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CBECC-Res Variable Capacity Heat Pump Compliance Option

10/16/2018

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BACKGROUND

The Central Valley Research Homes (CVRH) project monitored Variable Capacity Heat Pump (VCHP) systems in three houses in Stockton, CA from 2014 - 2018. Different VCHP model numbers and system types were evaluated in each year of the project. The system types evaluated included ductless mini and multi split systems and short-duct mini splits with ducts inside the conditioned space. A single speed system with ducts inside the conditioned space was also monitored in each house, and VCHP system energy performance was compared to this single speed "Reference" system.

The data generated in the CVRH projects was used to develop algorithms for VCHP system performance as described in this report. Staff proposes to incorporate these VCHP algorithms into the Alternative Calculation Method (ACM), and the residential California Building Energy Code Compliance (CBECC-Res) performance compliance software, for use for demonstrating compliance with the Performance Standards specified in Title 24 Part 6, section 150.1(b).

Efficiency characteristics of the systems monitored in the CVRH projects are shown in Table 1. In order for a VCHP to be eligible for improved energy efficiency credit using the Performance Standards, the HVAC system will be required to provide conditioned air directly to each habitable room in the dwelling unit. A habitable space is defined as a space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces.

As noted in Table 1, one VCHP system suffered from low refrigerant charge, and 8 systems were ductless installations for which each habitable room was not directly served by the HVAC system. Thus these systems were excluded from the analysis, and the analysis used to develop the algorithms proposed in this report were based on the remaining 10 systems that represent installations for which each habitable room was directly served by the system, and that have no known installation defects.

With the exception of the 2014 project, the Reference systems were SEER 14, HSPF 8.2 single speed heat pumps. The 2014 project used air conditioners and electric resistance heat only as the reference systems. For the purpose of this analysis, the 2014 results were adjusted to represent VCHP performance relative to a SEER 14, HSPF 8.2 reference system.

Table 1: VCHP Systems Monitored in CVRH Project

	Reference HP			VCHP			
	SEER	EER	HSPF	SEER	EER	HSPF	Notes
Grange 2014	15.5	11.9	3.412	21.7	13.4	9.4	Found to be 29% undercharged
Mayfair 2014	16	13	3.412	21.5	14.5	12.2	
Caleb 2015	14	12	8.2	20.9	12.68	10.52	Not all habitable rooms were served
Grange 2015	14	11.5	8.2	25.5	13.8	11.5	Not all habitable rooms were served
Mayfair 2015	14	11.5	8.2	16	12.5	10	
Caleb 2016 Ducted	14	12	8.2	19.0	12.8	10.6	
Caleb 2016 Ductless	14	12	8.2	21.0	13.2	10.4	Not all habitable rooms were served
Caleb 2016 Ductless + Fans	14	12	8.2	21.0	13.2	10.4	Not all habitable rooms were served
Grange 2016 Ducted	14	11.5	8.2	29.3	15.2	14	
Grange 2016 Ductless	14	11.5	8.2	29.3	15.2	14	Not all habitable rooms were served
Grange 2016 Ductless + Fans	14	11.5	8.2	29.3	15.2	14	Not all habitable rooms were served
Mayfair 2016 Ducted	14	11.5	8.2	21	12.5	12	
Mayfair 2016 Ductless	14	11.5	8.2	21	12.5	12	Not all habitable rooms were served
Mayfair 2016 Ductless + Fans	14	11.5	8.2	21	12.5	12	Not all habitable rooms were served
Caleb 2017 Ducted	14	12	8.2	14.6	9.34	9.08	
Grange 2017 Ducted 1 Ton	14	11.5	8.2	29.3	15.2	14	
Grange 2017 Ducted .75 Ton	14	11.5	8.2	33	18	14.2	
Mayfair 2017 Ducted 1.5 Ton	14	11.5	8.2	21	12.5	12	
Mayfair 2017 Ducted 1 Ton	14	11.5	8.2	26.1	13.8	12.5	

Sources of Uncertainty in Applying the CVRH Results to CBECC-Res Assumptions

Indoor Temperature Control

The CVRH project was conducted in unoccupied houses, and a constant thermostat setpoint was used. When operated with a constant setpoint, the VCHP systems did not control indoor temperature in the same way as the single speed reference system with a traditional thermostat. The reference system maintained indoor temperature at the thermostat location near setpoint at all times. But in many cases the VCHP systems allowed indoor temperature at the thermostat location to drift above setpoint during hot afternoon hours. And in some cases the VCHP systems also overcooled the houses during lower load conditions.

It is likely that occupants would respond to these uneven temperature control conditions by adjusting the thermostat setpoint, which would increase the VCHP energy use during hot afternoons, and would cause actual energy use in occupied dwellings to be greater than the monitored values from the CVRH data used to develop the algorithms described in this report.

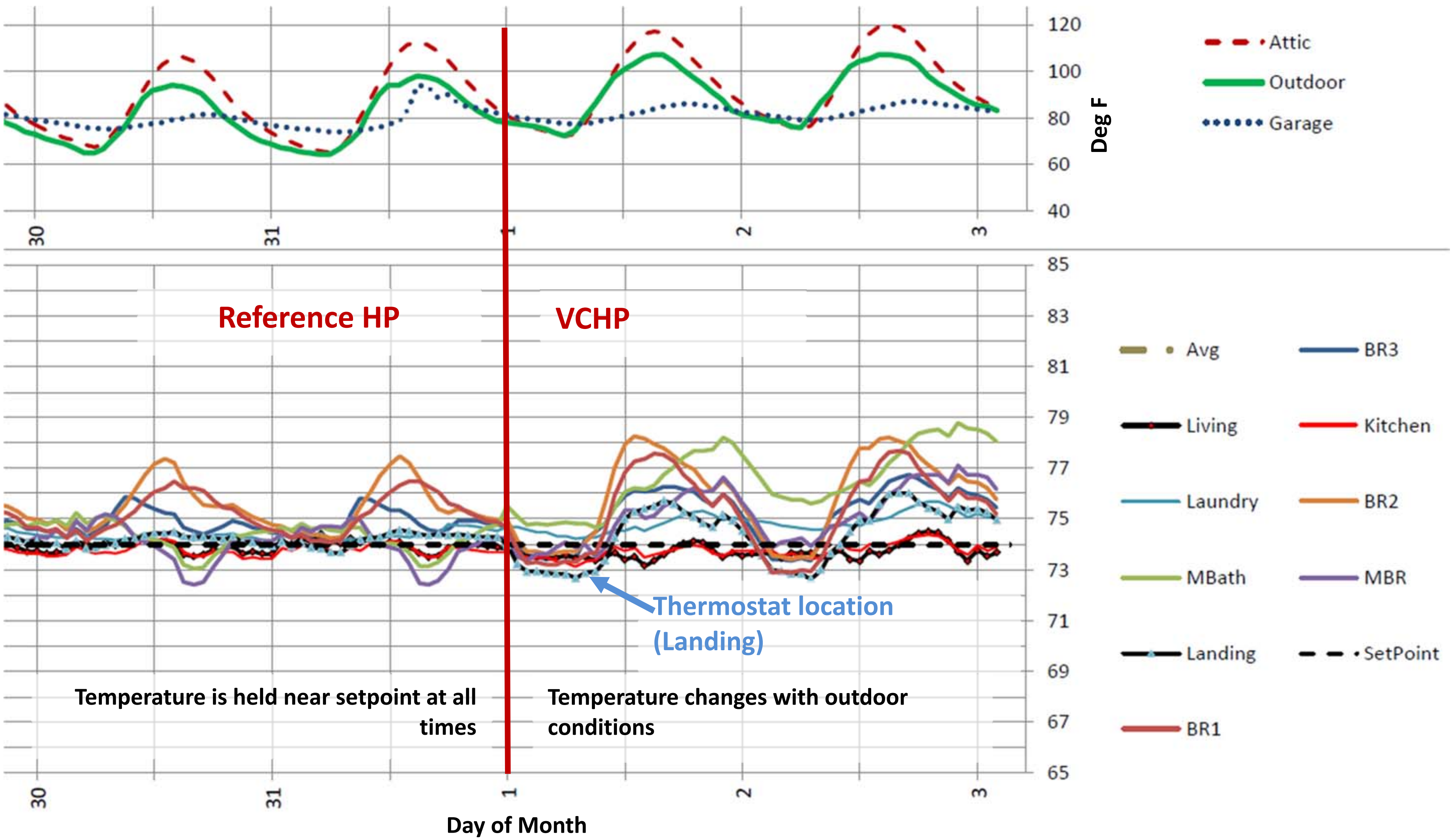

Figure 1: VCHP and Reference heat pump indoor temperature control differences, cooling season

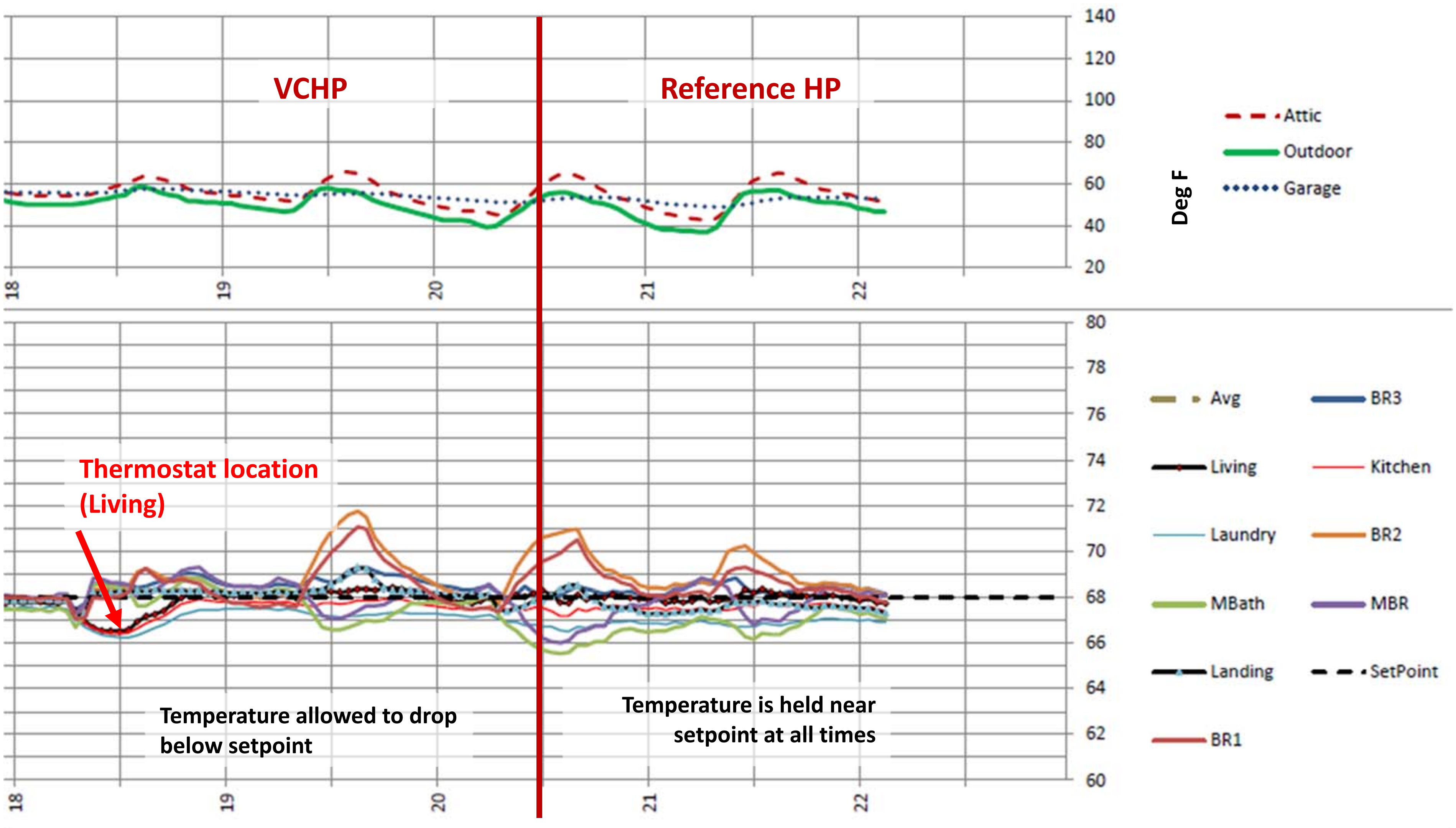

Figure 2: VCHP and Reference heat pump indoor temperature control differences, heating season

VCHP System Selection and Installation

VCHP systems are an emerging technology that is not widely used for space conditioning in residential newly constructed buildings. The VCHP systems that were used for CVRH projects were selected either by the system manufacturer or by the CVRH project team. For typical system installation procedures used for newly constructed buildings, a builder would not likely receive the same level of guidance from highly skilled VCHP manufacturer engineers and technicians as was given to the installers of the systems in the CVRH projects. Builders are likely to prioritize low installation cost over the improved energy performance that may result from the highest quality system selection, design and installation practices. It is uncertain whether the VCHP systems installed by builders would provide equivalent energy efficiency when operated in occupied homes as compared to the efficiency levels attained by the CVRH projects.

SCOPE

The VCHP algorithms described in this report should only be used to determine performance compliance for the equipment types that have been studied under the CVRH projects, specifically:

- Mini and multi split VCHP systems with, low-static pressure ducted indoor units
- Mini and multi-split VCHP systems with ductless indoor units.

Ductless units are defined as those that meet the following criteria:

- The unit meets the AHRI 210/240-2017 definition of a non-ducted indoor unit: "An Indoor Unit designed to be permanently installed, mounted to/in ceilings and/or room walls, and/or to floors, and that directly heats or cools air within the conditioned space."
- The unit is installed with no connection to any external ductwork.

(Note: ductless systems that provide conditioned air to each habitable room in the dwelling are being tested in the 2018-19 CVRH projects, but the performance data for this ductless system configuration are not represented in the CVRH VCHP monitoring data as of July, 2018)

The 2017 Department of Energy (DOE) final rule on test procedures for central air conditioners and heat pumps[1] defines two classifications of ducted indoor units for mini and multi split systems:

1) Low-static systems "*produce greater than 0.01 in. wc. and a maximum of 0.35 in. wc. external static pressure when operated at the cooling full-load air volume rate not exceeding 400 cfm per rated ton of cooling*"
2) Mid static systems "*produce greater than 0.20 in. wc. and a maximum of 0.65 in. wc. when operated at the cooling full-load air volume rate not exceeding 400 cfm per rated ton of cooling*"

The ducted VCHP systems tested in the CVRH projects are representative of low-static systems. Mid static systems have not been evaluated at CVRH. As the maximum operating pressure for mid-static systems is 0.65 inch w.c., these systems are equivalent to the air handlers used in conventional central air conditioning systems – i.e. gas furnaces rated for 0.5 inch w.c.. The algorithms described in this report that are applicable to ducted systems, should be applied only to ducted systems that meet the DOE's low-static pressure system definition given in the Test Procedures for Central Air Conditioners and Heat Pumps adopted in 2017 (see footnote 1).

The current performance ratings information, and equipment type classifications given in the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory of Certified Product Performance do not identify these low-static systems or provide a means to differentiate between low-static systems and those designed to operate at higher static pressures. This is because the current DOE test procedure for residential central air conditioners and heat pumps evaluates all

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[1] 10 CFR Parts 429 and 430, Docket No. EERE–2016–BT–TP–0029, Federal Register Vol. 82, No. 3, January 5, 2017

ducted systems at low static pressure, with the exception of small duct high velocity systems as shown in Table 2 below.

Table 2: AHRI 210/240-2017 External Static Pressure for Ducted Systems - Currently in Effect

Table 11. Minimum External Static Pressure for Ducted Systems Tested with an Indoor AMS Installed

Rated Cooling[1] or Heating[2] Capacity, Btu/h	Minimum External Resistance[3], in H_2O	
	All Other Systems	Small-duct, High-velocity Systems[4]
Up Through 28,800	0.10	1.10
29,000 to 42,500	0.15	1.15
43,000 to 65,000	0.20	1.20

Note:
1 For air-conditioners and heat pumps, the value cited by the manufacturer in published literature for the unit's capacity when operated at the A_{Full} Test conditions.
2 For heating-only heat pumps, the value the manufacturer cites in published literature for the unit's capacity when operated at the $H1_{Full}$ Test conditions.
3 For Ducted Systems tested without an air filter installed, increase the applicable tabular value by 0.08 in H_2O.
4 If a closed-loop, air-enthalpy test apparatus is used on the indoor side, limit the resistance to airflow on the inlet side of the Indoor Unit to a maximum value of 0.1 in H_2O. Impose the balance of the airflow resistance on the outlet side of the Indoor Unit.

The revised test procedures adopted by DOE in January of 2017 (see footnote 1) will not become effective until 2023. The new DOE rules evaluate systems at different static pressures depending on their classification as low-static, mid-static or conventional systems as shown in Table 3 below.

Table 3: DOE 2017 Final Rule External Static Pressure for Ducted Systems, Effective 2023

Table III-3—Minimum External Static Pressure Requirements

CAC/HP variety	Minimum external static pressure (in. wc.)
Conventional (*i.e.*, all central air conditioners and heat pumps not otherwise listed in this table)	0.50
Ceiling-mount and Wall-mount	0.30
Mobile Home	0.30
Low-Static	0.10
Mid-Static	0.30
Small Duct, High Velocity	1.15
Space-Constrained (indoor and single-package units only)	0.30

<u>All VCHP systems</u> (ducted and ductless) must comply with the following requirements in order to qualify for performance compliance credit using the algorithm described in this report:

1. Dwelling units shall be provided with heating and cooling supply airflow in each habitable[2] room by use of a ductless VCHP indoor unit located in the room, or by use of ducts connected directly to the supply air outlet of a ducted VCHP indoor unit. Transfer fans do not meet this requirement.

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[2] From Title 24, Part 6, Section 100.1 definitions: HABITABLE SPACE is space in a building for living, sleeping, eating or cooking, excluding bathrooms, toilets, hallways, storage areas, closets, utility rooms and similar areas.

2. All ducts and ductless indoor units must be located entirely in conditioned space[3]. In order for a duct system to be considered entirely in conditioned space, all ducts, connections, and terminal devices must be verified visually, and also by a leakage to outside field diagnostic test. Generally, ducts in conditioned space are inside the thermal envelope, and also inside the pressure boundary of the dwelling. If parts of the duct system or terminal devices are located in locations such as unconditioned attics, the system will not be considered entirely in conditioned space. Duct systems that are located in dropped ceilings that are inside the thermal envelope, and inside the pressure boundary of the dwelling are considered entirely in conditioned space.
3. All VCHP indoor units serving zones larger than 150 square feet shall be controlled by external wall mounted thermostats located within the zone served.
4. The installed system must have refrigerant charge verified by a HERS Rater.
5. The system installer is required to document the model number, nominal cooling capacity, and location of each indoor unit, which will be verified by a HERS Rater.

<u>Ducted VCHP systems</u>, including multi split systems with one or more ducted indoor units, must also comply with the following requirements:

1. Ducts shall be tested and verified to meet the Verified Low Leakage Ducts in Conditioned Space requirements according to the procedure in RA3.1.4.3.8. This field diagnostic protocol uses a visual verification the ducts are entirely in conditioned space, and also verifies that the duct leakage to outside is no more than 25 cfm.
2. The manufacturer must provide certification to the Energy Commission that the system does not operate the indoor unit fan continuously by default as a condition to receiving the fan energy credit (see discussion of default settings in "continuous fan energy" section below).
3. When credit is claimed for use of a ducted system that does not operate the fan continuously when the controls use the factory default setting, the system shall be verified in the field to confirm the fan does not operate continuously when the system is in cooling mode and the thermostat is not calling for cooling, and when the system is in heating mode and the thermostat is not calling for heating. "Default" refers to:
    a. The control settings that are present in the unit when it ships from the factory, and
    b. The control settings that are activated when a "factory reset" or equivalent controls reset is performed that is intended to restore the original as-shipped settings.

    The default control settings shall not operate the indoor fan when the compressor is off, except for a fan overrun (fan off delay) of less than 10 minutes that occurs at the end of the compressor on cycle.
4. The manufacturer must certify to the Energy Commission that the system is a VCHP that meets the definition of a low-static system as defined in the new DOE rule adopted January 5, 2017 (see footnote 1).

[3] From Title 24, Part 6, Section 100.1 definitions: CONDITIONED SPACE is an enclosed space within a building that is either directly conditioned or indirectly conditioned. DIRECTLY CONDITIONED SPACE is an enclosed space that is provided with wood heating, mechanical heating that has a capacity exceeding 10 Btu/hr-ft², or mechanical cooling that has a capacity exceeding 5 Btu/hr-ft². Directly conditioned space does not include process space. INDIRECTLY CONDITIONED SPACE is enclosed space that (1) is not directly conditioned space; and (2) either (a) has a thermal transmittance area product (UA) to directly conditioned space exceeding that to the outdoors or to unconditioned space and does not have fixed vents or openings to the outdoors or to unconditioned space, or (b) is a space through which air from directly conditioned spaces is transferred at a rate exceeding three air changes per hour.

5. The manufacturer's model number(s) must be included in listings of certified low-static pressure VCHP systems published on the Energy Commission's website.
6. The installed system must be verified by a HERS Rater to confirm the installed system is included in the listings of certified low-static pressure VCHP systems published on the Energy Commission's website.
7. Each new ducted indoor unit must have airflow verified by a HERS Rater to confirm the airflow at full capacity in cooling mode is equal to or greater than 350 cfm/ton of nominal cooling capacity of the indoor unit. 300 cfm/ton shall be verified for altered systems if required for compliance with the refrigerant charge verification procedure.
8. Ducted system air filters must be sized according to the requirements in 2019 Title 24 Part 6 Standards Section 150.0(m)12B except that all filters shall have a maximum clean filter pressure drop of 0.1 inch w.c. at the filter's design airflow rate, regardless of filter depth.

COOLING PERFORMANCE

The CVRH projects found that VCHP system energy performance was not reliably predicted by the SEER rating. VCHP energy performance relative to the SEER 14 single speed Reference system is shown in Figure 3. These results represent performance when each system is controlled to a constant thermostat setpoint with no setbacks or occupant interactions. These results also exclude indoor fan energy that occurs between compressor cycles, which represents a substantial amount of energy for several of the VCHP systems that have been configured by the manufacturer to operate the indoor unit fan continuously by default. Additional fan energy associated with continuous fan operation will be accounted for separately in CBECC-Res.

The higher SEER rated VCHP systems did not perform to expectations based on SEER. For example, a SEER 33 rated system would be expected to use 58% less cooling energy than a SEER 14 rated system, but the monitored results showed a cooling energy use reduction of only 28%. The lowest SEER rated VCHP system demonstrated the best energy performance relative to the single speed reference system.

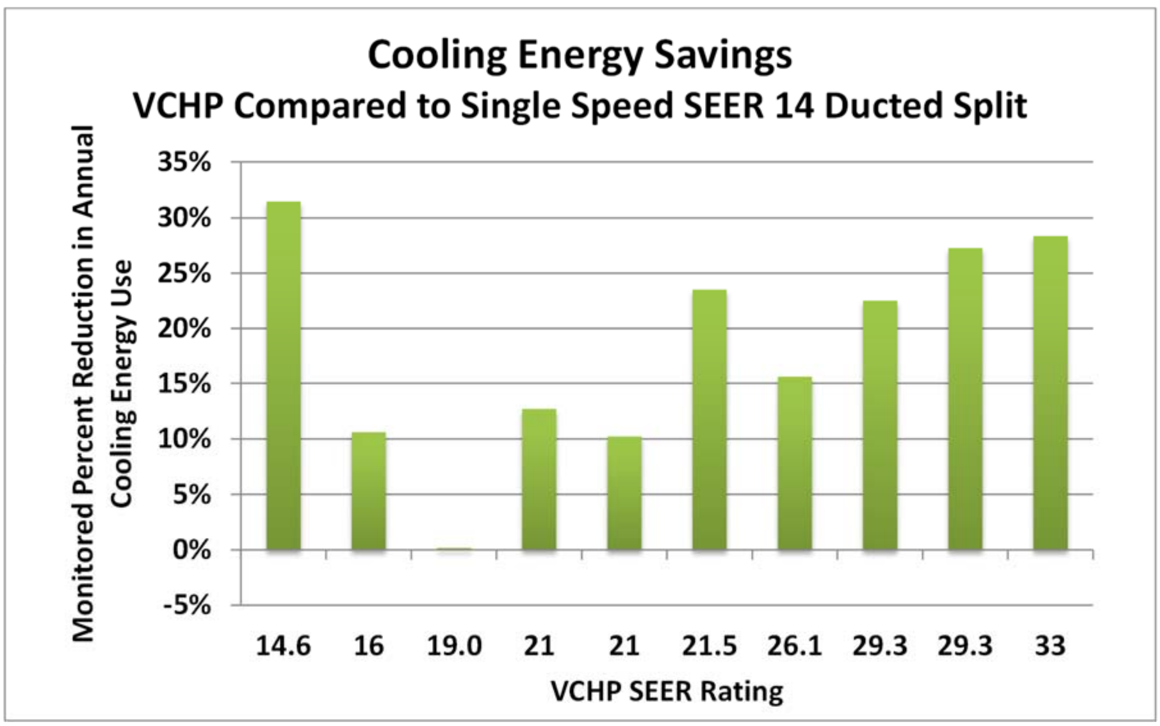

Figure 3: VCHP Cooling Energy Relative to SEER 14 Single Speed System, by SEER Rating

The EER rating was found to be a similarly poor predictor of cooling energy performance, as shown in Figure 4.

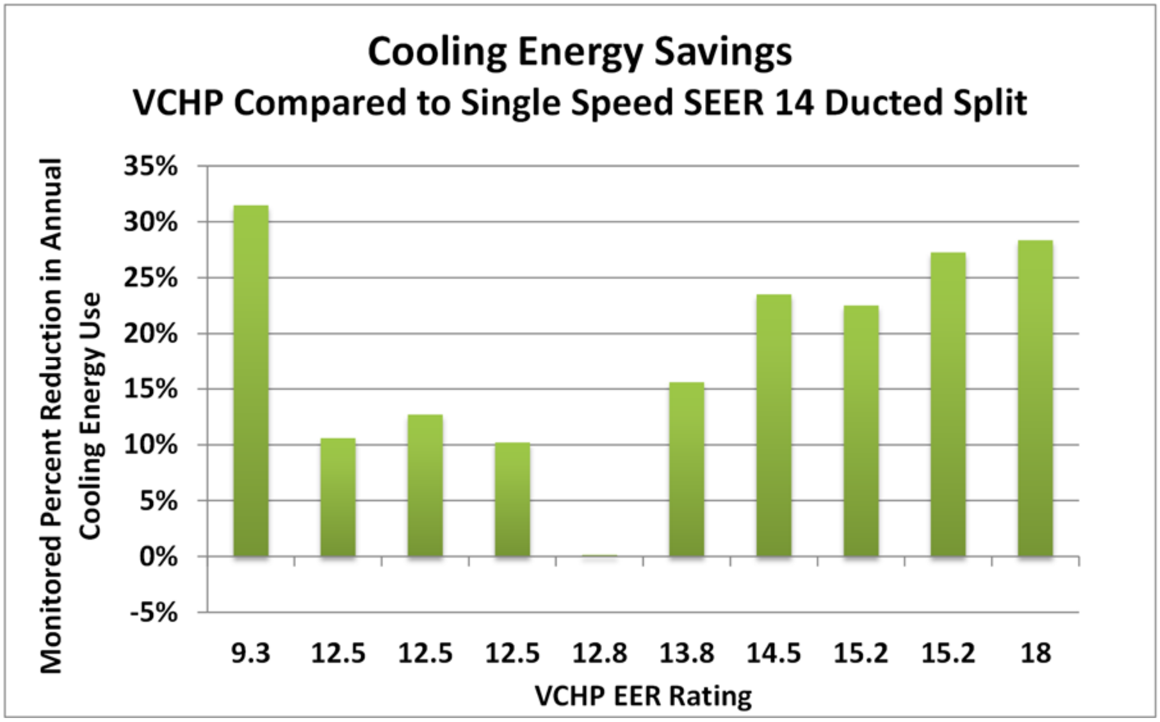

Figure 4: VCHP Cooling Energy Relative to SEER 14 Single Speed System, by EER Rating

The CVRH projects demonstrated that VCHP systems can deliver cooling energy savings over minimum efficiency single speed systems, but that the amount of energy savings is not well predicted by the SEER and EER ratings. The research justifies adopting a simplified CBECC-Res performance model that calculates improved energy performance over a single speed SEER 14 system, based on statistical analysis of the CVRH results, shown in Table 4.

Table 4: VCHP Cooling Energy Performance Summary

Number of Test Cases	10
Mean Annual Cooling Energy Savings over SEER 14 Reference HP	18%
Minimum	0%
Maximum	31%
Standard Deviation	10%

Based on these results as shown in Figure 5 below, CBECC-Res would calculate VCHP system cooling energy performance to be 5% better than a single speed SEER 14 / EER 11.6 system. The same calculation would be used in the analysis regardless of the VCHP system's AHRI rating. This corresponds to a 90% probability that a typical VCHP system will achieve at least 5% savings, anticipating that the sample of VCHP systems tested in the CVRH projects is representative of the general population.

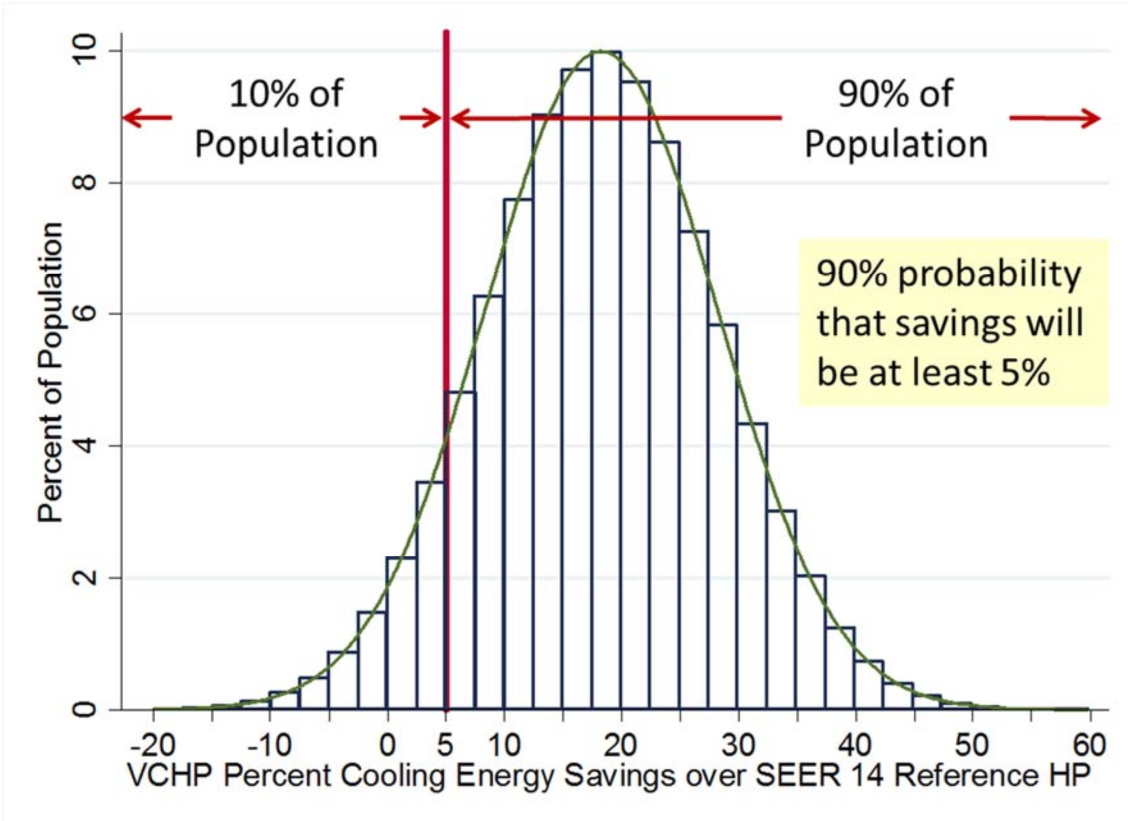

Figure 5: VCHP System Cooling Energy Performance Distribution Based On CVRH Results

HEATING PERFORMANCE

The CVRH projects found that VCHP system energy performance was not reliably predicted by the HSPF rating. VCHP energy performance relative to the HSPF 8.2 single speed Reference system is shown in Figure 6. These results represent performance when each system is controlled to a constant thermostat setpoint with no setbacks or occupant interactions. These results also exclude indoor fan energy that occurs between compressor cycles, which represents a significant amount of energy for several of the VCHP systems that have been configured by the manufacturer to operate the indoor fan continuously by default. Additional fan energy associated with continuous fan operation will be accounted for separately in CBECC-Res.

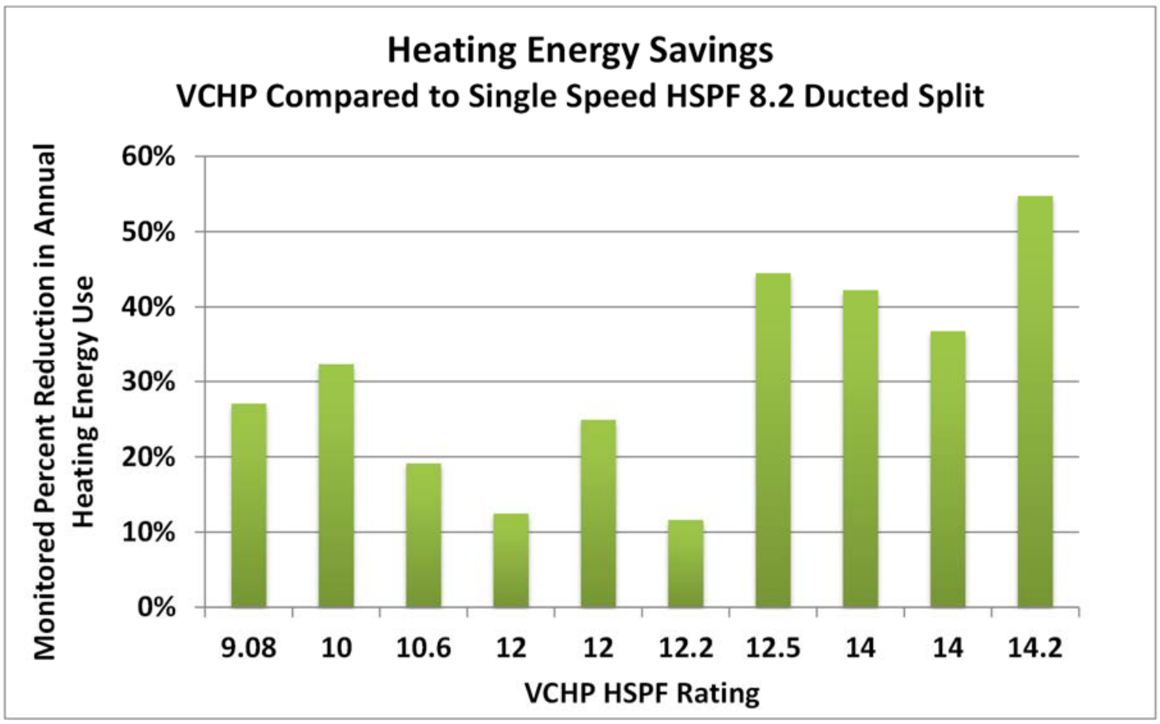

Figure 6: VCHP Heating Energy Relative to HSPF 8.2 Single Speed System, by HSPF Rating

The CVRH projects demonstrated that VCHP systems can deliver heating energy savings over minimum efficiency single speed systems, but that the amount of energy savings is not well predicted by the HSPF rating. The research justifies adopting a simplified CBECC-Res performance model that calculates improved energy performance over a single speed HSPF 8.2 system, based on statistical analysis of the CVRH results, shown in Table 5.

Table 5: VCHP Heating Energy Performance Summary

Number of Test Cases	10
Mean Annual Heating Energy Savings over HSPF 8.2 Reference HP	31%
Minimum	12%
Maximum	55%
Standard Deviation	14%

Based on these results as shown in Figure 7 below, CBECC-Res should calculate VCHP system heating energy performance that is 12% better than a single speed HSPF 8.2 system. The same calculation would be used in the analysis regardless of the system's AHRI rating. This corresponds to a 90% probability that a typical VCHP system will achieve at least 12% savings, anticipating that the sample of VCHP systems tested in the CVRH projects is representative of the general population.

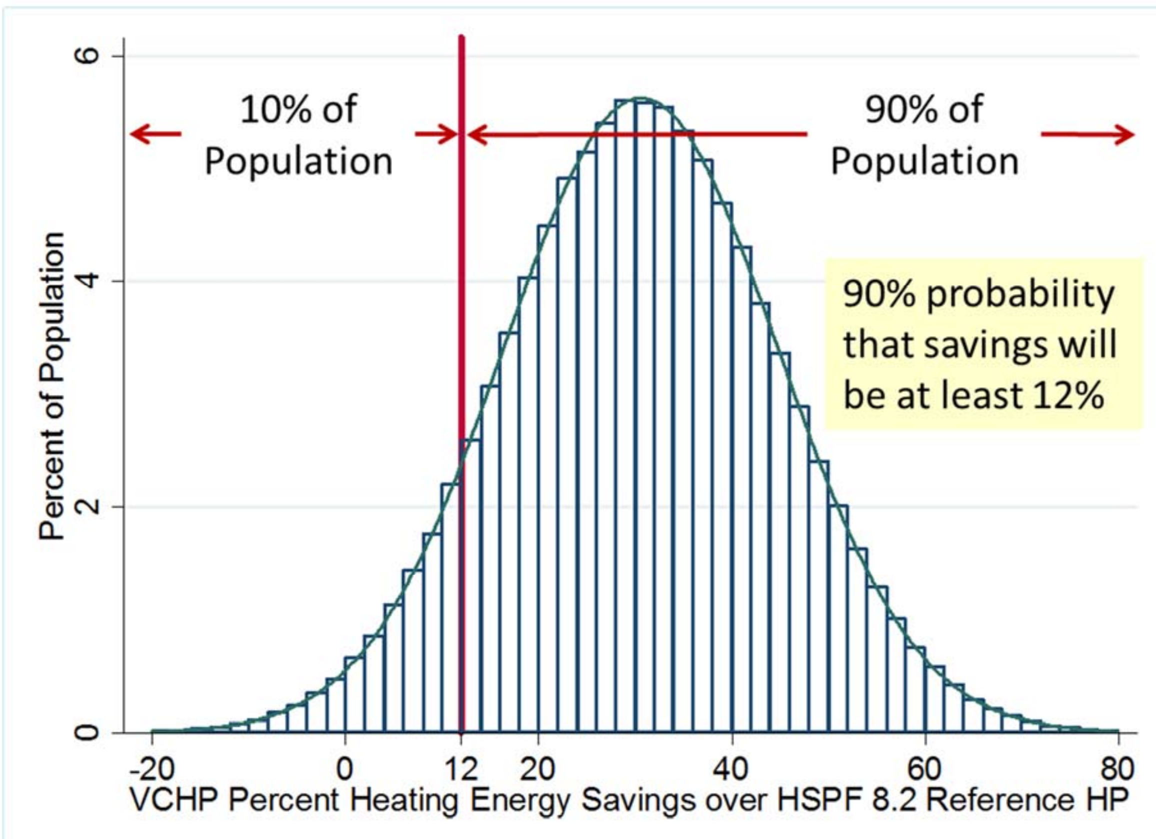

Figure 7: VCHP System Heating Energy Performance Distribution Based On CVRH Results

FAN ENERGY

Two indoor fan energy components must be addressed in the CBECC-Res algorithms:

1) Fan energy that occurs during compressor cycles
2) Fan energy that occurs when the compressor is off

Compressor Cycle Fan Energy

The CBECC-Res VCHP algorithms described in this report calculate performance referenced to a single speed minimum efficiency SEER 14 / HSPF 8.2 heat pump. The VCHP systems provide a 5% improvement in cooling efficiency and a 12% improvement in heating efficiency compared to the minimum efficiency (reference) heat pump, based on direct comparison of the measured energy performance of each system from the CVRH data. This comparison includes all fan energy that occurred during compressor cycles for the VCHP and single speed reference heat pump systems.

Because the simplified VCHP algorithm described in this report must calculate the performance of a proposed VCHP system relative to a single speed (reference) heat pump, and because that relationship is derived from the CVRH comparison of VCHP systems to a single speed reference heat pump system, it is necessary for the simplified algorithm to reference a single speed heat pump model with fan performance equivalent to the CVRH single speed reference heat pump system fans. The CVRH single speed reference heat pump system fan efficacy was lower than the maximum allowable 0.58 w/cfm fan efficacy specified in the 2016 and 2019 Title 24 standards for heat pump air-handling units. Thus the CBECC-Res VCHP algorithm described in this report will determine the standard design budget using a fan efficacy value equal to the average (0.35 w/cfm) of the monitored CVRH single speed (reference) heat pump system as shown in Table 6.

Table 6: CVRH Reference HP Fan Efficacy

Reference HP	Fan Efficacy (W/cfm)
Grange	0.29
Mayfair	0.34
Caleb 2015	0.40
Caleb 2017	0.38
Average	**0.35**

Continuous Fan Energy

Fan energy use that occurs when the compressor is off is an important consideration because the majority of VCHP systems tested in the CVRH project operated the indoor fan continuously according to the manufacturer's factory default control setting.

“default” means that when the system is purchased and installed without making any changes to any control settings, the indoor fan operates continuously whenever the system is in cooling or heating mode, including during times when the system is not providing any cooling or heat. The VCHP systems tested in the CVRH project provided installer and/or user control options to disable the default constant fan operation. The actions required to configure fan operation vary by manufacturer and model number, and sometimes are not well documented in the manufacturer’s literature. In some cases, modifying other control settings may reset fan controls or other settings back to the factory default mode. The average VCHP fan energy use during continuous fan operation was 50 W per ton of nominal cooling capacity.

Staff proposes to make available to manufacturers, the option to certify to the Energy Commission that their low-static VCHP systems do not operate the fan continuously by default. Staff proposes that the CBECC-Res calculations for VCHP energy use include a contribution due to continuous fan operation equal to the average of the monitored energy use for continuous fan operation from the CVRH projects data (50 W per ton of nominal cooling capacity). This additional fan energy use will be incurred during each hour when there is no cooling load during cooling season, or during each hour when there is no heating load during heating season unless one of the following exceptions applies:

1. If the VCHP system is ductless, continuous fan energy is expected to be insignificant, and will be set to a value of zero in the CBECC-Res calculations. This is supported by the CVRH data, which shows ductless indoor units operating at very low fan speed use less than 10W when the compressor is off.

2. If the VCHP system is ducted and the installed system is from a manufacturer who has certified to the Energy Commission that the applicable combination of outdoor unit and indoor unit(s) does not operate the indoor fan(s) continuously by default, then continuous fan energy shall be set to a value of zero in the CBECC-Res calculations. The HERS verification will confirm that installed systems are included in the applicable Energy Commission listings of certified VCHP products, and that the installed indoor unit does not run the fan continuously when there is no call for conditioning..

Air Distribution Type Definitions and Assumptions

Since continuous fan energy is applied to ducted systems and is not applied to ductless systems, it is necessary for inputs to the CBECC-Res software to identify the system type. Three system types are recommended:

1. <u>VCHP - Ducted</u>: Continuous fan energy is applied unless the system indoor unit + outdoor unit combinations are certified by the manufacturer to not operate the indoor fan continuously by default
2. <u>VCHP - Ductless</u>: Continuous fan energy is not applied
3. <u>VCHP - Mixed Ducted and Ductless</u>: Continuous fan energy is applied to the ducted fraction of the system, which is assumed to be 50% of system total capacity. The continuous fan energy is applied unless the system indoor unit + outdoor unit combinations are certified by the manufacturer to not operate the indoor fan(s) continuously by default.

AIR FILTER SIZING

In order to ensure that ducted low-static systems provide the required airflow rates, and do not consume fan energy greater than systems monitored in the CVRH project, the air filter requirements in 2019 Title 24 Part 6 Standards Section 150.0(m)12B shall be met for systems that use any length of duct. The systems shall be equipped with air filters that meet one of the following two alternatives:

1. Nominal two-inch minimum depth filter(s) shall be sized by the system designer to accommodate a maximum allowable clean-filter pressure drop of 0.1 inch w.c at the design airflow rate, or

2. Nominal one-inch minimum depth filter(s) shall be allowed if the filter(s) are sized based on a maximum face velocity of 150 ft per minute at the design airflow rate, and a maximum allowable clean-filter pressure drop 0.1 inch w.c..

SUMMARY

General description of the algorithm approach:

- Credit for cooling 5% as compared to a single speed SEER 14 / EER 11.7 system
- Credit for heating 12% as compared to a single speed HSPF 8.2 system
- Also assume additional energy use due to continuous fan operation equal to 50 W per ton of nominal cooling capacity. This additional fan energy use will be incurred during each hour where there is no cooling load during cooling season, or heating load during heating season unless one of the following exceptions applies:

1. If the VCHP system is ductless, continuous fan energy is expected to be insignificant and will be set to a value of zero in the CBECC-Res calculations.
2. If the VCHP system is ducted and the installed system is from a manufacturer who has certified to the Energy Commission that the applicable combination of outdoor unit and indoor unit(s) does not operate the indoor fan(s) continuously by default, then continuous fan energy shall be set to a value of zero in the CBECC-Res calculations.

Eligibility Requirements:

1. The credit is applicable only to these system types:
   - Ducted mini and multi split VCHP systems with, low-static indoor units (low-static as defined by 10 CFR Parts 429 and 430, Docket No. EERE–2016–BT–TP–0029, Federal Register Vol. 82, No. 3, January 5, 2017)
   - Mini and multi-split VCHP systems with ductless indoor units
2. Dwelling units shall be provided with heating and cooling supply airflow in each habitable room by use of a ductless VCHP indoor unit located in the room, or by use of ducts connected directly to the supply air outlet of a ducted VCHP indoor unit. Transfer fans do not meet this requirement.
3. All ducts, ducted indoor units, and ductless indoor units must be located entirely in conditioned space.
4. All VCHP indoor units serving zones larger than 150 square feet shall be controlled by external wall mounted thermostats located within the zone served.
5. The manufacturer of ducted indoor units must certify to the Energy Commission that the system is a VCHP that meets the definition of a low-static system as defined in the new DOE rule adopted January 5, 2017 (see detail in 1 above).
6. The manufacturer may certify to the Energy Commission that their ducted indoor unit + outdoor unit combination does not operate the fan continuously by default. This certification is required in order to receive credit for non-continuous fan operation.
7. In order to receive credit, the installed low-static system manufacturer's model number(s) must be included in listings of certified-to-the-Energy Commission low-static pressure VCHP systems published on the Energy Commission's website

8. Air filter sizing is required according to 2019 Title 24 Part 6, Section 150.0(m)12B for any ducted systems, except that a maximum clean filter pressure drop of 0.1 inch w.c. is required for all filter depths.
9. It must be possible to view the manufacturer indoor unit and outdoor unit make/model/serial number in the field-installed unit in order to comply with the required field verifications.

Field Verification Requirements

1. The installed system must have refrigerant charge verified by a HERS Rater according to applicable procedures in RA3.2, as specified in Title 24, Part 6 Standards Sections 150.1(c)7A and 150.2(b)1Fii, or 150.2(b)1Fiii.
2. Ducted systems shall be HERS verified to meet the Verified Low Leakage Ducts in Conditioned Space requirements according to the procedure in RA3.1.4.3.8.
3. HERS verification shall confirm that the manufacturer's model number of the installed unit is included in listings of certified low-static pressure VCHP systems published on the Energy Commission's website (if applicable).
4. If non-continuous fan operation is claimed for credit in CBECC-Res, HERS verification shall confirm that the installed system's indoor unit + outdoor unit combination is certified to the Energy Commission and listed on the Energy Commission website as a type that does not operate the fan continuously by default. Additionally, HERS field verification of the installed system operation shall confirm that the installed system's indoor unit fan does not run continuously when the system is not calling for conditioning.
5. Each new ducted indoor unit must have airflow verified by a HERS Rater to confirm the airflow at full capacity in cooling mode is equal to or greater than 350 cfm/ton of nominal cooling capacity of the indoor unit. 300 cfm/ton shall be verified for altered systems if required for compliance with the refrigerant charge verification procedure.
6. The HERS Rater is required to verify the model number, nominal cooling capacity, and location of each indoor unit.
7. HERS verification of the air filter sizing that is specified in Section 150.0(m)12B, and verification that the clean filter pressure drop rating on the installed filter label is less than or equal to 0.1 inch w.c. at the design airflow rate.