# HVAC Subcommittee Meeting #4


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# Agenda



- Discuss Measure Summary Template
  - Question: What changes should we make before you see your first example? (*Requested feedback by Friday, 6/8/18*)
- Q2 HVAC Measure review

Blue text = Changing and first time that item is mentioned
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# Parallel Path Approach – eTRM / HVAC



**Q2'18** **Q3'18** **Q4'18** **Q1'19** **Q2'19**

## Path 1: HVAC Measure Consolidation

- Create structure
- Consolidate 50+ HVAC Measures
- Affirmation of 50+ HVAC Measure for eTRM

## Path 2: HVAC Measure Analysis and Evolution

- Stakeholder Feedback on Measure Summary Template
- Complete 50+ Measures Summaries
- HVAC Modelling Charette
- Feedback on existing Measures
- Sensitivity analyses
- Prototype comparison
- Develop & validate/ compare modelling approach

Questions at end...

# Questions that Subcommittee Members Will Be Asked…



- Do Cal TF Subcommittee Members agree with savings?
- Are the base case models reasonable at predicting actual load
  - Should schedules be different
  - Are internal loads what they think they would be for this building prototype
  - Are the measures being modeled correctly? (Different EER value or change run time variables)
  - Input on most sensitive parameters for measure (e.g. infiltration, hours of operation, LPD, etc.)
  - How are we documenting base and measure case for these measures (for example, why is base case efficiency whatever it is? Is saying it is Title 24 enough)?
  - Are there additional degradation factors built in to the model?
- What other questions should we be asking or planning for?

*Disclaimer – CA Building Prototype models are likely to change through the DEER2020 Update*

# Review “Measure Summary Template”

# HVAC Measure List – for Q2 Consolidation



- *Draft* HVAC Measure List for Q2
  - 5.05 Water-Cooled Chillers
  - 5.39 Air-Cooled Packaged Chiller
  - 5.09 Res DuctTestSeal
  - 5.17 Whole House Fan
  - 5.18 High Efficiency Furnaces - Residential
  - 5.22 Variable Refrigerant Flow - Commercial
    - Heat Pump & Heat Recovery Systems >65kBtu/h
  - 5.24 Unitary Air-Cooled - Commercial
    - Air Conditioners and Heat Pump >=65 kBtu/h
  - 5.25 Unitary Air Cooled - Commercial
    - Air Conditioners and Heat Pump Units Under 65 kBtuh
  - 5.27 High Efficiency Package Terminal AC and Heat Pump
    - 24kBtu/h (2 tons) and under
  - 5.40 Upstream Residential HVAC

  - 5.51 Water Source Heat Pumps
  - 5.03 Space Heating Boilers

# Measure Consensus - 5.05 – Water Cooled Chillers



- Offering
  - SCE workpaper (SCE17HC043.0)
    - Variable speed centrifugal chiller
      - 5 capacity sizes:
        - <150 tons, (added)
        - ≥150 to <300 tons,
        - ~~≥300 to <600 tons~~, ≥300 to <400 tons, ≥400 to <600 tons, (split)
        - ≥600 tons
      - ~~2 efficiency tiers~~ Path A and Path B (10% improvement of kW/ton and IPLV)
    - ~~Constant speed centrifugal chiller~~
    - ~~Constant speed screw / scroll chillers~~
    - Variable speed screw chiller
      - 5 capacity sizes:
        - <75 tons,
        - ≥75 to <150 tons,
        - ≥150 to <300 tons,
        - ≥300 to <600 tons, (split)
        - ≥600 tons
      - Path A and Path B (10% improvement of kW/ton and IPLV)

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# Measure Consensus - 5.05 – Water Cooled Chillers



- Offering
  - Savings use a weighted average approach for building type and select Climate Zones are chosen for savings, which matches the lighting approach.

| Program Type | HVAC Vintage | Building Type | PA | Climate Zone |
|---|---|---|---|---|
| ROB | Ex | Com | SCE | CZ06, CZ08, CZ09, CZ10, CZ13, CZ14, CZ15, CZ16 |
| | | | PGE | CZ01, CZ02, CZ03, CZ04, CZ05, CZ11, CZ12 |
| | | | SDG | CZ07 |

  - Savings come directly from DEER.
  - Question: Recommend moving CZ13 to the PG&E value based upon weighted area (or does this weighting reflect a larger percentage of claims from SCE/CZ13?).

| Ref No | Name | PGE | SCE | SCG | SDGE |
|---|---|---|---|---|---|
| 5.05 | Water-Cooled Chillers | | 1,071,870 | | |

  - HVAC Types: cWtd
  - Delivery: Upstream / Midstream; ROB
  - Climate Zones: Includes all climate zones

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# Measure Consensus - 5.05 – Water Cooled Chillers



- Stage 1 Issues
  - Programs offer incentives in both Path A and Path B
    - Exceed Path A requirements for full-load and integrated part-load efficiency
    - Exceed Path B requirements for full-load and integrated part-load efficiency

*TABLE 110.2-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQU*

| Equipment Type | Size Category | Path A Efficiency [a,b] | Path B Efficiency [a,b] | | |
|---|---|---|---|---|---|
| Water Cooled, Electrically Operated Positive Displacement | < 75 Tons | ≤0.750kW/ton ≤ 0.600 IPLV | ≤ 0.780 kW/ton ≤ 0.500 IPLV | | |
| | ≥ 75 tons and < 150 tons | ≤ 0.720 kW/ton ≤ 0.560 IPLV | ≤ 0.750 kW/ton ≤ 0.490 IPLV | ≤ 0.610 kW/ton ≤ 0.550IPLV | ≤ 0.695 kW/ton ≤ 0.440 IPLV |
| | ≥ 150 tons and < 300 tons | ≤ 0.660 kW/ton ≤ 0.540 IPLV | ≤ 0.680 kW/ton ≤ 0.440 IPLV | ≤ 0.610 kW/ton ≤ 0.550 IPLV | ≤ 0.635 kW/ton ≤ 0.400 IPLV |
| | ≥ 300 Tons and < 600 tons | ≤ 0.610kW/ton ≤ 0.520 IPLV | ≤ 0.625 kW/ton ≤ 0.410 IPLV | ≤ 0.560 kW/ton ≤ 0.520 IPLV | ≤ 0.595 kW/ton ≤ 0.390 IPLV |
| | ≥ 600 tons | ≤ 0.560 kW/ton ≤ 0.500 IPLV | ≤ 0.585 kW/ton ≤ 0.380 IPLV | ≤ 0.560 kW/ton ≤ 0.500 IPLV | ≤ 0.585 kW/ton ≤ 0.380 IPLV |
| | | | ≥ 600 tons | ≤ 0.560 kW/ton ≤ 0.500 IPLV | ≤ 0.585 kW/ton ≤ 0.380 IPLV |

- Savings Methodology
  - Direct from DEER

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# Measure Consensus - 5.39 – Air Cooled Chiller



- Offering
  - Workpaper (PGECOAPP1200 R7, SCE17HC030.1)
  - Base = Code / Path A
    - Air-Cooled Constant Speed Screw Chillers, for use in non-residential buildings, meeting the 2016 California Title 24 minimum efficiency standards in both full load (EER) AND part load conditions (IPLV)
  - Measure
    - Tier 1 – 10% Improvement (EER and IPLV)
    - Tier 2 – 20% Improvement (EER and IPLV)
    - 2 capacity bins: <150 tons and >=150 tons
    - Question: Note that this measures excludes Title 24 “Path B” chillers ; limit technology meets the Tier 2 standard currently.
  - Delivery: Upstream and Midstream; ROB
  - Climate Zones: 1-16



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# Measure Consensus - 5.39 – Air Cooled Chiller



- Offering
  - Question: Any insights from Impact Evaluation 2015 (Upstream HVAC program)
  - Savings use a weighted average approach for building type and select Climate Zones are chosen for savings, which matches the lighting approach.

| Program Type | HVAC Vintage | Building Type | PA | Climate Zone |
|---|---|---|---|---|
| ROB | Ex | Com | SCE | CZ06, CZ08, CZ09, CZ10, CZ13, CZ14, CZ15, CZ16 |
| | | | PGE | CZ01, CZ02, CZ03, CZ04, CZ05, CZ11, CZ12 |
| | | | SDG | CZ07 |

  - Savings come directly from DEER.
  - Question: Recommend moving CZ13 to the PG&E value based upon weighted area.
    - FYI – no claims in 2017 (Q1-Q3) in CZ13 for either PG&E or SCE
    - Claim in other climate zones (PG&E - ~100,000 kWh; SCE - ~1,500,000 kWh)

| Ref No | Name | PGE | SCE | SCG | SDGE |
|---|---|---|---|---|---|
| **5.39** | Air-Cooled Packaged Chiller | 100,295 | 1,516,405 | | |



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# Measure Consensus - 5.09 – Duct Test & Seal, Residential



- Offering
  - Workpaper (PGE3PHVC159, R4)
  - High Duct Leakage:
    - Base case description for High Duct Leakage:
      - 40% (20% Supply/20% Return) Leakage (single- and multi-family)
      - 35% Supply Leakage (mobile home)
    - Measure case description for High Duct Leakage Reduction:
      - Residential: Duct Sealing (Total Leakage Reduced from High (35/40%) to Low (15/12%)
      - (35% to 15% for mobile home and 40% to 12% for single- and multi- family)
  - Medium Duct Leakage:
    - Base case description for Medium Duct Leakage:
      - 24% (12% Supply/12% Return) Leakage (single- and multi-family)
      - 25% Supply Leakage (mobile home)
    - Measure case description for Medium Duct Leakage Reduction:
      - Residential: Duct Sealing (Total Leakage Reduced from High (25/24%) to Low (15/12%)
      - (25% to 15% for mobile home and 24% to 12% for single- and multi- family)
  - Building Types
    - Res: MFm, DMo, SFm
  - HVAC Types
    - rDXGF
  - Delivery: Upstream; RC (Retro-commissioning)
  - Climate Zones: 1-5, 11-13, 16 (PG&E)

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# Measure Consensus - 5.09 – Duct Test & Seal, Residential



- Stage 1 Issues
  - Offering:
    - Climate zones seem to be limited to PG&E territory
- Savings Methodology
  - DEER values

| Measure Name | Impact ID |
|---|---|
| Residential: Duct Sealing (Total Leakage Reduced from (40/35%) to (12/15%)) | Res-DuctSeal-HighToLow-wtd |
| Residential: Duct Sealing (Total Leakage Reduced from (25/24%) to (15/12%)) | Res-DuctSeal-MedToLow-wtd |

  - Normalized units
    - Question: Translated from “Cap-Tons” to “per Household”
      - Should we revert back to using “Cap-Tons”?
    - “Capacity values per Household” comes from EnergyImpacts_RB-HV-MHDuctSeal-25pct-15pct; EnergyImpacts_RB-HV-MFDuctSeal-40pct-12pct
      - Varies by BT and CZ (except DMo)

| Ref No | Name | PGE | SCE | SCG | SDGE |
|---|---|---|---|---|---|
| **5.09** | Res DuctTestSeal | 56,299 | | 84,744 | 87,493 |



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# Measure Consensus - 5.17 – Whole House Fan (WHF), Residential



- Offering (no claims in 2017, Q1-Q3)
  - Workpaper (SCE13HC005.2, PGECOHVC134 R2) – SCE update in 2018
  - Base case
    - Includes an HVAC system; however, does not include air-economizing
  - Measure case
    - Requires that WHF be sized at least 2 cfm/sqft. of conditioned floor area
    - Have at least 1 sqft. of attic vent free area for each 375 cfm of rated WHF air flow
    - May include a control timer (e.g., 30 min. WHF operation) and/or a two speed controller (e.g., low fan speed and high fan speed).
  - Building Types
    - Res: MFm, DMo, SFm
  - HVAC Types
    - rDXGF
  - Delivery: DI and Downstream; REA (Retrofit Add-On)
  - Climate Zones: 6, 8, 9, 10, 13 – 16 (SCE)

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# Measure Consensus - 5.17 – Whole House Fan (WHF), Residential



- Stage 1 Issues
  - Offering:
    - Climate zones seem to be limited to SCE territory
    - Older version of PG&E workpaper can extend climate zones
- Savings Methodology

| Measure Name | Impact ID |
|---|---|
| Whole house fan | D03-441 |

  - Normalized units
    - Translated from “1000 sqft” (measure area) to “per Household”
    - Translation based upon prototype buildings (per BT and CZ). Example:

| Climate Zone | Bldg. Type | Bldg. Vintage | Bldg. HVAC | Square Feet/Home | Num. Unit |
|---|---|---|---|---|---|
| 6 | DMo | Ex | rWtd | 1,220 | 1.22 |
| 6 | MFm | Ex | rWtd | 1,000 | 1.00 |
| 6 | SFm | Ex | rWtd | 1,710 | 1.71 |

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# Measure Consensus - 5.18 – High Efficiency Furnaces



- Offering
  - Workpaper (PGECOHVC145 R3, PGECOHVC147 R3, WPSCGREHC130115A-Rev04)
  - Common Offerings
    - Res-GasFurnace-AFUE95 (AFUE ≥ 95% & < 96%)
    - Res-GasFurnace-AFUE97 (AFUE ≥ 97%)
  - PG&E Specific Offerings
    - Furnace with variable speed motor (VFD or ECM), only CZ11, 12, 13
  - SCG Specific Offerings
    - Res-GasFurnace-AFUE92 (AFUE ≥ 92% & < 95%)
    - Res-GasFurnace-AFUE96 (AFUE ≥ 96% & < 97%)
  - Building Types
    - Res: MFm, DMo, SFm
  - HVAC Types
    - rWtd
  - Delivery: DI and Downstream; ROB (PG&E) / ROBNC (SCG)
  - Climate Zones: 1-16, IOU

# Measure Consensus - 5.18 – High Efficiency Furnaces



- Stage 1 Issues
  - Offering:
    - Question: SCG uses additional tiers
    - Question: PG&E offers variable speed fan addition
- Savings Methodology

| Measure Name | Impact ID |
|---|---|
| High efficiency furnace | Res-Furnace-dHIR |

  - Normalized units
    - Translated from “cap-kBTUh” to “per Household”
  - Motor calculations
    - Based upon scaled values from a disposition from a high efficiency blower motor workpaper (PGECOHVC139)
    - Calculates kWh, kW, and negative gas impact

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# Measure Consensus - 5.18 – High Efficiency Furnaces



- Stage 1 Issues
  - Offering:
    - SCG uses additional tiers

| *(source 2017, Q1-Q3 IOU Claims Data)* | | Gross Therms | | | |
|---|---|---|---|---|---|
| **Ref No** | **Name** | **PGE** | **SCE** | **SCG** | **SDGE** |
| **5.18** | High Efficiency Furnaces - Residential | | | 11,196 | 542 |

| SCG | PG&E | Measure Description | Number of Units | Gross Therms |
|---|---|---|---|---|
| 540357 | | Central Gas Furnace 92% AFUE | 7 | 169 |
| 540358 | x | Central Gas Furnace 95% AFUE | 237 | 6,338 |
| 530641 | | Central Gas Furnace 96% AFUE | 85 | 2,805 |
| 530642 | x | Central Gas Furnace 97% AFUE | 54 | 1,885 |

  - Notes
    - Not a large savings measures
    - More savings could be claimed with additional offerings (like SCG), but equivalent of about 6% increase.

# Measure Consensus - 5.24 – Unitary Air-Cooled A/C ≥65 kBTU/hr



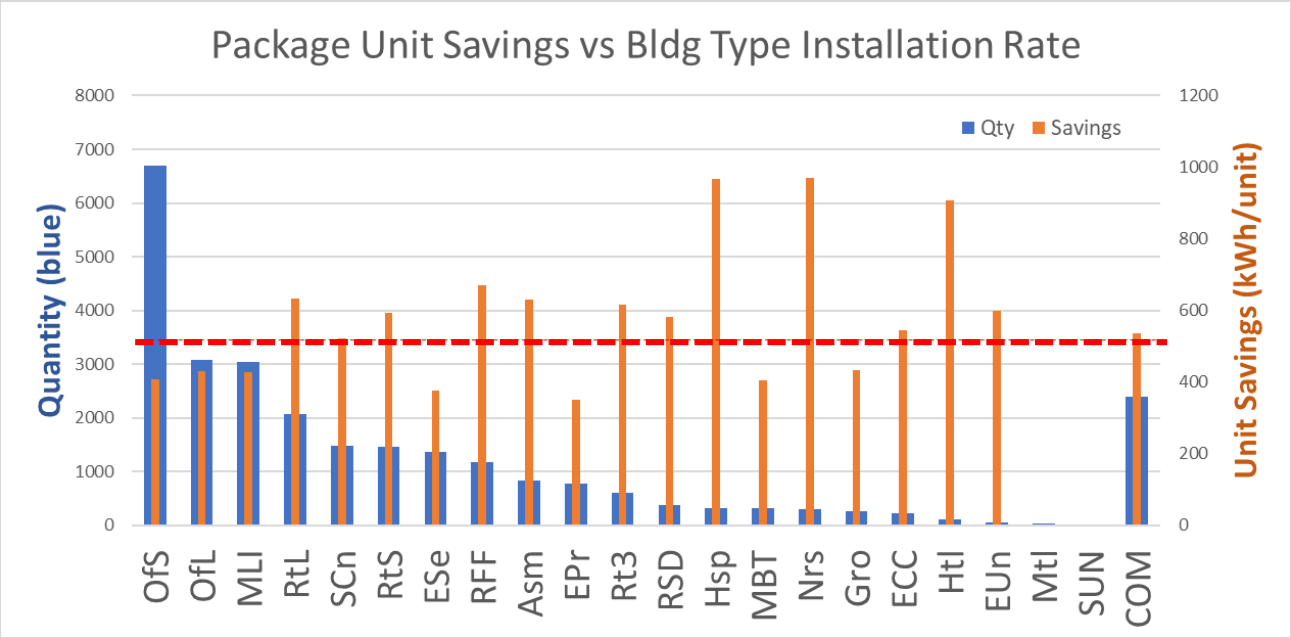
- Offering
  - Workpaper (PGECOHVC128 R9, SCE17HC035.0)
  - Base case = Code
    - Standard Efficient EER/IEER Rated Packaged/Split Air Conditioner, 65kBtu/h or larger
  - Measure case
    - High Efficient EER/IEER Rated Packaged/Split Air Conditioner, 65kBtu/h or larger
    - Split-package or Single-package units
    - Like for like; within 5% of existing capacity
  - Capacity Ranges / Efficiency Tiers
    - ≥5.4 to <11.3 tons; 4 tiers plus to-code offering
    - ≥11.3 to <20 tons; 3 tiers plus to-code offering
    - ≥20 to <63.3 tons; 3 tiers plus to-code offering
    - ≥63.3 tons; 3 tiers plus to-code offering
  - Building Types
    - Com (weighted average commercial building type)
  - HVAC Types
    - cDXGF
  - Delivery: Upstream / Midstream; ROB and NC (PG&E)
  - Climate Zones: 1-16, IOU

| *(source 2017, Q1-Q3 IOU Claims Data)* | | Gross kWh | | | |
|---|---|---|---|---|---|
| **Ref No** | **Name** | **PGE** | **SCE** | **SCG** | **SDGE** |
| **5.24** | Unitary Air-Cooled Commercial Air Conditioners and Heat Pumps >=65 kBtu/h | 1,736,774 | 322,188 | | 1,833 |

# Measure Consensus - 5.24 – Unitary Air-Cooled A/C ≥65 kBTU/hr



- Savings Methodology
  - DEER savings are used directly
    - Question: Simplified approach (only using one package unit savings / one CZ to get profile)
    - Why is the weighted average building type savings used? Claims data still reports BT, so difference can be calculated.
  - Weighted value – claims quantity (dotted red line) is very similar to COM value



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# Measure Consensus - 5.25 – Unitary Air-Cooled A/C <65 kBTU/hr



- Offering
  - Workpaper (PGECOHVC126 R7, SCE17HC012.0, WPSDGENRHC0023 R1)
  - Base case = Code
    - Air cooled air conditioning or heat pump units with cooling capacities less than 65 kBtuh, for use in non-residential buildings, meeting the federal minimum efficiency standard of 14 SEER.
  - Measure case
    - Air cooled air conditioning or heat pump units with cooling capacities less than 65 kBtuh, for use in non-residential buildings, meeting the minimum efficiency requirements
    - Packaged A/C, Split System A/C, Packaged HP, Split System HP
    - Like for like; within 5% of existing capacity
  - Capacity Ranges / Efficiency Tiers
    - Packaged Air Conditioner
      - <55 kBTUh; 4 tiers plus to-code offering
      - 55 to <65 kBTUh; 4 tiers plus to-code offering
    - Split System Air Conditioner
      - <45 kBTUh; 4 tiers plus to-code offering
      - 45 to <55 kBTUh; 4 tiers plus to-code offering
      - 55 to <65 kBTUh; 4 tiers plus to-code offering
    - Packaged Heat Pump
      - <55 kBTUh; 4 tiers plus to-code offering
      - 55 to <65 kBTUh; 4 tiers plus to-code offering
    - Split System Heat Pump
      - <55 kBTUh; 4 tiers plus to-code offering
      - 55 to <65 kBTUh; 4 tiers plus to-code offering
  - Building Types
    - Com (weighted average commercial building type)
  - HVAC Types
    - cDXGF
  - Delivery: Upstream / Midstream; ROB and NC (PG&E)
  - Climate Zones: 1-16, IOU

**Table 2: Minimum Efficiency Requirements**

| | Program Tier | Minimum SEER | Minimum EER |
|---|---|---|---|
| Packaged Air Conditioner | Code | 14.0 | 11.6 |
| | Tier 1 | 15.0 | 12.0 |
| | Tier 2 | 16.0 | 12.4 |
| | Tier 3 | 17.0 | 13.0 |
| | Tier 4 | 18.0 | 14.0 |
| Split System Air Conditioner | Code | 14.0 | 12.0 |
| | Tier 1 | 15.0 | 12.5 |
| | Tier 2 | 16.0 | 13.0 |
| | Tier 3 | 17.0 | 13.5 |
| | Tier 4 | 18.0 | 14.0 |
| Packaged Air Cooled Heat Pump | Code | 14.0 | 11.6 |
| | Tier 1 | 15.0 | 12.0 |
| | Tier 2 | 16.0 | 12.4 |
| | Tier 3 | 17.0 | 13.0 |
| | Tier 4 | 18.0 | 14.0 |
| Split System Air Cooled Heat Pump | Code | 14.0 | 12.0 |
| | Tier 1 | 15.0 | 12.5 |
| | Tier 2 | 16.0 | 13.0 |
| | Tier 3 | 17.0 | 13.5 |
| | Tier 4 | 18.0 | 14.0 |

| *(source 2017, Q1-Q3 IOU Claims Data)* | | Gross kWh | | | |
|---|---|---|---|---|---|
| **Ref No** | **Name** | **PGE** | **SCE** | **SCG** | **SDGE** |
| **5.25** | Unitary Air Cooled Commercial Air Conditioning and Heat Pump Units Under 65 kBtuh | 856,208 | 395,891 | | 54,665 |

# Measure Consensus - 5.25 – Unitary Air-Cooled A/C <65 kBTU/hr



- Savings Methodology
  - DEER savings are used directly
  - "To-Code" savings are calculated as follows:

**To Code Savings Portion Measures**

The To Code Savings Portion measures in this work paper are the savings from retrofitting customer existing equipment (various SEER values) to 14 SEER code-compliant equipment. The savings were determined by subtracting the "AStdWB" savings from the "APreWB" savings for 15 SEER ACs and HPs. The result was the difference between customer existing equipment and 14 SEER equipment. Measures savings (ROB, NEW) are attributed to the Upstream and Midstream HVAC programs.

Example: <55kBtuh To Code Savings Portion Packaged Air Conditioner, SCE, Assembly, CZ 06

DEER savings:

| EnergyImpactID | APreWBkWh | APreWBkW | APreWBtherm | AStdWBkWh | AStdWBkW | AStdWBtherm |
|---|---|---|---|---|---|---|
| NE-HVAC-airAC-Pkg-lt55kBtuh-15p0seer | 560 | 0.293 | -3.12 | 129 | 0.0454 | -1.2 |

kWh Savings = 560 - 129 = **431 kWh**

kW Reduction = 0.293 - 0.0454 = **0.2476 kW**

therm Savings = -3.12 - (-1.2) = **-1.92 therms**

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# Measure Consensus - 5.27 – High Efficiency PTAC and HP (<2 tons)



- Offering
  - Workpaper (PGECOHVC114 R5, SCE17HC007.0, WPSDGENRHC1052 R0)
  - Base = Code
    - Package terminal air conditioning units (PTAC) or package terminal heat pumps (PTHP) that are through the wall, self-contained and less than or equal to 2 tons (<=24kBtu/h)
  - Measure = 20% Higher than Code
    - Ductless mini-split A/C do not apply

| Installation Type | Unit Capacity | T24 Minimum EER (AC) | T24 Minimum EER (HP) | Measure Minimum EER (AC) | Measure Minimum EER (HP) |
|---|---|---|---|---|---|
| ROB | ≤ 7,000 Btu/hr | 9.41 | 9.31 | 11.29 | 11.17 |
| | > 7,000 and ≤ 15,000 Btu/hr | 8.56 | 8.46 | 10.27 | 10.15 |
| | >15,000 Btu/hr | 7.71 | 7.61 | 9.25 | 9.13 |
| NEW | ≤ 7,000 Btu/hr | 11.9 | 11.9 | 14.28 | 14.28 |
| | > 7,000 and ≤ 15,000 Btu/hr | 10.7 | 10.7 | 12.84 | 12.84 |
| | >15,000 Btu/hr | 9.5 | 9.5 | 11.4 | 11.4 |

- Building Types
  - SDG&E – no residential

| DEER Building Type used for Measure Savings | Work Paper Building Type |
|---|---|
| Lodging – Hotel | Agricultural |
| | Health/Medical - Nursing Home |
| | Health/Medical - Clinic |
| | Lodging - Hotel |
| | Lodging - Guest Rooms |
| | Manufacturing - Bio/Tech |
| | Manufacturing - Light Industrial |
| | Industrial |
| | Office - Large |
| | Office - Small |
| | Restaurant - Fast-Food |
| | Retail - Small |
| | Warehouse - Refrigerated |
| | Residential Multi-family (Dwelling) |
| Lodging - Motel | Lodging - Motel |
| | Residential Multi-family (Common) |
| | Residential Single Family |

- Delivery: Downstream; ROB, NC
  - Question: PG&E/SDG&E = ROB only
- Climate Zones: 1-16, IOU



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# Measure Consensus - 5.27 – High Efficiency PTAC and HP (<2 tons)



| Unit Capacity Ranges | % of Units Installed |
|---|---|
| PTAC/PTHP <7kBtuh | 5% |
| PTAC/PTHP 7-15kBtuh | 90% |
| PTAC/PTHP >15kBtuh | 5% |

- Offering
  - Norm Unit: Cap-Tons
  - HVAC Types
    - dxAC, dxHP
    - Question: Does this breakdown seem reasonable/accurate?
  - Energy Savings – from DEER
    - DEER provided data for the following unit capacity ranges for PTAC and PTHP units:
      - <7 kBtuh
      - 7-15 kBtuh
      - >15 kBtuh
    - Question: Which is the preferable approach?
      - PG&E: These ranges were combined, via a **weighted average**, into one <=24kBtuh range for PTAC units and one <=24kBtuh range for PTHP units per the following table.
      - SCE: Savings for this work paper are based on **7-15 kBtuh capacity range**, since nearly all of the previous participation falls under this range
      - SDG&E: Uses savings that align with each bin (2 types and 3 capacity ranges)

| *(source 2017, Q1-Q3 IOU Claims Data)* | | Gross kWh | | | |
|---|---|---|---|---|---|
| **Ref No** | **Name** | **PGE** | **SCE** | **SCG** | **SDGE** |
| **5.27** | High Efficiency Package Terminal Air Conditioners & Heat Pumps 24kBtu/h (2 tons) and under | | 232,306 | | |

# Measure Consensus - 5.40 – Upstream HVAC, Residential



- Offering
  - Workpaper (PGECOHVC166 R3, SCE13HC062.1)

| Tier 2 | | | | | |
|---|---|---|---|---|---|
| | Air Conditioners | | Heat Pumps | | Gas Furnaces |
| | Split System | Packaged | Split Air Source | Packaged | AFUE |
| Efficiency | 17 SEER, 13 EER | 15 SEER, 12 EER | 17 SEER, 13 EER, 9 HSPF | 15 SEER, 12 EER, 8 HSPF | 96% AFUE gas and propane furnaces, gas and propane boilers, oil furnaces and hot water boilers |

| Tier 3 | | | | | |
|---|---|---|---|---|---|
| | Air Conditioners | | Heat Pumps | | Gas Furnaces |
| | Split System | Packaged | Split Air Source | Packaged | AFUE |
| Efficiency | 18 SEER, 13 EER | 16 SEER, 12 EER | 18 SEER, 13 EER, 9 HSPF | 16 SEER, 12 EER, 9 HSPF | 97% AFUE gas and propane furnaces, gas and propane boilers, oil furnaces and hot water boilers |

  - Building Types: Residential
  - Delivery: Upstream; ROB
  - Climate Zones: 1-16, IOU



Blue text = Changing and first time that item is mentioned
*Italics* text = Item that has not been completed

# Questions…

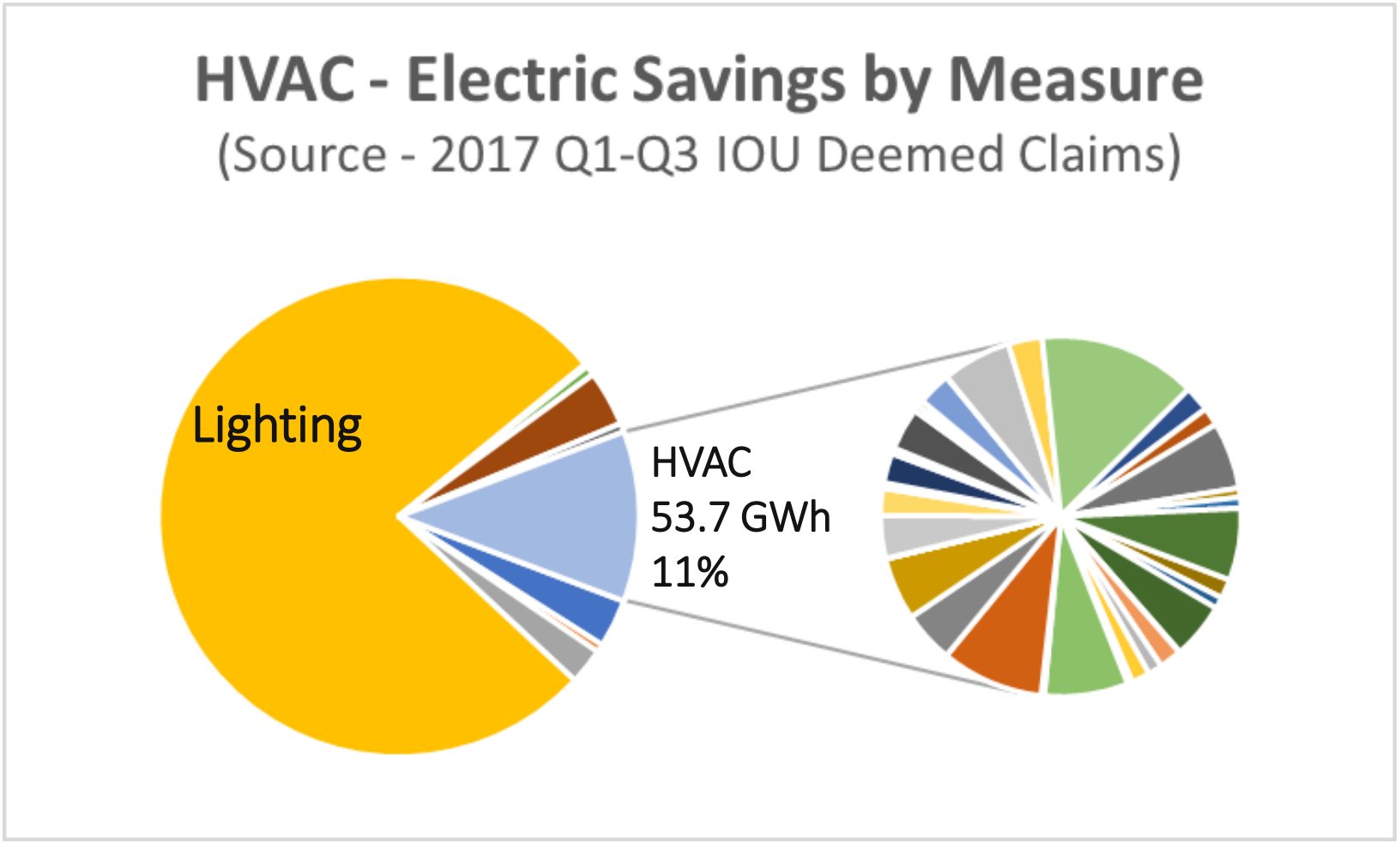


- Next meeting planned for June 14th (Thursday)
- Focus on finalizing questions related to Q2 Measures
- Request feedback regarding Measure Summary Template by June 8th.

# Back-up…

# HVAC Electric Savings (Source – 2017 Q1-Q3, IOU Claims Data)

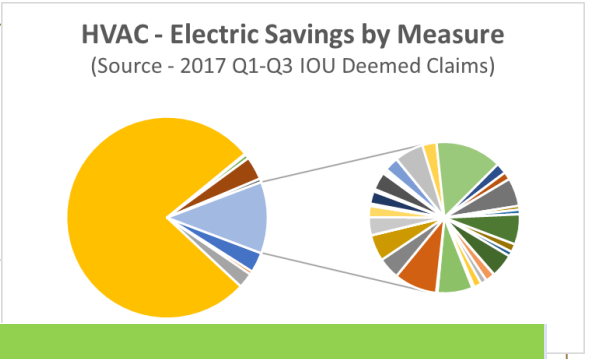




# HVAC Electric Savings

## (Source – 2017 Q1-Q3, IOU Claims Data)



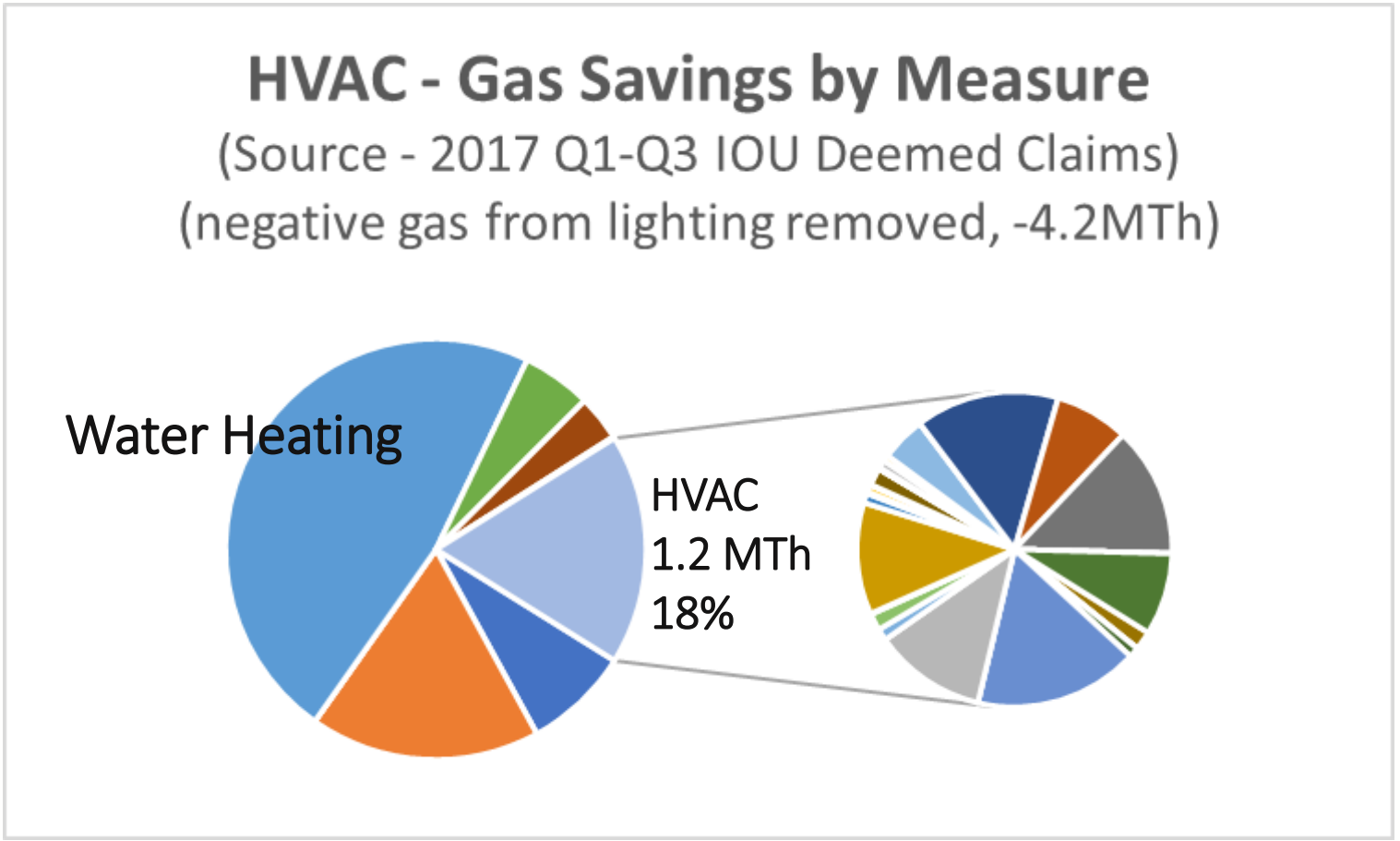



| Ref No | Name | Gross kWh | PGE | SCE | SDGE |
|---|---|---|---|---|---|
| 5.45 | Guest Room PTAC/PTHP Energy Management System | 7,626,835 | 7,599,985 | | |
| 5.13 | Efficient Fan Controller for Residential Air Conditioners | 4,940,741 | 2,474,047 | 2,394,509 | 72,185 |
| 5.10 | Residential HVAC Quality Maintenance and Motor Retrofit | 4,044,713 | 3,661,735 | 204,453 | 178,525 |
| 5.52 | Whole House - Residential | 3,460,215 | 290,621 | 3,169,595 | |
| 5.41 | Variable Speed Drive on HVAC Fan Control | 3,332,090 | 2,223,110 | 1,108,980 | |
| 5.49 | Enhanced Ventilation for Packaged HVAC Units with Gas Heating and Packaged Heat Pumps | 3,232,393 | 1,740,763 | 1,422,159 | |
| 5.15 | Unoccupied Supply Fan Control | 3,038,106 | 2,113,409 | 924,697 | |
| 5.02 | Economizer Repair | 2,704,019 | 679,997 | 2,024,022 | |
| 5.14 | VFD Retrofit to Central Plant Systems | 2,484,678 | | 2,484,678 | |
| 5.24 | Unitary Air-Cooled Commercial Air Conditioners and Heat Pumps >=65 kBtu/h | 2,060,795 | 1,736,774 | 322,188 | 1,833 |
| 5.32 | Commercial Condenser Coil Cleaning | 2,039,439 | 66,164 | 490,331 | 1,482,943 |
| 5.42 | Brushless Fan Motor for Residential Central AC | 1,638,174 | | 1,638,174 | |
| 5.39 | Air-Cooled Packaged Chiller | 1,616,700 | 100,295 | 1,516,405 | |
| 5.30 | Refrigerant Charge | 1,433,067 | 164,420 | 732,081 | 536,566 |
| 5.25 | Unitary Air Cooled Commercial Air Conditioning and Heat Pump Units Under 65 kBtuh | 1,306,765 | 856,208 | 395,891 | 54,665 |
| 5.46 | Programmable Communicating Thermostat for Demand Response | 1,233,427 | 1,218,918 | | 14,508 |
| 5.05 | Water-Cooled Chillers | 1,071,870 | | 1,071,870 | |

*Includes measures with at least 1M kWh; 18 more measures with savings not shown.*

# HVAC Gas Savings (Source – 2017 Q1-Q3, IOU Claims Data)



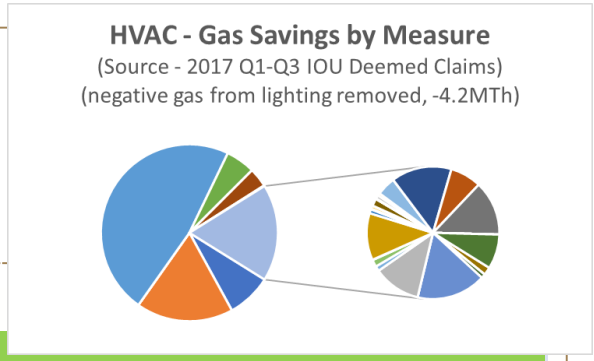



Note: "DEER Measures", which includes some HVAC measures, was removed since it is only a small part (SDG&E – Refrig Charge Adjustment, VAV Box).

# HVAC Gas Savings

## (Source – 2017 Q1-Q3, IOU Claims Data)






| Ref No | Name | Gross Therms | PGE | SCE | SCG | SDGE |
|---|---|---|---|---|---|---|
| 5.03 | Space Heating Boilers | 203,869 | 131,218 | | 72,651 | |
| 5.46 | Programmable Communicating Thermostat for Demand Response | 177,985 | 174,913 | | | 3,072 |
| 5.49 | Enhanced Ventilation for Packaged HVAC Units with Gas Heating and Packaged Heat Pumps | 161,068 | 156,723 | 1,311 | | |
| 5.06 | Demand Controlled Ventilation for Single Zone Packaged HVAC | 139,559 | 130,290 | 9,269 | | |
| 5.15 | Unoccupied Supply Fan Control | 138,272 | 124,211 | 14,061 | | |
| 5.52 | Whole House - Residential | 101,711 | 34,536 | 67,175 | | |
| 5.47 | Smart Thermostat | 91,797 | 63,393 | | 17,719 | 10,685 |
| 5.43 | Multifamily Domestic Hot Water Temperature Reset Controller | 55,749 | | | 55,749 | |
| 5.09 | Res DuctTestSeal | 14,603 | 6,052 | | 4,321 | 4,230 |
| 5.02 | Economizer Repair | 12,644 | 9,122 | 3,522 | | |
| 5.18 | High Efficiency Furnaces - Residential | 11,737 | | | 11,196 | 542 |
| 5.40 | Upstream Residential HVAC | 1,587 | 1,587 | | | |
| 5.19 | High Efficiency Furnaces-Com | 1,583 | 1,583 | | | |
| 5.11 | Quality Installation for Residential Split Systems | 1,027 | | 1,027 | | |
| 5.20 | Gravity Wall Furnaces in Single-Family and Multi-Family Homes | 252 | | | 252 | |
| 5.22 | Variable Refrigerant Flow Commercial Heat Pumps & Heat Recovery Systems >65kBtu/h | 14 | 14 | | | |

Note: “DEER Measures”, which includes some HVAC measures, was removed since it is only a small part (SDG&E – Refrig Charge Adjustment, VAV Box).
Eight (8) measures with negative gas savings, not shown.

# HVAC "Types": DEER Measure



- Step 1: From READi, download a Measure ID and savings
- Step 2: Reproduce savings for a few test cases (if you have correct version of MASControl, possible to reproduce)
- Step 3: Using MASControl, generate base case and measure case for all applicable permutations (Building Type, Climate zone)
  - Vintage and HVAC Type may be required
  - Save as documentation in eTRM
- Step 4: Identify key differences between base and measure case (HVAC measure and other parameters)
- Step 5: Prepare "Measure Summary" template
- Step 6: Seek subcommittee feedback (for Stage II) on Measure Summary template
  - "Correctness" of base and measure case
  - Identified sensitive parameters (perhaps this is area for more EM&V)
- Step 7: Review OpenStudio measures to see if measure could be re-run in EnergyPlus to compare with DOE 2.2/eQUEST results.

# HVAC "Types": "Roots" Within DEER Measure



- Step 1: From READi, download a Measure ID and savings
- Step 2: Locate building simulation models (from all utilities with WP) and results
  - Probably with utility WP developer consultant
- Step 3: Compare base case and measure case for all applicable permutations (Building, Climate zone)
  - Save as documentation in eTRM
  - Likely many fewer permutations because "typical" vintage and "typical" HVAC type used
- Step 4: Identify key differences between base and measure case for an individual utility (HVAC measure and other parameters) for each utility model.
- Step 5: Compare utility modeling approaches across utilities: 1. base case models and 2. measure case models
  - Identify key differences between utility base cases and utility measure cases
- Step 6: Complete "Measure Summary" template
- Step 7: Seek subcommittee feedback (for Stage II) on
  - "Correctness" of base and measure case
  - Different approaches taken by each utility
  - Which utility approach is best and run preferred models to fill in gaps throughout state
  - Identified sensitive parameters (perhaps this is area for more EM&V)
- Step 6: Review OpenStudio measures to see if measure could be re-run in EnergyPlus to compare with DOE 2.2/eQUEST results.

# HVAC Types: Non-DEER HVAC Measure



- Same approach as used for other non-HVAC measures, examples
  - Review RCT
  - Review savings calculation
  - Etc.