TITLE 24, PART 6 | 2028 CODE CYCLE

Return-to-Primary Configuration for Central HPWHs in NR Buildings

Codes and Standards Enhancement (CASE) Proposal

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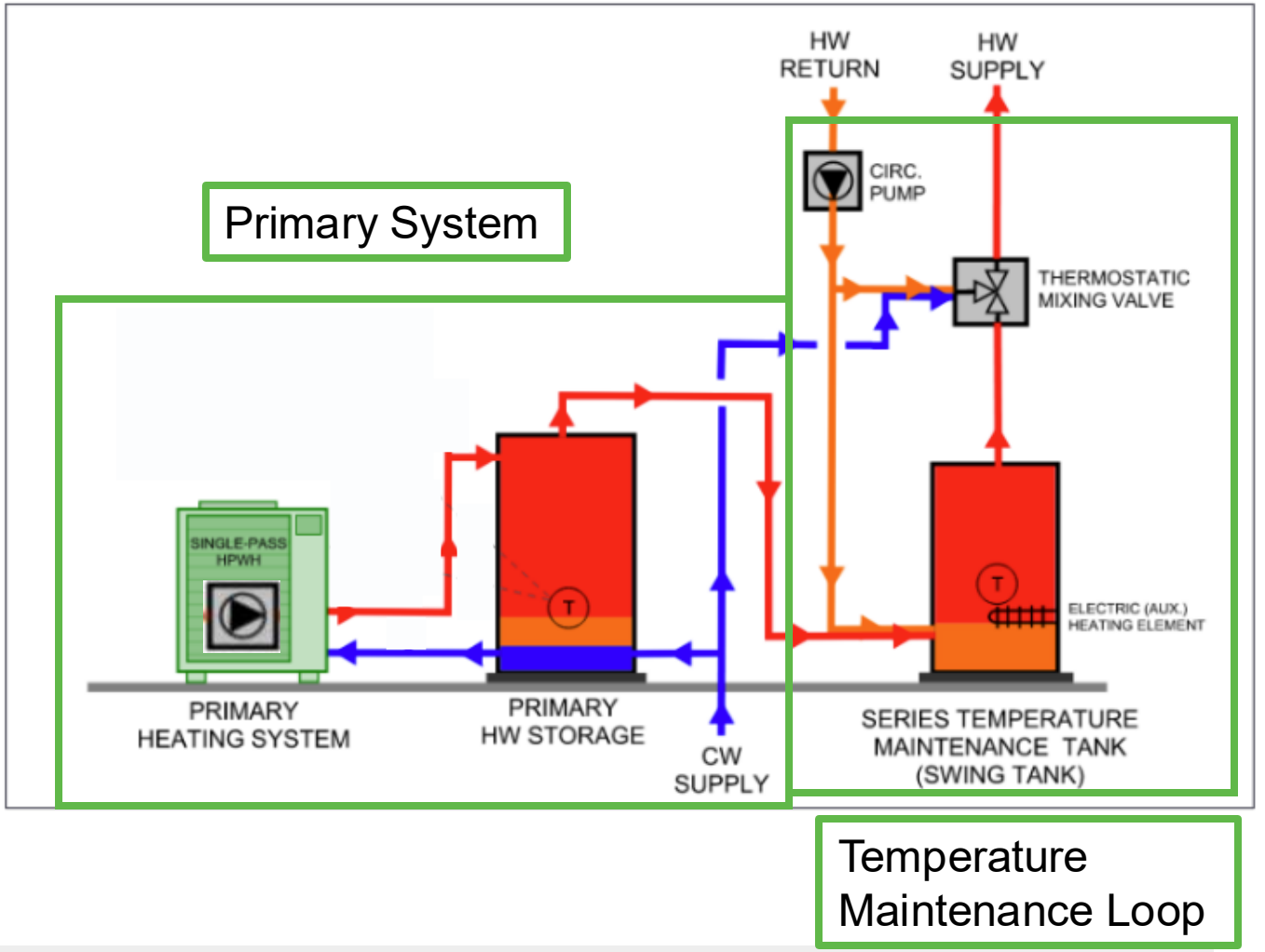
CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Proposal Description

- Background Information
- Current Code
- Code Change Proposal
- Benefits

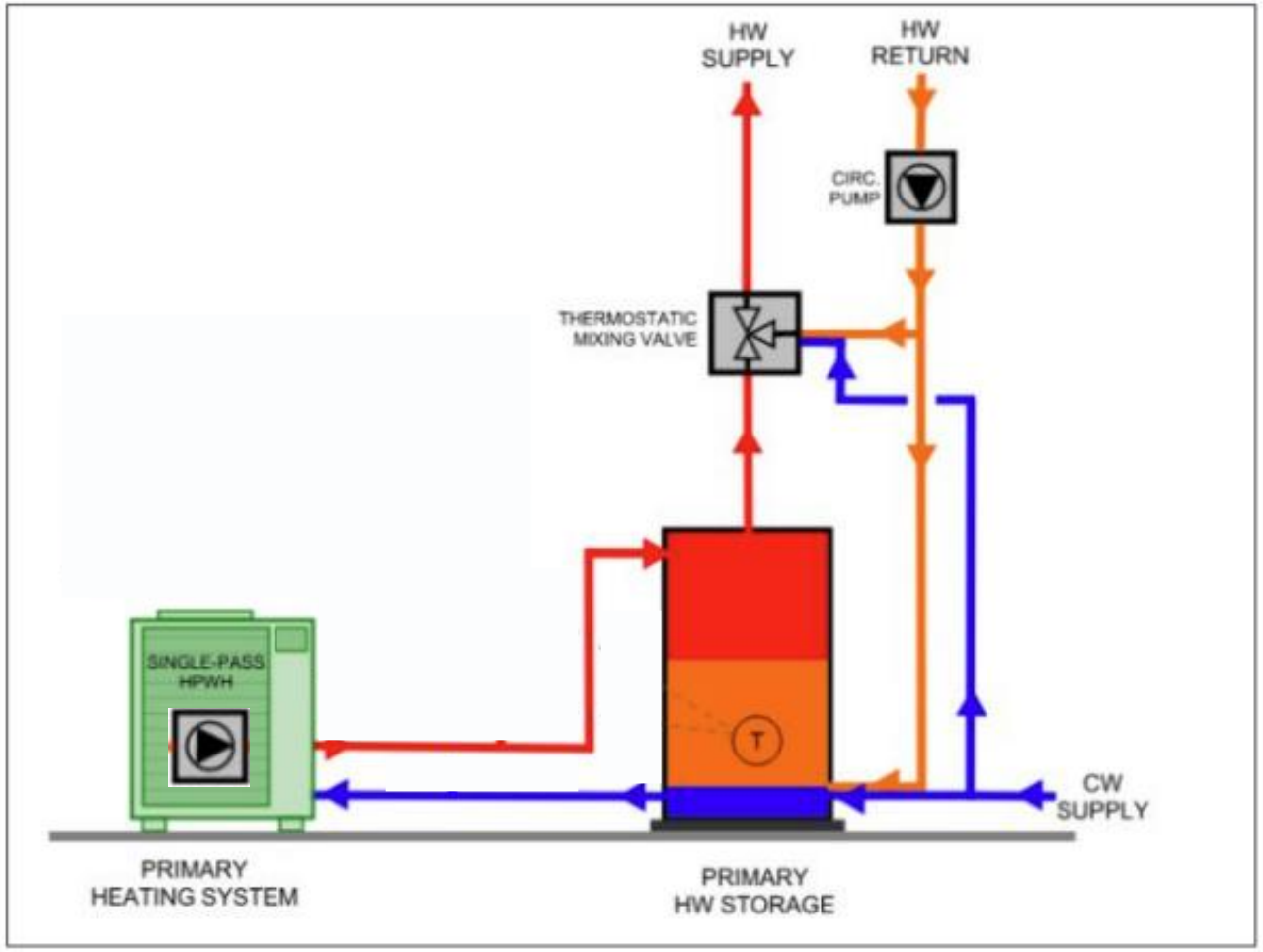
Background Information – Series Temperature Maintenance Heater Configuration (Formerly Known as Swing Tank Configuration)

- 2022 code cycle – Swing tank configuration was the standard practice in many CHPWH applications and considered the most reliable option since it has electric resistance back up
- Many NR buildings using a Series Temperature Maintenance Heater configuration (TMHS) have relatively low draws compared to recirculation heat losses, such as supermarkets, office buildings, retail, arenas, assembly, etc.
- Building types with TMHS configurations will experience high recirculation heat losses and use significant electric resistance.



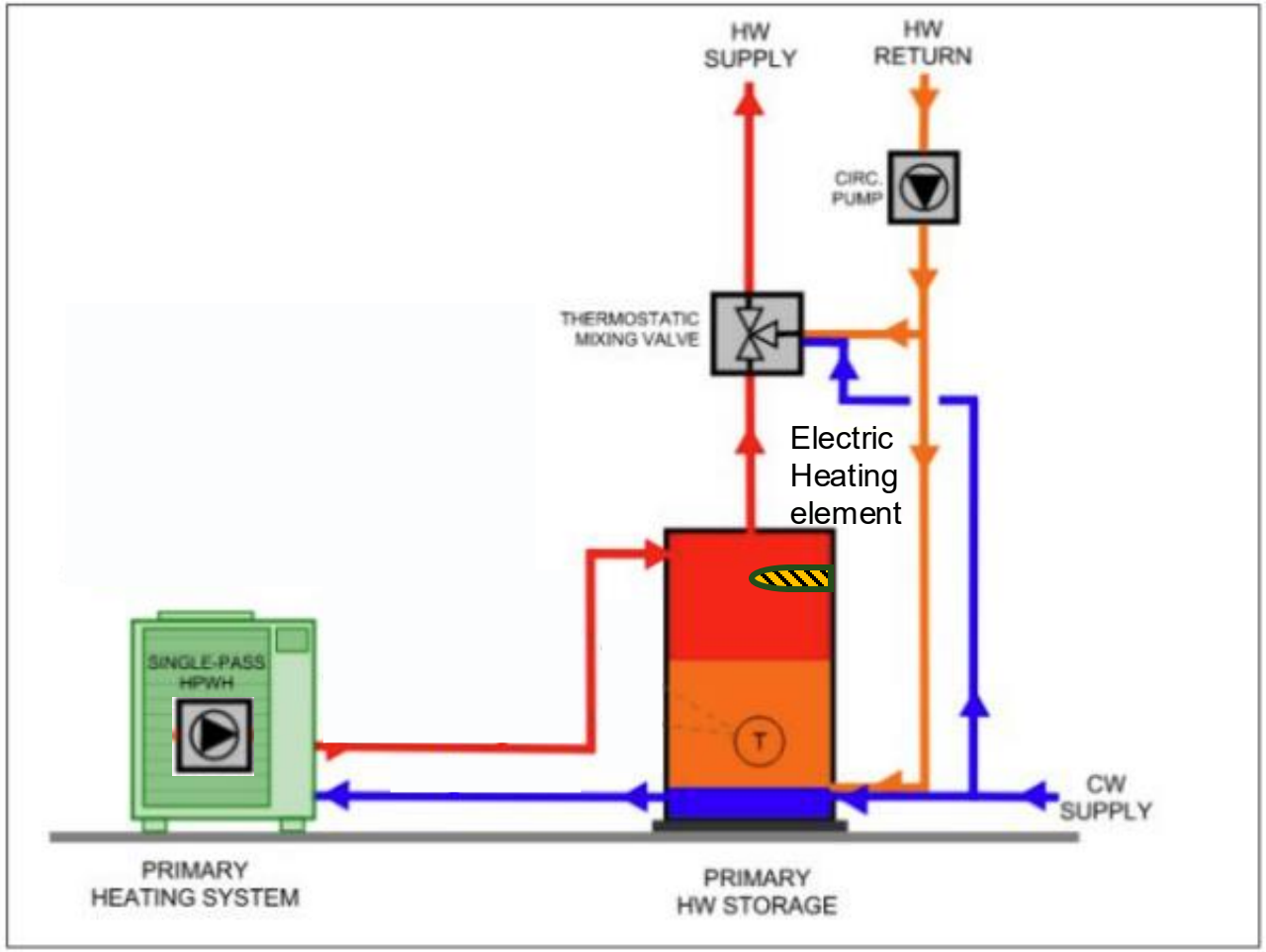
Background Information – Return-to-Primary (RtP)

- Lab tests and field tests have shown
  - RtP configuration operates at higher COP compared to swing tank configuration
  - RtP configuration works reliably with conventional and low-GWP refrigerants (R-134a, R-410A, R-513A, R-454B, etc.)
  - RtP configuration can work without reliability issues with ultra-low GWP refrigerants (e.g., CO2) at lower return water temperatures
- Code readiness funded research is underway to quantify the minimum recirculation return water temperature for reliable operation for large CO2 HPs with advanced controls



Background Information – RtP Back Up Heating Considerations

- The RtP configuration does not require back up heating
- If it is necessary to add back up heating, either for redundancy or extreme outdoor temperatures, we will add code language to ensure the back up heater operates appropriately, e.g., not having the back up heating element or control sensor at the bottom of the primary tank



Background Information – Air Quality Rule

- **SCAQMD zero NOx** water heater compliance dates for new buildings range from 2026 to 2028 (Rule 1146.2), and **BAAQMD** compliance dates range from 2027 to 2031
- **60% of Californians** in SoCal and NorCal won't be able to install gas water heaters
- There is currently no alignment with the new AQMD requirements in Title 24 for NR buildings outside of large schools.
- Providing HPWH design, installation and startup guidance ensures a successful transition from conventional water heating solutions.

Reference: https://www.aqmd.gov/docs/default-source/rule-book/recent-rules/r1146_2-060724.pdf?sfvrsn=8

Current Code

- Current code requires HPWHs for school buildings less than 25,000 square feet and less than 4 stories in Climate Zones 2 through 15
- No requirements or guidance for HPWHs for all other occupancies.

Note: The current NR prescriptive Service Hot Water System requirements do not include requirements specific to split system HPWHs despite the increasing use of central HPWHs in medium to large NR buildings

Proposed Code Change

- **Create a prescriptive pathway** to **require return-to-primary configuration** for split-system Heat Pump Water Heater (HPWH) systems in nonresidential (NR) buildings
- **Include an alternative pathway** for products on the NEEA Tier 2 qualified product list, including standardized configurations and manufacturer's requirements
- **Update Joint Appendix JA14** – Qualification Requirements for Central Heat Pump Water Heater Systems to include new requirements for the design documents, installation, equipment and control start up, alarms, power restoration, performance data reporting (COP, Defrost derate, Input power, Output capacity, Refrigerant type, etc.), and RtP back up heating.
- This proposal would apply to **new construction, additions, and alterations** of NR buildings and all CA climate zones. This requirement would apply to additions and alterations with proposed water heater replacements with split HPWHs. The proposal does not require installation of HPWHs.
- This proposal would require additions to the compliance forms, changes to the compliance software, and new plan check and building inspector activities.
- Reference: Advanced-Water-Heating-Specification.pdf

See Title24stakeholders.com for proposal description, justification, draft code language, and requested data

Benefits of the Proposed Change

- Obtain overall electrical capacity reduction, peak demand savings, installation cost savings, space savings, and operational savings vs. previous HPWH base case (TMHS)
- Reduce grid impact and improve grid reliability during peak demand
- Return-to-primary can maintain hot water delivery reliability
- Start-up requirements ensure long-term savings for the central HPWH systems
- Reduce complexity with equipment and controls installation and start-up

Poll

Are you aware of any HPWH systems deployed in central applications in NR buildings? If so, please explain

Poll

Are you aware of any RtP HPWH system deployed in central applications in NR buildings? If so, please explain

Marked-up Code Language

See Title24stakeholders.com for marked-up code language

Title 24, Part 1	Title 24, Part 6	Reference Appendices
▪ No Changes	▪ SECTION 140.5(a) Prescriptive Requirements for Service Hot Water Systems ▪ SECTION 141.0(a) Additions ▪ SECTION 141.0(b) Alterations	▪ Update Joint Appendix JA14 -- Qualification Requirements for Central Heat Pump Water Heater Systems

Market and Technical Considerations

- Current Market Conditions
- Current Market Trends
- Potential Barriers and Solutions
- Technical feasibility

Current Market Conditions

- The current market share of RtP systems is small
- TMHS configuration has been established and advocated as the current best practice
- Most RtP systems with continuous recirculation are applicable to medium and larger NR buildings
- Incentive program offerings were primarily provided to unitary HPWH in NR buildings due to overestimated energy saving calculations. IOUs are developing new incentive designs to better cover both unitary and split systems.

Current Market Trends

- In small central HPWH applications, we are seeing deployments of small CO2 HPWH in RtP configuration with non-continuous recirculation, which is the most cost-effective and retrofittable option
- Currently, we are seeing conventional refrigerant based HPWHs primarily being installed in RtP configuration with continuous recirculation
- New modular 120V/240V low-GWP low-cost split system HPWHs are reaching the market and may be good candidates for small NR buildings, e.g., salons, small retail, outpatient offices, etc.

Market Barriers and Solutions

Market Barriers	Potential Solutions
1. Limited number of Central HPWH RtP system designs and field installations in NR buildings to document design and installation practices 2. Lack of awareness of RtP performance in NR buildings 3. Lack of awareness that RtP configuration is a viable option in many applications	1. Contact building community, vendors and distributors to identify buildings to attain building plans with RtP systems in NR buildings. 2. Interview and survey manufacturers, distributors, designers, contractors, and developers to understand design decisions, product availability, reliability and performance. 3. Provide more training and education of various RtP designs

Current Market Share

Market share: percentage of buildings that already installed RtP for central HPWHs with recirculation based on our best guess (PENDING plans review)

Current Market Share

New Construction and Additions	**10%** Voluntarily installed RtP systems either through Reach Codes or to meet corporate and institutional buildings' sustainability goals

Alterations	**20%** ▪ Incentive programs have contributed to mainly unitary HPWH in NR

Poll

The Statewide CASE Team has identified the following market forces that drive the future adoption of RtP configurations, please select all the following items that you think are true about RtP Configurations compared to TMHS:

a. Less complexity in design, installation, and start-up

b. Less space requirements

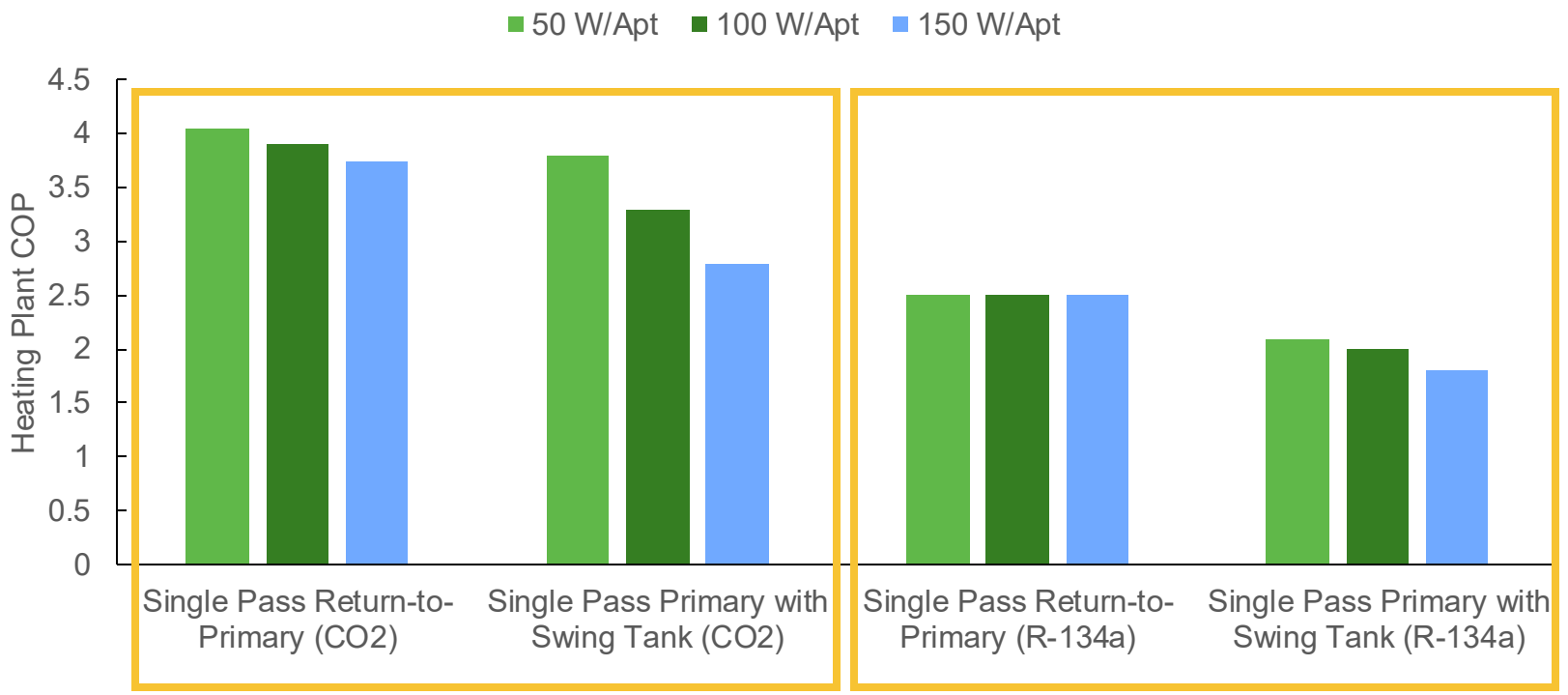
c. Lower installed costs

d. Higher operating COP

For items you do not think are true, please enter your comments in the Q&A window

Technical Considerations

- Data from lab tests and field demonstrations of central HPWH systems show that RtP system performs better than swing tank configuration.



Lab test results on Heating Plant COP for various central HPWH configurations with different refrigerants

Technical Considerations: NEEA AWHS V8.1

- NEEA V8.1 as alternative prescriptive pathway
  - SysCOP: *Vendor submit performance data and estimate annual SysCOP using CHPWH System Performance Calculator which is built into the Product Assessment Datasheet (PADS)*
  - Efficiency Tiers: *Minimum SysCOP used for listing on the Qualified Products List*

Table 3. CHPWH System Efficiency Tiers

	Minimum SysCOP			
	Hot Climate (IECC Zones 1–2)	Mild Climate (IECC Zones 3–4)	Cold Climates (IECC Zones 5–6)	Extremely Cold Climates (IECC Zones 7–8)
Tier 1	1.75	1.50	1.25	1.15
Tier 2	2.25	2.00	1.60	1.50
Tier 3	2.75	2.50	2.25	2.15
Tier 4	3.50	3.00	2.75	2.50

  - QPL: *Currently, there are 121 products with various configurations listed on the commercial HPWH Qualified Products List*

Reference: commercial-HPWH-qualified-products-list.pdf

Central HPWH System Reliability

- The Statewide CASE Team will evaluate the RtP system reliability, specific to refrigerant type, defrost derate, back up heating requirements, diagnostics capabilities, and controls, etc.
- The code will add Qualification Requirements for Central Heat Pump Water Heater Systems to include new requirements for the design documents, installation, start up, and performance data report
- The performance data report will require the CHPWH system sized using the derate data. If no derating information is provided, the design must use the worst-case derating factor to calculate output capacity on defrost design day

Technical Barriers and Solutions

Technical Barriers	Potential Solutions
1. There is no current standard practice for design, installation and start-up of CHPWH configurations in NR buildings 2. Which HP RtP configurations require back up heating?	1. Review field demonstrations and lab test data. Conduct interviews and surveys with designers, manufacturers, contractors and building officials to develop requirements for quality installation and operation. 2. Modify compliance forms to ensure RtP systems are properly designed and installed. 3. Review manufacturer's literature, lab and field test data, and conduct interviews to identify guardrails needed to ensure hot water reliability

Poll

Are there current standard practice guidelines or requirements for design, installation, and start up of RtP configurations in NR buildings?

Per Unit Energy and Cost Impacts

Methodology and Assumptions

- Energy and Energy Cost Savings
- Incremental Costs

Energy and Energy Cost Savings Methodology

- Water use (GPD/ft^2) provided by Ecotope that they sourced from an LBNL study
- Estimate system COP to calculate savings per square foot of NR buildings
- Estimate the share of buildings with RtP systems in NR to calculate statewide savings of NR buildings

Reference: Technology Data Characterizing Water Heating in Commercial Buildings: Application to End-Use Forecasting

Preliminary Savings Estimates

Measure	Annual per Unit Electricity Savings* (kWh/sqft)	Annual per Unit Natural Gas Savings* (Therms/sqft)	First Year Statewide Electricity Savings (GWh)	First Year Statewide Natural Gas Savings (Million Therms)	Confidence Level in Preliminary Energy Savings (low, medium, high)
Return-to-primary – NR buildings, new constructions and alterations	0.00138	NA	10.6	NA	Medium

Energy Modeling Assumptions

- Simulating using the following prototypical buildings and climate zones
- There are limited prototypes in **CBECC**

Prototypical Buildings
▪ Office (large, medium, small) ▪ School (large, small) ▪ Laboratory ▪ Restaurant ▪ Grocery

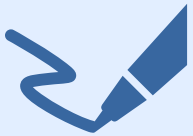
Climate Zones
▪ CA Climate Zones 1 to 16

Key Modeling Assumptions

Prototype: Each Prototypical Building

Standard Design

1. For new construction, the base case system COP is assumed to be 2.1
2. For existing buildings, the base case system COP is assumed to be 1.8



Proposed Design

1. For new construction, the measure case system COP is assumed to be 2.5
2. For existing buildings, the measure case system COP is assumed to be 2.5

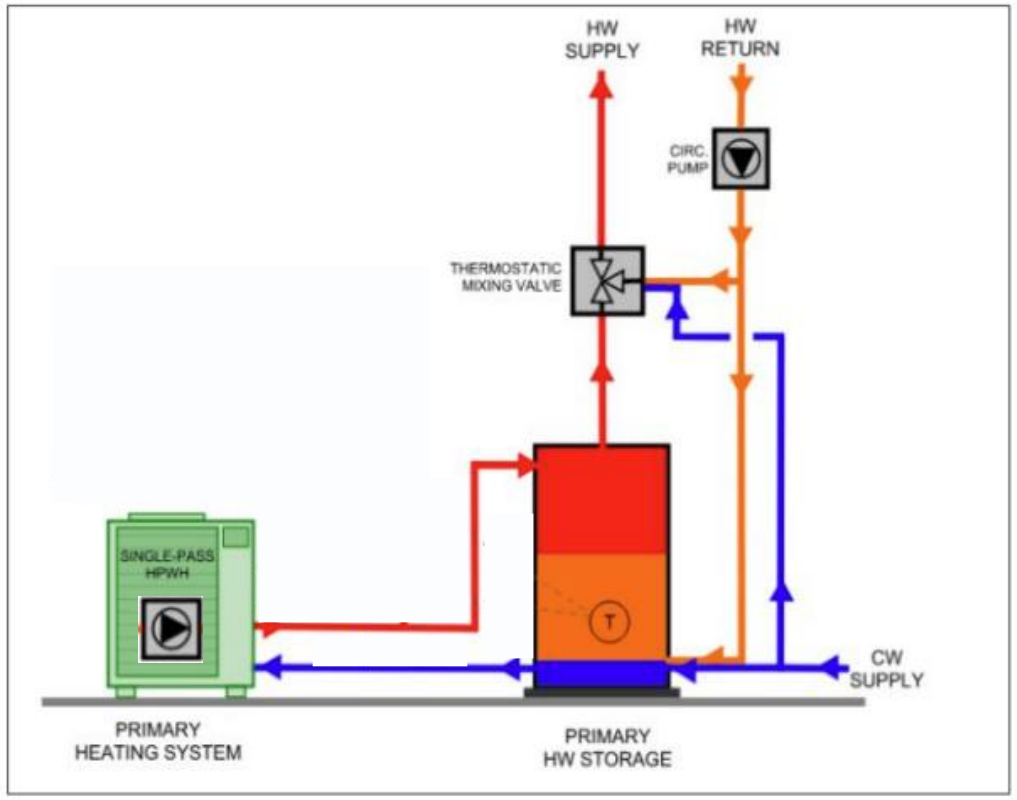
Approach for Gathering Costs

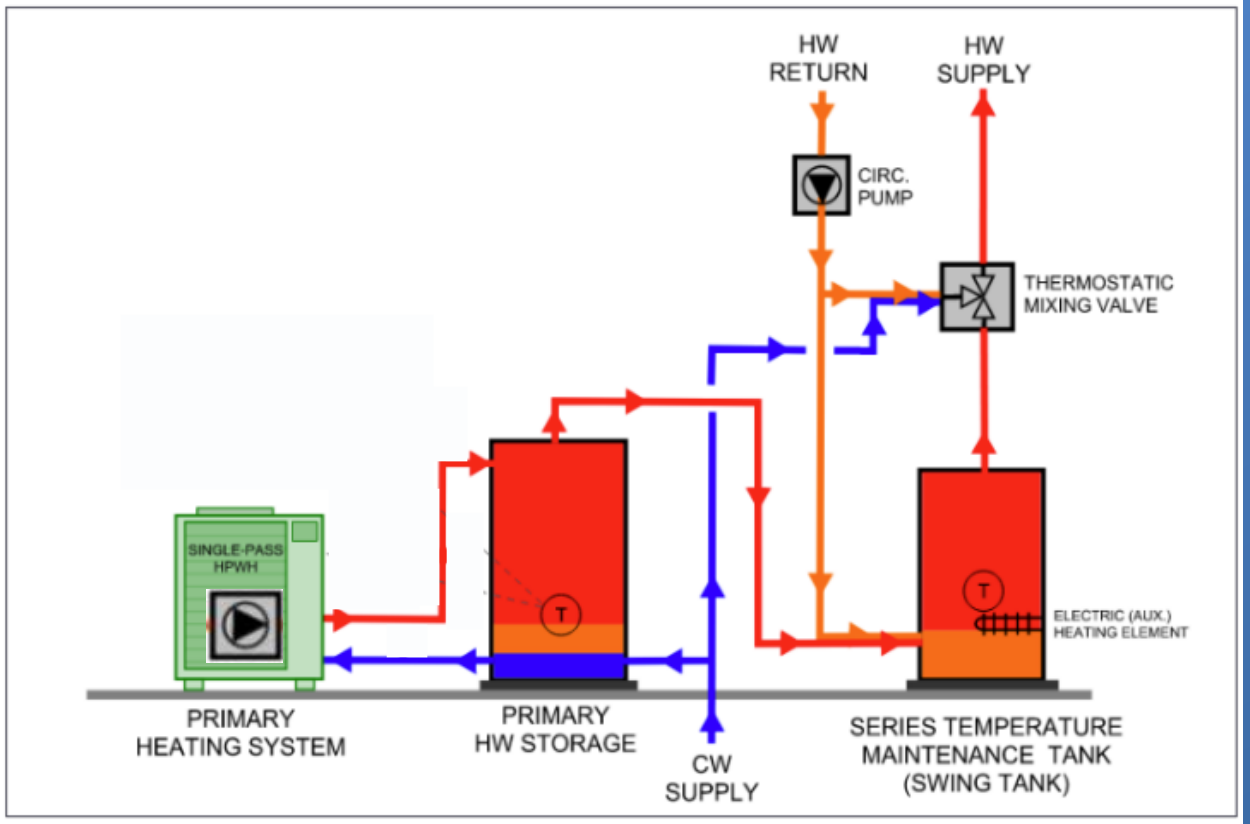
Methodology for cost collection

- Interviews with manufacturers, distributors or contractors to confirm the design concept
- Experienced plumbing engineers will provide basis of design (BOD) for base case and measure case
- Design-build contractors will provide cost estimation for the BOD, we will obtain quotes from at least two different contractors as the primary sources
- Use costs from RSMeans, published studies to vet our primary sources and fill in any gaps

Poll

Do you think installation cost for RtP systems is less or more than TMHS systems?





Compliance Verification

- Key Aspects of Compliance Verification
- Barriers and Solutions
- Revisions to Compliance Software

Key Aspects of Compliance Verification

- We will update JA14 for design documentation to require design documents, installation, and start up, this applies to both prescriptive and alternative pathway
- We will add additions to the compliance forms to ensure that applicable appendices are followed, including NRCC-PLB-E and NRCI-PLB-E
- We will make changes to the compliance software
- New plan check and building inspector activities related to compliance with this measure, e.g.,
  - Make sure the return is piped to the primary tank
  - Make sure the start-up procedures are outlined correctly for the contractors, etc.

Poll

Rate the likelihood the **proposed measure** would **increase** the number of water heater replacements **without proper permits** for alterations.

a. Very Unlikely
b. Unlikely
c. Likely
d. Very Likely

Compliance Barriers and Solutions

Compliance Verification Barriers	Potential Solutions
1. Design engineers have experience with gas boiler split systems but limited experience with heat pump-based RtP systems 2. Contractors have limited or no experience installing systems with RtP configurations	1. Require manufacturers to provide readily available product specifications. Create awareness and training, and developing best practice guides for designers 2. Update JA14 to require proper installation. We are collaborating with incentive programs, specifically developers and implementers to provide a list of installation requirements and require permitting for alterations in new programs. Additionally, we recommend implementers provide installation and startup oversight. 3. Create awareness and training, and develop best practice guides for contractors

Compliance Software Updates

- The Statewide CASE Team will update CBECC software so it can model RtP for NR buildings.
- The Statewide CASE Team will update the prescriptive requirements for compressor cut-off temperatures to better reflect the capabilities of different HPWH types.
- The Statewide CASE Team will add heating capacity derating factors to more accurately model defrost conditions for RtP systems with different refrigerants and controls.

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More information on
CEC's 2028 proceeding website.

We want to hear from you!

CALIFORNIA ENERGY CODES & STANDARDS
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Cost Effectiveness Results

Climate Zone	Benefits *30-year Energy Cost Savings + Other PV Savings* (2029 PV$)	Costs *Total Incremental PV Costs* (2029 PV$)	Benefit-to-Cost Ratio
1	$#,### – $#,###	$#,### – $#,###	#.# – #.#
2			
3			
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Results vary by prototypical building

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Call out – Lorem ipsum dolor sit amet.

Added slides for clarity

Not necessary part of a presentation but help to focus on answering some of the comments above.

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