



TITLE 24, PART 6 2025 CODE CYCLE

Space Heating

Codes and Standards Enhancement (CASE) Proposal
NR | HVAC



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May 18, 2023

Utility Sponsored Stakeholder Meeting – Round 2



A STATEWIDE UTILITY PROGRAM

Agenda

Overview of Code Change Proposal (focusing on changes since 1st stakeholder meeting)

Summary of Stakeholder Feedback

Cost-effectiveness, Energy Savings and Statewide Impacts

Data Gaps and Additional Feedback Requested

Next Steps



Proposed Code Changes

CASE Report includes three measures:

- A. Mandatory hydronic hot water supply temperature (HWST) limit of 130°F**
- B. Prescriptively require heat recovery (HR) and/or thermal energy storage (TES) in large buildings** (when triggering conditions are met)
 - 140.4(r)1 – Simultaneous Condenser Heat Recovery
 - 140.4(r)2 – Thermal Energy Storage
 - 140.4(r)3 – Heat Recovery for Service Water Heating
- C. Prescriptively allow electric resistance zone heating in zones with:**
 1. Prescriptive envelope
 2. Low ventilation rates
 3. Heating decoupled from primary air (e.g., fan-powered boxes)
 4. Occupant sensor ventilation controls, if allowed
 5. Demand controlled ventilation (CO₂), if high density
 6. Computer room heat recovery, where available

Changes to Proposed Language Since 1st Meeting

Limit Hot Water Supply Temperature

- Clarified that the 130F limit applies to water entering zones

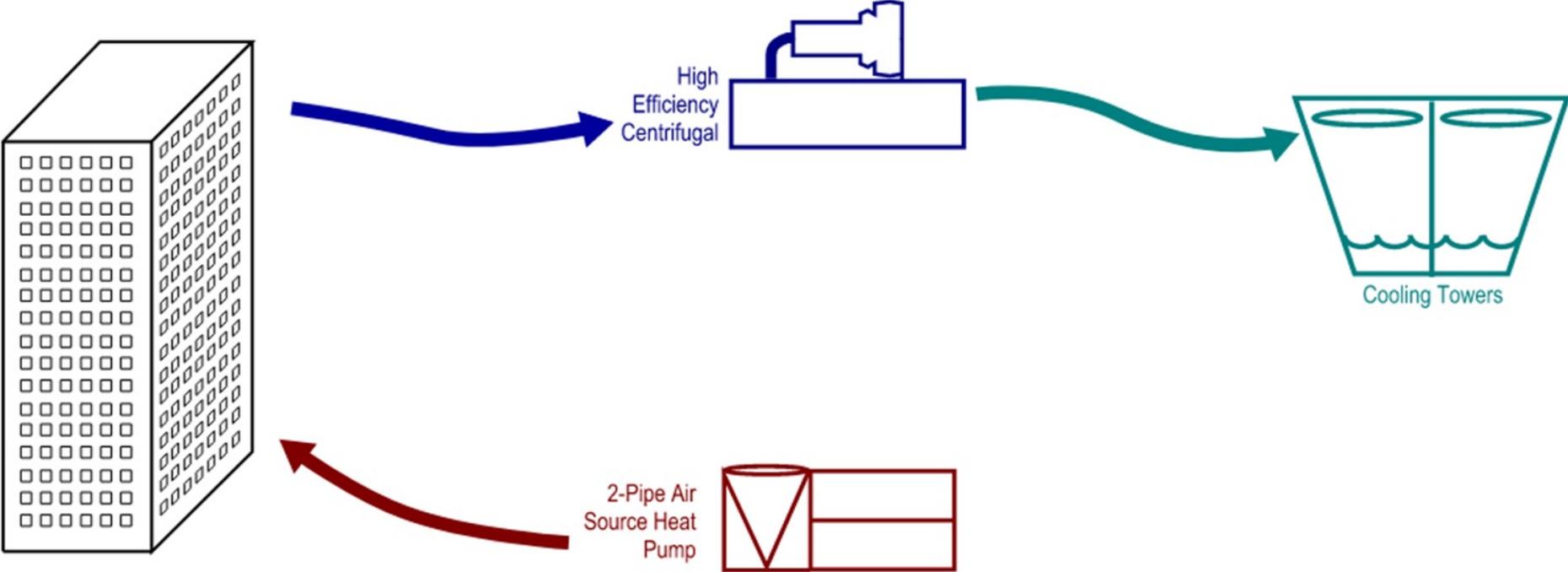
Condenser Heat Recovery

- Broadened condenser heat recovery scope to encompass all large buildings pursuing all-electric (previously it would have only applied to hydronic systems)
- Moved language from 140.4(k) to a new proposed subsection, 140.4(r)
- Added a new subsection to explicitly require heat recovery for service water heating when capacity trigger is met
- Regarding thresholds for heat recovery, replaced all placeholder capacity trigger values with values based on modeling

Electric Resistance Heating

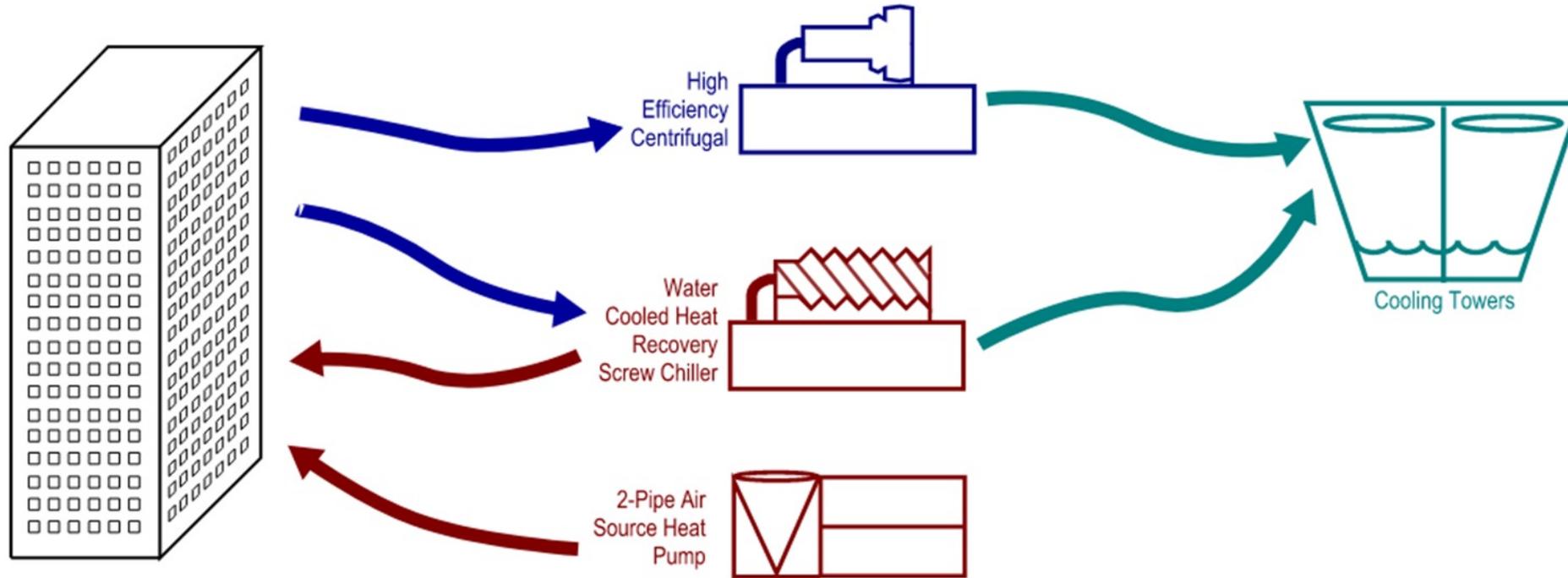
- Clarified that 140.3 prescriptive envelope is required if project is an addition/alteration

Condenser Heat Recovery Technical Refresher: No Heat Recovery



Source: Taylor Engineers

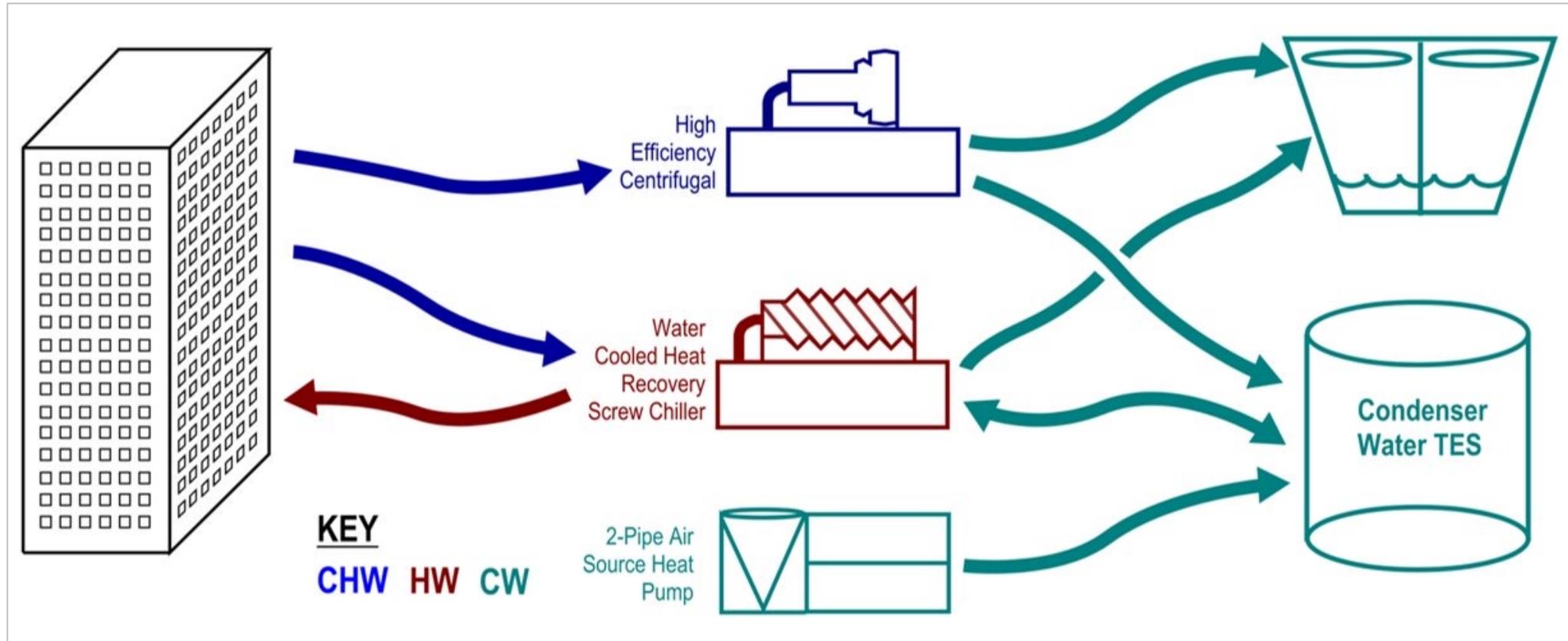
Condenser Heat Recovery Technical Refresher: Simultaneous Heat Recovery



Source: Taylor Engineers

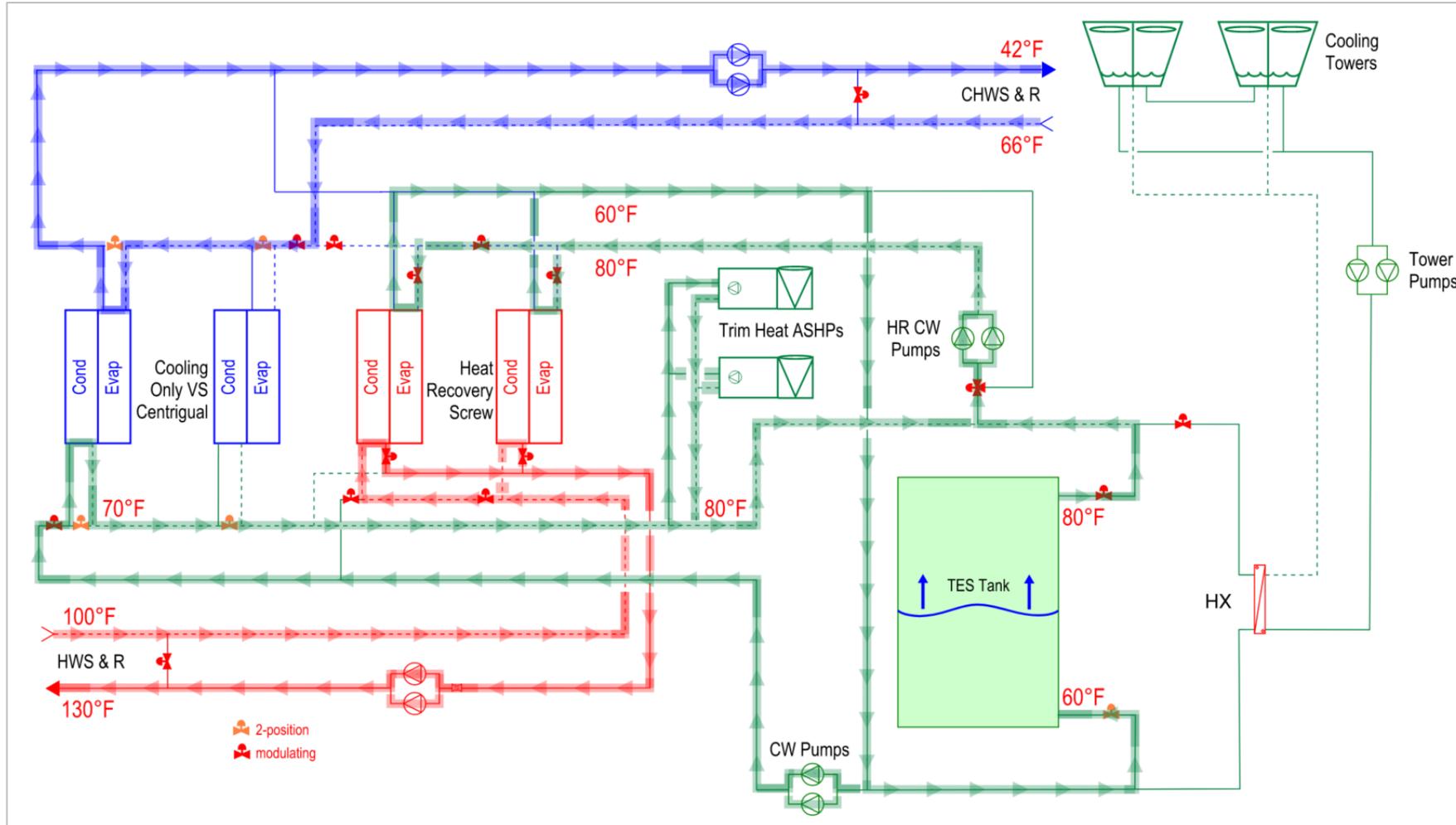
Condenser Heat Recovery Technical Refresher: Thermal Energy Storage

Taylor Engineers' Time Independent Energy Recovery (TIER) Schematic



Source: Taylor Engineers

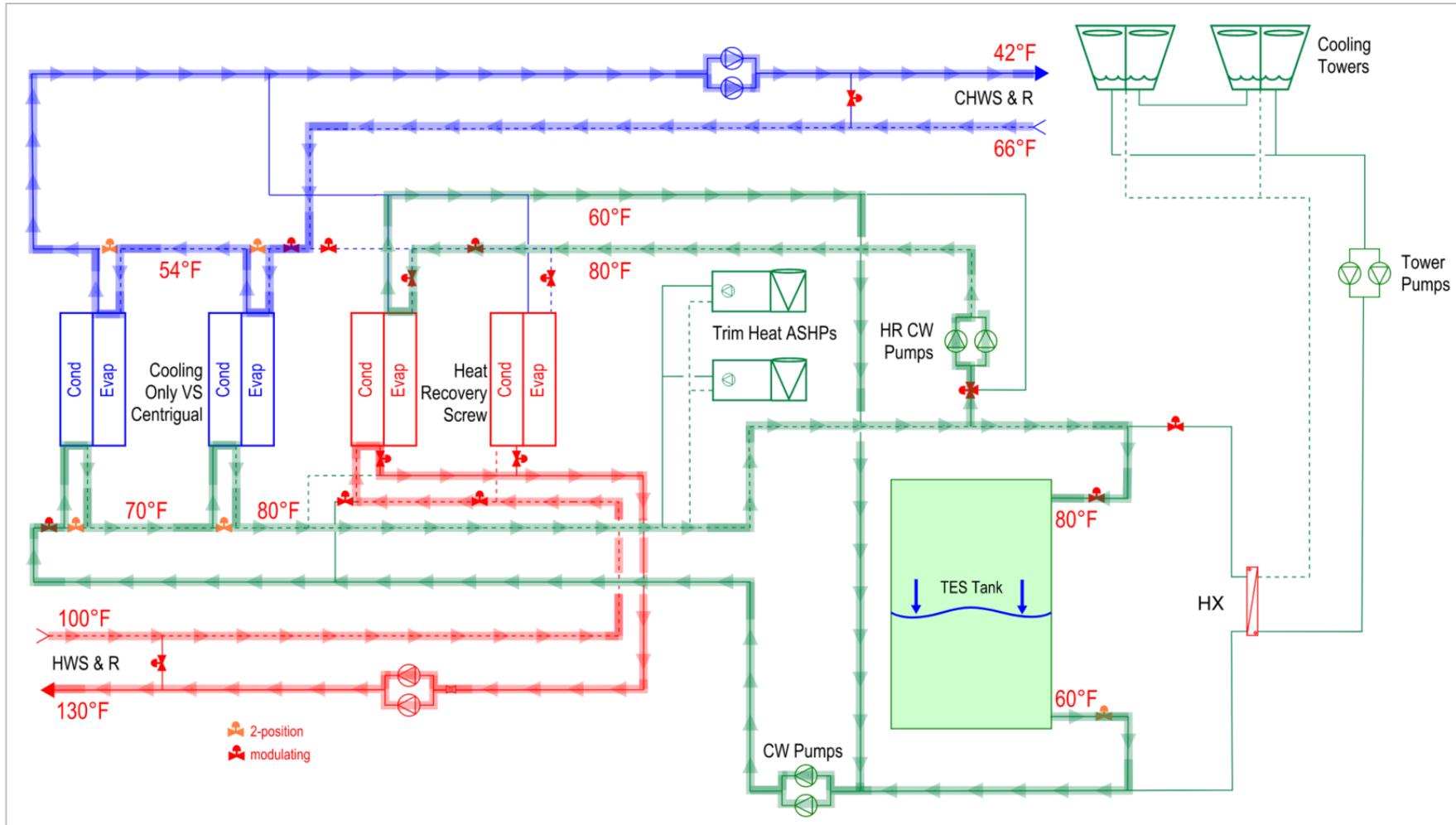
Condenser Heat Recovery Refresher



TIER Plant Diagram:
cool morning operation

Source: Taylor Engineers

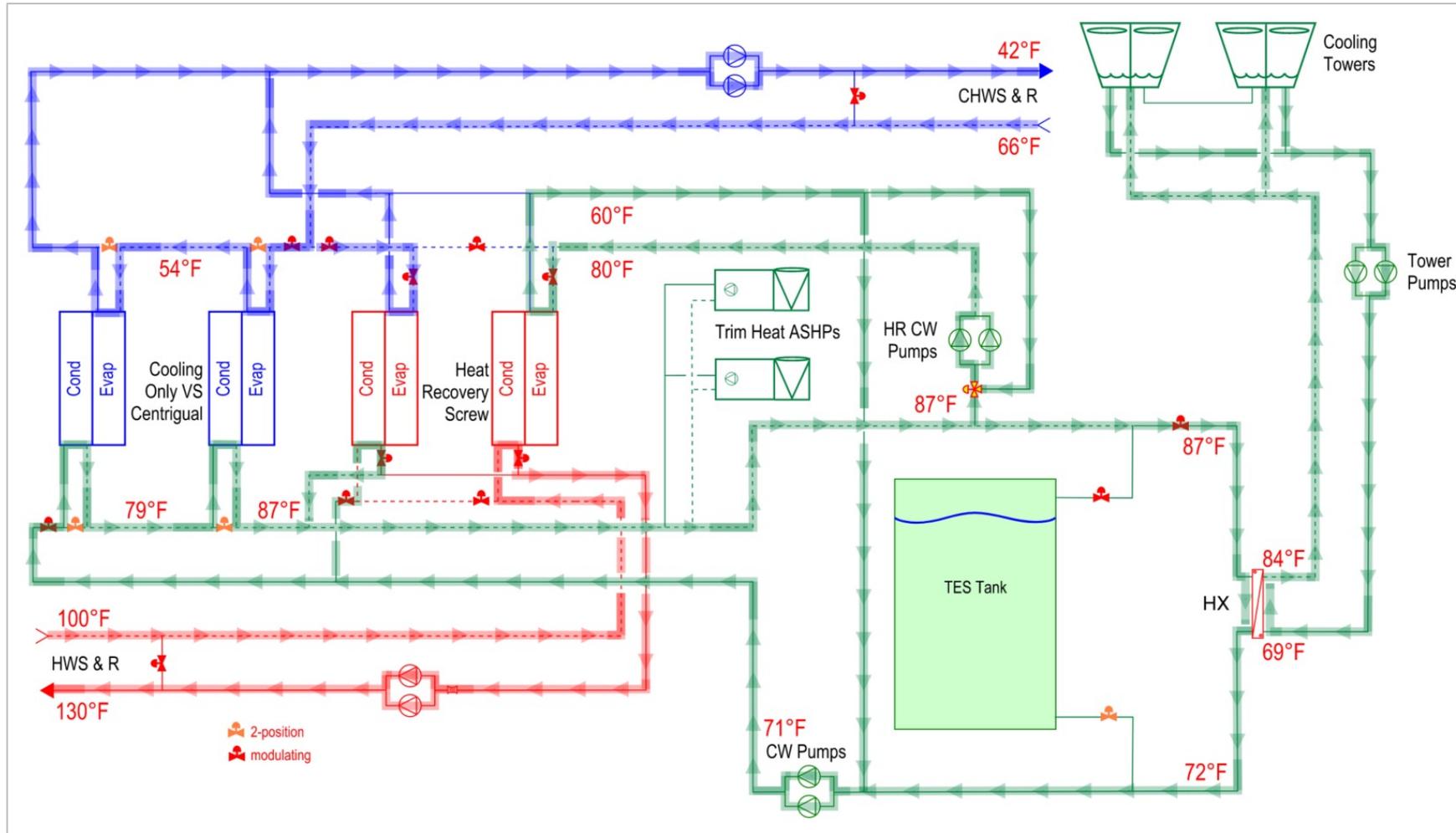
Condenser Heat Recovery Technical Refresher



TIER Plant Diagram:
cool afternoon
operation

Source: Taylor Engineers

Condenser Heat Recovery Technical Refresher



TIER Plant Diagram:
warm afternoon
operation

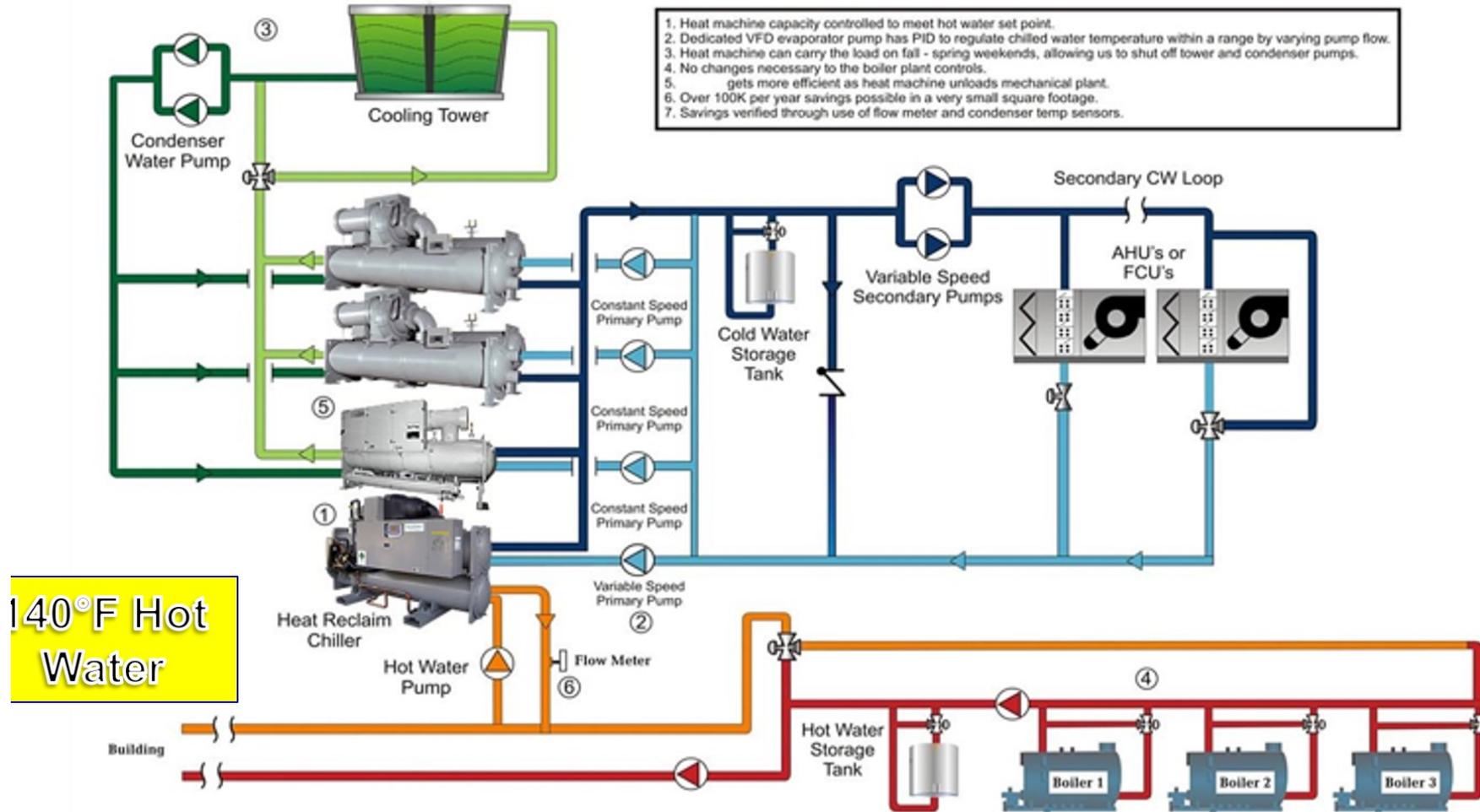
Source: Taylor Engineers

Condenser Heat Recovery Technical Refresher – TES Image



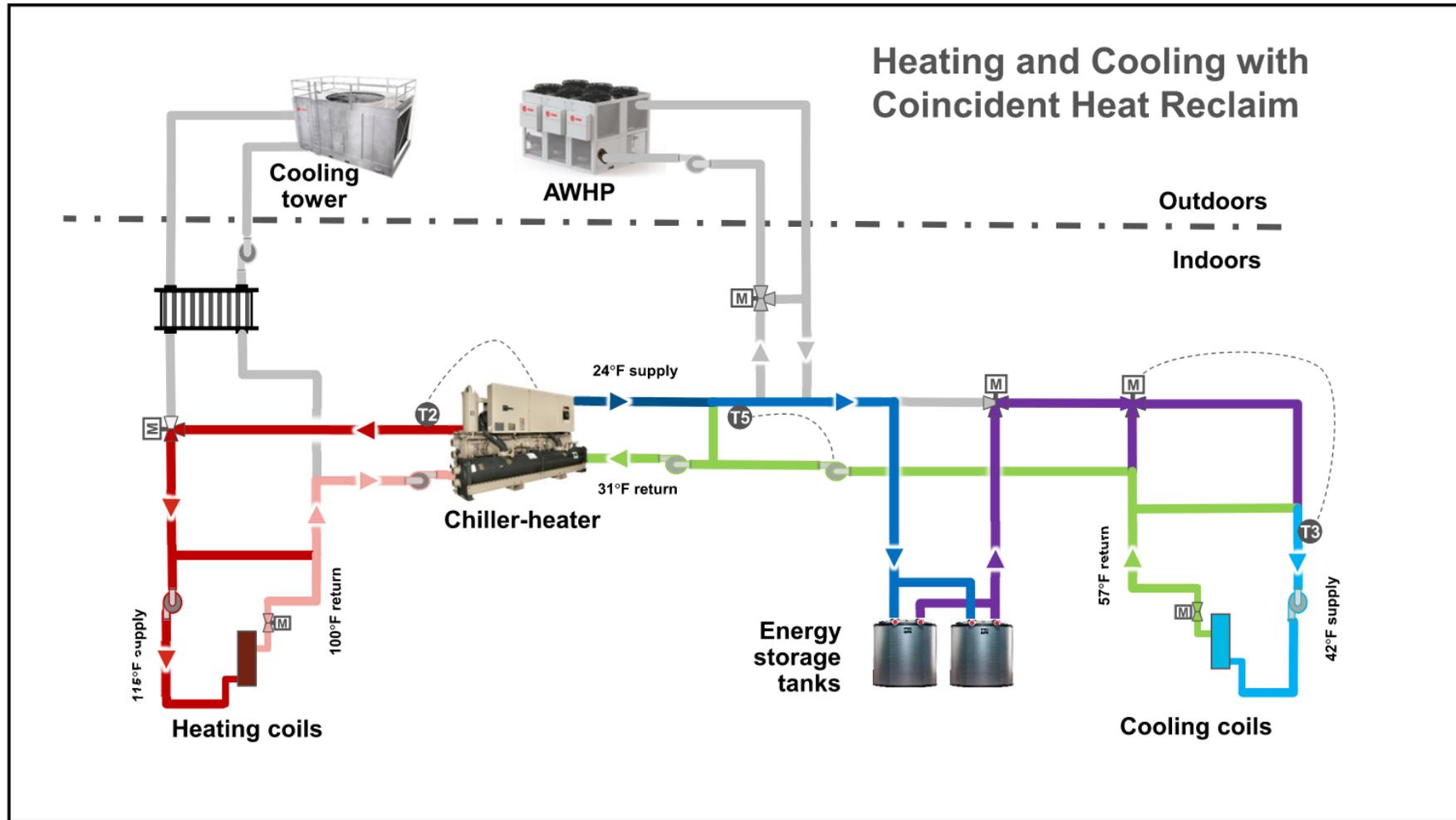
Source: Taylor Engineers

Condenser Heat Recovery + TES – Chilled & Hot Water Storage



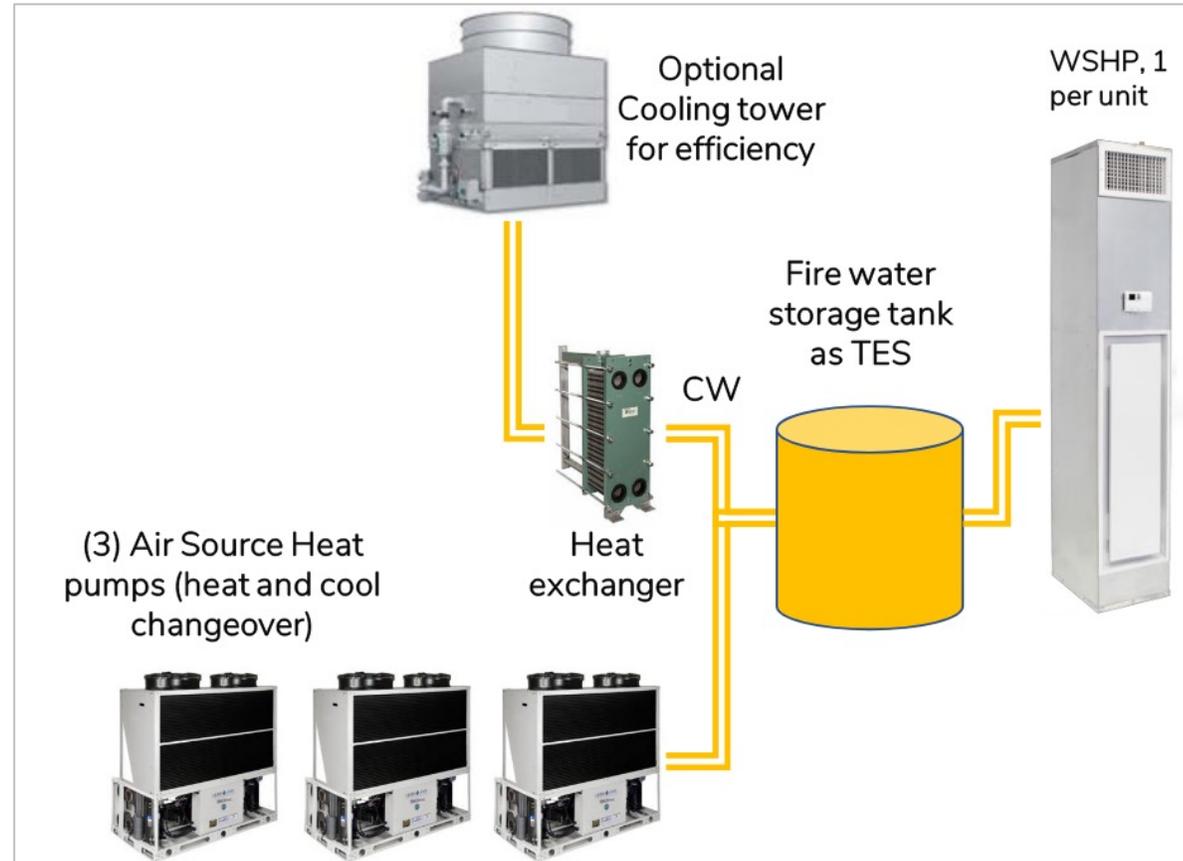
Source: Carrier, used with permission

Condenser Heat Recovery + TES – Ice Storage



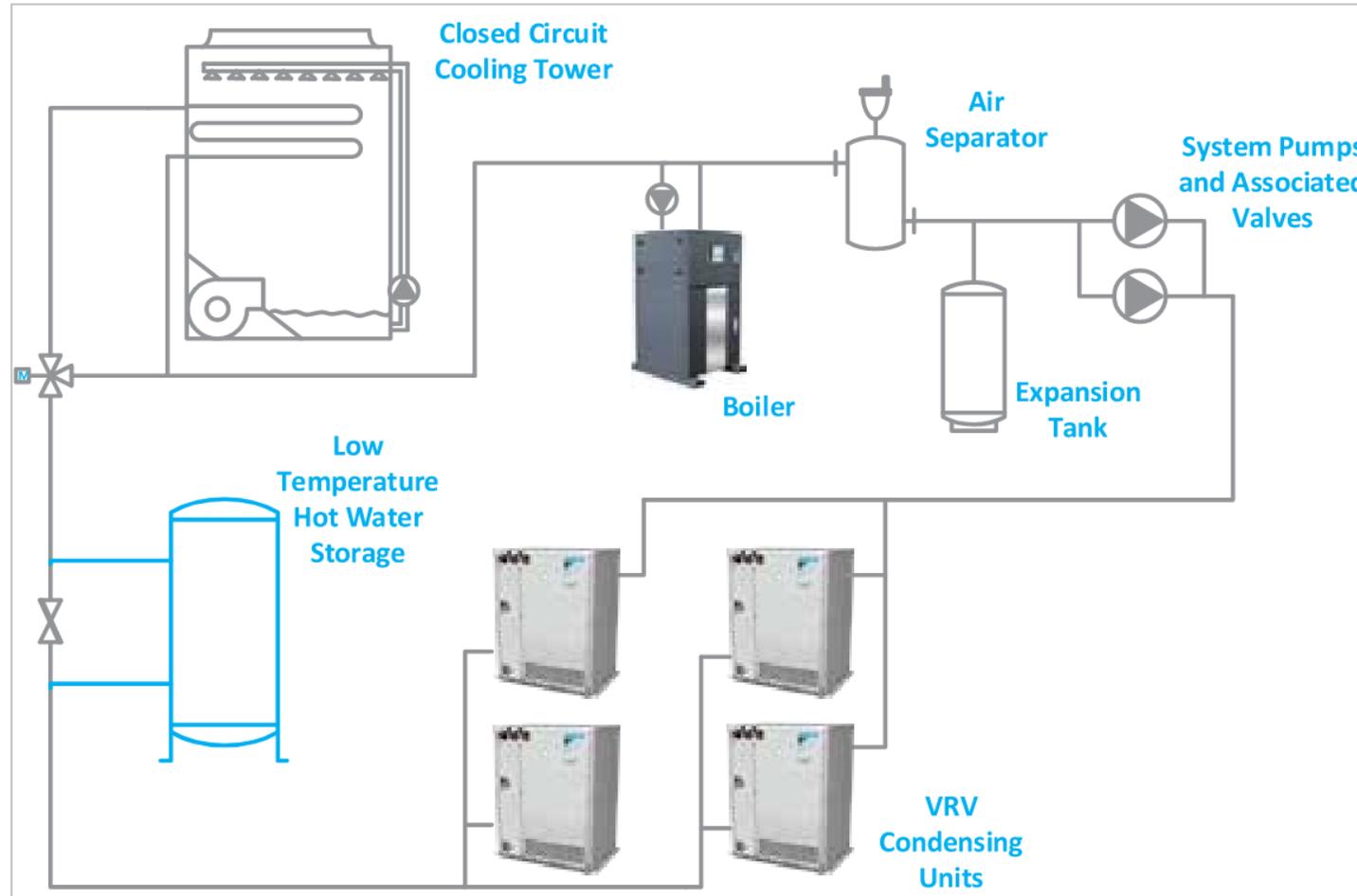
Source: Trane, used with permission

Condenser Heat Recovery + TES – WHSP Application



Source: Taylor Engineers

Condenser Heat Recovery + TES – VRF Application



Source: Daikin, used with permission

Draft Code Change Language: Limit HWST

SECTION 120.2 – REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS

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

Proposed Code Change – Condenser HR (1 of 2)

(r) Condenser Heat Recovery

1. Simultaneous Condenser Heat Recovery is required for buildings with electric heat (not gas boilers) that meet either A or B:

- A. $\text{Cooling}_{\text{HL}} + 0.1 * \text{Cooling}_{\text{LL}} \geq 200$ tons and $\text{SHW}_{\text{cap}} + \text{Heating}_{\text{cap}} \geq 2000$ kBtuh, or
- B. $\text{Cooling}_{\text{cap}} \geq 300$ tons and $\text{SHW}_{\text{cap}} + 0.1 * \text{Heating}_{\text{cap}} \geq 600$ kBtuh
 - $\text{Cooling}_{\text{cap}} =$ design capacity of all mechanical cooling systems
 - $\text{Cooling}_{\text{HL}} =$ design capacity of all mechanical cooling systems serving spaces with a design equipment power density > 5 watts/ft² and $< 40\%$ outdoor air at design airflow, i.e., high load spaces.
 - $\text{Cooling}_{\text{LL}} = \text{Cooling}_{\text{cap}} - \text{Cooling}_{\text{HL}}$. If the design includes capacity for future cooling systems, then assume 20% of future systems serve high load spaces.
 - $\text{SHW}_{\text{cap}} =$ design capacity of all service hot water (SHW) systems, excluding systems expected to operate less than 5 hours/week, such as instant-hot for emergency eyewash.
 - $\text{Heating}_{\text{cap}} =$ design capacity of all 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 the following from spaces in cooling to spaces in heating:

- 50% of the peak heat rejection of the cooling system
- 50% of $(\text{SHW}_{\text{cap}} + \text{Heating}_{\text{cap}})$

EXCEPTION 1 to Section 140.4(r)1: Buildings that include thermal energy storage meeting 140.4(r)2

EXCEPTION 2 to Section 140.4(r)1: Laboratory buildings with exhaust air heat recovery systems meeting 140.9(c)6.

Proposed Code Change – Condenser HR (2 of 2)

2. Thermal Energy Storage is required for buildings with electric heat (not gas boilers) that meet both A and B:

- A. Cooling_{cap} ≥ 800 tons
- B. SHW_{cap} + Heating_{cap} ≥ 4,000 kBtuh

The thermal energy storage systems shall include both:

1. a condenser water storage tank, or other means, capable of storing 2 hours times (SHW_{cap} + Heating_{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.

3. Heat Recovery for Service Water Heating.

If the building is required to have simultaneous condenser heat recovery by 140.4(r)1 or thermal energy storage by 140.4(r)2 and SHW_{cap} ≥ 500 kBtuh then the heat recovery system shall also heat or preheat the service hot water. The heat recovery system shall have the capacity to transfer the smaller of:

- 30% of the peak heat rejection of the cooling system
- 30% of SHW_{cap}

EXCEPTION 1 to Section 140.4(r): Buildings with a computer room heat recovery system capable of meeting 60% of the design space heating load.

Proposed Code Change – ER Heating (1 of 3)

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

1. **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 2 to Section 140.4(g): Where an electric resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the design heating load calculated in accordance with Section 140.4(a) at the design outdoor temperature specified in Section 140.4(b)4.

Exception 3 to Section 140.4(g): Where the total capacity of all electric resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating equipment serving the entire building.

Exception 4 to Section 140.4(g): Where the total capacity of all electric resistance heating systems serving the entire building, excluding those allowed under Exception 2, is no more than 3 kW.

~~**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.

Proposed Code Change – ER Heating (2 of 3)

Exception 7 to Section 140.4(g): in zones complying with the following:

(a) the zone is not served by a hydronic heating system

(b) each heating zone serves no more than one cooling zone and each cooling zone serves no more than one heating 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 continuous 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) for zones on the same floor as, and within 30 feet of, a computer room with a design equipment load > 12 kW and at least 50% of the heat from the computer room at design conditions is not otherwise being recovered for space heating (e.g., condenser heat recovery), hot aisle air from the computer room shall be transferred 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

(h) has the capability to detect failure of the heater in the ON position. Capabilities include manual reset thermal cutout or discharge air temperature sensor with associated fault detection logic.

Proposed Code Change – ER Heating (3 of 3)

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

(a) Additions

~~**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).~~

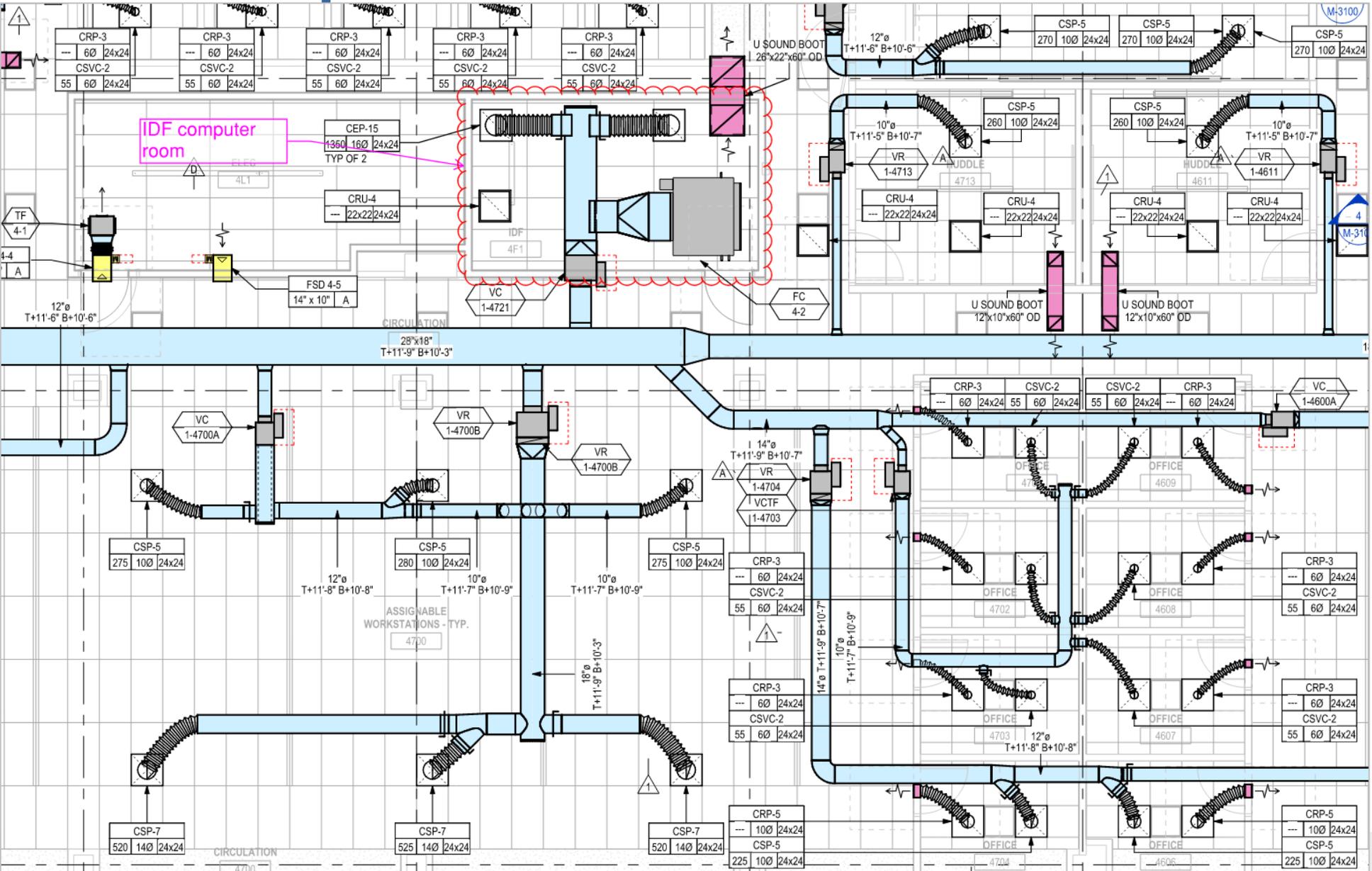
(b) Alterations

2. Prescriptive approach.

C. New or Replacement Space-Conditioning Systems or Components other than new or replacement space-conditioning system ducts shall meet the requirements of Section 140.4 applicable to the systems or components being altered.

Exception 6 to Section 141.0(b)2C: Exception 7 to Section 140.4(g) (allowing electric resistance heating) only applies to spaces meeting the prescriptive envelope requirements in section 140.3 and systems meeting the exhaust air heat recovery requirements in section 140.4(q).

“Available” Computer Room Heat – Not Transferred





Summary of Stakeholder Feedback

- Summary of Feedback Received
- Measure Evolution
- Potential Barriers and Solutions

Summary of Feedback – Condenser Heat Recovery

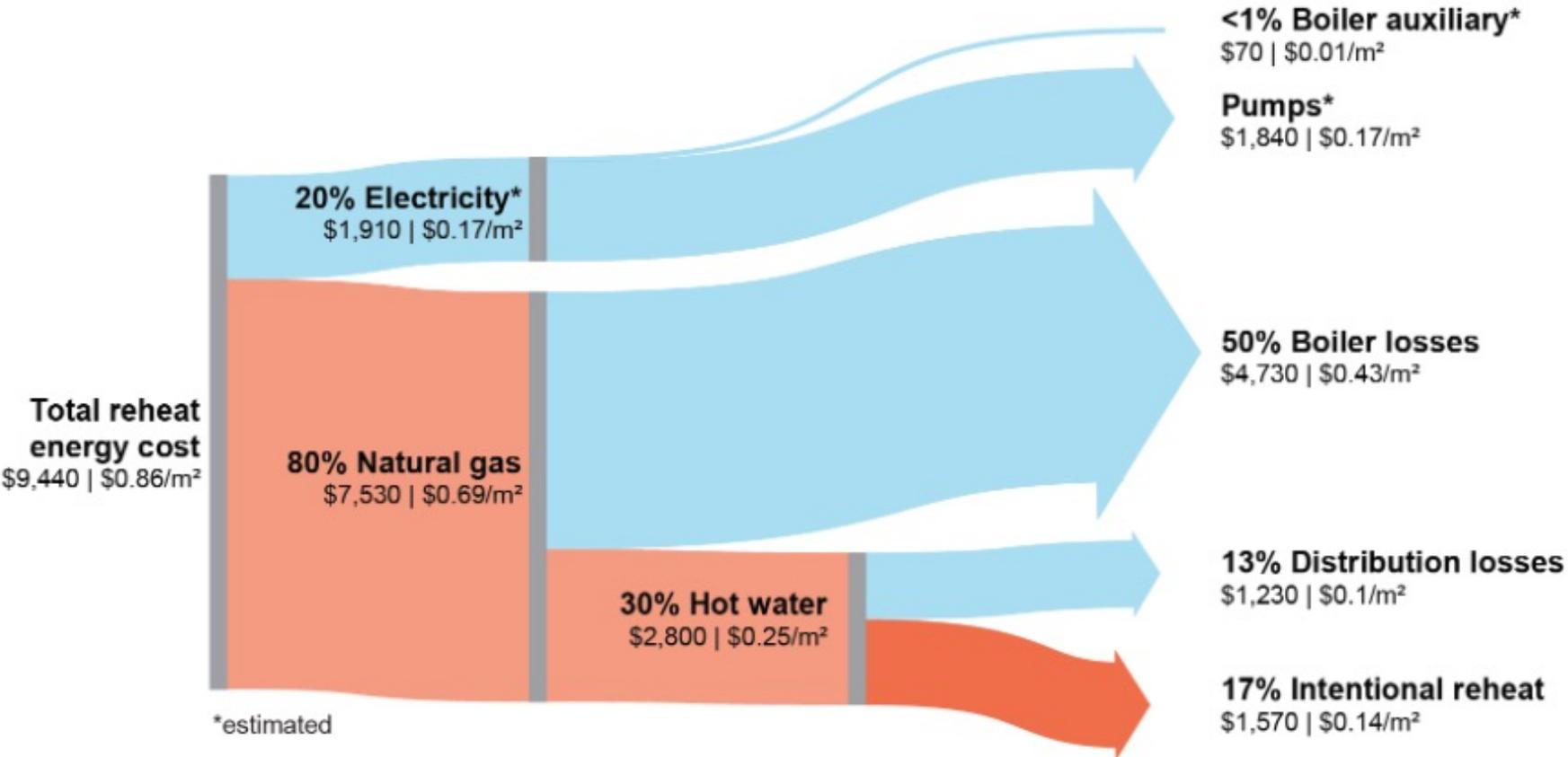
Concerns with unfairly promoting or disadvantaging certain system types with TES and/or HR requirements.

- In response we have sought to broaden the scope of condenser HR so that it's more system neutral.
- We're also investigating making it fuel neutral (i.e., applicable to buildings using all-electric and gas space heating)

Summary of Feedback – Electric Resistance Heating

- Peak load impacts of using electric resistance for space heating
- Envelope efficiency for existing buildings
- Scope of ER exception (currently there is no building size limit or other cutoff)
- Automatic fault detection and diagnostics
- Negative energy savings
 - Energy model does not account for:
 - Actual Piping Losses
 - Actual Boiler, AWHHP Performance
 - Energy Savings from DCV, Occupied Standby, Computer Room Heat Recovery
 - Prescriptive Benefits (window switches, good envelope, PV+storage, etc.)
 - Refrigerant Leakage, Gas Leakage
 - Embodied Carbon

Electric Resistance Heating - Considerations



A recent UCB CBE study of a Bay Area office building with HW reheat found that 17% of the reheat energy cost is converted to useful heat.

With electric resistance, 100% of the energy cost is converted to useful heat.

Source: UC Berkeley Center for the Built Environment ([link](#))

Cost Effectiveness and Energy Savings

Methodology and Assumptions

- Energy Savings Methodology and Results
- Cost Impacts Methodology and Results
 - Incremental costs
 - Energy cost savings



Incremental Cost for Heat Recovery Chiller

Over 30 Year Period of Analysis

typical AWHP unit tons:		130
incremental equip cost \$/ton	\$	500
incremental piping \$ / AWHP	\$	(15,000)
incremental piping \$/ton	\$	(115)
incremental controls \$ / AWHP	\$	(17,500)
incremental controls \$/ton	\$	(135)
incremental maint \$/yr/AWHP	\$	250
incremental maint \$/yr/ton	\$	1.92
NPV multiplier for annual maintenance		19.6
NPV of annual maintenance \$/ton	\$	38
Expected life of AWHP (yrs)		20
Replacement Cost Multiplier		0.55
incremental replacement cost \$/ton	\$	277
net incremental cost for 4pipe \$/ton	\$	565
net incremental cost for 4pipe \$/kBtuh	\$	47
incr. cost is fixed below this tons:		90
incr. cost floor:	\$	50,808

Cost data came from:

Bay Area Mechanical
Contractor

Total cost to upgrade 2-
pipe AWHP to 4-pipe
AWHP

Incremental Cost for SHW Heat Recovery

Over 30 Year Period of Analysis

HX 2-1 gpm		7.1
HX dT		55
HX kbtuh		195
pipe size		1"
pipe cost \$/LF	\$	111
LF of pipe mech		104
LF of pipe plmbg		20
LF of pipe		124
cost of piping	\$	13,764
cost of HX	\$	6,540
install cost of HX, excluding piping above	\$	1,200
incremental controls per HX (see pts and SOO below)	\$	6,500
incr. annual maint. per HX	\$	-
maint. Multiplier		19.60
NPV of maint.	\$	-
Incr. cost	\$	28,004
Incr. cost \$/kBtuh of HR capacity	\$	143

Cost data came from:

Bay Area Mechanical Contractors and HX vendors

Six real water heaters in commercial buildings to calculate HX size, pipe size/distance, etc.

Incremental Cost for Thermal Storage + HR

Location	Santa Clara	Sunnyvale	San Jose	Oakland
Stories	3	3	6	27
Building area (ft2)	314,000	1,100,000	1,022,981	718,000
CHWcap (tons)	780	2,660	1,800	1,200
SHWcap (kBtuh)	307		553	
Hwcap (kBtuh)	5,000	18,986	11,896	10,215
Tank capacity (kBtu)	12,125	45,807	**	34,436
Tank capacity (gallons)	35,000	141,000		53,000
Tank doubles as fire water storage?	No	Yes	Yes	Yes
First Cost Savings (\$)	*	1,500,000	6,725,003	2,200,000
First cost savings (\$/ft2)	*	\$ 1.36	\$ 6.57	\$ 3.06

Cost data came from:
Real world buildings where TIER was bid as an alternate to a conventional all-electric design

Incremental Cost for Electric Resistance Heating – Gas Baseline

Baseline: Gas Boiler serving HW Reheat Boxes	Data	Source
Avg cost/reheat box	\$345	Bay Area equip. rep.
Cost of reheat boxes	\$18,282	Bay Area equip. rep.
Mech install cost for typical HW reheat box (\$/box)	\$5,000	Bay Area mech. Contractor
Mech install cost for reheat boxes (\$)	\$265,000	Calculation
Boiler cost - installed (\$/btuh)	0.1	Bay Area equip. reps
Boiler cost - installed (\$)	\$72,000	Calculation
HW piping cost \$/ft2 (does not include box piping)	5.68	Bay Area mech. Contractor
HW piping cost \$ (does not include box piping)	\$227,200	Calculation
Pump cost \$/gpm installed	170.5	Bay Area equip. reps
Gpm	86	Calculation
Pump cost \$	\$14,663	Calculation
Misc. hydronics cost \$ (ET, TES, WTS, etc.)	\$30,000	Bay Area mech. Contractor

Cost data came from:
Bay Area equipment rep.
and mech. contractor

Incremental Cost for Electric Resistance Heating – Gas Baseline – Cont'd

Baseline: Gas Boiler serving HW Reheat Boxes	Data	Source
Boiler/HW incremental controls \$	\$15,000	Bay Area mech. Contractor
Gas service to building and to boiler	\$20,000	Bay Area mech. Contractor
Plumbing for boiler \$ (MUW, drain, etc.)	\$10,000	Bay Area mech. Contractor
Structural/arch for boiler (pad, roof screen, mech room, etc.)	0	Bay Area mech. Contractor
Annual maintenance for HW system, incl boiler (\$/yr)	\$1,000	Bay Area service Contractor
Other first costs	\$12,500	Bay Area mech. Contractor
Total first cost	\$684,645	Calculation
Total annual costs	\$1,000	Bay Area service Contractor
PV of annual	\$19,600	Calculation
Boiler expected life (yrs)	30	ASHRAE database
Boiler replacement cost	0	Calculation
NPV	\$704,246	Calculation
Savings/ft2 vs Gas Baseline	\$5.91	Calculation

Cost data came from:
Bay Area equipment rep.
and mech. contractor

Incremental Cost for Electric Resistance Heating – Electric Baseline

Baseline: AWHP serving HW Reheat Boxes	Data	Source
Interior zones	16	Real Building Drawings
Perimeter zones	37	Real Building Drawings
Single duct avg cost/box	\$1,033	Bay Area equip. rep.
Fan box avg cost/box	\$1,789	Bay Area equip. rep.
Cost of electric resistance boxes (SD + FPB)	\$82,721	Calculated
Mechanical installation cost of typical single duct box with electric resistance (\$/box)	\$2,000	Bay Area mech. Contractor
Mechanical installation cost of typical FPB with electric resistance (\$/box)	\$3,000	Bay Area mech. Contractor
Mechanical installation cost for boxes	\$143,000	Calculated
Electrical service to FPBs	\$1,820	Bay Area elec. Contractor
Electrical install for boxes	\$96,460	Calculated

Cost data came from:
Bay Area equipment rep
and mech. contractor

Incremental Cost for Electric Resistance Heating – Electric Baseline – Cont'd

Baseline: AWHP serving HW Reheat Boxes	Data	Source
Unit price of filter change for FPB (\$/box)	150	Bay Area mech. Contractor
Sound boot per box (\$/box)	1,000	Bay Area mech. Contractor
% of FPB with sound boots	100%	Conservative estimate
Sound boot cost	\$37,000	Calculated
Total first cost	\$359,181	Calculated
Total annual costs	\$5,550	Calculated
PV of annual	\$108,782	Calculated
NPV	\$467,963	Calculated
Savings/ft2 vs AWHP baseline	\$12.19	Calculated

Cost data came from:
Bay Area equipment rep.
and mech. contractor

Simultaneous Condenser Heat Recovery – Space Heating

- Hospital

	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	Benefit-to-Cost Ratio
1	\$5.96	\$0.41	14.4
2	\$5.77	\$0.41	13.9
3	\$4.69	\$0.41	11.3
4	\$5.97	\$0.41	14.4
5	\$5.28	\$0.41	12.7
6	\$4.62	\$0.41	11.2
7	\$3.93	\$0.41	9.5
8	\$4.56	\$0.41	11.0
9	\$4.54	\$0.41	11.0
10	\$4.52	\$0.41	10.9
11	\$4.56	\$0.41	11.0
12	\$5.09	\$0.41	12.3
13	\$4.25	\$0.41	10.3
14	\$5.91	\$0.41	14.3
15	\$3.42	\$0.41	8.3
16	\$7.15	\$0.41	17.3

Simultaneous Condenser HR Scenario “A”:

Cooling_{HL} + 0.1*Cooling_{LL} ≥ 200 tons and SHW_{cap} + Heating_{cap} ≥ 2000 kBtuh,

- large office
- all electric baseline
- no SHW HR
- Cooling_{HL} = 180 tons
- Cooling_{HL} + 0.1*Cooling_{LL} ~ 200 tons
- SHW_{cap} = 0 kBtuh
- SHW_{cap} + Heating_{cap} ~ 2000 kBtuh
- HR chiller sized per measure (50%...)
- Avg AWHP Heating COP: 3.3
- Avg WWHP Heating COP: 4.5
- air economizer is throttled to make CHW load match HHW load, if possible

	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	Benefit-to-Cost Ratio
1	\$ 1.05	\$ 0.22	4.9
2	\$ 1.05	\$ 0.21	5.1
3	\$ 1.01	\$ 0.20	4.9
4	\$ 1.04	\$ 0.24	4.3
5	\$ 1.01	\$ 0.20	5.0
6	\$ 0.37	\$ 0.20	1.8
7	\$ 0.30	\$ 0.20	1.5
8	\$ 0.39	\$ 0.20	1.9
9	\$ 0.46	\$ 0.20	2.2
10	\$ 0.51	\$ 0.20	2.5
11	\$ 0.93	\$ 0.22	4.2
12	\$ 0.83	\$ 0.21	4.0
13	\$ 0.71	\$ 0.20	3.5
14	\$ 0.90	\$ 0.21	4.3
15	\$ 0.29	\$ 0.20	1.4
16	\$ 1.39	\$ 0.22	6.5

Simultaneous Condenser HR Scenario “B”:

Cooling_{cap} ≥ 300 tons and SHW_{cap} + 0.1*Heating_{cap} ≥ 600 kBtuh

- large office
- all electric baseline
- yes SHW HR
- Cooling_{HL} = 0 tons
- Cooling_{HL} + 0.1*Cooling_{LL} ~ 300 tons
- SHW_{cap} = 320 kBtuh
- SHW_{cap} + Heating_{cap} ~ 600 kBtuh
- HR chiller sized per measure (50%...)
- SHW HX sized per measure (30%...)
- Avg AWHP Heating COP: 3.3
- Avg WWHP Heating COP: 4.5
- air economizer is throttled to make CHW load match HHW+SHW load, if possible

	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	Benefit-to-Cost Ratio
1	\$ 0.91	\$ 0.29	3.2
2	\$ 0.78	\$ 0.28	2.8
3	\$ 0.78	\$ 0.27	2.9
4	\$ 0.73	\$ 0.32	2.3
5	\$ 0.76	\$ 0.27	2.8
6	\$ 0.83	\$ 0.25	3.4
7	\$ 0.87	\$ 0.23	3.8
8	\$ 0.83	\$ 0.24	3.4
9	\$ 0.80	\$ 0.25	3.2
10	\$ 0.80	\$ 0.26	3.1
11	\$ 0.70	\$ 0.29	2.4
12	\$ 0.76	\$ 0.28	2.7
13	\$ 0.73	\$ 0.28	2.7
14	\$ 0.76	\$ 0.28	2.7
15	\$ 0.83	\$ 0.25	3.3
16	\$ 0.61	\$ 0.29	2.1

Condenser Heat Recovery – Thermal Energy Storage + Heat Recovery

- large office

	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	Benefit-to-Cost Ratio
1	\$5.96	(3.66)	infinite
2	\$5.77	(3.66)	infinite
3	\$4.69	(3.66)	infinite
4	\$5.97	(3.66)	infinite
5	\$5.28	(3.66)	infinite
6	\$4.62	(3.66)	infinite
7	\$3.93	(3.66)	infinite
8	\$4.56	(3.66)	infinite
9	\$4.54	(3.66)	infinite
10	\$4.52	(3.66)	infinite
11	\$4.56	(3.66)	infinite
12	\$5.09	(3.66)	infinite
13	\$4.25	(3.66)	infinite
14	\$5.91	(3.66)	infinite
15	\$3.42	(3.66)	infinite
16	\$7.15	(3.66)	infinite

Electric Resistance Heating – Gas Baseline

- large office

	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	Benefit-to-Cost Ratio
1	(\$2.75)	(\$6.73)	2.45
2	(\$3.57)	(\$6.73)	1.89
3	(\$3.07)	(\$6.73)	2.19
4	(\$3.73)	(\$6.73)	1.81
5	(\$2.76)	(\$6.73)	2.44
6	(\$2.00)	(\$6.73)	3.37
7	(\$1.63)	(\$6.73)	4.14
8	(\$2.38)	(\$6.73)	2.84
9	(\$2.48)	(\$6.73)	2.72
10	(\$2.65)	(\$6.73)	2.54
11	(\$4.34)	(\$6.73)	1.55
12	(\$3.34)	(\$6.73)	2.02
13	(\$3.20)	(\$6.73)	2.10
14	(\$4.56)	(\$6.73)	1.48
15	(\$2.74)	(\$6.73)	2.46
16	(\$7.19)	(\$6.73)	0.94

Electric Resistance Heating – Electric Baseline

- large office

	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	Benefit-to-Cost Ratio
1	(\$2.00)	(\$9.75)	4.9
2	(\$2.13)	(\$9.75)	4.6
3	(\$3.11)	(\$9.75)	3.1
4	(\$2.18)	(\$9.75)	4.5
5	(\$2.33)	(\$9.75)	4.2
6	(\$2.32)	(\$9.75)	4.2
7	(\$2.02)	(\$9.75)	4.8
8	(\$2.58)	(\$9.75)	3.8
9	(\$2.66)	(\$9.75)	3.7
10	(\$2.79)	(\$9.75)	3.5
11	(\$3.06)	(\$9.75)	3.2
12	(\$2.32)	(\$9.75)	4.2
13	(\$2.47)	(\$9.75)	3.9
14	(\$2.09)	(\$9.75)	4.7
15	(\$2.80)	(\$9.75)	3.5
16	(\$1.67)	(\$9.75)	5.8

Statewide Impacts

Methodology and Assumptions

- Statewide Energy Impacts
Methodology and Results



Statewide Economic Impacts Methodology

The Statewide CASE Team estimates annual statewide impacts by multiplying **A x B x C**:

- A. per-unit energy impacts (discussed in previous section)
- B. number of units of new construction/additions/alterations of each applicable building type
- C. portion of affected units in each climate zone

Example:

Per Unit Impacts

Savings type	Savings per square foot
Electricity	[X] kWh
Peak demand	[X] Watts
Natural gas	[X] Therms
GHG emissions	[X] Tons CO ₂ e



Affected New Construction

Climate Zone	Large Office sq ft	Assembly sq ft
1	100	20
2	1,000	1,500
...		
16	5,000	3,000



Statewide Energy Impacts

Climate Zone	Elec Savings (GWh)	...	GHG savings (MT CO ₂ e)
1	20		1,500
2	50		3,000
...			
16	100		2,000

2026 Construction Forecast for Limit HWST – Gas Baseline

Construction Forecast Building Type		Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)
Residential	SF500	0%	0%
	SF2100	0%	0%
	SF2700	0%	0%
	Low-rise Garden	0%	0%
	Loaded Corridor	0%	0%
	High-rise Multifamily	60%	2%
	Mid-rise Multifamily	0%	0%
Nonresidential	Large Office	60%	2%
	Medium Office	60%	2%
	Small Office	0%	0%
	Large Retail	0%	0%
	Medium Retail	0%	0%
	Strip Mall	0%	0%
	Mixed-use Retail	0%	0%
	Large School	60%	2%
	Small School	0%	0%
	Non-refrigerated Warehouse	0%	0%
	Hotel	60%	2%
	Assembly	0%	0%
	Hospital	60%	2%
	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%	

2026 Construction Forecast for Limit HWST – AWHP Baseline

Construction Forecast Building Type		Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)
Residential	SF500	0%	0%
	SF2100	0%	0%
	SF2700	0%	0%
	Low-rise Garden	0%	0%
	Loaded Corridor	0%	0%
	High-rise Multifamily	30%	1%
	Mid-rise Multifamily	0%	0%
Nonresidential	Large Office	30%	1%
	Medium Office	30%	1%
	Small Office	0%	0%
	Large Retail	0%	0%
	Medium Retail	0%	0%
	Strip Mall	0%	0%
	Mixed-use Retail	0%	0%
	Large School	30%	1%
	Small School	0%	0%
	Non-refrigerated Warehouse	0%	0%
	Hotel	30%	1%
	Assembly	0%	0%
	Hospital	30%	1%
	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%	

2026 Construction Forecast for Condenser HR and TES

Recall Condenser HR has three subsections:

- 1: simultaneous space heating/cooling
- 2: thermal energy storage
- 3: service HW heat recovery

Fields with 30% assume that one (or a combination) of these three would impact this fraction of buildings.

Construction Forecast Building Type		Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)
Residential	SF500	0%	0%
	SF2100	0%	0%
	SF2700	0%	0%
	Low-rise Garden	0%	0%
	Loaded Corridor	0%	0%
	High-rise Multifamily	0%	0%
	Mid-rise Multifamily	0%	0%
Nonresidential	Large Office	30%	0%
	Medium Office	30%	0%
	Small Office	0%	0%
	Large Retail	0%	0%
	Medium Retail	0%	0%
	Strip Mall	0%	0%
	Mixed-use Retail	0%	0%
	Large School	30%	0%
	Small School	0%	0%
	Non-refrigerated Warehouse	0%	0%
	Hotel	0%	0%
	Assembly	0%	0%
	Hospital	30%	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%	

2026 Construction Forecast for Electric Resistance Heating – Gas Baseline

Construction Forecast Building Type		Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)
Residential	SF500	0%	0%
	SF2100	0%	0%
	SF2700	0%	0%
	Low-rise Garden	0%	0%
	Loaded Corridor	0%	0%
	High-rise Multifamily	0%	0%
	Mid-rise Multifamily	0%	0%
Nonresidential	Large Office	7%	1%
	Medium Office	7%	1%
	Small Office	0%	0%
	Large Retail	0%	0%
	Medium Retail	0%	0%
	Strip Mall	0%	0%
	Mixed-use Retail	0%	0%
	Large School	7%	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%	

2026 Construction Forecast for Electric Resistance Heating – Electric Baseline

Construction Forecast Building Type		Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)
Residential	SF500	0%	0%
	SF2100	0%	0%
	SF2700	0%	0%
	Low-rise Garden	0%	0%
	Loaded Corridor	0%	0%
	High-rise Multifamily	0%	0%
	Mid-rise Multifamily	0%	0%
Nonresidential	Large Office	3%	0%
	Medium Office	3%	0%
	Small Office	0%	0%
	Large Retail	0%	0%
	Medium Retail	0%	0%
	Strip Mall	0%	0%
	Mixed-use Retail	0%	0%
	Large School	3%	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%	

Poll

Hypothetically, if all of our proposed measures were to become adopted into 2025 Title 24 Part 6, which system would you favor for the following building types: large office, medium office, large school, hotel, high-rise mixed use, hospital?

- VAV with all-electric hydronic reheat (complying with 120.2(l) & 140.4(r) if applicable)
- SZ-VAV unitary heat pumps
- Decoupled ventilation with zone level electric resistance heating (complying with Exception 7 to 140.4(g))
- VRF with DOAS (complying with 140.4(r) if applicable)
- WSHP with DOAS (complying with 140.4(r) if applicable)



Additional Feedback Requested

- Additional Data Needs
- Feedback Requested

Additional Feedback Requested

- We are open to additional feedback and suggestions regarding the measures under consideration.
- Feedback and suggestions on the code language are welcome.
- Examples of building designs leveraging the systems being considered by the CASE Team (e.g., electric resistance heating, hydronic heat recovery, thermal energy storage for space heating) would be appreciated.
- Examples of EnergyPlus models using hydronic heat recovery & thermal energy storage.



Discussion and Next Steps

We want to hear from you!

- Provide **any last comments or feedback** on this presentation now verbally or over the GoTo Webinar Questions Pane
- More information on pre-rulemaking for the 2025 Energy Code at <https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency>

Comments on this measure are due by May 31, 2023. Please send comments to info@title24stakeholders.com and copy CASE Authors (see contact info on following slide).

Thank You

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