Short Form Work Paper WPSDGENRHC0029

**Revision 0**

**San Diego Gas & Electric**

**Energy Efficiency Engineering**

**Enhanced Ventilation for Packaged HVAC Units with Gas Heating and Packaged Heat Pumps**

**April 26, 2019**

# SDG&E Enhanced Ventilation for Package HVAC units with Gas Heating and Package Heat Pumps

## Introduction

This short form workpaper documents the ex-ante load impact and cost-effectiveness values used for Enhanced Ventilation for package units, with and without, gas heating and package heat pumps. All of the given measures have been adopted and cited from the lead IOU workpapers “PGECOHVC143 Rev 3 Enhanced Ventilation and VFD.doc”, with no exceptions.

## Difference between lead IOU Workpapers and Ex Ante data

The differences are listed herein below:

* SDG&E created new measure cost identifications that are included herein in section 4.1 Measure Cost.
* SDG&E included unique Implementation identifications in section 1.2 Technical Descriptions -Measures.

**Document Revision History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 04/26/2019 | Keith Valenzuela (AESC)  Eduardo Reynoso (SDG&E) | * New adoption of lead IOU workpapers “PGECOHVC143 Rev03 Enhanced Ventilation and VFD.doc” |

## Measure Summary

Table 1: Measure Summary Table

| **Section** | **Value** |
| --- | --- |
| **Summary & Purpose** | This short form workpaper documents ex-ante load impacts and cost-effectiveness values for Enhanced Ventilation of HVAC Package Units (with and without) Gas and Heat Pump units. The energy savings and load impacts are based on the lead IOU workpaper“PGECOHVC143 Rev 3 Enhanced Ventilation and VFD.doc”. SDG&E takes no exceptions to PGE Enhanced Ventilation with VSD workpaper measures. |
| **1.1 Measure & Baseline Data** | As cited per lead IOU workpapers by “PGECOHVC143 Rev 3” and summarized below:  Measure: Enhanced Ventilation installed on existing Packaged HVAC Units with Gas Heating (Gas Packs), AC only units, and Packaged Heat Pumps consists of 24 measures that reduce the energy associated with providing outdoor air ventilation to a building and its occupants.  Baseline: The base case for each measure is either a single zone constant volume packaged HVAC unit with direct expansion cooling with or without a natural gas furnace or a single zone packaged heat pump. The base case also has an outdoor air economizer to provide cooling when conditions permit. |
| **1.2 Technical Description** | No exception taken from lead IOU workpapers by “PGECOHVC143 Rev 3”.  Abbreviations:  ADEC – Advanced Digital Economizer Controller  AC – Unitary Air Conditioner  HP – Unitary Heat Pump  PMM – Permanent Magnet Motor  RTU – Roof Top Unit  VFD – Variable Frequency Drive |
| Measures | |  |  |  |  |  | | --- | --- | --- | --- | --- | | Measure Code | | | Measure Name | SDGE Measure ID  (WPSDGENRHC0029-Rev00 -MsrXX) | | PGE | SCE | SDG&E | | HV054 | AC-72014 | 463783  467086 | Add VFD with AC unit with Gas Heat and ADEC | Msr01 | | HV055 | AC-97565 | 463784  467087 | Add VFD and NEMA motor with AC unit with Gas Heat and ADEC | Msr02 | | HV056 | AC-63277 | 463785  467088 | Add VFD and PMM with AC unit with Gas Heat and ADEC | Mrs03 | | HV057 | AC-14815 | 463786  467089 | Add VFD with AC unit only and ADEC | Msr04 | | HV058 | AC-30287 | 463787  467090 | Add VFD and NEMA motor with AC unit only and ADEC | Msr05 | | HV059 | AC-67253 | 463788  467091 | Add VFD and PMM with AC unit only and ADEC | Msr06 | | HV060 | AC-18726 | 463789  467092 | Add VFD with Heat Pump and ADEC | Msr07 | | HV061 | AC-36894 | 463790  467093 | Add VFD and NEMA motor with Heat Pump and ADEC | Msr08 | | HV062 | AC-32399 | 463791  467094 | Add VFD and PMM with Heat Pump and ADEC | Msr09 | | HV063 | AC-42889 | 463792  467095 | Add VFD and ADEC to AC unit with Gas Heat | Msr10 | | HV064 | AC-88048 | 463793  467096 | Add VFD, NEMA motor, and ADEC to AC unit with Gas Heat | Msr11 | | HV065 | AC-52735 | 463794  467097 | Add VFD, PMM, and ADEC to AC unit with Gas Heat | Msr12 | | HV066 | AC-32686 | 463795  467098 | Add VFD and ADEC to AC unit only | Msr13 | | HV067 | AC-70123 | 463796  467099 | Add VFD, NEMA motor, and ADEC with AC unit only | Msr14 | | HV068 | AC-62985 | 463797  467100 | Add VFD, PMM, and ADEC with AC unit only | Msr15 | | HV069 | AC-71385 | 463798  467101 | Add VFD and ADEC to Heat Pump | Msr16 | | HV070 | AC-28655 | 463799  467102 | Add VFD, NEMA motor, and ADEC to Heat Pump | Msr17 | | HV071 | AC-12899 | 463800  467103 | Add VFD, PMM, and ADEC to Heat Pump | Msr18 | |  |  | 467104  467105 | HVAC ENHANCED VENT GAS HEAT, including adding ADEC, CO2 sensor, VFD to units with Gas Heat | Msr19 | |  |  | 467106  467107 | HVAC ENHANCED VENT NEMA GAS HEAT, including adding ADEC, CO2 sensor, VFD, NEMA motor to units with Gas Heat | Msr20 | |  |  | 467108  467109 | HVAC ENHANCED VENT PMM GAS HEAT, including adding ADEC, CO2 sensor, VFD, PMM motor to units with Gas Heat | Msr21 | |  |  | 467110  467111 | HVAC ENHANCED VENT HEAT PUMP, including adding ADEC, CO2 sensor, VFD to Heat Pump | Msr22 | |  |  | 467112  467113 | HVAC ENHANCED VENT NEMA HEAT PUMP, including Adding ADEC, CO2 sensor, VFD, NEMA motor to Heat Pump | Msr23 | |  |  | 467114  467115 | HVAC ENHANCED VENT PMM HEAT PUMP, including Adding ADEC, CO2 sensor, VFD, PMM motor to Heat Pump | Msr24 | |
| Code for All Measures | As cited per “PGECOHVC143 Rev 3” lead IOU workpapers with no exceptions and summarized below:  This measure is a retrofit to an existing system and is not governed by either state or federal codes and standards as long as the project does not include other code-triggering activities such as replacement of HVAC systems. However, Title 24 2016 provides economizer control and general ventilation requirements that are considered to be best practice and are provided here for reference.  **Code Summary**   |  |  |  | | --- | --- | --- | | **Code** | **Reference** | **Effective Dates** | | Title 24 2016 | Table 140.4-B: High limit shut-off control requirements by device type and climate zone |  | | Title 24 2016 | §120.1: Minimum ventilation requirements |  | |
| Requirements | As cited per lead IOU workpaper by “PGECOHVC143 Rev 3” Enhanced Ventilation with new VFD workpapers with no exceptions and summarized below:     * Existing system must be packaged single zone DX cooling unit with gas heat, cooling only unit, or heat pump. * Existing system must have a constant volume supply fan. * Existing system must have an operable airside economizer installed, and economizer high limit must be optimized for the climate per Title 24 2016 Table 140.4-B, adapted below in Table 2 for reference. * Maintenance, and repairs to economizer should be completed prior to or in conjunction with this measure. * The measures described in this workpaper are only applicable for the building types shown listed in Ex Ante data. |
| **1.3 Installation Type and Delivery Mechanisms** |  |
| Installation Type | * Add-On Equipment (AOE)   Full EUL granted to this AOE measure since the motor may be replaced but the VSD controller and electrical termination remain. |
| Delivery Mechanisms | * Downstream Rebate – Deemed Rebate |
| **1.4.1 DEER Data** |  |
| Net-to-Gross Ratio | NTG = 0.7 (DEER NTGR ID: All-Default<=2yrs) |
| GSIA | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | As cited per lead IOU workpapers “PGECOHVC143 Rev 3” with no exception. | | | | | | | GSIA | Description | Sector | BldgType | ProgDelivID | GSIAValue | | Def-GSIA | Default GSIA | Any | Any | Any | 1 | |
| Effective and Remaining Useful Life | |  |  |  |  |  | | --- | --- | --- | --- | --- | | EUL ID | Description | Sector | UseCategory | EUL / RUL | | HVAC-airHP | Heat Pumps (split and unitary) | Com | HVAC | 15 / 5 | | HVAC-airAC | Air Conditioners (air-cooled, split and unitary), | |
| **Section 2. Calculation Methodology** |  |
| Energy Savings/Peak Demand Reduction – All Measures | All Energy Impacts as cited per lead IOU workpapers “PGECOHVC143 Rev 3”. All energy savings impacts are available in the Ex Ante data file submittal.  Sample Annual Energy Savings Impact Values for: BldType= Asm; BldgVint =Ex; BldgLoc= CZ 10; BldgHVAC =Any.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Solution Code | | | Annual Energy Savings (KWh/HP/Yr) | DEER Peak Demand (KW/HP) | Annual NG Savings (therm) | | PGE | SCE | SDGE | | HV057 | AC-14815 | 463783 | 567 | 0.132 | 0.00 | |
| **Section 3. Load Shapes** | DEER:HVAC\_Split-Package\_AC,  DEER:HVAC\_Split-Package\_HP |
| **Section 4. Costs** |  |
| **Section 4.1 Modeled Costs** | All cost adopted and cited from lead IOU workpapers “PGECOHVC143 Rev 3. |
| Base Cost – Measure1 | $0.00  For this measure category, the base case cost is assumed to be zero given that the alternative is to make no changes to their existing system. |
| Measure Cost – Measure 1 | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Units: Cap Tons | | | | | | | Product Code | | | Labor Cost ($/ton) | Material Cost ($/ton) | Measure Cost ($/ton) | | PGE | SCE | SDG&E | | HV054  HV057  HV060 | AC-72014  AC-14815 AC-18726 | 463783, 463786  463789, 467086,  467089, 467092 | $32.21 | $77.15 | $109.36 | | HV055  HV058  HV061 | AC-97565  AC-30287  AC-36894 | 463784, 463787  463790, 467087,  467090, 467093 | $56.37 | $116.19 | $172.56 | | HV056  HV059  HV062 | AC-63277  AC-67253  AC-32399 | 463785, 463788  463791, 467088  467091, 467094 | $56.37 | $125.75 | $182.12 | | HV063  HV066  HV069 | AC-42889  AC-32686  AC-71385 | 463792, 463795  463798, 467095,  467098, 467101 | $65.64 | $124.01 | $189.65 | | HV064  HV067  HV070 | AC-88048 AC-70123  AC-28655 | 463793, 463796  463799, 467096  467099, 467102 | $89.80 | $163.05 | $252.85 | | HV065  HV068  HV071 | AC-52735 AC-62985 AC-12899 | 463794, 463797  463800, 467097,  467100, 467103 | $89.80 | $172.61 | $262.41 | | SA07, SA10 |  | 467104, 467105,  467110, 467111 | $97.85 | $156.49 | $254.34 | | SA08, SA11 |  | 467106, 467107,  467112, 467113 | $122.01 | $195.53 | $317.54 | | SA09, SA12 |  | 467108, 467109,  467114, 467115 | $122.01 | $205.09 | $327.10 |  |  |  |  | | --- | --- | --- | | Measure ID | Measure Cost ID | IMC | | WPSDGENRHC0029-Rev00-Msr001 | SDG-VFD\_dxAC\_gasheat\_ADEC | $109.36 | | WPSDGENRHC0029-Rev00-Msr002 | SDG-VFD\_NEMAmotor\_dxAC\_gasheat\_ADEC | $172.56 | | WPSDGENRHC0029-Rev00-Msr003 | SDG-VFD\_PMM\_dxAC\_gasheat\_ADEC | $182.12 | | WPSDGENRHC0029-Rev00-Msr004 | SDG-VFD\_dxAC\_ADEC | $109.36 | | WPSDGENRHC0029-Rev00-Msr005 | SDG-VFD\_dxAC\_NEMAmotor\_ADEC | $172.56 | | WPSDGENRHC0029-Rev00-Msr006 | SDG-VFD\_dxAC\_PMM\_ADEC | $182.12 | | WPSDGENRHC0029-Rev00-Msr007 | SDG-VFD\_HP\_ADEC | $109.36 | | WPSDGENRHC0029-Rev00-Msr008 | SDG-VFD\_HP\_NEMAmotor\_ADEC | $172.56 | | WPSDGENRHC0029-Rev00-Msr009 | SDG-VFD\_HP\_PMM\_ADEC | $182.b12 | | WPSDGENRHC0029-Rev00-Msr010 | SDG-ADEC\_VFD\_dxAC\_gasheat | $189.65 | | WPSDGENRHC0029-Rev00-Msr011 | SDG-ADEC\_VFD\_dxAC\_NEMAmotor\_gasheat | $252.85 | | WPSDGENRHC0029-Rev00-Msr012 | SDG-ADEC\_VFD\_dxAC\_PMM\_gasheat | $262.41 | | WPSDGENRHC0029-Rev00-Msr013 | SDG-ADEC\_VFD\_dxAC | $189.65 | | WPSDGENRHC0029-Rev00-Msr014 | SDG-ADEC\_VFD\_dxAC\_NEMAmotor | $252.85 | | WPSDGENRHC0029-Rev00-Msr015 | SDG-ADEC\_VFD\_dxAC\_PMM | $262.41 | | WPSDGENRHC0029-Rev00-Msr016 | SDG-ADEC\_VFD\_HP | $189.65 | | WPSDGENRHC0029-Rev00-Msr017 | SDG-ADEC\_VFD\_HP\_NEMAmotor | $252.85 | | WPSDGENRHC0029-Rev00-Msr018 | SDG-ADEC\_VFD\_HP\_PMM | $262.41 | | WPSDGENRHC0029-Rev00-Msr019 | SDG-HVAC\_Enhanced\_Vent\_Gas\_Heat | $254.34 | | WPSDGENRHC0029-Rev00-Msr020 | SDG-HVAC\_Enhanced\_Vent\_NEMA\_Gas\_Heat | $317.54 | | WPSDGENRHC0029-Rev00-Msr021 | SDG-HVAC\_Enhanced\_Vent\_PMM\_Gas\_Heat | $327.10 | | WPSDGENRHC0029-Rev00-Msr022 | SDG-HVAC\_Enhanced\_Vent\_Heat\_Pump | $254.34 | | WPSDGENRHC0029-Rev00-Msr023 | SDG-HVAC\_Enhanced\_Vent\_NEMA\_Heat\_Pump | $317.54 | | WPSDGENRHC0029-Rev00-Msr024 | SDG-HVAC\_Enhanced\_Vent\_PMM\_Heat\_Pump | $327.10 | |