# Proposal Summary

## Nonresidential HVAC Space Heating

Updated: February 23, 2023
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## Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on February 27, 2023. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by March 13, 2023.

## Measure Description

The fraction of newly constructed nonresidential buildings that rely on all-electric space heating is expected to increase rapidly in the coming years in California. This is being driven primarily by market forces such as corporate and institutional decarbonization targets and local reach codes. This proposal addresses the segment of nonresidential buildings that have historically relied on gas boilers providing hydronic heating but must now select an all-electric space heating design.

This study includes three measures, each geared toward addressing all-electric space heating opportunities in large buildings.

1. Measure 1 tackles hydronic electric readiness through a proposed limit on hot water supply temperatures (HWST).
2. Measure 2 seeks to improve the energy efficiency of all-electric hydronic designs through requiring hydronic heat recovery and thermal energy storage.
3. Measure 3 seeks to provide an additional pathway to prescriptively comply with Title 24 Part 6 by allowing electric resistance heat for some systems with space heating decoupled from ventilation.

Measure 1 proposes a mandatory 130 °F limit for HWST in new construction and major retrofits. This measure is being proposed to ensure electric readiness for sites that install gas boilers. When it comes time to retrofit the building, all-electric hydronics should be a more compelling option than if the building was designed around a higher HWST, such as 160 or 180 °F. Lower HWST will have the benefit of reducing the energy consumption of the plant equipment due to reduced distribution system losses (a

recent UC Berkeley study found that almost as much heat is lost to piping losses as is used to heat buildings[1]). Boiler and heat pump efficiency are also better at lower HWST. Incremental first costs for this measure include higher pump and piping costs due to lower hot water temperature differences and larger flow rates. However, initial modeling indicates this proposal is cost-effective in all climate zones.

Measure 2 seeks to address the energy efficiency of all-electric hydronic systems. Many designers are familiar with strategies for designing hydronic space heating systems served by natural gas boilers. Familiar strategies include sizing equipment based on design heating loads as well as a tendency to oversize boilers. The continued reliance on these approaches as designs shift to all-electric is likely to result in many designs that are more expensive and inefficient than they could be. This measure seeks to ensure that the typical hydronic all-electric design makes appropriate use of techniques such as hydronic heat recovery and thermal energy storage. For sites with minimal overlapping cooling and heating loads, we propose a prescriptive requirement for thermal energy storage and hydronic heat recovery equipment. We also propose a prescriptive requirement of hydronic heat recovery for sites with significant overlapping cooling and heating loads. The inclusion of thermal energy storage (set to either chilled water, condenser water, or hot water ranges) is intended to lower the installed capacity of air to water heat pumps by storing afternoon heat rejection when the building is in cooling mode and using it to warm the building when in heating mode. Hydronic heat recovery can also reduce system capacity and save energy when appropriately specified. The proposed systems are being compared to a “baseline” all-electric system consisting solely of 2-pipe air to water heat pumps.

Measure 3 seeks to broaden the number of all-electric options available for prescriptive compliance. Currently, electric resistance heating at the zone level is prescriptively banned. This measure proposes that an exception be added for sites that meet several criteria intended to absolutely minimize heating loads. These criteria include the low prescriptive window-wall ratios, prohibiting hot water piping, minimizing ventilation loads with $CO_2$ and occupant sensing ventilation resets, heat recovery from computer rooms, and largely eliminating reheat by using parallel fan-powered boxes (FPB) or other systems that decouple heating and primary air. This prescriptive option could encourage electrification because systems that use electric resistance heat with FBPs should have lower first cost than buildings that use hydronics. Including the criteria listed above will minimize the energy discrepancy versus hydronic heat pump systems. Moving more designs to the prescriptive path can improve real savings associated with the more enforceable and durable prescriptive requirements, such as envelope efficiency and the recently added solar PV and battery storage requirements. This measure is lifecycle cost-effective when compared to a boiler or heat pump hydronic heating system. It will

[1] https://cbe.berkeley.edu/research/comparison-of-hot-water-and-electric-reheat/.

also reduce greenhouse gas emission associated with gas heating and with heat pump refrigerants.

## Data Needs/Stakeholder Information Requests

- Information about typical installation practices regarding nonresidential hydronic space heating systems (both electric and natural gas) is desired. Information could include the frequency of different space heating system designs, the rate of inclusion of heat recovery and thermal energy storage in all-electric designs, the breakout between projects using the prescriptive and performance paths, and the frequency of different HWST setpoints.
- Retrofit costs for existing buildings that are converting from high (e.g., 180 °F) to low (e.g., 130 °F) temperature space heating. What are design considerations for converting from high to low temperature hydronic space heating? What are the costs associated?
- Costs for nonresidential space heating equipment, including noncondensing and condensing gas boilers, 2-pipe air to water heat pumps, and 4-pipe heat recovery chillers (both air-source and water-source). Costs at a range of system capacities and efficiency levels (if appropriate) would be appreciated.
- Performance data for nonresidential hydronic heat pump equipment for use in building energy modeling (BEM) software such as EnergyPlus.
- Design tools such as Excel-based calculators that provide estimates for energy savings. The CASE Team will use EnergyPlus to model savings for the identified measures, however, Excel-based tools will provide a useful reality check for our estimates. Tools have been created or reviewed by manufacturers would be particularly appreciated.

Data may be provided anonymously. To participate or provide information, please email Bryan Boyce, bboyce@energy-solution.com directly and cc info@title24stakeholders.com.

## Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2022 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

## Standards

SECTION 120.2 – REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS

**(k) HVAC Hot Water Temperature**. Systems that use hot water for space heating shall be designed for a hot water supply temperature of no greater than 130°F.

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

**(g) Electric resistance heating.** Electric resistance heating systems shall not be used for space heating.

**Exception 1 to Section 140.4(g):** Where an electric resistance heating system supplements a heating system in which at least 60 percent of the annual heating energy requirement is supplied by site-solar or recovered energy.

**…**

**Exception 5 to Section 140.4(g):** Where an electric resistance heating system serves an entire building that is not a hotel/motel building; and has a conditioned floor area no greater than 5,000 square feet; and has no mechanical cooling~~; and is in an area where natural gas is not currently available~~.

**Exception 6 to Section 140.4(g):** Heating systems serving as emergency backup to gas or heat pump heating equipment.

**Exception 7 to Section 140.4(g):** in zones where all the following is true:

(a) the heating system is not hydronic

(b) all heating for each zone is provided by heater(s) dedicated to that zone

(c) the primary airflow delivered to the zone at design heating conditions does not exceed the minimum required for ventilation

(d) the zone does not have exhaust makeup air or pressurization requirements that require an outdoor air rate greater than 0.15 cfm/ft2.

(e) All spaces with Note F in Table 120.1-A have occupant sensor ventilation controls meeting 120.1(d)5.A to G

(f) All spaces with $R_t \geq 0.3$ in Table 120.1-A have demand control ventilation meeting 120.1(d)4

(g) If the zone is on the same floor and within 30 feet of a computer room with a design equipment load > 10 kW and heat from the computer room is not otherwise being recovered for space heating then hot aisle air shall be transferred from the computer room to the zone in heating. The transfer system shall be sized for at least:

1. 50% of the design equipment load of the computer room, or

2. 50% of the design heating load of the zone

….

**(k) Hydronic System Measures**

…

**9. Simultaneous Hydronic Heat Recovery** is required for hydronic systems meeting 1 or 2:

1. $CHW_{HL}$ + 0.1*$CHW_{LL}$ ≥ 500 tons and $SHW_{cap}$ + $HW_{cap}$ ≥ 300 kBtuh, or
2. $CHW_{HL}$ + $CHW_{LL}$ ≥ 100 tons and $SHW_{cap}$ + 0.1*$HW_{cap}$ ≥ 2,000 kBtuh
    - $CHW_{cap}$ = design capacity of all chilled water (CHW) cooling systems
    - $CHW_{HL}$ = CHW High Load = design capacity of all CHW cooling systems serving spaces with a design equipment power density > 5 watts/ft2.
    - $CHW_{LL}$ = CHW Low Load = $CHW_{cap}$ - $CHW_{HL}$. If the CHW plant includes capacity for future systems, then assume 20% of future systems serve high load spaces.
    - $SHW_{cap}$ = design capacity of all service hot water (SHW) systems
    - $HW_{cap}$ = design capacity of all HW space heating systems

The heat recovery system shall have a heating COP of at least 3.5 at design conditions and shall be capable of transferring the lesser of:

- 0.5*($CHW_{cap}$)
- 0.5*($SHW_{cap}$ + $HW_{cap}$)

**EXCEPTION to Section 140.4(k)9**: Buildings that include Time Independent Energy Recovery meeting 140.4(k).10.1 and 140.4(k).10.2

**10. Time Independent Energy Recovery (TIER)** is required for hydronic systems meeting the following:

1. $CHW_{cap}$ ≥ 800 tons
2. $SHW_{cap}$ + $HW_{cap}$ ≥ 4,000 kBtuh
3. The hot water heating system is electric (not gas boilers)

TIER systems shall include both:

1. a condenser water storage tank, or other means, capable of storing 2 hours times ($SHW_{cap}$ + $HW_{cap}$), and
2. water-to-water chillers or other means of heat recovery to extract heat from the storage system in heating and reject heat to the storage system in cooling

SECTION 141.0 – ADDITIONS, ALTERATIONS, AND REPAIRS TO EXISTING NONRESIDENTIAL

~~**Exception 2 to Section 141.0(a):** Where an existing system with electric reheat is expanded by adding variable air volume (VAV) boxes to serve an addition, total electric~~

~~reheat capacity may be expanded so that the total capacity does not exceed 150 percent of the existing installed electric heating capacity in any one permit, and the system need not comply with Section 140.4(g). Additional electric reheat capacity in excess of 150 percent of the existing installed electric heating capacity may be added subject to the requirements of Section 140.4(g).~~

## Reference Appendices

Changes to the Reference Appendices are being considered, draft language may become available later.