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Response to comments on Controlled Environment Horticulture Space Conditioning proposal

Additional submitted attachment is included below.

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

RESPONSE TO COMMENTS ON CONTROLLED ENVIRONMENT HORTICULTURE SPACE CONDITIONING PROPOSAL

September 16, 2026

California Energy Commission

Docket No. 25-BSTD-03

1. Introduction

The California Statewide Codes and Standards Enhancement (CASE) Team appreciates Mr. Atkins's ongoing engagement in the 2028 CASE process and the time Mr. Atkins has spent to provide detailed technical review and thoughtful responses to the Controlled Environment Horticulture (CEH) Indoor Growing Space Conditioning CASE proposal. The team has already integrated feedback that Mr. Atkins has provided, and we appreciate the opportunity to respond the additional comments submitted on July 17, 2026, regarding the Final CASE Report for the Controlled Environment Horticulture Indoor Growing Space Conditioning measure and the associated proposed changes to the 2028 California Energy Code, Title 24, Part 6.

The Statewide CASE initiative supports the California Energy Commission's efforts to develop reasonable, responsible, and cost-effective updates to the Energy Code. Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Edison sponsored this effort as a group.

The Final CASE Report recommends mandatory requirements intended to improve the energy performance of HVAC and dehumidification systems serving indoor growing spaces while preserving compliance options for both integrated and coordinated decoupled systems. A docketed stakeholder letter raises 11 issues concerning the modeled baseline and proposed case, equipment staging and capacity thresholds, treatment of chilled-water and hybrid systems, heat-recovery requirements, standardized efficiency ratings, commercial dehumidifier performance, and desiccant technologies. Several comments identify opportunities to improve the clarity,

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consistency, technology neutrality, or application of the proposed code language. Other comments warrant clarification of the technical record or are based on interpretations with which the Statewide CASE Team does not agree.

This response is intended to support the Energy Commission in evaluating the stakeholder's comments and finalizing clear, enforceable requirements that accommodate a variety of different technologies. Addressing each comment individually, this document explains the technical basis and intended application of the proposed requirements, identifies limited code-language refinements for the Energy Commission's consideration, and describes supplemental technical information that may be added to the rulemaking record. The potential refinements discussed in this response are intended primarily to correct inconsistencies, clarify compliance expectations, or accommodate additional system configurations that satisfy the proposal's functional energy-efficiency requirements.

The Statewide CASE Team continues to support the measure's core objectives: efficient equipment, appropriate sensible and latent load sizing, useful heat recovery, staged or modulating operation, coordinated temperature and humidity control, and acceptance testing of the completed system.

2. Statewide CASE Team Responses to Ian Atkins Comments

Excerpts from Comment Letter TN#271531 are reproduced below verbatim. Responses from the Statewide CASE Team follow the stakeholder comment.

2.1 Issue 1: The modeled comparison changes too many variables to establish the savings attributable to each proposed requirement.

2.1.1 Stakeholder comment

The comparison between the baseline decoupled system and the proposed CASE integrated system changes both the fundamental system architecture and numerous equipment and control characteristics. The proposed case is described as an integrated, variable-capacity, variable supply fan volume system with integrated controls, while the baseline consists of standalone dehumidifiers, single-stage space-conditioning equipment, constant-volume fans, and electric resistance reheat.

As a result, the modeled 25% difference in energy use represents the combined effect of many simultaneous differences, including:

- integrated versus decoupled equipment;
- variable-capacity versus single-stage cooling;

- variable-airflow versus constant-airflow operation;
- recovered-heat reheat versus electric resistance reheat;
- differing equipment efficiencies;
- differing sensible heat ratios;
- differing control sequences;
- potentially also, differing equipment-sizing assumptions.

The analysis therefore does not establish which of the proposed requirements are responsible for the modeled savings.

The CASE analysis should evaluate comparable baseline and proposed systems within each system category. For example:

- A baseline integrated system complying with the existing 75% annual recovered-reheat requirement should be compared with an integrated system complying with the proposed requirements.
- A current-code decoupled system should be compared with a decoupled system incorporating the proposed staging, control, and dehumidifier-efficiency requirements.

This would allow the Commission to identify the incremental energy savings attributable to each proposed requirement rather than attributing the total difference between two substantially different system designs to the proposed measure as a whole.

2.1.2 Statewide CASE Team Response

The Statewide CASE Team agrees that the energy model was not designed to assign a unique savings value to each individual CEH space conditioning requirement. The reported savings represent the combined effect of the proposed HVAC/D requirements and are not intended to report separate savings attributable to variable airflow, compressor staging, recovered reheat, sensible heat ratio, integrated controls, or another individual provision.

This package-level comparison is consistent with the CASE Methodology Report. The proposed model is intended to estimate the effect of the measure as a whole, rather than perform a one-variable-at-a-time attribution analysis. The proposed requirements also have substantial interactive effects. For example, the savings associated with fan-speed reduction may depend on which compressor stages are operating; the value of recovered reheat depends on latent operation and supply-air temperature; and the benefits of equipment staging depend on the control sequence. Sequentially adding individual features would produce results that depend on the order in which they were

added and could require analysis of configurations that are not technically representative or code compliant.

The baseline and proposed cases used the same building prototype, process loads, schedules, environmental setpoints, full-load cooling EER of 11.9, cooling-fan efficiency, and fan-motor efficiency. Both systems were sized from the same prototype loads and design conditions. Their resulting capacities part-load operating characteristics differ because the decoupled and integrated systems serve sensible and latent loads differently and because modulation, airflow control, heat recovery, and system coordination are part of the proposed package.

2.2 Issue 2: The baseline code minimum system description including "electric reheat" is inconsistent with my view of both the definition of a decoupled system and a code compliant system under the existing Title 24 efficient dehumidification rule

2.2.1 Stakeholder comment

Page 170 describes the baseline system as follows:

"The baseline system includes humidistat-controlled standalone dehumidifiers and thermostat-controlled, single-stage space conditioning systems with electric resistance reheat."

In a "fully decoupled system", standalone dehumidifiers provide humidity control, not reheat.

The report should also identify the existing compliance pathway under which that arrangement of electric resistance reheat is considered code compliant, given the existing 75% recovered heat requirement applicable to integrated or reheat-based dehumidification systems, which in my understanding, pure electric resistance reheat would not comply with.

Table 98 appears to include 4 kW of electric resistance heat per unit. Across 24 units, this represents 96 kW of installed electric heat. This is a highly unusual amount of heat for a fully decoupled system.

2.2.2 Statewide CASE Team Response

The 75 percent recovered-reheat requirement applies only to integrated HVAC/D systems but does not apply to cooling equipment used in combination with federal minimum efficiency dehumidifiers in a decoupled configuration. Section 120.6(h)1 of the 2025 Energy Code establishes options for dehumidification equipment. Federally regulated standalone dehumidifiers are one option; integrated HVAC and chilled-water systems providing at least 75 percent of annual dehumidification reheat energy through

onsite heat recovery are separate options. A system using qualifying standalone dehumidifiers under Section 120.6(h)1A is not also required to satisfy the recovered-reheat provisions applicable to Sections 120.6(h)1B and C.

The quoted text states that the standalone dehumidifiers in the baseline case are controlled by humidistats, and that the space conditioning systems, including electric reheat, are controlled by thermostats. The dehumidifiers do not include electric reheat.

The 4-kW electric-heating entry in Table 98 was not an input to the energy model. It represented the smallest incremental electric reheat equipment purchase option for the equipment used in developing the incremental equipment cost estimate. Accordingly, multiplying 4-kW by 24 units does not establish that the modeled baseline contained 96 kW of installed electric heating capacity, or that the equipment used all available electric heating capacity. In fact, on an annual basis, the decoupled simulation showed very low, almost negligible, electric heating energy consumption.

2.3 Issue 3: Multiple single-stage units should be permitted to satisfy staging requirements at the system level

2.3.1 Stakeholder comment

Section 2.2.2 (pg 203) requires at least two stages of fan control and two stages of cooling capacity for cooling equipment used in decoupled systems. This requirement should be based on room level capacity control rather than requiring every individual unit to have multiple stages.

A room served by multiple single stage units can provide substantial capacity turndown by staging the units in groups or by controlling units from separate local thermostats with coordinated setpoints. For example, the baseline modeled room with 24 5-Ton units has many possible increments of cooling capacity even when each individual unit is single-stage.

Requiring every unit to have two-stage or variable-capacity operation may unnecessarily exclude common 3Ton and 5Ton equipment without demonstrating energy savings. Single stage equipment will generally also achieve lower leaving air temperatures and lower coil SHR than variable capacity equipment operating at reduced compressor speed.

2.3.2 Statewide CASE Team Response

The Statewide CASE Team will recommend new language to allow the use of multiple pieces of single-stage equipment in 908.1.6.2.2.2 in Section 3 of this document but will not propose to change the integrated control requirements.

The Statewide CASE Team agrees that multiple single-stage units can provide meaningful aggregate cooling-capacity staging when each unit is independently enabled and sequenced by a common control system. The Statewide CASE Team does not consider multiple independent thermostats with offset setpoints to be equivalent to coordinated system-level staging. A qualifying alternative should provide direct common control of individual units, including appropriate staging hysteresis, lead-lag rotation, minimum runtime, anti-short-cycle logic, and coordination with humidity control and standalone dehumidifiers. The proposed requirements already call for one integrated control system to stage or modulate all space-conditioning equipment based on canopy-level temperature and humidity measurements.

Three- and five-ton equipment will be addressed in the next comment.

2.4 Issue 4: 65,000 BTU/hr minimum unit-capacity requirement lacks a demonstrated energy-efficiency basis.

2.4.1 Stakeholder comment

Section 2.2.2 (pg 204) appears to exclude cooling equipment with capacities of 65,000 BTU/h or less from decoupled systems. The Final CASE Report does not demonstrate that smaller equipment is inherently less efficient or that multiple smaller units consume more annual energy than using larger units.

3Ton and 5Ton split and mini-split equipment are widely available and may have high rated efficiencies, strong part-load performance, and practical redundancy benefits. Multiple small units are also commonly used to serve a single zone in restaurants and bars for example, among other spaces, and I am not aware of energy code limiting the use of multiple smaller units in these applications.

2.4.2 Statewide CASE Team Response

As explained on page 133 of the CASE Report, the minimum capacity requirement was not proposed because larger equipment is inherently more efficient. Rather, it reflects the substantially more stringent federal energy conservation standards that will apply beginning January 1, 2029, to commercial unitary air conditioners and heat pumps with capacities of at least 65,000 Btu/h. For equipment with cooling capacities from 65,000 to less than 135,000 Btu/h, the US Department of Energy's analysis indicates that the

2029 minimum efficiency requirements are approximately 33 to 37 percent more stringent than the equivalent baseline corresponding to the current standards[1].

2.5 Issue 5: The mandatory requirements should explicitly recognize chilled-water cooling combined with standalone dehumidifiers

2.5.1 Stakeholder comment

The proposed system categories do not clearly include a decoupled system consisting of chilled-water fan coils and standalone dehumidifiers. This is, in my opinion, a really good and efficient system type that should be expressly permitted.

I recently evaluated a successful cultivation facility using a two-pipe chilled-water system with standalone dehumidifiers and 8 nominal 5-ton fan coils per flower room. The code should not inadvertently exclude this system type by imposing a minimum indoor-unit capacity or by defining compliant decoupled cooling systems around direct-expansion equipment.

2.5.2 Statewide CASE Team Response

The Statewide CASE Team agrees that the proposed coordinated-system pathway should not exclude a chilled-water cooling system used with qualifying standalone commercial dehumidifiers. The Statewide CASE Team proposed language for 908.1.6.2.2.4 to include chillers in Section 3 of this document.

2.6 Issue 6: The requirement that the integrated system meet 80% of the latent load (pg. 203, 2.1.2) is not supported by a demonstrated energy-efficiency basis and restricts an efficient system architecture of "combined systems"

2.6.1 Stakeholder comment

I do not think the requirement that 80% of the latent load be met by the integrated system has any basis in energy efficiency. The integrated system needs to meet the sensible cooling load, and total load with all standalone dehumidifiers running. But once it does, adding dehumidifiers to then also meet the latent load at the desired setpoints

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[1] **U.S. Department of Energy.** *Energy Conservation Program: Energy Conservation Standards for Air-Cooled Commercial Package Air Conditioners and Heat Pumps*, Direct Final Rule, 89 Fed. Reg. 44,052 (May 20, 2024), and accompanying *Technical Support Document*, Docket No. EERE-2022-BT-STD-0015. Available at: https://www.energy.gov/cmei/buildings/air-cooled-unitary-air-conditioners-and-heat-pumps.

can have multiple benefits including cost and efficiency. For example, integrated systems can easily need 1 Ton capacity per kW lighting to meet the moisture removal at say 75F/50% later flower. However, using a half ton integrated system and half ton of dehumidifiers per kW of lighting can have several advantages. For one, it will generally cost less (lower cost per incremental Ton/moisture removal of dehumidifier vs Integrated unit). In addition, fully meeting (or meeting 80%) of the latent load with integrated units also means excess supply fan capacity for much of the grow cycle, limited turndown, and excess condenser capacity. In addition, using a significant amount of dehumidifiers in combination with integrated DX units, allows using lower cost packaged DX units that may recover closer to 50-75% of their heat of rejection (described more in next comment), while also avoiding additional resistance or combustion reheat.

2.6.2 Statewide CASE Team Response

The Statewide CASE Team recognizes that the Final CEH CASE Report does not establish 80 percent as a uniquely energy-optimal division of capacity between integrated equipment and standalone dehumidifiers. The Statewide CASE Team also recognizes that supplemental standalone dehumidification can reduce system first cost, particularly when the additional capacity is needed primarily during the higher-load portion of the grow cycle.

The 80 percent criterion is intended to balance this consideration with the energy-efficiency benefits of integrated temperature and humidity control. The criterion applies to the combined peak sensible and latent load; it does not require the integrated system to independently meet 80 percent of the peak latent load. Loads vary over the grow cycle and typically reach their highest levels later in the cycle. As a result, an integrated system sized to meet at least 80 percent of the peak sensible and latent load can meet the full latent and sensible load during a substantial portion of the grow cycle, allowing the facility to rely on integrated temperature and humidity control during those periods. Supplemental dehumidification can then provide additional capacity as needed as loads approach peak conditions.

Conversely, eliminating or substantially reducing the minimum integrated-system requirement could result in greater reliance on standalone dehumidification throughout the grow cycle, reducing the energy-efficiency benefits associated with integrated temperature and humidity control. The 80 percent threshold therefore balances first cost and energy efficiency by allowing supplemental dehumidification to address peak conditions while ensuring that integrated equipment provides the primary conditioning capacity over the grow cycle.

The Statewide CASE Team reviewed this value with most of the subject matter experts with whom individual interviews were conducted in person or via email, which included

12 equipment manufacturer representatives, 7 designers, and one owner/manager of several cannabis production facilities in California (see Table 152 on page 334 of the CASE Report). The CASE team also engaged with SMEs in several presentations to the ASHRAE SSPC 90.1 Indoor Agriculture Working Group, where over 10 additional experts including designers, manufacturers, and consultants were engaged. There was widespread agreement that 80 percent is a reasonable value. Therefore, the Statewide CASE Team recommends retaining the 80 percent threshold.

2.7 Issue 7: "Combined" systems with lower than 90% recovery of Integrated Unit heat of rejection should be permitted where supplemental dehumidifiers eliminate the need for non-recovered reheat.

2.7.1 Stakeholder comment

An integrated system that cannot independently recover 90% of its heat rejection should be permitted to operate in conjunction with standalone dehumidifiers, provided the combined control sequence prevents electric resistance or combustion heat from being used for dehumidification reheat.

Some commercially available integrated or DOAS-type units can recover approximately 50% to 70% of heat rejection for hot gas reheat. These units are often more cost-effective than "purpose built" units and when combined with standalone dehumidifiers that add heat to the room, can be part of efficient systems that do not require external sources of reheat energy.

A pathway for these "Combined Systems" could require the heat from dehumidifiers and hot gas reheat to cover all of the reheat needed at the design conditions.

2.7.2 Statewide CASE Team Response

The Statewide CASE Team acknowledges that there may be other successful ways to operate a properly controlled integrated CEH HVAC/D system. However, based on the CASE analysis and input from subject matter experts, the proposed requirements reflect the integrated system configuration that is most commonly deployed and expected to provide the greatest energy savings. The capability to recover at least 90 percent of the heat of rejection, together with the proposed control requirements, minimizes the need for supplemental reheat while providing a clear, readily verifiable compliance criterion for code officials. Furthermore, the 2025 California Energy Code requires all integrated and DOAS-type units to provide 75% reheat on an annual basis, so equipment recovering 50% to 70% would not comply with current code.

2.8 Issue 8: The 3.0 L/kWh CIEF threshold should have some justification

2.8.1 Stakeholder comment

The 3.0 L/kWh CIEF threshold should have some justification.

2.8.2 Statewide CASE Team Response

The proposed 3.0 L/kWh CIEF value was selected as a market-informed minimum qualification level. Unlike the test conditions used for consumer dehumidifiers, the proposed standard is based on the average of three test conditions reflecting conditions commonly encountered in indoor growing facilities.

To assess technical feasibility, the Statewide CASE Team reviewed available performance information for eight commercial standalone dehumidifiers from the market-leading manufacturer of units for indoor growing flower rooms. Using published information and the manufacturer's performance-calculation tool, the CASE Team estimated that seven of the eight products would meet the proposed 3.0 L/kWh CIEF level. These calculations were used to assess preliminary market feasibility; they were not certified results under the proposed JA19 test procedure. This manufacturer later indicated that their engineers could tune the unit that does not meet the proposed limit to have higher efficiency, so all their units could be qualified.

Following publication of the CASE Report, the Statewide CASE Team continued to engage with manufacturers and obtained efficiency data from another leading manufacturer. Analysis of this data confirmed that their products that will be on the market when the code goes into effect in 2029 should also meet the proposed 3.0L/kWh.

The Statewide CASE Team also contacted several other standalone dehumidifier manufacturers and requested input regarding the proposed minimum. Those manufacturers did not provide sufficient product-performance information for the CASE Team to determine whether their individual products would meet the proposed threshold. None of the manufacturers objected to the 3.0 L/kWh level, identified it as technically infeasible, or stated that it would eliminate their product offerings.

The available information supports the conclusion that the proposed level is achievable by commercially available equipment from two of the leading dehumidifier manufacturers in the California commercial indoor cannabis cultivation market. The proposal did not generate an identified feasibility concern from the broader group of manufacturers contacted. The Statewide CASE Team acknowledges, however, that the available data do not independently demonstrate compliance by products from more than two manufacturers.

The 3.0 L/kWh value is intended to establish a commercially achievable minimum level of multi-condition performance. CIEF is a standardized product-qualification index and is not intended to predict annual facility energy use or to establish that 3.0 L/kWh is a unique theoretical dividing line between efficient and inefficient equipment.

2.9 Issue 9: Existing standardized equipment efficiency ratings remain valuable indicators of relative equipment efficiency and should not be dismissed simply because they are based on standardized operating conditions

2.9.1 Stakeholder comment

Throughout the Final CASE Report, the CASE Team repeatedly states that existing federal and industry efficiency ratings “do not reflect the operating conditions” found in indoor growing facilities. Examples include EER, IEER, SEER, IPLV, ISMRE2, consumer dehumidifier test procedures, commercial cooling equipment, VRF equipment, and commercial dehumidifiers. The report further states that actual equipment performance and efficiency “can deviate significantly from its official rating” and uses this as justification for developing additional California-specific performance requirements.

I agree that standardized rating conditions are not perfect. Indoor growing spaces experience unique combinations of sensible load, latent load, lighting schedules, and operating setpoints, etc.

However, the report appears to equate “not identical to actual operating conditions” with “not useful for evaluating equipment efficiency.” I do not believe the report demonstrates this conclusion.

Standardized efficiency ratings are fundamentally comparative metrics, not project-specific energy models. For example, DX dedicated outdoor air systems (DOAS) are evaluated using the ISMRE2 rating, even though the same equipment may be installed in substantially different climates such as Dallas vs Denver, it can still be a useful metric.

The same principle applies to commercial dehumidifiers. A dehumidifier that removes more moisture per unit of electrical energy at the AHAM rating condition of 80F / 60% (a very common condition in indoor grows) generally remain more efficient than a lower-rated unit when both are operated at cooler and drier cultivation conditions such as 73F / 50%, even though both units will experience lower capacity and lower efficiency at those conditions. The report provides no analysis demonstrating that equipment efficiency rankings materially change under representative cultivation operating conditions.

2.9.2 Statewide CASE Team Response

The Statewide CASE Team agrees that federal and industry efficiency ratings are valuable for comparing products that fall within the scope of the same test procedure and are tested under common conditions. The proposed requirements are not based on the conclusion that EER, IEER, ISMRE2, federal dehumidifier ratings, or other standardized metrics have no value.

There are two distinct limitations relevant to controlled environment horticulture.

First, purpose-built integrated CEH HVAC and dehumidification systems do not have an industry-recognized test procedure and are not subject to a federal equipment-efficiency standard. Although some equipment has an ISMRE2 rating, other similar equipment does not. Manufacturers often report performance at various conditions, but there is no standard method of reporting.

Further, members of the Air-Conditioning, Heating and Refrigeration Institute (AHRI) Dehumidification Standards Technical Committee (STC), many of whom manufacture both DX-DOAS and integrated CEH equipment, assert that ISMRE2 is not representative of CEH performance. The STC has created a working group to propose test conditions for integrated CEH systems.[2]

Another manufacturer advised that the federal ducted-dehumidifier test configuration, while appropriate for consumer dehumidifiers, is not well suited to the higher airflows of CEH-specific commercial dehumidifiers. Differences in airflow and external static pressure can affect fan energy, moisture-removal capacity, and overall measured efficiency.

Second, for standalone dehumidifiers, the CASE Team received manufacturer feedback that performance at the single test points in the federal standard (80°F/60% RH in Appendix X or 65F/60% RH in Appendix X1) condition does not represent comparative performance under common flower-room conditions that change through the grow cycle. One manufacturer reported that its equipment may appear less efficient than competing products at full capacity, but it provides better efficiency than others under some cultivation conditions.

The proposed CIEF procedure therefore retains the commonly used 80°F/60% RH condition while adding conditions representing cooler and drier flower-room operation and representative ducted operation. The purpose is to supplement—not dismiss—the

[2] Source: A member of the Statewide CASE Team is an active member of the AHRI Dehumidification STC.

existing standardized conditions, and to provide directly comparable capacity and efficiency information under a broader range of conditions relevant to the covered application.

If a CEH prescriptive/performance path is implemented in a future code cycle, the Statewide CASE Team will evaluate applicability of existing vs. new CEH-specific efficiency ratings as inputs to the performance model.

2.10 Issue 10: Solid Desiccant

2.10.1 Stakeholder comment

Liquid desiccant is included in the definition of an “integrated system” (pg 198) without having been modelled. However, solid desiccant is not explicitly included. I think solid desiccant should be allowed and explicitly listed if liquid desiccant is, as long as recovered heat is used for desiccant regeneration.

2.10.2 Statewide CASE Team Response

The proposed definition was not intended to exclude solid-desiccant systems. The reference to liquid desiccants was included as an example of a heat- or moisture-exchange medium that may be used in an integrated HVAC/D system. The definition subsequently refers more generally to regeneration of “desiccant media,” and the operative equipment provision refers to a “desiccant dehumidification system” without limiting the type of desiccant.

The Statewide CASE Team agrees, however, that specifically naming “liquid desiccants” could be read as excluding solid-desiccant systems. To eliminate that ambiguity, the Statewide CASE Team recommends removing the word “liquid” and to use the term “desiccant media.” The revised definition would therefore encompass both solid- and liquid-desiccant systems.

Desiccant systems would remain subject to the applicable requirements for sensible and latent load sizing, use of recovered energy for regeneration, modulation, integrated controls, and acceptance testing. The energy analysis modeled a representative integrated direct-expansion system and was not intended to separately model every technology eligible to comply with the mandatory functional requirements.

2.11 Issue 11: Final CASE Report framing decoupled systems as inherently energy inefficient and needing to compensate in various ways (higher efficiency dehumidifiers, central control system)

2.11.1 Stakeholder comment

And finally, while the proposal has certainly dialed back the narrative on integrated systems being more energy efficient than decoupled systems compared to the Draft CASE Report, I still take issue with how the Final CASE Report frames decoupled systems as inherently energy inefficient and needing to compensate in various ways (higher efficiency dehumidifiers, central control system).

The Draft Case Report notes that One Stakeholder (me), “objected to the characterization of integrated systems as generally more efficient than decoupled systems, citing instances of integrated systems with insufficient hot gas reheat capacity.” I wanted to expand on why I objected to this characterization beyond just integrated systems with insufficient hot gas reheat capacity.

The Integrated vs Decoupled topic has been actively discussed for years, including during the 2022 Title 24 CEH code cycle, where it was first proposed to require integrated systems in facilities with greater than 2000 sf canopy, but following public comment, it was determined that decoupled systems should continue to be allowed, including for facilities with greater than 2,000 sf canopy. (https://title24stakeholders.com/wp-content/uploads/2021/03/2022-T24-NR-CEH-Final-CASE-Report_w-Addendum.pdf, pg 165). Given the rejection of the 2022 proposal, and the prevalence of decoupled systems per data included in the Draft CASE Report (up to 75% of facilities in California, pg 117, 129), a high standard of evidence should be used to establish the categorical claim that integrated systems are more energy efficient than decoupled systems.

The Final CASE Report continues to perpetuate the idea that the heat from dehumidifiers results in systems including them being overall less energy efficient than “integrated” systems without standalone dehumidifiers because “the heat they generate then needs to be removed by the cooling system”. This is not inherently true because anytime a dehumidifier is running, it is because there is a call for dehumidification, the heat generated by the dehumidifier, actually helps the cooling system dehumidify more. It is not “extra” heat, it is helpful heat. While its true ACs can often have high SHRs at say 73F/48%, the assumption for the baseline cooling system having an SHR of 1.0 in Table 104 is not accurate across the grow cycle. As the Final Case Report notes, only some facilities try to or have the capacity to get this low. At the conditions for most of the grow cycle (Table 63), a cooling only AC does do significant moisture removal. In addition, there are various factors like the high moisture removal efficiency of some

standalone dehumidifiers, high cooling efficiencies of VRF, mini splits, and chillers operating at higher chilled water temperatures that offset the inefficiency of the higher SHR of some cooling only equipment.

Publicly available data is lacking. Though I have often heard over the years that in general HVAC (including dehumidification) and lighting energy use are close to 1:1, and this ratio is also noted in the Final CASE Report. A 2018 study (link below) by SMUD documented energy use for 2 integrated systems (AAON and Desert Aire). (https://www.smud.org/-/media/Documents/Business-Solutions-and-Rebates/Advanced-Tech-Solutions/Indoor-Horticulture-HVAC-System-Evaluation-Final-Report-113018.ashx). The HVAC to lighting energy use ratios were 125.8% and 99.8% for the two integrated systems in the SMUD study. This seems like normal energy use, but does not necessarily show high efficiency.

2.11.2 Statewide CASE Team Response

The CASE Team does not agree that the Final CASE Report characterizes all decoupled systems as inherently inefficient or all integrated systems as inherently efficient.

The report states that not all integrated systems are inherently efficient, and not all decoupled systems are inherently inefficient. It recognizes that high-efficiency decoupled systems with central controls that stage or modulate equipment using co-located canopy temperature and humidity sensors can operate efficiently. It also recognizes that integrated systems with insufficient heat-recovery capacity, fixed-capacity operation, inadequate airflow modulation, or excessive electric resistance reheat can perform poorly.

The modeled comparison is between a representative current-code, fixed-capacity decoupled system and a representative integrated system meeting the proposed package. It is not intended to establish that every integrated system will outperform every possible decoupled system. The proposed code permits coordinated decoupled systems and imposes architecture-appropriate minimum requirements on both pathways.

The commercial-dehumidifier efficiency and common-control requirements are not intended as compensation for an assumed categorical disadvantage. They directly regulate:

- The efficiency of the latent-removal equipment; and
- The sequencing of cooling and dehumidification equipment that would otherwise respond independently.

Integrated systems are subject to their own functional requirements for sizing, variable sensible heat ratio, heat recovery, heat rejection, fan-speed modulation, central controls, and acceptance testing.

The Statewide CASE Team agrees that the thermal effect of a standalone dehumidifier should be described precisely. Condensing moisture converts latent energy in the room air into sensible heat; that latent-to-sensible conversion is not itself new energy. However, the dehumidifier's compressor, fan, and other electrical input also become sensible heat in the space. That electrical input is useful when the room has a simultaneous net heating or reheat requirement, but it increases the heat that must ultimately be removed when the space is cooling dominated. The Final CASE Report recognizes that dehumidifier heat can be useful during lights-off or other heating conditions and proposes controls that restrict operation to periods when latent removal is needed and the heat can be used or the other equipment cannot meet the load.

The baseline design SHR of 1.0 was used for late-flower design sizing, where cooling-coil latent capacity was assumed to be severely degraded and standalone dehumidifiers were sized for the full latent load. In the annual simulation, however, the cooling coil does provide latent removal: EnergyPlus determines that a rated SHR of 1.0 is not physically achievable at the specified capacity and airflow and operates the coil at an effective rated SHR of ~0.75, so the coil condenses moisture whenever its surface is below the entering dewpoint. The model therefore assumes that conventional cooling equipment provides moisture removal capacity during many hours in each grow cycle, but that moisture removal capacity is severely degraded during late-flower conditions.

The 2022 code-development history supports retaining a standalone-dehumidifier compliance option, and the 2028 proposal does so. In response to 2022 stakeholder comments, the Statewide CASE Team removed the proposed canopy-area restriction and retained standalone dehumidifiers subject to minimum efficiency requirements. That history does not establish that all system configurations have equivalent energy performance and does not preclude adding requirements in subsequent code cycles to address system controls, staging, equipment qualification, or sizing.

The SMUD study cited in the comment provides useful measured-energy data for two facilities using an early generation of integrated equipment, but it was not designed as a controlled comparison between current-gen integrated and decoupled systems. An HVAC-to-lighting energy ratio is affected by lighting power, cultivation schedules, moisture loads, environmental setpoints, ventilation, equipment sizing, and controls. Without a matched decoupled alternative or a documented before-and-after comparison, the cited ratios do not establish the relative efficiency of the two system architectures. Other publicly available evidence that more directly addresses comparative performance was cited in the Final CASE Report in section 4.1.4.3.8.

System configuration alone does not determine efficiency, and equipment efficiency alone also does not determine total HVAC/D system performance. Proper sizing, useful heat recovery, fan speed and capacity modulation or staging, and coordinated temperature and humidity controls are important under both integrated and coordinated system configurations.

3. Recommended Revisions to Code Language Proposed in the Final CASE Report

The proposed changes to the standards and Reference Appendices are provided below. Changes to the 2025 documents that were proposed in the Final CASE Report were marked with dark blue underlining (new language) and strikethroughs (deletions). Changes to the final CASE Report language proposed in this document are marked with red underline for newly proposed text and red strikethrough for newly proposed deletions.

Markups are provided to the restructured 2025 Energy Code that the CEC developed in response to feedback that aligning the structure of Title 24, Part 6 with other parts of the California Building Standards Code (Title 24) would improve readability, usability, and navigation. New section numbers are shown as bold followed square brackets that document the section in the 2025 Title 24, Part 6 section numbers prior to the restructuring. For example, "Section 601.1 [Section 130.0(a)] General" contains the content that is in the current Section 130.0(a).

SUBCHAPTER 2 DEFINITIONS
SECTION 201
DEFINITIONS
…
INTEGRATED SPACE CONDITIONING SYSTEM is an HVAC and dehumidification system designed to handle both sensible and latent heat removal. Integrated HVAC/D systems may use one or more heat and/or moisture exchange mediums including refrigerant, chilled water, and/or ~~liquid~~ desiccants to dehumidify and cool air. Integrated HVAC/D systems use recovered heat to *reheat* air to meet supply air setpoints and/or regenerate desiccant media.

SECTION 908
CONTROLLED ENVIRONMENTAL HORTICULTURE (CEH)
(NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)

908.1 *[Section 120.6(h)]* **Mandatory requirements (Newly Constructed, Additions, Alterations).**

…

908.1.6. ***Indoor growing space conditioning systems.***

…

908.1.6.2. ***Indoor growing space conditioning system* characteristics.** The *indoor growing space conditioning system* shall meet all requirements of one of the following systems:

…

908.1.6.2.2. A *coordinated decoupled HVAC/D system* meeting the requirements of 2.2.1 and ~~either~~ one of 2.2.2, ~~or~~ 2.2.3, or 2.2.4.

2.2.1 *Commercial dehumidifiers* that comply with Reference Joint Appendix JA19 and certified as required by JA19.

2.2.2 Commercial unitary air-conditioning, or *heat pump* equipment with a minimum of two stages of cooling capacity and at least two stages of fan control, tested in accordance with AHRI 1340 and meeting minimum IVEC and/or IVHE requirements ~~effective 1/1/2029.~~ in Tables 400.5-A [*Table 110.2-A*] and Table 400.5-B [*Table 110.2-B*]. The staging requirement can also be met by multiple pieces of single stage equipment with a central controller.~~:~~

~~2.2.2.1 65,000 to < 135,000 Btu/h: IVEC 13.8 (AC) or 13.4 (HP).~~

~~2.2.2.2 135,000 to < 240,000 Btu/h: IVEC 13.8 (AC).~~

~~2.2.2.3 240,000 to < 760,000 Btu/h: Specific efficiency requirements mandated by 10 CFR Part 431 Subpart F.~~

2.2.3 Variable refrigerant flow systems tested in accordance with AHRI 1230 and meeting minimum IEER requirements~~.~~ in Table 400.5-F [*Table 110.2-F*] and Table 400.5-G [*Table 110.2-G*].

~~2.2.3.1. Up to < 135,000 Btu/h: 15.5 *IEER* (*Heat Pumps*: 14.6 *IEER*, 3.3 *COP*).~~

~~2.2.3.2 Up to < 240,000 Btu/h: 14.9 *IEER* (*Heat Pumps:* 14.4 *IEER*, 3.3 *COP*).~~

~~2.2.3.3 Up to < 760,000 Btu/h: 13.9 *IEER*.~~

2.2.4 Water chilling packages meeting the requirements in Table 400.5-D [*Table 110.2-D*].