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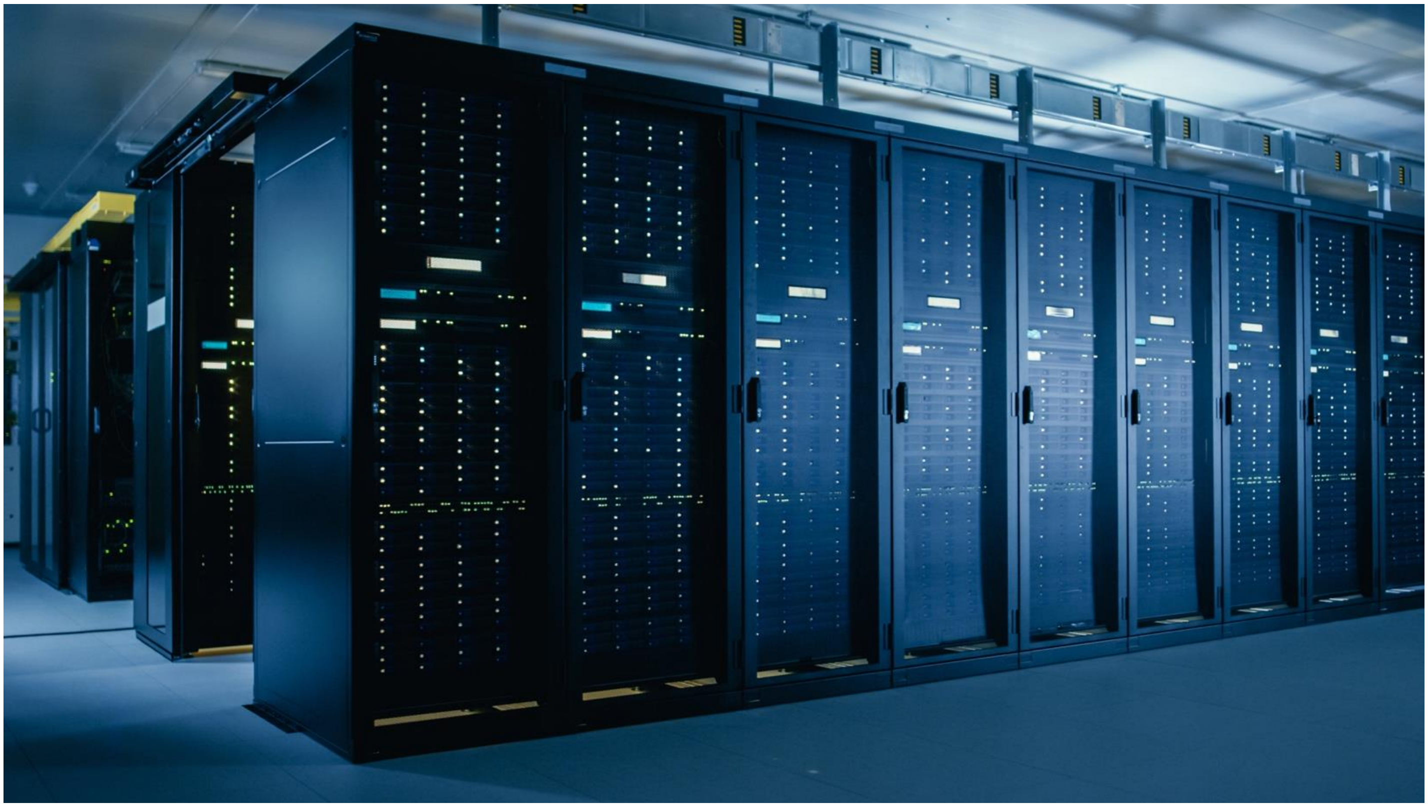
Codes and Standards Enhancement (CASE) Initiative

2028 California Energy Code

Data Centers Efficiency Improvements



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Final CASE Report

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Pacific Gas and Electric Company® Southern California Edison® Energy for What's Ahead® SDGE™

Category: Codes and Standards

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Executive Summary

This proposal presents updates to data center and computer room efficiency requirements for consideration in the 2028 California Energy Code (Title 24, Part 6 or Energy Code). The proposals were developed by the Statewide Codes and Standards Enhancement (CASE) Team to improve data center energy performance, strengthen compliance clarity, and support California's long-term energy efficiency and greenhouse gas (GHG) reduction goals. The CASE Report evaluates three measures applicable to nonresidential buildings: Computer Room Economizers, Fan Control Requirements, and Computer Room Heat Recovery.

The Statewide CASE Team developed these proposed measures for submission to the California Energy Commission (CEC) for potential inclusion in the 2028 update to Title 24, Part 6. To be adopted, each measure must be technically feasible and cost effective. The measures focus on increasing economizer utilization, improving computer room fan control, and capturing useful heat from computer rooms to offset building heating loads.

Stakeholder engagement included work with MEP firms, construction firms, building officials, appliance manufacturers, builders, utility incentive program managers, Title 24 energy analysts, state agencies, Lawrence Berkeley National Laboratory, data center operators, design and engineering firms, cooling equipment manufacturers, appliance standards associations, and national experts. The Statewide CASE Team also held workshops on September 30, 2025 and March 17, 2026, presented at a BayREN forum on March 18, 2026, engaged AHRI and ASHRAE committee members, and held one-on-one conversations with manufacturers including Carrier Corporation, Vertiv, Daikin Applied, and Johnson Controls. Feedback on code complexity and compliant approaches was used to simplify the air-cooled and liquid-cooled ITE economizing requirements.

The Statewide CASE Team recognizes ongoing systemic inequities in environmental and social justice (ESJ) communities and developed the proposal with consideration of potential unintended impacts.

Computer Room Economizers

Proposed Code Change

This proposed measure would expand definitions related to computer rooms and data centers, including liquid-cooled information technology equipment (ITE), facility water, and computer room economizers. It would also increase the amount of time economizers serve full or part-load cooling in newly constructed computer rooms and in computer room additions and alterations.

The measure would raise the 100 percent wet-bulb economizer threshold from 45°F wet-bulb to 60°F wet-bulb for air-cooled ITE, add new 75°F wet-bulb and 75°F dry-bulb economizer thresholds for buildings with more than 2 MW of liquid-cooled ITE load, establish minimum water and air temperature differentials and variable flow requirements, add computer room commissioning requirements, and add an economizer exception for qualifying heat recovery systems.

Benefits of Proposed Change

The measure addresses rising energy use in data centers, which are highly energy intensive and can increase statewide emissions and grid demand if not managed through efficiency improvements.

By increasing economizer operating opportunities and clarifying integrated economizer requirements, the proposal would reduce compressor operation, lower energy and operating costs, and improve clarity for designers, contractors, and code officials as data center cooling technologies evolve.

Compliance and Enforcement

Compliance would build on existing computer room economizer requirements by increasing economizing temperature thresholds and adding minimum water and air temperature differential and variable flow provisions. The proposed code language would provide examples of compliant and non-compliant integrated economizer designs to improve consistency in design and enforcement.

The measure would require updates to compliance forms including NRCC-PRC-E, NRCI-PRC-E, and NRCC-PRF-01-E, and would require training for designers, contractors, and enforcement personnel on new triggers, thresholds, documentation, and field verification.

Market Assessment

Computer room economizers have been required in Title 24, Part 6 since the 2013 edition, and economizing has become common practice in California. The market is described as prepared to implement updated economizing requirements because cooling technology and practices have continued to advance.

For air-cooled ITE, common economizer products can support the proposed thresholds. For liquid-cooled ITE, the report states that proposed outdoor temperature thresholds for full economizing are achievable with available cooling products and support manufacturer-stated product temperature requirements. These conclusions were guided via a code readiness survey and a review of product literature for various manufacturers.

Cost Effectiveness

The computer room economizer measure is identified as cost effective. The extracted source snippets include cost-effectiveness tables showing cost-effective or infinite benefit-to-cost[1] results for three economizer scenarios, and statewide first-year savings are reported for new construction, additions, and alterations. Contractors working with the CASE team were requested to specify cost differences between the baseline scenario and the proposed scenarios.

First-Year Statewide Impacts

Table 1: Summary of Statewide Impacts — Computer Room Economizers

Metric [a]	Total Statewide Impacts
Annual Electricity Savings (GWh)	8.68
Peak Demand Reduction (MW)	0.56
Annual Natural Gas Savings (Million Therms)	-
Annual Source Energy Savings (Million kBtu)	9.3
30-Year Long-term System Cost Savings (Million 2029 PV$)	$69.22
Annual Avoided GHG (Metric Tons CO2e/yr)	492

a. Values represent impacts from buildings permitted during the first year the code is in effect. Where annual avoided GHG values were not extracted from the available table snippets, the table directs readers to the corresponding source report table.

Fan Control Requirements

Proposed Code Change

This proposed measure would add fan control requirements for computer room cooling equipment. It is intended to reduce unnecessary fan energy in smaller computer rooms and related nonresidential applications by requiring more efficient fan operation as cooling load varies.

[1] The benefit-to-cost ratio (BCR) compares benefits or cost savings to costs over the 30-year period of analysis. Proposed code changes with a BCR of 1.0 or greater are cost effective.

The measure would apply to new construction, additions, and alterations where applicable computer room cooling equipment is installed or replaced, and would be reflected in compliance documentation and software updates.

Benefits of Proposed Change

Fan energy is a persistent operating load in computer rooms. Requiring improved fan controls would reduce electricity consumption and peak demand while maintaining the cooling needed for ITE reliability.

Because the measure focuses on controls rather than a broad equipment replacement mandate, it provides a practical pathway to capture energy savings in both new and altered systems.

Compliance and Enforcement

Compliance would entail development of training documentation showing that applicable cooling equipment includes the required fan controls.. The proposed measure reduces the threshold for systems that must comply, so the approach to verifying compliance will remain unchanged.

Training and outreach would help designers, contractors, and enforcement personnel identify affected systems and confirm that fan controls are specified, installed, and documented correctly.

Market Assessment

The measure relies on fan control approaches that are available in the market. The report includes a market survey of cooling products and expects implementation to be feasible for affected projects.

The economic analysis focuses on affected commercial construction, building design and energy consulting, and building inspection sectors; the extracted cost-effectiveness table indicates a total benefit-to-cost ratio of 9.29.

These conclusions were guided via a review of product literature for various major manufacturers, interviews with mechanical contractors, and the U.S. Department of Energy’s estimates on expanded scope electric motors embedded in HVACR equipment.

Cost Effectiveness

The proposed code change is cost effective across the applicable climate zones represented in the extracted cost-effectiveness table. Benefit-to-cost ratios range from

9.21 to 9.41, with a total weighted BCR of 9.29. The incremental cost was developed using a weighted average of market share by motor speed control technology type.

First-Year Statewide Impacts

Table 2: Summary of Statewide Impacts — Fan Control Requirements

Metric [a]	Total Statewide Impacts
Annual Electricity Savings (GWh)	1.6
Peak Demand Reduction (MW)	0.2
Annual Natural Gas Savings (Million Therms)	-
Annual Source Energy Savings (Million kBtu)	2.4
30-Year Long-term System Cost Savings (Million 2029 PV$)	$14
Annual Avoided GHG (Metric Tons CO2e/yr)	129

a. Values represent impacts from buildings permitted during the first year the code is in effect. Where annual avoided GHG values were not extracted from the available table snippets, the table directs readers to the corresponding source report table.

Computer Room Heat Recovery

Proposed Code Change

This proposed measure would add requirements for computer room heat recovery in applicable new construction. The measure is based on the opportunity to use heat generated by computer rooms to serve building heating loads through heat recovery strategies.

The measure would apply to new construction and would require design review and commissioning coordination when triggered by the computer room requirements described in the report.

Benefits of Proposed Change

Computer rooms reject substantial heat. Recovering that heat can reduce heating energy use elsewhere in the building and improve overall building system efficiency.

The measure complements the economizer proposal because the economizer requirements include an exception for computer rooms using qualifying heat recovery systems, creating flexibility while still supporting energy and GHG reductions.

Compliance and Enforcement

The proposed measure builds on the heat recovery requirement adopted in the 2025 California Energy Code for nonresidential buildings and is already a familiar topic for market actors. Compliance would be coordinated through mechanical system design, permit application, construction, and inspection requirements for applicable computer rooms. The economizer section notes that computer room commissioning design review must verify compliance with mandatory heat recovery requirements where applicable.

The measure would require designers and enforcement personnel to confirm that heat recovery capacity and receiving heating loads meet the applicable thresholds and that compliance forms and documentation reflect the installed design.

Market Assessment

The report describes several heat recovery system configurations, including water-to-water heat recovery chillers, four-pipe heat pumps, and VRF heat recovery systems. The market assessment focuses on feasibility in medium and large office buildings with computer rooms. The Statewide CASE Team considered several real-world examples on heat recovery. The Statewide CASE Team also engaged with interested parties at the BayREN Codes & Standards regional forum on this proposed measure, and nearly 200 individuals participated in this discussion, including but not limited to county representatives, energy and sustainability staff of local jurisdictions, consulting engineering firms, national laboratories, state agencies, and universities.

Cost Effectiveness

The Statewide CASE team established incremental costs through a mechanical contractor with significant experience designing and installing cooling equipment in data centers in California.

The proposed code change is cost effective in the extracted source data. Benefit-to-cost ratios range from 2.22 to 14.29, with a total weighted BCR of 4.29 and total incremental PV costs of $1.34 per square foot.

First-Year Statewide Impacts

Table 3: Summary of Statewide Impacts — Computer Room Heat Recovery

Metric [a]	Total Statewide Impacts
Annual Electricity Savings (GWh)	0.63
Peak Demand Reduction (MW)	0.18
Annual Natural Gas Savings (Million Therms)	$0.14
Annual Source Energy Savings (Million kBtu)	$14.17
30-Year Long-term System Cost Savings (Million 2029 PV$)	$19.01
Annual Avoided GHG (Metric Tons CO2e/yr)	847

a. Values represent impacts from buildings permitted during the first year the code is in effect. Where annual avoided GHG values were not extracted from the available table snippets, the table directs readers to the corresponding source report table.

Acronyms

Table 4 presents a list of acronyms used in this report. Title24stakeholders.com also maintains a glossary of terms.

Table 4: List of Acronyms

Acronym	Definition
ACM	Alternative Calculation Method
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
BCR	Benefit-to-cost ratio
BEM	Building energy modeling
Btu	British thermal units
CASE	Codes and Standards Enhancement
CBECC	California Building Energy Code Compliance
CEC	California Energy Commission
CDU	Coolant distribution unit
CPUC	California Public Utilities Commission
CPU	Central processing unit
CZ	Climate Zone
DFDD	Dual fan dual duct
DOAS	Dedicated outdoor air system
DOSH	Division of Occupational Safety and Health
ECC	Energy Code Compliance
ECM	Electronically commutated motor
ESJ	Environmental and social justice
GHG	Greenhouse gas
GPU	Graphics processing unit
GWh	Gigawatt-hour
HVAC	Heating, ventilation, and air conditioning
IDF	Intermediate distribution frame
IECC	International Energy Conservation Code
IOU	Investor-owned utility
ITE	Information technology equipment
kWh	Kilowatt-hour
LSC	Long-term system cost
NPDI	Net private domestic investment

Acronym	Definition
PUE	Power usage effectiveness
PV	Present value
RAT	Return air temperature
RDHx	Rear door heat exchanger
SAT	Supply air temperature
SRIA	Standardized Regulatory Impact Assessment
W	Watt

1. Introduction

1.1 Report Context

This proposal describes specific energy efficiency code changes (referred to as "measures") aimed at reducing wasteful, uneconomic, inefficient, or unnecessary consumption of energy in California. These measures are submitted to the California Energy Commission (CEC) for consideration and potential inclusion in California's Energy Code (Title 24, Part 6), which sets statewide energy efficiency requirements for newly constructed buildings and for additions and alterations to existing buildings. Measures may also be considered for inclusion in California Green Building Standards Code (Title 24, Part 11) as voluntary energy efficiency standards, which would take effect only if adopted by a local jurisdiction seeking to exceed the minimum requirements of the Energy Code. Measures submitted to the CEC will be reviewed, may be modified, and may be incorporated into a broader regulatory package proposed and adopted by the CEC. To be included in the Energy Code, proposed measures must be both cost effective and technically feasible.

1.2 Proposal Sponsors

Three California Investor-Owned Utilities (IOUs)—Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison jointly sponsored this effort. Where the term "Statewide CASE Team" is used in this report, it refers to the authors and State Building Codes Advocacy activities supported through the Codes and Standards program.

1.3 Engagement with Interested Parties to Inform Proposal

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with many industry parties including MEP firms, construction firms, building officials, appliance manufacturers, builders, utility incentive program managers, Title 24 energy analysts, state agencies, Lawrence Berkeley National Laboratory, and others involved in the code compliance process. In addition to those interested parties, the Statewide CASE Team engaged market actors who manage data centers, design and engineering firms specializing in data centers and smaller computer rooms, manufacturers of cooling equipment, appliance standards associations, and national experts involved in data center projects across the country to provide updates on the proposed measure and invite their input and participation in the process. To understand the cost implications of this proposal to computer room builders and developers in California, the Statewide CASE Team engaged with two mechanical engineering and construction firms who were able to provide cost estimates of code compliant approaches.

The proposal also incorporates feedback received during workshops of interested parties that the Statewide CASE Team held on September 30, 2025 and March 17, 2026 (California Energy Codes & Standards: A Statewide Utility Program 2025). The CASE Team was invited to present on the proposed measures in this report on March 18, 2026, at the BayREN Codes & Standards regional forum, and on the "Powering Data Centers: Balancing Growth with Sustainability & Affordability"[2]. Some of the specific feedback the Statewide CASE Team received during this workshop related to the complexity of the proposed code language and questions around specific compliant approaches. The Statewide CASE Team took that feedback and simplified the air-cooled and liquid-cooled information technology equipment (ITE) economizing requirements as shown in Section 2.6 of this report.

Members of the Statewide CASE Team are on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI)'s Datacom Standards Technical Committee, the committee overseeing revisions to AHRI Standard 1360, the performance rating standard of Computer and Data Processing Room Air Conditioners. On February 18, 2026, the Statewide CASE Team provided an overview of the measures in this CASE Report to AHRI and American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) members at a joint meeting of committees dealing with revisions to AHRI Standard 1360 and ASHRAE 127.

Members of the Statewide CASE Team are also on ASHRAE's Standard Standing Standard Project Committees 100 and 90.4. The Statewide CASE Team engaged with interested parties within the ASHRAE community and considered CEC's Building Energy Benchmarking Program data. The program requires owners of large commercial and multifamily buildings to report energy use to the CEC.[3] The Statewide CASE Team analyzed benchmarking data for 2024, and determined that although data centers had higher ENERGY STAR® scores than some buildings, data centers have the highest average weather normalized site energy use intensities and greenhouse gas intensities relative to all other benchmarked buildings, and thereby hold a significant potential to save energy and reduce greenhouse gas emissions.

Aside from the two utility-sponsored public meetings, the Statewide CASE Team engaged in one-on-one conversations with manufacturers such as Carrier Corporation, Vertiv, Daikin Applied, and Johnson Controls. The Statewide CASE Team appreciates the valuable insights offered by these manufacturers during these meetings.

[2] https://www.bayren.org/events/powering-data-centers-balancing-growth-sustainability-affordability-2026-03-18

[3] https://www.energy.ca.gov/programs-and-topics/programs/building-energy-benchmarking-program

See Appendix E for details on the Statewide CASE Team's engagement with interested parties.

1.4 Addressing Energy Equity and Environmental Justice

The Statewide CASE Team recognizes, acknowledges, and accounts for a history of prejudice and inequality in environmental and social justice (ESJ) communities.[4] These issues persist today. To minimize the risk of perpetuating inequity, code change proposals are being developed with intentional consideration of the unintended consequences on ESJ communities. These issues persist today. To minimize the risk of perpetuating inequity, code change proposals were developed with intentional consideration of the unintended consequences on ESJ communities.

When analyzing impacts for nonresidential buildings, the Statewide CASE Team reviewed each nonresidential building type through the lens of the four criteria: cost, health, resiliency, and comfort. The Statewide CASE Team examined which building types are used by ESJ communities most frequently and evaluated the allocation of impacts related to the following areas among all populations. Some building types have unique environmental justice concerns due to their common uses, location, or other factors.

The Statewide CASE Team will continue to build relationships with CBOs and other stakeholders to improve the identification of potential impacts for future code cycles and is open to additional resources that can contribute to this effort.

[4] The CPUC refers to ESJ communities as "low-income or communities of color that have been underrepresented in the policy setting or decision-making process, are subject to a disproportionate impact from one or more environmental hazards, and likely to experience disparate implementation of environmental regulations and socio-economic investments in their communities" (CPUC 2022). ESJ communities also include the CPUC definition for Disadvantaged Communities, which comprises "(1) Census tracts receiving the highest 25 percent of overall scores in CalEnviroScreen 4.0 (1,984 tracts); (2) Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps, but receiving the highest 5 percent of CalEnviroScreen 4.0 cumulative pollution burden scores (19 tracts); (3) Census tracts identified in the 2017 disadvantaged communities designation as disadvantaged, regardless of their scores in CalEnviroScreen 4.0 (307 tracts); and (4) Lands under the control of federally recognized Tribes (OEHHA 2022).

2. Computer Room Economizers

2.1 Computer Room Economizers – Measure Description

2.1.1 Proposed Code Change

This measure would expand definitions related to computer rooms and data centers, such as Liquid-cooled Information Technology Equipment (ITE), and increase the amount of time an economizer serves full or part load cooling in newly constructed computer rooms and existing computer room additions and alterations. These specific measures include:

Added to Definition Section 201 *[Section 100.1(b)]*

- **Liquid-cooled ITE** describes the cooling technology, common types of liquid cooling, and highlights that servers can be partially air-cooled and liquid-cooled.
- **Facility Water** describes the cooling fluid serving liquid-cooled ITE.
- **Computer Room Economizer** describes what a computer room economizer is and provides specific guidance on how to ensure it is fully integrated when the economizer is part of a cooling system that also includes a refrigerant compressor.

Section 1001.2 *[Section 120.8(a)]* **Mandatory Commissioning Requirements**

- Add requirements for computer room commissioning.

Section 910.2 *[Section 140.9(a)]* **– Computer Rooms**

This measure proposes modifying the computer room economizer requirements in the California Energy Code to expand the number of hours economizers must meet all or part of the computer room cooling load. Specific modifications are as follows and additional details about these changes are provided in Section 2.1.3.

A. Raise the 100 percent wet-bulb economizer threshold from 45°F wet-bulb to 60°F wet-bulb for air-cooled ITE.
B. Add new economizer thresholds at 75°F wet-bulb and 75°F dry-bulb for >2MW liquid-cooled ITE loads.
C. Impose minimum water and air temperature differentials and variable flow requirements to ensure integrated economizer savings.
D. Add economizer exception for computer rooms using a heat recovery system meeting specified minimum capacity thresholds.

Existing Building Economizers Section 910.4.1 ***[Section 141.1, 141.1(b)]*****:**

This code change would modify the requirement for additions and alterations so that they are subject to the New Construction requirements as stated in Section 910.2.1. This change would also modify Exception 1 and increase the ITE threshold to 10 Tons for when an economizer is not needed. The change would also delete Exception 2 and Exception 3. Lastly, a new exception would be added, allowing flexibility for existing buildings to comply with the Title 24, Part 6 economizer requirements that were in effect when the building was permitted. Table 5 summarizes the scope of the proposed code change.

Table 5: Scope of Proposed Code Change

A ☑ indicates the proposed code change is relevant.

Building Type(s)	Construction Type(s)	Type of Change
☐ Single Family	☑ New Construction	☑ Mandatory (Commissioning Requirements Only)
☐ Multifamily	☑ Additions	☑ Prescriptive
☑ Nonresidential (Not Group R uses)	☑ Alterations	☑ Performance

Application Climate Zones	Energy Code Sections	Compliance Forms	Sections of ACM Reference Manuals
Climate Zones 1-16	• Part 6, Sections 201, 910.2.1, 910.4.1, 1001	NRCC-PRC-E NRCI-PRC-E NRCC-PRF-01-E	Mandatory

Third Party Verification	Updates to Compliance Software
☑ No changes to third party verification	☐ No updates
☐ Update existing verification requirements	☑ Update existing feature
☐ Add new verification requirements	☐ Add new feature

2.1.2 Benefits of Proposed Change

To achieve California's ambitious climate action plan and hit carbon neutrality by 2045, addressing rising energy use in data centers is critical. With building emissions contributing to roughly 25 percent of California's greenhouse gas (GHG) emissions, increased growth in a highly energy intensive industry such as data centers has the potential to increase overall emissions and negatively impact statewide climate goals (California Air Resources Board 2022). In addition to increased emissions, dramatic rise in energy load to the grid to support data centers could potentially result in increased costs for consumers in the state, if not appropriately managed. One cost-effective way to manage demand growth in data centers is to increase their overall efficiency through energy code measures and technological advancements.

Although projections vary, energy consumption in data centers is projected to increase significantly over the next few decades. According to a recent Lawrence Berkeley National Laboratory (LBNL) report, “data centers consumed about 4.4 percent of total U.S. electricity in 2023 and are expected to consume approximately 6.7 to 12 percent of total U.S. electricity by 2028 (Shehabi, et al. 2024).” During this same time, data centers have become increasingly efficient in computer processing and server cooling technologies, especially with the rise of liquid-cooling technologies. These technologies have improved energy-efficiency, characterized by power usage effectiveness (PUE), by as much as ten percent in some data centers (McKinsey & Company 2024).

While data center energy use roughly doubled from 2000 to 2010, increases from 2010 to 2020 were modest, largely due to technological advancements in servers and cooling technologies. This rapid change in technologies means that current Title 24 requirements and definitions, which were last updated during the 2022 cycle, are falling behind current trends. The inclusion of new definitions such as liquid-cooled ITE and integrated computer room economizers would improve clarity and consistency across the industry and code-enforcement community.

In addition to myriad societal benefits, increasing the outdoor air temperature for when economizers operate would result in operational efficiencies at the individual computer room or data center level. These include, but are not limited to:

- **Energy and Operational Cost Savings:** Raising the server air or liquid inlet temperature in data centers has a direct effect on energy use. It is widely claimed that data centers can save 4-5 percent on energy costs for every 1°F increase in server air or liquid inlet temperature. Various mechanisms exist for saving energy by raising temperatures (Beaty et. al 2016).
- **Reduced Compressor Load:** Increasing the operating temperature and running equipment in economizing mode reduces the time when mechanical cooling is necessary and puts less strain on equipment to meet the load.

2.1.3 Background Information

2.1.3.1 Computer Room Economizer Requirements

Computer room economizer requirements were first introduced in Title 24, Part 6 during the 2013 cycle. During this cycle, 910.2 Prescriptive Requirements for Computer Rooms were established and included provisions regulating economizers, reheat, humidification, fan control, and air containment (California Energy Commission 2012). As it relates to this proposed measure, economizer requirements in the code were established in 2013 and updated in 2022 to reflect technological advancements and increased opportunity for cooling efficiencies.

- 2013 Requirements: When first introduced, cooling systems primarily serving computer rooms were required to include either an integrated dry-bulb or wet-bulb economizer, meeting 100 percent of the cooling load at 55°F dry-bulb or 35°F wet-bulb, respectively. Four exceptions applied.
- 2022 Requirements: These thresholds were updated in the 2022 standard to 65°F dry-bulb or 45°F wet-bulb for a dry-bulb and wet-bulb economizer, respectively. Exceptions were reduced and streamlined.

During and since the previous economizer requirements were implemented, recommended operating temperatures for ITE have steadily increased as technology has advanced. For example, in 2015, IBM's FlashSystem 900 had a recommended operating temperature of 50°F, where the FlashSystem 5200 can operate at 41-95°F (Hopwood 2025). Meanwhile NVIDIA's Grace Blackwell GB200 NVL72 graphics processing units (GPUs)/central processing units (CPUs) use a liquid cooling system with a maximum liquid inlet temperature of 113°F.

ASHRAE's Technical Committee 9.9, which develops guidelines and standards for mission critical facilities, data centers, technology spaces, and electronic equipment/systems has also increased thermal guidelines for data centers over the years. The primary recommended temperature range for general data center equipment (all classes) has increased from 68-77°F in the 2004 edition to a wider range of 64-81°F in the 5th edition, with wider allowanced temperatures depending on the class and cooling approach (ASHRAE 2021).

Air-Cooled versus Liquid-Cooled ITE

Air-cooled ITE uses ambient air to help dissipate heat in computer rooms and data centers through established cooling technologies such as DX Air conditioners, chilled water air handlers, airside economizers, etc. Air-cooled technology has been the dominant approach to remove heat from ITE, and it has evolved and become more efficient over time through design approaches such as hot aisle containment. Liquid-cooling technology is typically employed in enterprise level data centers with high heat density workloads, such as artificial intelligence (AI), and high-performance computing (HPC) data centers. Liquid-cooled ITE uses a cooling liquid to provide cooling at the chip-level; two common liquid cooling systems are direct to chip (D2C) cold plates and immersion systems. According to a recent study from the Uptime Institute, there continues to be a trend toward rapid growth in rack densities, with colocation data centers – a data center where companies can rent space to locate their servers – seeing the strongest uptick in rack power (Donnellan, et al. 2024). As densities increase, traditional air-cooled ITE approaches may not effectively cool the servers, necessitating a switch to liquid-cooled ITE. Liquid cooling has a much higher heat-rejection capacity than air-cooled technologies—roughly 1,000 times the cooling capacity of air—enabling it to support heat loads exceeding 100 kW per rack (Lawrence

Berkeley National Laboratory 2021). Liquid-cooled ITE can also operate at temperatures above 100°F entering water temperature; this allows for greater heat recovery potential than air-cooled ITE systems by rejecting heat directly to a hydronic heating system and meet space heating needs without the need to boost the temperature higher through a mechanical heating system for many, or all, hours of the year.

The primary goal of the proposed computer room definitions is to improve clarity and align the code language with common terminology within the industry and describe liquid-cooled ITE. As defined in the proposed definition:

> ***Liquid-cooled ITE***: components of ITE that are cooled by a fluid other than air and that do not use server fans to flow air across the components. Common liquid cooling fluids include water, glycol, and refrigerant. Individual servers can be partially liquid-cooled and partially air-cooled, with server fans serving the air-cooled components and pumps serving the liquid-cooled components.

The most common types of liquid-cooled ITE approaches include direct-to-chip (D2C) and immersion cooling. These technologies are described below:

- **Direct-to-chip:** D2C cools ITE by moving coolant (dielectric single-phase fluid) through server racks and directly connected to a cold plate that is connected to the central processing unit (CPU) or graphics processing unit (GPU). This enables heat to be removed directly from the chip, typically flowing through a coolant distribution unit and heat exchanger, and then rejected through a central chiller or cooling tower. Figure 1 is an image of a D2C cooling approach.
- **Immersion cooling:** This approach still uses a dielectric single-phase fluid for cooling, but instead of piping it through the servers, servers are directly submerged in fluid for cooling.
- **Rear door heat exchanger (RDHx):** This cooling approach offers precision cooling at the server cabinet level. A heat exchanger is attached directly to the door of the cabinet and heat generated by the servers is extracted through chilled water circulation. RDHx can either be passive—relying on server fans to drive airflow through the heat exchanger—or active with the use of additional auxiliary fans. This approach is often used in tandem with a building cooling system and airside economizer.

Figure 1 shows a server with air-cooled components on the left side and D2C liquid-cooled components on the right side.

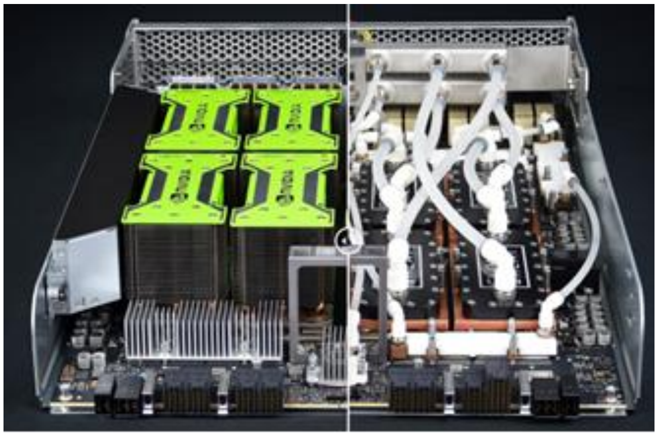

Figure 1: Air-Cooled ITE (left) and D2C Liquid-Cooled ITE (right)

Figure 2: Immersion Cooling at Sandia National Laboratories

Photo by Craig Fritz and published by Sandia National Laboratories 2024

Figure 3: Passive RDHx Devices at LBNL

Background on Changes to Section 910.2.1 *[Section 140.9(a)]*

Additional context and design approaches for each of the proposed changes to 910.2.1 are described below:

1. Raise the 100 percent wet-bulb economizer threshold from 45°F wet-bulb to 60°F wet-bulb for air-cooled ITE.
    a. Unlike an airside economizer which has a direct cooling option, there is no direct option for waterside economizers. A typical waterside economizer serving air-cooled ITE is a water-cooled chilled water plant with plate heat exchangers. It has three approaches: 1) the cooling tower’s leaving condenser water approach to the outdoor wet-bulb, 2) the heat exchanger approach from condenser water to chilled water, and 3) the air handler coil approach from chilled water to the supply air temperature. For the current 45°F threshold and a typical 75°F supply air temperature, the total of these three approaches must not exceed 30°F. Raising the full economizing threshold to 60°F outdoor wet-bulb means the three approaches must total no greater than 15°F. This would require larger equipment to reduce approach temperature: larger cooling towers, and/or larger heat exchangers, and/or larger cooling coils.
2. New economizer thresholds at 75°F wet-bulb and 75°F dry-bulb for >2MW liquid-cooled ITE loads.
    a. Air-cooled ITE can typically be satisfied with 60-65°F chilled water supply to the air handler. Liquid-cooled ITE can be satisfied with the same 60-65°F chilled water, but it can also be satisfied with higher entering fluid temperatures, like 80-105°F to the coolant distribution unit (CDU) which distributes liquid cooling to the chips and rejects the heat via a heat exchanger through a facility water loop connected to a chiller or cooling tower (Conroy, Weitze and Droitcour 2026). Most large data centers with liquid-cooled ITE also have a significant air-cooled ITE load, often in the same rack. It is common for these types of data centers to have a single chilled water distribution system serving both the air-cooled ITE and the liquid-cooled ITE with 60-65°F chilled water. It is also common for these types of data centers to include two sets of distribution piping: 60-65°F chilled water from chillers to the air-cooled ITE and 80-105°F chilled water to the liquid-cooled ITE. 80-105°F chilled water can be generated more efficiently than 60-65°F chilled water.
    b. Note that the 2MW trigger applies only to the liquid-cooled ITE. For example, if a data center has 1.5 MW of air-cooled ITE and 1.5 MW of liquid-cooled ITE. Then the 2 MW trigger is not reached and the 75F ambient threshold does not apply. Note also that the 75F threshold applies only to the liquid-cooled ITE. For example, if a data center has 3 MW of air-cooled ITE and 3MW of liquid-cooled ITE then only the 3MW of liquid-cooled ITE must meet the 75F full economizer threshold.

3. Impose minimum temperature differential and variable flow requirements.
    a. Currently Title 24, Part 6 simply states that a computer room economizer must be integrated, which means it is capable of partial economizer and partial mechanical cooling. This measure would also effectively establish return air temperature and return water temperature requirements. In addition to the proposed definition of an integrated economizer, this new requirement would be a way to further define computer room economizer integration and promote increased economizer utilization at part-load conditions through elevated return air and water temperatures.
    b. It is common to design computer room heating, ventilation, and air conditioning (HVAC) systems for an airside dT of 20F or higher (e.g. 75F design supply air temperature (SAT) and 95F design return air temperature (RAT)). There are many ways to control the system to vary the airflow as a function of ITE load, in order to maintain a constant dT down to 25% ITE load. One common control sequence is to modulate computer room air handler (CRAH) unit supply fan speed to maintain a constant differential pressure (e.g. +0.03") between the cold aisles and hot aisles in a data center. As the ITE load varies (e.g. as servers are added or removed from the room) the total server fan flow rate varies with the ITE load. By controlling to a fixed cold-hot aisle dP the CRAH airflow closely tracks the server fan flow and thus the ITE load. To maintain a constant dT down to 25% ITE the CRAH unit fans must have a minimum speed of 25% or lower.
    c. Similarly, it is common to select CRAH unit chilled water coils for a 15°F or higher dT. For example, for a SAT/RAT of 75/95F there are many available coils that can be selected at chilled water supply/return temperatures of 65/80F. This meets the proposed requirement of a 15°F dT for chilled water and facility water systems. The dT will remain relatively constant from 25% to 100% ITE load if a two-way chilled water valve is used to modulate chilled water coil flow to achieve a constant SAT (e.g. 75F). dT will not remain sufficiently constant if a three-way chilled water valve is used.

Integrated Computer Room Economizers

There are many types of computer room economizers in use today. Many of these are integrated and meet the new definition of integrated economizer. Many are not integrated and may not comply with the proposed prescriptive requirements in the measure. The following two sections provide detailed explanations and illustration of compliant (integrated) designs and non-compliant (non-integrated) designs.

Compliant Designs

The new definition would spell out several prescriptively compliant economizer types.[5] A description and diagram of potentially compliant dry-bulb and wet-bulb economizers for air-cooled and liquid-cooled ITE is outlined below.

1. Waterside economizer heat exchangers that are piped in series with chillers on the chilled water (evaporator) side. This allows the waterside economizer heat exchanger to cool the return chilled water before it reaches the chiller evaporator and reduces the load on the chiller from 1-99 percent during partial economizer operation. (see Figure 4).

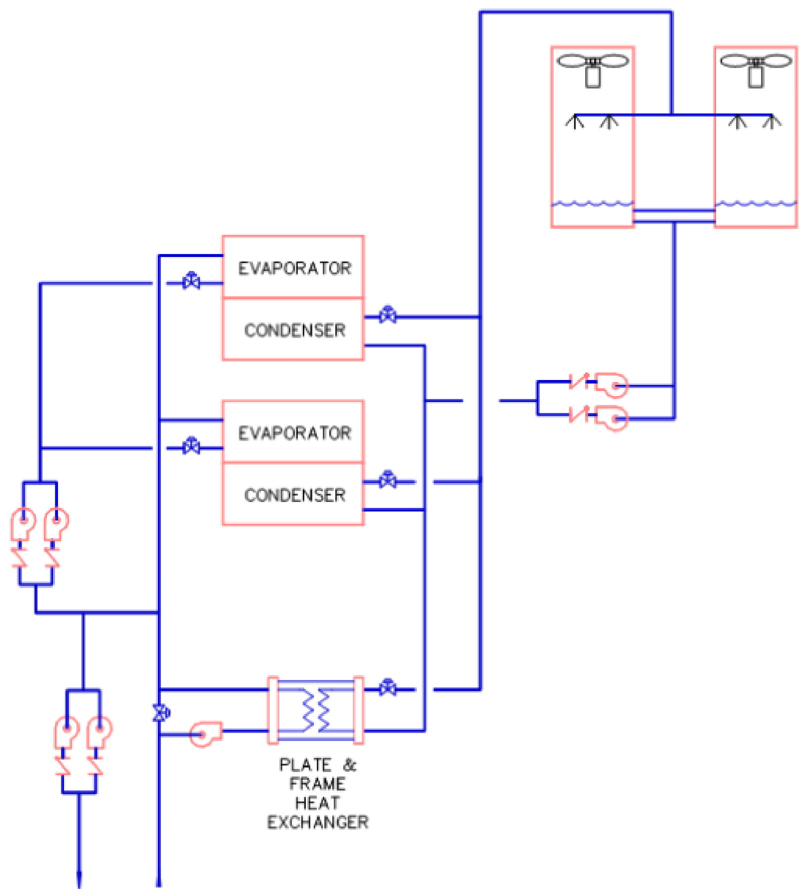

Figure 4: Compliant Waterside Economizer (Piped in Series with Evaporator)

2. Air-cooled chillers with integrated economizer coils that are piped into the secondary circuit of a primary/secondary system. This allows the economizer to operate based on the return water temperature to the data center cooling coils, which is typically warmer, and therefore allows for more economizing hours, than

[5] Note that just because an economizer meets the definition of integrated does not mean that it automatically complies. It must still meet the economizer temperature threshold requirements.

the primary return water temperature which may be lower due to mixing with supply water to meet chiller minimum flow requirements. (see Figure 5)

3. Air-cooled chillers with integrated economizer coils that are served by dedicated economizer fans and not by condenser fans that serve refrigerant condenser coils. This allows for the dry cooler condenser fans to operate independently from the chiller condenser fans and not be limited by the chiller head pressure control requirements. This also allows the dry cooler to make colder water at low outdoor temperatures and increase economizer cooling capacity (see Figure 5).

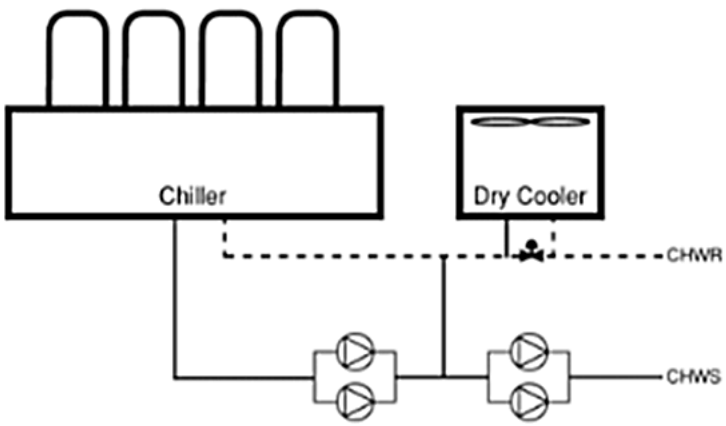

Figure 5: Potentially Compliant Air-Cooled Chiller with Dry Cooler Piped into Secondary Circuit

4. Refrigerant economizer systems where 10-90 percent of the load on a refrigerant circuit could be met by a passive condenser or refrigerant pump, while the other 90 to ten percent of the load is met by an active condenser or refrigerant compressor.
5. In a scenario where a data center has both air-cooled and liquid-cooled ITE, separate plants for air-cooled and liquid-cooled ITE are more likely to comply. This enables the liquid-cooled ITE to be served at a high enough condenser water temperature to meet the liquid-cooled ITE economizer requirement and the other plant can operate at a lower temperature to meet the air-cooled ITE economizer requirement (see Figure 6).

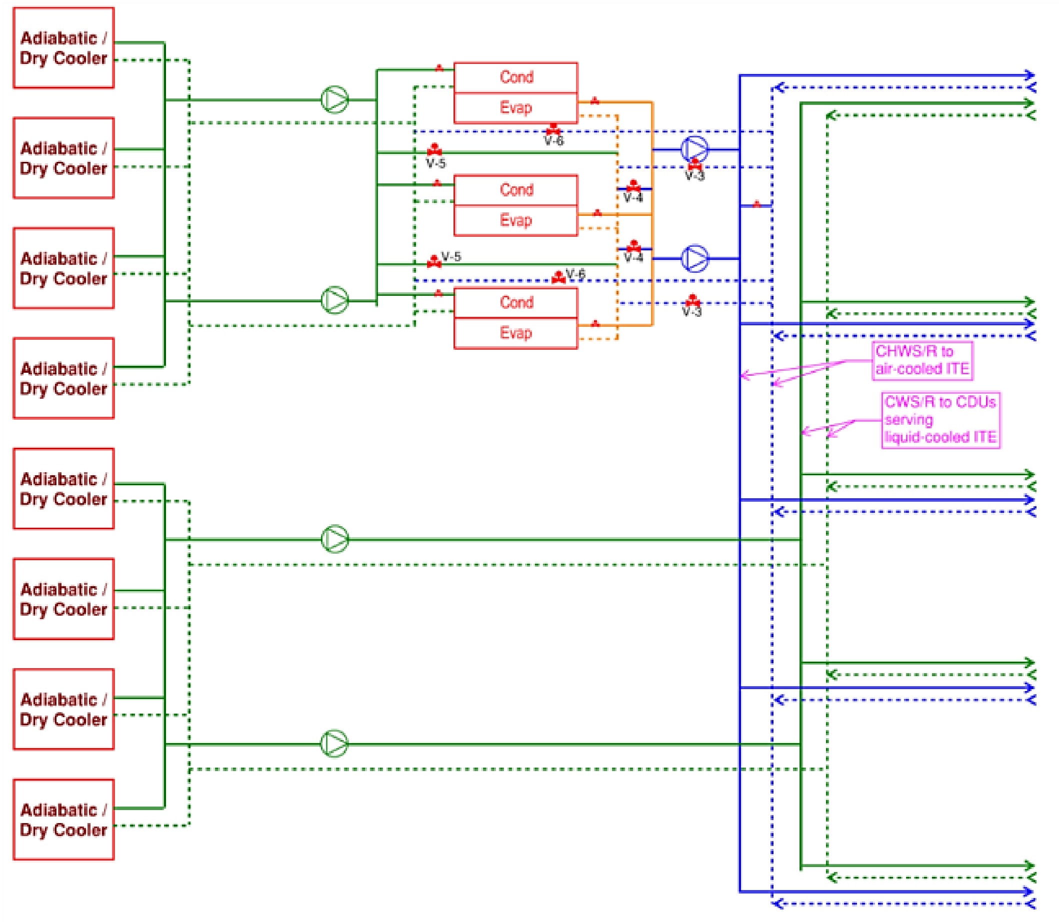

Figure 6: Potentially Compliant Liquid-Cooled ITE Economizer: Chillers and Wet-Bulb Economizer Dedicated to Air-Cooled ITE and Separate Economizer-Only Plant Dedicated to Liquid-Cooled ITE (Note: CWS/R is Same as FWS/R)

Figure 6 shows the liquid-cooled ITE served by dry coolers with adiabatic assist. In this configuration, water is sprayed into the airstream entering the dry-cooler coil, evaporatively pre-cooling the entering air and allowing the dry cooler to achieve a lower leaving-water temperature. This system has no mechanical cooling. This is one of many systems that could meet the proposed liquid-cooled ITE economizer thresholds. Other systems include:

1. Cooling towers with heat exchangers (no mechanical cooling)
    - Typical approach from outdoor air wet-bulb (OAWB) to facility water supply temperature (FWST): 7°F-12°F
2. Dry-coolers with adiabatic assist (no mechanical cooling)
    - Typical approach from OADB to FWST: 10°F-15°F
    - Adiabatic assist typical effectiveness: 85%
3. Dry-coolers with air-cooled or water-cooled chillers (no evaporation)

- Typical approach from OADB to FWST: 10°F-15°F

4. Refrigerant economizers with DX compressors, with optional adiabatic assist
    - Typical approach from OADB to TCS: 22°F (typically no CDU)

The design technology cooling system (TCS), which is a closed-loop liquid directly cooling ITE, supply temperature and the design CDU approach are the most critical factors in determining what cooling system will meet the requirement. Table 6 shows the required FWST for a range of possible TCS supply temperatures and CDU approaches. The table also shows the required approach of the cooling system to the FWST in order to meet the 75°F dry-bulb and 75°F wet-bulb threshold for >2MW liquid-cooled ITE loads.

Table 6: Technology Cooling System Supply Temperatures and Approaches

TCS Supply (C)	TCS Supply (F)	CDU approach (F)	FWST (F)	Required approach (F)
50	122	10	112	37
45	113	10	103	28
40	104	5	99	24
35	95	5	90	15
32	90	3	87	12

Non-Compliant Designs

The new definition also would spell out several non-compliant economizer types. A description and diagram of potentially non-compliant dry-bulb and wet-bulb economizers for air-cooled and liquid-cooled ITE is outlined below.

1. Waterside economizer heat exchangers that are piped in parallel with chillers on the chilled water (evaporator) side. This prevents the economizer from providing partial economizing capacity; the waterside economizer heat exchanger only operates, and therefore only saves energy, when it can meet 100 percent of the cooling load (see Figure 7).

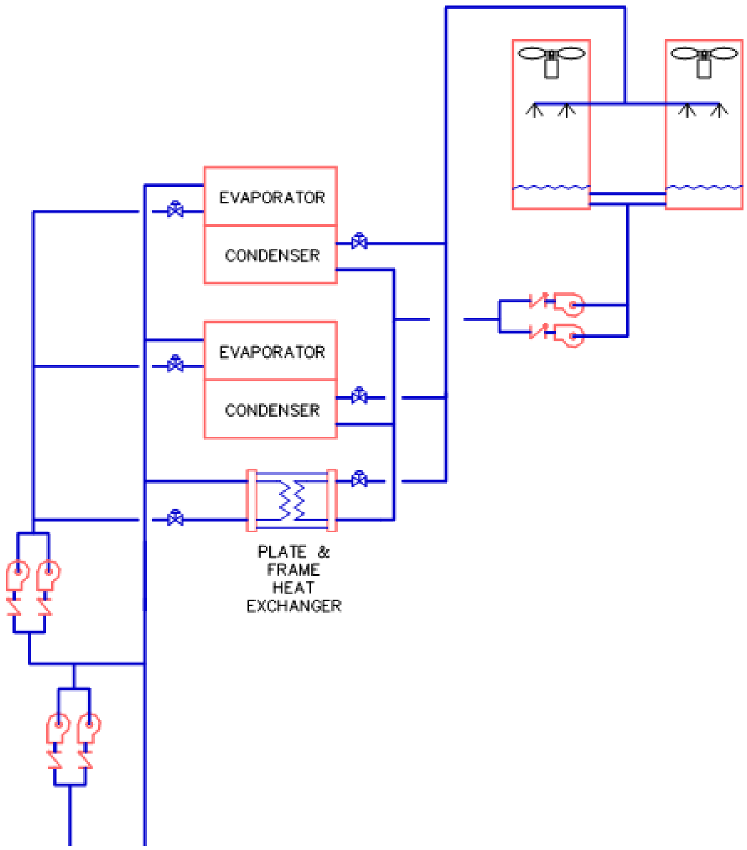

Figure 7: Non-Compliant Waterside Economizer (Piped in Parallel with Evaporator)

2. Air-cooled chillers with integrated economizer coils that are piped into the primary circuit of a primary/secondary system. The primary loop return chilled water temperature is typically lower than the secondary chilled water return temperature due to mixing with supply water through the minimum flow bypass pipe, which reduces the amount of economizer load that can be served by the dry cooler (see Figure 8).

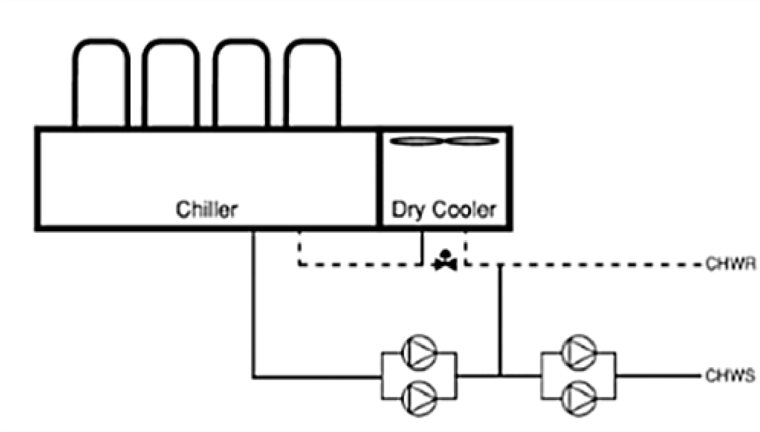

Figure 8: Non-Compliant Air-Cooled Chiller with Dry Cooler Piped into Primary Circuit

3. Air-cooled chillers with integrated economizer coils that are served by the same condenser fans that serve refrigerant condenser coils. The refrigerant condenser fan speed is thus limited by the need to maintain a minimum refrigerant head pressure, which may reduce economizer heat rejection capacity at low outdoor temperatures (see Figure 9).

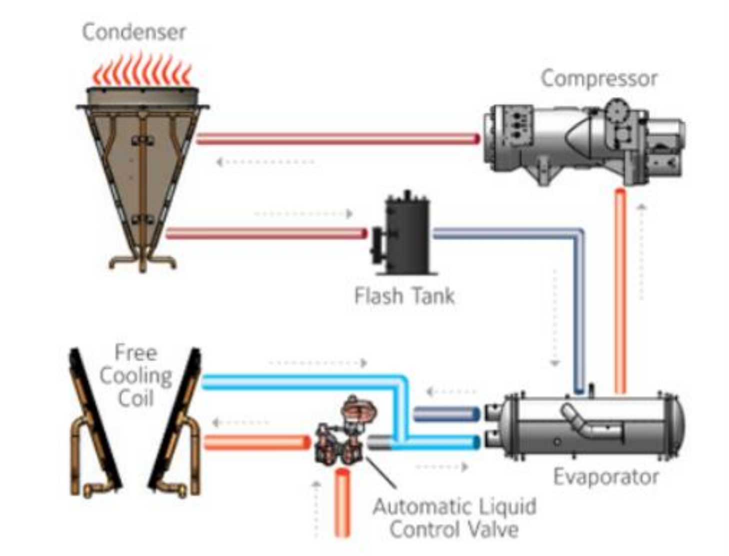

Figure 9: Likely Non-Compliant Air-Cooled Chillers with Integrated Economizer Coils that Are Served by the Same Condenser Fans that Serve Refrigerant Condenser Coils

4. Refrigerant economizer systems with one or more refrigerant circuits that must switch from full refrigerant compressor operation to full refrigerant pump condenser operation. This limits partial economizer capacity to the capacity of each circuit.

5. In a scenario where a data center has both air-cooled and liquid-cooled ITE, a single chilled-water plant serving both is unlikely to meet the liquid-cooled ITE economizer requirement. This is because the chilled water required for the air-cooled ITE is too cold to meet the liquid-cooled ITE economizer requirement (see Figure 10).

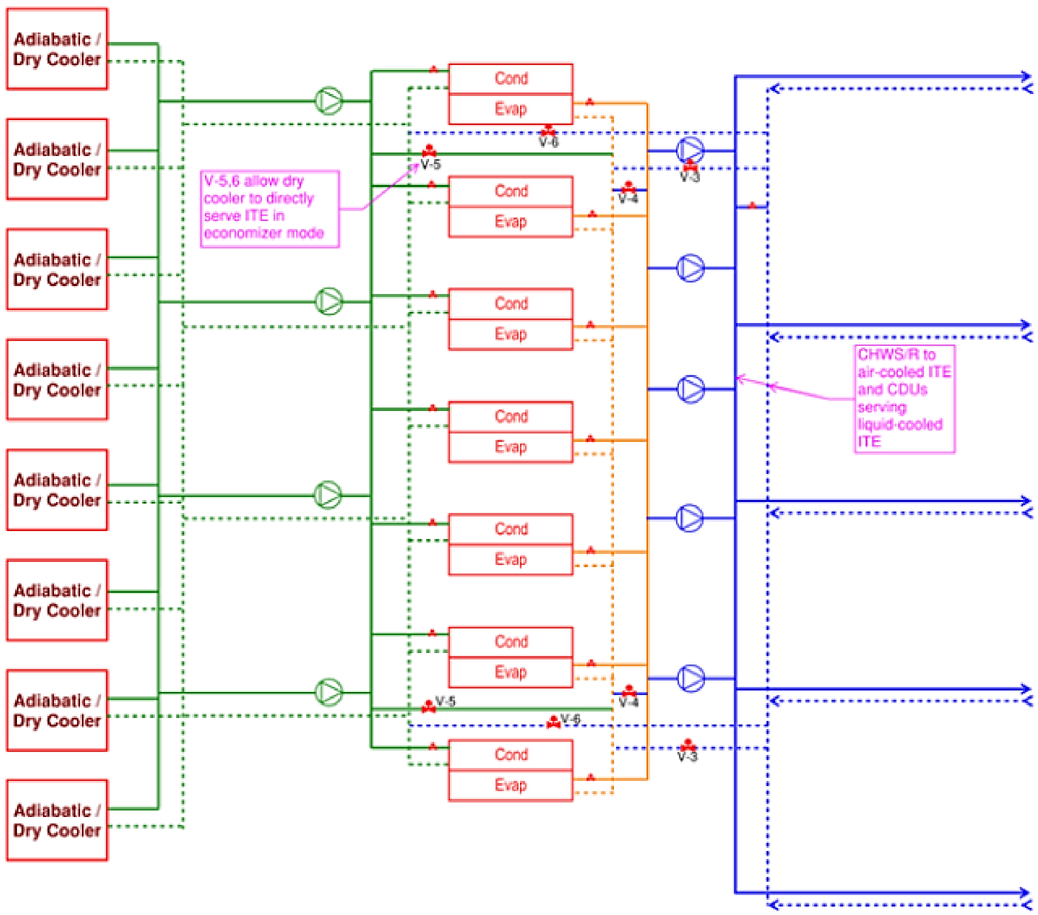

Figure 10: Likely Non-Compliant Liquid-Cooled ITE Economizer: Chiller Plant with Wet-Bulb Economizer that Serves Both Air-Cooled ITE and Liquid-Cooled ITE with Chilled Water

2.1.3.2 Humidity Considerations

Many data centers comply with the ASHRAE TC9.9 Guidelines on space humidity. Many data centers are also not limited to the TC 9.9 humidity constraints. It is important to understand if any of the proposed changes to Title 24 would hinder a data center's ability to meet the TC 9.9 humidity guidelines. As shown in Figure 11, TC 9.9 recommends a lower humidity limit of 15°F dewpoint and an upper humidity limit of 70 percent RH and 59°F dewpoint. Nothing in the proposed changes affects the lower dewpoint. The only proposed change that might impact the upper humidity limit is the change in the threshold for full airside economizing from 65°F DB / 50°F WB to 65°F DB

/ 60°F WB. It turns out, however, that 65°F DB / 60°F WB corresponds to a dewpoint of 57°F, which is safely below the recommendation of 59°F dewpoint. Thus, there are no proposed changes that would hinder a data center's ability to meet the TC 9.9 humidity guidelines.

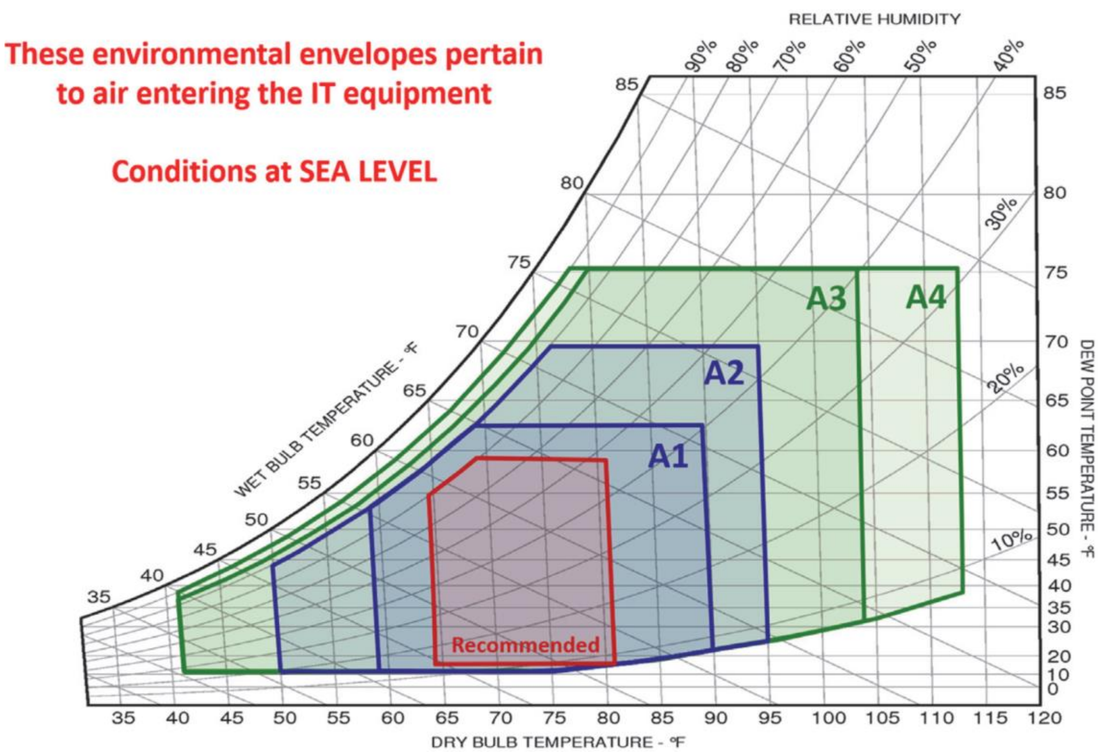

Figure 11: ASHRAE TC 9.9 Thermal Guidelines

2.1.3.3 Supply Air Temperature Rating Conditions

The current economizer requirement in Title 24 requires that the ambient threshold for 100 percent economizing be achieved at a supply-air temperature (SAT) between 65°F to 80.6°F. Achieving 100 percent economizing across this entire SAT range can be onerous and may limit economizer options. This SAT requirement was added to the 2022 edition of Title 24, Part 6, for a few reasons. First, the provisions in the code sought to ensure compliance by demonstrating that the economizer could meet 100 percent of the load at the SAT at which the system actually operates, rather than at an unrealistically high SAT such as 100°F. If a system could meet the criteria only at 100°F but actually operated at 70°F SAT, most of the economizer benefit would be lost. Second, the requirement demonstrated that the Title 24 economizer provision does not conflict with the ASHRAE TC 9.9 Thermal Guidelines, which recommend SATs between 64.4°F and 80.6°F. Finally, it encouraged the use of a higher SATs. At the time, it was still common to supply computer rooms with 55°F SAT, and it was rare to supply above 75°F.

In this proposal the SAT rating range is changed from 65°F-80.6°F to 75°F to a single SAT of 75°F. The primary reason for this change is to demonstrate compliance using a single SAT at which the economizer can be consistently rated. For example, if Economizer A can meet 100 percent of the load at ambient conditions of 65°F OADB and 80°F SAT, then it has an approach from OADB to SAT of 15°F. If Economizer B can meet 100 percent of the load at 65°F OAD and 75°F SAT, then it has an approach from OADB to SAT of 10°F. If both economizers operate at SAT of 75°F, Economizer B will be in full economizer mode, while Economizer A will only be able to provide partial cooling. Economizer A will not be able to meet the entire load until the ambient DB falls below 60°F.

A SAT of 75°F is chosen for the rating range because it is the SAT used in all of the lifecycle cost analyses to justify the currently proposed thresholds and the existing thresholds. This value was also chosen because it is a common design SAT. Few data centers consistently operate above 75°F SAT (i.e., cold-aisle temperature).

Using a rating condition of 75°F SAT does not mean that computer rooms must operate at exactly this SAT. It is simply a condition at which the economizer is rated. Computer rooms are free to operate at any SAT. There are many other examples of Title 24 requirements based on defined rating conditions. For example, the cooling tower GPM/HP efficiency requirements in 140.4(h)5 are based on the following rating conditions: 95°F entering water, 85°F leaving water, 75°F ambient air WB. This does not mean cooling towers must be selected at a 10°F approach or designed or operated at these entering and leaving water temperatures. It only means that they must meet the minimum GPM/HP at these rating conditions.

The SAT rating condition is changed from a range to a single value because it is a rating condition. Using a range of say 65°F to 75°F implies that the economizer must be capable of meeting 100 percent of the load at both 65°F SAT and 75°F SAT (and every SAT in between). This works fine for a direct airside economizer (which has 0°F approach) but any other type of economizer has an approach and cannot necessarily provide 100 percent of the load at 65°F SAT, even if it can provide 100 percent at 75°F SAT. Using a single number removes any confusion about how to rate the economizer.

2.1.3.4 Background on Nonresidential Alternative Calculation Method (ACM)

The current economizer requirement in Title 24 requires that the ambient threshold for 100 percent airside economizing is 65F. This generally requires a direct airside economizer. These baselines were developed in 2012 and represented reasonable best practice for most computer rooms and data centers at that time. Much has changed since that time. One significant change is increased power density per rack. In 2012 typical racks were in the 2-10 kW/rack range. Now it is common for racks to have air-cooled ITE exceeding 25 kW/rack. Airside economizing is increasingly expensive and impractical at very high density. An airside economizer typically requires air handlers along an exterior wall of a data center for access to outside air, with long cold aisles perpendicular to the exterior wall to supply outdoor air from the AHU to the racks. The airflow requirement for high density ITE facilities means the cold aisles can only be a couple racks deep. Any deeper and the aisle cross sectional area would be prohibitively large. High density air cooling typically requires close-couple cooling solutions, like rear door heat exchangers or in-row coolers (IRCs). Airside economizing with close-coupled airside cooling is not practical. Waterside economizers are common for high density air-cooling but unfortunately waterside economizers are not as energy efficient as direct air economizers. As a result, a baseline system with an airside economizer is not a reasonable baseline for high density air-cooled ITE. As described below high density air-cooled ITE is now mapped to a new baseline system (11a) with a dry cooler economizer, which is in line with the new prescriptive economizer threshold for high density air-cooled ITE.

Another factor that must be considered is water scarcity. With the explosive growth of data centers there is real concern that water-cooled data centers will use an excessive quantity of water to the detriment of other critical uses such as agriculture and residential. For this reason, the data center industry is making great efforts to minimize or eliminate water use. Data centers that use water (e.g. cooling towers) use less electricity and conversely data centers that do not use water (e.g. dry coolers) require more electricity. In the Title 24 performance approach water is free but electricity is valued using the TDV/LSCC values. Currently, system 10 for large data centers uses water-cooled chillers. This makes it difficult or impossible for large data centers striving to minimize water use to meet the baseline. Consequently, the performance approach is effectively requiring water-cooled data centers. For these reasons System 10 is being changed from water-cooled chillers to air-cooled chillers. This change does not prohibit a data center from using water-cooled chillers, but it no longer requires it.

Another development is the growth of liquid cooling and the new proposed prescriptive requirement for large liquid cooled ITE loads. New System 11b is the new baseline corresponding to the new proposed prescriptive requirement for large liquid cooled ITE loads.

System 10 will be modified from water-cooled chillers to high efficiency air-cooled chillers. The CRAH units with airside economizers will be unchanged. SAT is updated to 75°F and RAT is updated to 95°F.

2.1.4 Modifications to Energy Code Documents

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 2.6 of this report for detailed revisions to code language.

2.1.4.1 Energy Code Change Summary

SECTION 200.3 *[SECTION 100.1(b)]* – DEFINITIONS AND RULES OF CONSTRUCTION

This section would expand definitions pertaining to computer rooms and data centers to accommodate changes in technology and construction practices, especially as it relates to ways to efficiently cool ITE and computer room buildings. This expanded set of definitions would cover: Liquid-cooled ITE, Computer Room Economizer, Computer Room Wet-Bulb Economizer, and Computer Room Dry-Bulb Economizer. A primary goal of including the computer room economizer definition is to provide additional guidance on how to design a fully integrated computer room economizer.

SECTION 1001 – MANDATORY REQUIREMENTS FOR COMMISSIONING

A new subsection would be added for computer room commissioning requirements. Computer rooms with an ITE load greater than 1 MW would be required to undergo commissioning activities for mechanical systems. Design phase requirements would include 1001.2.1 owner's project requirements, 1001.2.2 basis of design, 1001.2.3 design review, 1001.2.4 commissioning measures shown in the construction documents, and 1001.2.5 commissioning plan. The design review must include verification that the design meets mandatory heat recovery requirements and prescriptive economizer and variable flow (deltaT) requirements. Construction phase requirements would include 1001.2.6 functional performance testing, 1001.2.7 documentation and training, and 1001.2.8 commissioning report.

SECTION 910.2 *[SECTION 140.9(a)]* – PRESCRIPTIVE REQUIREMENTS FOR COMPUTER ROOMS

Subsection 910.2.2: The proposed changes to this section would modify the computer room economizer requirements in several ways. Some of the proposed changes are more editorial, such as the removal of a wet-bulb temperature reference for dry-bulb economizer requirements, and dry-bulb temperature reference for wet-bulb economizers. The primary impact from the proposed changes, however, would increase the amount of time economizers must be capable of meeting all or part of the cooling load in computer rooms. Economizer temperature thresholds would be increased for wet-bulb economizers in computer rooms with air-cooled ITE. New economizing requirements are added for data centers with a liquid-cooled ITE load greater than 2

MW. Additionally, minimum water and air temperature differentials and variable flow are required. Exception 2 is modified to raise the outdoor temperature for when an economizer must meet the design cooling load of the computer room. A third exception is proposed for computer rooms with a heat recovery system that can accept at least 50 percent and the design heating load of the system(s) to which the heat is transferred is at least five times greater than the computer room design cooling load. Functional testing set forth in section 910.2.2.6 must include an integrated economizer functional test.

SECTION 910.4 *[SECTION 141.1, 141.1(b)]* – REQUIREMENTS FOR COMPUTER ROOMS IN ADDITIONS, ALTERATIONS TO EXISTING NONRESIDENTIAL, AND HOTEL/MOTEL BUILDINGS

Subsection 910.4.1: The proposed changes to the additions and alterations section would incorporate the expanded economizer requirements in 910.4.1 and apply them to new cooling systems serving computer rooms in existing buildings. This change would also modify Exception 1 and increase the ITE threshold to 10 tons when an economizer is not required. The change would also delete Exception 2 and Exception 3. Lastly, a new exception would be added, allowing flexibility for existing buildings to comply with the Title 24, Part 6 economizer requirements that were in effect when the building was originally permitted.

2.1.4.2 Reference Appendices Change Summary

The proposed changes would not impact the reference appendices as there is no acceptance testing for computer room requirements.

2.1.4.3 Compliance Manuals Change Summary

Section 10.4 of the Nonresidential Compliance Manual, which outlines Computer Room requirements in the code, would need to be updated. Specifically, section 10.4.1 would include proposed computer room economizing definitions. Section 10.4.3.1 – Economizers, would be updated to reflect economizing threshold changes for computer rooms with air-cooled and/or liquid-cooled ITE.

Additional guidance would also need to be included to describe a compliance scenario for data centers with part liquid-cooled ITE and part air-cooled ITE.

Alternative Calculation Method Reference Manual Change Summary

The following sections in the ACM would need to be updated based on the proposed change:

- Appendix 5.4B: Modify the cooling setpoint for data centers from 80°F to 90°F. Per ACM section 5.7.2.3 Supply Air Temperature Control, raising the cooling setpoint from 80°F to 90°F, will raise the SAT from 60°F to 70°F, which is more consistent with current standard practice.

- Section 5.7.4.2 Air Side Economizers: Revise the Economizer High Temperature Lockout standard design from a fixed dry-bulb high limit of 80°F to 90°F.

The Standard Computer Room Design (System 10 and System 11) includes a dry-bulb economizer. System 11 would be the baseline system to which a large liquid-cooled ITE data center is compared. A liquid-cooled ITE data center that meets the new prescriptive requirements in 140.9 should be at least as efficient as System 11. There is no need to add a new standard design for liquid-cooled ITE data centers.

2.1.4.4 Compliance Forms Change Summary

Please refer to section 2.6.7 for a summary of the proposed revisions to the compliance forms due to the proposed changes to the energy code.

2.1.5 Measure Context

2.1.5.1 Comparable Model Codes or Standards

ANS/ASHRAE/IES Standard 90.1 – 2022 defines a computer room in the same way as Title 24, Part 6, specifying an equipment power density of 20 watts (W)/ft^2 of conditioned floor area. This standard does not, however, include additional definitions for computer room economizers and liquid-cooling ITE that are recommended as part of this measure. Section 6.5.1 requires computer room economizing in Climate Zones 2A or greater with specific exceptions. Exceptions are based on cooling load thresholds for new systems and alterations, or when the local water authority does not allow cooling towers. The primary exception for additions or alterations states that an economizer is not required if the added cooling equipment capacity is less than 600,000 British thermal units (Btu)/hr.

Economizer high-limit setpoints based on outdoor air temperature vary by climate zone and moisture regimes, but they are less stringent than what the Statewide CASE Team is proposing in this measure. ASHRAE 90.1 also does not require a minimum economizing load fraction based on temperature (ASHRAE 2022).

2024 International Energy Conservation Code (IECC) defines a computer room in the same way as Title 24, Part 6 but does not include additional definitions for computer room economizers and liquid-cooling ITE. Section C403.5 requires computer room economizing and specifies the same high-limit shutoff control table as ASHRAE 90.1-2022 for when economizing is no longer required based on outdoor air temperature and climate zone. This section does not include specific economizer exceptions for computer rooms.

As specified in Chapter 5—Existing Buildings, new cooling systems for computer rooms in existing buildings must comply with economizer requirements as described in C403.5 (International Code Council 2024).

ASHRAE 90.4 – 2022 serves as an optional compliance pathway for computer room or data centers with HVAC systems serving computer rooms with ITE load greater than 10kW. This standard provides more options for performance-based compliance of data center facilities (ASHRAE 2022).

2.1.5.2 Interactions with Other Regulations

There are no relevant local, state, or federal laws related to increased temperature thresholds for computer room economizers, but some of these laws do impact data center efficiency. These are described below:

Federal Laws: The Energy Independence and Security Act of 2007 required that a voluntary national information program be developed to address energy efficiency in data centers. This provision defined data center as “any facility that primary contains electronic equipment used to process, store and transmit digital information, which may be (A) a free-standing structure; or (B) a facility within a larger structure, that uses environmental control equipment to maintain the proper conditions for the operation of electronic equipment (Energy Independence and Security Act of 2007 2007).” The U.S. EPA and U.S. DOE established the National Data Center Energy Efficiency Information Program after this law and incorporated many of the requirements, such as developing specifications and benchmarks, coordinating with the industry, and an open data initiative, through existing programs like EPA’s ENERGY STAR® Program.

California State Laws: As outlined in section 1820.3 of the California State Administrative Manual, State-owned or leased data centers include additional requirements to measure and report PUE, and must reduce PUE by ten percent, annually, if it exceeds 1.5 (Services 2014). While there is no specific requirement related to economizing, existing state-owned or leased data centers that exceed 1.5 PUE will likely consider increased economizing as a cost-effective strategy to reduce PUE and bring the data center into compliance with the state requirement. State owned and leased data centers are managed through the California Department of Technology.

Interactions with California Building Code: Appendix E: Sustainable Practices of the 2025 California Mechanical Code includes prescriptive requirements for computer room economizers in Section E 503.5. Exceptions (11) and (12) specify when economizer requirements apply to computer rooms. This appendix is provided for reference and is not mandatory in jurisdictions throughout California.

2.2 Computer Room Economizers – Compliance and Enforcement

2.2.1 Compliance Considerations

The proposed measure would build off the existing requirement for economizing in computer rooms by increasing minimum economizing temperature thresholds and requiring minimum water and air temperature differentials and variable flow provisions.

To help improve clarity and provide additional guidance in the code, the proposed measure would expand the definition of a computer room economizer to describe and provide examples of fully integrated economizers that are compliant and non-compliant. This additional information provided directly in the code would help address common confusion about integrated economizers in the marketplace and improve design efficiency and rates of compliance. Education and training would need to be developed and delivered across the industry to ensure new economizer requirements, potential compliant design solutions, and ways to enforce and provide appropriate documentation for measures are fully understood.

The proposed measure would result in the following changes for market actors at each step of the design and construction process.

- **Design Phase:** The mechanical design engineering process would not change based on the proposed measure. A design engineer would still determine if an economizer requirement were triggered based on computer room ITE load. With the proposed ITE threshold change, more existing buildings would require an economizer and thus additional projects for a designer to support. Mechanical design engineers or energy consultants would complete Nonresidential Certificate of Compliance (NRCC) forms with the permit package. These activities are the same as current requirements; however, the mechanical design engineer would need to follow the new requirements.
- **Permit Application Phase:** The plans examiner would review mechanical permit drawings, specifications, and equipment schedules to confirm economizer type and newly proposed design temperatures are met, depending on if it is a dry-bulb or wet-bulb economizer, and if it is servicing air-cooled and/or liquid-cooled ITE.
- **Construction Phase:** The mechanical contractor reviews mechanical design documents to confirm new economizer requirements and then selects and installs an economizer that meets the design specification. The controls contractor installs controls to allow the economizer system to operate at the full or part load cooling design specifications.
- **Inspection Phase:** The mechanical contractor will complete the Nonresidential Certificate of Installation (NRCI) forms, and the building inspector will need to verify compliance.

2.2.2 Impact on Market Actors

The increased temperature thresholds and additional requirements around integrated economizers would primarily impact HVAC contractors but are also expected to impact electrical and HVAC controls contractors.

Table 7 summarizes impacts on market actors and suggests outreach and education that would be helpful to support market actors as they prepare for the effective date of the requirements.

Table 7: Impacts on Market Actors and Suggested Training and Education Opportunities

Market Actor	Impact(s)	Suggested Outreach and Education
Owner/Developer [a]	Limited to no impact	Coordination with design professionals and the compliance improvement team to raise awareness.
Design Professional [b]	Mechanical Engineers will need to be aware of increased temperature thresholds and design compliant systems with updated design temperatures on drawings	Provide outreach and training on new triggers and requirement thresholds through local ASHRAE chapters and/or other relevant technical / professional societies.
Construction Team [c]	HVAC Contractors will need to verify the installed system matches plans and meets temperature thresholds. Controls Contractors will install controls for system to economize and meet full and part cooling load based on design temperatures.	Provide outreach and training on new triggers and requirement thresholds. This is already part of the Controls Contractor's scope based on current economizer requirements. Limited training is needed on updated design thresholds.
Building Department [d]	Plan examiners and inspectors confirm equipment achieves new economizer design temperatures on mechanical plans and in the field and learn how to appropriately review designs to ensure compliance is achieved.	Provide outreach through building official associations and conferences and provide CEUs for training provided online and in-person. Develop robust education and training outlining new requirements and compliant design solutions.
Verification Tester [e]	No impact.	No impact.
Manufacturers and Distributors	Limited impact.	Awareness of new economizing requirements in data centers to ensure equipment that can serve compliant designs are readily available to the market.

a. Owner/Developer is funding the project and is the primary decision maker.

b. Design professionals include architects, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.

c. Construction team includes general contractors, design-build contractors, installation contractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople.

d. Building departments include plans reviewers, building inspectors, specialty inspectors, permit counter technicians and third-party plan review and inspection.

e. Verification testers include commissioning agents, Energy Code Compliance (ECC) Raters, and Acceptance Test Technicians

The 2028 CASE Methodology Report presents a quantitative assessment of how changes to the California building code impact builders, building designers and energy consultants, and building owners and occupants. While the analysis in the methodology report is not specific to the code change(s) presented in this report, this measure focuses on HVAC contractors but are also expected to impact electrical and HVAC controls contractors, since these market actors are expected to experience the most direct impacts from increased temperature thresholds and additional requirements around integrated economizers. The following provides a qualitative description of how this specific code change affects various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

Builders. The proposed change would likely affect commercial builders; however, it would likely not impact firms focused on the construction or retrofitting of industrial buildings, utility systems, public infrastructure, or other heavy construction. The proposed change would not affect all firms and workers in the commercial building industry; instead, it would primarily affect specific subsectors within the industry. Table 8 shows the commercial building subsectors that the Statewide CASE Team expects to be impacted by the changes proposed in this report.

Building occupants (owners and tenants). The proposed code change would have incremental costs and would reduce building owners' utility bills throughout the measure lifetime. See the 2028 CASE Methodology Report for a description of how long-term system cost (LSC) savings relate to occupant utility bill savings.

Table 8: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)

Construction Subsector	Establishments *	Employment	Annual Payroll (Billions $)
Commercial Building Construction	5,491	87,450	$10.6
Other Nonresidential Exterior Contractors	234	2,259	$0.1
Nonresidential Electrical Contractors	3,245	72,794	$7.8
Nonresidential Plumbing & HVAC Contractors	2,270	55,182	$5.8
Other Nonresidential Equipment Contractors	580	9,749	$1.1
Nonresidential Site Preparation Contractors	1,147	19,273	$1.9
All Other Nonresidential Trade Contractors	948	17,084	$1.7

Source: (State of California n.d.)

*An establishment is single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. https://www.bls.gov/opub/hom/cew/concepts.htm

2.2.3 Compliance Software Updates

If the proposal is adopted, then the California Building Energy Code Compliance (CBECC) software will be modified based on the proposed changes to the ACM, as described in Section 2.6.6.

The Statewide CASE Team also considered CBECC's current lack of ability to model "Data Center" buildings. A calculation methodology was implemented to estimate savings for data center buildings, and prototypes currently in CBECC were relied upon to estimate energy savings for computer rooms in Large Offices, Medium Offices, Small Offices, Large Schools, Small Schools, and Hospitals.

The Statewide CASE Team is aware that, in recent years, LBNL has developed two new data center prototype models through OpenStudio and EnergyPlus™. For each of models LBNL evaluated two levels of ITE load density, covering wide range of IT power density of data centers between 40 and 100 W/ft^2.

a. The small-size data center model represents a computer room in a building served by computer room air conditioners (CRACs).
b. The large-sized model represents stand-alone data centers served by computer room air handlers (CRAHs) with a central chiller plant.

Future CBECC enhancements could potentially build upon the approach taken by LBNL.

2.2.4 Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report is an evaluation of specific measures, and the collective impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

Given that the proposed change increases the temperature threshold and requires minimum water and air temperature differentials and variable flow provisions to existing computer room economizing requirements, the Statewide CASE Team anticipates that additional training will need to be provided to the enforcement community to fully understand and effectively implement the proposed changes. As part of the triennial process to update the California Energy Code, education, training, and resources will need to be developed to highlight this proposed change.

The NRCC-PRC-E, NRCI-PRC-E, and NRCC-PRF-01-E compliance forms will be required regarding the design and installation of this measure. Please refer to section 2.6.7 for specific details.

Plan review would consist of reviewing NRCC-PRC-E and, if applicable, NRCC-PRF-01-E, and ensuring that it meets the new code requirement and is consistent with the drawings and specifications.

Inspection review would consist of reviewing NRCI-PRC-E and ensuring that the information on the forms is consistent with the approved NRCC-PRC-E forms and with what is actually installed.

2.3 Computer Room Economizers – Market and Economic Analysis

2.3.1 Market Structure and Availability

2.3.1.1 Current Market Structure and Availability

Requirements for computer room economizing have been in Title 24, Part 6 since the 2013 edition, and temperature thresholds were increased during the 2022 cycle. Since this time, economizing in computer rooms has become common practice for the industry in California, as building owners and operators are identifying cost-effective opportunities to reduce energy demand on the grid and overall energy costs to cool servers. As previously stated in section 2.1.3, with the growing demand for hyperscale data centers and higher computing CPUs and GPUs, the industry has embraced new cooling technologies such as liquid-cooled ITE systems, in addition to air-cooled ITE systems. The proposed measure would affect both air-cooled ITE and liquid-cooled ITE systems that utilize a dry-bulb or wet-bulb economizer. Given that computer room economizers have been required as industry standard since 2014, and energy efficient cooling technology and practices has only continued to advance, the market is well prepared to implement updated economizing requirements in the proposed measure.

Air-cooled ITE

For air-cooled ITE, many common economizer products could be used to achieve the proposed full economizing outdoor temperature thresholds of 65°F outdoor dry-bulb or 60°F outdoor wet-bulb. Examples of these systems include:

- Airside economizers
- Waterside economizer heat exchangers that are piped in series with chillers on the chilled water side.
- Air-cooled chillers with integrated economizer coils that are piped into the secondary circuit of a primary/secondary system.
- Air-cooled chillers with integrated economizer coils that are served by dedicated economizer fans and not by condenser fans that serve refrigerant condenser coils.
- Refrigerant economizer systems where 10-90 percent of the load on a refrigerant circuit can be met by a passive condenser or refrigerant pump.

Liquid-Cooled ITE

For liquid-cooled ITE, the proposed outdoor temperature thresholds for full economizing are easily achievable by cooling products available on the market and supports manufacturer-stated liquid-cooled ITE product temperature requirements. A Code Readiness survey of 32 liquid-cooled ITE cooling products and case studies revealed a typical advertised ITE inlet liquid temperature of 45°C (113°F), with some products advertising as high as 70°C (160°F), as shown in the table below (Conroy, Weitze and Droitcour 2026).

Table 9: Liquid-Cooled ITE Cooling Equipment Supply Temperatures (Conroy, Weitze and Droitcour 2026)

Category	Product Name	FW Supply Temperature (C)	FW Supply Temperature (F)	TCS Supply Temperature (C)	TCS Supply Temperature (F)
Product (CDU)	JetCool Smartsense CDU	Not listed	-	15-70	59-158
Product (CDU)	nVent Rackchiller CDU100	60	140	70	158
Product (CDU)	nVent Rackchiller CDU40	60	140	70	158

Category	Product Name	FW Supply Temperature (C)	FW Supply Temperature (F)	TCS Supply Temperature (C)	TCS Supply Temperature (F)
Product (CDU)	LBNL Open Specification for a Liquid Cooled Server Rack	-	-	66	151
Product (CDU)	JetCool NVIDIA H100 SmartPlate	55	131	60	140
Product (CDU)	Nortek ServerCool CD6	45	113	55	131
Product (CDU)	Vertiv DCP Coolant Pumping Unit	-	-	53	127
Product (CDU)	Chilldyne CF-CDU300	45	113	52	126
Product (CDU)	LiquidCool Solutions ZPServer	45	113		
Product (CDU)	DCX HYDRO CDU 1	35	95	45	113
Product (CDU)	DCX HYDRO CDU 3	36	97	45	113
Product (CDU)	DCX HYDRO CDU 6	35	95	45	113
Product (CDU)	DCX HYDRO CDU 12	35	95	45	113
Product (Cold Plate)	DCX HYDRO Intel Sapphire/ Emerald Rapids LGA 4677 CPU	-	-	32-45	90-113
Product (Immersion)	IceTope KUL AI	-	-	40-45	104-113
Case Study (Cold Plate)	DOD Maui HPC	-	-	44	111
Product	IceTope KUL DC	-	-	40	104
Product (CDU)	Vertiv CoolPhase L2R CDU	-	-	40	104

Category	Product Name	FW Supply Temperature (C)	FW Supply Temperature (F)	TCS Supply Temperature (C)	TCS Supply Temperature (F)
Product (CDU)	DCX HYDRO CDU 2	35	95	40	104
Case Study	Meta	30	86	40	104
Product (Immersion)	Green Revolution Cooling HashRaQ Max	-	-	40	104
Product (CDU)	Vertiv CoolChip CDU XDU 450	32	90	36	97
Product (Immersion)	DCX Standard, Medium, and Short Server Immersion Enclosure	-	-	32	90
Product (Immersion)	**Asperitas Direct Forced Convection**	-	-	32	90
Product (Immersion)	Asperitas Perpetual Natural Convection	-	-	32	90
Product (Immersion)	Green Revolution Cooling ICEraQ Micro, SX, and FLEX	-	-	32	90
Case Study	Vertiv CDU product eBook	-	-	30	86
Case Study (Multiple Technologies)	Sandia HPC DC	16	60	24	76
Case Study (Cold Plates)	NREL ESIF HPC	-	-	24	75
Case Study (Immersion	DoD (by LBNL)	20	68	20	67
Product (CDU)	Vertiv CoolChip CDU XDU 1350	(6-48)	43-119	(10-52)	50-126
Case Study (Confidential)	Confidential	-	-	30	86

Additionally, the Statewide CASE Team reviewed temperature requirements for NVIDIA liquid-cooled ITE products,[6] as summarized in Table 9. The maximum supply water temperature ranged from 30 to 50°C (86 to 122°F). At the January 2026 Consumer Electronics Show (CES), NVIDIA's Chief Executive Officer advertised that NVIDIA's newest product, Vera Rubin chips, can be cooled with water at 45°C (113°F) "with no chillers necessary."[7]

Table 10: Liquid-Cooled ITE Product Operating Temperatures

Product	Inlet Temperature Requirements (Operating)
NVIDIA H100 NVL GPU •NVIDIA H100 Tensor Core GPUs	0-50°C (32-122°F)
NVIDIA A2 Tensor Core GPUs (2022)	0-50°C (32-122°F)
NVIDIA Vera Rubin NVL72 • (72) Rubin GPUs, (36) Vera CPUs, ConnectX-9 SuperNICs, BlueField-4 DPUs • Rack-scale platform uses NVLink 6 Switch and scales out with NVIDIA Quantrum-X800 InfiniBand and Spectrum-X Ethernet	45°C (113°F)
NVIDIA GB200 NVL72 • Includes 72 Blackwell GPUs and 36 Grace CPUs	max 45°C
NVIDIA H200 NVL GPU	10-45°C (50-113°F)
NVIDIA GB200 NL4 • Includes 4 Blackwell GPUs and 2 Grace CPUs	5–35°C (41–95°F)
NVIDIA DGX B200 • Includes 8 NVIDIA Blackwell GPUs	10-35°C (50-90°F)
NVIDIA DGX H100/H200 • NVIDIA Tensor Core GPUs	5-30°C (41-86°F)
NVIDIA DGX Spark • NVIDIA Grace Blackwell architecture with integrated GPU and CPU	5-30°C (41-86°F)

Alterations and Additions

Computer rooms that were built before 2013 Title 24, Part 6 went into effect, and computer rooms with an ITE design load below the cooling capacity thresholds in 141.1(b)1 exceptions, may not have economizers installed. Economizer requirements for existing computer rooms where new cooling systems are being installed were adopted during the 2022 Title 24, Part 6 code cycle, meaning the market has been

[6] NVIDIA products were the focus of the product review because they represent about 90% of the US AI chip market (source: https://www.techpowerup.com/347125/nvidia-grabs-94-aib-gpu-market-share-amd-falls-to-5)

[7] https://www.datacenterdynamics.com/en/news/vera-rubin-hot-water-cooling-reveal-triggers-hvac-share-drop/

subject to requirements updating existing computer rooms to include economizers. While this proposed change will lower the ITE design-load threshold at which an economizer must be installed, equipment manufacturers and companies that support computer room design and installation are well equipped to install an integrated economizer when updating a cooling system for these smaller ITE load computer rooms. Like new construction, computer rooms in existing buildings use a variety of economizer types listed above.

However, given the documented implementation challenges of installing economizers in existing buildings that were not initially designed for them, and the added cost and complexity of adding an economizer during an alteration, the Statewide CASE Team is proposing a new exception. This exception would allow new or modified systems that are smaller than 500 tons and less than 50 percent of the total computer-room cooling capacity to comply with the Title 24, Part 6 economizing requirements that were in effect during the date of the initial building permit.

2.3.1.2 Market Challenges and Solutions

Although the industry is well equipped to install a fully integrated economizer in new computer room cooling systems, some commonly used cooling systems do not currently comply with this proposed code change and would require design adjustments to achieve compliance. However, the proposed updates to the economizer definitions and requirements close a loophole in the existing code language, and additional training on these changes will help the market adapt and modify their approaches. These cooling systems as well as the proposed solution to ensure compliance are described below and further outlined with diagrams in Section 2.1.3:

Waterside Economizer:

- **Non-Compliant Approach**: Waterside economizer heat exchangers that are piped in parallel with chillers on the chilled water side.
    - **Solution:** This would require a simple design adjustment to pipe waterside economizer heat exchangers in series with chiller evaporators to allow for partial pre-cooling of return chilled water before it enters the chiller evaporators. Providing education and training through Energy Code Ace, ASHRAE associations, and other venues can train the design community on ways to make this approach more efficient and code compliant.

Air-Cooled Chiller and Refrigerant Economizers:

- **Non-Compliant Approach**: Air-cooled chillers with integrated economizer coils that are piped into the primary circuit of a primary/secondary system.
    - **Solution:** Install dry cooler economizer coils on the chilled water return secondary loop.

- **Non-Compliant Approach**: Air-cooled chillers can include integrated economizer coils. The economizer coils allow chilled water to be cooled by ambient air or precooled by ambient air before being further cooled by the chiller evaporator. Often these chillers use the same condenser fans to serve both the refrigerant condenser coils and the economizer coils. In cool weather the speed of these condenser fans is limited by the need to maintain a minimum refrigerant head pressure for the refrigeration circuit. But limiting the condenser fan speed limits the ability of the economizer coil to provide free cooling.
    - **Solution:** Use separate dry coolers piped on the chilled water return pipe. This would allow for the dry cooler condenser fans to operate independently from the chiller condenser fans and not be limited by the chiller head pressure control requirements. This would also allow the dry cooler to make colder water at low outdoor temperatures and increase economizer cooling capacity.
- **Non-Compliant Approach**: Refrigerant economizer systems with one or more refrigerant circuits that must switch between full circuit capacity in refrigerant compressor operation to full circuit capacity in refrigerant pump operation.
    - **Solution:** Use refrigerant economizers where equipment components are configured and controlled to provide continuous cooling capacity from at least 10-90 percent of full load through economizer or compressor cooling.

Liquid-Cooled ITE

Liquid-cooled ITE is a new and rapidly-growing market, with many new ITE products and cooling solutions coming onto the market. One potential issue is that if liquid-cooled ITE is built for higher density, lower entering liquid temperatures may be required to provide adequate cooling. This would make it harder to comply with the increased economizer requirements.

- **Solution:** Size heat exchangers (cooling towers, waterside economizers, CDUs) for lower approach temperatures.
- **Solution:** Design system to use heat recovery to avoid the economizer requirement.

Alterations and Additions

When updating a cooling system in an existing computer room space the updated cooling system only has to meet the economizer requirements that were in place when the computer room was first built. So if the computer room was not required to have an economizer when it was built then updating the cooling system does not trigger the need for an economizer. The only exception to this is if the new cooling system is over 500 tons and results in an increase in the total cooling capacity of more than 100%.

This is effectively a large new data center and thus is subject to the current economizer requirements.

Unlike existing computer rooms, new computer rooms in existing buildings have to meet the new economizer requirements, if they are over 10 tons. If the computer room is less than 20 tons, then the computer room can be served by a non-economizer system, if it is also served by a VAV box served by an existing AHU. The AHU does not need to be sized for the added computer room load, per EXCEPTION 2 to Section 910.2.1. If the computer room is over 20 tons then it will be cost-effective to provide a economizer system or to use the heat recovery economizer exemption. Note: Currently new computer rooms over 20 tons in existing buildings must include economizers. This is not a code change.

See Section 2.2.2 for a description of workforce trainings that may be needed to ensure effective design, installation, and commissioning.

2.3.2 Design and Construction Practices

2.3.2.1 Current Design and Construction Practices

The proposed measure would affect dry-bulb and wet-bulb economizer designs for computer rooms with air-cooled and liquid-cooled ITE. As a result, there are many different code compliant designs that computer-room mechanical designers can specify and install.

Air-Cooled ITE

For computer rooms with air-cooled ITE, the proposed measure would require computer rooms to be designed for a minimum 65-70°F server inlet air temperature (or higher), which aligns with ASHRAE Thermal Guidelines' Recommended range of 64.4-80.6°F.[8] Many of the same cooling systems and products that are used to comply with the economizer requirements as specified in 2025 Title 24, Part 6 could still be used.

For example, for a water-economizer to meet ten percent load fraction at 70°F outdoor air wet-bulb (OAWB), the system must be designed for a reasonably high return air temperature (e.g., 95°F) and a reasonably high return chilled water temperature (e.g., 82°F). The proposed new variable air and water flow requirements will encourage more efficient designs that leverage partial economizer performance during high ambient temperatures and periods of low load. For example, an AHU designed for 65°F SAT and 20°F airside differential temperature (i.e., 85°F return air temperature) means that even at 84°F outside air dry-bulb there is some economizing (or free cooling). For this same system, if the dT is only 10°F then there is no economizer free cooling even at 76°F ambient dry-bulb. Similarly, if system is designed for 65°F SAT and 20°F airside

[8] ASHRAE Thermal Guidelines for Data Processing Environments.

differential temperature (dT) and the airflow varies with the load then at low load the economizer is still providing partial cooling at 84°F OADB. But if the airflow does not vary with load, then at low load the economizer might not be providing any free cooling even at 70°F OADB. Unnecessarily high minimum air handling fan speeds would not be able to maintain good dT at low load.

Similarly, varying the chilled water and facility water flow as a function of load ensures that economizer savings are captured at high ambient temperatures and low loads for both dry-bulb and wet-bulb economizer systems. For example, three-way CHW valves at air handling coils would make it difficult or impossible to meet the variable flow requirement. To elaborate, if a system is designed for CHW supply temperature of 70°F and return temperature of 85°F (15°F dT) with 100 percent water economizing at 60°F OAWB, then it can do partial water economizing up to about 75°F OAWB. If the CHW coils have two-way control valves, then the dT will stay constant at 15°F at low load. However, if the coils have three-way valves, then the dT will degrade at low load. At 50 percent load the dT will only be about 7°F, so the return water temperature will be about 77°F, and there will be no economizing above about 67 OAWB.

Liquid-Cooled ITE

For computer rooms with liquid-cooled ITE, the proposed measure would require computer rooms to be designed with a technology cooling system (TCS) that meets ASHRAE Thermal Guidelines class W27 or W32[9] (e.g., supply fluid temperature to ITE of 29°C/85°F) or higher. As shown in Figure 12, D2C and immersion cooling are typically cooled by a liquid cooling loop TCS connected to a CDU that includes a pump for the TCS loop. The CDU includes a heat exchanger that is connected to a facility chilled water loop (or in some cases a refrigerant loop).

[9] ASHRAE Thermal Guidelines for Data Processing Environments provides standardized operating environments and guidance for ITE. Classes W17, W27, W32, W40, and W45 represent environmental specifications for liquid cooling.

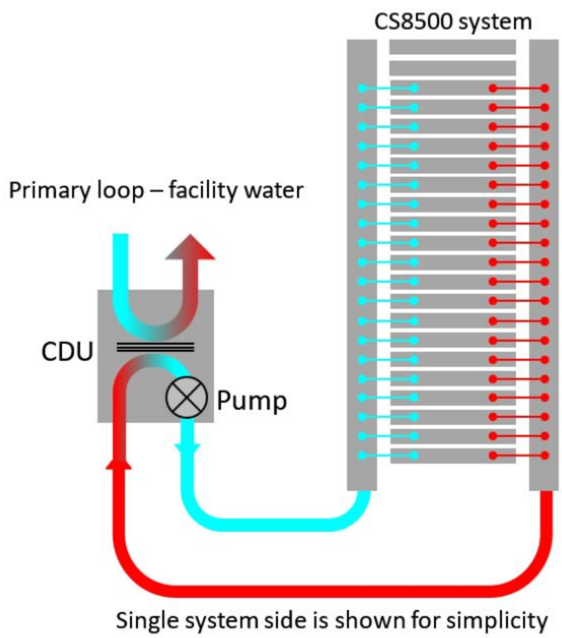

Figure 12: Diagram of CDU with TCS Pump and Heat Exchanger Connected to Facility Water Loop[10]

A portion of the liquid-cooled ITE rejects heat to the air, so traditional cooling systems for air-cooled ITE, such as computer room air-conditioners (CRAC) and computer room air-handlers (CRAH), would still be required for a portion of the cooling load. Economizing could be provided by a computer room wet-bulb economizer or computer room dry-bulb economizer. Many different cooling system options could be used for heat rejection on the facility water side, including evaporative cooling towers, chillers (air-cooled or water-cooled with cooling tower), and dry coolers.

Additions and Alterations

The design process for computer rooms in additions and alterations projects is similar to that for new construction. Equipment is selected and laid out based on coordination and constraints imposed by other trades (electrical, structural, architectural, etc.). Design engineers perform computer-room load calculations and determine whether economizing is required. This process would remain unchanged; however, the economizer-capacity sizing and setpoints would change.

Commissioning

Adding commissioning requirements for computer rooms greater than 1 MW of ITE load is expected to have minimal impact on current design and construction practices.

[10] NVIDIA Docs Hub: https://docs.nvidia.com/networking/display/cs8500sysum/system+cooling+design+overview

Commissioning is already common practice for computer rooms / data centers of this capacity, including design review, system startup, and functional testing, as well as activities beyond what would be required by Title 24, Part 6 (Morris 2026).

2.3.2.2 Health and Safety Considerations

The proposed code change would not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by the California Division of Occupational Safety and Health (DOSH). All existing health and safety rules would remain in place. Complying with the proposed code change is not anticipated to have adverse impacts on the safety or health of occupants or those involved with the construction, commissioning, and maintenance of the building. In cases where airside economizing would be used to comply with this code requirement, indoor air quality for occupants (when present) would be improved by increasing the amount of outside air entering the computer room.

2.3.2.3 Design and Construction Challenges and Solutions

Liquid-cooled ITE cooling systems designed for facility water supply temperatures in temperature classes below W32 (e.g., W17 (62.6°F facility supply water temperature) and W27 (80.6°F facility supply water temperature)) would not be able to comply with the proposed economizer requirement. However, in the majority of cooling products and case studies reviewed in a recent study (Conroy, Weitze and Droitcour 2026), the products were marketed with design temperatures meeting ASHRAE Class W32 or higher. This indicates that many cooling products are available that can meet the proposed economizer temperature thresholds, so systems needing to meet the cooler temperatures of Class W17 or W27 would likely not be a widescale design and construction challenge.

Adding economizers to computer rooms in existing buildings may pose a range of design challenges. Fitting ducting for airside economizing in existing buildings may be challenging due to space constraints or may require structural upgrades. However, given that existing building economizer requirements already exist in the code, these would likely not be new challenges. Some potential solutions include:

- For very small computer rooms, the economizer capacity from the building's cooling system may be used rather than needing to install a dedicated economizer for the computer room.
- For larger computer rooms, heat recovery may be used instead of economizing to provide design flexibility.
- Multiple economizer technologies may be used to comply with the proposed code change.

- For expansions to existing computer rooms, only projects with substantial increases in capacity would be required to meet the new economizer temperature thresholds.

Additionally, increased temperature thresholds for existing computer rooms would push cooling equipment to be designed for warmer indoor operating temperatures, which would require operators to adapt to different operating conditions than they might be used to. To overcome this challenge, operators may need additional training and offered ways to advance their expertise and be equipped for modern day practices.

See Table 7 in Section 2.2.2 or a description of workforce trainings that could support effective design, installation, and commissioning.

2.3.3 Energy Equity and Environmental Justice

Each measure in this CASE Report was evaluated for ESJ impacts using 4 criteria: cost, health, resiliency, and comfort. The details of that evaluation can be found in Section 1.4 and the 2028 CASE Methodology Report.

With this proposal impacting data center design and efficiency, this proposal would likely not result in any negative impacts to ESJ communities. In fact, improving data center efficiency could provide secondary benefits to all communities, including ESJ. As data center efficiency increases, it will reduce energy and water usage, which will help alleviate strain on those resources. A recent example is the San Jose City Council's 2025 approval on the development of 1,492 homes across two multi-story towers in downtown along with twin data centers.11 The project proposal was submitted after city officials announced the Innovative Project Pathway Program. The program allows housing developers to override the city's usual development standards—including reductions in construction taxes and the waiving of affordable-housing impact fees on specific projects—in order to open up more areas downtown for housing.

On March 18, 2026, the Statewide CASE Team participated on the "Powering Data Centers: Balancing Growth with Sustainability & Affordability" topic at the BayREN Codes & Standards regional forum.12 Important questions around grid capacity, electricity costs, waste heat, air quality impacts from diesel backup generators, and equity for surrounding communities were raised while acknowledging that data centers represent a significant economic driver at both regional and national levels. PG&E was requested to provide an update on Rule 30 filed with the California Public Utilities

[11] https://sanjosespotlight.com/data-center-hundreds-of-homes-coming-to-downtown-san-jose/

[12] BayREN represents the Bay Area Regional Energy Network, a coalition of local governments convened under the Association of Bay Area Governments. The key participants are all nine counties surrounding the San Francisco Bay. The coalition works together to promote energy efficiency, water conservation, and greenhouse gas reduction—primarily serving residents, but also small businesses and local governments themselves.

Commission (CPUC).13 It was reported that data centers provide a significant amount of economic benefit to regions, and there are protections in place within Rule 30 that address concerns for utility customers. The scope of Rule 30 covers engineering construction and cost responsibility to connect to the transmission grid and does not address supply. Advance funds are expected to be required for customers with facility types (e.g., data center, university, hospital, or EV entity) with transmission service that only serve the applicant from switching station to meter, transmission interconnection connection upgrades that only serve the applicant, and transmission interconnection network upgrades to serve switching station (including remote end and transmission line re-route). For customers whose facility types require transmission-level network upgrades to provide load-serving capacity and interconnection with the broader utility-owned system, these upgrades are considered system-wide benefits that improve reliability and grid stability; therefore, all ratepayers will be expected to bear that cost since the grid, and therefore the ratepayers at large, will benefit.

Representatives of some Bay Area counties offered the following perspectives on data centers at the BayREN Codes & Standards regional forum:14

- **Contra Costa County:** Interested parties have expressed caution around data centers due to the potential to increase the regional water demand. Contra Costa sits along the Sacramento and San Joaquin delta and has observed decreasing flow over the years due to drought, or other diversions. Water reliability and interconnection infrastructure are a few reasons for the reluctance in data center development within the county.
- **Marin County:** Data centers are currently not planned in this county, but concerns about energy use, affordability, greenhouse gas emissions, water use, and impacts on marginalized communities near whom data centers are often located.
- **Napa County:** This county is more of an agricultural economy. Interested parties have expressed concerns about resiliency and grid reliability due to the sudden, large increase in energy demand associated with a data center. The potentially excessive strain on the energy grid in wildfire-prone areas could place residents and small businesses at risk.
- **San Francisco:** Economic development potential exists but concerns around existing data centers have revolved around noise pollution and air pollution from backup power systems.

[13] https://www.youtube.com/watch?v=Zy0MuJyFsUc

[14] https://www.youtube.com/watch?v=atCFEC4rv5U

- **San Mateo County:** The County does not currently host any data centers, but it is home to a community that is extremely sensitive to rising energy costs. Data-center energy bills raise concerns about affordability. Investments in grid-hardening and transmission-level resilience infrastructure are a priority, so the County has meaningful safeguards in place.
- **Santa Clara County:** Strong interest due to the scale of data centers in the County along with its own municipal utility. Balancing economic benefits and land-use impacts is important. Innovative development models have been considered such as balancing multifamily housing units with data centers.
- **Solano County:** Potential benefits of data centers are property tax revenue and economic diversification benefits, with attention to land use and energy impacts.
- **Sonoma County:** Shared concerns are similar to those in Napa and Marin Counites. County representatives have received concerns from local residents and small businesses about long grid-interconnection wait times and the infrastructure upgrades required due to prioritization of data center construction.

2.3.4 Impacts on Jobs and Businesses

The Statewide CASE Team does not anticipate significant employment or financial impacts on any particular sector of the California economy. However, the proposed change may have modest impacts on employment in California. The Statewide CASE Team estimates the proposed change would affect statewide employment and economic output directly and indirectly through its impact on builders, designers, energy consultants, and building inspectors. Table 11, Table 12, and Table 13 outline the statewide implications for these job categories. For more information on the Statewide CASE Team's economic impacts methodology, see the 2028 CASE Methodology Report.

The Statewide CASE Team does not anticipate that the proposed changes would lead to the creation of new types of jobs or the elimination of existing types of jobs. In other words, the Statewide CASE Team's proposed change would not result in economic disruption to any sector of the California economy. Rather, it would lead to modest changes in the employment of existing jobs. The Statewide CASE Team does not expect designers or inspectors to spend additional time since the proposed code change pertains to a change in threshold value associated with an existing mandatory requirement.

Table 11: Estimated Impact that Adoption of the Proposed Measure Would Have on the California Nonresidential Construction Sector

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by Commercial Builders)	2	$149,740	$225,449	$487,802
Indirect Effect (Additional spending by firms supporting Commercial Builders)	1	$86,556	$148,598	$260,154
Total Economic Impacts	**3**	**$236,296**	**$374,047**	**$747,956**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.[1]

Table 12: Estimated Impact that Adoption of the Proposed Measure Would Have on the California Building Designers and Energy Consultant Sectors

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by building designers and energy consultants)	0	$6,770.93	$6,703.14	$10,594.94
Indirect Effect (Additional spending by firms supporting building designers and energy consultants)	0	$2,016.05	$2,801.90	$4,510.49
Total Economic Impacts	**0**	**$8,786.97**	**$9,505.04**	**$15,105.42**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

Table 13: Estimated Impact that Adoption of the Proposed Measure Would Have on California Building Inspectors

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by building inspectors)	0	$459.57	$545.00	$662.28
Indirect Effect (Additional spending by firms supporting building inspectors)	0	$42.56	$66.29	$115.46
Total Economic Impacts	**0**	**$502.14**	**$611.29**	**$777.74**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

The proposed change represents a modest adjustment, which is not expected to excessively burden or competitively disadvantage California businesses, nor is it expected to lead to a competitive advantage for California businesses. Therefore, the Statewide CASE Team does not expect the proposed code changes to result in the creation of new businesses or the elimination of existing ones.

The proposed code changes would apply to all businesses operating in California, regardless of whether the business is incorporated inside or outside of the state.[2] Therefore, the Statewide CASE Team does not anticipate that the proposed changes would have advantageous or an adverse effect on the competitiveness of California businesses.

The Statewide CASE Team derived a reasonable estimate of the change in investment by California businesses based on the estimated change in economic activity associated with the proposed measure and its expected effect on business income. The Statewide CASE Team's IMPLAN modeling resulted in an estimated $70,325 increase in California business income due to the proposed code change. The Statewide CASE Team assumed that net business investment is positively correlated with business income and that a portion of business income will be allocated to net business investment.

To estimate the portion of business income that would be allocated to net investment, the Statewide CASE Team analyzed national data on corporate profits and net capital investment by businesses that expand a firm's capital stock (referred to as net private domestic investment, or net private domestic investment (NPDI)).[3] As Table 14 shows, between 2020 and 2024, NPDI as a percentage of corporate profits ranged from a low of 18 percent in 2020 due to the worldwide economic slowdowns associated with the COVID 19 pandemic to a high of 28 percent in 2022, with an average of 23 percent. While only an approximation of the proportion of business income used for net capital investment, it provides a reasonable estimate of the proportion of incremental income that business owners would reinvest into expanding their capital stock.

Table 14: Net Domestic Private Investment and Corporate Profits, U.S.

Year	Net Domestic Private Investment by Businesses, Billions of Dollars	Corporate Profits After Taxes, Billions of Dollars	Ratio of Net Private Investment to Corporate Profits (Percent)
2020	389	2,212	18
2021	545	2,888	19
2022	825	2,951	28
2023	836	3,069	27
2024	885	3,441	26
5-Year Average	Intentionally blank	Intentionally blank	23

Source: (Federal Reserve Economic Data (FRED) n.d.)

Given the estimated total increase in California business income and net business investment ratio described above, the Statewide CASE Team estimates the proposed code change would result in a $16,508 increase in net private investment by California businesses.

2.3.5 Economic and Fiscal Impacts

This section includes information that CEC uses in the economic analysis that is required by statutes. CEC uses the information to complete Form STD 399 (Economic and Fiscal Impact Statement), including identifying whether the proposed update will be greater than $50 million, triggering the requirement for the CEC to complete a Standardized Regulatory Impact Assessment ("SRIA"). This section addresses how the code change impacts the statewide economy.

The Statewide CASE Team does not anticipate that the economic impacts associated with the proposed measure would lead to a significant change (increase or decrease) in investment, directly or indirectly, in any affected sectors of California's economy. The proposed change would not result in economic disruption to any sector of the California economy. For more information on the Statewide CASE Team's economic and fiscal impacts methodology, see the 2028 CASE Methodology Report.

Adoption of this code change proposal would result in relatively modest economic impacts through additional direct spending by commercial/industrial contractor establishments. The Statewide CASE Team does not anticipate that money saved by businesses or other organizations affected by the proposed 2028 code cycle regulations would result in additional spending by those businesses.

2.3.5.1 Effects on the State General Fund, State Special Funds, and Local Governments

The Statewide CASE Team does not expect the proposed code changes to have a measurable impact on California's General Fund, any state special funds, or local government funds.

Cost to State: The state government already has a budget for code development, education, and compliance enforcement. While the state government would be allocating resources to update the Title 24, Part 6 Standards, including updating education and compliance materials and responding to questions about the revised requirements, these activities are already covered by existing state budgets. The costs for the state government are small when compared to the overall cost savings and policy benefits associated with the code change proposals. The proposed code change measures may impact state buildings but they have been found to be cost effective.

Cost to Local Governments: All proposed code changes to Title 24, Part 6 would result in changes to compliance determinations. Local governments would need to train building department staff on the revised Title 24, Part 6 Standards. While this retraining is an expense to local governments, it is not a new cost associated with the 2025 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining, including tools, training, and resources provided by the IOU Codes and Standards program (such as Energy Code Ace). As noted in Section 2.2, the Statewide CASE Team considered how the proposed code change might impact various market actors involved in the compliance and enforcement process and aimed to minimize negative impacts on local governments.

2.3.5.2 Mandates on Local Agencies or School Districts

There are no relevant mandates to local agencies or school districts since the proposed code change pertains to a prescriptive requirement.

2.3.5.3 Costs to Local Agencies or School Districts

There are no costs to local agencies or school districts. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

2.3.5.4 Costs or Savings to Any State Agency

There are no costs to any state agencies. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

2.3.5.5 Other Non-Discretionary Cost or Savings Imposed on Local Agencies

There are no added non-discretionary costs or savings to local agencies. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

2.3.5.6 Costs or Savings in Federal Funding to the State

There are no costs or savings to federal funding to the state. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

2.4 Computer Room Economizers – Cost Effectiveness

2.4.1 Cost Effectiveness Methodology

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost inclusion parameters. The 2028 CASE Methodology Report and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its benefit-cost ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on long-term system cost (LSC), which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code. The analysis excludes design costs and incremental code compliance verification costs.

2.4.2 Energy and Energy Cost Savings Results

To assess the energy and energy cost savings of the proposed measure, the Statewide CASE Team conducted a custom spreadsheet-based analysis across three different data center scenarios. These scenarios were selected because they assess the impact of the proposed code change and are commonly found in the California marketplace. This approach, compared to an energy modeling (CBECC) based analysis, was used for the following reasons:

- Custom analysis can account for specific data center design efficiencies that would not be considered in CBECC.
- CBECC does not allow separate plants for air-cooled and liquid-cooled ITE as described in the analysis below.
- To represent real world data center scenarios that can help validate savings in the final report when energy modeling is used.

Proposed modifications would affect computer rooms with air-cooled ITE using wet-bulb economizers and computer rooms with liquid-cooled ITE using wet-bulb and/or dry-bulb economizers.

A significant change to the economizer thresholds is a reduction (i.e., relaxation) of the dry-bulb threshold for high-density air-cooled ITE. Currently the economizer requirement in Title 24 requires that the ambient threshold for 100 percent airside economizing is 65°F dry-bulb. This generally requires a direct airside economizer. This threshold were developed in 2012 and represented reasonable best practice for most computer rooms and data centers at that time. Much has changed since that time. One significant change is increased power density per rack. In 2012 typical racks were in the 2-10 kW/rack range. Now it is common for racks to have air-cooled ITE exceeding 25 kW/rack. Direct airside economizing is increasingly expensive and impractical at very high density. An airside economizer typically requires air handlers along an exterior wall of a data center for access to outside air, with long cold aisles perpendicular to the exterior wall to supply outdoor air from the AHU to the racks. The airflow requirement for high density ITE facilities means the cold aisles can only be a couple racks deep. Any deeper and the aisle cross sectional area would be prohibitively large. High density air cooling typically requires close-couple cooling solutions, like rear door heat exchangers (RDHX) or in-row coolers (IRCs). Economizing for RDHX or IRCs can be done with a waterside economizer which can be served by a cooling tower or by dry coolers. The wet-bulb threshold (discussed below) applies to cooling towers. The dry-bulb threshold applies to dry coolers. Dry coolers typically have an approach to ambient dry-bulb of 8-15°F. A water economizer heat exchanger is not required but is common and can add 2-5°F to the approach, and a cooling coil can be selected for an approach of 7-10°F. This gives a total approach of about 18-25°F. To achieve the 55°F threshold and 75°F SAT rating condition the total approach must be 20°F or less, including redundancy.

A lifecycle cost analysis is not required to justify a relaxation of Title 24 and thus none was conducted to justify this reduced economizer threshold.

To assess the impacts of the increased economizer thresholds and differential temperature and variable flow requirements, the Statewide CASE Team conducted three analyses: 1) a data center with air-cooled ITE and a wet-bulb economizer, 2a) a data center with liquid-cooled and air-cooled ITE with a wet-bulb economizer using a cooling tower, and 2b) a data center with liquid-cooled and air-cooled ITE with a dry-bulb economizer using a dry cooler. Detailed information about each scenario is described below:

1) **Air-Cooled ITE – Wet-Bulb Economizer Scenario Modeling Assumptions:** This analysis demonstrates the energy, cost, and environmental impacts associated with updating the wet-bulb economizing threshold from 45°F in the current code language to 60°F.

   Assumptions for this analysis include the following:

   - Standalone data center with air-cooled ITE
   - Air-cooled ITE with 75°F design supply air temperature (SAT) to the server
   - ITE load at 300 W/ft^2
   - ITE load profile: Title 24 ACM load profile (equal time at 25 percent, 50 percent, 75 percent, 100 percent load)
   - Chiller design kW/ton: 0.35
   - Cooling tower nominal efficiency: 80 GPM/HP
   - Redundancy for heat exchanger (HX), chiller, cooling tower (CT), CRAH: 10 percent

Base-Case Design:

- The approach from OAWB to SAT is 30°F for base-case design.
  - The approach is the sum of the approaches of the CT, the HX, and the CRAH coil
- Fewer hours of full and partial economizer operation than proposed design
- CHW/CW pump and supply fan pressure drop is adjusted based on CT/HX/Coil selections

Proposed Design:

- The approach from OAWB to SAT is 15°F for proposed design. Note that the proposed case uses the same type of equipment as the base case, the equipment is simply larger to achieve a better approach. See Section 2.4.3 for details on the equipment (cooling towers, heat exchangers, and cooling coils).
- The proposed design has significantly greater hours of full and partial economizer operation
- CHW/CW pump and supply fan pressure drop is adjusted based on CT/HX/Coil selections

2) Separate Liquid-Cooled ITE Economizer Scenario Modeling Assumptions:

This analysis demonstrates the energy, cost, and environmental impacts associated with updating the economizing threshold to 75°F. Assumptions for these analyses include the following:

- Standalone data center with liquid-cooled and air-cooled ITE
- 80 percent Liquid-cooled ITE, 20 percent air-cooled ITE
- 15°F dry cooler approach (90°F condenser supply temperature at 75°F OADB)
- 5F CDU approach
- 95F TCS to ITE
- Title 24 load profile (equal time at 25 percent, 50 percent, 75 percent, 100 percent load)
- Dry cooler dT: 15°F
- TCS pump energy same for base-case and proposed, so not modeled
- CRAH fan energy same for base-case and proposed, so not modeled

While cost data was only provided for plants with cooling towers, two types of plants were simulated. The reason the Statewide CASE Team only derived costs for the cooling tower scenario is because it is the most common approach across the California market. The two scenarios include the following assumptions:

1. **Cooling Towers** – The baseline is a single chilled water plant with cooling towers, and the proposed case includes two chilled water plants and distribution piping for air-cooled ITE and liquid-cooled ITE. The primary reason the proposed design must have separate plants is because a single chilled water plant serving both air-cooled ITE and liquid-cooled ITE is unlikely to meet the proposed temperature threshold for a liquid-cooled ITE economizer. The two chilled water plants is the scenario that was costed.
2. **Dry Coolers** – In this scenario the baseline is a single chilled water plant with water-cooled chillers rejecting heat via dry coolers (rather than cooling towers). The proposed case includes two dry cooler plants and distribution piping for air-cooled ITE and liquid-cooled ITE. The dry cooler plants use adiabatic spray assist if the dry coolers cannot achieve the required dry cooler leaving water temperature in a given hour.

Additional details describing the analytical approach and various assumptions used in the analysis are provided in Appendix A.

Results

Scenario 1. Air-Cooled ITE – Wet-Bulb Economizer Scenario

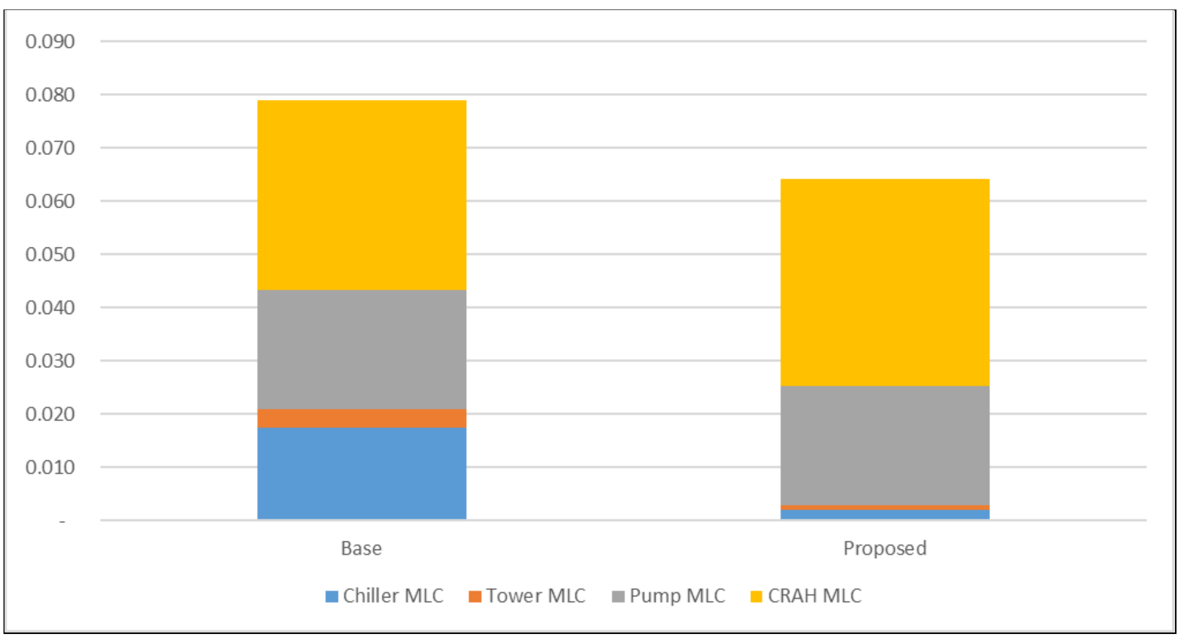

Figure 13: Summary Results on the Impacts of Increased Economizer Thresholds, Differential Temperature, and Variable Flow Requirements on a Data Center with Air-Cooled ITE and a Wet-Bulb Economizer in San Jose with Mechanical Load Expressed in Component Total Kilowatt-Hour (kWh)/ITE kWh.

Table 15: Percentage of Time Base vs. Proposed Design in Economizing Only Mode (Chillers Off)

Climate Zone (Location)	Base-Case	Proposed Design
4 (San Jose)	23%	81%
7 (San Diego)	10%	59%
9 (Los Angeles)	11%	65%
12 (Sacramento)	25%	75%

Scenario 1 per-unit energy savings (electricity, natural gas, and source energy) and peak demand reductions are presented in Table 16. Per-unit savings for the first year are expected to range from 0.25 to 0.37 gigawatt-hour (GWh/yr, depending upon climate zone.

Table 17 presents total energy cost savings per unit for newly constructed buildings, additions, and alterations in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV$). The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods.

Table 16: Scenario 1 Air-Cooled ITE – Wet-Bulb Economizer – Energy and Energy Cost Savings – Per MW ITE – New Construction, Additions and Alterations

Climate Zone	First Year Electricity Savings (kWh)	First Year Peak Demand Reduction (W)	First Year Natural Gas Savings (kBtu)	First Year Source Energy Savings (kBtu)	Total 30-Year LSC Savings (2029 PV$)
1	59,563	6,942	0	96,794	516,969
2	77,738	7,738	0	116,722	656,646
3	79,756	6,963	0	125,004	677,886
4	70,970	4,794	0	93,687	584,545
5	72,538	6,445	0	108,543	621,221
6	110,030	9,695	0	182,902	957,188
7	123,478	11,543	0	197,229	1,097,098
8	116,975	9,669	0	190,329	1,043,433
9	103,071	7,640	0	147,682	927,793
10	95,146	6,670	0	132,057	838,660
11	79,889	6,322	0	114,757	693,276
12	88,993	5,729	0	121,071	756,196
13	96,297	7,036	0	133,558	848,249
14	59,398	4,217	0	70,021	542,802
15	111,355	8,060	0	157,342	954,597
16	31,657	2,320	0	41,469	310,781

Table 17: Scenario 1 Air-Cooled ITE – Wet-Bulb Economizer 2029 PV LSC Savings Over 30-Year Period of Analysis – Per MW ITE – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2029 PV$)	30-Year LSC Natural Gas Savings (2029 PV$)	Total 30-Year LSC Savings (2029 PV$)
1	516,969	0	516,969
2	656,645.58	0	656,645.58
3	677,886.16	0	677,886.16
4	584,545.16	0	584,545.16
5	621,221.36	0	621,221.36
6	957,188.17	0	957,188.17
7	1,097,098.05	0	1,097,098.05
8	1,043,432.58	0	1,043,432.58
9	927,792.97	0	927,792.97

Climate Zone	30-Year LSC Electricity Savings (2029 PV$)	30-Year LSC Natural Gas Savings (2029 PV$)	Total 30-Year LSC Savings (2029 PV$)
10	838,659.65	0	838,659.65
11	693,276	0	693,276
12	756,196.23	0	756,196.23
13	848,249	0	848,249
14	542,802.42	0	542,802.42
15	954,597.11	0	954,597.11
16	310,781.15	0	310,781.15

Scenario 2. Separate Liquid-Cooled ITE Economizer Scenario

Table 18 and Table 19 show the partial PUE for the base case and proposed chilled water plants for Scenarios 2a and 2b. A lower PUE indicates better efficiency. In both scenarios, the proposed plant is more efficient than the base case plants.

Table 18: Scenario 2a – Partial PUE of Cooling Tower Scenario

Simulation #	Description	Partial PUE (chiller, tower, cooling tower, pump)
1A – Base-Case	Combined Plant with low LWT for all	1.031
1B – Base-Case	Combined Plant with high LWT, then Chillers cool to low LWT for RDHXs	1.043
2 – Proposed	Separate 1B (tower-only) Plant for CDUs Separate 1A Plant for RHDX	1.023

Table 19: Scenario 2b – Partial PUE of Dry Cooler Scenario

Simulation #	Description	Partial PUE (chiller, tower, dry cooler, pump)
1A – Base-Case	Combined Plant with low LWT for all	1.071
1B – Base-Case	Combined Plant with high LWT, then Chillers cool to low LWT for RDHXs	1.045
2 - Proposed	Separate 1B (tower-only) Plant for CDUs Separate 1A Plant for RHDX	1.031

Scenario 2a savings per unit are presented in Table 20 and Table 21. Per-unit savings for the first year are expected to range from 0.06 to 0.10 GWh/yr, depending upon climate zone. Table 22 and Table 23 present total energy cost savings in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV$). The

LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods.

Table 20: Scenario 2a Liquid-Cooled ITE Wet-Bulb Economizer – Energy and Energy Cost Savings – Per MW ITE – New Construction, Additions, and Alterations

Climate Zone	First Year Electricity Savings (kWh)	First Year Peak Demand Reduction (kW)	First Year Natural Gas Savings (kBtu)	First Year Source Energy Savings (kBtu)	Total 30-Year LSC Savings (2029 PV$)
4	57,400	0	0	144,300	474,000
7	104,270	0	0	262,140	903,000
9	94,350	0	0	237,200	817,000
12	66,060	0	0	166,080	544,000

Table 21 presents total energy cost savings per unit for newly constructed buildings, additions, and alterations in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV$). The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods.

Table 21: Scenario 2a Liquid-Cooled ITE Wet-Bulb Economizer- 2029 PV LSC Savings Over 30-Year Period of Analysis – Per MW ITE – New Construction, Additions, Alterations

Climate Zone	30-Year LSC Electricity Savings (2029 PV$)	30-Year LSC Natural Gas Savings (2029 PV$)	Total 30-Year LSC Savings (2029 PV$)
4	474,000	0	474,000
7	903,000	0	903,000
9	817,000	0	817,000
12	544,000	0	544,000

Scenario 2b energy savings (electricity, natural gas, source energy, total 30-year LSC) and peak demand reductions per-unit are presented in Table 22 for new construction, additions, and alterations. Per-unit savings for the first year are expected to range from 0.11 to 0.37 GWh/yr, depending upon climate zone. Demand reductions/increases are expected to be lower since there might not be any economizing when the peak load occurs.

Table 22: Scenario 2b Liquid-Cooled ITE Dry-Bulb Economizer – Energy and Energy Cost Savings – Per MW ITE – New Construction, Additions, and Alterations

Climate Zone	First Year Electricity Savings (kWh)	First Year Peak Demand Reduction (kW)	First Year Natural Gas Savings (kBtu)	First Year Source Energy Savings (kBtu)	Total 30-Year LSC Savings (2029 PV$)
1	108,334	9.1	0	141,692	868,642
2	184,649	14.1	0	196,135	1,430,976
3	180,390	13.6	0	221,422	1,432,386
4	218,827	13.9	0	222,411	1,717,513
5	182,910	13.6	0	206,664	1,424,287
6	274,403	26.5	0	392,301	2,316,999
7	307,481	29.3	0	438,607	2,634,384
8	291,284	28.3	0	405,520	2,528,617
9	287,723	21.6	0	371,951	2,507,065
10	274,750	23.7	0	349,523	2,375,050
11	254,074	21.9	0	322,566	2,229,763
12	241,451	17.6	0	265,916	2,014,099
13	282,805	21.6	0	346,028	2,455,910
14	269,150	22.2	0	309,272	2,392,811
15	369,673	29.7	0	445,719	3,079,746
16	173,376	17.6	0	237,317	1,637,272

Table 23 presents total energy cost savings per unit for newly constructed buildings, additions, and alterations in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV$). The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods.

Table 23: Scenario 2b Liquid-Cooled Dry-Bulb ITE Economizer – 2029 PV LSC Savings Over 30-Year Period of Analysis – Per MW ITE – New Construction, Additions, Alterations

Climate Zone	30-Year LSC Electricity Savings (2029 PV$)	30-Year LSC Natural Gas Savings (2029 PV$)	Total 30-Year LSC Savings (2029 PV$)
1	868,642	0	868,642
2	1,430,976.33	0	1,430,976.33
3	1,432,386.38	0	1,432,386.38
4	1,717,512.97	0	1,717,512.97
5	1,424,286.62	0	1,424,286.62
6	2,316,999.22	0	2,316,999.22
7	2,634,384.31	0	2,634,384.31
8	2,528,616.97	0	2,528,616.97
9	2,507,065.22	0	2,507,065.22
10	2,375,049.92	0	2,375,049.92
11	2,229,763	0	2,229,763
12	2,014,099.30	0	2,014,099.30
13	2,455,910	0	2,455,910
14	2,392,811.16	0	2,392,811.16
15	3,079,746.28	0	3,079,746.28
16	1,637,272.34	0	1,637,272.34

2.4.3 Incremental First Cost

Incremental first costs represent the overall cost to the building owner when constructing a data center to the proposed design, as compared to the base-case design. This does not represent the overall cost to build a data center, rather the additional cost needed to comply with the proposed code change.

To establish incremental costs for two of the California data center scenarios (Scenario 1 and Scenario 2a) as described in 2.4.2, the Statewide CASE Team requested a detailed cost bid from equipment manufacturers and local mechanical contractors in December 2025.

These detailed costs for baseline and proposed designs across each scenario are provided in the tables below:

Scenario 1: Air-Cooled ITE – Wet-Bulb Economizer Scenario Incremental Costs

Incremental cost data for CRAH coils was provided by two Bay Area representatives for two of the largest packaged CRAH manufacturers. Each representative provided pricing for a standard CRAH unit with a 4 row coil selected for a design of 14,500 cfm. Pricing was also provided for the same unit with a 6 row coil. The 4 and 6 row units are the same size and have the same size motor so there are no impacts on other contractor prices (e.g., mechanical, structural, electrical.) The average incremental cost was $0.23/cfm, which translates to $35.68/kW of ITE capacity.

Incremental cost data for waterside economizer heat exchangers (WSE HX) was provided by a Bay Area representative for a large heat exchanger manufacturer. Cost data was provided for a range of HX approaches, as outlined in Table 24.

Table 24: Contractor Pricing Per Range of WSE HX Approaches

Approach	2	3	4	5	6	7	8	9
CHWST Hot Leaving (°F)	65	65	65	65	65	65	65	65
CHWRT Hot Entering (°F)	85	85	85	85	85	85	85	85
Hot Water Flowrate (GPM)	1620	1620	1620	1620	1620	1620	1620	1620
Cold Entering (°F)	63	62	61	60	59	58	57	56
Cold Leaving (°F)	81	80	79	78	77	76	75	74
Cold Water Flowrate (GPM)	1800	1800	1800	1800	1800	1800	1800	1800
Max Pressure Drop Either Side (psi)	10	10	10	10	10	10	10	10
Budget Price ($)	$193,895	$154,377	$129,931	$114,487	$101,827	$94,391	$88,143	$83,567
$/KW ITE	$40.85	$32.52	$27.37	$24.12	$21.45	$19.89	$18.57	$17.61

The lower the approach the larger and heavier the heat exchanger. To account for the cost impact on other trades (e.g., structural, rigging, etc.) a conservative installation multiplier of two is applied to the incremental cost for all approaches.

Incremental cost data for cooling towers was provided by a Bay Area representative for a large cooling tower manufacturer. Cost data was provided for a range of cooling tower approaches, as outlined in Table 25.

Table 25: Contractor Pricing Per Range of Cooling Tower Approaches

Approach	3	5	7	9	11
Tower gpm	1253	1253	1253	1253	1253
Tower Range	12	12	12	12	12
Tower Btu/hr	7518000	7518000	7518000	7518000	7518000
Tower Tons	626.5	626.5	626.5	626.5	626.5
Approximate Chiller Tons	537	537	537	537	537
Approximate kW	1880	1800	1800	1800	1800
Budget Price	$212,070	$200,010	$182,160	$160,460	$125,640
$/KW ITE	$113	$106	$97	$85	$67

As with heat exchangers, the lower the cooling-tower approach, the larger and heavier the cooling tower becomes. To account for the cost impact on other trades (structural, rigging, etc.), a conservative installation multiplier of two is applied to the incremental cost. Note that a larger cooling lower tower approach does not require a larger motor, only a greater surface area (i.e., larger cooling tower).

Table 26: Wet-Bulb Economizer Scenario: Cost and Performance Data, per kW of ITE Capacity

Description	CRAH Coil	WSE HX	Cooling Tower	Total	CRAH Total Static Pressure (" w.g.)
Base-Case Design Approach (°F)	8	11	11	30	2.25
Proposed Design Approach (°F)	5	5	5	15	2.45
Incremental Cost / KW of ITE capacity	$35.68	$6.98	$42.40	$85.06	-
Installation multiplier	1	2	2	1.58	-
Total incremental cost	$35.68	$13.96	$84.80	$134.44	-

Chiller Downsizing:

Please note that this incremental cost for the Wet-Bulb Economizer Scenario is conservative because it does not take credit for chiller downsizing. In the base-case the approach to the wet-bulb is 30°F, meaning that for a 75°F SAT the economizer provides 100 percent free cooling at 45°F OAWB and partial economizer free cooling at OAWB up to 65°F. Above 65°F there is no partial economizing and 100 percent of cooling is provided by chillers. Data center cooling systems are typically designed to meet the design loads at the ASHRAE 20-year or 50-year extreme dry-bulb/wet-bulb conditions.

The extreme wet-bulb temperatures are listed below. In all locations the extremes are above 65°F so the chillers must be sized for 100 percent of the load.

In the proposed case, however, the approach to wet-bulb is 15°F, meaning that the economizer will provide partial cooling up to about 80°F OAWB. This is higher than all of the extreme OAWBs, meaning that the economizer should always provide at least partial free cooling and the chiller can be downsized. Table 27 shows the chillers can be downsized between 7 percent and 18 percent.

Table 27: Chiller Downsizing Percentage Based on Proposed Approach, by Climate Zone

Description	CZ04	CZ07	CZ09	CZ12
Weather file (TMY3)	San Jose	San Diego	Los Angeles	Sacramento
20yr extreme WB (°F)	75	76.8	77.3	77.3
50yr extreme WB (°F)	76.5	78.2	78.4	78.6
Baseline: WB Temp No Economizing (°F)	65	65	65	65
Proposed: WB Temp No Economizing (°F)	80	80	80	80
Chiller cap at 20 yr extreme	75%	84%	87%	87%
Chiller cap at 50 yr extreme	83%	91%	92%	93%
Percent chiller reduction at 50yr	18%	9%	8%	7%

Chiller downsizing will make the payback even better by reducing the net incremental cost. One reason this analysis does not take credit for downsizing is because downsizing requires the airside dT for the CRAH coil and the waterside dT for the CRAH coil to be at least 20°F (e.g., 75°F SAT, 95°F RAT, 70°F CHWST, 90°F CHWRT). Some engineers may not feel comfortable relying on this assumption. As such, this analysis uses conservative cost assumptions.

Scenario 2a: Separate Liquid-Cooled ITE Economizer Scenario Incremental Costs

Incremental costs were determined by starting with a real data center in the Bay Area that meets the proposed design and is currently under construction. The data center was used as the proposed scenario in the analysis and has a total ITE load of 8.5 MW with 6.5 MW of liquid-cooled ITE and 2.0 MW of air-cooled ITE. The proposed data center uses separate cooling plants for the air-cooled and liquid-cooled ITE. In December 2025, the Statewide CASE Team engaged the mechanical and electrical contractors building this data center to determine the incremental cost of combining the separate plants into a single plant serving both the air-cooled and liquid-cooled ITE, reflecting the baseline case. The mechanical contractor was asked to estimate the cost increase when moving from the base-case design to proposed design for the air-cooled ITE and liquid-cooled ITE scenarios. The mechanical contractor was selected based on significant experience designing and installing cooling equipment in data centers in California. Contractor pricing reflects a complete system and includes equipment, labor, and acceptance testing.

- **Proposed case:** The existing (under construction) data center includes the following:
  - Water-cooled chilled water plant with waterside economizer serving chilled water (CHW) to air-cooled ITE via CRAH units.
  - Separate tower condenser water plant serving tower water (TW) to liquid-cooled ITE via CDUs (cooling distribution units).
  - Separate CHW and TW piping throughout each data hall.
- **Base-case:** Contractors provided alternate pricing to combine the two plants into a single water-cooled chilled water plant serving both air and liquid cooled ITE. This is further described in Appendix A.

A summary of the incremental costs when going from the proposed case of two cooling plants to a single plant serving both air-cooled and liquid-cooled ITE is provided in Table 28. As shown in this table, it is less expensive to design and install the two cooling plant scenario serving air and liquid-cooled ITE separately, than a single system.

Table 28: Summary of Separate Liquid-Cooled ITE Economizer Scenario Incremental Costs

Proposed Case	Electrical	Mechanical	Total
Total Incremental first cost	$ (1,950,000)	$ (1,926,586)	$ (3,876,586)
Incremental first cost per kW of Liquid-Cooled ITE	$ (300)	$ (296)	$ (596)

2.4.4 Incremental Maintenance and Replacement Costs

Within the mechanical contractor incremental cost bid, costs associated with additional maintenance and replacement costs were established. The Statewide CASE Team secured these costs in December 2025. While the maintenance costs are negligible between the two scenarios and system types, it is anticipated that certain components will wear out and need to be replaced over the 30-year analysis period.

Air-Cooled ITE – Wet-Bulb Economizer Scenario: There is no incremental maintenance cost. The incremental replacement cost is calculated based on an expected life of 20 years for CRAH units, heat exchangers, and cooling towers.

Separate Liquid-Cooled ITE Economizer Scenario: The proposed case has 6 (smaller) cooling towers compared to 4 (larger) towers in the base-case. The proposed case has 9 (smaller) pumps, compared to 6 (larger) pumps in the base-case. The mechanical and electrical contractors estimate the incremental maintenance cost for the proposed case to be between $0 and $20,000/yr. To be conservative the worst case scenario of $20,000/yr is used in the analysis. For the 6.5 MW of liquid-cooled ITE capacity, this works out to $3.1/kW of ITE capacity.

Incremental Replacement cost is calculated based on a replacement period of 20 years for chillers, towers, and pumps.

2.4.5 Cost Effectiveness

In the tables below, all values are presented in 2029 present value dollars (2029 PV$). Benefits represent 30-year LSC savings and other savings, including incremental first-cost savings if the proposed first cost is less than the current first cost, incremental maintenance cost savings if the proposed maintenance costs are less than the current maintenance costs, and incremental residual value if proposed residual value is greater than current residual value at the end of the 30-year period of analysis. Costs represent the total incremental PV cost, including incremental equipment, replacement, and maintenance costs over the period of analysis. The analysis treats a negative incremental maintenance cost as a positive benefit. If total incremental costs are zero, the benefit-cost ratio (BCR) is considered infinite. Costs and other savings are discounted at a real (inflation-adjusted) three percent rate. If there are no total incremental PV costs, the BCR is infinite.

Scenario 1 results of the per-unit cost-effectiveness analyses are presented in Table 29 for new construction/additions and alterations.

Scenario 2 results of the per-unit cost-effectiveness analyses are presented in Table 30 for new construction/additions and alterations. Cost savings results are based on Scenario 2b, but both Scenario 2a and 2b have negative incremental implementation costs and therefore have infinite cost-effectiveness.

Table 29: Scenario 1 Air-Cooled ITE—Wet-Bulb Economizer-30-Year Cost-Effectiveness Summary Per MW of ITE Capacity – New Construction, Additions, and Alterations

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV$ / MW ITE)	Costs Total Incremental PV Costs (2029 PV$ / MW ITE)	Benefit-to-Cost Ratio
1	516,969	208,876.17	2.48
2	656,645.58	208,876.17	3.14
3	677,886.16	208,876.17	3.25
4	584,545.16	208,876.17	2.80
5	621,221.36	208,876.17	2.97
6	957,188.17	208,876.17	4.58
7	1,097,098.05	208,876.17	5.25
8	1,043,432.58	208,876.17	5.00
9	927,792.97	208,876.17	4.44
10	838,659.65	208,876.17	4.02
11	693,276	208,876.17	3.32
12	756,196.23	208,876.17	3.62
13	848,249	208,876.17	4.06
14	542,802.42	208,876.17	2.60
15	954,597.11	208,876.17	4.57
16	310,781.15	208,876.17	1.49

Table 30: Scenario 2 Liquid-Cooled ITE Economizer-30-Year Cost-Effectiveness Summary Per MW of ITE Capacity – New Construction, Additions, and Alterations

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV$ / MW ITE)	Costs Total Incremental PV Costs (2029 PV$ / MW ITE)	Benefit-to-Cost Ratio
1	$ 868,642	$-	Cost Effective (Infinite)
2	$1,430,976.33	$-	Cost Effective (Infinite)
3	$1,432,386.38	$-	Cost Effective (Infinite)
4	$1,717,512.97	$-	Cost Effective (Infinite)
5	$1,424,286.62	$-	Cost Effective (Infinite)
6	$2,316,999.22	$-	Cost Effective (Infinite)
7	$2,634,384.31	$-	Cost Effective (Infinite)
8	$2,528,616.97	$-	Cost Effective (Infinite)
9	$2,507,065.22	$-	Cost Effective (Infinite)
10	$2,375,049.92	$-	Cost Effective (Infinite)
11	$2,229,763	$-	Cost Effective (Infinite)
12	$2,014,099.30	$-	Cost Effective (Infinite)
13	$2,455,910	$	Cost Effective (Infinite)
14	$2,392,811.16	$-	Cost Effective (Infinite)
15	$3,079,746.28	$-	Cost Effective (Infinite)
16	$1,637,272.34	$-	Cost Effective (Infinite)

2.5 Computer Room Economizers – Statewide Impacts

2.5.1 Statewide Energy and Energy Cost Savings

See the 2028 CASE Methodology Report for details on how statewide savings are calculated. Appendix C presents the assumptions on the percentage of the total construction forecast that the proposed measure would impact.

For more details on the methodology and context about estimating the current market share rate, as well as statewide energy and energy cost savings, see the 2028 CASE Methodology Report.

To estimate statewide impacts of the proposed data center economizer changes, the Statewide CASE Team weighted potential savings across the three scenarios (1, 2a, and 2b) representing the likelihood of air-cooled and liquid-cooled ITE using either an airside or waterside economizer. To determine the breakdown of dry-bulb or wet-bulb economizers likely to be installed across the state, the Statewide CASE Team leveraged the market analysis conducted in the 2022 CASE Report *Nonresidential Computer Room Efficiency*. This assessment assumed 34.5 percent use a wet-bulb economizer while 65.5 percent use a dry-bulb economizer (Weitze, Bulger and Stein 2021).

Additionally, the Statewide CASE Team determined the likely ratio of new and existing data centers with air-cooled and liquid-cooled ITE. Two market assessments, one from Uptime Institute and another from Mordor Intelligence, which were conducted in 2024 and 2026, respectively, were used to generate a reasonable approximation of liquid-cooled and air-cooled ITE. The Uptime Institute Survey found that 22 percent of the global market currently uses liquid-cooled ITE, while another 61 percent would consider it. While the Mordor Intelligence Global Data Center Cooling Market Source found that 53.4 percent of the global data center market currently uses air-cooled ITE and 46.6 percent use liquid-cooled ITE. However, this assessment also shows that liquid cooled ITE is expected to grow by over 17 percent by 2032. Based on these assessments, the Statewide CASE Team estimates that 70 percent of the new data center load will be liquid-cooled ITE with 30 percent air-cooled ITE.

The tables below present the first-year statewide energy and LSC savings from newly constructed buildings and additions (Table 31) and alterations (Table 32) by climate zone and involving an air-cooled ITE with a wet-bulb economizer (WSE) or a liquid-cooled ITE economizer (LCE). Table 33 presents first-year statewide savings from new construction, additions, and alterations.

Table 31: Statewide Energy and LSC Impacts – New Construction and Additions

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1 (WSE)	-	-	-	-	-	-
2 (WSE)	0.001	0.000041	0.000	-	0.000	0.000346
3 (WSE)	0.315	0.025107	0.002	-	0.039	0.213398
4 (WSE)	3.834	0.272098	0.018	-	0.359	2.241152
5 (WSE)	0.004	0.000273	0.000	-	0.000	0.002336
6 (WSE)	0.008	0.000828	0.000	-	0.001	0.007200
7 (WSE)	0.005	0.000557	0.000	-	0.001	0.004951
8 (WSE)	0.015	0.001760	0.000	-	0.003	0.015698

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
9 (WSE)	0.032	0.003334	0.000	-	0.005	0.030009
10 (WSE)	0.002	0.000172	0.000	-	0.000	0.001514
11 (WSE)	-	-	-	-	-	-
12 (WSE)	0.595	0.052950	0.003	-	0.072	0.449935
13 (WSE)	-	-	-	-	-	-
14 (WSE)	0.002	0.000105	0.000	-	0.000	0.000960
15 (WSE)	0.000	0.000000	0.000	-	0.000	0.000004
16 (WSE)	0.002	0.000052	0.000	-	0.000	0.000514
1 (LCE)	-	-	-	-	-	-
2 (LCE)	0.00350	0.00065	0.000049	-	0.00069	$0.0050

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
3 (LCE)	2.09182	0.37734	0.028525	-	0.46318	$2.9963
4 (LCE)	25.47671	5.57499	0.353813	-	5.66630	$43.7566
5 (LCE)	0.02499	0.00457	0.000341	-	0.00516	$0.0356
6 (LCE)	0.04998	0.01372	0.001324	-	0.01961	$0.1158
7 (LCE)	0.02999	0.00922	0.000878	-	0.01315	$0.0790
8 (LCE)	0.09997	0.02912	0.002828	-	0.04054	$0.2528
9 (LCE)	0.21493	0.06184	0.004643	-	0.07994	$0.5388
10 (LCE)	0.01200	0.00330	0.000284	-	0.00419	$0.0285
11 (LCE)	-	-	-	-	-	-
12 (LCE)	3.95371	0.95463	0.069671	-	1.05136	$7.9632

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
13 (LCE)	-	-	-	-	-	-
14 (LCE)	0.01175	0.00316	0.000260	-	0.00363	$0.0281
15 (LCE)	0.00002	0.00001	0.000001	-	0.00001	$0.0001
16 (LCE)	0.01100	0.00191	0.000193	-	0.00261	$0.0180
Total	**37**	**7.39**	**0.48**	**-**	**7.83**	**$58.79**

Table 32: Statewide Energy and LSC Impacts – Alterations

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1 (WSE)	-	-	-	-	-	$0.00
2 (WSE)	0.001	0.000041	0.000	-	0.000	0.000346
3 (WSE)	0.315	0.025107	0.002	-	0.039	0.213398
4 (WSE)	3.834	0.272098	0.018	-	0.359	2.241152
5 (WSE)	0.004	0.000273	0.000	-	0.000	0.002336
6 (WSE)	0.008	0.000828	0.000	-	0.001	0.007200
7 (WSE)	0.005	0.000557	0.000	-	0.001	0.004951
8 (WSE)	0.015	0.001760	0.000	-	0.003	0.015698

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
9 (WSE)	0.032	0.003334	0.000	-	0.005	0.030009
10 (WSE)	0.002	0.000172	0.000	-	0.000	0.001514
11 (WSE)	-	-	-	-	-	$0.00
12 (WSE)	0.595	0.052950	0.003	-	0.072	0.449935
13 (WSE)	-	-	-	-	-	$0.00
14 (WSE)	0.002	0.000105	0.000	-	0.000	0.000960
15 (WSE)	0.000004	0.0000004	0.000000	-	0.000001	0.000004
16 (WSE)	0.002	0.000052	0.000	-	0.000	0.000514

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1 (LCE)	-	-	-	-	-	$0.00
2 (LCE)	0.00045	0.00008	0.000006	-	0.00009	$0.0006
3 (LCE)	0.27774	0.05010	0.003787	-	0.06150	$0.3978
4 (LCE)	3.38127	0.73991	0.046958	-	0.75203	$5.8074
5 (LCE)	0.00333	0.00061	0.000045	-	0.00069	$0.0047
6 (LCE)	0.00670	0.00184	0.000178	-	0.00263	$0.0155
7 (LCE)	0.00382	0.00118	0.000112	-	0.00168	$0.0101
8 (LCE)	0.01313	0.00382	0.000371	-	0.00532	$0.0332

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
9 (LCE)	0.02855	0.00822	0.000617	-	0.01062	$0.0716
10 (LCE)	0.00162	0.00044	0.000038	-	0.00057	$0.0038
11 (LCE)	-	-	-	-	-	$0.00
12 (LCE)	0.52473	0.12670	0.009247	-	0.13953	$1.0569
13 (LCE)	-	-	-	-	-	$0.00
14 (LCE)	0.00157	0.00042	0.000035	-	0.00049	$0.0038

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2026 (ITE Capacity MW)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
15 (LCE)	0.000004	0.000001	0.000000	-	0.000002	0.000011
16 (LCE)	0.00148	0.00026	0.000026	-	0.00035	$0.0024
Total	**9**	**1.29**	**0.08**	**-**	**1.47**	**$10.43**

Table 33: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations

Construction Type	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
New Construction & Additions	7.39	0.48	-	7.83	58.79
Alterations	1.29	0.08	-	1.47	10.43
Total	**8.68**	**0.56**	**-**	**9.3**	**69.22**

2.5.2 Statewide Greenhouse Gas Emissions Reductions

Table 34 presents the estimated first-year reduction in GHG emissions resulting from the proposed code change. In this initial year, the Statewide CASE Team expects to avoid 492 metric tons of carbon dioxide equivalent (CO_2e) emissions. These reductions, along with their associated monetary value, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of CBECC, as well as data from the CEC's 2028 Metrics Report. See the 2028 CASE Methodology Report for additional information.

Table 34: First-Year Statewide GHG Emissions Impacts

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions ($)
New Construction, Additions, and Alterations (LCE)	441	0	441	71,567
New Construction, Additions, and Additions (WSE)	51	0	51	8,342
Total	**492**	**0**	**492**	**79,909**

2.5.3 Statewide Water Use Impacts

While this proposed measure does not require an increase in water use, water use could increase in individual computer rooms if the requirements push designers to use certain cooling solutions over others. The 2022 CASE Report *Nonresidential Computer Room Efficiency*, which evaluated the impact of increased economizing thresholds, conducted a water use analysis based on an estimate statewide average for all economizer types (Weitze, Bulger and Stein 2021).

This analysis found that water use could increase or decrease based on the following scenarios:

1. **Design that increases water use:** A computer room design that changes from air-cooled cooling equipment under the current code requirement to an evaporative cooling tower for wet-bulb economizing based on the new temperature thresholds. The previous CASE Report estimated this increased annual water use at 1,000 – 2,500 gallons per kW of ITE design load depending on climate zone.
2. **Design that decreases water use:** A computer room design using dry-bulb economizers and evaporative-cooled chiller plant would result in reduced water use by decreasing the cooling load on the evaporative cooling towers. The previous CASE Report estimated this decreased water use at 100 – 900 gallons per kW of ITE design load depending on climate zone.

While the first scenario described above would increase water use, the Statewide CASE Team does not anticipate that the proposed change would result in more designers switching from air-cooled to water-cooled equipment. Because the proposed change would increase the temperature threshold and economizer stringency for wet-bulb economizers and not dry-bulb economizers, the opposite effect may occur, and designers may opt for air-cooled equipment to avoid the new waterside requirements. Additionally, by increasing the threshold for wet-bulb economizers, more of the cooling load would be taken by the wet-bulb economizer, thus decreasing the cooling load on the evaporative cooling towers, which would reduce overall water use in those systems.

There are also other ways to reduce potable water consumption in evaporative systems, such as:

- Use recycled water in evaporatively-cooled systems.
- Design Hybrid air-cooled and (for peak days only) evaporatively-cooled systems.
- Design a closed loop heat recovery system where computer room heat can be rejected to a heating load instead of outdoors.

Considering these factors, the Statewide CASE Team does not anticipate this proposed change will result in increased water use and may in fact decrease overall water use if more designs use air-cooled cooling equipment.

2.5.4 Statewide Material Impacts

Material impacts related to this proposed measure would largely depend on how a cooling system is designed to comply with the proposed economizer requirements.

Certain approaches may result in less materials, or different types of materials being used, while other approaches, such as the two analysis scenarios described in Section 2.4.2, would increase overall material use. While the Statewide CASE Team recognizes there are many other code compliant designs, as described in Sections 2.1.3 and 2.3.2, the material impacts defined in this section of the report are based on the two selected scenarios and described below.

Air-Cooled ITE—Wet-Bulb Economizer Scenario:

Using a larger cooling tower and heat exchanger sized for lower approach temperatures to meet the increased wet-bulb economizer threshold would result in an increase in steel use, as shown in Table 35.

Table 35: First-Year Statewide Impacts on Material Use for Air-Cooled ITE – Wet-Bulb Economizer Scenario

Material	Impact	Per-Unit Impacts (Pounds per MW of ITE)	First-Year Statewide Impacts (Pounds)	Embodied GHG emissions saved (Metric Tons CO2e)
Steel	NC, Additions, Alterations	1.7	16,495	-9

Liquid-Cooled ITE Economizer – Wet-Bulb Economizer Scenario:

Using a separate waterside economizing plant for liquid-cooled ITE is expected to result in steel savings compared to a single cooling plant for all ITE. While using two cooling plants would result in a net increase in linear feet of piping, the piping required would be smaller in diameter, resulting in a net decrease in piping material of 2.5 pounds per kW of ITE load.

Table 36: First-Year Statewide Impacts on Material Use for Liquid-Cooled ITE Economizer – Wet-Bulb Economizer Scenario

Material	Impact	Per-Unit Impacts (Pounds per MW of ITE)	First-Year Statewide Impacts (Pounds)	Embodied GHG emissions saved (Metric Tons CO2e)
Steel	NC, Additions, Alterations	-2.5	-90,562	50

The estimated net impact in statewide material impacts for this measure is a reduction in steel use, as shown in Table 37. For more information on the Statewide CASE Team's methodology and assumptions used to calculate embodied GHG emissions, see the 2028 CASE Methodology Report.

Table 37: First-Year Statewide Impacts on Material Use

Material	Impact	Per-Unit Impacts (Pounds per MW of ITE)	First-Year Statewide Impacts (Pounds)	Embodied GHG emissions saved (Metric Tons CO2e)
Steel	**NC, Additions, Alterations**	**Varies depending on system type (see previous two tables)**	**-74,067**	**41**

2.5.5 Environmental Impacts

This measure is not expected to result in any environmental impacts. While certain cooling system designs do increase water use in computer rooms and data centers, the proposed changes are not expected to increase the use of those designs. As such, the code change will not directly impact water use or quality.

2.5.6 Other Non-Energy Impacts

This measure is not expected to result in any non-energy impacts.

2.6 Computer Room Economizers – Proposed Language Code

2.6.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions). New to the 2028 energy code is to *italicize defined terms* when the terms are being used in its defined context. In-line comments that are not part of the proposed code language but are used to help describe the purpose of what is proposed are included *with greyed highlight and italics.*

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.[8] 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).

Posting the proposed code language in this format is useful as it helps describe how the Energy Code changes proposed for nonresidential occupancies are isolated from the requirements for residential occupancies which are prohibited from being changed until the 2031 code cycle by Assembly Bill 130.

2.6.2 Energy Code (Title 24, Part 6)

SECTION 201 *[SECTION 100.1(b)]* – DEFINITIONS

INFORMATION TECHNOLOGY EQUIPMENT (ITE) includes computers, data storage, servers, and network/communication equipment located in a computer room. ITE definitions include the following:

> **ITE, LIQUID-COOLED** are the components of ITE that are cooled by a fluid other than air and that do not use server fans to flow air across the components. Common liquid cooling fluids include water, glycol, and refrigerant. Individual servers can be partially liquid-cooled and partially air-cooled, with server fans serving the air-cooled components and pumps serving the liquid-cooled components.

> **ITE, AIR-COOLED** are the components of ITE that are cooled by the flow of air through the ITE equipment. Onboard server fans are typically used to move air through servers.

FACILITY WATER is the cooling fluid loop that carries heat away from liquid-cooled ITE toward plant-level heat rejection infrastructure, including but not limited to chillers, cooling towers, and/or dry coolers.

ECONOMIZER, COMPUTER ROOM is a system by which heat from ITE is rejected to the environment without the use of a refrigerant compressor. If a computer room economizer is part of a cooling system that also includes a refrigerant compressor, then the system shall be fully integrated, meaning it shall be capable of providing partial economizer cooling without limiting the capacity of compressor cooling and without limiting the capacity of compressor-less cooling.

~~**ECONOMIZER, PUMPED REFRIGERANT,** is a system by which the supply air of a cooling system is cooled directly by refrigerant pumped between indoor and outdoor units during cooler ambient temperatures in order to reduce or eliminate the need for mechanical cooling.~~

SECTION 1001 – NONRESIDENTIAL OCCUPANCIES (NEWLY CONSTRUCTED)

1001.1 *[Section 120.8]* General.

Nonresidential buildings other than *healthcare facilities*, with *conditioned space* of 10,000 square feet or more, shall comply with the applicable requirements

of Section 1001.2 in the building design and construction processes.
All *building* systems and components covered by Sections 101.2 *[Section 110.0]*, 301.1 *[Section 120.0]*, 601 *[Section 130.0]*, and 102 *[Section 140.0]*, and *computer rooms* covered by section 1001.2 *[New section]*, shall be included in the scope of the commissioning requirements in this Section, excluding those related solely to *covered processes* with the exception of *computer rooms*.

Nonresidential buildings other than *healthcare facilities*, with *conditioned space* of less than 10,000 square feet shall comply with the *design review* requirements specified in Section 1001.2.3 *[Section 120.8(d)],* and shall include any measures or requirements necessary for completing this review in the construction document in a manner consistent with Section 1001.2.4 *[Section 120.8(e)].*

1001.2 *[Section 120.8(a)]* Mandatory requirements (Newly Constructed)

1001.2.9 *[New section] Computer Room* Commissioning. All buildings with at least 1 MW of new *ITE design load* shall complete the following commissioning scope.

1001.2.9.1 Design Phase

1001.2.9.1.1 *Computer rooms* shall comply with sections 1001.2.1 through 1001.2.5 for the following systems serving computer rooms. The 10,000 sq. ft. trigger in *Part 1* Section 10-103 shall not apply:

- Cooling
- Pumps
- Fans
- Ventilation
- Heat recovery
- Humidification

1001.2.9.1.2 The design review shall include the following in addition to 1001.2.3 requirements:

1. Economizers: Economizer is designed to meet economizer temperature thresholds in 910.2.1A at design conditions, and confirm economizer is designed to meet *Computer Room Economizer* definition in 200.3.
2. Variable airflow control: System is designed to maintain at least 20°F airside deltaT at 25-100% part loads per 910.2.1C.
3. Variable water flow control: System is designed to maintain at least 15°F water deltaT at 25-100% part loads per 910.2.1C.

4. Heat recovery: System is designed to meet Computer Room Heat Recovery requirements in 910.1.4. If project is utilizing Exception 3 to 910.2.1, confirm system is designed to meet the requirements for Exception 3 to 910.2.1.

1001.2.9.2 Construction Phase

1001.2.9.2.1 Computer rooms shall comply with sections 1001.2.6 and 1001.2.8 for the following systems serving computer rooms:

- Cooling
- Pumps
- Fans
- Ventilation
- Heat recovery
- Humidification

1001.5 Additions and alterations to existing buildings

1001.5.1 *[New section]* Computer Room Commissioning

All additions and alterations with at least 1 MW of new design ITE load shall comply with 1001.2.9.

Exception to Section 1001.5.1: Computer rooms in hotel/motel buildings and nonresidential buildings with Group R occupancies.

SECTION 910

COMPUTER ROOMS

(NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)

SECTION 910.2 *[SECTION 140.9(a)]* – PRESCRIPTIVE REQUIREMENTS (NEWLY CONSTRUCTED)

910.2 *[Section 140.9(a)]* **Prescriptive Requirements (Newly Constructed).**

~~Computer rooms with a power density greater than 20 W/ft2 shall comply with this section.~~

910.2.1 *[Section 140.9(a)1]* ***Computer Room*** ***Economizers*** **– Hotel/motel buildings and nonresidential buildings with Group R occupancies.**

Each individual cooling system primarily serving *computer rooms* shall include either:

1. An integrated *air economizer* capable of providing partial cooling even when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F *supply air* temperature at

outside air temperatures of 65°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 401.2.2.9 *[Section 120.2(i)]*; or

2. An integrated *water economizer* capable of providing partial cooling even when additional *mechanical cooling* is required and capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 50°F dry-bulb and below or 45°F wet-bulb and below.

Exception 1 to Section 910.2.1: Individual *computer rooms* with an *ITE design load* under 5 tons (18 kW) in a *building* that does not have any economizers.

Exception 2 to Section 910.2.1: A *computer room* with an *ITE design load* less than 20 tons (70 kW) may be served by a second *fan system* without an economizer if it is also served by a *fan system* with an economizer that also serves other spaces within the *building*, provided that all of the following are met:

1. The economizer system is sized to meet the design cooling load of the *computer room* when the other spaces within the *building* are at 50 percent of their design load at *outside air* temperatures of 65°F dry-bulb and below or 50°F wet-bulb and below; and
2. An economizer system that can stop *service* to other spaces in the *building* when those spaces are unoccupied and serve only the *computer rooms*.

910.2.2 *[New section]* ***Computer Room Economizers – All other nonresidential buildings.***

Each cooling system serving *computer room(s)* shall include a *computer room economizer, and* comply with the requirements of this section.

1. Systems that meet the definition of a *computer room economizer* include but are not limited to the following:

1.1 Waterside economizer heat exchangers that are piped in series with chillers on the chilled water side.

1.2 Air-cooled chillers with integrated economizer coils that are piped into the secondary circuit of a primary/secondary system. The fans serving the integrated economizer coils must be able to modulate speed without being limited by the need to maintain a minimum refrigerant head pressure.

1.3 Air-cooled chillers with integrated economizer coils that are served by dedicated economizer fans and not by condenser fans that serve refrigerant condenser coils.

1.4 Refrigerant economizer systems where 10-90% of the load on a refrigerant circuit can be met by a passive condenser or refrigerant pump, while the other 90% to 10% of the load is met by an active condenser or refrigerant compressor

2. Systems that DO NOT meet the definition of a *computer room economizer*

and do not meet the requirements of this section include the following:

2.1 Waterside economizer heat exchangers that are piped in parallel with chillers on the chilled water side.

2.2 Air-cooled chillers with integrated economizer coils that are piped into the primary circuit of a primary/secondary system, or on the chiller side of a chiller minimum flow bypass valve.

2.3 Air-cooled chillers with integrated economizer coils that are served by the same condenser fans that serve refrigerant condenser coils whose speed is limited by the need to maintain a minimum refrigerant head pressure.

2.4 Refrigerant economizer systems with one or more refrigerant circuits that must switch from refrigerant compressor operation to refrigerant pump operation.

3. The *computer room economizer* shall be designed and operated to provide 100 percent of the computer room cooling load without *mechanical cooling* at the outdoor conditions in Table 910.2-A. Compliance shall be determined with redundant *equipment* operating if the redundant *equipment* is expected to operate in normal operation. Compliance shall be determined at 75°F *supply air* temperature for air-cooled *ITE* and at the design supply fluid temperature for liquid-cooled *ITE*.

Table 910.2-A Computer Room Economizer Outdoor Thresholds.

Type of *ITE*	**Outdoor Dry-Bulb**	**Outdoor Wet-Bulb**
Air-Cooled *ITE* in a *computer room* with average air-cooled *ITE design load* > 25 kW/rack and served by a cooling system that does not evaporate water at these outdoor conditions	≤ 55°F	≤ 55°F
All liquid-cooled ITE in *buildings* with a design liquid-cooled *ITE design load* greater than 2 MW	≤ 75°F	≤ 75°F
All other *ITE*	≤ 65°F	≤ 60°F

4. The economizer shall be equipped with a fault detection and diagnostic system as specified by Section 401.2.2.9 *[Section 120.2(i)]*

5. Differential Temperature (dT) and Variable Flow

5.1 Air handling systems with a capacity exceeding 30,000 Btu/hr serving *air-cooled ITE* shall be designed for a return to supply air dT of at least 20°F. These systems shall be designed and controlled to vary airflow as a function of *ITE load* or *ITE* airflow with a minimum airflow not to exceed

25% of design airflow, in order to maintain constant dT at *ITE* loads from 25% to 100% of max ITE load.

5.2 Chilled water and facility water systems serving *air-cooled* and *liquid-cooled ITE* shall be designed for a return to supply fluid dT of at least 15°F. These systems shall be designed and controlled to vary fluid flow as a function of *ITE* load, in order to maintain constant dT at *ITE* loads from 25% to 100% of max *ITE* load.

6. Economizer Acceptance Testing: in addition to meeting the requirements in 1001.2.6, an integrated economizer cooling functional test shall be performed that demonstrates cooling system operation in full economizing mode, such that compressor cooling shall not occur at the conditions specified in Table 910.2-A, and in partial economizing mode and full compressor cooling mode.

EXCEPTION 1 to Section 910.2.2: Individual *computer rooms* with an *ITE design load* under 5 tons (18 kW) in a *building* that does not have any economizers.

EXCEPTION 2 to Section 910.2.2: A *computer room* with an *ITE design load* less than 20 tons (70 kW) may be served by a second *fan system* without an economizer if it is also served by a *fan system* with an economizer that also serves other spaces within the *building*, provided that all of the following are met:

1. The economizer system is sized to meet the design cooling load of the *computer room* when the other spaces within the building are at 50 percent of their design load at *outside air* temperatures of 65°F dry-bulb and below ~~or 50°F~~ and 60°F wet-bulb and below; and
2. An economizer system that can stop service to other spaces in the *building* when those spaces are unoccupied and serve only the *computer rooms*.

EXCEPTION 3 to Section 910.2.2: *Computer rooms* that reject heat to a heat recovery system that is sized to accept at least 50% of the design *computer room* heat and that serves either:

1. Space heating systems and/or service water heating systems with design loads greater than 5 times the *computer room* design cooling load, or
2. Processes determined by the *Executive Director* to require more than 50% of the design *computer room* heat for more than 3,000 hours/year.

910.2.~~2~~3 *[Section 140.9(a)2]* **Power Consumption of Fans.**

…

910.2.~~3~~4 *[Section 140.9(a)3]* **Air Containment.**

…

910.2.~~4~~5 *[Section 140.9(a)4]* **Alternating Current-Output Uninterruptible Power Supplies (UPS).**

Alternating current-output UPS systems serving a *computer room* shall meet or exceed minimum average efficiencies in Table 910.2-~~A~~B *[Table 140.9-B]*.

TABLE 910.2-~~A~~B [Table 140.9-B] ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY MINIMUM AVERAGE EFFICIENCY

AC Output	Voltage and Frequency Dependent	Voltage Independent	Voltage and Frequency Independent
P≤350 W	$5.71 \times 10^{-5} \times P + 0.962$	$5.71 \times 10^{-5} \times P + 0.964$	$0.011 \times \ln(P) + 0.824$
350 W<P≤1,500 W	0.982	0.984	$0.011 \times \ln(P) + 0.824$
1,500 W<P≤10,000 W	$0.981 - E_{MOD}$	$0.980 - E_{MOD}$	$0.0145 \times \ln(P) + 0.800 - E_{MOD}$
P>10,000 W	0.970	0.940	$0.0058 \times \ln(P) + 0.886$

Minimum average efficiency for alternating current-output UPS shall meet or exceed calculation and testing requirements identified in ENERGY STAR Program Requirements for Uninterruptible Power Supplies (UPSs) – Eligibility Criteria Version 2.0.

where:

P is the rated output power in watts (W).

E_{MOD} is an allowance of 0.004 for modular UPSs applicable in the commercial 1,500-10,000 W range.

ln is the natural logarithm.

The requirement shall be rounded to the third decimal place for certification and reporting.

Exception to Section 910.2.45: Alternating current-output UPS that utilizes standardized NEMA 1-15P or NEMA 5-15P input plug, as specified in *ANSI*/NEMA WD-6-2016.

SECTION 910.4 *[SECTION 141.1, 141.1(b)]* – ADDITIONS and ALTERATIONS TO EXISTING BUILDINGS

Covered processes in *additions* or *alterations* to existing *buildings* that will be *hotel/motel*, *multifamily or nonresidential buildings with Group R* occupancies shall comply with the applicable requirements of section 910.1 *[Section 120.6(j)]*, Sections 910.2.3 and 910.2.5 *[Sections 140.9(a)2 and 4]*, Section 910.4.1 *[Section 141.1(b)]*, and the applicable requirements of Section 400.5.1 *[Section 110.2(a)]* and Section 913 *[Section 120.3]*.*Covered processes* in *additions* or *alterations* to all other existing *nonresidential buildings* shall comply with the applicable requirements of section 910.1 *[Section 120.6(j)]*, Sections 910.2.3 and 910.2.5 *[Sections 140.9(a)2 and 4]*, Section 910.4.2 *[New section]*, and the applicable requirements of Section 400.5.1 *[Section 110.2(a)]* and Section 913 *[Section 120.3]*.

910.4.1 *[Section 141.1(b)]* Computer Room Economizers – Hotel/motel buildings and nonresidential buildings with Group R occupancies.

Each individual cooling system primarily serving *computer rooms* in an existing *building* shall include either:

1. An integrated *air economizer* capable of partial cooling when additional *mechanical cooling* is required and capable of providing 100 percent of the expected system cooling load up to 80°F room *supply air* temperature at *outside air* temperatures of 55°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 401.2.2.9 *[Section 120.2(i)]*; or
2. An integrated *water economizer* capable of partial cooling when additional *mechanical cooling* is required and capable of providing 100 percent of the expected system cooling load up to 80°F room *supply air* temperature at *outside air* temperatures of 40°F dry-bulb and below or 35°F wet-bulb and below.

Exception 1 to Section 910.4.1: Individual *computer rooms* with an *ITE design load* under 5 tons (18 kW) in a *building* that does not have any economizers.

Exception 2 to Section 910.4.1: New cooling systems serving an existing *computer room* in an existing *building* with an *ITE design load* up to a total of 50 tons (176 kW).

Exception 3 to Section 910.4.1: New cooling systems serving a new *computer room* in an existing *building* with an *ITE design load* up to a total of 20 tons (70 kW).

910.4.2 *[New Section]* **Computer Room Economizers – All other nonresidential buildings.**

Each individual cooling system primarily serving computer rooms in an existing building shall meet the requirements of Section 910.2.2.

EXCEPTION 1 to Section 910.4.2: Individual computer rooms with an ITE design load under 10 tons (35 kW) in a building that does not have any economizers or modulating DOAS.

EXCEPTION 2 to Section 910.4.2: new cooling systems serving an existing *computer room* where:

1. Total capacity of the new cooling system is less than 500 tons and less than 50% of the total *computer room* cooling system capacity, and
2. The new cooling system includes an integrated *computer room economizer* capable of providing 100 percent of the design cooling load at 75°F *supply air* temperature at the following *outside air* conditions:

Original Permit Date of Existing Computer Room	**Dry-Bulb**	**Wet-Bulb**
Before 1/1/2014	No economizer requirement	
1/1/2014 – 12/31/2022	55°F	35°F
1/1/2023 – 12/31/2028	65°F	45°F

2.6.3 Administrative Code (Title 24, Part 1)

There are no proposed changes to Title 24, Part 1.

2.6.4 Reference Appendices

There are no proposed changes to the Reference Appendices.

2.6.5 Compliance Manuals

Sections 10.4.3.1 and 10.4.5.1 of Chapter 10 (Covered Processes) in the nonresidential compliance manual will need to be updated to describe the new economizer requirements for new construction and additions and alterations for computer rooms. A new section of Chapter 13 (Commissioning) in the nonresidential compliance manual will need to be added for new computer room commissioning requirements. The

Statewide CASE Team can provide CEC with more detailed recommended revisions to compliance manuals after the 45-Day Language is published. Additionally, the 2028 compliance manual should incorporate the same content that is included in the 2022 compliance manual, rather than referring readers to the 2022 compliance manual as is done in the 2025 version.

2.6.6 ACM Reference Manual

The following sections in the Nonresidential ACM would need to be updated based on the proposed change.

- Appendix 5.4B: Modify the cooling setpoint for data centers from 80°F to 95°F. Per ACM Section 5.7.2.3 Supply Air Temperature Control, raising the cooling setpoint from 80°F to 90°F, will raise the SAT from 60°F to 75°F, which is more consistent with current standard practice.
- Section 5.7.4.2 Air Side Economizers: Revise the Economizer High Temperature Lockout standard design from a fixed dry-bulb high limit of 80°F to 95°F.

Currently the ACM has two baseline systems for computer rooms:

System 10: Single zone VAV chilled water CRAH unit with airside economizer, served by water-cooled chillers served by cooling towers. This system is currently assigned to computer rooms with total process load > 800kW

System 11: Single zone VAV packaged DX with airside economizer. This system is currently assigned to computer rooms with total process load ≤ 800kW

Three new baseline systems will be added:

System 11a: Air-cooled ITE served by CRAH units served by water-cooled chillers served by dry coolers that also function as fully integrated economizers. Some details of this system:

a. Dry coolers design approach to ambient dry-bulb: 15°F (accounts for redundancy)
b. No waterside economizer heat exchanger. The dry cooler fluid is piped direct to the CRAH units in partial or full economizer mode.
c. CRAH unit SAT approach to facility water temperature: 5°F (accounts for redundancy)
d. Dry coolers controlled to maintain SAT of 75°F in full economizer mode.
e. Chillers controlled to maintain SAT of 80°F, i.e., in cold weather the dry cooler will maintain SAT = 75°F. As ambient temperature rises the SAT will drift up to 80°F before the chillers are enabled. The plant will operate in integrated economizer mode until ambient dry-bulb exceeds 100°F or higher (depending on IT load) at which point the chiller will meet the entire load.

f. Waterside economizer modeled in series with chillers on CHW side and in parallel on CW side.
g. CW flow to chillers modulates to maintain constant CW dT at chillers, (i.e., as the economizer serves more of the load the chiller CW flow goes down and approaches zero as chiller load approaches zero).

System 11b: Liquid-cooled ITE served by CDUs, served by water-cooled chillers served by dry coolers that also function as fully integrated economizers. Some details of this system:

1. Dry coolers design approach to ambient dry-bulb: 15°F
2. No waterside economizer heat exchanger. The dry-cooler fluid (FWS) is piped directly to the CDUs in partial or full economizer mode.
3. CDU FWS to TCS approach: 5°F
4. FWS and TCS: variable flow with constant dT of 15°F
5. Dry coolers controlled to maintain TCS supply temperature of 95°F in full economizer mode, i.e., 100% economizer at ambient dry-bulb of 75°F at full load.
6. Chillers controlled to maintain TCS supply temperature of 95°F in partial economizer mode and non-economizer mode.

System 11c: Same as System 10 (A/C chillers / CRAHs) but no airside or waterside economizer. Note that this applies only to systems that qualify for the heat-recovery economizer exception. As such, the load on the chillers is the current computer room load minus the lesser of:

1. The total current load of the heating systems used to qualify for the exception.
2. Fifty percent of the design computer room load

New mapping is as follows:

System	Serves…
11a (W/C Chillers / Dry Cooler Econ)	Air-Cooled ITE in a computer room with total ITE load > 200 kW and with average Air-cooled ITE power density > 25 kW/rack and Liquid-Cooled ITE in buildings with a design liquid-cooled ITE load ≤ 2 MW
11b (High Temp W/C Chillers / Dry Cooler Econ)	All liquid-cooled ITE in buildings with a design liquid-cooled ITE load greater than 2 MW
11c (A/C Chillers / No Econ)	ITE in Computer rooms that meet EXCEPTION 3 to Section 910.2.1

10 (A/C Chillers / Air Econ)	All other ITE prescriptively required to have an economizer

Note that a building with computer rooms may have several separate computer room systems in the baseline. For example, a proposed data center with liquid cooled ITE, high-density air-cooled ITE and low density air-cooled ITE would be compared to a baseline with System 11b for all liquid cooled ITE, 11a for air-cooled ITE in high density computer rooms, and 10 for air-cooled ITE in low density computer rooms.

2.6.7 Compliance Forms

NRCC-PRC-E and NRCI-PRC-E, would need to be updated to reflect new economizer requirements and improve compliance enforcement. No Acceptance Tests are proposed for this measure. The NRCC-PRF-01-E form does not currently support computer rooms and will need to be modified from the standpoint of the performance reports and the ACM. The existing NRCC-PRC-E form contains a single dropdown menu for users to select which eligible economizer type or exception is being used to comply with 140.9(a)1 or 141.1(b)1. However, the form does not require any design-specific information to be input to validate the identified compliance option being used. To improve compliance with the updated economizer requirements, the Statewide CASE Team recommends the dropdown menu in NRCC-PRC-E is replaced with a table for computer room economizer information, as shown in Figure 14.

										[If 141.1(b)1 Exception 2 selected in Column 08]			
01	02	03	04	05	06	07	08	09	10	11	12	13	14
Computer Room Room #	Computer Room Type	Air-Cooled ITE Design Load (kW)	Liquid-Cooled ITE Design Load (kW)	Total Computer Room Design Load (kW)	Average Air-Cooled ITE Design Load Density (kW/rack)	Economizer Equipment Tag(s)	Type of Economizer	At 75F Supply Air Temperature, Minimum Outdoor Temperature where Cooling System Can Serve 100% of the Load with Economizer (No Compressor Cooling)		Total Cooling Capacity of New Cooling System (ton)	Total Cooling Capacity of New + Existing Cooling System (ton)	Original Permit Date of Existing Computer Room	Does Computer Room Comply with Code?
								Drybulb Temperature (F)	Wetbulb Temperature (F)				
	[1]			[2]			[3]						[4]
Building Total		[5]	[5]	[5]									

Notes

[1] Input would be a dropdown list: New Construction, New Computer Room in Existing Building, Existing Computer Room.

[2] Input would be automatically calculated in form = air-cooled ITE + liquid-cooled ITE.

[3] Input would be a dropdown list of economizer types and Exceptions; form would only say project complies with code if table inputs validate exception requirements. If the heat recovery exception is used (910.2.1 Exception 3); check inputs to Computer Room Heat Recovery NRCC table support exception.

[4] Input would be automatically calculated in form to check that inputs in columns 09 and 10 meet the applicable code temperature requirement.

[5] Input would be automatically calculated in form = sum of all computer rooms.

Figure 14: Proposed New Computer Room Economizer Table in NRCC-PRC-E

The existing NRCI-PRC-E contains a single input to verify the installed economizer meets the dropdown option selected in NRCC-PRC-E for the economizer compliance method. NRCI-PRC-E should be updated for the inspector to verify the installed economizer system and design ITE loads (air-cooled and liquid-cooled) match the information in the updated NRCC-PRC-E form. Additionally, the inspection form should include verification that a dedicated cooling plant is used for liquid-cooled ITE loads greater than 2 MW.

These proposed changes to compliance forms NRCC-PRC-E and NRCI-PRC-E will close loopholes in existing compliance methods to improve compliance enforcement.

3. Fan Control Requirements

3.1 Fan Control Requirements – Measure Description

3.1.1 Proposed Code Change

This measure proposes to modify mandatory requirements in Section 120.6(j)3 by reducing the cooling capacity threshold for when variable supply airflow is required for direct expansion (DX) units in new and existing computer rooms. This would result in a greater number of air conditioners for computer rooms being installed with variable speed supply fans that modulate airflow based on cooling load. The threshold for when variable airflow fan control is required would be reduced from a 60,000 Btu/hr unit to a 30,000 Btu/hr unit. Table 38 summarizes the scope of the proposed code change.

Table 38: Scope of Proposed Code Change

A ☑ indicates the proposed code change is relevant.

Building Type(s)	Construction Type(s)	Type of Change
☐ Single Family	☑ New Construction	☑ Mandatory
☐ Multifamily	☑ Additions	☐ Prescriptive
☑ Nonresidential (Not Group R uses)	☑ Alterations	☐ Performance

Application Climate Zones	Energy Code Sections	Compliance Forms	Sections of ACM Reference Manuals
Climate Zones 1-16	Part 6, Section 120.6(j)3	NRCCPRC - update	None

Third-Party Verification)	Updates to Compliance Software
☑ No changes to third party verification	☑ No updates
☐ Update existing verification requirements	☐ Update existing feature
☐ Add new verification requirements	☐ Add new feature

3.1.2 Benefits of Proposed Change

In addition to the critical need to reduce energy, emissions, and water use in computer rooms and achieve statewide carbon reduction goals, as described in Section 2.1.2, requiring variable airflow control for air conditioners in small computer rooms would reduce energy use and improve temperature control stability in those rooms.

Given that this measure is already required for systems that are greater than 60,000 Btu/hr (5 tons), this proposed change would extend the energy efficiency, cost savings, emissions reduction, and enhanced control benefits to smaller computer room systems down to 30,000 Btu/hr (2.5 tons). This measure can be implemented using cooling equipment that is widely available by many manufacturers with no incremental cost in many cases, as variable speed fans are often standard features.

This reduced capacity threshold for VAV control would enable all computer rooms down to 10 kW (34,120 Btu/hr)—which are already prescriptively required to have air containment under 910.2.3—to take full advantage of the energy savings potential of fan speeds varying in response to load. Additionally, the proposed capacity threshold change would expand the variable airflow requirement to many intermediate distribution frame (IDF) rooms, which are present in nearly every nonresidential building type (e.g., typically one per floor or one per 15,000 square foot for offices[15]).

There are currently thousands of small computer rooms with dedicated DX cooling systems. Many of these systems are oversized and run at constant speed. When the cooling system is oversized, not only is energy wasted, but the compressor often cycles on and off in short time intervals, leading to unstable temperature control. Variable speed fans allow the fan airflow to vary with the load and help avoid over cooling the space.

3.1.3 Background Information

Title 24, Part 6 first began regulating computer rooms in 2013. The requirements focused on cooling system efficiency, particularly fan energy and cooling compressor energy. During the 2022 code cycle, three requirements were moved from prescriptive to mandatory, including fan control (910.1.3), and new and updated prescriptive requirements for new and existing computer rooms were added. Title 24, Part 6 requirements for computer rooms have not been substantially updated since that time.

Title 24, Part 6, 2025 has the following requirements related to computer room fan energy use:

- Section 910.1.3 has a mandatory requirement that fan airflow rate varies in response to computer room load for unitary air conditioners above 60,000 Btu/hr and all chilled water cooling units. Other than moving from prescriptive to mandatory, this requirement has not changed since its introduction to Title 24 in 2013.
- Section 910.2.2 prescriptively limits computer room total fan power to no greater than 27 W/kBtu·h of net sensible cooling capacity.
- Section 910.2.3 prescriptively requires air containment for computer rooms with air-cooled ITE load exceeding 10 kW (34,120 Btu/hr) per room. This requirement

[15] Based on review of Code Readiness field site data (Conroy, Weitze and Droitcour 2026).

has a direct impact on computer room system fan energy by reducing airflow needed for cooling.

Common computer room cooling efficiency strategies have progressed beyond the minimum requirements in Title 24, Part 6. Efficient computer room products have become less expensive as they have become more widely adopted. In 2013, electronically commutated motors (ECMs), which allow for variable fan speed control, were still uncommon in the market, and there was not a cost-effective option for small variable speed fans for computer room cooling units at the time. Today, ECMs have become a common method of fan speed control for small computer room cooling units, with many products available to computer room owners (see Section Fan Control Requirements – Market and Economic Analysis).

3.1.4 Modifications to Energy Code Documents

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 3.6:Fan Control Requirements – Proposed Language Code of this report for detailed revisions to code language.

3.1.4.1 Energy Code Change Summary

This proposed measure would impact Section 910.1 – which regulates mandatory requirements for covered processes. Changes are described below.

SECTION 910.1 *[SECTION 120.6(j)]* – MANDATORY REQUIREMENTS FOR COMPUTER ROOMS

Subsection 910.1.3: This proposed measure would adjust the design cooling load threshold for when fan speed and airflow is modulated based on load. The design cooling threshold is being adjusted from 60,000 Btu/hr to 30,000 Btu/hr. This would require that fans serving computer rooms have either variable-speed control or two-speed motors that provide for a reduction in fan motor power to ≤ 50 percent of power at design airflow when the airflow is at 66 percent of design airflow. This would apply to chilled water units of all sizes and DX units with a rated cooling capacity of ≥ 2.5 tons.

3.1.4.2 Reference Appendices Change Summary

The proposed changes would not impact the reference appendices as there is no acceptance testing for computer room requirements.

3.1.4.3 Compliance Manuals Change Summary

Section 10.4.2.3 of the Nonresidential Compliance Manual, which outlines mandatory requirements for computer room HVAC fan system efficiency, would be updated. This would need to be updated to reflect the cooling capacity threshold change from ≥ 5 tons to ≥ 2.5 tons.

3.1.4.4 Alternative Calculation Method Reference Manual Change Summary

The proposed modification to 120.6(j)3 would not require any updates to the Alternative Calculation Method (ACM) Reference.

3.1.4.5 Compliance Forms Change Summary

The proposed modification to 120.6(j)3 would require minimal updates to NRCC-PRC-E to reflect the variable airflow threshold change from 60 kBtuh to 30 kBtuh. No changes would be required to NRCI, NRCA, or NRCC-PRF forms.

3.1.5 Measure Context

3.1.5.1 Comparable Model Codes or Standards

ASHRAE 90.1 – 2022 While Standard 90.1 does not include a separate section for mandatory computer room requirements, like Title 24, Part 6, fan control requirements as specified in Section 6.5.3.2 are required on DX cooling systems with cooling capacity ≥65,000 Btu/h.

2024 IECC Per C403.8.6.1, the 2024 IECC also has similar requirements for fan airflow control that apply to computer rooms and data centers but are not called out specifically like Title 24, Part 6.

ASHRAE 90.4 – 2022 serves as an optional compliance pathway for computer room or data centers with HVAC systems serving computer rooms with ITE load greater than 10kW. This standard provides more options for performance-based compliance of data center facilities.

3.1.5.2 Interactions with Other Regulations

There are no direct federal or state laws and other requirements that conflict with this measure.

There would be no additional interactions or changes with the California Building Code or local requirements as a result of this proposed change.

3.2 Fan Control Requirements – Compliance and Enforcement

3.2.1 Compliance Considerations

Extending fan control as a function of load to 2.5-to-5-ton cooling systems serving computer rooms will require the same process as is currently employed in larger systems. Despite the straightforward change being proposed, education and training will be needed to ensure designers, installers, plan reviewers, and inspectors fully understand and can implement the change. The impacts to the current compliance approach for this modified measure are described below:

- Design Phase: Designers would need to know how to specify cooling equipment with variable speed fans or ECM for 2.5-to-5-ton systems. As described in Section 3.3.1, systems with this integrated technology are readily available and, for most equipment, come as a standard feature.
- Permit Application Phase: The current process to demonstrate compliance with this measure for systems 5-ton or greater would be applied to smaller systems.
- Construction Phase: The Statewide CASE Team does not anticipate any change during the construction phase as the only difference in approach would be the installation of a slightly more efficient cooling unit.
- Inspection Phase: Inspectors would need some additional training on which systems must now comply with this requirement. Aside from that, the inspection process remains the same.

3.2.2 Impact on Market Actors

Most market actors are already aware of the requirement and currently specify and install equipment capable of meeting the proposed code change.

Table 39 summarizes impacts on market actors and suggests outreach and education that might be helpful to support market actors as they prepare for the effective date of the requirements.

Table 39: Impacts on Market Actors and Suggested Training and Education Opportunities

Market Actor	Impact(s)	Suggested Outreach and Education
Owner/Developer [a]	Minimal impact	Increased awareness of code requirement.
Design Professional [b]	MEP firms will need to specify 2.5-to-5-ton equipment with ECM or VFD fans. This equipment is readily available, so designers will need to be trained in the code change so they can specify the right equipment.	Use local ASHRAE chapters and CI Team trainings to raise awareness and ensure capabilities are reflected in designs.
Construction Team [c]	Construction teams will potentially need to select different equipment than their standard practice.	Increased awareness of code requirement.
Building Department [d]	Verify that smaller systems have VAV controls and ECMs on plans and in field.	Inform code officials about new requirements through newsletters and training sessions.
Verification Tester [e]	No impact	None required
Manufacturers and Distributors	Manufacturers will need to be aware of the requirements for smaller systems and may need to increase availability of compliant products.	Systems with these capabilities are readily available. Additional outreach could underscore the need to increase availability of equipment in time for the 2028 code cycle's enforcement period which would begin on 1/1/2029.

a. Owner/Developer is funding the project and is the primary decision maker.
b. Design professionals include architects, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.
c. Construction team includes general contractors, design-build contractors, installation contractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople.
d. Building departments include plans reviewers, building inspectors, specialty inspectors, permit counter technicians and third-party plan review and inspection.
e. Verification testers include commissioning agents, ECC Raters, and Acceptance Test Technicians.

The 2028 CASE Methodology Report presents a quantitative assessment of how changes to the California building code impact builders, building designers and energy consultants, and building owners and occupants. While the analysis in the methodology report is not specific to the code change(s) presented in this report, this measure focuses on manufacturers, distributors and HVAC contractors, since these market actors are expected to experience the most direct impacts from the reduced cooling capacity threshold for when variable supply airflow is required for DX units. The following provides a qualitative description of how this specific code change affects various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

Builders. The proposed change would likely affect commercial builders; however, it would likely not impact firms focused on the construction or retrofitting of industrial buildings, utility systems, public infrastructure, or other heavy construction. The proposed change would not affect all firms and workers in the commercial building industry equally; instead, it would primarily affect specific subsectors within the industry. Table 40 shows the commercial building subsectors that the Statewide CASE Team expects to be impacted by the changes proposed in this report.

Building occupants (owners and tenants). The proposed code change would have incremental costs and would reduce building owners' utility bills throughout the measure lifetime. See the 2028 CASE Methodology Report for a description of how LSC savings relate to occupant utility bill savings.

Table 40: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)

Construction Subsector	Establishments *	Employment	Annual Payroll (Billions $)
Commercial Building Construction	5,491	87,450	$10.6
Nonresidential Electrical Contractors	3,245	72,794	$7.8
Nonresidential Plumbing & HVAC Contractors	2,270	55,182	$5.8
Other Nonresidential Equipment Contractors	580	9,749	$1.1

Source: (State of California n.d.)

*An establishment is single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. https://www.bls.gov/opub/hom/cew/concepts.htm

Manufacturers. As discussed in Section 3.3.1, manufacturers are already producing 2.5-to-5-ton equipment with ECMs that can turn down as fan speed is decreased. Some manufacturers may need to increase compliant products in the California market to meet new demand.

3.2.3 Compliance Software Updates

The proposed modification to 120.6(j)3 would not require any compliance software updates.

3.2.4 Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement training-related costs. This report is an evaluation of specific measures, and the collective impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

The proposed change to this measure would not be expected to increase the cost of enforcement. Proposed changes to this measure would reduce the threshold for systems that must comply, but the approach to verifying compliance will remain the same. Education and training would need to be provided to ensure code officials fully understand the proposed changes, if adopted.

A plan review would consist of reviewing NRCC-PRC-E and ensuring that it meets the new code requirement and is consistent with the drawings and specifications.

Inspection review would consist of reviewing NRCI-PRC-E and ensuring that the information on the forms is consistent with the approved NRCC-PRC-E forms and with what is actually installed.

3.3 Fan Control Requirements – Market and Economic Analysis

3.3.1 Market Structure and Availability

3.3.1.1 Current Market Structure and Availability

This proposed measure would lower the threshold for when DX cooling systems are designed to vary the airflow rate as a function of cooling load. For computer rooms 30,000 – 60,000 Btu/hr, which would be impacted by this measure, the cooling load is typically provided by split system fan coils with an evaporator fan and cooling coil located in the computer room and connected to an outdoor condensing unit. For small cooling loads, using products marketed for computer room precision cooling or for standard commercial cooling applications are common practice.

A review of manufacturer literature and information provided by equipment vendors shows that supply fans with ECMs are a standard feature across most precision cooling and standard commercial cooling products (Conroy, Weitze and Droitcour 2026). While there is theoretically an increased first cost of having ECM fans, for most products they are a standard feature leaving no option to select a less expensive option. Below is a summary of products reviewed. Only three of the products do not come with ECM supply fans as a standard feature. All products are by major manufacturers with a large presence in the United States (U.S.) and are readily available.

The CASE Team interviewed four mechanical contractors in the Bay Area specializing in commercial buildings about the impacts of EC motors on supply fans in DX cooling units 2 to 5 tons. Three of four contractors said they thought EC motors were now standard practice for this capacity range, and the fourth contractor noted that AC motors with VFDs were very common, which would also meet the intent of this measure. There was no clear consensus among contractors about increased first costs of EC motors, with one contractor saying incremental cost would be 'miniscule' for this size unit and others noting there would be increased first costs. All contractors indicated there is no increased lead time for equipment with EC motors. The U.S. Department of Energy (DOE) issued a pre-published final rule on Expanded Scope Electric Motors (ESEMs) in 2025 and noted that ECMs are a common design option for embedded motors in HVACR equipment[16], with over 2 million units with ECMs sold compared to less than 200,000 units sold with other motor types. DOE determined that it is reasonable to expect that manufacturers would likely replace non-compliant ESEMs with an ECM, so that manufacturers can avoid having to use a larger motor design to achieve improved motor efficiency.

[16] See: https://www.energy.gov/sites/default/files/2025-01/esem-ecs-fr.pdf?utm_medium=email&utm_source=govdelivery

Table 41: Summary of Cooling Products Fan Speed Control Market Survey

Capacity kBtu/hr	Manufacturer	Model	Unit type	Airflow Discharge	Supply Fan Motor Type and Control
12	Vertiv (Liebert)	VRC100KIT	Active in-row fan coil	Upflow	EC variable-speed
12	Vertiv (Liebert)	VRC100KIT split	Active in-row fan coil	Upflow	EC variable-speed
12-38	Vertiv (Liebert)	CoolPhase Wall	Wall-Mounted CRAC (R-32)	Horizontal flow	EC variable-speed
12-119	Stulz	CeilAir OHS	Split/packaged (R-407C)	Upflow/Downflow	EC (optional)
14-41	STULZ	MiniSpace EC (DX 4-12 kW family)	Floor-Mounted CRAC (R410A)	Upflow/Downflow	EC variable-speed
17-36	Vertiv (Liebert)	DataMate	Floor-Mounted CRAC	Upflow	2-speed Permanent Split Capacitor (PSC)
17-68	APC (Schneider)	Uniflair AM (5-20 kW family)	Floor-Mounted CRAC (R410A)	Upflow/Downflow	EC variable-speed
20-118	Stulz	CyberAir Mini	Floor-Mounted CRAC (R-513A)	Upflow/Downflow	EC variable-speed
21-51	APC (Schneider)	Uniflair Ceiling Mount UCF / MRA	Ceiling-Mounted CRAC	Horizontal flow	Not Listed
24-119	Stulz	CyberOne COS	Floor-Mounted CRAC (R-407C)	Upflow/Downflow	EC variable-speed
30	Vertiv (Liebert)	Mini-Mate2 MMD36E (8.3 kW)	Ceiling-Mounted CRAC (R410A)	Direct throw	2-speed PSC

Capacity kBtu/hr	Manufacturer	Model	Unit type	Airflow Discharge	Supply Fan Motor Type and Control
30	APC (Schneider)	Uniflair SP (Ceiling/wall split family)	Ceiling-Mounted CRAC	Ceiling/wall direct throw	EC variable-speed
30	Mitsubishi Electric	PKA-A30KA8	Wall-Mounted VRF Fan Coil	Direct throw wall unit	EC variable-speed
34	Vertiv (Liebert)	CRV CRD10	Active in-row fan coil (R410A)	Horizontal flow (in-row)	EC variable-speed
34-143	APC (Schneider)	Uniflair ACRD	Active in-row fan coil (R-32)	Horizontal flow (in-row)	EC variable-speed
36, 42, 48, 56	Mitsubishi Electric	PVA	Floor-Mounted CRAC (R-454B)	Upflow/Downflow/Horizontal flow	EC variable-speed
36-60	Vertiv (Liebert)	New Mini-Mate	Ceiling-Mounted CRAC (R410A)	Horizontal flow	EC variable-speed
36-99	Vertiv (Liebert)	PDX PX011 (11-29 kW family)	Floor-Mounted CRAC (R410A)	Upflow/Downflow/Horizontal flow	EC variable-speed
41-113	Stulz	CyberRow	Active in-row fan coil	Horizontal flow (in-row)	EC variable-speed
48, 54	Mitsubishi Electric	PEFY-P48NMAU-E4	VRF Fan Coil	Ceiling concealed (ducted)	EC variable-speed
60	Mitsubishi Electric	s-MEXT + high sensible config	Floor-Mounted CRAC (R410A)	Upflow/Downflow	EC variable-speed

As demonstrated in Table 41, because ECM motors are standard feature in many products, the increased first costs is minimal, and lack of available products in the California market is unlikely.

3.3.1.2 Market Challenges and Solutions

As previously described, this technology is standard in new cooling equipment in the marketplace, and this requirement has been in the code as a mandatory requirement since it took effect in 2012.[17] As such, no market challenges have been identified.

See Section 3.2.2 for a description of workforce trainings that may be needed to ensure effective design, installation, and commissioning.

3.3.2 Design and Construction Practices

3.3.2.1 Current Design and Construction Practices

Most cooling products in the impacted cooling system size category come standard with EC motors, which allow for variable speed control. ECMs enable continuously variable speed fan control; however, some manufacturers limit the control of the ECM to two, three, four, or more fan speeds. Varying fan speed based on load is a standard product feature and, as such, this code change should be common in the design and implementation of smaller cooling systems in computer rooms.

3.3.2.2 Health and Safety Considerations

The proposed code change would not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by the California DOSH. All existing health and safety rules would remain in place. Complying with the proposed code change is not anticipated to have adverse impacts on the safety or health of occupants or those involved with the construction, commissioning, and maintenance of the building.

3.3.2.3 Design and Construction Challenges and Solutions

No design and construction challenges have been identified.

See Table 39 in Section 2.2.2 for a description of workforce trainings that could support effective design, installation, and commissioning.

3.3.3 Energy Equity and Environmental Justice

Each measure in this CASE Report was evaluated for ESJ impacts using 4 criteria: cost, health, resiliency, and comfort. The details of that evaluation can be found in Section 1.4 and the 2028 CASE Methodology Report.

[17] 2008 Title 24 specified VAV in single zone systems with an effective date of January 1, 2012 for mechanical cooling capacity greater than or equal to 110,000 Btu/hr.

The Statewide CASE Team has not found any information showing that this measure would impact ESJ communities in terms of cost, health and safety, resilience, or comfort.

3.3.4 Impacts on Jobs and Businesses

The Statewide CASE Team does not anticipate significant employment or financial impacts on any particular sector of the California economy. However, the proposed change may have modest impacts on employment in California. The Statewide CASE Team estimates the proposed change would affect statewide employment and economic output directly and indirectly through its impact on builders, designers, energy consultants, and building inspectors. Table 42, Table 43, and Table 44 outline the statewide implications for these job categories. For more information on the Statewide CASE Team's economic impacts methodology, see the 2028 CASE Methodology Report.

The Statewide CASE Team expects that the proposed changes would lead to the creation of approximately 73 new types of jobs in the commercial building sector. In other words, the Statewide CASE Team's proposed change would not result in economic disruption to any sector of the California economy. Rather, it would lead to modest changes in the employment of existing jobs. The Statewide CASE Team does not expect designers or inspectors to spend additional time since the proposed code change pertains to a change in threshold value associated with an existing mandatory requirement.

Table 42: Estimated Impact that Adoption of the Proposed Measure Would Have on the California Nonresidential Construction Sector

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by Commercial Builders)	3	$227,129	$341,966	$739,909
Indirect Effect (Additional spending by firms supporting Commercial Builders)	2	$131,291	$225,397	$394,607
Total Economic Impacts	**5**	**$358,420**	**$567,363**	**$1,134,517**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.[1]

Table 43: Estimated Impact that Adoption of the Proposed Measure Would Have on the California Building Designers and Energy Consultant Sectors

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by building designers and energy consultants)	0	$0.00	$0.00	$0.00
Indirect Effect (Additional spending by firms supporting building designers and energy consultants)	0	$0.00	$0.00	$0.00
Total Economic Impacts	**0**	**$0.00**	**$0.00**	**$0.00**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

Table 44: Estimated Impact that Adoption of the Proposed Measure Would Have on California Building Inspectors

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by building inspectors)	0	$0.00	$0.00	$0.00
Indirect Effect (Additional spending by firms supporting building inspectors)	0	$0.00	$0.00	$0.00
Total Economic Impacts	**0**	**$0.00**	**$0.00**	**$0.00**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

The proposed change represents a modest adjustment, which is not expected to excessively burden or competitively disadvantage California businesses, nor is it expected to lead to a competitive advantage for California businesses. Therefore, the Statewide CASE Team does not expect the proposed code changes to result in the creation of new businesses or the elimination of existing ones.

The proposed code changes would apply to all businesses operating in California, regardless of whether the business is incorporated inside or outside of the state.[2] Therefore, the Statewide CASE Team does not anticipate that the proposed changes would have advantageous or an adverse effect on the competitiveness of California businesses.

The Statewide CASE Team derived a reasonable estimate of the change in investment by California businesses based on the estimated change in economic activity associated with the proposed measure and its expected effect on business income. The Statewide CASE Team's IMPLAN modeling resulted in an estimated $105,505 increase in California business income due to the proposed code change. The Statewide CASE Team assumed that net business investment is positively correlated with business income and that a portion of business income will be allocated to net business investment.

To estimate the portion of business income that would be allocated to net investment, the Statewide CASE Team analyzed national data on corporate profits and net capital investment by businesses that expand a firm's capital stock (referred to as net private domestic investment, or NPDI).[3] As Table 45 shows, between 2020 and 2024, NPDI as a percentage of corporate profits ranged from a low of 18 percent in 2020 due to the worldwide economic slowdowns associated with the COVID 19 pandemic to a high of 28 percent in 2022, with an average of 23 percent. While only an approximation of the proportion of business income used for net capital investment, it provides a reasonable estimate of the proportion of incremental income that business owners would reinvest into expanding their capital stock.

Table 45: Net Domestic Private Investment and Corporate Profits, U.S.

Year	Net Domestic Private Investment by Businesses, Billions of Dollars	Corporate Profits After Taxes, Billions of Dollars	Ratio of Net Private Investment to Corporate Profits (Percent)
2020	389	2,212	18
2021	545	2,888	19
2022	825	2,951	28
2023	836	3,069	27
2024	885	3,441	26
5-Year Average	**Intentionally blank**	**Intentionally blank**	**23**

Source: (Federal Reserve Economic Data (FRED) n.d.)

Given the estimated total increase in California business income and net business investment ratio described above, the Statewide CASE Team estimates the proposed code change would result in a $24,766 increase in net private investment by California businesses.

3.3.5 Economic and Fiscal Impacts

This section includes information that CEC uses in the economic analysis that is required by statutes. CEC uses the information to complete Form STD 399 (Economic and Fiscal Impact Statement), including identifying whether the proposed update will be greater than $50 million, triggering the requirement for the CEC to complete an SRIA. This section addresses how the code change impacts the statewide economy.

The Statewide CASE Team does not anticipate that the economic impacts associated with the proposed measure would lead to a significant change (increase or decrease) in investment, directly or indirectly, in any affected sectors of California's economy. The proposed change would not result in economic disruption to any sector of the California economy. For more information on the Statewide CASE Team's economic and fiscal impacts methodology, see the [2028 CASE Methodology Report.]

Adoption of this code change proposal would result in relatively modest economic impacts through additional direct spending by commercial/industrial contractor establishments. The Statewide CASE Team does not anticipate that money saved by businesses or other organizations affected by the proposed 2028 code cycle regulations would result in additional spending by those businesses.

3.3.5.1 Effects on the State General Fund, State Special Funds, and Local Governments

The Statewide CASE Team does not expect the proposed code changes to have a measurable impact on California's General Fund, any state special funds, or local government funds.

Cost to State: The state government already has a budget for code development, education, and compliance enforcement. While the state government would be allocating resources to update the Title 24, Part 6 Standards, including updating education and compliance materials and responding to questions about the revised requirements, these activities are already covered by existing state budgets. The costs for the state government are small when compared to the overall cost savings and policy benefits associated with the code change proposals. The proposed code change measures may impact state buildings but they have been found to be cost effective.

Cost to Local Governments: All proposed code changes to Title 24, Part 6 would result in changes to compliance determinations. Local governments would need to train building department staff on the revised Title 24, Part 6 Standards. While this retraining is an expense to local governments, it is not a new cost associated with the 2025 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining, including tools, training, and resources provided by the IOU Codes and Standards program (such as Energy Code Ace). As noted in 91, the Statewide CASE Team considered how the proposed code change might impact various market actors involved in the compliance and enforcement process and aimed to minimize negative impacts on local governments.

3.3.5.2 Mandates on Local Agencies or School Districts

There are no relevant mandates to local agencies or school districts since the proposed code change pertains to a change in threshold value associated with an existing mandatory requirement.

3.3.5.3 Costs to Local Agencies or School Districts

There are no costs to local agencies or school districts. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

3.3.5.4 Costs or Savings to Any State Agency

There are no costs to any state agencies. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

3.3.5.5 Other Non-Discretionary Cost or Savings Imposed on Local Agencies

There are no added non-discretionary costs or savings to local agencies. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

3.3.5.6 Costs or Savings in Federal Funding to the State

There are no costs or savings to federal funding to the state. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

3.4 Fan Control Requirements – Cost Effectiveness

3.4.1 Cost Effectiveness Methodology

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost inclusion parameters. The 2028 CASE Methodology Report and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its Benefit-Cost Ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on Long-term System Cost (LSC), which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code. The analysis excludes design costs and incremental code compliance verification costs.

3.4.2 Energy and Energy Cost Savings Results

The Statewide CASE Team conducted a non-CBECC analysis to estimate energy, emissions, and cost savings, and cost-effectiveness of the proposed measure. A custom Excel file was used to calculate the per-unit fan energy consumption for a base and proposed case.

The base case energy use assumed a weighted average by estimated market share of three fan motor speed control types: constant speed (30 percent), two-speed (30 percent) and variable speed ECM (40 percent). Annual energy use was calculated for each of the three base cases and then multiplied by the market share.

The proposed case energy use used a similar approach to the base case. Two variable speed fan types were used: ECM (60 percent) and VFD (40 percent). Annual energy use was calculated for each of the two proposed cases and then multiplied by the estimated market share.

Energy savings from the Excel-based approach were applied to six building prototype models (Hospital, Large office, Medium Office, Small Office, Large School, Small School) to represent potential savings from smaller computer rooms within those buildings. These building types were selected because they often include a small computer room or IDF room where this proposed code change would be applicable. To estimate the total impact per building, the Statewide CASE Team assumed that affected computer rooms in new construction and additions represent 1 percent of hospital floor area, and 0.5 percent of floor area for all other building types. For alterations, the Statewide CASE Team assumed that affected computer rooms represent 0.002 percent for the six affected building types.

A more detailed description of the methodology employed, and specific assumptions used, is outlined in Appendix A: Assumptions for Cost-effectiveness Analysis.

Energy savings (electricity, natural gas, and source energy) and peak demand reductions per-unit are presented in Table 46 through Table 48. Per-unit savings for the first year are expected to be 4.06 kWh/yr for all prototypes and climate zones. Per-unit square footage is the square footage of the modeled computer room. Energy savings only includes supply fan energy for cooling ITE load and, therefore, is the same for all climate zones. This proposed measure will only impact cooling systems and thus will not result in any natural gas savings. Demand reductions/increases are expected to be 0.43 kW per square foot across all climate zones.

Table 49 presents total energy cost savings per unit for newly constructed buildings and additions in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV$). The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods. Table 50 presents a breakdown of total LSC savings from electricity and natural gas cost savings for the prototypical building.

Table 46: First Year Electricity Savings (kWh) Per Square Foot – Fan Control

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Hospital	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06
Large Office	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06
Large School	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06
Medium Office	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06
Small Office	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06
Small School	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06

Table 47: First Year Peak Demand Reduction (kW) Per Square Foot – Fan Control

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Hospital	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Large Office	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Large School	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Medium Office	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Small Office	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Small School	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43

Table 48: First Year Source Energy Savings (kBtu) Per Square Foot – Fan Control

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Hospital	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14
Large Office	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14
Large School	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14
Medium Office	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14
Small Office	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14
Small School	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14

Table 49: Total 30-Year LSC Savings (2029 PV$) Per Square Foot – Fan Control

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Hospital	34.84	34.94	34.80	34.91	34.85	34.89	34.74	34.91	34.49	34.68	35.12	34.96	34.77	34.53	35.26	35.02
Large Office	34.84	34.94	34.80	34.91	34.85	34.89	34.74	34.91	34.49	34.68	35.12	34.96	34.77	34.53	35.26	35.02
Large School	34.84	34.94	34.80	34.91	34.85	34.89	34.74	34.91	34.49	34.68	35.12	34.96	34.77	34.53	35.26	35.02
Medium Office	34.84	34.94	34.80	34.91	34.85	34.89	34.74	34.91	34.49	34.68	35.12	34.96	34.77	34.53	35.26	35.02
Small Office	34.84	34.94	34.80	34.91	34.85	34.89	34.74	34.91	34.49	34.68	35.12	34.96	34.77	34.53	35.26	35.02
Small School	34.84	34.94	34.80	34.91	34.85	34.89	34.74	34.91	34.49	34.68	35.12	34.96	34.77	34.53	35.26	35.02

Table 50: 2029 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction, Additions, and Alterations – All Prototypes

Climate Zone	30-Year LSC Electricity Savings (2029 PV$)	30-Year LSC Natural Gas Savings (2029 PV$)	Total 30-Year LSC Savings (2029 PV$)
1	34.84	0.00	34.84
2	34.94	0.00	34.94
3	34.80	0.00	34.80
4	34.91	0.00	34.91
5	34.85	0.00	34.85
6	34.89	0.00	34.89
7	34.74	0.00	34.74
8	34.91	0.00	34.91
9	34.49	0.00	34.49
10	34.68	0.00	34.68
11	35.12	0.00	35.12
12	34.96	0.00	34.96
13	34.77	0.00	34.77
14	34.53	0.00	34.53
15	35.26	0.00	35.26
16	35.02	0.00	35.02

3.4.3 Incremental First Cost

The Statewide CASE Team used a similar approach to estimating incremental cost as analyzing energy use based on a weighted average of market share by motor speed control technology type for a 45,00 Btu/hr DX cooling unit.

The base case first cost assumed a weighted average by estimated market share of three fan motor speed control types: constant speed permanent split capacitor (PSC) (30 percent), two-speed PSC (30 percent) and variable speed ECM (40 percent). Annual energy use was calculated for each of the three base cases and then multiplied by the market share.

The proposed case first cost assumed a weighted average of ECM (60 percent) and induction motor with VFD (40 percent) costs. Costs were normalized based on the analyzed computer room floor area. Incremental cost was calculated by subtracting the baseline cost from the proposed cost, as summarized in Table 51.

Table 51: Costs on Base-Case and Proposed Designs, and Incremental First Cost

Scenario	Formula	First Cost[18]
Base-case Design: weighted average of constant-speed PSC, 2-speed PSC, and ECM	(0.3*$1.80/sq ft) + (0.3*$1.57/sq ft) + (0.4*$2.62/sq ft)	$2.05/sq ft
Proposed Design: weighted average of ECM, VFD + induction motor	(0.6*$2.62/sq ft) + (0.4*$5.28/sq ft)	$3.68/sq ft
Incremental First Cost	Proposed Design minus Base-case Design First Cost	$1.63/sq ft

Although, through conversations with manufacturers, it was revealed that ECMs are standard practice in many cases of computer room air conditioners, and the incremental cost would be zero in those cases. However, for cases when ECMs are not standard and an upgrade from a split capacity motor to an ECM is required, an assumed incremental first cost of $1.63/sq ft is used in the cost-effectiveness analysis. The Statewide CASE Team secured these costs in May 2026.

3.4.4 Incremental Maintenance and Replacement Costs

The estimated maintenance and replacement cost for this measure is zero or negative, meaning ECMs typically require lower maintenance and have a longer estimated useful

[18] Source: Various sources from national manufacturers and online resources.

life (EUL) than traditional constant or two-speed permanent split capacitor motors (PSCs). ECMs eliminate many of the components that require maintenance or replacement during the life of a PSC, such as belts, shafts, or greased bearings. An assumed incremental maintenance cost of $0 is used in the cost-effectiveness analysis. A 10-year EUL was assumed in the base and proposed cases, meaning the 30-year cost-effectiveness analysis assumes the equipment will be replaced twice during the analysis period and includes the incremental cost of replacement.

Description of the incremental maintenance and replacement costs, as well as estimation of present value of maintenance and replacement costs, are provided in the 2028 CASE Methodology Report. The Statewide CASE Team secured these costs in May 2026.

3.4.5 Cost Effectiveness

Results of the per-unit cost-effectiveness analyses are presented in Table 52 for new construction/additions and alterations.

In the tables below, all values are presented in 2029 present value dollars (2029 PV$). Benefits represent 30-year LSC savings and other savings, including incremental first-cost savings if the proposed first cost is less than the current first cost, incremental maintenance cost savings if the proposed maintenance costs are less than the current maintenance costs, and incremental residual value if proposed residual value is greater than current residual value at the end of the 30-year period of analysis. Costs represent the total incremental present value (PV) cost, including incremental equipment, replacement, and maintenance costs over the period of analysis. The analysis treats a negative incremental maintenance cost as a positive benefit. If total incremental costs are zero, the benefit-cost ratio (BCR) is considered infinite. Costs and other savings are discounted at a real (inflation-adjusted) three percent rate. If there are no total incremental PV costs, the BCR is infinite.

Table 52: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction, Additions, and Alterations – All Prototypes

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV$ / square foot)	Costs Total Incremental PV Costs (2029 PV$ / square foot)	Benefit-to-Cost Ratio
1	34.84	3.75	9.30
2	34.94	3.75	9.33
3	34.80	3.75	9.29
4	34.91	3.75	9.32
5	34.85	3.75	9.30
6	34.89	3.75	9.31
7	34.74	3.75	9.28
8	34.91	3.75	9.32
9	34.49	3.75	9.21
10	34.68	3.75	9.26
11	35.12	3.75	9.38
12	34.96	3.75	9.33
13	34.77	3.75	9.28
14	34.53	3.75	9.22
15	35.26	3.75	9.41
16	35.02	3.75	9.35
Total	34.78	3.75	9.29

3.5 Fan Control Requirements – Statewide Impacts

3.5.1 Statewide Energy and Energy Cost Savings

See the 2028 CASE Methodology Report for details on how statewide savings are calculated. Appendix C presents the assumptions on the percentage of the total construction forecast that the proposed measure would impact.

For more details on the methodology and context about estimating the current market share rate, as well as statewide energy and energy cost savings, see the 2028 CASE Methodology Report.

The tables below present the first-year statewide energy and LSC savings from newly constructed buildings and additions (Table 53) and alterations (Table 54) by climate zone. Table 55 presents first-year statewide savings from new construction, additions, and alterations.

Table 53: Statewide Energy and LSC Impacts – New Construction and Additions

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (Square Feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1	1,479	0.01	0.00	-	0.01	$0.05
2	9,128	0.04	0.00	-	0.06	$0.32
3	41,590	0.17	0.02	-	0.26	$1.45
4	21,943	0.09	0.01	-	0.13	$0.76
5	5,020	0.02	0.00	-	0.03	$0.17
6	25,356	0.10	0.01	-	0.16	$0.88
7	20,610	0.08	0.01	-	0.13	$0.72
8	36,205	0.15	0.02	-	0.22	$1.26
9	64,696	0.26	0.03	-	0.40	$2.25
10	28,749	0.12	0.01	-	0.18	$1.00
11	7,012	0.03	0.00	-	0.04	$0.24
12	40,639	0.17	0.02	-	0.25	$1.42
13	13,684	0.06	0.01	-	0.08	$0.48
14	6,662	0.03	0.00	-	0.04	$0.23
15	3,812	0.02	0.00	-	0.02	$0.13
16	2,307	0.01	0.00	-	0.01	$0.08
Total	**328,889**	**1.34**	**0.14**	**-**	**2.02**	**$11.46**

Table 54: Statewide Energy and LSC Impacts – Alterations

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (Square Feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1	278	0.00	0.00	-	0.00	$0.01
2	1,671	0.01	0.00	-	0.01	$0.06
3	7,724	0.03	0.00	-	0.05	$0.27
4	3,951	0.02	0.00	-	0.02	$0.14
5	770	0.00	0.00	-	0.00	$0.03
6	5,594	0.02	0.00	-	0.03	$0.19
7	4,414	0.02	0.00	-	0.03	$0.15
8	8,088	0.03	0.00	-	0.05	$0.28
9	13,086	0.05	0.01	-	0.08	$0.46
10	6,391	0.03	0.00	-	0.04	$0.22
11	1,398	0.01	0.00	-	0.01	$0.05
12	8,027	0.03	0.00	-	0.05	$0.28
13	2,840	0.01	0.00	-	0.02	$0.10
14	1,517	0.01	0.00	-	0.01	$0.05
15	850	0.00	0.00	-	0.01	$0.03
16	489	0.00	0.00	-	0.00	$0.02
Total	**67,087**	**0.27**	**0.03**	**-**	**0.41**	**$2.34**

Table 55: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations

Construction Type	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
New Construction & Additions	1.3	0.1	-	2.0	11
Alterations	0.3	0.0	-	0.4	2
Total	**1.6**	**0.2**	**-**	**2.4**	**14**

3.5.2 Statewide Greenhouse Gas Emissions Reductions

Note to CEC - Conducting QC on GHG emissions results and will update them as soon as they are finalized.

Table 56 presents the estimated first-year reduction in GHG emissions resulting from the proposed code change. In this initial year, the Statewide CASE Team expects to avoid 129 metric tons of carbon dioxide equivalent (CO_2e) emissions. These reductions, along with their associated monetary value, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of CBECC, as well as data from the CEC's 2028 Metrics Report. See the [2028 CASE Methodology Report] for additional information.

Table 56: First-Year Statewide GHG Emissions Impacts

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions ($)
New Construction, Additions and Alterations	129	0	129	20,091
Total	**129**	**0**	**129**	**20,091**

3.5.3 Statewide Water Use Impacts

The proposed code change would not result in water use impacts.

3.5.4 Statewide Material Impacts

The proposed code change would not result in impacts on material use.

3.5.5 Environmental Impacts

This measure would reduce energy use and overall emissions from computer rooms across California and would not result in any adverse environmental effects. Statewide emissions impacts from this change are summarized in Table 56.

3.5.6 Other Non-Energy Impacts

This measure is not expected to result in any non-energy impacts.

3.6 Fan Control Requirements – Proposed Language Code

3.6.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions). New to the 2028 energy code is to *italicize defined terms* when the terms are being used in its defined context. In-line comments that are not part of the proposed code language but are used to help describe the purpose of what is proposed are included *with greyed highlight and italics.*

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.[8] 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).

Posting the proposed code language in this format is useful as it helps describe how the Energy Code changes proposed for nonresidential occupancies are isolated from the requirements for residential occupancies which are prohibited from being changed until the 2031 code cycle by Assembly Bill 130.

3.6.2 Administrative Code (Title 24, Part 1)

There are no proposed changes to Title 24, Part 1.

3.6.3 Energy Code (Title 24, Part 6)

SECTION 910

COMPUTER ROOMS

(NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)SECTION 910.1 *[SECTION 120.6(j)]* – MANDATORY REQUIREMENTS (Newly Constructed, Additions, Alterations)

Space-conditioning systems serving a *computer room* shall meet the requirements of this section.

910.1.1 *[Section 120.6(j)1]* **Reheat.**

Each *computer room* zone shall have controls that prevent reheating, recooling and simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by *cooling equipment* or by economizer systems.

910.1.2 *[Section 120.6(j)2]* **Humidification.**

Humidification shall be adiabatic. Nonadiabatic humidification, including but not limited to steam and infrared, is prohibited.

910.1.3 *[Section 120.6(j)3]* **Fan control – Hotel/motel buildings and nonresidential buildings with Group R occupancies.**

Each unitary *air conditioner* with *mechanical cooling* capacity exceeding 60,000 Btu/hr and each chilled water *fan system* shall be designed to vary the airflow rate as a function of actual load. Fan motor demand shall not exceed 50 percent of design wattage at 66 percent of design fan speed.

910.1.4 *[New section]* **Fan control – All other nonresidential buildings.**

Each direct expansion system with *mechanical cooling* capacity exceeding 30,000 Btu/hr and each chilled water *fan system* shall be designed to vary the airflow rate as a function of actual load. Fan motor demand shall not exceed 50 percent of design wattage at 66 percent of design fan speed.

3.6.4 Reference Appendices

There are no proposed changes to the Reference Appendices.

3.6.5 Compliance Manuals

Section 10.4.2.3 of Chapter 10 (Covered Processes) in the nonresidential compliance manual will need to be updated to reflect the fan control capacity threshold reduction. Additionally, the 2028 compliance manual should incorporate the same content that is included in the 2022 compliance manual, rather than referring readers to the 2022 compliance manual as is done in the 2025 version.

3.6.6 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

3.6.7 Compliance Forms

As discussed in Section 3.1.4.5, the NRCC-PRC-E compliance form would be updated to reflect the proposed capacity threshold change for variable airflow DX cooling systems. Figure 15 shows the existing online form and where this change would need to be made in the user input dropdown menu.

Is the system designed to vary the airflow rate as a function of actual load and have controls that will result in fan motor demand <= 50% of design wattage at 66% of design fan speed?

§120.6(j)3

Is the system designed to vary the airflow rate as a function of actual load and have

Yes, these fan controls are included in the design

This doesn't apply because the system is not direct expansion > 30 kBtuh ~~unitary AC > 60 kBtuh~~ or a chilled water fan system

Select one

Figure 15: Proposed Update to NRCC-PRC-E Form

4. Computer Room Heat Recovery

4.1 Computer Room Heat Recovery – Measure Description

4.1.1 Proposed Code Change

This proposed measure would add mandatory requirements to Section 910.1 to require new nonresidential buildings with both a computer room(s) and sizable heating loads to recover heat from the computer room(s) to serve other building heating loads. Computer room heat recovery is being defined as a mechanical system that transfers heat from a computer room(s) to provide heating to other zones or end-uses in the building that require heating. Heat recovery would be required in new buildings with computer rooms if the following conditions were met:

- Buildings with a design computer room(s) ITE load greater than 100 kW; and
- Buildings with non-computer room conditioned floor area greater than 35,000 square feet.

The required capacity of the heat recovery system would depend on the peak cooling capacity of the computer room and the combined total peak heating capacity of the space heating system and service water heating (i.e., domestic hot water) system. The heat recovery system's heat recovery capacity must be the lesser of the two values:

- 0.5 times the total design ITE load of all computer rooms in the building
- 0.2 times (the total capacity of the space heating system plus the SWH system)

The reason the heat recovery system is not required to be sized larger than 50 percent of the IT load or 20 percent of the heating load is because there is a diminishing marginal return. Computer rooms rarely operate at 100 percent of design load and space heating, and water heating systems rarely operate above 20 percent of design. For example, the Climate Zone 4 (San Jose) model used to justify this measure has a space-heating load that is less than 20 precent of peak load 81 percent of the year. Good data on typical computer room loads is hard to come by, but load profile used by Title 24, ASHRAE 90.1 and ASHRAE 90.4 all assume that computer rooms spend one quarter time at each of the following loads: 25 percent, 50 percent, 75 percent, and 100 percent. This averages out to about 62 percent load. The 0.5 sizing criteria is based on this typical average computer room load. And the 0.2 sizing criteria is based on capturing 80 percent or more of the total annual heating load in most climate zones. In many cases the heat recovery system will not replace the base building heating system (e.g., gas boiler or heat pump). If the base system is sized for the full load, then the optimal size of the heat recovery system is clearly less than 100 percent.

Designers are free to size the heat recovery system larger than 0.5 and 0.2 but are not required to do so. For example, if the computer room load is quite large relative to the space heating and SWH heating load and the computer room load is reliable then it makes sense to downsize or even eliminate the base building heating sources. In that case the heat recovery system could be sized for 100 percent of the heating loads.

Many of the new buildings to which this measure would apply will already be prescriptively required to include computer room heat recovery by Section 401.3.19 – Mechanical Heat Recovery. Section 401.3.19 does not explicitly reference computer rooms. Instead, it is triggered by a formula that references both high load spaces (>5 w/sf) and all other spaces. Computer rooms are high load spaces. There are many different combinations of computer room load, building size (heating load, cooling load) and service water heating load that would trigger 401.3.19. For example, a 100,000 ft2 building with 500 kW of computer rooms would almost certainly trigger the Mechanical Heat Recovery requirement.

Table 57 summarizes the scope of the proposed code change.

Table 57: Scope of Proposed Code Change

A ☑ indicates the proposed code change is relevant.

Building Type(s)	Construction Type(s)	Type of Change
☐ Single Family	☑ New Construction	☑ Mandatory
☐ Multifamily	☐ Additions	☐ Prescriptive
☑ Nonresidential (Not Group R uses)	☐ Alterations	☐ Performance

Application Climate Zones	Energy Code Sections	Compliance Forms	Sections of ACM Reference Manuals
Climate Zones 1-16	Part 6, Section 910.1	NRCC-PRC-E and NRCI-PRC-E	Mandatory

Third Party Verification	Updates to Compliance Software
☑ No changes to third party verification	☐ No updates
☐ Update existing verification requirements	☑ Update existing feature
☐ Add new verification requirements	☐ Add new feature

4.1.2 Benefits of Proposed Change

In addition to the critical need to address increased energy, emissions, and water use from new computer rooms and achieve statewide carbon reduction goals, as described in Section 2.1.2, requiring heat recovery in computer rooms would provide significant benefits at the building level. Computer rooms need constant cooling to remove heat from ITE and maintain optimal temperatures for ITE performance. When a computer room is in a facility that also requires heating, transferred heat from the computer room can be used to heat other parts of the building. Rejecting the computer room's heat to the heating system instead of the computer room's cooling system reduces the energy used by the computer room cooling system.

Traditionally, computer room waste heat is rejected through a mechanical cooling system consisting of cooling compressors and an economizer, and separate heating equipment is used to meet building heating loads. Although economizers improve cooling system efficiency by reducing cooling loads on energy-intensive compressors, the computer room waste heat can be used more efficiently by being captured to serve concurrent building heating loads, such as space heating or service hot water loads, through a heat recovery system. Depending on the heat recovery system components and configuration, this can provide two key benefits – reduced load on the computer room cooling system leading to reduced cooling energy, and reduced load on the heating system leading to reduced heating energy, with a net result of improved overall building heating and cooling efficiency. In buildings where natural gas is used for heating loads, the computer room heat recovery system reduces direct greenhouse gas (GHG) emissions from a combustion appliance (Scope 1 emissions).

While this proposal would only require heat recovery in buildings with both a computer room with an ITE load greater than 100 kW and a non-computer room with conditioned space greater than 35,000 square feet, this could provide proof of concept and demonstrate cost-effectiveness to expand this approach to other applications, such as industrial or other processes heating loads.

For computer rooms using water-cooled mechanical cooling systems, rejecting heat to the heating system instead of to an evaporative condenser would reduce water use by reducing the load on the evaporative equipment.

4.1.3 Background Information

There are many forms of computer room heat recovery. Heat recovery from computer rooms in large office buildings is common and has been deployed in California and elsewhere for decades. One of the most common forms of heat recovery is a water-source heat pump system: water-cooled CRAC units connected to a building condenser water system that also serves heat pumps serving occupied spaces (See Figure 16). The cooler is this figure is typically a fluid cooler.

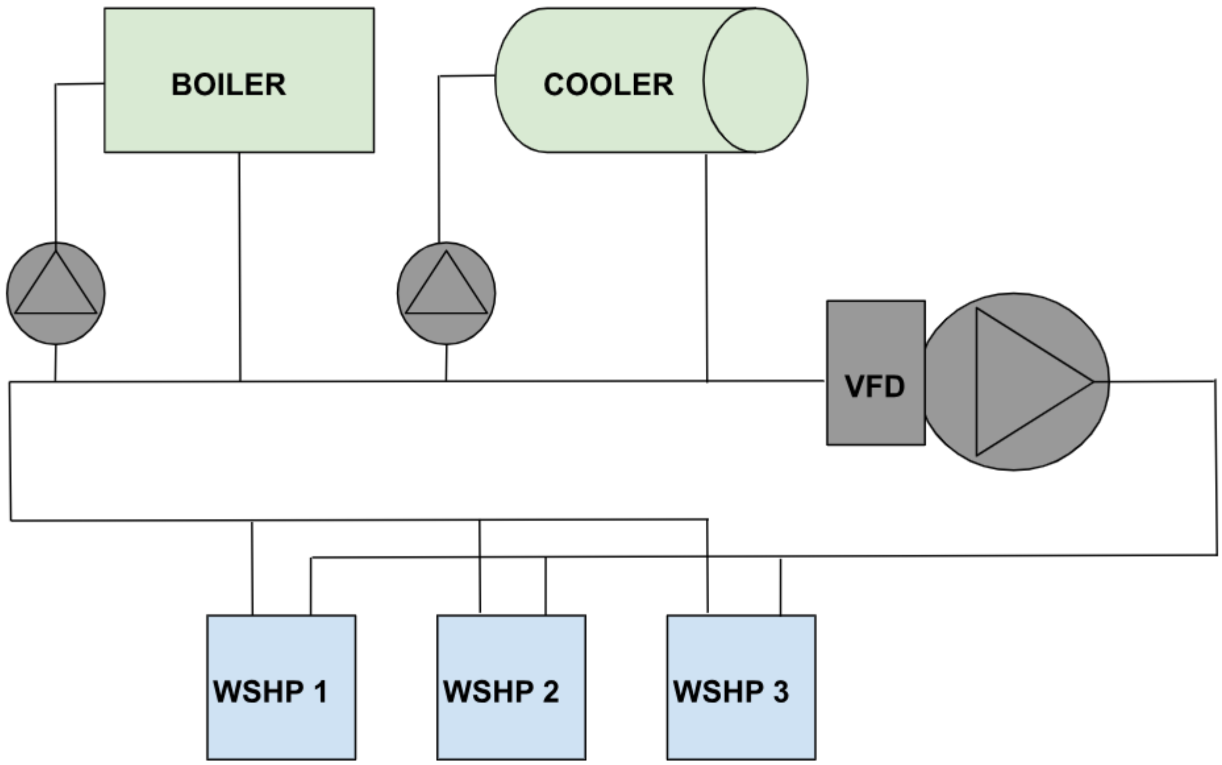

Figure 16. Water-Source Heat Pump Schematic

One of the most efficient and economical forms of heat recovery is direct or indirect air transfer. Computer room hot aisle temperatures are typically 90-110°F. This air can be ducted directly to occupied spaces[19] and used for space-comfort heating without increasing the transferred-air temperature. Figure 17 is an example of direct air transfer. A duct connects the return air path of the computer room air handler and diverts the hot return air to the hot deck air handler of a dual fan dual duct system. If the computer room is large enough and reliable enough to meet all space heating needs, then the hot deck air handler does not need another heating source. If not, then the hot deck air handler should have another heating source. Please note that in many cases a computer room heat recovery system will have a negative incremental cost. Electric resistance heating is the lowest cost heating option, but Title 24 Section 140.4(g) prohibits electric resistance heating. Thus, most buildings use fossil fuel or heat pumps for heating. However, Exception 1 to Section 140.4(g) allows electric resistance when it supplements a heating system in which at least 60 percent of the annual energy

[19] Section 120.1 states that computer room (not printing) spaces have an Air Class 1 designation per Table 120.1-A – Minimum Ventilation Rates, and therefore computer room air may be transferred to any space type per 120.1(g)1.

requirement is supplied by site-solar or recovered energy. Many computer room heat recovery systems will qualify for this exception.

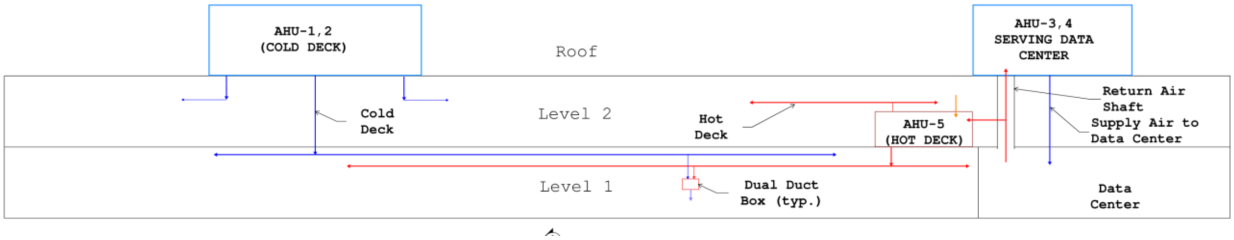

Figure 17. Dual Fan Dual Duct Heat (DFDD) Recovery Design

Figure 18 shows another form of direct heat recovery: The ceiling plenum return air from an IDF room is ducted to the secondary air inlet of nearby parallel fan-powered boxes. Unlike DFDD and other centralized heat recovery systems, this is a distributed/localized heat recovery system. If the IDF rooms are relatively small compared to the total building heating load and to the nearby heating loads, then simply ducting from the computer room(s) to adjacent zones would meet the heat recovery requirement.

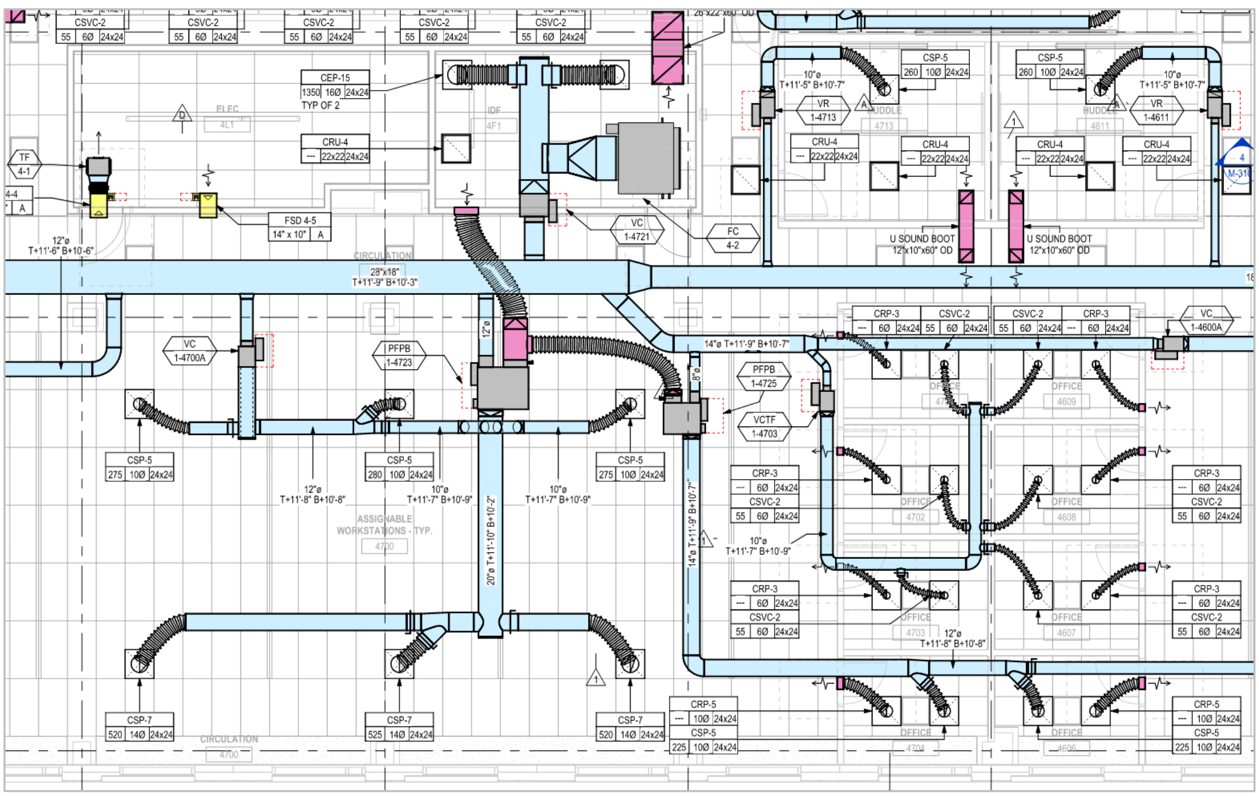

Figure 18. Fan Powered Box Heat Recovery

Other common forms of heat recovery are heat recovery chillers (see Figure 19 and Figure 20) and four-pipe air-to-water heat pumps (see Figure 21 and Figure 22).

With these systems, computer rooms are served by chilled-water fan coils or CRAH units, and chillers or heat pumps end up increasing the chilled water return temperature from computer rooms to the required hot water supply temperature to heat the occupied spaces. All of these heat recovery systems can recover heat not just from computer rooms but from any zone in cooling mode to serve any zone in heating mode.

With recent focus on building decarbonization through electrification of heating systems – including the 2025 Title 24, Part 6 prescriptive requirement for nonresidential building heat recovery of simultaneous loads under 140.4(s) – heat recovery chillers and heat pumps are becoming more common. Computer-room heat-recovery requirements were proposed for the Title 24, Part 6 2022 code cycle in the *Nonresidential Computer Room Efficiency* CASE Report; however, the proposed code change was not adopted due to lack of market readiness at the time, measure complexity, and enforcement challenges (Weitze, Bulger and Stein 2021). To address concerns with enforcement, this proposed computer room heat recovery requirement would use similar code language as structured in the 140.4 prescriptive heat recovery requirement in the 2025 code along with proposed revisions to the compliance manuals, ACM reference manual, and compliance forms – please refer to sections 4.6.5, 4.6.6 and 4.6.7 for the proposed revisions on these topics.

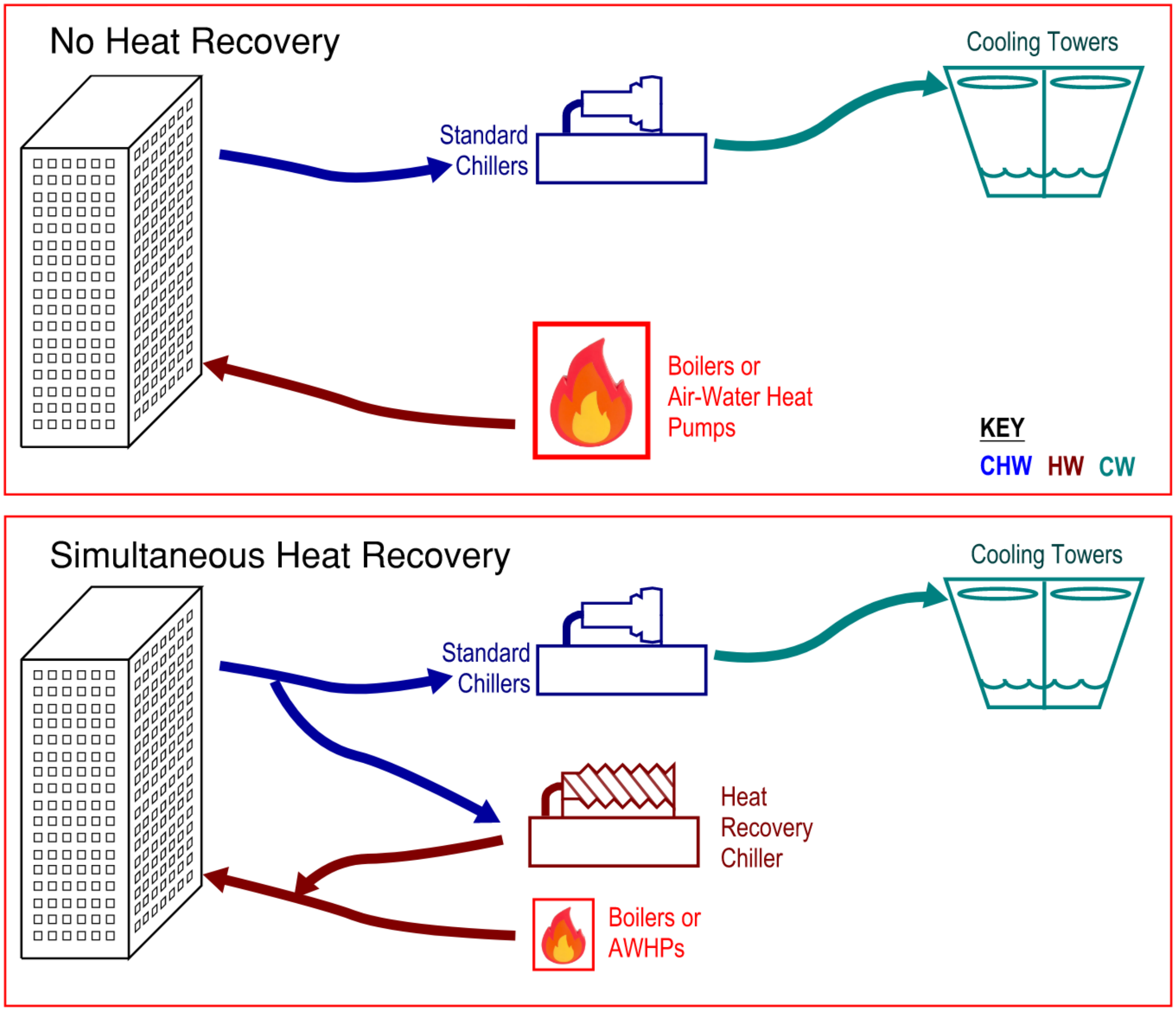

Figure 19. Simplified Schematics Without and With Water-to-Water Heat Recovery Chiller

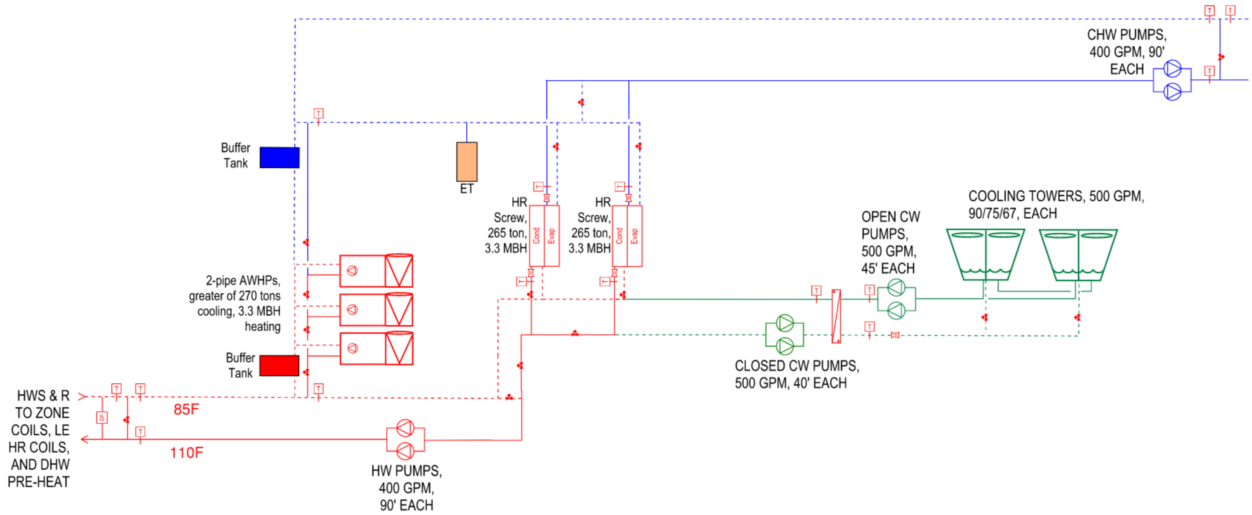

Figure 20. Schematic of Central Plant with Water-to-Water Heat Recovery Chillers

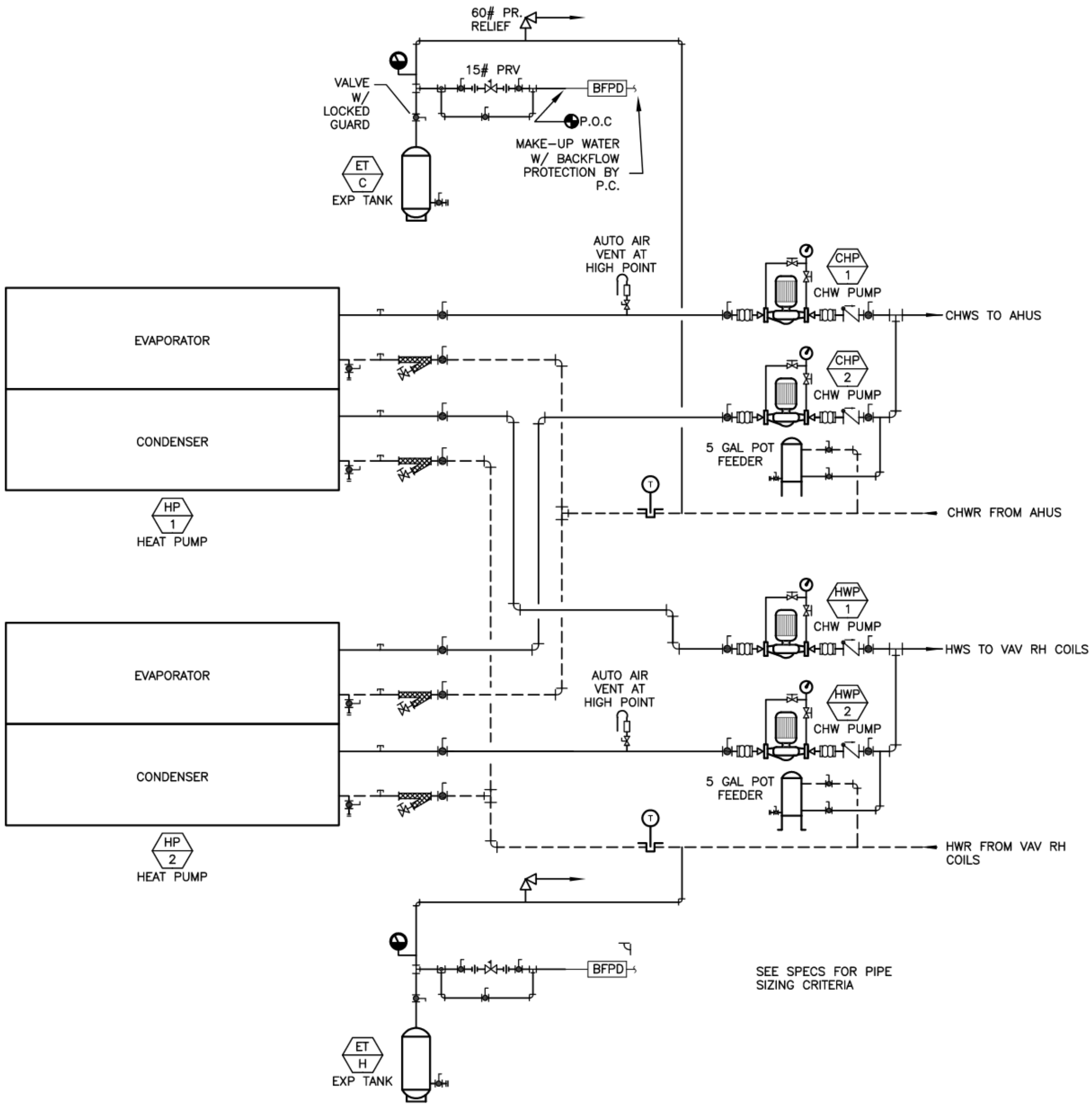

Figure 21. Heat Recovery System with (2) 4-Pipe Air-to-Water Heat Pumps

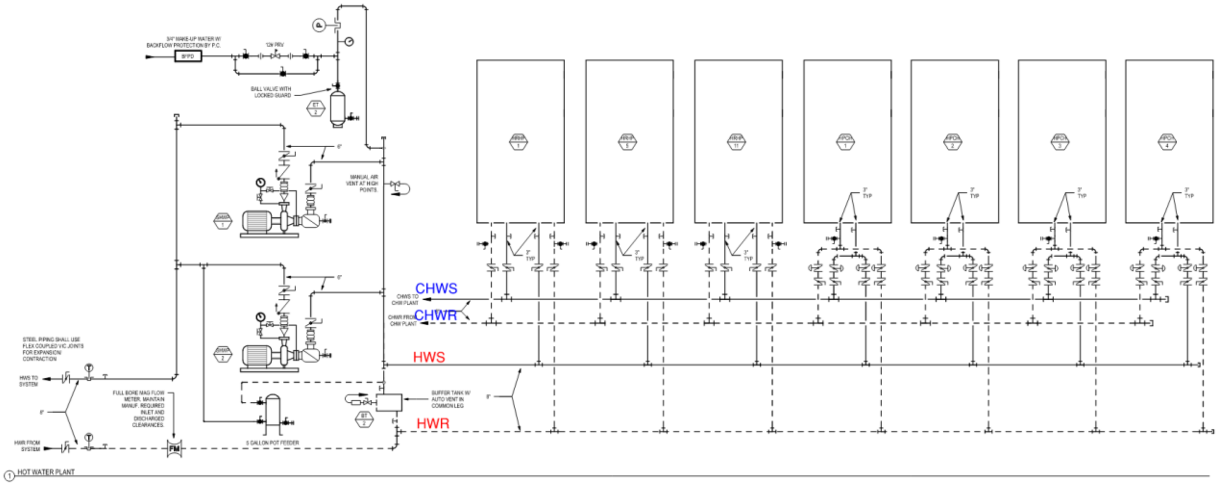

Figure 22. Heat Recovery System with 4-Pipe and 2-Pipe Air-to-Water Heat Pumps

Variable Refrigerant Flow (VRF) can also be used to meet the heat recovery requirement. One option is water-cooled condensing units that are configured similar to a water-source heat pump system (see Figure 23). Another option is simply including VRF fan coils in computer rooms on an air-cooled VRF heat recovery system that also includes fan coils in occupied spaces needing heating.

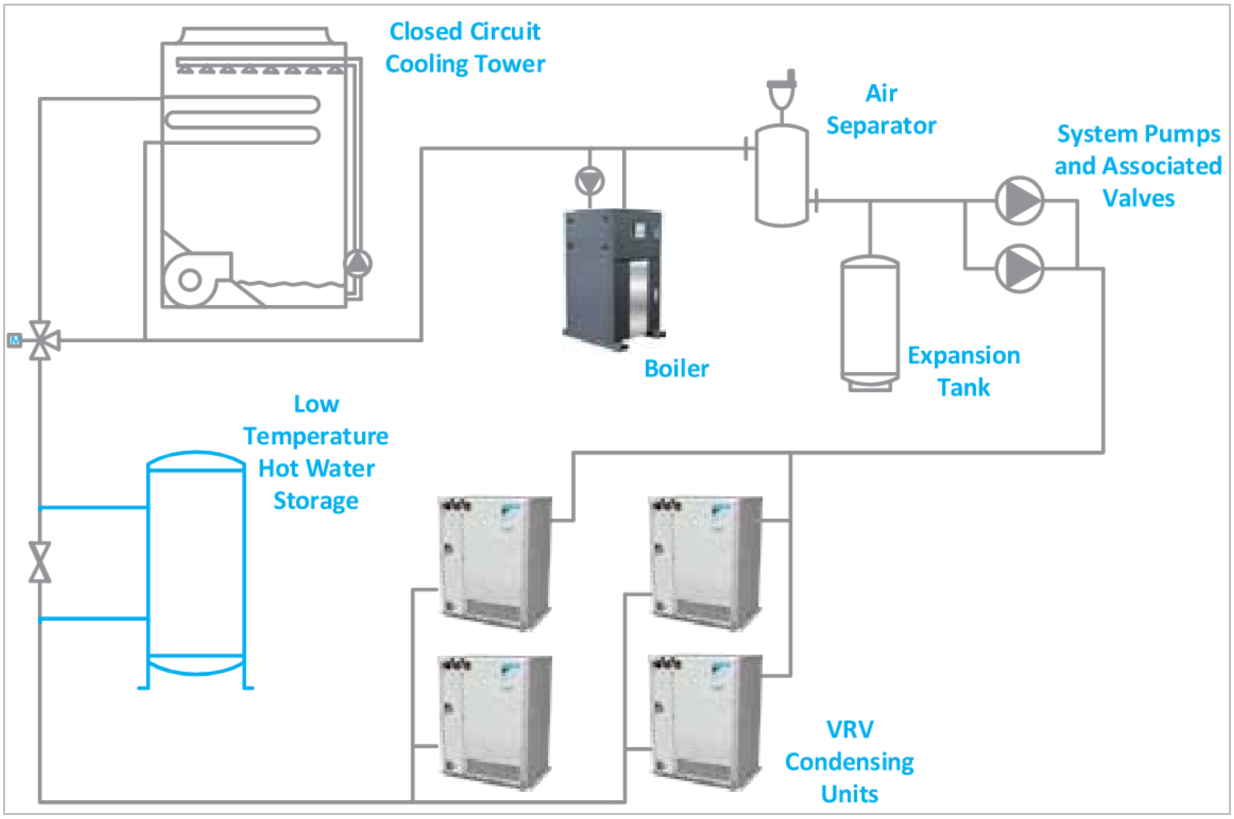

Figure 23. VRF Heat Recovery System

Another highly efficient form of heat recovery is direct heat transfer from liquid-cooled ITE. As described in 2.1.3, liquid-cooled ITE can operate at temperatures above 100°F entering water temperature allowing for warmer leaving water temperatures above 120°F that can reject heat to a hydronic heating system, without the need to boost the temperature higher for many, or any, hours of the year.

Section 4.3 Computer Room Heat Recovery – Market and Economic Analysis provides additional detail on heat recovery systems that can be used to meet this proposed requirement.

The Statewide CASE Team considered several of the following real-world examples on heat recovery:

- Pacific Gas & Electric (PG&E) and Lawrence Berkeley National Laboratory (LBNL) previously monitored eight data centers in Northern California.[20] An identified purpose of this study was to investigate the effect of air-side economizers on energy savings. It was stated that during cold ambient

[20] Scofield, Mike C. and Weaver, Thomas S. “Using Wet-Bulb Economizers Data Center Cooling.” ASHRAE Journal (August 2008).

temperatures, if the mixed air delivery temperature to the cold aisle results in a lower than 40% relative humidity entering the electronics, humidification may be required to achieve the desired room dew point. The research team studied the impact of wet-bulb economizers and concluded that for San Francisco, wet-bulb economizing uses heat recovery for free humidification while keeping refrigeration off, and this constitutes up to 3,261 hours of free humidification per year.

- In 2025, the San Jose City Council approved Westbank, a Canada-based real estate company, to develop 1,492 homes across two muti-story towers along with twin data centers.[21] The captured data center waste heat will be routed to the housing project next door.
- The Adobe North Tower in San Jose, California, is primarily an office building with extensive commercial kitchens on three levels along with a 1 MW data center.[22] The air-source heat pump hot water plant installed in this building includes heat-recovery heat pumps that provide simultaneous cooling to serve the data center loads and heating to the variable air volume reheat system.
- A Utah data center case study reported the system's use of ITE waste heat for space humidification in the winter by mixing the hot air from the ITE with the cold outdoor dry air and passing it over a wet media. The air is cooled in the process from the standpoint of evaporative cooling. The case study reported that free humidification and cooling were provided 74% of the time and partial free cooling was available for the remaining 26% of the time.[23]
- In Seattle, Amazon's corporate headquarters relies on waste heat from a data center based in the neighboring Westin Building Exchange, a "carrier hotel" that houses more than 250 telecom and internet companies.[24] Instead of venting its heat into the atmosphere from rooftop cooling towers, the Westin Building Exchange pipes it to a central plant in Amazon's Doppler tower. Amazon's staff estimates that recycling waste heat from the Westin Building Exchange will save 80 million kWh of electricity use over 25 years.
- Outside of the U.S., the European Union has established policies requiring data center heat recovery. This is outlined in their revised Energy Efficiency Directive (EU/2023/1791), which requires that data centers with greater than 1 MW ITE load must utilize their waste heat (European Union 2023). In Europe, it is

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[21] https://sanjosespotlight.com/data-center-hundreds-of-homes-coming-to-downtown-san-jose/

[22] https://www.taylorengineers.com/work-detail/adobe-north-tower

[23] Khattar, Mukesh K., "Free Cooling for Data Center." 2014 ASHRAE Technology Award Case Studies. ASHRAE Journal, October 2014

[24] https://www.aboutamazon.com/news/sustainability/the-super-efficient-heat-source-hidden-below-amazons-seattle-headquarters

increasingly common practice for large data centers to reject heat to district heating systems[25], and the same practices can be adopted in the U.S. A supercomputer cluster in Germany implemented waste heat reuse sufficient to reheat office buildings and to thermally drive an adsorption chiller for rear-door heat exchangers.[26]. The capturing of non-liquid-cooled heat eliminated the need to potentially add computer room air conditioning/computer room air handler (CRAC/CRAH) to the data center. In Stockholm, Sweden, three data center parks utilized data center waste heat to help the city's district heating network and have allowed the city to boost its IT industry while reducing system emissions by 50g of CO_2 per kilowatt hour.[27]

Existing codes, standards, and efficiency metrics account for heat recovery in various ways:

- ANSI/ASHRAE Standard 90.4-2025, Energy Standard for Data Centers, accounts for the effect of heat recovery in the maximum annualized mechanical load metric (MLC) calculation specified in Section 6.5.2(d). For data center designs where heat recovery measures are being provided, Equation 6.5 for annualized MLC must be calculated for compliance with each of the design's heat recovery measures either "active" (e.g., on-site heat recovery measures) or "inactive" (at the discretion of the design professional.) ANSI/ASHRAE Standard 90.4-2025 leaves all energy or emission savings credits available for the benefit of the data center's host or neighboring projects, without the possibility of double counting such energy or emission credits. ANSI/ASHRAE Standard 90.4-2025 specifies that data centers can be reliable and economical all-electric heat sources for nearby buildings and industrial processes. Since the success of heat recovery requires proximity between data center and neighboring buildings, the standard specifies that any lower-efficiency ITE cooling modes associated with heat export may be considered "inactive" in the data center's annualized MLC compliance calculation. The standard also specifies that recovered heat from a data center that routinely shares a mechanical system with non-data-center spaces can reduce the energy use of non-data-center spaces that are designed to accept the recovered heat. If the heat required by the non-data-center spaces

[25] "Europe is far ahead of the United States in seizing this opportunity with dozens of heat reuse projects across the region, including a Google project in Finland, a Microsoft project in Denmark, and, perhaps the most widely publicized, an Equinix project to heat the Olympic swimming pool in France." https://www.dgardiner.com/policies-support-data-center-heat-reuse/

[26] "CooLMUC-2: A Supercomputing Cluster with Heat Recovery for Adsorption Cooling." January 2017, https://www.researchgate.net/publication/316352834_CooLMUC-2_A_supercomputing_cluster_with_heat_recovery_for_adsorption_cooling

[27] "Heat recovery from data centres." September 2023. https://eu-mayors.ec.europa.eu/sites/default/files/2023-10/2023_CoMo_CaseStudy_Stockholm_EN.pdf

is significant, such a relationship can provide energy savings far beyond the savings that would be brought by applying an economizer to the data center addition.

- The revised provisions in ANSI/ASHRAE Standard 127-2020, the Method of Testing for Rating Cooling Equipment Serving Data Center (DC) and Other ITE Spaces, have provided the data center industry additional basis to compare the performance of vendor solutions using liquid-to-liquid (single phase) coolant distribution units (L2L CDUs) in a consistent manner, thereby encouraging the use of a liquid-to-liquid heat exchanger between a rack, row or facility-level CDU, and the facility water system (FWS). ANSI/ASHRAE Addendum b to ANSI/ASHRAE Standard 127-2020 has implemented the following for ITE L2L CDUs:[28]
    - A definition for L2L CDU;
    - Calculations and conversions in Section 6;
    - Test requirements in Section 7;
    - Data recording requirements in Section 8;
    - Test runs and specific conditions in Section 9; and
    - Reporting of results in Section 10
- The Green Grid, a non-profit open industry consortium comprising of end-users, policy makers, technology providers, facility architects, and utility companies, developed the calculation of an Energy Reuse Effectiveness (ERE) metric that tracked and effectively credited the overall energy efficiency of a data center if waste energy from the data center was reused.[29]

Studies suggest that liquid cooling can be more efficient than air cooling in heat rejection from server to space.[30] The unit heat transport energy for liquid heat rejection is typically less than for heat rejection by air, greatly aided by the difference in the specific heat of the two (water is 1.00 Btu/lb·°F vs air at 0.24 Btu/lb·°F). The differential can be even greater with two-phase flow. Heat rejection from server to space occurs in the following manner:

- Air-cooled servers – air, using onboard fans
- Hybrid direct-to-chip liquid servers – forced convection heat transfer from processor cold plate to pumped liquid. Two-phase also possible.

[28] Demetriou, Dustin W., Gross, John, Shedd, Tim, and McGlocklin, David. “Coolant Distribution Units Part 2: Rating” ASHRAE Journal (February 2026)

[29] Beaty, Donald L. “Data Center Energy Metric.” ASHRAE Journal (January 2013)

[30] Demetriou, Dustin W., Quirk, David, and Davidson, Tom. “Energy Efficiency of Liquid-Cooled Data Centers.” ASHRAE Journal (March 2025)

- Immersion liquid-cooled servers – natural or forced convection heat transfer using dielectric liquid

The energy savings of liquid cooling is dependent on the heat rejection pathway and the local climate. Heat rejection pathways for TCS liquid options are as follows:

- TCS liquid-to-air heat exchanger in the CDU, with heat rejected to the data center space;
- TCS liquid-to-cold liquid heat exchanger in the CDU, with heat rejected to the chilled water loop;
- TCS liquid-to-warm liquid heat exchanger, with heat rejected to the dry cooler or cooling tower; and
- TCS liquid-to-hot liquid heat exchanger, with heat reclaimed for another use (such as office heating).

The rejection of heat from a processor to a liquid coolant followed by the use of air to reject it back into the data center is a more efficient process rather than using liquid as the medium. However, if a liquid-cooled server is installed in an air-cooled data center without any chilled or condenser water, it may only be a short-term option.

The potential for heat reclaim is enhanced when higher allowed fluid temperatures are used.[31] The reclaimed waste heat can serve symbiotic uses such as building heating, greenhouses and fish farming (typically ASHRAE Liquid Cooling Class W45/W+, but all classes have the potential for some heat recovery, depending on the leaving fluid temperature), thereby reducing the heat that would be otherwise generated using a primary energy source. ASHRAE Liquid Class W45/W+ consists of a building cooling / heating system as the main cooling equipment and a cooling tower as the supplemental cooling equipment and is representative of a system that is permanently operated in a water-side economizer mode. The heat rejection at high temperatures in this class of system can be captured and recycled for reuse for heating local buildings, etc. with FWS temperatures ≥113°F.[32,33]

The CDU can play an important role in data center liquid cooling by also providing the function of heat transfer from the TCS to the FWS. The CDU can rely on a water-to-water heat exchanger to reject ITE heat without exposing the sensitive ITE cooling

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31 Beaty, Donald L., et al. “Liquid-Cooling Trends in Data Centers.” ASHRAE Journal (July 2019)

32 Beaty, Donald L. “Liquid Cooling Guidelines.” ASHRAE Journal (October 2014)

33 ASHRAE TC 9.9. “2021 Equipment Thermal Guidelines for Data Processing Environments ASHRAE TC 9.9 Reference Card.” 2021. https://www.ashrae.org/file%20library/technical%20resources/bookstore/supplemental%20files/therm-gdlns-5th-r-e-refcard.pdf

components to the FWS water.[34] Scenarios also exist where an ITE can be directly coupled to FWS and is referred to as a "Non-CDU" water-cooling implementation. The non-CDU implementation has advantages such as closer coupling of ITE heat sources with final heat dissipation medium (reduced thermal resistance, shared pumping redundancy, and improved liquid-cooling efficiency, but non-CDU implementation requires increased up-front design consideration, specifically in the realm of water quality, material selection, and filtration.

Regarding heat recovery measurements, Data Center Infrastructure Management (DCIM) measurements are recommended for direct-to-chip liquid cooling, but another possible option is to meter the liquid-cooling infrastructure with Btu meters, and assume that the ITE computed energy consumption is equal to the liquid-cooled heat rejection.[35] Heat recovery system capacity can be estimated with knowledge of the entire facility load available from a building demand meter or equal and the ITE compute energy obtained from the Btu meters.

4.1.4 Modifications to Energy Code Documents

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 4.6: Computer Room Heat Recovery – Proposed Language Code of this report for detailed revisions to code language.

4.1.4.1 Energy Code Change Summary

SECTION 910.1 – MANDATORY REQUIREMENTS FOR COMPUTER ROOMS

The proposed code change would require a heat recovery system, such as a heat recovery chiller or direct transfer of air through a dual fan dual duct system capable of transferring heat from the computer room cooling system to the space heating system and/or to the service water heating (SWH) system. This would need to be installed in a building with a computer-room ITE load greater than 100 kW and a non-computer-room conditioned floor area greater than 35,000 square feet. This requirement cost-effectively would improve computer room efficiency and overall stringency of the Energy Code, thereby reducing its energy demand on the grid and more effectively using waste heat.

4.1.4.2 Reference Appendices Change Summary

The proposed changes would not impact the reference appendices there is no acceptance testing for computer room requirements.

[34] Beaty, Donald L., et al. "Liquid-Cooling Trends in Data Centers." ASHRAE Journal (July 2019).

[35] Demetriou, Dustin W., Quirk, David, and Davidson, Tom. "Energy Efficiency of Liquid-Cooled Data Centers." ASHRAE Journal (March 2025).

4.1.4.3 Compliance Manuals Change Summary

Section 10.4 of the Nonresidential Compliance Manual, which outlines Computer Room requirements in the code, would need to be updated. Specifically, a new subsection would be added to 10.4.3 to include heat recovery requirements. Additionally, this change will need to be reflected in other chapters related to space conditioning and service water heating.

4.1.4.4 Alternative Calculation Method Reference Manual Change Summary

No changes are required since the measure is mandatory. However, it is recommended that the compliance software be able to model heat recovery in the baseline and proposed mode where required and in the proposed model where implemented but not required.

4.1.4.5 Compliance Forms Change Summary

The existing nonresidential compliance forms NRCC-PRC-E and NRCI-PRC-E would need to be updated to add the computer room heat recovery requirement with the following changes:

- Add new table to NRCC-PRC-E for Computer Room Heat Recovery like the Mechanical Heat Recovery table in NRCC-MCH-E
- Add new table to NRCI-PRC-E for Computer Room Heat Recovery like the Mechanical Heat Recovery table in NRCI-MCH-E.

4.1.5 Measure Context

4.1.5.1 Comparable Model Codes or Standards

ANSI/ASHRAE/IES Standard 90.1 – 2022 does not include specific requirements for heat recovery in computer rooms.

2024 IECC provides an exception for economizers if the system includes a heat recovery system in accordance with Section C403.11.5.

ASHRAE 90.4 – 2022 added guidance to encourage and calculate heat recovery savings in data center performance compliance. Language has been carefully included to avoid counting energy savings twice.

4.1.5.2 Interactions with Other Regulations

There are no direct federal or state laws and other requirements that conflict with this measure. Federal and state laws that address energy efficiency in computer rooms are described in Section 2.1.5.2.

Interactions with California Building Code

Section 401.3.19 – Mechanical Heat Recovery was adopted in the 2025 California Energy Code. This measure requires the use of heat recovery for large buildings with significant simultaneous cooling and heating loads pursuing all-electric space heating. The mandatory heat recovery requirements proposed in 910.1 are similar to prescriptive requirements in 401.3.19. As such, 910.1 will effectively extend the current heat recovery requirement to more buildings.

4.2 Computer Room Heat Recovery – Compliance and Enforcement

4.2.1 Compliance Considerations

The proposed heat recovery requirement for nonresidential buildings with a computer room would build on the heat recovery requirement adopted in the 2025 California Energy Code for nonresidential buildings. As such, heat recovery is not a new concept for typical market actors involved in its implementation, such as HVAC designers, installers, code officials, and controls contractors. Given that computer rooms generate 24/7 heat, heat recovery is common in computer room designs, so many designers will be familiar with various compliant approaches. The proposed impact at each step of the design and construction process is outlined below.

- Design Phase: The implementation of heat recovery would require new design strategies, such as directly or indirectly transferring air from the computer room to an adjacent office, as further described in Section 4.3.2. Additional workforce education on the range of design strategies for heat-recovery systems that is suitable for computer rooms and compliant with code requirements would be necessary.
- Permit Application Phase: The design phase changes would affect the plan reviewers and energy consultant's role and the permit application process. Plan reviewers and energy consultants would need training to understand the changes in energy code, as they typically guide the design team in interpreting and integrating these requirements. Documentation would need to be revised to ensure compliance.
- Construction Phase: The types of equipment will not change, but the configuration of that equipment will. Most construction practices would remain consistent before and after this measure.
- Inspection Phase: While this would be a new requirement for computer rooms, heat recovery is not new to the code for nonresidential building types. This would be a new requirement for computer rooms, so inspectors would need training on how to inspect and confirm that a compliant heat-recovery system has been

installed, confirming that all the required equipment is present as specified in the measure’s heat-recovery requirements and in the project plans.

4.2.2 Impact on Market Actors

Table 58 summarizes impacts on market actors and suggests outreach and education that might be helpful to support market actors as they prepare for the effective date of the requirements.

Table 58: Impacts on Market Actors and Suggested Training and Education Opportunities

Market Actor	Impact(s)	Suggested Outreach and Education
Owner/Developer [a]	Awareness of requirement.	Increased awareness through Energy Code ACE and commercial building associations.
Design Professional [b]	Designers will need to be aware of new requirements, and when they apply to nonresidential buildings. If applicable, they will need to factor in new heating and cooling approaches, including heat recovery.	Provide outreach through local ASHRAE chapters and training on new computer room heat recovery requirement.
Construction Team [c]	HVAC, plumbing, electrical contractors may have additional scope in applicable nonresidential buildings.	Provide training through local unions and skilled trade training facilities on new requirements.
Building Department [d]	Understand when heat recovery threshold and verify when system is capable of recovering computer room heat and supplementing heating load in applicable non-computer rooms. Ensure this heat recovery system and space or water heating are appropriately designed to meet the overall heating loads.	Engage local code official chapters to improve awareness of new computer room heat recovery requirement.
Manufacturers and Distributors	Ensuring equipment is available to support requirement in applicable building types	Increased awareness through Energy Code Ace and conversations to manufacturers through other utility programs.

a. Owner/Developer is funding the project and is the primary decision maker.

b. Design professionals include architects, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.

c. Construction team includes general contractors, design-build contractors, installation contractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople.

d. Building departments include plans reviewers, building inspectors, specialty inspectors, permit counter technicians and third-party plan review and inspection.

e. Verification testers include commissioning agents, ECC Raters, and Acceptance Test Technicians.

The 2028 CASE Methodology Report presents a quantitative assessment of how changes to the California building code impact builders, building designers and energy consultants, and building owners and occupants. While the analysis in the methodology report is not specific to the code change(s) presented in this report, this measure focuses on building owners/developers, design professionals and construction teams, since these market actors are expected to experience the most direct impacts from the requirement for new nonresidential buildings with both a computer room(s) and sizable heating loads to recover heat from the computer room(s) to serve other building heating loads. The following provides a qualitative description of how this specific code change affects various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

Builders. The proposed change would likely affect commercial builders; however, it would likely not impact firms focused on the construction or retrofitting of industrial buildings, utility systems, public infrastructure, or other heavy construction. The proposed change would not affect all firms and workers in the commercial building industry equally; instead, it would primarily affect specific subsectors within the industry. Table 59 shows the commercial building subsectors that the Statewide CASE Team expects to be impacted by the changes proposed in this report. This proposal includes requirements for heat recovery which will impact electrical and mechanical contractors.

Building occupants (owners and tenants). The proposed code change would have incremental costs and would reduce building owners' utility bills throughout the measure lifetime. See the [2028 CASE Methodology Report] for a description of how LSC savings relate to occupant utility bill savings.

Table 59: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)

Construction Subsector	Establishments *	Employment	Annual Payroll (Billions $)
Commercial Building Construction	5,491	87,450	$10.6
Other Nonresidential Exterior Contractors	234	2,259	$0.1
Nonresidential Electrical Contractors	3,245	72,794	$7.8
Nonresidential Plumbing & HVAC Contractors	2,270	55,182	$5.8
Other Nonresidential Equipment Contractors	580	9,749	$1.1
Nonresidential Site Preparation Contractors	1,147	19,273	$1.9
All Other Nonresidential Trade Contractors	948	17,084	$1.7

Source: (State of California n.d.)

*An establishment is single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. https://www.bls.gov/opub/hom/cew/concepts.htm

Manufacturers. The Statewide CASE Team anticipates the proposed change would have minimal material impact on California component retailers. This proposed requirement for heat recovery in computer rooms would be achievable with existing commercially available equipment. As described in 4.3.2, almost all major manufacturers produce heat recovery chillers or heat pumps capable of meeting this requirement, which are some of the most common approaches in nonresidential buildings.

4.2.3 Compliance Software Updates

If the proposal is adopted, then the CBECC software will be modified based on the proposed changes to the ACM, as described in Section 4.6.6. Final recommendations will be provided in Summer 2026 based on the final proposal.

The Statewide CASE Team also considered CBECC's current lack of ability to model "Data Center" buildings. A calculation methodology was implemented to estimate savings for data center, the Medium Office prototype in CBECC was relied upon to estimate energy savings for computer rooms in those buildings.

The Statewide CASE Team is aware that in recent years LBNL has developed the following two new data center prototype models through OpenStudio and EnergyPlus™. For each of the following data center models, LBNL evaluated two levels of ITE load density and covered a wide range of IT power densities between 40 and 100 W/ft^2:

a. The small-size data center model represents a computer room in a building served by computer room air conditioners (CRACs).
b. The large-sized model represents stand-alone data centers served by computer room air handlers (CRAHs) with a central chiller plant.

Future CBECC enhancements could potentially build upon the approach taken by LBNL.

4.2.4 Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report is an evaluation of specific measures, and the collective impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

The Statewide CASE Team anticipates this proposed measure would require additional training, through Energy Code Ace, and other venues. This will be provided as part of the 2028 Title 24, Part 6 code update, and this measure would be included and need to be emphasized in that training. Additionally, local building departments would have had recent training and awareness of heat recovery systems in nonresidential building types due to the adoption and implementation of Section 140.4(s) – Mechanical Heat Recovery in the 2025 California Energy Code. plan review would consist of reviewing NRCC-PRC-E and ensuring that it meets the new code requirement and is consistent with the drawings and specifications.

Inspection review would consist of reviewing NRCI-PRC-E and ensuring that the information on the forms is consistent with the approved NRCC-PRC-E forms and with what is actually installed.

4.3 Computer Room Heat Recovery – Market and Economic Analysis

4.3.1 Market Structure and Availability

4.3.1.1 Current Market Structure and Availability

With the introduction of 140.4(s) mechanical heat recovery in 2025 Title 24 and recent focus on building decarbonization and electrification[36], heat recovery has become increasingly common for computer rooms located in nonresidential buildings with high simultaneous cooling and heating loads.

Successful implementation of heat recovery requires planning by the mechanical engineer, to incorporate heat recovery systems into the design. Heat recovery systems are designed and specified by the mechanical engineer using off-the-shelf products. A heat recovery system may consist of multiple mechanical system components specified together or packaged products such as heat recovery chillers. In either case, there are many manufacturers that make and sell these products in California, ranging from a few tons to greater than 1,000 tons of cooling capacity.

4.3.1.2 Market Challenges and Solutions

For the proposed code requirement, a computer room heat recovery system would be any mechanical system that transfers heat from computer room return air to provide heating to other zones in the building demanding heating. Examples of heat recovery systems include computer room return air transferred directly to air systems providing heating, heat recovery chillers, air-source or water-source heat pumps providing simultaneous heating and cooling, and variable refrigerant flow systems with heat recovery.

Although heat recovery has become a common practice in nonresidential buildings with computer rooms, there is a first-cost increase for heat recovery equipment which may pose a perceived challenge for the market. In order to comply with the proposed measure, there are many simple and economical designs.

- One approach is to directly or indirectly transfer hot air from a computer room to a non-computer room with a heating load. Computer room hot aisle temperatures are typically 90-110°F. This air could be directly ducted to occupied spaces and would not require the temperature to be boosted or tempered.

[36] One of the predominate methods of buildings reducing their scope 1 carbon emissions is by using electric heating (https://www.ashrae.org/about/cebd-building-decarb-101, https://www.csemag.com/four-strategies-for-decarbonization-electrification-in-commercial-buildings/), including heat pumps and heat pumps with heat recovery for space heating.

- Another common approach is using water-to-water heat pumps or heat recovery chillers. Heat recovery chillers/heat pumps combine heating and cooling into single equipment, which helps reduce first cost and space requirements.

While the design and installation of a heat recovery system, as described above, does modestly increase the overall construction cost, the system is cost-effective over its useful life and makes optimal use of computer room heat instead of dumping it to the outside. This approach would reduce the cooling load of computer rooms and heating load of the adjacent non-computer room space in a nonresidential building.

See Section 4.2.2 for a description of workforce trainings that may be needed to ensure effective design, installation, and commissioning.

4.3.2 Design and Construction Practices

4.3.2.1 Current Design and Construction Practices

Heat recovery chillers / heat pumps are one of the simplest ways to implement heat recovery. These products are offered by nearly all major chiller manufacturers in the U.S., in capacities ranging from a few tons to thousands of tons.

Other common examples of heat recovery systems include:

- Heat exchangers on the chilled water loop that transfer computer room waste heat directly to another hydronic loop that needs slightly warmer water (e.g., certain process cooling applications, preheating for space heating or domestic hot water, low-temperature radiant heating systems)
- Direct transfer of warm computer room return air to another space that requires heating (e.g., via dual duct dual fan system).
- Heat exchanger or heat recovery coil located in the computer room return airstream used to transfer computer room waste heat to another space that requires heating.

4.3.2.2 Health and Safety Considerations

The proposed code change would not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by the California DOSH. All existing health and safety rules would remain in place. Complying with the proposed code change is not anticipated to have adverse impacts on the safety or health of occupants or those involved with the construction, commissioning, and maintenance of the building.

4.3.2.3 Design and Construction Challenges and Solutions

Some of the approaches to implement heat recovery, such as the use of hydronic loops, would require both the cooling and heating system to use water. This can limit cooling and heating system options. However, this is not anticipated to be a significant design challenge to comply with this measure as hydronic heating and cooling systems are already standard practice in system sizes that are required to have heat recovery under this measure.

Another design challenge is that the additional controls required to operate heat recovery systems effectively may increase overall design complexity and designers and building operators may lack familiarity with heat recovery systems in computer rooms. To overcome this challenge, additional education, training, and resources would be provided to the market through Energy Code ACE and other training venues. Fortunately, with the inclusion of a new heat recovery requirement (140.4(s)) for large buildings with significant simultaneous heating and cooling loads in 2025 Title 24, Part 6, many of these training materials would have already been developed and distributed to the market. By the time this proposed 2028 measure goes into effect in 2029, many designers and building operators will already have had time to adapt to this technology and approach.

See Table 58 in Section 4.2.2 for a description of workforce trainings that could support effective design, installation, and commissioning.

4.3.3 Energy Equity and Environmental Justice

Each measure in this CASE Report was evaluated for ESJ impacts using 4 criteria: cost, health, resiliency, and comfort. The details of that evaluation can be found in Section 1.4 and the 2028 CASE Methodology Report.

With this proposal impacting computer room design and efficiency, this proposal would likely not result in any negative impacts to ESJ communities and should improve impacts. Using recovered waste heat from computer rooms instead of natural gas avoids pollution associated with onsite combustion and would improve air quality for surrounding communities. The value of improved air quality from the proposed code changes is amplified by the fact that many industrial facilities, including data centers, are more often located near ESJ and Low- and Moderate-Income (LMI) housing, thus disproportionally exposing these residents to lower air quality. As a result, the Statewide CASE Team expects that ESJ communities would see a disproportionate health benefit from these changes over time.

4.3.4 Impacts on Jobs and Businesses

The Statewide CASE Team does not anticipate significant employment or financial impacts on any particular sector of the California economy. However, the proposed change may have modest impacts on employment in California. The Statewide CASE Team estimates the proposed change would affect statewide employment and economic output directly and indirectly through its impact on builders, designers, energy consultants, and building inspectors. Table 60, Table 61, and Table 62 outline the statewide implications for these job categories. For more information on the Statewide CASE Team's economic impacts methodology, see the 2028 CASE Methodology Report.

The Statewide CASE Team does not anticipate that the proposed changes would lead to the creation of new types of jobs or the elimination of existing types of jobs. In other words, the Statewide CASE Team's proposed change would not result in economic disruption to any sector of the California economy. Rather, it would lead to modest changes in the employment of existing jobs.

Table 60: Estimated Impact that Adoption of the Proposed Measure would have on the California Nonresidential Construction Sector

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by Commercial Builders)	9	$700,680	$1,054,944	$2,282,577
Indirect Effect (Additional spending by firms supporting Commercial Builders)	5	$405,024	$695,337	$1,217,341
Total Economic Impacts	**14**	**$1,005,704**	**$1,750,280**	**$3,499,918**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.[1]

Table 61: Estimated Impact that Adoption of the Proposed Measure would have on the California Building Designers and Energy Consultant Sectors

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by building designers and energy consultants)	2	$194,200.38	$192,256.05	$303,878.79
Indirect Effect (Additional spending by firms supporting building designers and energy consultants)	1	$57,823.23	$80,362.75	$129,367.55
Total Economic Impacts	**3**	**$252,023.60**	**$272,618.80**	**$433,246.34**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

Table 62: Estimated Impact that Adoption of the Proposed Measure would have on California Building Inspectors

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by building inspectors)	0	$13,181.29	$15,631.40	$18,995.27
Indirect Effect (Additional spending by firms supporting building inspectors)	0	$1,220.75	$1,901.31	$3,311.45
Total Economic Impacts	**0**	**$14,402.04**	**$17,532.71**	**$22,306.72**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

The proposed change represents a modest adjustment, which is not expected to excessively burden or competitively disadvantage California businesses, nor is it expected to lead to a competitive advantage for California businesses. Therefore, the Statewide CASE Team does not expect the proposed code changes to result in the creation of new businesses or the elimination of existing ones.

The proposed code changes would apply to all businesses operating in California, regardless of whether the business is incorporated inside or outside of the state. Therefore, the Statewide CASE Team does not anticipate that the proposed changes would have advantageous or an adverse effect on the competitiveness of California businesses.

The Statewide CASE Team derived a reasonable estimate of the change in investment by California businesses based on the estimated change in economic activity associated with the proposed measure and its expected effect on business income. The Statewide CASE Team's IMPLAN modeling resulted in an estimated $383,005 increase in California business income due to the proposed code change. The Statewide CASE Team assumed that net business investment is positively correlated with business income and that a portion of business income will be allocated to net business investment.

To estimate the portion of business income that would be allocated to net investment, the Statewide CASE Team analyzed national data on corporate profits and net capital investment by businesses that expand a firm's capital stock (referred to as net private domestic investment, or NPDI).[3] As Table 63 shows, between 2020 and 2024, NPDI as a percentage of corporate profits ranged from a low of 18 percent in 2020 due to the worldwide economic slowdowns associated with the COVID 19 pandemic to a high of 28 percent in 2022, with an average of 23 percent. While only an approximation of the proportion of business income used for net capital investment, it provides a reasonable estimate of the proportion of incremental income that business owners would reinvest into expanding their capital stock.

Table 63: Net Domestic Private Investment and Corporate Profits, U.S.

Year	Net Domestic Private Investment by Businesses, Billions of Dollars	Corporate Profits After Taxes, Billions of Dollars	Ratio of Net Private Investment to Corporate Profits (Percent)
2020	$389	$2,212	18%
2021	$545	$2,888	19%
2022	$825	$2,951	28%
2023	$836	$3,069	27%
2024	$885	$3,441	26%
5-Year Average	**Intentionally blank**	**Intentionally blank**	**23%**

Source: (Federal Reserve Economic Data (FRED) n.d.)

Given the estimated total increase in California business income and net business investment ratio described above, the Statewide CASE Team estimates the proposed code change would result in an $89,906 increase in net private investment by California businesses.

4.3.5 Economic and Fiscal Impacts

This section includes information that CEC uses in the economic analysis that is required by statutes. CEC uses the information to complete Form STD 399 (Economic and Fiscal Impact Statement), including identifying whether the proposed update will be greater than $50 million, triggering the requirement for the CEC to complete an SRIA. This section addresses how the code change impacts the statewide economy.

The Statewide CASE Team does not anticipate that the economic impacts associated with the proposed measure would lead to a significant change (increase or decrease) in investment, directly or indirectly, in any affected sectors of California's economy. The proposed change would not result in economic disruption to any sector of the California economy. For more information on the Statewide CASE Team's economic and fiscal impacts methodology, see the 2028 CASE Methodology Report.

Adoption of this code change proposal would result in relatively modest economic impacts through additional direct spending by energy consultants. The Statewide CASE Team does not anticipate that money saved by businesses or other organizations affected by the proposed 2028 code cycle regulations would result in additional spending by those businesses.

4.3.5.1 Effects on the State General Fund, State Special Funds, and Local Governments

The Statewide CASE Team does not expect the proposed code changes to have a measurable impact on California's General Fund, any state special funds, or local government funds.

Cost to State: The state government already has a budget for code development, education, and compliance enforcement. While the state government would be allocating resources to update the Title 24, Part 6 Standards, including updating education and compliance materials and responding to questions about the revised requirements, these activities are already covered by existing state budgets. The costs for the state government are small when compared to the overall cost savings and policy benefits associated with the code change proposals. Nonresidential measures may impact state buildings (new construction) but the proposed code changes have been found to be cost effective.

Cost to Local Governments: All proposed code changes to Title 24, Part 6 would result in changes to compliance determinations. Local governments would need to train building department staff on the revised Title 24, Part 6 Standards. While this retraining is an expense to local governments, it is not a new cost associated with the 2025 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining, including tools, training, and resources provided by the IOU Codes and Standards program (such as Energy Code Ace). As noted in 4.2, the Statewide CASE Team considered how the proposed code change might impact various market actors involved in the compliance and enforcement process and aimed to minimize negative impacts on local governments.

4.3.5.2 Mandates on Local Agencies or School Districts

There are no relevant mandates to local agencies or school districts due to the 100 kW total computer room ITE load minimum nature of the measure for newly constructed buildings.

4.3.5.3 Costs to Local Agencies or School Districts

There are no costs to local agencies or school districts. There are no fiscal impacts due to the 100 kW total computer room ITE load minimum nature of the measure for newly constructed buildings.

4.3.5.4 Costs or Savings to Any State Agency

There are no costs or savings to any state agencies. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

4.3.5.5 Other Non-Discretionary Cost or Savings Imposed on Local Agencies

There are no added non-discretionary costs or savings to local agencies. The proposed code change measure has been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

4.3.5.6 Costs or Savings in Federal Funding to the State

There are no costs or savings to federal funding to the state. The proposed code change measures have been found to be cost effective, so there are no fiscal impacts due to the nature of this measure.

4.4 Computer Room Heat Recovery – Cost Effectiveness

4.4.1 Cost Effectiveness Methodology

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost inclusion parameters. The [2028 CASE Methodology Report]() and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its Benefit-Cost Ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on Long-term System Cost (LSC), which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code. The analysis excludes design costs and incremental code compliance verification costs.

4.4.2 Energy and Energy Cost Savings Results

Analysis Approach

To assess energy, economic and environmental impacts of this proposed change, the Statewide CASE Team used a hybrid analytical approach. This hybrid approach involved energy modeling to determine the heat load for a prototype building and a custom Excel tool to calculate the impact of a heat recovery system and a post-processing analysis to evaluate computer room size and load profile in terms of Btuh/ft^2 (e.g., 100 kW computer room at 100 percent load for a 35,000 square feet building is 9.75 Btuh/ft^2). The analysis was completed for all climate zones and two office building types: medium and large office.

CBECC Medium Office and Large Office prototype models were used with changes to plug density and schedules in the baseline model. An overall building average plug load density of 0.5 W/sf for all spaces was used and extended schedules match typical office operation.[37] The medium office baseline model includes an air-to-water (AWHP) heat pump for space heating, and the large office baseline model includes a natural gas boiler for space heating. To establish baseline energy use of a medium office without heat recovery, the Statewide CASE Team simulated a medium office with VAV reheat and without heat recovery. The hourly heating load (Btuh/ft^2), AWHP heating energy (kW/ft2), and electricity costs were exported from CBECC. To establish baseline energy use of a large office without heat recovery, the Statewide CASE Team simulated a large office with VAV reheat and without heat recovery. The hourly heating load (Btuh/ft^2), natural gas boiler heating energy (therm/ft^2), and natural gas costs were exported from CBECC. Additionally, hourly office air handler fan power (kW/ft^2) was exported from CBECC, and an estimated 4% fan power increase was assumed based on the fan affinity law during hours when the heat recovery system operated. This equates to a 0.1 in. w.g. fan system pressure drop increase for the heat recovery system on a baseline fan system designed for 3.5 in. w.g. total static pressure. These outputs were used in an annual hourly post processing analysis to determine the hourly and annual heating energy savings from computer room heat recovery.

In this analysis, a medium office building with a 100-kW data center is used to represent the potential impact of this change. In the base-case and proposed case, the Statewide CASE Team assumed the following:

- **Base-Case (building energy monitoring (BEM) + Custom Excel Tool):** 53,628 sq. ft. medium office building with a 100-kW computer room
    - Air-to-water heat pump (AWHP) is the heating source to the HW coil in hot deck (sized for full capacity)
    - No heat recovery system is assumed - dual fan dual duct (DFDD) with air handling unit (AHU) mixing section not included
    - Hourly heating load and energy per sq. ft. were scaled for a 35,000 sq. ft. building used for the cost-effectiveness analysis.

[37] Based on recommendations in docket comment: https://efiling.energy.ca.gov/GetDocument.aspx?tn=265693&DocumentContentId=102545

- **Proposed Case (Custom Excel Tool):** medium office building (53,628 sq. ft. prototype results scaled to 35,000 sq. ft.) with a 100-kW computer room
    - Air-to-water heat pump (AWHP) serves as a backup to the HW coil in hot deck (sized for full capacity)
    - DFDD system
    - Computer room return air ducted to hot deck AHU mixing section to supply heat to office as the primary heating source

In this analysis, a large office building with a 100-kW data center is used to represent the potential impact of this change. In the base-case and proposed case, the Statewide CASE Team assumed the following:

- **Base-Case (BEM + Custom Excel Tool):** 498,637 sq. ft. large office building with a 100-kW computer room
    - Natural gas boiler is the heating source to the HW coil in hot deck (sized for full capacity)
    - No heat recovery system is assumed - dual fan dual duct (DFDD) with air handling unit (AHU) mixing section not included
    - Hourly heating load and energy per sq. ft. were scaled for a 35,000 sq. ft. building used for the cost-effectiveness analysis.
- **Proposed Case (Custom Excel Tool):** large office building (498,637 sq. ft. prototype results scaled to 35,000 sq. ft.) with a 100-kW computer room
    - Natural gas boiler serves as a backup to the HW coil in hot deck (sized for full capacity)
    - DFDD system
    - Computer room return air ducted to hot deck AHU mixing section to supply heat to office as the primary heating source

Using the base-case and proposed cases described above, the annual space heating load that can be met by computer room heat recovery is above 90% for all climate zones for a 35,000 sq. ft. office using the medium office prototype and above 80% for all climate zones for a 35,000 sq. ft. office using the large office prototype, as shown in Table 64.

Table 64: 35,000 Square Foot Office Percent Annual Heating Load Met by 100 kW Computer Room Heat Recovery

Climate Zone	Medium Office Prototype	Large Office Prototype
1	98%	91%
2	98%	90%
3	97%	93%
4	98%	89%
5	98%	93%
6	99%	97%
7	99%	98%
8	98%	96%
9	98%	95%
10	98%	95%
11	95%	89%
12	97%	91%
13	97%	92%
14	96%	86%
15	98%	94%
16	96%	84%

Energy and Energy Cost Savings

Energy savings (electricity, natural gas, and source energy) and peak demand reductions per-unit for the four analyzed climate zones are presented in Table 65. Per-unit (sq. ft.) savings for the first year for new construction ranges from 0.24 to 2.57 kWh/yr electricity for medium offices and from 11.52 to 3.72 kBtu/yr natural gas for large offices.

Table 66 presents total energy cost savings per unit for newly constructed buildings and additions in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV$). The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods. Table 67 presents a breakdown of total LSC savings from electricity and natural gas cost savings for the prototypical building.

Table 65: Energy and Energy Cost Savings – Per Square Foot – New Construction – Medium Office with Computer Room

Measure	First Year Electricity Savings (kWh)	First Year Peak Electrical Demand Reduction (W)	First Year Natural Gas Savings (kBtu)	First Year Source Energy Savings (kBtu)	Total 30-Year LSC Savings (2029 PV$)
1	1.82	0.42	0	4.53	19.11
2	1.33	0.37	0	3.84	14.03
3	0.9	0.23	0	2.37	9.51
4	1.18	0.36	0	3.72	12.23
5	0.88	0.21	0	2.4	8.92
6	0.39	0.09	0	1.06	4.09
7	0.33	0.08	0	0.9	3.32
8	0.37	0.12	0	1.18	3.67
9	0.45	0.13	0	1.44	4.46
10	0.43	0.11	0	1.41	4.31
11	1.11	0.28	0	3.34	10.8
12	1.11	0.32	0	3.45	11.02
13	0.74	0.25	0	2.47	7.57
14	1.06	0.37	0	3.67	10.71
15	0.24	0.09	0	0.97	2.83
16	2.57	0.39	0	5.74	21.63

Table 66: Energy and Energy Cost Savings – Per Square Foot – New Construction – Large Office with Computer Room

Measure	First Year Electricity Savings (kWh)	First Year Peak Electrical Demand Reduction (W)	First Year Natural Gas Savings (kBtu)	First Year Source Energy Savings (kBtu)	Total 30-Year LSC Savings (2029 PV$)
1	-0.01	0	10.61	9.11	-
2	-0.01	0	8.43	7.24	-
3	-0.01	0	7.88	6.76	6.68
4	-0.01	0	7.37	6.32	6.42
5	-0.01	0	7.23	6.21	-
6	-0.01	0	5.15	4.38	4.43
7	-0.01	0	6.15	5.22	5.24
8	-0.01	0	5.96	5.07	5.17
9	-0.01	0	4.58	3.9	4.02
10	-0.01	0	4.44	3.78	3.92
11	-0.01	0	7.7	6.6	-
12	-0.01	0	7.42	6.36	6.46
13	-0.01	0	5.49	4.7	-
14	-0.01	0	6.67	5.68	6.09
15	-0.01	0	3.72	3.16	3.42
16	-0.02	0	11.52	9.82	10.36

Table 67: 2029 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction – Medium and Large Office with Computer Room

Climate Zone	30-Year LSC Electricity Savings (2029 PV$)	30-Year LSC Natural Gas Savings (2029 PV$)	Total 30-Year LSC Savings (2029 PV$)
1	19.11	0.00	19.11
2	14.03	0.00	14.03
3	1.81	5.44	7.25
4	3.39	4.67	8.07
5	8.92	0.00	8.92
6	1.42	2.89	4.30
7	0.98	3.65	4.64
8	1.24	3.39	4.63
9	0.94	3.18	4.12
10	2.34	1.79	4.14
11	10.80	0.00	10.80
12	0.55	6.18	6.73
13	7.57	0.00	7.57
14	4.71	3.43	8.15
15	2.13	0.84	2.97
16	14.99	3.20	18.19

4.4.3 Incremental First Cost

Incremental first costs represent the overall cost to the building owner when constructing a computer room to the proposed design, as compared to the base-case design. This does not represent the overall cost to build a computer room, but rather the additional cost needed to comply with the proposed code change.

To establish incremental costs when adding computer room heat recovery as described in 4.4.2, the Statewide CASE Team requested a detailed cost bid from a local mechanical contractor in November 2025. The mechanical contractor included all additional costs associated with the design and installation of a DFDD system with return air ducted to hot deck AHU mixing section to supply heat from the data center to the office. The mechanical contractor was selected based on significant experience designing and installing cooling equipment in data centers in California.

It should be noted that the DFDD with hot deck AHU mixing is one of many ways to comply with this proposed code change. Additional compliant designs are described in 4.3.2. The additional design components and materials for the proposed heat recovery design, and the cost to install them are provided below.

Table 68: Computer Room Heat Recovery Incremental Costs

Design Component	Proposed Costs (2029 PV$)
Fire Smoke Damper (FSD)	$10,000
Duct from FSD to AHU Transfer Air opening	$7,000
Additional Controls	$20,000
Economizer mixing section to hot deck AHU	$7,250
Total First Cost	$44,250
Total First Cost (per sq. ft.)	$1.26

Total first costs were derived based on a 35,000 square foot office building which yields $1.26 per square.

4.4.4 Incremental Maintenance and Replacement Costs

Description of the incremental maintenance and replacement costs, as well as estimation of present value of maintenance and replacement costs, are provided in the 2028 CASE Methodology Report. It is assumed that with proper maintenance, as described below, additional equipment required for this measure will last at least 30 years, so replacement costs were not considered in this analysis.

Maintenance Costs: The mechanical contractor that provided the cost bid to design and install a heat recovery system as described in this analysis, is assuming that the system should be tested every four years to ensure it is working properly. The assumed maintenance cost for this system is $2,940 over its lifetime. The Statewide CASE Team requested a detailed cost bid from a local mechanical contractor in November 2025.

4.4.5 Cost Effectiveness

Results of the per-unit cost-effectiveness analyses are presented in Table 69 for new construction and additions.

In the tables below, all values are presented in 2029 present value dollars (2029 PV$). Benefits represent 30-year LSC savings and other savings, including incremental first-cost savings if the proposed first cost is less than the current first cost, incremental maintenance cost savings if the proposed maintenance costs are less than the current maintenance costs, and incremental residual value if proposed residual value is greater than current residual value at the end of the 30-year period of analysis. Costs represent the total incremental PV cost, including incremental equipment, replacement, and maintenance costs over the period of analysis. The analysis treats a negative incremental maintenance cost as a positive benefit. If total incremental costs are zero, the benefit-cost ratio (BCR) is considered infinite. Costs and other savings are discounted at a real (inflation-adjusted) three percent rate. If there are no total incremental PV costs, the BCR is infinite.

Table 69: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV$/square foot)	Costs Total Incremental PV Costs (2029 PV$/square foot)	Benefit-to-Cost Ratio
1	19.11	1.34	14.29
2	14.03	1.34	10.49
3	7.25	1.34	5.42
4	8.07	1.34	6.03
5	8.92	1.34	6.67
6	4.30	1.34	3.22
7	4.64	1.34	3.47
8	4.63	1.34	3.47
9	4.12	1.34	3.08
10	4.14	1.34	3.09
11	10.80	1.34	8.07
12	6.73	1.34	5.03
13	7.57	1.34	5.66
14	8.15	1.34	6.09
15	2.97	1.34	2.22
16	18.19	1.34	13.60
Total	**5.74**	**1.34**	**4.29**

4.5 Computer Room Heat Recovery – Statewide Impacts

4.5.1 Statewide Energy and Energy Cost Savings

See the 2028 CASE Methodology Report for details on how statewide savings are calculated. Appendix C presents the assumptions on the percentage of the total construction forecast that the proposed measure would impact.

For more details on the methodology and context about estimating the current market share rate, as well as statewide energy and energy cost savings, see the 2028 CASE Methodology Report.

The table below presents the first-year statewide energy and LSC savings from newly constructed buildings (Table 70) by climate zone, and presents first-year statewide savings from new construction.

Table 70: Statewide Energy and LSC Impacts – New Construction

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2029 (Square Feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
CZ01	6,422	0.01	0.00	0.00	0.03	$0.12
CZ02	48,859	0.06	0.02	0.00	0.19	$0.69
CZ03	452,922	0.08	0.02	0.03	2.67	$3.28
CZ04	246,079	0.08	0.02	0.01	1.37	$1.98
CZ05	27,562	0.02	0.01	0.00	0.07	$0.25
CZ06	285,147	0.04	0.01	0.01	0.91	$1.23
CZ07	198,469	0.02	0.00	0.01	0.77	$0.92
CZ08	417,631	0.05	0.02	0.02	1.54	$1.94
CZ09	812,369	0.08	0.02	0.03	2.71	$3.35
CZ10	197,553	0.05	0.01	0.00	0.49	$0.82
CZ11	28,224	0.03	0.01	0.00	0.09	$0.30
CZ12	462,406	0.02	0.01	0.03	2.86	$3.11
CZ13	38,822	0.03	0.01	0.00	0.10	$0.29
CZ14	52,403	0.02	0.01	0.00	0.25	$0.43
CZ15	24,157	0.00	0.00	0.00	0.04	$0.07
CZ16	13,055	0.02	0.00	0.00	0.09	$0.24
Total	**3,312,078**	**0.63**	**0.18**	**0.14**	**14.17**	**$19.01**

4.5.2 Statewide Greenhouse Gas Emissions Reductions

Note to CEC - Conducting QC on GHG emissions results and will update them as soon as they are finalized.

Table 71 presents the estimated first-year reduction in GHG emissions resulting from the proposed code change. In this initial year, the Statewide CASE Team expects to avoid 101 metric tons of carbon dioxide equivalent (CO_2e) emissions. These reductions, along with their associated monetary value, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of CBECC, as well as data from the CEC's 2028 Metrics Report. See the 2028 CASE Methodology Report for additional information.

Table 71: First-Year Statewide GHG Emissions Impacts

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Million therms/yr)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions ($)
New Construction	101	0.14	746	847	137,654
Total	**101**	**0.14**	**746**	**847**	**137,654**

4.5.3 Statewide Water Use Impacts

The proposed code change would not result in water use impacts.

4.5.4 Statewide Material Impacts

The proposed code change would result in additional materials being used to design a heat recovery system capable of transferring heat from a computer room to an adjacent space with a heating demand. The type and extent of additional materials would depend on the type of heat recovery design selected, but for the analysis described in 4.4.2, which ducts air from hot aisles to the hot deck of a DFDD HVAC system, the additional materials largely include metal ductwork. The additional materials for a heat recovery system serving a 100kW computer room and a 35,000 sq. ft. office are outlined in Table 72.

For more information on the Statewide CASE Team's methodology and assumptions used to calculate embodied GHG emissions, see the 2028 CASE Methodology Report.

Table 72: First-Year Statewide Impacts on Material Use

Material	Impact	Per-Unit Impacts (Pounds per Square Foot)	First-Year Statewide Impacts (Pounds)	Embodied GHG emissions saved (Metric Tons CO2e)
Steel	New Construction	0.007	7,312	-4

4.5.5 Environmental Impacts

This measure would reduce energy use and overall emissions from computer rooms across California and does not result in any adverse environmental effects. Statewide emissions impacts from this change are summarized in Table 71.

4.5.6 Other Non-Energy Impacts

This measure is not expected to result in any non-energy impacts.

4.6 Computer Room Heat Recovery – Proposed Language Code

4.6.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions). New to the 2028 energy code is to *italicize defined terms* when the terms are being used in its defined context. In-line comments that are not part of the proposed code language but are used to help describe the purpose of what is proposed are included *with greyed highlight and italics.*

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.[8] 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).

Posting the proposed code language in this format is useful as it helps describe how the Energy Code changes proposed for nonresidential occupancies are isolated from the requirements for residential occupancies which are prohibited from being changed until the 2031 code cycle by Assembly Bill 130.

4.6.2 Administrative Code (Title 24, Part 1)

There are no proposed changes to Title 24, Part 1.

4.6.3 Energy Code (Title 24, Part 6)

SECTION 910

COMPUTER ROOMS

(NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)

SECTION 910.1 *[SECTION 120.6(j)]* – Mandatory requirements (Newly Constructed, Additions, Alterations).

Space-conditioning systems serving a *computer room* shall meet the following requirements of this section.

910.1.4. *[New Section]* **Computer Room Heat Recovery.**

New buildings with a design computer room ITE load greater than 100 KW and a non-computer room conditioned floor area greater than 35,000 square feet shall include a heat recovery system, such as ducting hot aisles to the hot deck of a dual fan dual duct system, or a heat recovery chiller, capable of transferring the lesser of the following from the computer room cooling system to the space heating system and/or to the service water heating (SWH) system:

1. 0.5 times the total design ITE load of all computer rooms in the building
2. 0.2 x (capacity of space heating system + capacity of SWH system)

Exception to Section 910.1.4: Hotel/motel buildings and nonresidential buildings with Group R occupancies.

4.6.4 Reference Appendices

There are no proposed changes to the Reference Appendices.

4.6.5 Compliance Manuals

A new section to Chapter 10 (Covered Processes) in the nonresidential compliance manual will need to be added to describe the new heat recovery requirements for computer rooms. The Statewide CASE Team can provide CEC with more detailed recommended revisions to compliance manuals after the 45-Day Language is published. Additionally, the 2028 compliance manual should incorporate the same content that is included in the 2022 compliance manual, rather than referring readers to the 2022 compliance manual as is done in the 2025 version.

4.6.6 ACM Reference Manual

No changes are required to the ACM since the measure is mandatory. However, it is still important that the compliance software be able to accurately model computer room heat recovery in both the base-case and the proposed case so that designers and owners have reasonably accurate information to make good decisions. For example, if a computer room heat recovery system is able to meet 90% of the annual heating load in a building, then the owner is likely to opt for an inexpensive electric resistance back up heating system. But if the model gives no credit for heat recovery, then the owner may be “tricked” into putting in a much more expensive heating system that will not be cost-effective.

Therefore, the Statewide CASE Team proposes the following procedure for modeling heat recovery in the baseline model when it is mandatory:

The base-case system serving the non-computer room spaces is most likely one with hydronic space heating (e.g. System 5 –Packaged VAV, System 6 – Built-up VAV, or System 15 – Packaged VAV with AWHP heating).

The base-case system serving the computer rooms is a hydronic system (see section 2.6.6).

The base-case model will include a water-to-water heat recovery chiller that will serve as the first stage of space heating. Heat is not transferred to the SWH system in the base-case.

The peak heating capacity of the heat recovery chiller is the smaller of the following:

1. 0.5 times design computer room ITE load of all computer rooms in the building
2. 0.2 x (capacity of all space heating systems + capacity of SWH systems)

Appendix 5.4B includes the following computer room fractional load schedules.

JanMaySep	0.25
FebJunOct	0.50
MarJulNov	0.75
AprAugDec	1.00

The total computer room design load is then multiplied by these fractions to determine the current hourly computer room load for every hour that month (CR-LOAD).

The current hour computer room heat recovery = the smallest of the following:

1. Heat recovery chiller capacity
2. CR-LOAD
3. Total HW heating load

4.6.7 Compliance Forms

As discussed in Section 4.1.4.5, the NRCC-PRC-E and NRCI-PRC-E compliance forms would be updated to reflect the proposed change. Figure 24 and Figure 25 provide examples of new compliance tables for computer room heat recovery. No Acceptance Tests are proposed for this measure.

Computer Room Heat Recovery

01	02	03	04	05	06	07
Building Conditioned Floor Area (sq. ft.)	Total Design ITE Load for All Computer Rooms (kW)	Design Heating Capacity of All Service Water Heating System (kW)	Design Heating Capacity of All Space Heating Systems (kW)	Design Heat Recovery System Capacity (kW)	Heat Recovery System Description / Equipment Tag	Heat recovery system shall transfer the lesser of the following from the computer room cooling system(s) to space heating and service hot water systems: • 50% of the design ITE load of all computer rooms • 20% of the combined total design capacity of: all service water heating systems + all space heating systems
-	-	-	-	-	-	-

Figure 24: Proposed New Computer Room Heat Recovery Table in NRCC-PRC-E

Computer Room Heat Recovery

01		02	03
Equipment Tag or Description		Design Heat Recovery System Capacity (kW)	Heat recovery system shall transfer the lesser of the following from the computer room cooling system(s) to space heating and service hot water systems: • 50% of the design ITE load of all computer rooms • 20% of the combined total design capacity of: all service water heating systems + all space heating systems
Per NRCC-PRC-E	-	-	-
As-Built Conditions	-	-	-

Figure 25: Proposed New Computer Room Heat Recovery Table in NRCI-PRC-E

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Appendix A: Assumptions for Cost-effectiveness Analysis

Section 910.2.1 *[Section 140.9(a)1]* – Computer Room Economizers

Key Assumptions for Energy Savings Analysis

The Statewide CASE Team conducted a non-CBECC analysis to estimate energy, emissions, and cost savings, and cost-effectiveness of the proposed measure for two scenarios representing standalone data centers with air-cooled and liquid-cooled ITE.

- The Statewide CASE Team assessed the energy impacts in all climate zones and applied the climate-zone-specific LSC hourly factors when calculating energy and energy cost impacts.
- A custom spreadsheet was developed based on previous energy and cost-saving analysis generated for data centers with integrated wet-bulb economizers for air-cooled and liquid-cooled ITE data centers.
- Three scenarios were analyzed: 1) a data center with air-cooled ITE and a wet-bulb economizer and 2a) a data center with liquid-cooled and air-cooled ITE with a wet-bulb economizer and 2b) a data center with liquid-cooled and air-cooled ITE with a dry-bulb economizer.

Energy Savings Methodology

Detailed information about each scenario is described below:

1) **Air-Cooled ITE – Wet-Bulb Economizer Scenario Modeling Assumptions:** This analysis demonstrates the energy, cost, and environmental impacts associated with updating the wet-bulb economizing threshold from 45°F to 60°F.

   Assumptions for this analysis include the following:

   - Standalone data center with Air-cooled ITE
   - Air-cooled ITE with 75°F design Supply Air Temperature (SAT) to the server
   - ITE Load at 300 W/ft^2
   - ITE Load profile: Title 24 ACM load profile (equal time at 25%, 50%, 75%, 100% load)
   - Chiller design kW/ton: 0.35
   - Cooling Tower Nominal Efficiency: 80GPM/HP

- Redundancy for heat exchanger (HX), chiller, cooling tower (CT), CRAH: 10%

Base-Case Design:

- The approach from OAWB to SAT is 30°F for base-case design.
  - The approach is the sum of the approaches of the CT, the HX, and the CRAH coil
- Fewer hours of full and partial economizer operation than proposed design
- CHW/CW pump and supply fan pressure drop is adjusted based on CT/HX/Coil selections

Proposed Design:

- The approach from OAWB to SAT is 15°F for proposed design.
- The proposed design has significantly greater hours of full and partial economizer operation
- CHW/CW pump and supply fan pressure drop is adjusted based on CT/HX/Coil selections

Table 73: Base-Case vs. Proposed Design Approach

Description	CRAH Coil	Water Side Economizer HX	Cooling Tower	Total	CRAH Total Static Pressure (" w.g.)
Base-Case Design Approach (F)	8	11	11	30	2.25
Proposed Design Approach (F)	5	5	5	15	2.45

2) Separate Liquid-Cooled ITE Economizer Scenario Modeling Assumptions:

This analysis demonstrates the energy, cost, and environmental impacts associated with updating the economizing threshold to 75°F. Assumptions for these analyses include the following:

- Standalone data center with liquid-cooled and air-cooled ITE
- 80% Liquid-cooled ITE, 20% air-cooled ITE
- ITE Load at 300 W/ft^2
- Title 24 load profile (equal time at 25%, 50%, 75%, 100% load)
- Dry cooler dT: 15°F
- TCS pump energy same for base-case and proposed, so not modeled
- CRAH fan energy same for base-case and proposed, so not modeled

While cost data was only provided for plants with cooling towers, two types of plants were simulated with the following assumptions:

> **2a – Cooling Towers** – The baseline is a single chilled water plant with cooling towers, and the proposed case includes two chilled water plants – one serving the liquid-cooled ITE. The proposed case is a data center designed with separate plants and distribution piping for air-cooled ITE and liquid-cooled ITE. The primary reason the proposed design must have separate plants is because a single chilled water plant serving both air-cooled ITE and liquid-cooled ITE is unlikely to meet the proposed temperature threshold for a liquid-cooled ITE economizer. This is the scenario that was costed.

2b - Dry Coolers – In this scenario the baseline is a single chilled water plant with water-cooled chillers rejecting heat via dry coolers (rather than cooling towers). The proposed case includes two dry cooler plants – one serving the liquid-cooled ITE. The dry cooler plants use adiabatic spray assist if the dry coolers cannot achieve the required dry cooler leaving water temperature in a given hour.

Parametric analysis was performed with different sequences of operation to achieve the lowest electricity consumption.

Table 74: Sequence of Operation Description for Cooling Towers

Case	Sequence
Base-Case 1A	CHWST Setpoint = 60°F. When possible, tower fan speed modulates to meet constant CWST = CHWST Setpoint - WSE HX approach to serve all loads via the waterside economizer and the chiller is off. If the tower fan is at max speed and WSE is not fully maintaining CHWST at setpoint, the chiller runs to cool the remaining load.
Base-Case 1B	Towers maintain 85 CWST Setpoint to set CDUs via WSE HX. Chiller then runs 24/7 at high lift (i.e., no WSE) to bring RDHX water down to low LWT for just the RDHXs loads that need low LWT
Proposed Case 2	Separate tower plants and operate under two temperature setpoints: The chiller + tower plant supply low LWT (per base-case 1A SOO) and separate tower plant supplies high LWT (per base-case 1B SOO).

Table 75: Sequence of Operation Description for Dry Coolers

Case	Sequence
Base-Case 1A	The dry coolers are controlled to maintain 60°F LWT for both dry coolers and chillers in dry mode. If the dry coolers cannot make dry LWT setpoint then fans run full speed. If dry CWST exceeds the Adiabatic Assist LWT Setpoint, then run spray and modulate fan speed to maintain the Adiabatic Assist LWT Setpoint. Chiller load (via WSE) and lift is reduced when low temperature LWT is provided.
Base-Case 1B	The dry coolers run with a high temperature LWT setpoint for CDUs and Chillers. Chiller then runs 24/7 at high lift (i.e., no WSE) to bring RDHX water down to low LWT for just the RDHXs loads that need low LWT
Proposed Case 2	Dry coolers are separated and operate under two temperature setpoints: The chiller dry coolers supply low LWT (per base-case 1A SOO), and the CDU dry coolers supply high LWT (per base-case 1B SOO).

Description	Base-Case 1A	Base-Case 1B	Proposed
Dry Cooler Leaving Water Temperature Setpoint (LWT) for CDUs	60	88	88
Dry Cooler Entering Water Temp (EWT) for CDUs	75	103	103
Dry Cooler LWT for Chillers	60	88	60
Dry Cooler EWT for Chillers	75	103	75
Adiabatic Assist LWT Setpoint	88	88	88
Chilled Water Delta T @ 100% Load	25	15	-
Chilled Water Delta T @ 75% Load	20	12	-
Chilled Water Delta T @ 50% Load	15	10	-
Chilled Water Delta T @ 25% Load	10	7	-

The energy impacts of the proposed code change do vary by climate zone. The Statewide CASE Team assessed the energy impacts in four climate zones and applied the climate-zone-specific LSC hourly factors when calculating energy and LSC impacts.

Scenario 2a - Incremental Cost Assumptions

Instructions to the contractors for pricing the cost difference between the proposed scenario 2a, which uses separate cooling plants for air-cooled and liquid-cooled ITE, and the baseline scenario, using a single plant. The proposed scenario is a data center currently under construction, so the contractor was asked to adjust pricing to reflect a baseline scenario. These instructions are outlined below:

Mechanical Revisions

1. Delete from base design:
    a. Three York YZ 225-ton water-cooled variable speed centrifugal chillers (CH-1, CH-2, CH-3) piped in parallel with 4” chilled water piping and 6” condenser water piping
    b. One B&G AP 585 GPM waterside economizer plate and frame heat exchanger with 2°F approach, 316 stainless steel plates, and 6” chilled water piping and 6” condenser water piping
    c. Four Marley NC 475 GPM crossflow cooling towers (TWCT-1, TWCT-2, TWCT-3, TWCT-4) with 304 stainless steel basins, ultra quiet fans, PVC fill, drift eliminators, and 5’ fan cylinder extensions with 6” condenser water piping, 4” CPVC sweeper piping and 8” common equalizer
    d. Two Marley NC 610 GPM crossflow cooling towers (CWCT-1, CWCT-2) with 304 stainless steel basins, ultra quiet fans, PVC fill, drift eliminators, and 5’ fan cylinder extensions with 6” condenser water piping, 4” CPVC sweeper piping and 8” common equalizer
    e. Three headered 340 GPM 20 HP variable speed chilled water pumps (CHWP-1, CHWP-2, CHWP-3) with 6” chilled water piping
    f. Three headered 600 GPM 15 HP variable speed condenser water pumps (CWP-1, CWP-2, CWP-3) with 6” condenser water piping
    g. Three headered 950 GPM 40 HP variable speed tower water pumps (TWP-1, TWP-2, TWP-3) with 8” condenser water piping
    h. Two Hellan FB 1900 GPM carbon steel basket strainers with 1/8” holes, 200 mesh liner, and 10” condenser water piping
    i. Two Cary Company 1900 GPM carbon steel bag filters with 35 micron filter bags and 10” condenser water piping
    j. Schedule 40 carbon steel piping of the following diameters and lengths
        i. 30 ft of uninsulated 4” piping
        ii. 560 ft of uninsulated 6” piping
        iii. 610 ft of uninsulated 8” piping
        iv. 395 ft of uninsulated 10” piping
        v. 25 ft of 1” insulated 3” piping
        vi. 50 ft of 1” insulated 6” piping
        vii. 100 ft of 1” insulated 8” piping
2. Add for alternative design:
    a. Three York YZ 875-ton water-cooled variable speed centrifugal chillers (CH-1, CH-2, CH-3) piped in parallel with 8” chilled water piping and 10” condenser water piping

b. One B&G AP 2540 GPM waterside economizer plate and frame heat exchanger with 2°F approach, 316 stainless steel plates, and 12” chilled water piping and 12” condenser water piping
c. Four Marley NC 1190 GPM crossflow cooling towers (CWCT-1, CWCT-2, CWCT-3, CWCT-4) with 304 stainless steel basins, ultra quiet fans, PVC fill, drift eliminators, and 5’ fan cylinder extensions with 10” condenser water piping, 5” CPVC sweeper piping and 12” common equalizer
d. Three headered 1320 GPM 60 HP variable speed chilled water pumps (CHWP-1, CHWP-2, CHWP-3) with 10” chilled water piping
e. Three headered 2375 GPM 60 HP variable speed condenser water pumps (CWP-1, CWP-2, CWP-3) with 12” condenser water piping
f. Two Hellan BS 4750 GPM basket strainers with 1/8” holes, 200 mesh liner, and 16” condenser water piping
g. Two Cary Company 4750 GPM carbon steel bag filters with 35 micron filter bags and 16” condenser water piping
h. Schedule 40 carbon steel piping of the following diameters and lengths
    i. 55 ft of uninsulated 12” piping
    ii. 355 ft of uninsulated 16” piping
    iii. 30 ft of 1” insulated 4” piping
    iv. 585 ft of 1” insulated 10” piping
    v. 315 ft of 1” insulated 12” piping

Electrical Revisions

1. Delete from base design:
    a. CH-1, CH-2, and CH-3: 115 kW each (all on s-power)
    b. CWCT-1 and CWCT-2, 10 HP each (all on s-power)
    c. TWCT-1, TWCT-2, TWCT-3, and TWCT-4, 10 HP each (three on s-power)
    d. CHWP-1, CHWP-2, and CHWP-3: 20 HP each (all on s-power)
    e. CWP-1, CWP-2, and CWP-3: 15 HP each (all on s-power)
    f. TWP-1, TWP-2, and TWP-3: 40 HP each (two on s-power)
2. Add for alternative design:
    a. CH-1, CH-2, and CH-3: 450 kW each (all on s-power)
    b. CWCT-1, CWCT-2, CWCT-3, and CWCT-4, 15 HP each (all on s-power)
    c. CHWP-1, CHWP-2, and CHWP-3: 60 HP each (all on s-power)
    d. CWP-1, CWP-2, and CWP-3: 60 HP each (all on s-power)

Add Alternate Pricing Details – Mechanical

A breakdown of mechanical and electrical modifications costs when moving from the proposed two-plant (proposed scenario) to a baseline single-plant scenario is detailed in Table 73 through Table 77.

Table 76: Mechanical Modification Costs (Equipment and Labor)

EQUIPMENT DESCRIPTION	% of Trips		HRS (ST)	HRS (OT)	HRS (DT)	HRS (SHIFT)	LABOR RATE	LABOR $	MATERIAL $	TOTAL $
See attached sheet: Equipment									$1,555,803.16	$1,555,803.16
Equipment Totals:			0.0	0.0	0.0	0.0		$ -	$1,555,803.16	$1,555,803.16
PIPING - FIELD INSTALL			**HRS (ST)**	**HRS (OT)**	**HRS (DT)**	**HRS (SHIFT)**	**LABOR RATE**	**LABOR $**	**MATERIAL $**	**TOTAL $**
Material Handling	8%		(59.00)	$ -	$ -		$ 161.10	$ (9,540.90)		$ (9,540.90)
Credit Pipe - CHW (1,141 LF)	(1,470.20)	80%	(1,170.20)	$ -	$ -		$ 161.10	$ (189,479.38)	$ (167,363.64)	$ (356,843.22)
Added Pipe - CHW (1,827 LF)	2,795.50	80%	2,795.10	$ -	$ -		$ 161.10	$ 360,284.04	$ 517,568.80	$ 877,852.84
Credit Pipe - CWR (2,889 LF)	(4,023.30)	80%	4,023.10	$ -	$ -		$ 161.10	$ 581,522.90	$ (513,845.35)	$ 67,677.55
Added Pipe - CWR (703 LF)	1,821.40	80%	1,824.40	$ -	$ -		$ 161.10	$ 234,742.03	$ 492,098.62	$ 726,840.65
Tagging & Labeling	2%		(14.00)	$ -	$ -		$ 161.10	$ (2,259.52)		$ (2,259.52)
Field Detailing	3%		(21.00)	$ -	$ -		$ 161.10	$ (3,389.29)		$ (3,389.29)
QA/QC Inspection/Testing	2%		(14.00)	$ -	$ -		$ 161.10	$ (2,259.52)		$ (2,259.52)
Clean-up for added work	2%		(16.00)	0.0	0.0	0.0	$ 161.10	$ (2,577.60)		$ (2,577.60)
Field Consumables	2%								$ 4,926.83	$ 4,926.83
Field General Foreperson Time	12%		(100.00)	0.0	0.0	0.0	$ 176.86	$ (17,686.00)		$ (17,686.00)
Piping Field Totals:			(925.40)	0.0	0.0	0.0		$ (150,653.04)	$ 333,382.06	**$ 182,729.02**
RIGGING			**HRS (ST)**	**HRS (OT)**	**HRS (DT)**	**HRS (SHIFT)**	**LABOR RATE**	**LABOR $**	**MATERIAL $**	**TOTAL $**
HVAC/P - Anchorage/Seismic (See attached breakdown)			(12.00)	0.0	0.0	0.0	$ 161.10	$ (7,088.40)		$ (7,088.40)
Rigging Totals:			(44.00)	0.0	0.0	0.0		$ (7,088.40)		**$ (7,088.40)**

SYSTEMS OPERATIONS								
HVAC Startup Equip (See attached breakdown)	(52.00)	0.0	0.0	0.0	$ 179.97	$ (9,358.44)		$ (9,358.44)
Systems Operation Totals:	(52.00)	0.0	0.0	0.0		$ (9,358.44)		**$ (9,358.44)**
SUBCONTRACTS								
Mechanical Insulation - Net Add/Credit								$ 93,312.85
DDC Controls - Net add/credits								$ (60,000.00)
Subcontract Totals:								**$ 33,312.85**
Jobsite Expenses				**# PAGES**			**RENTAL $**	**TOTAL $**
Truck Charge								$ 1,200.00
Jobsite Expense Totals:							$ -	**$ (1,200.00)**

Table 77: Mechanical Modification Costs (Various Equipment and Associated Labor)

Tag	Vendor	Description	Equip Scope	Equip Type	Quantity	Unit (Equipment)	Total (Equipment)	ST Unit (Install Labor Hrs)	OT Unit (Install Labor Hrs)	DT Unit (Install Labor Hrs)	Shift Unit (Install Labor Hrs)	Subtotal Units (Install Labor Hrs)	Total (Install Labor Hrs)	ST Unit (SU Labor Hrs)	OT Unit (SU Labor Hrs	DT Unit (SU Labor Hrs	Shift Unit (SU Labor Hrs	Subtotal Units (SU Labor Hrs	Total (SU Labor Hrs
CH	USACD	York YZ 225-ton Chillers	HVAC	Chillers (H20 Cooled)	(3)	$277,469.50	($832,408.50)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HX	CHC	B&G AP Waterside Economizer	HVAC	Heat Exchangers - HVAC	(1)	$86,546.25	($86,546.25)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TWCT	NSW	Marley NC crossflow cooling towers	HVAC	Cooling Towers	(4)	$122,088.75	($488,355.00)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CWCT	NSW	Marley NC crossflow cooling towers	HVAC	Cooling Towers	(2)	$122,088.75	($244,177.50)	16.0	0.0	0.0	0.0	16.0	-32.0	20.0	0.0	0.0	0.0	20.0	-40.0
CHWP	CHC	20HP Chilled Water pumps	HVAC	Pumps - HVAC	(3)	$9,393.30	($28,179.90)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CWP	CHC	15HP Condenser Water pumps	HVAC	Pumps - HVAC	(3)	$9,938.25	($29,814.75)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TWP	CHC	40 HP Tower Water pumps	HVAC	Pumps - HVAC	(3)	$9,938.25	($29,814.75)	4.0	0.0	0.0	0.0	4.0	-12.0	4.0	0.0	0.0	0.0	4.0	-12.0
BS	Hellan	Carbon Steel Basket Strainers	HVAC	Filters	(2)	$19,356.75	($38,713.50)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BF	CaryCo	Carbon Steel Bag Filter Vessels	HVAC	Filters	(2)	$43,027.43	($86,054.85)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VFD	NSW	Net Removed VFDs	HVAC	Variable Speed Drives - HVAC	(3)	$8,766.67	($26,300.00)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Tag	Vendor	Description	Equip Scope	Equip Type	Quantity	Unit (Equipment)	Total (Equipment)	ST Unit (Install Labor Hrs)	OT Unit (Install Labor Hrs)	DT Unit (Install Labor Hrs)	Shift Unit (Install Labor Hrs)	Subtotal Units (Install Labor Hrs)	Total (Install Labor Hrs)	ST Unit (SU Labor Hrs)	OT Unit (SU Labor Hrs	DT Unit (SU Labor Hrs	Shift Unit (SU Labor Hrs	Subtotal Units (SU Labor Hrs	Total (SU Labor Hrs
CH	USACD	York YZ 875-ton Chillers	HVAC	Chillers (H20 Cooled)	3	$623,333.33	$1,870,000.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HX	CHC	B&G AP Waterside Economizer	HVAC	Heat Exchangers - HVAC	1	$175,193.00	$175,193.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CWCT	NSW	Marley NC crossflow cooling towers	HVAC	Cooling Towers	4	$247,500.00	$990,000.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHWP	CHC	60HP Chilled Water pumps	HVAC	Pumps - HVAC	3	$14,459.00	$43,377.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CWP	CHC	60HP Condenser Water pumps	HVAC	Pumps - HVAC	3	$18,113.00	$54,339.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BS	Hellan	Carbon Steel Basket Strainers	HVAC	Filters	2	$19,590.00	$39,180.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BF	CaryCo	Carbon Steel Bag Filter Vessels	HVAC	Filters	2	$137,039.58	$274,079.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
							$0.00					0.0	0.0					0.0	0.0
		Totals			**(8)**		**$1,555,803.16**	**0**	**0**	**0**	**0**		**-44.0**						**-52.0**

Add Alternate Pricing Details - Electrical

Table 78: Electrical Connection Costs

Description	Total	#	Per unit
Old mech connections	-$87,368	18	-$4,854
New mechanical connections	$116,442	13	$8,957
Connection change pricing	**$29,074**		
1250kW/1563KVA - NEW†	**$1,950,000**		

†Recommended based on new loads. Pricing includes generator/ATS/feeders/switchboard

Table 79: Electrical Modification Costs (Labor and Material)

#	System	DB Material	Total Material	Direct Hrs	Direct Labor $	Total Hrs	Total Labor $	Markup	Defined Adj	Total	Area	DB Mtl $ / Area	Total Mtl $	Labor $ / Area	Total $ / Area	Direct Hrs / Area	Total Hrs / Area
1	OLD CHILLERS 115kW	($19,894.69)	($19,894.69)	-77.51	($11,765.94)	-77.51	($11,765.94)	-4749.09	-728.19	-37137.91	3	($6,631.56)	($6,631.56)	($3,921.98)	($12,379.30)	-25.8367	-25.8367
2	NEW CHILLERS 450kW	$36,335.21	$36,335.21	165.69	$25,151.98	165.69	$25,151.98	9223.06	1414.21	72124.46	3	$12,111.74	$12,111.74	$8,383.99	$24,041.49	55.2300	55.2300
3	OLD CWCT - 10HP	($714.85)	($714.85)	-20.50	($3,112.68)	-20.50	($3,112.68)	-574.13	-88.03	-4489.69	2	($357.43)	($357.43)	($1,556.34)	($2,244.85)	-10.2500	-10.2500
4	NEW CWCT - 15HP	$2,098.58	$2,098.58	53.15	$8,068.68	53.15	$8,068.68	1525.09	233.85	11926.20	4	$524.64	$524.64	$2,017.17	$2,981.55	13.2875	13.2875
5	OLD TWCT - 10HP	($2,054.70)	($2,054.70)	-67.53	($10,252.11)	-67.53	($10,252.11)	-1846.02	-283.06	-14435.89	4	($513.68)	($513.68)	($2,563.03)	($3,608.97)	-16.8825	-16.8825
6	OLD CHWP - 20HP	($1,942.39)	($1,942.39)	-32.57	($4,943.85)	-32.57	($4,943.85)	-1032.94	-158.38	-8077.56	3	($647.46)	($647.46)	($1,647.95)	($2,692.52)	-10.8567	-10.8567
7	NEW CHWP - 60HP	$5,336.15	$5,336.15	59.64	$9,054.11	59.64	$9,054.11	2158.54	330.98	16879.78	3	$1,778.72	$1,778.72	$3,018.04	$5,626.59	19.8800	19.8800
8	OLD CWP - 15HP	($1,681.36)	($1,681.36)	-36.68	($5,567.90)	-36.68	($5,567.90)	-1087.38	-166.73	-8503.37	3	($560.45)	($560.45)	($1,855.97)	($2,834.46)	-12.2267	-12.2267

#	System	DB Material	Total Material	Direct Hrs	Direct Labor $	Total Hrs	Total Labor $	Markup	Defined Adj	Total	Area	DB Mtl $ / Area	Total Mtl $	Labor $ / Area	Total $ / Area	Direct Hrs / Area	Total Hrs / Area
9	NEW CWP - 60HP	$4,958.00	$4,958.00	54.45	$8,266.07	54.45	$8,266.07	1983.61	304.15	15511.83	3	$1,652.67	$1,652.67	$2,755.36	$5,170.61	18.1500	18.1500
10	OLD TWP - 40HP	($4,867.69)	($4,867.69)	-50.62	($7,684.53)	-50.62	($7,684.53)	-1882.83	-288.70	-14723.75	3	($1,622.56)	($1,622.56)	($2,561.51)	($4,907.92)	-16.8733	-16.8733

Table 80: Electrical Modification Costs (Generation)

Tag	Old – Normal	Old Generator	New – Normal	Old Generator KVA	Normal Source	Length	DISC
CH1 - old	143.75	-	-	-	HMD-A	-100	250
CH2 - old	-	143.75	-	-	-	-100	250
CH3 - old	-	143.75	-	-	-	-110	250
CH1 - new	-	-	562.50	-	-	100	600
CH2 - new	-	-	562.50	-	-	110	600
CH3 - new	-	-	562.50	-	-	110	600
CWCT1 - 10 HP	-	11.64	-	-	-	-60	30
CWCT2 - 10 HP	-	11.64	-	-	-	-80	30
CWCT3 - 10 HP	-	11.64	-	-	-	-110	30
TWCT2 - 10HP	-	11.64	-	-	-	-120	30
TWCT3 - 10HP	-	11.64	-	-	-	-140	30
TWCT4 - 10HP	-	11.64	-	-	-	-150	30
CHWP1 - 20 HP	22.45	-	-	-	HMD-A	-70	60
CHWP2 - 20 HP	22.45	-	-	-	-	-80	60
CHWP3 - 20 HP	22.45	-	-	-	-	-90	60
CWP1 - 15 HP	-	17.46	-	-	HMD-A	-80	40
CWP2 - 15 HP	-	17.46	-	-	-	-60	40
CWP3 - 15 HP	-	17.46	-	-	-	-70	40
TWP1 - 40 HP	-	43.23	-	-	-	-110	100
TWP2 - 40 HP	-	43.23	-	-	-	-100	100
TWP3 - 40 HP	-	43.23	-	-	-	-90	100
CWCT1 - 15 HP	-	-	-	17.46	-	60	40
CWCT2 - 15 HP	-	-	-	17.46	-	80	40
CWCT3 - 15 HP	-	-	-	17.46	-	100	40
CWCT4 - 15 HP	-	-	-	17.46	-	100	40
CHWP1-60 HP - new	-	-	-	64.02	-	70	125
CHWP2-60 HP - new	-	-	-	64.02	-	80	125
CHWP3-60 HP - new	-	-	-	64.02	-	90	125
CWP1-60 HP - new	-	-	-	64.02	-	80	125

Tag	Old – Normal	Old Generator	New – Normal	Old Generator KVA	Normal Source	Length	DISC
CWP2-60 HP - new	-	-	-	64.02	-	60	125
CWP3-60 HP - new	-	-	-	64.02	-	70	125
TOTALS	**183.66**	**566.85**	-	**2141.44**			
NORMAL DELTA - KVA	-183.66						
GENERATOR DELTA - KVA	1574.59						
Delta KVA	1390.93						
Delta KW	1112.75						

Section 910.1.3 *[Section 120.6(j)3]* Fan Control Requirements

Key Assumptions for Energy Savings Analysis

- The Statewide CASE Team evaluated the energy impacts in every climate zone and applied the climate-zone-specific LSC hourly factors when calculating energy and energy cost impacts.
- A custom Excel file was used to calculate the unit energy consumption for fan energy consumption.
- The base case energy use assumed a weighted average by estimated market share of three fan motor speed control types: constant speed (30 percent), two-speed (30 percent) and variable speed ECM (40 percent). Annual energy use was calculated for each of the three base cases and then multiplied by the market share.
- The proposed case energy use used a similar approach to the base case. Two variable speed fan types were used: ECM (60 percent) and VFD (40 percent). Annual energy use was calculated for each of the two proposed cases and then multiplied by the estimated market share.
- Applied fan energy savings to the following building prototype models (Hospital, Large office, Medium Office, Small Office, Large School, Small School) which often include a small computer room or IDF to demonstrate proposed code change impacts.

Energy Savings Methodology

Energy savings were calculated in Excel for an example computer room as described in Table 81. Fan speed control energy use was calculated using the following assumptions in Table 82.

Because only fan energy for internal cooling load is considered in the cost-effectiveness analysis, the energy impacts of the proposed code change do not vary by climate zone. Since savings do not vary by climate zone, the Statewide CASE Team used the statewide LSC hourly factors when calculating energy and LSC impacts.

Table 81: Assumptions Used for Simplified Hourly Savings Analysis

Parameter	Description	Value	Notes
A	Full load capacity Btuh	45,000	Assumption (avg of 30 and 60 kBtu)
B	Sizing Factor	1.15	ACM
C	ITE 100% Load Btuh	39,130	A/B
D	Fan air Flow @ full load in cfm	1,919	445 cfm/ton (CBECC)
E	Maximum Fan Power W/cfm	0.58	ACM
F	Fan Power @ Full load in kW	1.11	D*E/1000
G	Assumed IT Load Density W/sq.ft	20	Title 24 minimum IT load density
H	Computer room CFA sq. ft.	573	C/3.412/H
J	Load profile	ITE load varied monthly among 25%, 50%, 75%, and 100% of design ITE load	CBECC Ruleset
K	Fan Performance Curve	Appendix 7 Performance Curves	-
L	Title 24 2028 CEC Metrics	Emission factor, source factor, LSC	-

Table 82: Fan Control Modeling Case Assumptions

Modeling Case	Fan Control Description	Modeled Parameter Value
Base Case 1	Constant single-speed	AF or BI riding the fan curve (Appendix 5.7 from CBECC)
Base Case 2	Two-speed	Multispeed fan power ratio provisions set forth in section 5.7.3.2 of the 2025 ACM reference manual. The standard design for two-speed fans prescribes 30 percent power at 50 percent airflow.
Base Case 3	ECM	ECM performance curves[38]
Proposed Case 1	ECM	ECM performance curves[39]
Proposed Case 2	VFD	VSD (Appendix 5.7 from CBECC)

Section 910.2.5 – Computer Room Heat Recovery

Key Assumptions for Energy Savings Analysis

- Energy savings analysis was conducted on two building types: medium office (with an electric heat pump heating system) and large office (with a natural gas boiler heating system).
- The Statewide CASE Team simulated the energy impacts in all 16 climate zones and applied the climate-zone-specific LSC hourly factors when calculating energy and energy cost impacts.
- A hybrid energy cost analysis was conducted, including energy modeling to determine the heat load for a medium office and large office building and a custom Excel tool to calculate the impact of a heat recovery system and a post-processing analysis to evaluate computer room size and load profile in terms of Btuh/ft^2. The 53,628 sq. ft. prototype medium office and 498,637 sq. ft. large office prototype building hourly heating load and energy per sq. ft. were scaled for a 35,000 sq. ft. building to demonstrate cost-effectiveness.
- Heat recovery cost-effectiveness is assessed based on a 100-kW computer room and 35,000 sq. ft. office space in the same building using per-square-foot scaled heating loads and energy use for a medium and large office building.

Energy Savings Methodology per Prototypical Building

The 2028 CASE Methodology Report provides details on estimating energy savings per prototypical building and unit. The CEC directed the Statewide CASE Team to model

[38] https://nailor.com/sites/default/files/documents/PDFC35FHECMVSPSC.pdf
[39] Ibid.

energy impacts using specific prototypical building models that represent typical building geometries for different building types. Table 83 presents the prototype buildings used in the analysis.

Table 83: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
OfficeMedium	3	53,628	3-story office building with 5 zones and a ceiling plenum on each floor. WWR–33%
LargeOffice	12	498,637	12-story + 1 basement office building with 5 zones and a ceiling plenum on each floor. WWR–40%.

There are no existing requirements in Title 24, Part 6 that require heat recovery for a computer room and non- computer room floor area of this size. The Statewide CASE Team modified the Standard Design so that it calculated energy impacts based on a building with a computer room and office without heat recovery. Base-case and proposed case assumptions are provided below:

Base-Case (BEM Model + Custom Excel Tool): 53,628 sq. ft. medium office building with a 100-kW computer room

- Air-to-water heat pump (AWHP) is heating source to HW coil in hot deck (sized for full capacity)
- No heat recovery system is assumed (DFDD with AHU mixing section not included)
- Hourly heating load and energy per sq. ft. were scaled for a 35,000 sq. ft. building used for the cost-effectiveness analysis.

The Proposed Design was identical to the Standard Design in all ways except for the revisions that represent the proposed changes to the code. Table 84 presents the parameters modified and the values used in the Standard Design and Proposed Design. Specifically, the proposed conditions assume:

Proposed Case (Custom Excel Tool): medium office building 53,628 sq. ft. (prototype results scaled to 35,000 sq. ft.) with a 100-kW computer room

- Air-to-water heat pump (AWHP) serves backup HW coil in hot deck (sized for full capacity)
- DFDD (dual fan dual duct) system
- Computer room return air ducted to hot deck AHU mixing section to supply heat to office is the primary heating source

A CBECC Medium Office and Large Office prototype were used with changes to plug density and schedules in the baseline model. An overall building average plug load density of 0.5 W/sf for all spaces was used and extended schedules match typical office operation.[40] To establish baseline energy use of a medium office without heat recovery, the Statewide CASE Team simulated a medium office with VAV reheat and without heat recovery. The hourly heating load (Btuh/ft2), AWHP heating energy (kW/ft2), and electricity costs were exported and used in a post processing analysis to determine the hourly heating load to computer room heating capacity and hourly and annual energy savings for a medium office. The hourly heating load (Btuh/ft2), natural gas boiler heating energy (therm/ft2), and natural gas costs were exported and used in a post processing analysis to determine the hourly heating load to computer room heating capacity and hourly and annual energy savings for a medium office. Additionally, hourly office air handler fan power (kW/ft2) was exported from CBECC, and an estimated 4% fan power increase was assumed based on the fan affinity law during hours when the heat recovery system operated.

Table 84: Modifications Made to Standard Design in Each Prototype to Simulate Proposed Code Change

Prototype ID	Climate Zones	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
OfficeMedium	All	NA	NA	NA	NA

The energy impacts of the proposed code change do vary by climate zone. The Statewide CASE Team simulated the energy impacts in every climate zone and applied the climate-zone-specific LSC hourly factors when calculating energy and LSC impacts.

[40] Based on recommendations in docket comment: https://efiling.energy.ca.gov/GetDocument.aspx?tn=265693&DocumentContentId=102545

Appendix B: Purpose and Necessity of Proposed Code Changes

Introduction

The sections below provide the purpose and necessity of proposed changes to Title 24, Part 1; Title 24, Part 6; and the reference appendices. This section intends to provide the CEC with the information needed for the Initial Statement of Reasons.

See Sections 2.6.2, 3.6.3, and 4.6.3 of this report for marked-up code language.

Section 910.2.1 *[Section 140.9(a)1]* – Computer Room Economizers

Purpose and Necessity of Changes to Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

Purpose and Necessity of Changes to Title 24, Part 6

Section: Section 200.3 *[Section 100.1(b)]*–

Purpose: The purpose of this change is to expand definitions pertaining to computer rooms and data centers to accommodate changes in technology and construction practices, especially as it relates to different ways to efficiently cool ITE and computer room buildings. This expanded set of definitions covers: Liquid-cooled ITE, Computer Room Economizer, Wet-Bulb Computer Room Economizer, and Dry-Bulb Computer Room Economizer.

Necessity: This change is necessary to ensure computer room definitions remain updated as cooling technologies and practices evolve. This change also provides additional guidance on how to design a fully integrated computer room economizer.

Section: Section 910.2.1

Purpose: The purpose of this change is to increase the amount of time economizers must be capable of meeting all or part of the cooling load in computer rooms. The proposed change provides specific guidance to the industry for the maximum outdoor air temperature threshold for when a dry-bulb or wet-bulb economizing system must meet all or some of the cooling load. Exception 2 is modified to raise the outdoor temperature for when an economizer must meet the design cooling load of the computer room. A third exception is proposed for computer rooms with a heat recovery system that can accept at least 50 percent of the design heat and recover at least 25 percent of the annual computer room heat.

Necessity: This change is necessary to continually improve data center operational efficiency and maximize economizer cooling when conditions are advantageous to do so. In addition to the energy and economic savings established in this report, the proposed change will also reduce data center cooling load and thus limit the rising electricity demand on the grid from data centers.

Section: Section 910.4.1

Purpose: The purpose of this change is to incorporate the expanded economizer requirements in 910.2.1 and apply those to new cooling systems serving computer rooms in an existing building. This change also covers existing computer rooms with new cooling systems serving smaller ITE loads by removing exception 3 and modifying exception 2.

Necessity: This change is necessary to reduce cooling load in existing computer rooms when it is most cost effective to do so—when a new cooling system is being installed. Small computer rooms are ubiquitous in nonresidential buildings across California and require significant cooling load to shed heat, so applying this requirement to smaller computer rooms will make a significant impact on the grid as these facilities are updated.

Purpose and Necessity of Changes to the Reference Appendices

There are no proposed changes to reference appendices.

Section 910.1.3 *[Section 120.6(j)3]* – Fan Control Requirements

Purpose and Necessity of Changes to Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

Purpose and Necessity of Changes to Title 24, Part 6

Section: Section 910.1.3

Purpose: The purpose of this change is to reduce the design cooling load threshold for when cooling equipment serving computer rooms must have an integrated ECM motor and VAV capable of modulating fan speed and airflow based on load. This change now includes DX units with a rated cooling capacity of ≥ 2.5 tons to 5 tons.

Necessity: This change is necessary to align standard practice with minimum code requirements. There are thousands of computer rooms with a cooling load between 2.5 – 5 tons and available cooling equipment with ECMs to meet this requirement. This change codifies standard practice and aligns the industry.

Purpose and Necessity of Changes to the Reference Appendices

There are no proposed changes to reference appendices.

Section 910.2.5 – Computer Room Heat Recovery

Purpose and Necessity of Changes to Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

Purpose and Necessity of Changes to Title 24, Part 6

Section: 910.2.5

Purpose: The purpose of this change is to require a heat-recovery system in buildings with a computer-room ITE load greater than 100 KW and a non-computer room with conditioned floor area greater than 35,000 square feet. This change requires efficient use of heat from a computer room in other spaces inside the building instead of wasting that heat to the outdoors.

Necessity: This change is necessary to manage waste heat from computer rooms more efficiently. Computer rooms produce heat 24/7 and by using that heat to supplement the heating load in another space, it will reduce energy use and overall demand on the grid.

Purpose and Necessity of Changes to the Reference Appendices

There are no proposed changes to reference appendices.

Appendix C: Assumptions for Statewide Savings Estimates

ITE load (MW), rather than building floor area, is the driver of statewide savings for computer room efficiency measures. The Statewide CASE Team gathered data to estimate the 2029 statewide ITE load as a starting point for statewide energy savings.

Statewide Data Center and ITE Load Estimates

The table below shows the analysis used to estimate the new 2029 statewide data center ITE load.

Table 85: Estimated New Statewide Data Center ITE Demand in 2029

Parameter Letter	Parameter Name	Unit	Value	Source/Notes
A	2025 Existing Average Total Data Center Demand (ITE + Support Systems)	MW	1,060	(Conroy, Weitze and Droitcour 2026)
B	Data Center Compound Annual Growth Rate (through 2030)	%	11%	(Conroy, Weitze and Droitcour 2026)
C	Number of Years Between 2028 and 2025	None	3	2028 - 2025
D	2028 Average Total Data Center Demand	MW	1,450	A*(1+B)^C
E	Number of Years Between 2029 and 2025	None	4	2029 - 2025
F	2029 Average Total Data Center Demand	MW	1,609	A*(1+B)^E
G	2029 New Total Data Center Demand	MW	156	F–D
H	New Construction Computer Room PUE	none	1.2	(Harms and Chen 2024)
I	2029 New Data Center ITE Demand	MW	133	G / H
J	Percent of New ITE Demand in New Construction and Additions	%	70%	(Conroy, Weitze and Droitcour 2026)
K	2029 New Data Center ITE Demand in New Construction and Additions	MW	93	I*J
L	2029 New Data Center ITE Demand in Alterations	MW	40	I*(1–J)

The table below shows the analysis used to estimate the existing statewide data center ITE load.

Table 86: Estimated Existing Statewide Data Center ITE Demand in 2029

Parameter Letter	Parameter Name	Unit	Value	Source/Notes
A	Existing Average Total Data Center Demand	MW	1,060	Parameter A in Table 85:[41]
B	Existing Computer Room PUE	None	1.5	(Conroy, Weitze and Droitcour 2026)
C	Existing Average Statewide ITE Demand	MW	707	A / B
D	Estimated Percent of Existing ITE Demand Impacted by Code	%	75%	Estimate.
E	End of Life HVAC Replacement Rate	%	5%	Assumed 20 year EUL.
F	Existing Average Statewide ITE Demand Impacted by Code	MW	27	C * D * E

Small computer room ITE load is assumed to be in addition to the ITE demands summarized in Table 85 and Table 86. It is estimated to be no greater than 5% of statewide data center ITE load.

Computer Room Economizers

The statewide savings and cost estimates take the current market share rate into account. For the air-cooled ITE wet-bulb economizer analysis, the Statewide CASE Team estimated that the current market share rate for the proposed code change is 50 percent for the new construction market and 25 percent for the retrofit market. For the liquid-cooled ITE economizer analysis, the Statewide CASE Team estimated the current market share rate for the proposed code change is 25 percent for new construction and 20 percent for alterations; this would include the portion of the market that is below the 2 MW ITE load threshold. The current market share rate is estimated based on the Statewide CASE Team's professional judgment and data from the evaluation of past Title 24 code cycles. The tables below show a summary of the estimated statewide electricity breakdown and assumptions for each climate zone. For the liquid-cooled ITE scenario, the CASE Team only included the portion of the market using dry cooler economizers as a conservative estimate of statewide savings. This approach was taken to avoid overestimating energy savings due to the extremely high ITE load increase projections and high volatility and therefore uncertainty in those projections for the next

[41] 2025 is used as a conservative estimate to avoid counting the anticipated rapid load growth between 2025-2029.

5-10 years. These assumptions are reflected in the statewide savings estimates as presented in Section 2.5.

Table 87: Air-Cooled ITE Wet-Bulb Economizer – Summary of Market Assumptions for Statewide Savings, New Construction and Additions

Parameter	A	B	C	D	E	F	E
Climate Zone	Annual Energy Savings (kWh/yr per MW ITE Load)	Percent of New ITE Capacity Assigned to Each Climate Zone	Air-Cooled ITE % of New ITE Load	% of Air-Cooled ITE Using Wet-Bulb Waterside Economizer	1-Market Share Rate (Percent of Market Not Already Complying with Measure)	Impacted New ITE Capacity per Climate Zone (MW)	Statewide Annual Energy Savings (GWh/yr)
Source	Table 16	See footnote[42]	Estimate	(Weitze, Bulger and Stein 2021)	Estimate	Table 85: Parameter K*B*C*D*E	A*F/(10^6)
CZ01	59,563	0%	30%	34.5%	50%	0	0
CZ02	77,738	0.0109%	30%	34.5%	50%	0.000527	0.00004
CZ03	79,756	6.5409%	30%	34.5%	50%	0.314873	0.02511
CZ04	70,970	79.6636%	30%	34.5%	50%	3.834904	0.27216
CZ05	72,538	0.0781%	30%	34.5%	50%	0.003762	0.00027
CZ06	110,030	0.1563%	30%	34.5%	50%	0.007524	0.00083
CZ07	123,478	0.0938%	30%	34.5%	50%	0.004514	0.00056
CZ08	116,975	0.3126%	30%	34.5%	50%	0.015048	0.00176
CZ09	103,071	0.6721%	30%	34.5%	50%	0.032353	0.00333
CZ10	95,146	0.0375%	30%	34.5%	50%	0.001806	0.00017
CZ11	79,889	0%	30%	34.5%	50%	0	0
CZ12	88,993	12.3629%	30%	34.5%	50%	0.595136	0.05296
CZ13	96,297	0%	30%	34.5%	50%	0	0
CZ14	59,398	0.0367%	30%	34.5%	50%	0.001768	0.00011
CZ15	111,355	0.0001%	30%	34.5%	50%	0.000004	0.0000004
CZ16	31,657	0.0344%	30%	34.5%	50%	0.001655	0.00005
Total	**-**	**100%**	**-**	**-**	**-**	**4.81387**	**0.35736**

[42] Equal to the portion of Data Center square footage for each climate zone from CEC Construction Forecast (Data Center new construction climate zone-specific floor area / total new statewide Data Center floor area).

Table 88: Air-Cooled ITE Wet-Bulb Economizer – Summary of Market Assumptions for Statewide Savings, Alterations

Parameter	A	B	C	D	E	F	E
Climate Zone	Annual Energy Savings (kWh/yr per MW ITE Load)	Percent of Existing ITE Capacity Assigned to Each Climate Zone	Air-Cooled ITE % of New ITE Load	% of Air-Cooled ITE Using Wet-Bulb Waterside Economizer	1-Market Share Rate (Percent of Market Not Already Complying with Measure)	Impacted Existing ITE Capacity per Climate Zone (MW)	Statewide Annual Energy Savings (GWh/yr)
Source	Table 16	See footnote[43]	Estimate	(Weitze, Bulger and Stein 2021)	Estimate	Table 86: Parameter F*B*C*D*E	A*F /(10^6)
CZ01	59,563	0%	70%	34.5%	75%	0	0
CZ02	77,738	0.0109%	70%	34.5%	75%	0.000535	0.00004
CZ03	79,756	6.5409%	70%	34.5%	75%	0.319877	0.02551
CZ04	70,970	79.6636%	70%	34.5%	75%	3.895848	0.27649
CZ05	72,538	0.0781%	70%	34.5%	75%	0.003822	0.00028
CZ06	110,030	0.1563%	70%	34.5%	75%	0.007643	0.00084
CZ07	123,478	0.0938%	70%	34.5%	75%	0.004586	0.00057
CZ08	116,975	0.3126%	70%	34.5%	75%	0.015287	0.00179
CZ09	103,071	0.6721%	70%	34.5%	75%	0.032867	0.00339
CZ10	95,146	0.0375%	70%	34.5%	75%	0.001834	0.00017
CZ11	79,889	0%	70%	34.5%	75%	0	0
CZ12	88,993	12.3629%	70%	34.5%	75%	0.604594	0.05380
CZ13	96,297	0%	70%	34.5%	75%	0	0
CZ14	59,398	0.0367%	70%	34.5%	75%	0.001796	0.00011
CZ15	111,355	0.0001%	70%	34.5%	75%	0.000004	0.0000004
CZ16	31,657	0.0344%	70%	34.5%	75%	0.001682	0.00005
Total	**-**	**100%**	**-**	**-**	**-**	**4.89038**	**0.36304**

[43] Equal to the portion of Data Center square footage for each climate zone from CEC Construction Forecast (Data Center existing construction climate zone-specific floor area / total existing statewide Data Center floor area).

Table 89: Liquid-Cooled ITE Economizer – Summary of Market Assumptions for Statewide Savings, New Construction, and Additions

Parameter	A	B	C	D	E	F	E
Climate Zone	Annual Energy Savings (kWh/yr per MW ITE Load)	Percent of New ITE Capacity Assigned to Each Climate Zone	Liquid-Cooled ITE % of New ITE Load	% of Liquid -Cooled ITE Using Drycooler Economizer	1-Market Share Rate (Percent of Market Not Already Complying with Measure)	Impacted New ITE Capacity per Climate Zone (MW)	Statewide Annual Energy Savings (GWh/yr)
Source	Table 22	See footnote[39]	Estimate	(Weitze, Bulger and Stein 2021)	Estimate	Table 85: Parameter K*B*C*D*E	A*F /(10^6)
CZ01	108,334	0%	70%	65.5%	75%	0	0
CZ02	184,649	0.0109%	70%	65.5%	75%	0.003500	0.00065
CZ03	180,390	6.5409%	70%	65.5%	75%	2.092308	0.37743
CZ04	218,827	79.6636%	70%	65.5%	75%	25.482660	5.57629
CZ05	182,910	0.0781%	70%	65.5%	75%	0.024998	0.00457
CZ06	274,403	0.1563%	70%	65.5%	75%	0.049995	0.01372
CZ07	307,481	0.0938%	70%	65.5%	75%	0.029997	0.00922
CZ08	291,284	0.3126%	70%	65.5%	75%	0.099991	0.02913
CZ09	287,723	0.6721%	70%	65.5%	75%	0.214980	0.06185
CZ10	274,750	0.0375%	70%	65.5%	75%	0.011999	0.00330
CZ11	254,074	0%	70%	65.5%	75%	0	0
CZ12	241,451	12.3629%	70%	65.5%	75%	3.954637	0.95485
CZ13	282,805	0%	70%	65.5%	75%	0	0
CZ14	269,150	0.0367%	70%	65.5%	75%	0.011749	0.00316
CZ15	369,673	0.0001%	70%	65.5%	75%	0.000025	0.0000092
CZ16	173,376	0.0344%	70%	65.5%	75%	0.010999	0.00191
Total	**-**	**100%**	**-**	**-**	**-**	**31.98784**	**7.03608**

Table 90: Liquid-Cooled ITE Economizer – Summary of Market Assumptions for Statewide Savings, Alterations

Parameter	A	B	C	D	E	F	E
Climate Zone	Annual Energy Savings (kWh/yr per MW ITE Load)	Percent of Existing ITE Capacity Assigned to Each Climate Zone	Air-Cooled ITE % of New ITE Load	% of Air-Cooled ITE Using Drycooler Economizer	1-Market Share Rate (Percent of Market Not Already Complying with Measure)	Impacted Existing ITE Capacity per Climate Zone (MW)	Statewide Annual Energy Savings (GWh/yr)
Source	Table 16	See footnote[40]	Estimate	(Weitze, Bulger and Stein 2021)	Estimate	Table 86: Parameter F*B*C*D*E	A*F /(10^6)
CZ01	108,334	0%	30%	65.5%	80%	0	0
CZ02	184,649	0.0109%	30%	65.5%	80%	0.000464	0.00009
CZ03	180,390	6.5409%	30%	65.5%	80%	0.277624	0.05008
CZ04	218,827	79.6636%	30%	65.5%	80%	3.381241	0.73991
CZ05	182,910	0.0781%	30%	65.5%	80%	0.003317	0.00061
CZ06	274,403	0.1563%	30%	65.5%	80%	0.006634	0.00182
CZ07	307,481	0.0938%	30%	65.5%	80%	0.003980	0.00122
CZ08	291,284	0.3126%	30%	65.5%	80%	0.013268	0.00386
CZ09	287,723	0.6721%	30%	65.5%	80%	0.028525	0.00821
CZ10	274,750	0.0375%	30%	65.5%	80%	0.001592	0.00044
CZ11	254,074	0%	30%	65.5%	80%	0	0
CZ12	241,451	12.3629%	30%	65.5%	80%	0.524733	0.12670
CZ13	282,805	0%	30%	65.5%	80%	0	0
CZ14	269,150	0.0367%	30%	65.5%	80%	0.001559	0.00042
CZ15	369,673	0.0001%	30%	65.5%	80%	0.000003	0.0000012
CZ16	173,376	0.0344%	30%	65.5%	80%	0.001459	0.00025
Total	-	**100%**	-	-	-	**4.24440**	**0.93360**

The 2028 CASE Methodology Report includes additional information about the methodology and assumptions used to calculate statewide energy impacts.

Fan Control Requirements

The Statewide CASE Team estimated statewide impacts for the first year by multiplying per-unit savings estimates by statewide construction forecasts provided by the CEC.

The 2028 CASE Methodology Report includes additional information about the methodology and assumptions used to calculate statewide energy impacts.

The statewide savings and cost estimates take the current market share rate into account. Because the cost-effectiveness analysis includes weighted average savings from multiple fan control types representing the market as a whole, market impacts are included in the calculated per unit savings and no separate market share rate estimate is required. Therefore, the Statewide CASE Team estimated that the current market share rate for the proposed code change is zero percent for the new construction market and zero percent for the retrofit market.

Table 91 presents the projected nonresidential new construction and additions that the proposed code change will impact in 2026. Table 92 shows the projected nonresidential existing statewide building stock that the proposed code change would affect through alterations in 2026. The Statewide CASE Team developed these estimates using the methods described in this section.

The Statewide CASE Team estimated the percentage of newly constructed floorspace that the proposed code change would impact. Table 93 shows the assumed percentage of affected floorspace by building type. If a proposed code change does not apply to a specific building type, the Statewide CASE Team assumes that zero percent of the floorspace would be impacted. If the assumed percentage is non-zero, but less than 100 percent, the proposal is expected to affect some—but not all—buildings. Table 94 represents the assumed percentage of affected floorspace by climate zone. Considering computer rooms affected by this measure (i.e., 30-60 kBtu/hr cooling capacity DX cooling units) and assuming computer rooms with a design ITE load density of 20 W/sq. ft., these percentages add up to five percent of the total new statewide ITE load (parameter I in Table 85); in other words, it is assumed that small computer rooms, to which this measure is applicable, are not included in statewide data center ITE load estimates and add up no more than five percent of statewide data center ITE load. Similarly for alterations and assuming 20 W/sq. ft. of design ITE load, the impacted floor area percentages add up to five percent of the existing statewide ITE undergoing an HVAC replacement (parameter F in Table 86).

Table 91: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026, by Climate Zone and Building Type (Million Square Feet) – Fan Control

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Large Office	0.0000	0.0000	0.0134	0.0065	0.0000	0.0067	0.0050	0.0100	0.0233	0.0033	0.0000	0.0161	0.0000	0.0011	0.0002	0.0001	0.086
Medium Office	0.0004	0.0034	0.0063	0.0048	0.0019	0.0072	0.0043	0.0103	0.0128	0.0076	0.0020	0.0019	0.0027	0.0016	0.0013	0.0006	0.069
Small Office	0.0002	0.0008	0.0015	0.0003	0.0006	0.0011	0.0001	0.0015	0.0032	0.0010	0.0004	0.0019	0.0017	0.0005	0.0002	0.0002	0.015
Large School	0.0004	0.0012	0.0057	0.0023	0.0005	0.0031	0.0028	0.0052	0.0058	0.0020	0.0004	0.0017	0.0008	0.0006	0.0001	0.0001	0.033
Small School	0.0001	0.0017	0.0054	0.0033	0.0010	0.0035	0.0034	0.0040	0.0096	0.0069	0.0024	0.0099	0.0050	0.0014	0.0011	0.0007	0.059
Hospital	0.0004	0.0022	0.0092	0.0047	0.0010	0.0038	0.0049	0.0053	0.0099	0.0080	0.0018	0.0092	0.0035	0.0015	0.0009	0.0006	0.067
TOTAL	**0.0015**	**0.0091**	**0.0416**	**0.0219**	**0.0050**	**0.0254**	**0.0206**	**0.0362**	**0.0647**	**0.0288**	**0.0070**	**0.0406**	**0.0137**	**0.0067**	**0.0038**	**0.0023**	**0.329**

Table 92: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2026 (Alterations), by Climate Zone and Building Type (Million Square Feet) – Fan Control

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Large Office	0.0000	0.0001	0.0026	0.0013	0.0000	0.0021	0.0015	0.0034	0.0060	0.0012	0.0001	0.0018	0.0002	0.0004	0.0001	0.0001	0.021
Medium Office	0.0001	0.0006	0.0014	0.0008	0.0003	0.0010	0.0009	0.0012	0.0017	0.0014	0.0003	0.0019	0.0005	0.0003	0.0002	0.0001	0.013
Small Office	0.0001	0.0002	0.0004	0.0002	0.0001	0.0003	0.0002	0.0003	0.0004	0.0005	0.0002	0.0008	0.0005	0.0001	0.0001	0.0001	0.004
Large School	0.0000	0.0001	0.0011	0.0004	0.0001	0.0007	0.0003	0.0006	0.0010	0.0003	0.0001	0.0007	0.0001	0.0001	0.0000	0.0000	0.006
Small School	0.0000	0.0004	0.0011	0.0007	0.0001	0.0009	0.0009	0.0017	0.0025	0.0021	0.0005	0.0017	0.0011	0.0005	0.0003	0.0002	0.015
Hospital	0.0000	0.0002	0.0010	0.0005	0.0001	0.0006	0.0006	0.0009	0.0015	0.0008	0.0002	0.0011	0.0005	0.0002	0.0001	0.0001	0.009
TOTAL	**0.0003**	**0.0017**	**0.0077**	**0.0040**	**0.0008**	**0.0056**	**0.0044**	**0.0081**	**0.0131**	**0.0064**	**0.0014**	**0.0080**	**0.0028**	**0.0015**	**0.0009**	**0.0005**	**0.067**

Table 93: Percentage of Nonresidential Floorspace Impacted by Proposed Code Change in 2026, by Building Type – Fan Control

Building Type	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
Large Office	0.50%	0.002%
Medium Office	0.50%	0.002%
Small Office	0.50%	0.002%
Large Retail	0%	0%
Medium Retail	0%	0%
Strip Mall	0%	0%
Mixed-Use Retail	0%	0%
Large School	0.50%	0.002%
Small School	0.50%	0.002%
Non-refrigerated Warehouse	0%	0%
Hotel	0%	0%
Assembly	0%	0%
Hospital	1.00%	0.002%
Laboratory	0%	0%
Restaurant	0%	0%
Enclosed Parking Garage	0%	0%
Open Parking Garage	0%	0%
Grocery	0%	0%
Refrigerated Warehouse	0%	0%
Controlled-Environment Horticulture	0%	0%
Vehicle Service	0%	0%
Manufacturing	0%	0%
Unassigned	0%	0%

Table 94: Percentage of Nonresidential Floorspace Impacted by Proposed Measure, by Climate Zone – Fan Control

Climate Zone	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
1	100%	100%
2	100%	100%
3	100%	100%
4	100%	100%
5	100%	100%
6	100%	100%
7	100%	100%
8	100%	100%
9	100%	100%
10	100%	100%
11	100%	100%
12	100%	100%
13	100%	100%
14	100%	100%
15	100%	100%
16	100%	100%

Computer Room Heat Recovery

The Statewide CASE Team estimated statewide impacts for the first year by multiplying per-unit savings estimates by statewide construction forecasts provided by the CEC. The statewide construction forecasts for new construction include the impact of additions. The analysis is based on a medium office and large office building prototypes. This measure only applies to new construction, so the Statewide CASE Team discounted the construction forecast for medium and large offices by 10 percent to account for the impact of additions. The 2028 CASE Methodology Report includes additional information about the methodology and assumptions used to calculate statewide energy impacts.

The statewide savings and cost estimates take the current market share rate into account. The Statewide CASE Team estimated that the current market share rate for the proposed code change is ten percent for the new construction market. The current market share rate is estimated based on the Statewide CASE Team's professional judgment and data from the evaluation of past Title 24 code cycles.

Table 95 presents the projected nonresidential new construction that the proposed code change will impact in 2026. The Statewide CASE Team developed these estimates using the methods described in this section.

The Statewide CASE Team estimated the percentage of newly constructed floorspace that the proposed code change would impact. Table 96 shows the assumed percentage of affected floorspace by building type. If a proposed code change does not apply to a specific building type, the Statewide CASE Team assumes that zero percent of the floorspace would be impacted. If the assumed percentage is non-zero, but less than 100 percent, the proposal is expected to affect some—but not all—buildings. Table 97 represents the assumed percentage of affected floorspace by climate zone.

Table 95: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026, by Climate Zone and Building Type (Million Square Feet) – Computer Room Heat Recovery

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Medium Office	0.01	0.05	0.09	0.07	0.03	0.10	0.06	0.15	0.18	0.11	0.03	0.03	0.04	0.02	0.02	0.01	1.00
Large Office	0	0	0.36	0.18	0	0.18	0.14	0.27	0.63	0.09	0	0.44	0	0.03	0.006	0.004	2.33
TOTAL	**0.01**	**0.05**	**0.45**	**0.25**	**0.03**	**0.28**	**0.2**	**0.42**	**0.81**	**0.2**	**0.03**	**0.47**	**0.04**	**0.05**	**0.026**	**0.014**	**3.33**

Table 96: Percentage of Nonresidential Floorspace Impacted by Proposed Code Change in 2026, by Building Type – Computer Room Heat Recovery

Building Type	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
Large Office	15%	0%
Medium Office	8%	0%
Small Office	0%	0%
Large Retail	0%	0%
Medium Retail	0%	0%
Strip Mall	0%	0%
Mixed-Use Retail	0%	0%
Large School	0%	0%
Small School	0%	0%
Non-refrigerated Warehouse	0%	0%
Hotel	0%	0%
Assembly	0%	0%
Hospital	0%	0%
Laboratory	0%	0%
Restaurant	0%	0%
Enclosed Parking Garage	0%	0%
Open Parking Garage	0%	0%
Grocery	0%	0%
Refrigerated Warehouse	0%	0%
Controlled-Environment Horticulture	0%	0%
Vehicle Service	0%	0%
Manufacturing	0%	0%
Unassigned	0%	0%

Table 97: Percentage of Nonresidential Floorspace Impacted by Proposed Measure, by Climate Zone – Computer Room Heat Recovery

Climate Zone	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
1	100%	0%
2	100%	0%
3	100%	0%
4	100%	0%
5	100%	0%
6	100%	0%
7	100%	0%
8	100%	0%
9	100%	0%
10	100%	0%
11	100%	0%
12	100%	0%
13	100%	0%
14	100%	0%
15	100%	0%
16	100%	0%

Appendix D: Environmental Analysis

Section 910.2.1 *[Section 140.9(a)1]* – Computer Room Economizers

The Statewide CASE Team has considered the environmental benefits and adverse impacts of its proposal, including—but not limited to—an evaluation of factors contained in the California Code of Regulations, Title 14, Section 15064, and has determined that the proposal will not result in a significant effect on the environment.

Direct Environmental Impacts

Direct Environmental Benefits

This measure is expected to result in energy savings and GHG emissions reductions by requiring higher thresholds for when economizers need to meet the cooling load when serving air-cooled and/or liquid-cooled ITE. The estimated impact of these benefits has been quantified in this report.

Direct Adverse Environmental Impacts

This measure is not expected to result in any direct adverse environmental impacts.

Indirect Environmental Impacts

Indirect Environmental Benefits

This measure is not expected to result in any indirect environmental benefits.

Indirect Adverse Environmental Impacts

This measure is not expected to result in any indirect adverse environmental impacts.

Mitigation Measures

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of "specific economic, environmental, legal, social, and technological factors" (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team determined this measure would not result in significant direct or indirect adverse environmental impacts, so mitigation measures were not considered or developed.

Reasonable Alternatives to Proposal

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternative would achieve its purpose with less environmental effect.

Water Use and Water Quality Impacts Methodology

While certain cooling system designs do increase water use in computer rooms and data centers, the proposed changes are not expected to increase the use of those designs. As such, the code change will not directly impact water use or quality.

Section 910.1.3 *[Section 120.6(j)3]* – Fan Control Requirements

Potential Significant Environmental Effect of Proposal

The Statewide CASE Team has considered the environmental benefits and adverse impacts of its proposal, including—but not limited to—an evaluation of factors contained in the California Code of Regulations, Title 14, Section 15064, and has determined that the proposal will not result in a significant effect on the environment.

Direct Environmental Impacts

Direct Environmental Benefits

This measure is expected to result in energy savings and GHG emissions reductions by requiring VAV fans capable of adjusting indoor airflow as a function of load and ECMs in 2.5-to-5-ton cooling systems serving computer rooms. The estimated impact of these benefits has been quantified in this report.

Direct Adverse Environmental Impacts

This measure is not expected to result in any direct adverse environmental impacts.

Indirect Environmental Impacts

Indirect Environmental Benefits

This measure is not expected to result in any indirect environmental benefits.

Indirect Adverse Environmental Impacts

This measure is not expected to result in any indirect adverse environmental impacts.

Mitigation Measures

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of "specific economic, environmental, legal, social, and technological factors" (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team determined this measure would not result in significant direct or indirect adverse environmental impacts, so mitigation measures were not considered or developed.

Reasonable Alternatives to Proposal

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternative would achieve its purpose with less environmental effect.

Water Use and Water Quality Impacts Methodology

There are no impacts on water quality or water use.

Section 910.2.5 – Computer Room Heat Recovery

Potential Significant Environmental Effect of Proposal

The Statewide CASE Team has considered the environmental benefits and adverse impacts of its proposal, including—but not limited to—an evaluation of factors contained in the California Code of Regulations, Title 14, Section 15064, and has determined that the proposal will not result in a significant effect on the environment.

Direct Environmental Impacts

Direct Environmental Benefits

This measure is expected to result in energy savings and GHG emissions reductions by requiring computer rooms to optimize waste heat through a heat recovery system that serves other spaces in the building with a heating load. The estimated impact of these benefits has been quantified in this report.

Direct Adverse Environmental Impacts

This measure is not expected to result in any direct adverse environmental impacts.

Indirect Environmental Impacts

Indirect Environmental Benefits

This measure is not expected to result in any indirect environmental benefits.

Indirect Adverse Environmental Impacts

This measure is not expected to result in any indirect adverse environmental impacts.

Mitigation Measures

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team determined this measure would not result in significant direct or indirect adverse environmental impacts, so mitigation measures were not considered or developed.

Reasonable Alternatives to Proposal

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternative would achieve its purpose with less environmental effect.

Water Use and Water Quality Impacts Methodology

There are no impacts on water quality or water use.

Appendix E: Summary of Engagement with Interested Parties

Introduction to Engagement with Interested Parties

Collaborating with interested parties who may be affected by proposed code changes is a core component of the Statewide CASE Team's process. The Statewide CASE Team engages interested parties to identify and address issues related to the proposals, with the goal of submitting recommendations to the CEC in this Draft CASE Report that reflect broad support. Public interested parties provide valuable feedback on draft analyses and help identify and address adoption challenges, including cost effectiveness, market and technical barriers, compliance and enforcement, and potential impacts on human health or the environment. Some interested parties also provide data that the Statewide CASE Team uses to support analyses.

This appendix summarizes the engagement with interested parties conducted by the Statewide CASE Team during the development and refinement of the report's recommendations.

All Measures

Utility-Sponsored Meetings of Interested Parties

Utility-sponsored meetings provide an opportunity to learn about the Statewide CASE Team's role in the advocacy effort and to hear about specific code change proposals that the Statewide CASE Team is pursuing for the 2028 code cycle. The goal of these meetings is to solicit input on proposals from interested parties early enough to ensure the proposals and the supporting analyses are vetted and have as few outstanding issues as possible. To promote transparency in the development of code change proposals, the Statewide CASE Team uses meetings of interested parties to solicit feedback on:

- Proposed code changes
- Draft code language
- Draft assumptions and results of analyses
- Data to support assumptions
- Compliance and enforcement
- Technical and market feasibility

The Statewide CASE Team hosted two public meetings with interested parties for the proposed data center efficiency improvements measures via webinar, as described in Table 98. The Statewide CASE Team will host a second stakeholder meeting on the proposed measure to gather feedback on this draft report. Please see below for dates and links to event pages on Title24Stakeholders.com. Materials from each meeting, such as slide presentations, proposal summaries with code language, and meeting notes, are included in the bibliography section of this report.

Table 98: Utility-Sponsored Meetings

Meeting Name and Link to Materials	Meeting Date	Summary of Items Discussed
First Round of Nonresidential Covered Processes, Envelope, Utility-Sponsored Meeting	Tuesday, September 30, 2025	• Proposed code change measures impacting new construction and alterations • Descriptions of compliant vs. non-compliant integrated economizer designs • Market and technical barriers • Compliance changes and challenges
Second Round of Nonresidential Data Centers, Healthcare Exceptions, and Nonresidential Fenestration, Utility-Sponsored Meeting	Tuesday, March 17, 2026	• Updates to proposed code language • Descriptions of cost-effectiveness analysis approach and results • ACM modeling baseline rules updates • Compliance form revisions

The first round of utility-sponsored meetings began in September 2025 and served as an early forum to promote transparency and gather feedback from interested parties on measures under consideration by the Statewide CASE Team.

The objectives of the first round of meetings were to solicit input on the scope of the 2028 code cycle proposals; request data and feedback on the specific approaches, assumptions, and methodologies for the energy impacts and cost-effectiveness analyses; and understand potential technical and market barriers. The Statewide CASE Team also presented the initial draft code language for interested parties to review.

The Statewide CASE Team received the following feedback from interested parties during this meeting and modified the proposal accordingly.

- Proposed part-load economizing requirements outlined in Table A and Table B were too complicated.
    - In response to this feedback, the Statewide CASE Team removed these tables and simplified the requirements.

The second utility-sponsored meeting occurred on March 17, 2026 to provide updated details on proposed code changes and engage additional interested parties impacted by the proposed measures. This meeting introduced early results of energy, cost-effectiveness, and incremental-cost analyses, and solicited additional feedback on refined draft code language.

Utility-sponsored meetings were open to the public. For each meeting, two promotional emails were distributed from info@title24stakeholders.com. One email was sent to the full Title 24 Stakeholders listserv, which includes over 3,000 individuals. A second email targeted specific recipients based on their subscription preferences.

The Title 24 Stakeholders listserv is an opt-in service comprising participants from a diverse industries and trades, such as manufacturers, advocacy groups, local government, and building and energy professionals. Each meeting was announced on the Title 24 Stakeholders LinkedIn page and cross-promoted on the CEC LinkedIn page approximately two weeks in advance to engage individuals, organizations, and broader channels outside beyond the listserv. The Statewide CASE Team conducted extensive personal outreach to interested parties identified in initial work plans who had not yet opted in to the listserv. Exported webinar meeting data captured attendance numbers, individual comments, and results from live attendee polls to help evaluate participation and support.

Statewide CASE Team Communications

The Statewide CASE Team held personal communications over email and phone with numerous interested parties when developing this report. The organizations listed in Table 99: Engaged Interested Parties provided input on the proposed measures and content in the report. In addition to those interested parties, the Statewide CASE Team engaged market actors who manage data centers, design and engineering firms specializing in data centers and smaller computer rooms, manufacturers of cooling equipment, appliance standards associations, and national experts involved in data center projects across the country to provide updates on the proposed measure and invite their input and participation in the process.

Table 99: Engaged Interested Parties

Organization/Individual Name	Market Role	Mentioned in CASE Report Sections
Air Conditioning Contractors of America	Trade Association for Contractors	-
ACCO	Mechanical contractor	Sections 2.4, 4.4
Air-Conditioning, Heating, and Refrigeration Institute	Trade Association of Appliance Manufacturers	Section 1.3
AAON, Inc.	Appliance Manufacturer	-
APC by Schneider Electric	Appliance Manufacturer	-
BayREN Codes & Standards regional forum	County representatives, energy and sustainability staff of local jurisdictions, consulting engineering firms, national	Section 1.3 – nearly 200 individuals registered for this session

Organization/Individual Name	Market Role	Mentioned in CASE Report Sections
	laboratories, state agencies, and universities	
California Building Energy Modeling (CalBEM)	Building Energy Modeling Industry Group involving energy modelers, compliance software developers, and energy code and building performance researchers	Table 96 – the Statewide CASE Team presented at the CalBEM Working Group 3 meeting on May 6, 2026, and summarized the ACM system map and energy modeling changes, particularly the new Systems (11a/11b) and the System 10 baseline change from water-cooled to air-cooled chillers.
California Energy Commission	Regulator	-
Carrier Corporation	Appliance Manufacturer	Section 1.3
Daikin U.S. Corporation, Daikin Applied, and Daikin Comfort Technologies	Appliance Manufacturer	Section 1.3
Heating, Air-conditioning & Refrigeration Distributors International	Trade Association for Distributors	-
Johnson Controls	Appliance Manufacturer	Section 1.3
Lawrence Berkeley National Laboratory	National Laboratory	Sections 2.2.3, 2.4, 3.4, 4.2.3 and 4.4
LG Air Conditioning Technologies	Appliance Manufacturer	-
Midea America Research Center and North America Technical Service Center	Appliance Manufacturer	-
Mitsubishi Electric US, Inc	Appliance Manufacturer	-
Rheem Manufacturing Company	Appliance Manufacturer	-
Trane	Appliance Manufacturer	-
Western Allied Mechanical	Mechanical contractor	Sections 2.4, 4.4
Vertiv	Appliance Manufacturer	Section 1.3

Appendix F: Code Language Markup (Non-Restructured)

The language below is from the Draft CASE Report and in the non-restructured 2025 Title 24 Part 6 Code Language. The proposed code language in this Final CASE Report is different than the Draft CASE Report following comments issued by some interested parties on or after the utility-sponsored meeting of interested parties on March 17, 2026. For example, the proposed heat recovery language is a mandatory requirement in the Final CASE Report, and was specified as a prescriptive requirement in the Draft CASE Report.

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION*:*

LIQUID-COOLED INFORMATION TECHNOLOGY EQUIPMENT (ITE) are the components of ITE that are cooled by a fluid other than air and that do not use server fans to flow air across the components. Common liquid cooling fluids include water, glycol, and refrigerant. Individual servers can be partially liquid-cooled and partially air-cooled, with server fans serving the air-cooled components and pumps serving the liquid-cooled components.

AIR-COOLED ITE are the components of ITE that are cooled by the flow of air through the ITE equipment. Onboard server fans are typically used to move air through servers.

FACILITY WATER is the cooling fluid loop that carries heat away from liquid-cooled ITE (typically via a coolant distribution unit heat exchanger) toward plant-level heat rejection infrastructure (like chillers, cooling towers, and/or dry coolers).

COMPUTER ROOM ECONOMIZER is a system by which heat from ITE is rejected to the environment without the use of a refrigerant compressor. If a computer room economizer is part of a cooling system that also includes a refrigerant compressor, then the system shall be fully integrated, meaning it shall be capable of providing partial economizer cooling without limiting the capacity of compressor cooling and without limiting the capacity of compressor-less cooling.

(b) Systems that DO meet the fully integrated criteria of a computer room economizer, include the following:

1. Waterside economizer heat exchangers that are piped in series with chillers on the chilled water side.
2. Air-cooled chillers with integrated economizer coils that are piped into the secondary circuit of a primary/secondary system. The fans serving the integrated economizer coils must be able to modulate speed without being

limited by the need to maintain a minimum refrigerant head pressure.

3. Air-cooled chillers with integrated economizer coils that are served by dedicated economizer fans and not by condenser fans that serve refrigerant condenser coils.
4. Refrigerant economizer systems where 10-90% of the load on a refrigerant circuit can be met by a passive condenser or refrigerant pump, while the other 90% to 10% of the load is met by an active condenser or refrigerant compressor

(c) Systems that DO NOT meet the fully integrated criteria of a computer room economizer include the following:

1. Waterside economizer heat exchangers that are piped in parallel with chillers on the chilled water side.
2. Air-cooled chillers with integrated economizer coils that are piped into the primary circuit of a primary/secondary system, or on the chiller side of a chiller minimum flow bypass valve.
3. Air-cooled chillers with integrated economizer coils that are served by the same condenser fans that serve refrigerant condenser coils whose speed is limited by the need to maintain a minimum refrigerant head pressure.

Refrigerant economizer systems with one or more refrigerant circuits that must switch from refrigerant compressor operation to refrigerant pump operation.

SECTION 120.6 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

(j) Mandatory requirements for computer rooms. Space-conditioning systems serving a computer room shall meet the following requirements:

1. Reheat. Each computer room zone shall have controls that prevent reheating, recooling and simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems.

2. **Humidification.** Humidification shall be adiabatic. Nonadiabatic humidification, including but not limited to steam and infrared, is prohibited.

3. **Fan control.** Each ~~unitary air conditioner~~ direct expansion system with mechanical cooling capacity exceeding ~~60,000~~ 30,000 Btu/hr and each chilled water fan system shall be designed to vary the airflow rate as a function of actual load. Fan motor demand shall not exceed 50 percent of design wattage at 66 percent of design fan speed.

SECTION 140.9 – PRESCRIPTIVE REQUIREMENTS FOR COVERED PROCESSES

a. **Prescriptive Requirements for Computer Rooms.** Computer rooms with a power density greater than 20 W/ft^2 shall comply with this section.

~~1. **Economizers.** Each individual cooling system primarily serving computer rooms shall include either:~~

~~3. An integrated air economizer capable of providing partial cooling even when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 65°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 120.2(i); or~~

~~4. An integrated water economizer capable of providing partial cooling even when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 50°F dry-bulb and below or 45°F wet-bulb and below.~~

2. **Economizers.**

A. Each individual cooling system primarily serving computer rooms shall include a computer room economizer, as defined in section 100.1, capable of providing 100 percent of the expected system design cooling load at the following ambient conditions and at 75°F supply air temperature for air-cooled ITE. Compliance shall be determined with redundant equipment operating if the redundant equipment is expected to operate in normal operation.

Type of ITE	Ambient Dry-Bulb	Ambient Wet-Bulb
Air-Cooled ITE in a computer room with average air-cooled ITE design load > 25 kW/rack and served by a cooling system that does not evaporate water at these ambient conditions	≤ 55°F	any
All liquid-cooled ITE in buildings with a design liquid-cooled ITE load greater than 2 MW	≤ 75°F	≤ 75°F
All other ITE	≤ 65°F	≤ 60°F

B. The economizer shall be equipped with a fault detection and diagnostic system as specified by Section 120.2(i)

C. Differential Temperature (dT) and Variable Flow

5.2 Air handling systems with a capacity exceeding 30,000 Btu/hr serving air-cooled ITE load shall be designed for a return to supply air dT of at least 20F. These systems shall be designed and controlled to vary airflow as a function of ITE load with a minimum airflow not to exceed 25% of design airflow, in order to maintain constant dT at ITE loads from 25% to 100%.

5.2 Chilled water and facility water systems serving air-cooled and liquid-cooled ITE shall be designed for a return to supply fluid dT of at least 15°F. These systems shall be designed and controlled to vary fluid flow as a function of ITE load, in order to maintain constant dT at ITE loads from 25% to 100%.

EXCEPTION 1 to Section 140.9(a)1: Individual computer rooms with an ITE design load under 5 tons (18 kW) in a building that does not have any economizers.

EXCEPTION 2 to Section 140.9(a)1: A computer room with an ITE design load less than 20 tons (70 kW) may be served by a second fan system without an economizer if it is also served by a fan system with an economizer that also serves other spaces within the building, provided that all of the following are met:

3. The economizer system is sized to meet the design cooling load of the computer room when the other spaces within the building are at 50 percent of their design load at outside air temperatures of 65°F dry-bulb and below or and ~~50°F~~ 60°F wet-bulb and below; and
4. An economizer system that can stop service to other spaces in the building when those spaces are unoccupied and serve only the computer rooms.

EXCEPTION 3 to Section 140.9(a)1: Computer rooms that reject heat to a heat recovery system that is sized to accept at least 50% of the design computer room heat and that serves a qualifying heating load. Qualifying heating loads include:

1. Space heating systems and/or service water heating systems with design loads at least 5 times greater than the computer room design cooling load.

    2. Processes determined by the Executive Director to require more than 50% of the design computer room heat for more than 3,000 hours/year.

2. **Power Consumption of Fans.** The total fan power at design conditions of each fan system shall not exceed 27 W/kBtu·h of net sensible cooling capacity.
3. **Air Containment.** Computer rooms with air-cooled computers in racks and with a ITE design load exceeding ten kW (2.8 tons) per room shall include air barriers such that there is no significant air path for computer discharge air to recirculate back to computer inlets without passing through a cooling system.

EXCEPTION 1 to Section 140.9(a)3: Expansions of existing computer rooms.

EXCEPTION 2 to Section 140.9(a)3: Computer racks with a design load less than 1 kW (0.28 tons) per rack.

EXCEPTION 3 to Section 140.9(a)3: Equivalent energy performance based on computational fluid dynamics or other analysis.

SECTION 140.9 – PRESCRIPTIVE REQUIREMENTS FOR COVERED PROCESSES

a. Prescriptive Requirements for Computer Rooms.

5. Computer Room Heat Recovery. Buildings with a design computer room ITE load greater than 100 KW and a non-computer room conditioned floor area greater than 35,000 ft2 shall include a heat recovery system, such as ducting hot aisles to the hot deck of a dual fan dual duct system, or a heat recovery chiller, capable of transferring the lesser of the following from the computer room cooling system to the space heating system and/or to the service water heating (SWH) system:

3. 0.25 times the peak heat rejection capacity of the computer room system
4. 0.25 x (capacity of space heating system + capacity of SWH system)

SECTION 141.1 – REQUIREMENTS FOR COVERED PROCESSES IN ADDITIONS, ALTERATIONS TO EXISTING NONRESIDENTIAL, AND HOTEL/MOTEL BUILDINGS

Covered processes in additions or alterations to existing buildings that will be nonresidential, and hotel/motel occupancies shall comply with the applicable subsections of section 120.6 and 140.9.

a. **Lab and Process Facility Exhaust Systems.** All newly installed fan systems for a laboratory or process facility exhaust system greater than 10,000 cfm shall meet the requirements of Section 140.9(c).

b. **Computer Rooms.** All newly installed computer room cooling systems and uninterruptible power supply systems in additions/alterations shall meet the requirements of Sections 120.6(j), 140.9(a)2, and 140.9(a)4 and comply with item 1 below.

1. **Economizers.** Each individual cooling system primarily serving computer rooms in an existing building shall ~~include either~~: meet the requirements of Section 140.9(a)1

~~A. An integrated air economizer capable of partial cooling when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load up to 80°F room supply air temperature at outside air temperatures of 55°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by section 120.2(i); or~~

B. ~~An integrated water economizer capable of partial cooling when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load up to 80°F room supply air temperature at outside air temperatures of 40°F dry-bulb and below or 35°F wet-bulb and below.~~

EXCEPTION 1 to Section 141.1(b)1: Individual computer rooms with an ITE design load under ~~5 tons (18 kW)~~ 10 tons (35 kW) in a building that does not have any economizers or modulating DOAS.

~~**EXCEPTION 2 to Section 141.1.(b)1:** New cooling systems serving an existing computer room in an existing building with an ITE design load up to a total of 50 tons (176 kW).~~

~~**EXCEPTION 3 to Section 141.1(b)1:** New cooling systems serving a new computer room in an existing building with an ITE design load up to a total of 20 tons (70 kW).~~

EXCEPTION 2 to Section 141.1(b)1: new cooling systems serving an existing computer room where:

3. Total capacity of the new cooling system is less than 500 tons and less than 50% of the total computer room cooling system capacity, and
4. the new cooling system includes an integrated computer room economizer capable of providing 100 percent of the design cooling load at 75°F supply air temperature at the following outside air conditions:

Original Permit Date of Existing Computer Room	Dry-Bulb	Wet-Bulb
Before 1/1/2014	No economizer requirement	

1/1/2014 – 12/31/2022	55°F	35°F
1/1/2023 – 12/31/2028	65°F	45°F