2. Energy Savings & Demand Reduction Calculations

Table 7 shows the appropriate calculation method for retrofit measures. For the measures in this paper, there is no code baseline, so the savings are the same for both periods.

Table 7 Calculation Methods

|  |  |  |  |
| --- | --- | --- | --- |
| Install / Program Type | Measure Life Basis | First Baseline Period -- Energy Savings Baseline | Second Baseline Period -- Energy Savings Baseline |
| ROB | EUL | Customer Average Baseline | Code Baseline |

## 2.1 Electric Energy Savings Estimation Methodologies

This measure is a Replace on Burnout measure. As a ROB Measure, there is one mandated baseline as defined earlier in this work paper. The savings from these are represented in the calculations below. For a complete table of savings and savings calculations, see the “WPSDGENRHC0027 Summary.xlsx” attachment.

**Annual Electric Savings:**

**For Replace on Burnout Measures:**

**EUL Energy Savings [kWh/Unit] = Existing KWh/Unit – Measure Case kWh/Unit**

Since there are no code requirements for this maintenance measure, the savings are the same for the EUL periods.

## 2.1.1 eQUEST Simulation for Energy Savings

The energy savings for this measure result from repairing the mechanical functionality of an existing economizer. The base case usage for all included building types was determined by degrading the performance of a reference model which is a modified DEER prototype. There were a total of 348 reference models created that represented the measure end state of 70% maximum outside air and 73 °F dry bulb temperature high limit.

As directed by the referenced Disposition, 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. The minimum outside air ventilation setting for “Other” building types per Title 24, Part 6 is 0.15 cfm/ft2. The DEER building prototypes assume a design air flow rate of 0.4 cfm/ft2. Therefore, the baseline assumption for a failed economizer was modeled as the weighted average between the 60% occurrence (37.5%) and the 40% occurrence (5%).

This resulted in a weighted average failed position of 24.5% maximum outside. The dry bulb high limit was modeled as 73 °F in both the base case and measure case such that all savings are related the mechanical repairs of the economizer only. Savings were calculated for 12 building types, 3 system types, and climate zones 06, 07, and 10 as shown in Table 8 below. Building type Rt3 was not included for analysis.

Table 8 Calculation Methods

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **System Type** | | |
| **Building Type** | **Building Code** | **Gas Packs** | **Heat Pump** | **Packaged VAV** |
| Assembly | Asm | **√** | **√** |  |
| Education – Primary School | EPr | **√** | **√** |  |
| Education – Secondary School | ESe | **√** | **√** | **√** |
| Education – Community College | ECC | **√** | **√** | **√** |
| Health/Medical – Nursing Home | Nrs | **√** | **√** | **√** |
| Manufacturing – Light Industrial | MLI | **√** | **√** |  |
| Office – Large | OfL | **√** | **√** | **√** |
| Office – Small | OfS | **√** | **√** | **√** |
| Restaurant - Sit-Down | RSD | **√** | **√** |  |
| Restaurant - Fast-Food | RFF | **√** | **√** |  |
| Retail - Single-Story Large | RtL | **√** | **√** |  |
| Retail – Small | RtS | **√** | **√** |  |

Weather

Weather files were updated from the CZ2 weather files developed based on TMY2 data to the CZ2010 weather files based on TMY3 and other more recent data. The CZ2010 weather files were developed for the CPUC by Joe Huang of Whitebox Technologies [6].

Modifications to DEER Prototype Reference Models

The default DEER prototypes used as the reference models for the measure case buildings were based on the “2005DEERNonresidentialPrototypeCharacteristics-051206modified.xls” [7] spreadsheet, and were modified in the following ways:

Gas Packs and Packaged Heat Pumps with Economizers:

• Weather file updated from CZ2 to CZ2010

• SYSTEM:DRYBULB-LIMIT set to 73°F

• SYSTEM:MAX-OA-FRACTION set to 0.70 instead of 1

• Unit Efficiency for vintages v75 and v85 were set equal to v96 as it was assumed that the older vintage units would have been replaced with a v96 efficiency unit

Packaged VAV Units with Economizers

• Weather file updated from CZ2 to CZ2010

• SYSTEM:DRYBULB-LIMIT set to 73°F

• SYSTEM:MAX-OA-FRACTION set to 0.70 instead of 1

• Unit Efficiency for vintages v75 and v85 were set equal to v96 as it was assumed that the older vintage units would have been replaced with a v96 efficiency unit

The maximum outdoor air fraction that the economizer can achieve was reduced from 1 to 0.7 to be consistent with PG&E’s approach, which relied on field data suggesting that within the current stock of buildings 70% outside air is the average maximum outdoor air fraction that is achieved[1].

Base Case Definition

The base case representing a customer average existing rooftop unit was simulated as a parametric run by changing the Max OSA = 24.5%.

Measure Case Definition

The measure case representing a customer average existing rooftop unit was of Max OSA = 70%. The dry bulb high temperature limit was set to 73 °F in both the base case and measure case.

## 2.2. Demand Reduction Estimation Methodologies

This measure is a Replace on Burnout measure. As a ROB Measure, there is one mandated baseline as defined earlier in this work paper. The savings from these are represented in the calculations below.

**Demand Reduction:**

**For Replace on Burnout Measures:**

**EUL Demand Reduction [kW/Unit] = Existing Peak KW/Unit – Measure Case Peak kW/Unit**

Since there are no code requirements for this maintenance measure, the savings are the same for the EUL periods.

The demand savings were calculated using the same eQUEST simulations detailed in Section 2.1.

## 2.3. Gas Energy Savings Estimation Methodologies

This measure is a Replace on Burnout measure. As a ROB Measure, there is one mandated baseline as defined earlier in this work paper. The savings from these are represented in the calculations below.

**Annual Gas Savings:**

**For Replace on Burnout Measures:**

**EUL Energy Savings [therms/unit] = Annual Existing Base Gas Usage – Annual Measure Case Gas Usage**

Since there are no code requirements for this maintenance measure, the savings are the same for the EUL periods.

The gas savings were calculated using the same eQUEST simulations detailed in Section 2.1.

# Section 3. Load Shapes

The difference between the base case load shape and the measure load shape would be the most appropriate load shape; however, only end-use profiles are available. Therefore, the closest load shape chosen for this measure is the DEER:HVAC\_Split-Package\_AC load shape. See Table 9 for a list of all Building Types and Load Shapes. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

Table 9 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| Building Type | E3 Alt. Building Type | Load Shape |
| Asm | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| EPr | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| ESe | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| ECC | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| Nrs | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| MLI | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| OfL | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| OfS | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| RSD | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| RFF | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| RtL | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |
| RtS | NON\_RES | *DEER: HVAC\_Split-Package\_AC* |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Cost

There are no base case costs since the base case is the customer’s existing equipment.

## 4.2 Gross Measure Cost

The gross measure cost was determined from the Premium Efficiency Cooling Program in SCE territory. The provided cost information listed five economizer repair treatments that could be applied. For purposes of estimating gross measure cost, it was assumed that each treatment had equal weighting, and therefore the average cost of the five treatments is provided as the gross measure cost. This cost includes labor and is detailed on the Summary Spreadsheet. The results of which are summarized in Table 10 below, with full results included on the attached “WPSDGENRHC0027 Summary.xlsx.”

Table 10 Measure Equipment Cost

|  |  |
| --- | --- |
| Measure Name | Measure  Equipment Cost |
| Economizer Repair | $230.00 |

## 4.3 Incremental Measure Cost

The incremental measure costs are equal to gross measure costs since the base equipment and labor costs are $0.

# Attachments



# References

[1] *PGE3PHVC152 R0 AirCare Plus Econ Cont.doc, available from deeresources.com*

[2] *DEER2011, from deeresources.com*

[3] *EUL\_Summary\_10-1-08.xls, available from deeresources.com*

[4] *DEER2011\_NTGR\_2012-05-16.xls available from deeresources.com*

[5] *GrossSavingsAdjustments.xlsx available from deeresources.com*

[6] *Whitebox Technologies, Moraga,CA .http://www.whiteboxtechnologies.com/weather\_data.html*

[7] *DEER2005 Update Study Final Report, available from deeresources.com*