Options for domestic water heating in biomass boiler systems

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August 20, 2020
1:00 PM

Moderated by:

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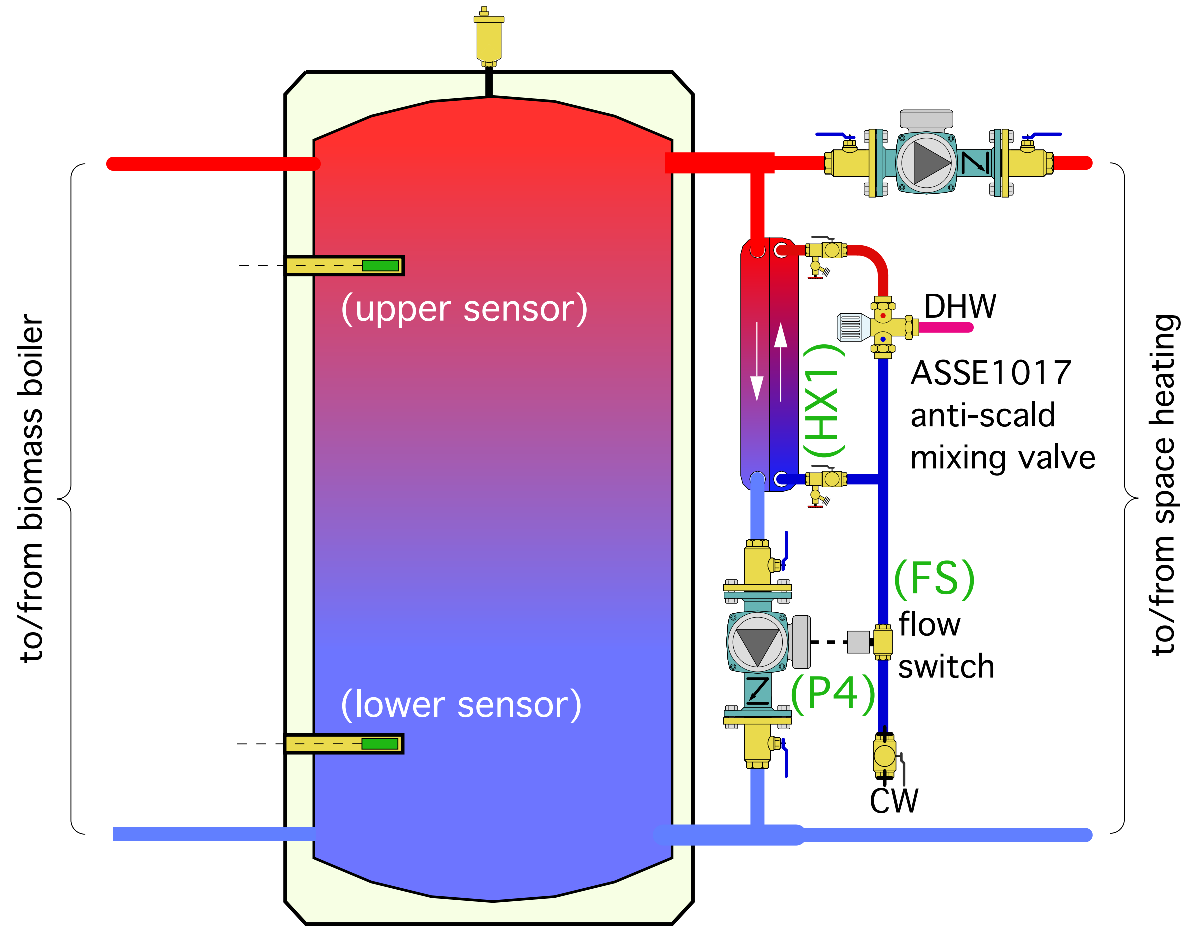

thermal storage tank

presented by:

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www.hydronicpros.com

Simplified Method for Controlling Heat Delivery from Biomass Boilers and Auxiliary Boilers

Session description: Most systems using pellet boilers, or cordwood gasification boilers, are designed for *space heating*. However, *many of the buildings in which these boilers are used also have a requirement for domestic hot water*. This webinar explores several design concepts and hardware options for integrating domestic water heating as an ancillary load. Specific topics include: DHW load estimation, internal and external heat exchangers, flow switches, preheating and auxiliary heating, on-demand versus storage based systems, and anti-scald protection.

Learning objectives:

1. Understand several design concepts for providing domestic hot water in systems supplied by pellet-fired boiler or cordwood gasification boilers.

2. Ability to describe several hardware devices used for domestic water heating.

3. Ability to describe methods for boosting domestic water from a “pre-heat” temperature to a final delivery temperature.

4. Explaining how to provide safe delivery hot water delivery temperatures to fixtures

Design Assistance Manual
for High Efficiency Low Emissions Biomass Boiler Systems

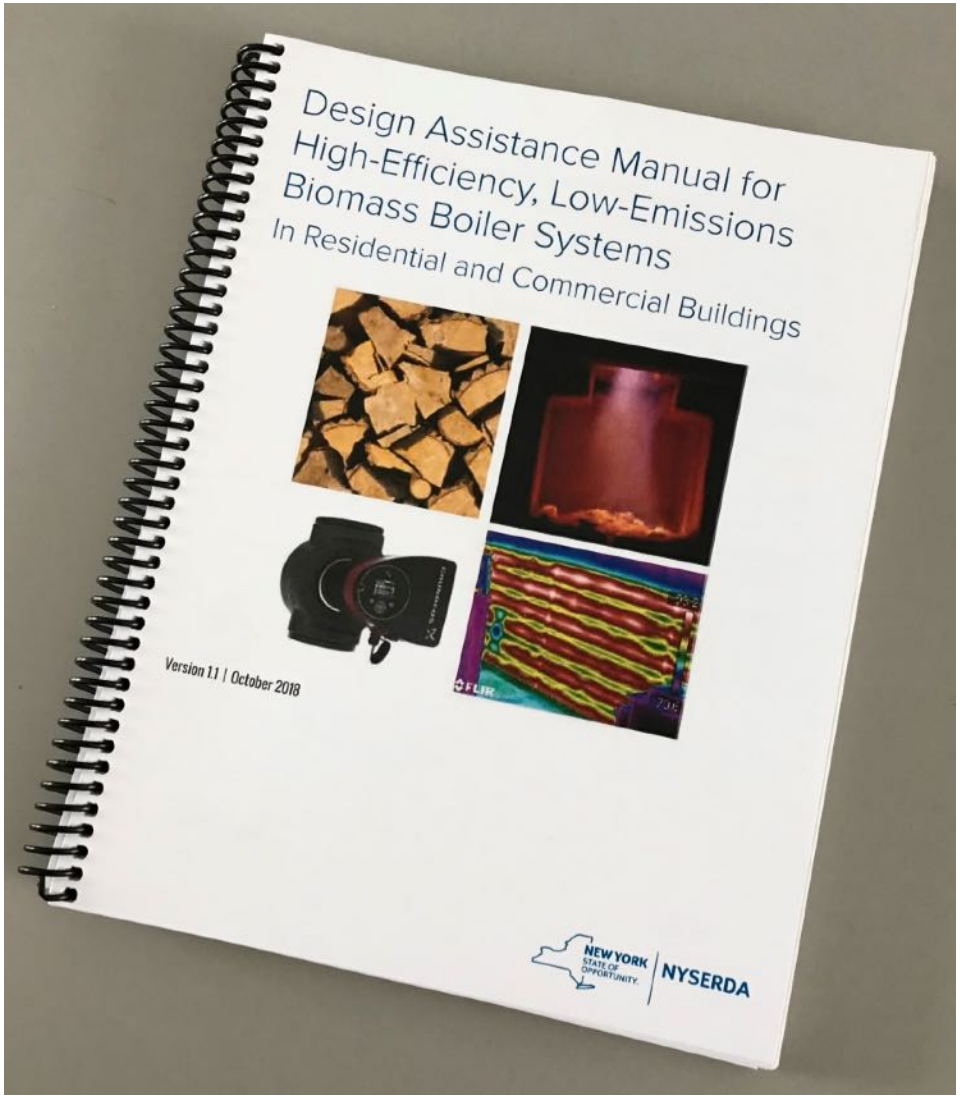


Table of Contents:

It’s available as a FREE downloadable PDF at:

https://www.nyserda.ny.gov/-/media/Files/EERP/Renewables/Biomass/Design-Assistance-Biomass-Boiler.pdf

Should DHW be provide by the pellet boiler that supplies space heating?

Arguments FOR doing this:

1. Circumstances where heat created from pellets is significantly lower cost in $/MMBtu compared to conventional fuel options.

2. DHW load is significant % of total heating energy use in building.

3. There is no other DHW energy source (or electricity is very expensive)

Arguments AGAINST doing this:

1. Don’t want to keep pellet boiler and thermal storage active during non-heating season.

2. Fuel cost difference between pellets and other fuel options is low.

3. DHW load is relatively small, and could cause pellet boiler to short cycle

4. Don’t know how to do it.

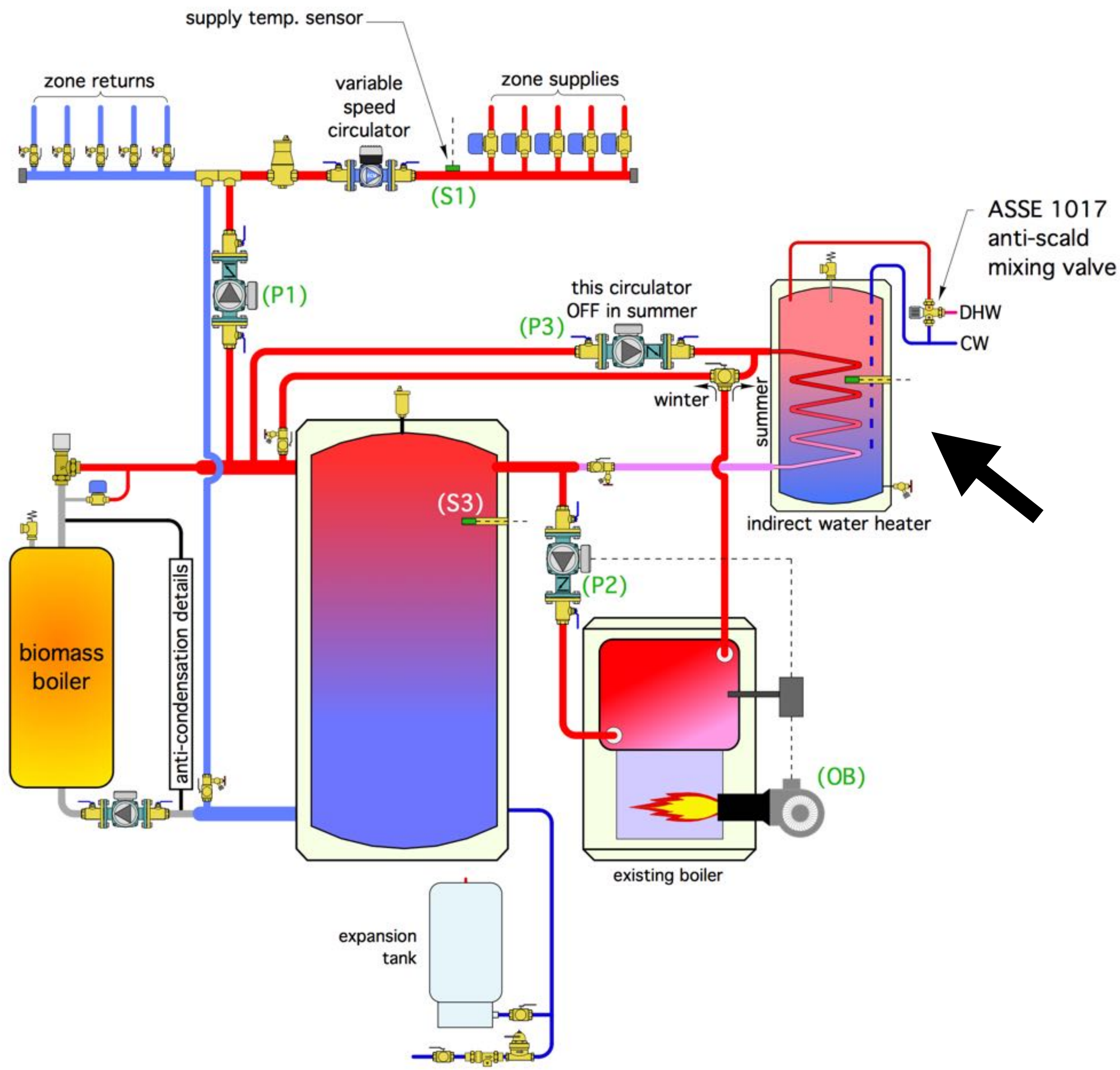
1. Use indirect DHW tank

Pros:

1. Adaptable to most thermal storage tanks

2. Allows heat from aux. boiler, which would only add to upper portion of tank.

3. Can use"summer/winter" switch to eliminate pellet heat in summer, but sustain DHW.

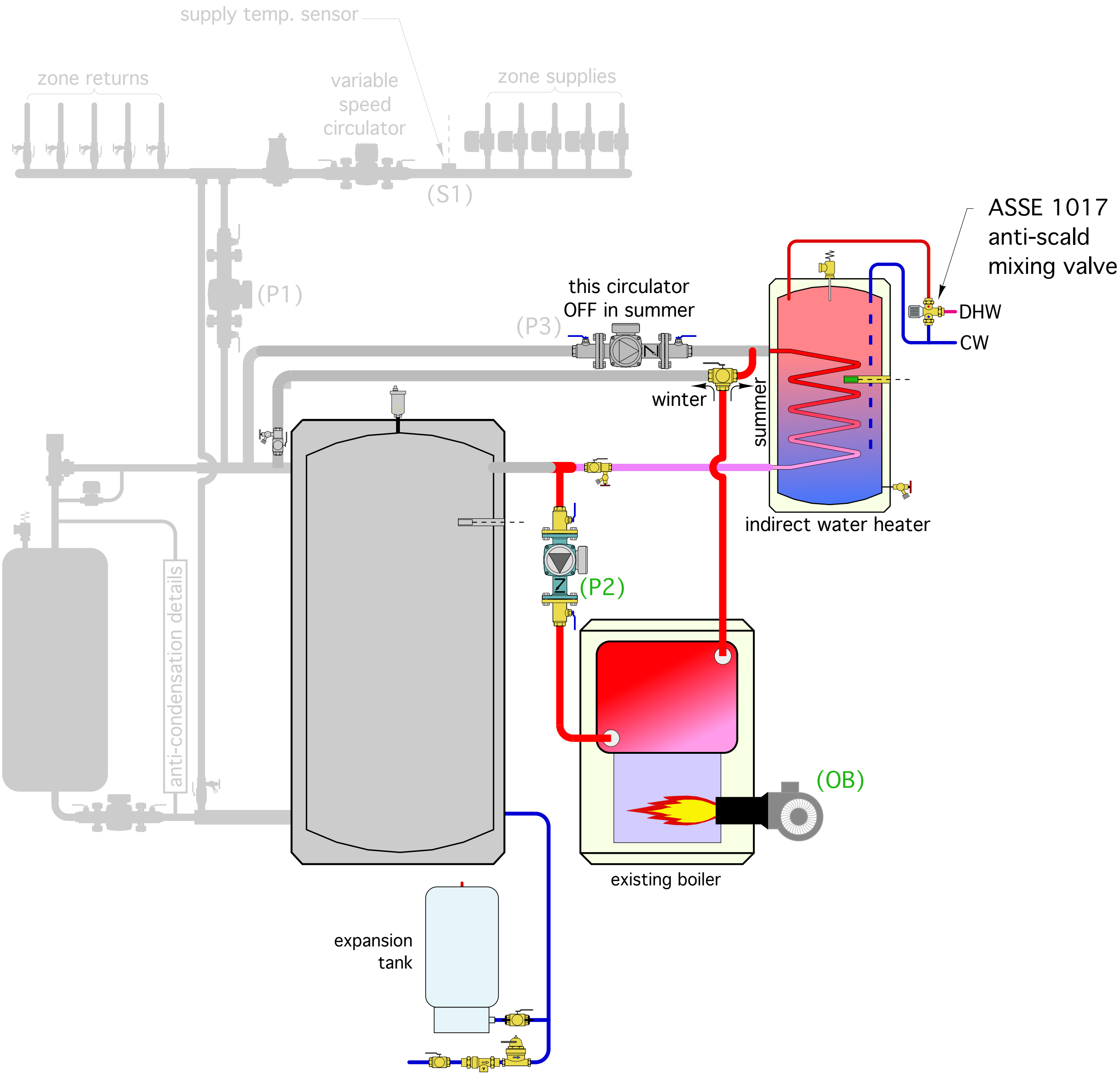


Cons:

1. Most currently available indirect tanks have small internal heat exchangers.

2. Scaling of internal coil could require replacement of indirect tank.

1. Use indirect DHW tank (summer mode)



2. Use *REVERSE* indirect water heater

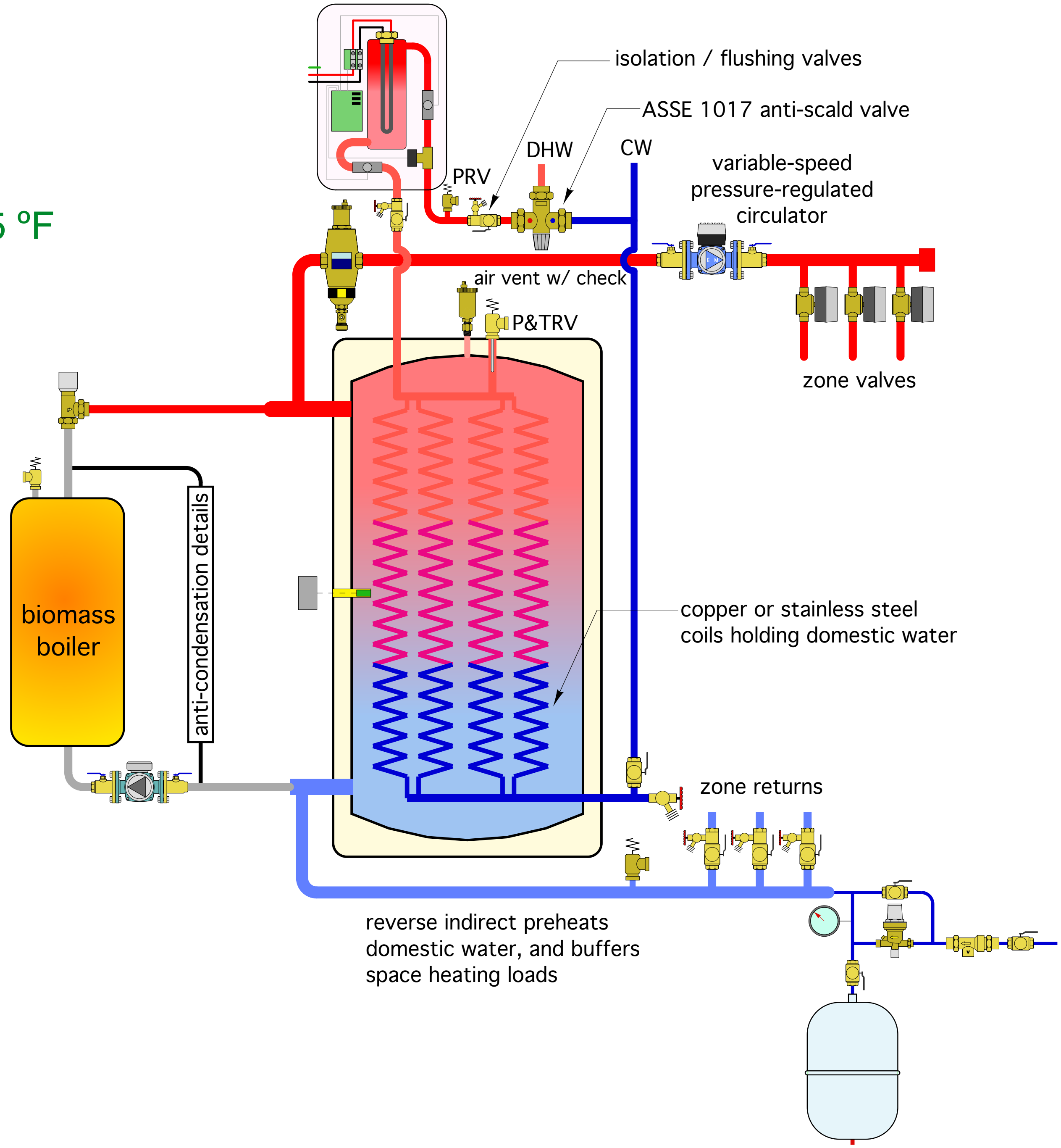
Pros:
1. Allows single tank to buffer boiler and provide DHW.

2. If tank temperature remains above 125 °F could likely eliminate tankless heater

Cons:
1. Limited to 119 gallon tanks at present (25KW pellet boiler under RHNY requirements).

2. Scaling of internal coil could require replacement of indirect tank.

Courtesy of Thermo 2000



3. Use REVERSE indirect water heater (tank-in-tank configuration)

Pros:

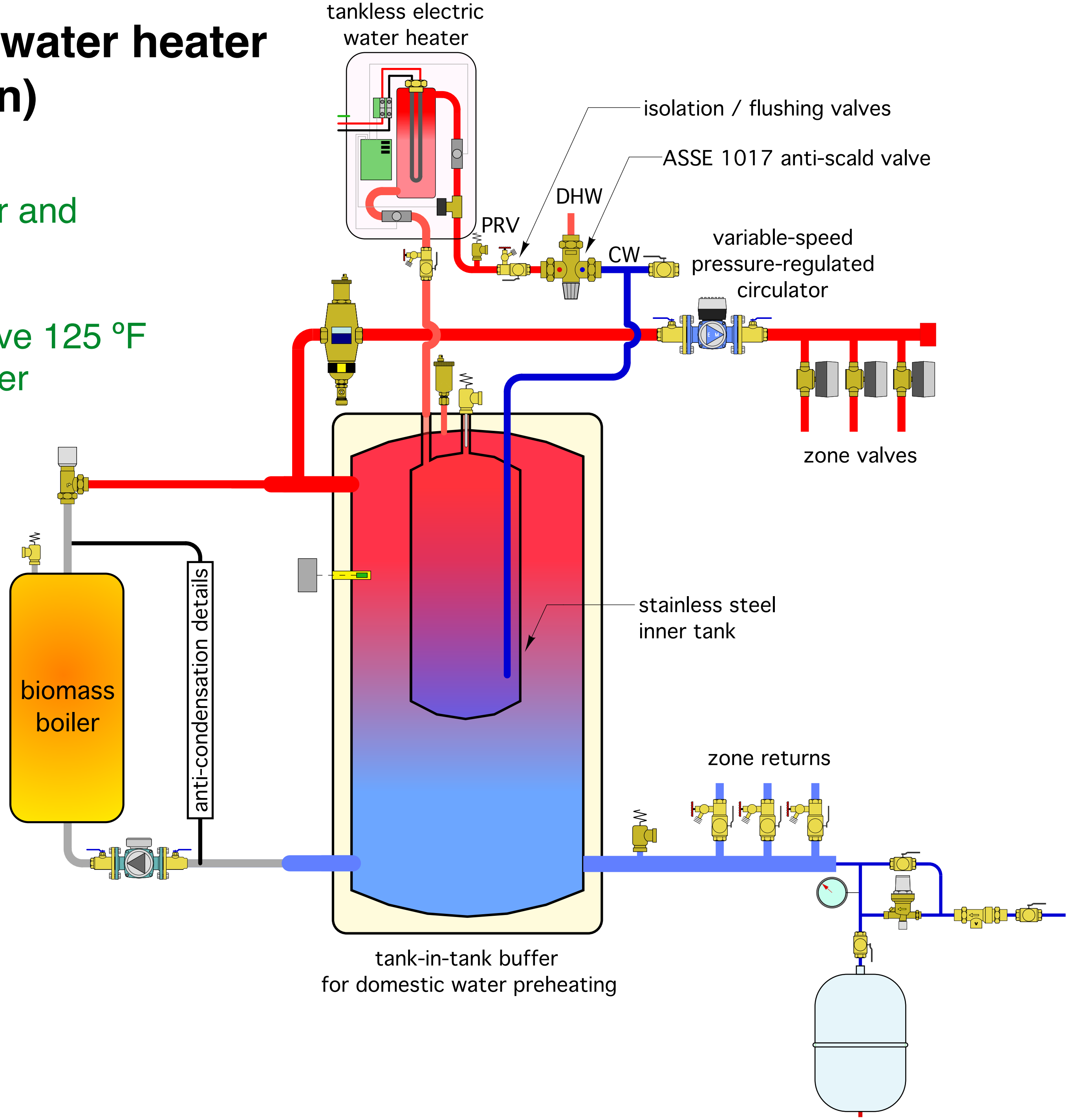
1. Allows single tank to buffer boiler and provide DHW.

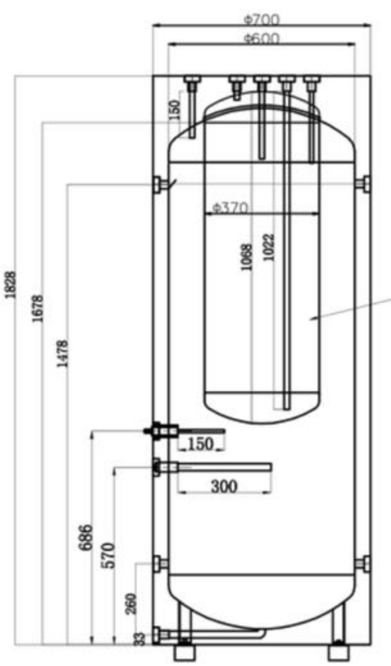
2. If tank temperature remains above 125 °F could likely eliminate tankless heater

Cons:

1. Limited to 119 gallon tanks at present (25KW pellet boiler under RHNY requirements).

2. Limited tank availability.





4. Internal heat exchanger at top of thermal storage

Pros:

1. Simple passive approach

2. Allows heat from aux. boiler, which would only add to upper portion of tank.

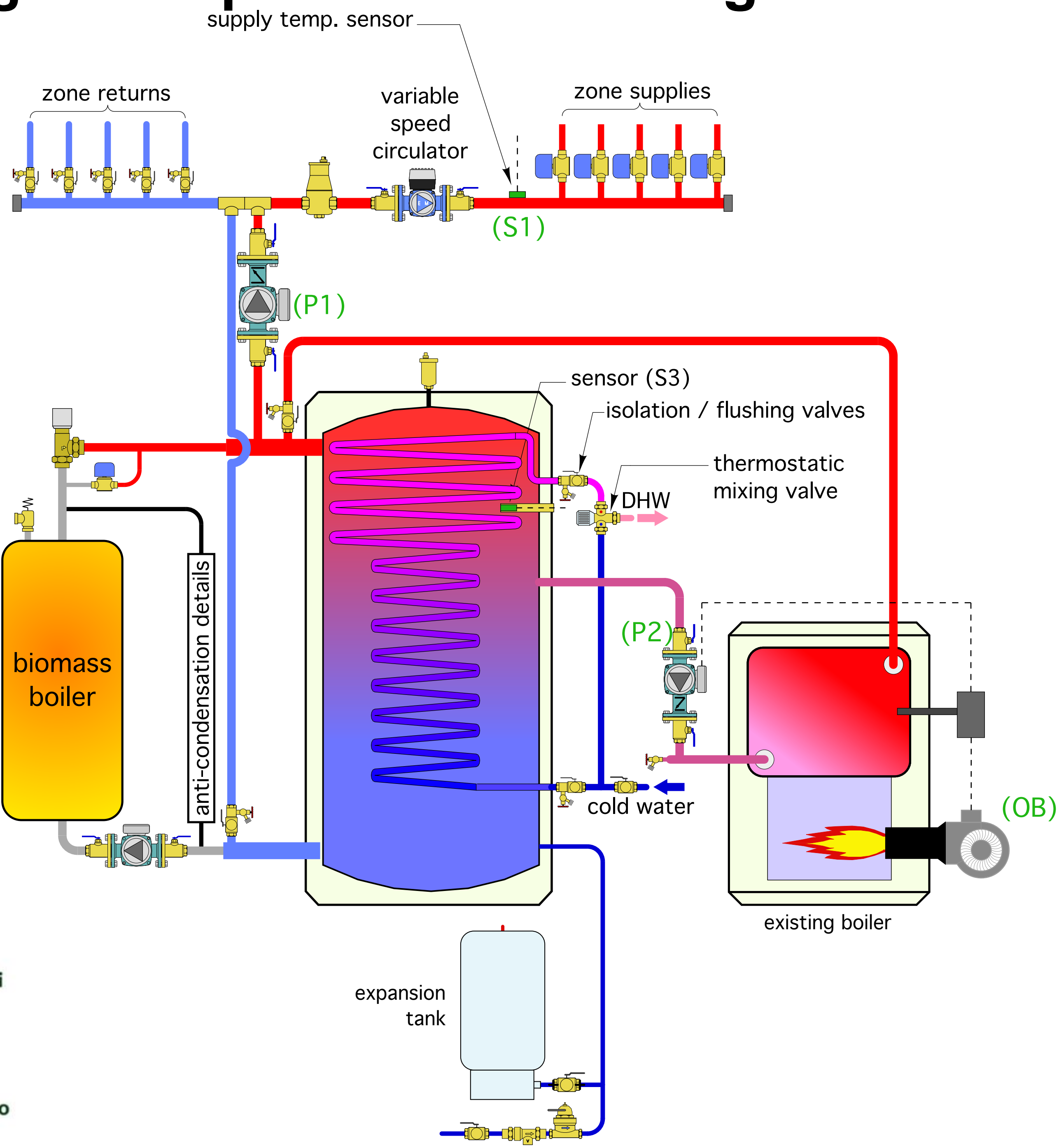
3. With proper tank temperature control no need for aux DHW temperature boost.

Cons:

1. Very limited selection of tanks in of adequate volume in North America. (Possible customized ASME rated tank)

2. Requires thermal storage to be at elevated temperature year round.

3. Any leak or other problem with internal coil very hard to access.



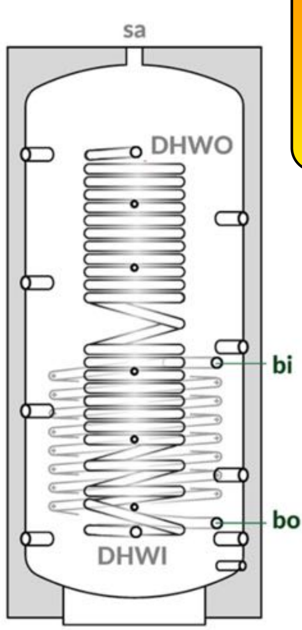
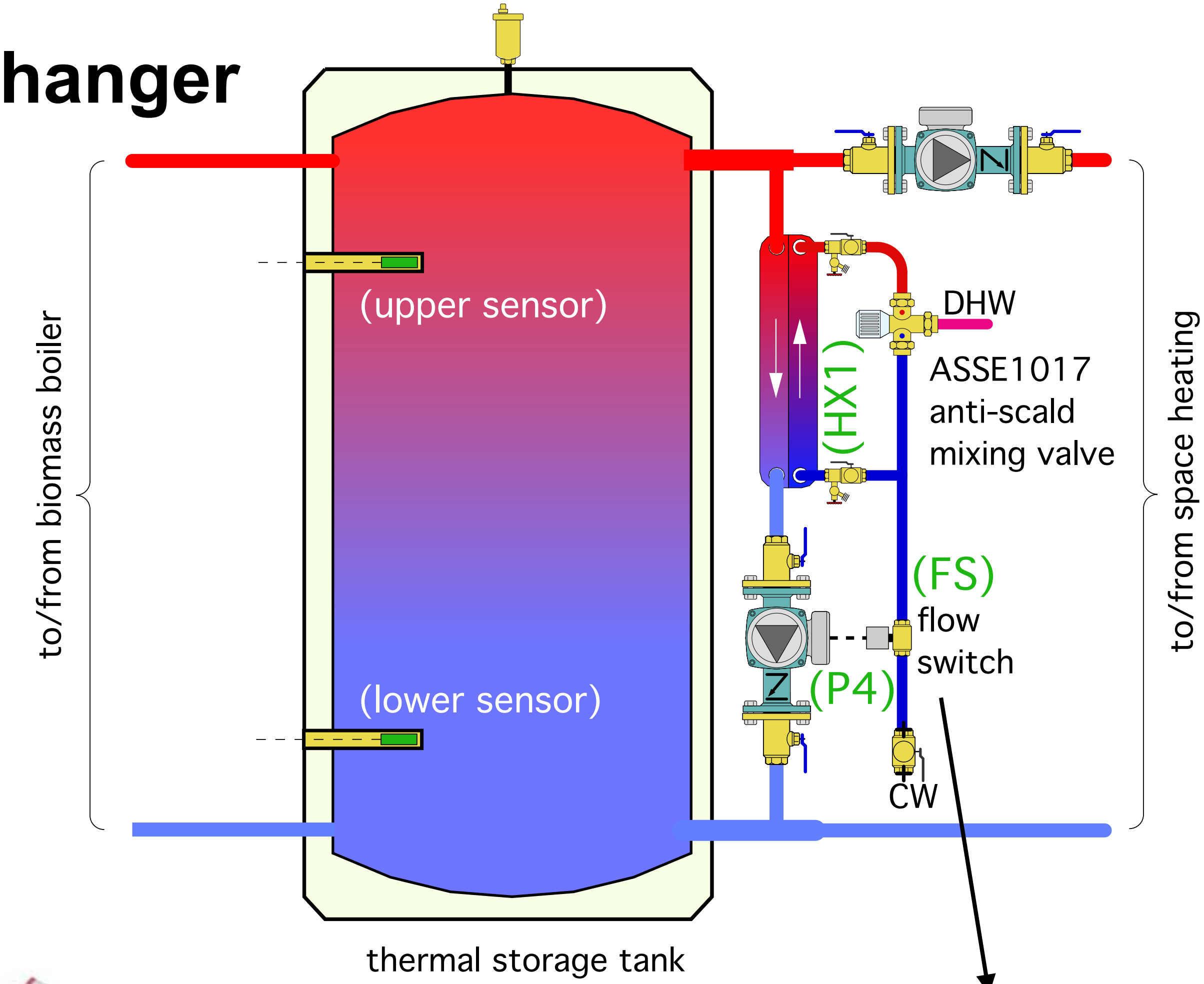


Image source: Adveco LTD

5. Use external heat exchanger

Pros:

- Leverages the thermal mass for stabilizing DHW delivery.
- Brazed plate heat exchanger provides very fast response (1-2 seconds)
- Fully serviceable heat exchanger (unlike an internal coil heat exchanger) Can be cleaned or replaced if necessary.
- Predictable heat exchanger performance
- **Very little heated domestic water is stored (reducing potential for Legionella growth)**.
- Very low wattage circulator needed on primary side of heat exchanger



Harwill flow switch in 3/4” SS tee

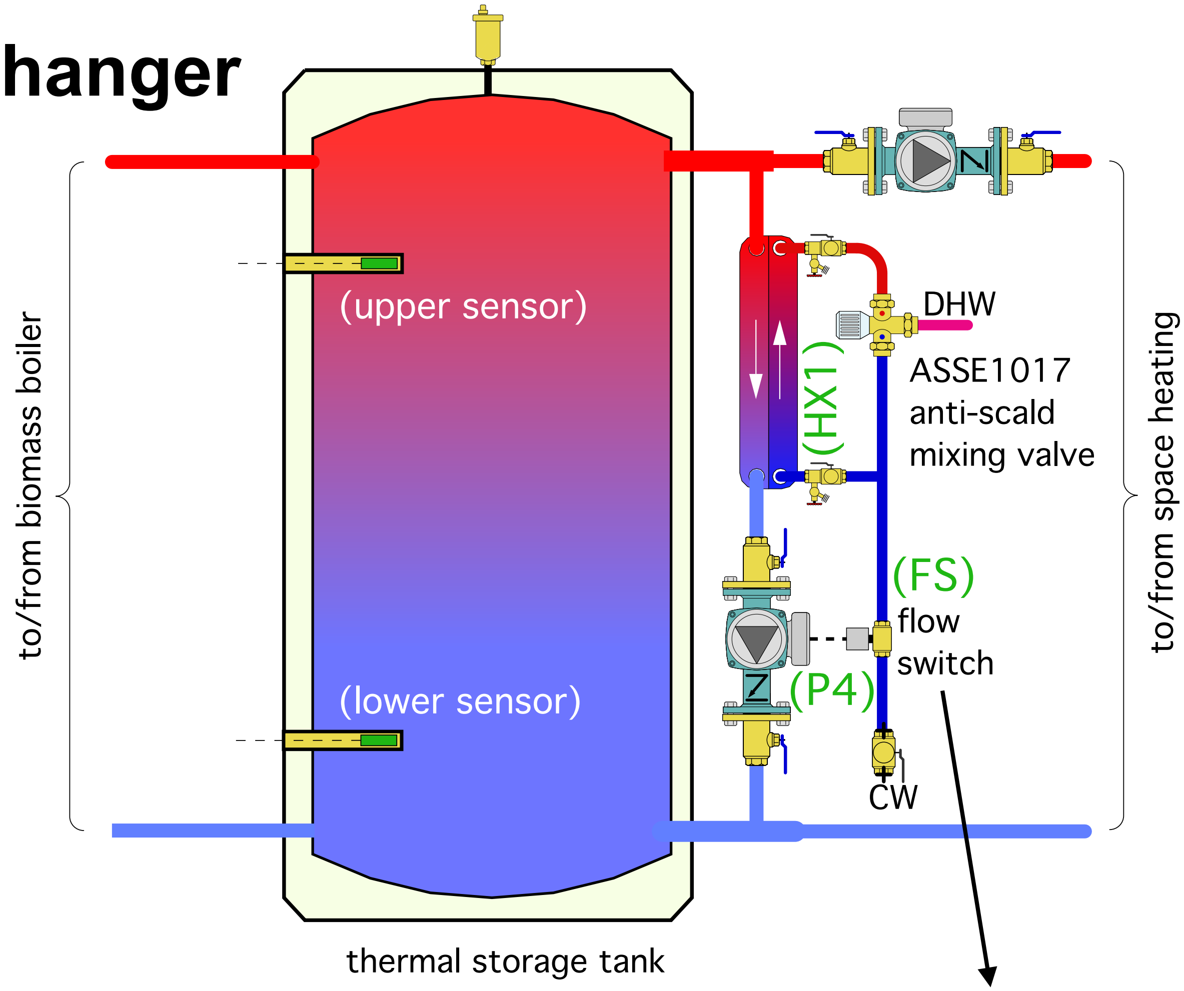
ON at 0.7 gpm
OFF at 0.4 gpm

5. Use external heat exchanger

Cons:

1. Requires flow switch and circulator to operate on each draw of DHW above min. flow rate (0.5 to 0.7 gpm).

2. More hardware to install relative to internal coils.

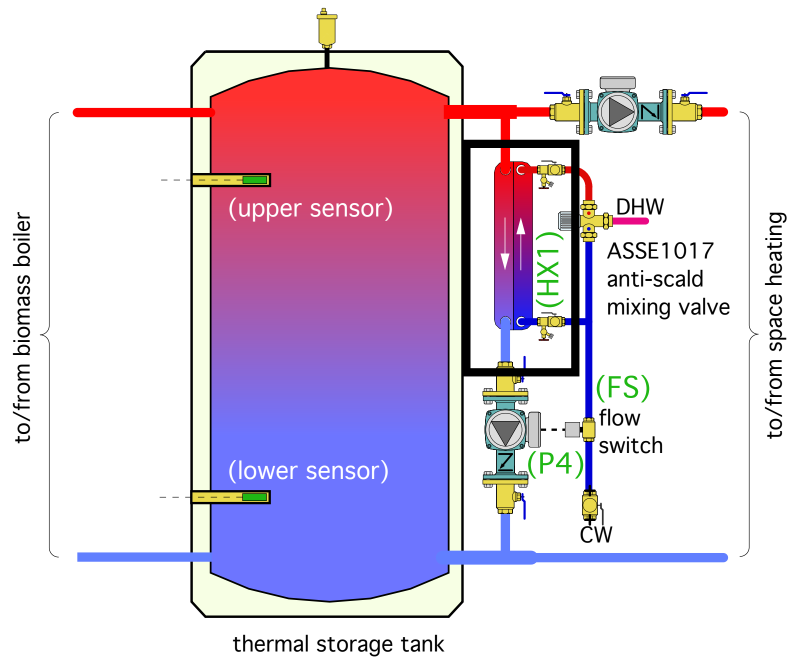


Harwill flow switch in 3/4” SS tee

ON at 0.7 gpm

OFF at 0.4 gpm

5. Use external heat exchanger



3”x5”

Too Small!

5”x12”

5”x20”

Brazed plate stainless steel heat exchangers are widely available.

They have very high ratio of surface area to volume.

Response time to quasi steady state = 1 to 2 seconds

Response time of this subassembly is likely under 5 seconds.
(assuming short, insulated piping b/w HX and storage tank)

5. Use external heat exchanger

Harwill flow switch
in 3/4” SS tee

ON at 0.7 gpm

OFF at 0.4 gpm

Install flow switch on cold water pipe upstream of heat exchanger

hot water from top of tank

heated domestic water

isolation/flush valves

5”x12”x40 plateSS flat plate heat exchanger

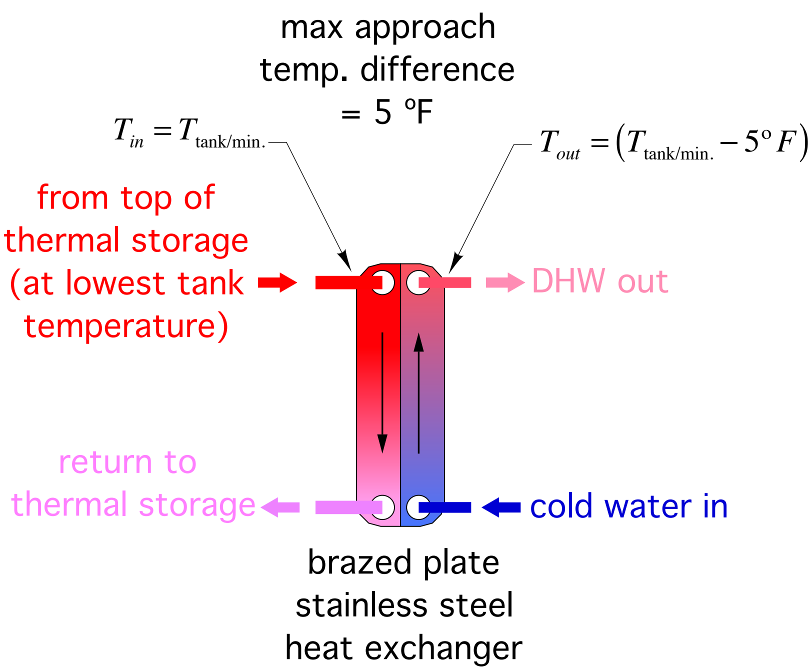
size for approach temperature difference not higher than 5 ºF

50 watt ECM circulator

water returns to lower connection on thermal storage tank

Sizing the brazed plate heat exchanger

Suggest a maximum approach temperature difference of 5 °F under max. anticipated water demand, and minimum preheat inlet temperature.

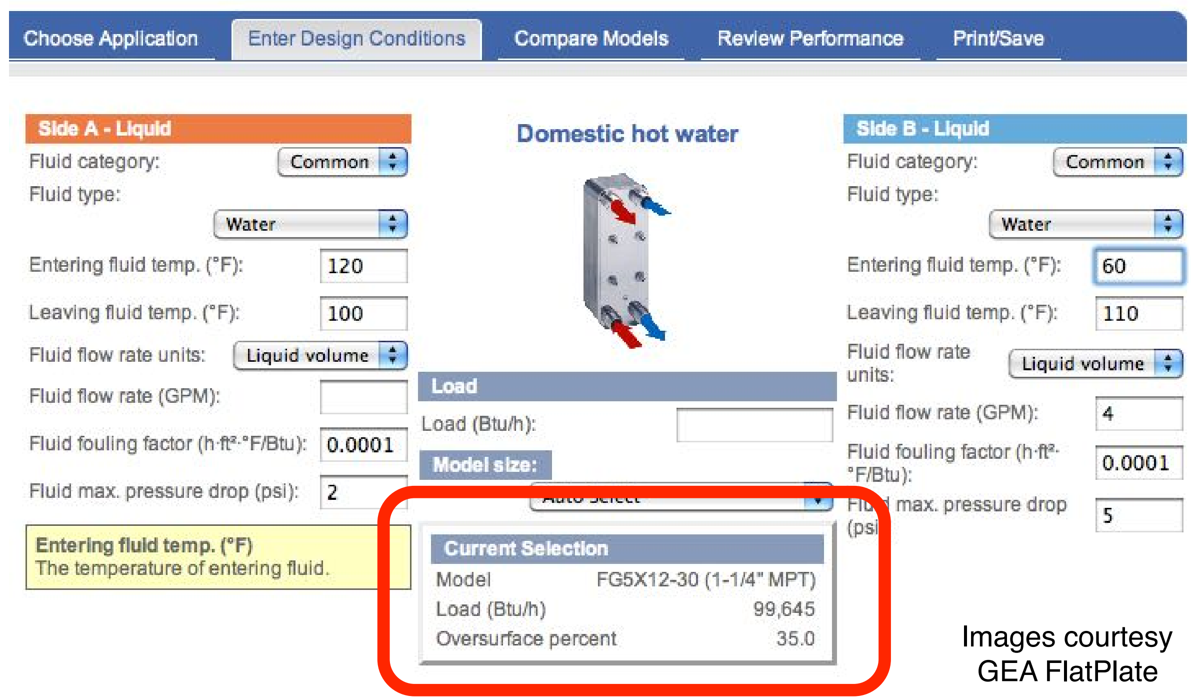


FG5x12-30

5” wide x12” long -30 plates

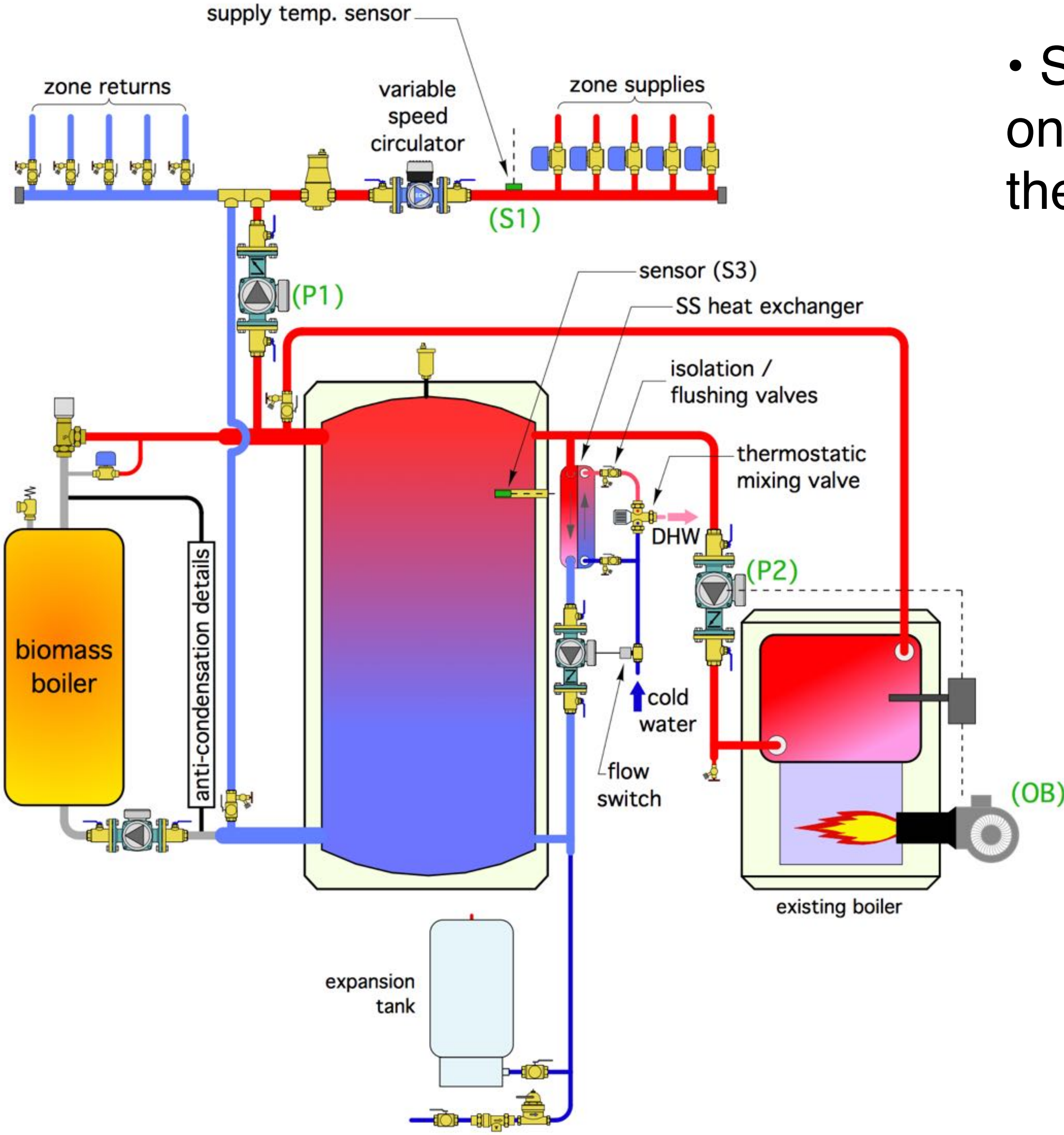
http://flatplateselect.com

GEA FlatPlateSELECT™ – ONLINE



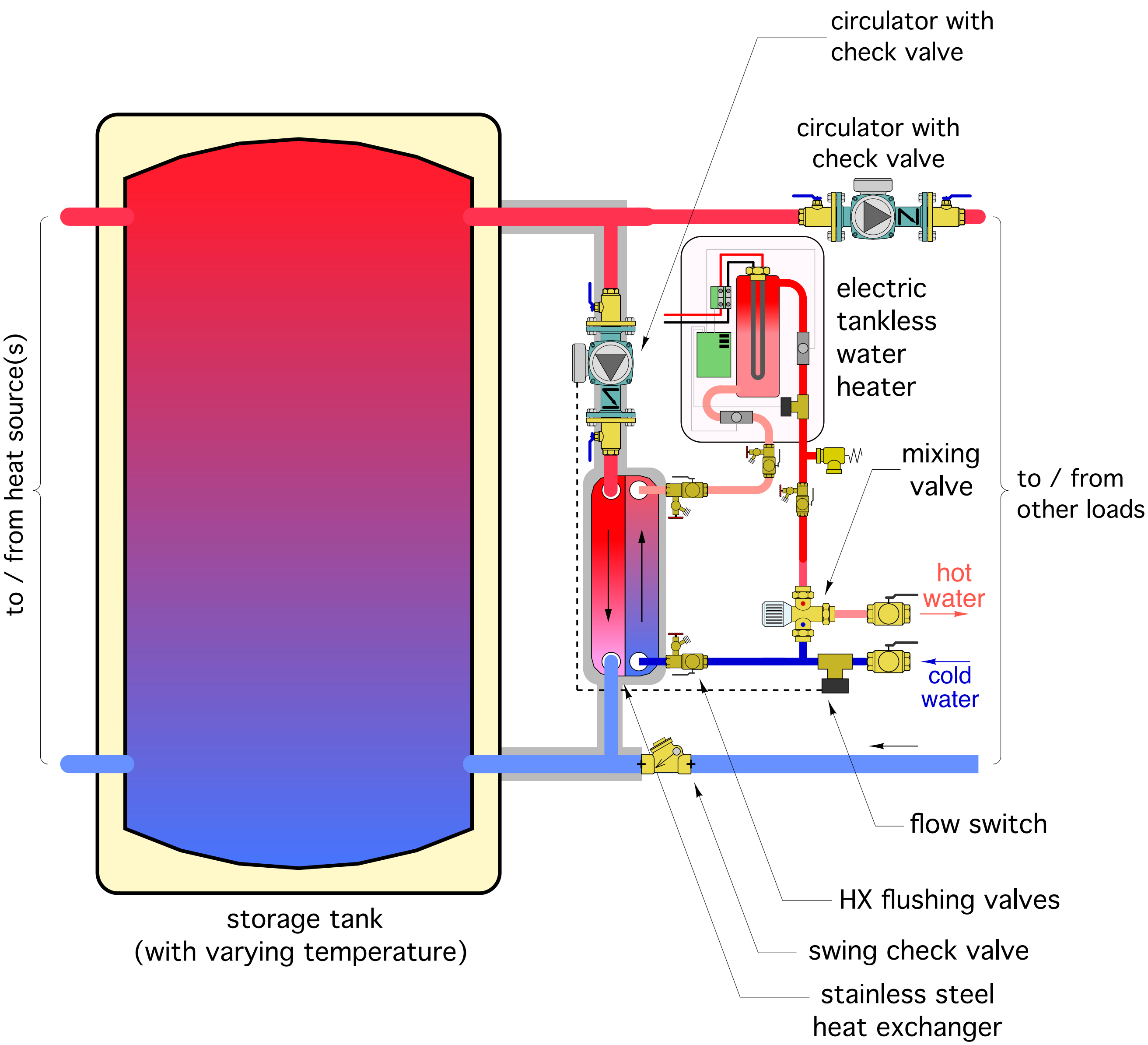
Images courtesy
GEA FlatPlate

Supplemental heat input from (existing) boiler



• Supplemental boiler only heats top of thermal storage tank

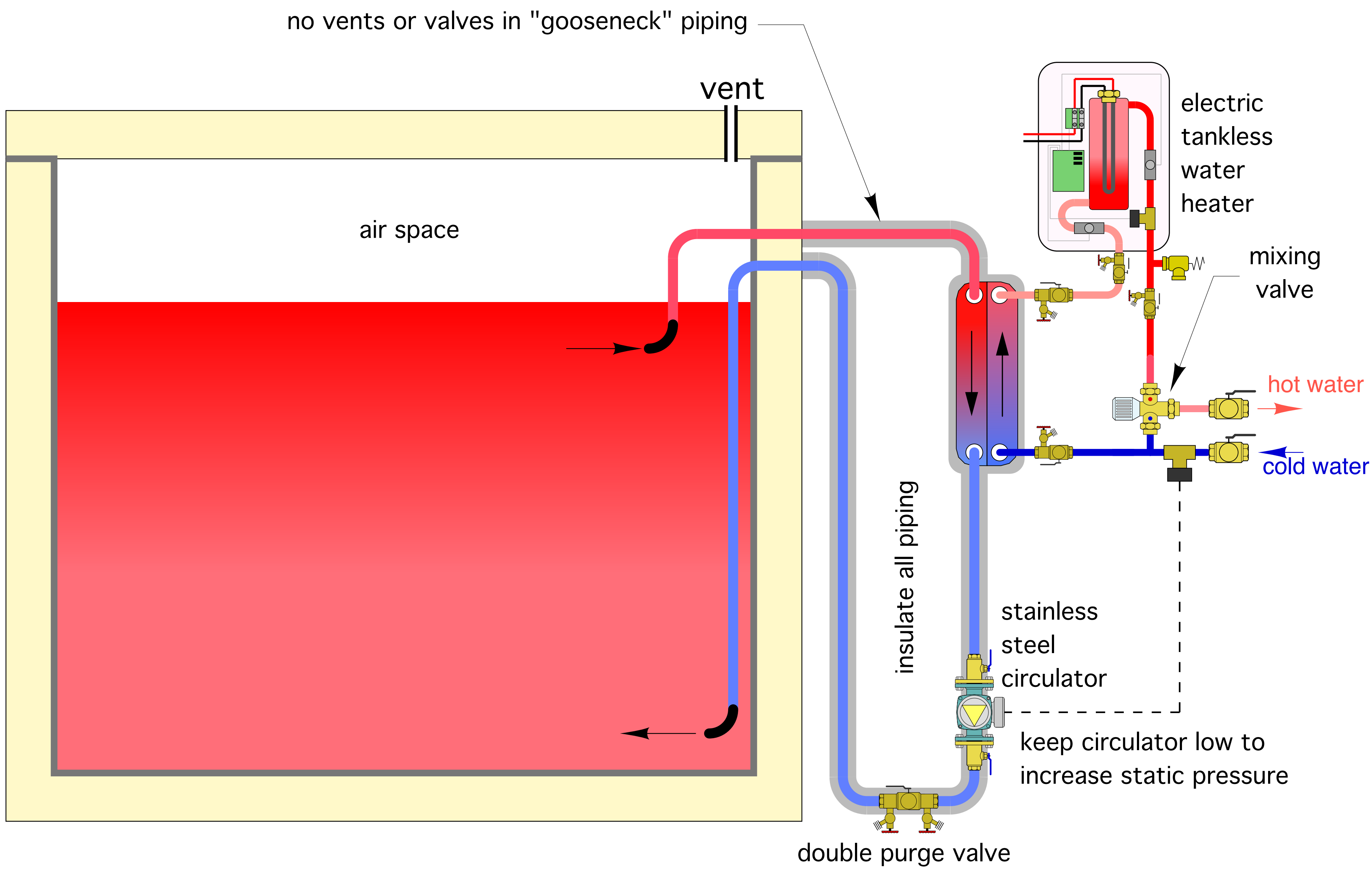
Supplemental input from tankless electric water heater



- Electric water heater is thermostatically controlled to provide necessary temperature boost.
- Should only consider when building has min. 200 amp service entrance.
- Provide pressure relieve valve.
- Provide combination isolation / flushing valves for electric heater and heat exchanger.

Instantaneous DHW subassembly piping

Using it with unpressurized thermal storage



Thermostatically controlled electric tankless water heaters

Electric tankless water heaters are HIGH AMPERAGE devices.

3.5 KW Requires
15 amp / 240VAC
breaker

$$Amps = \frac{KW}{0.24}$$

Minimum 200 Amp breaker panel recommended.

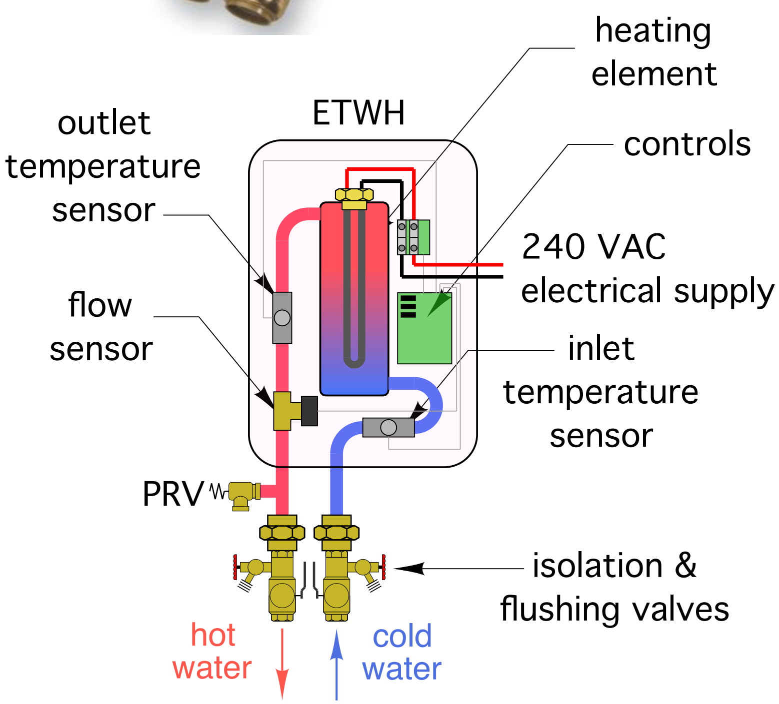
May be an issue in some older retrofits.

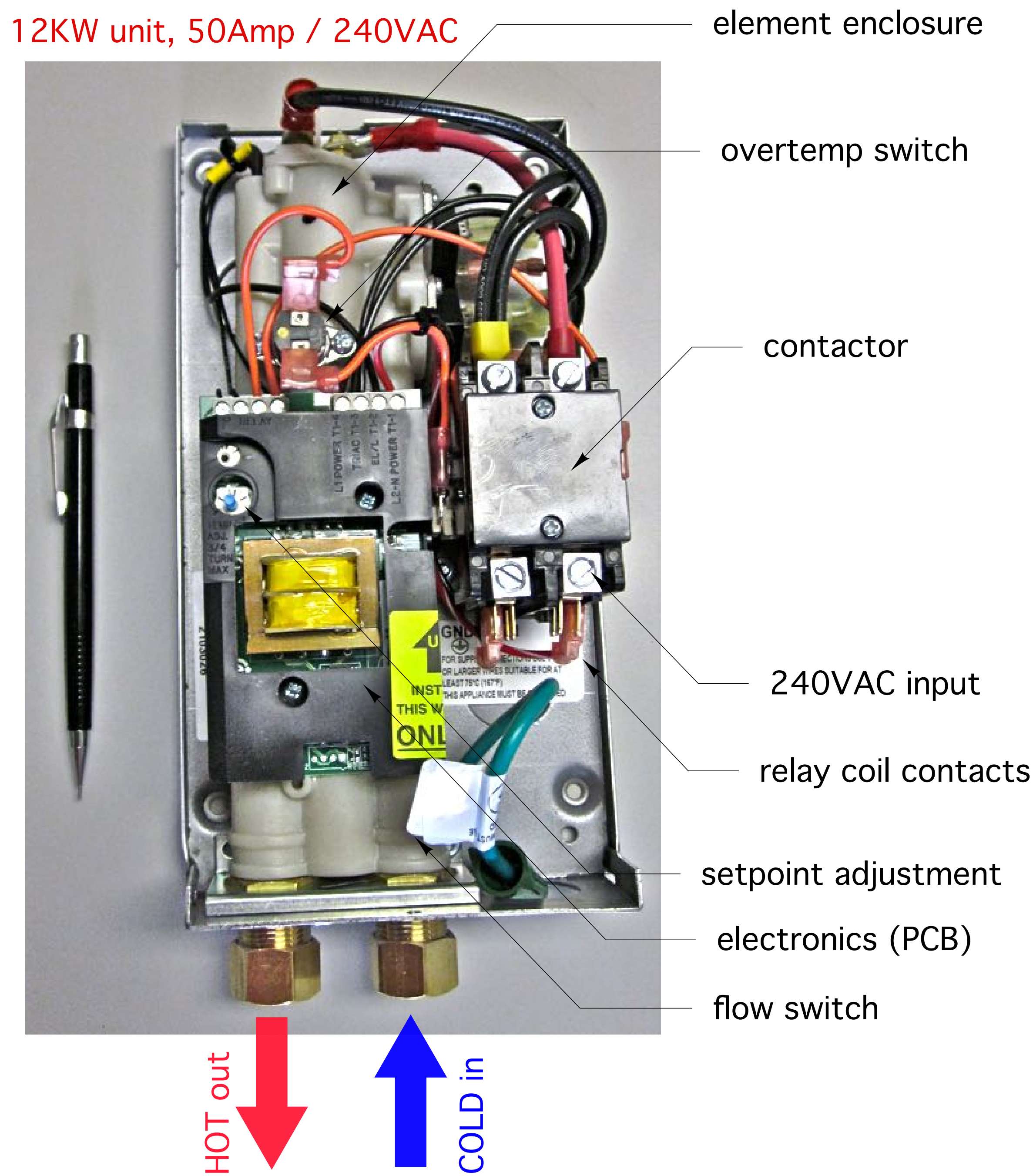
23 KW Requires **TWO**, 50 amp /240VAC breakers

Images courtesy Eemax

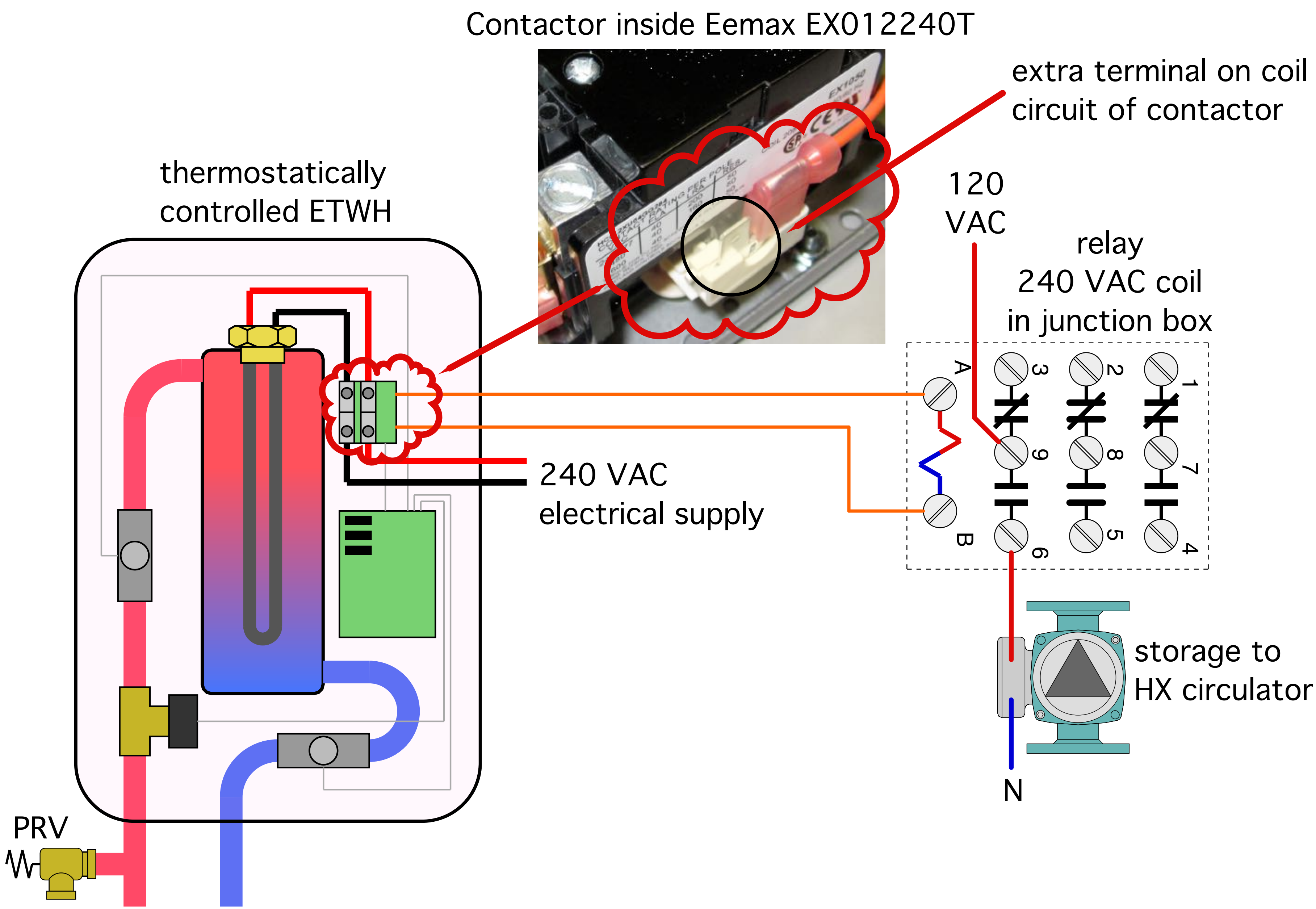
Thermostatically controlled electric tankless water heaters

Image
courtesy
Eemax





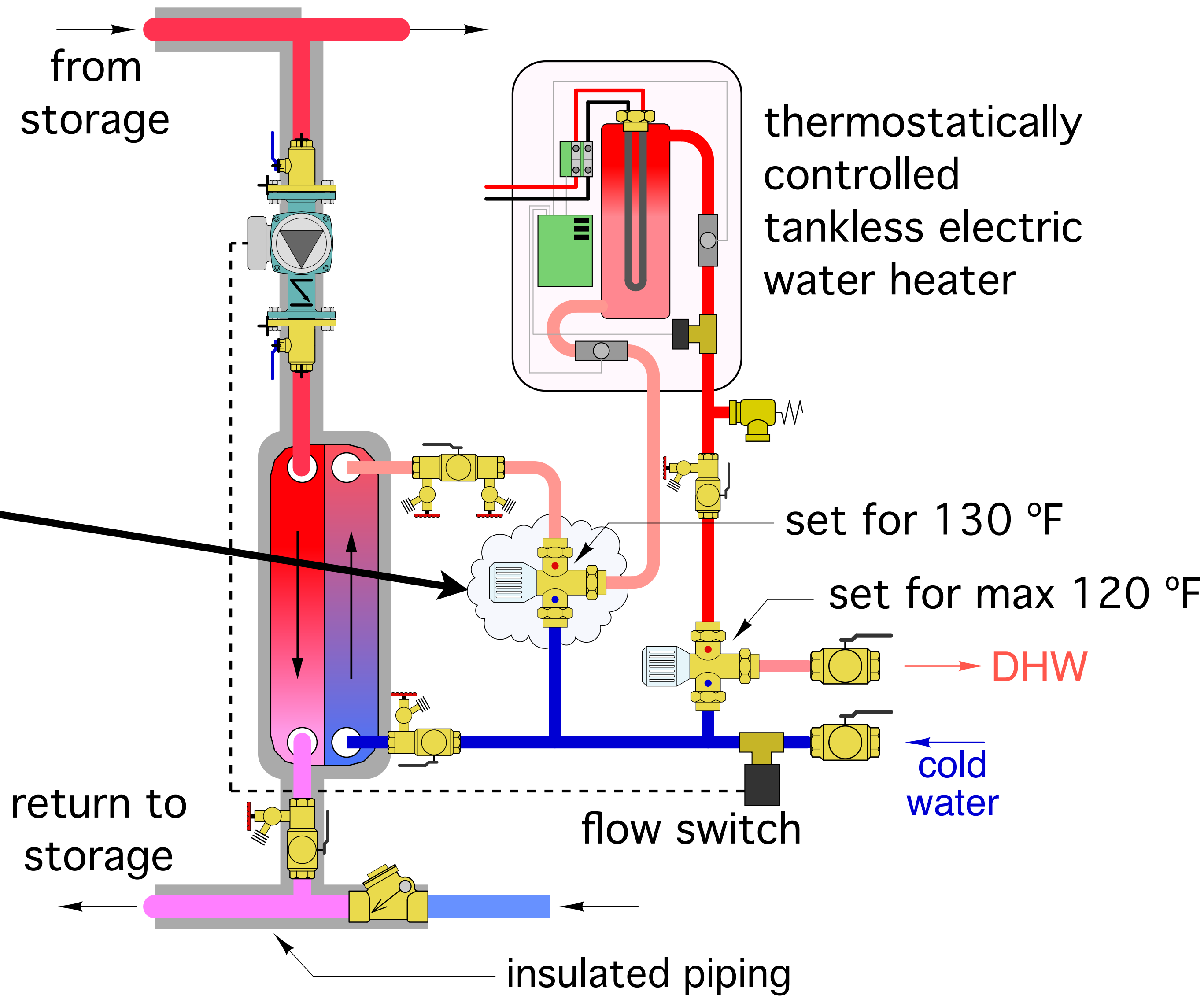
Using extra terminal on ETWH contactor to operate circulator
This eliminates the need for the flow switch.



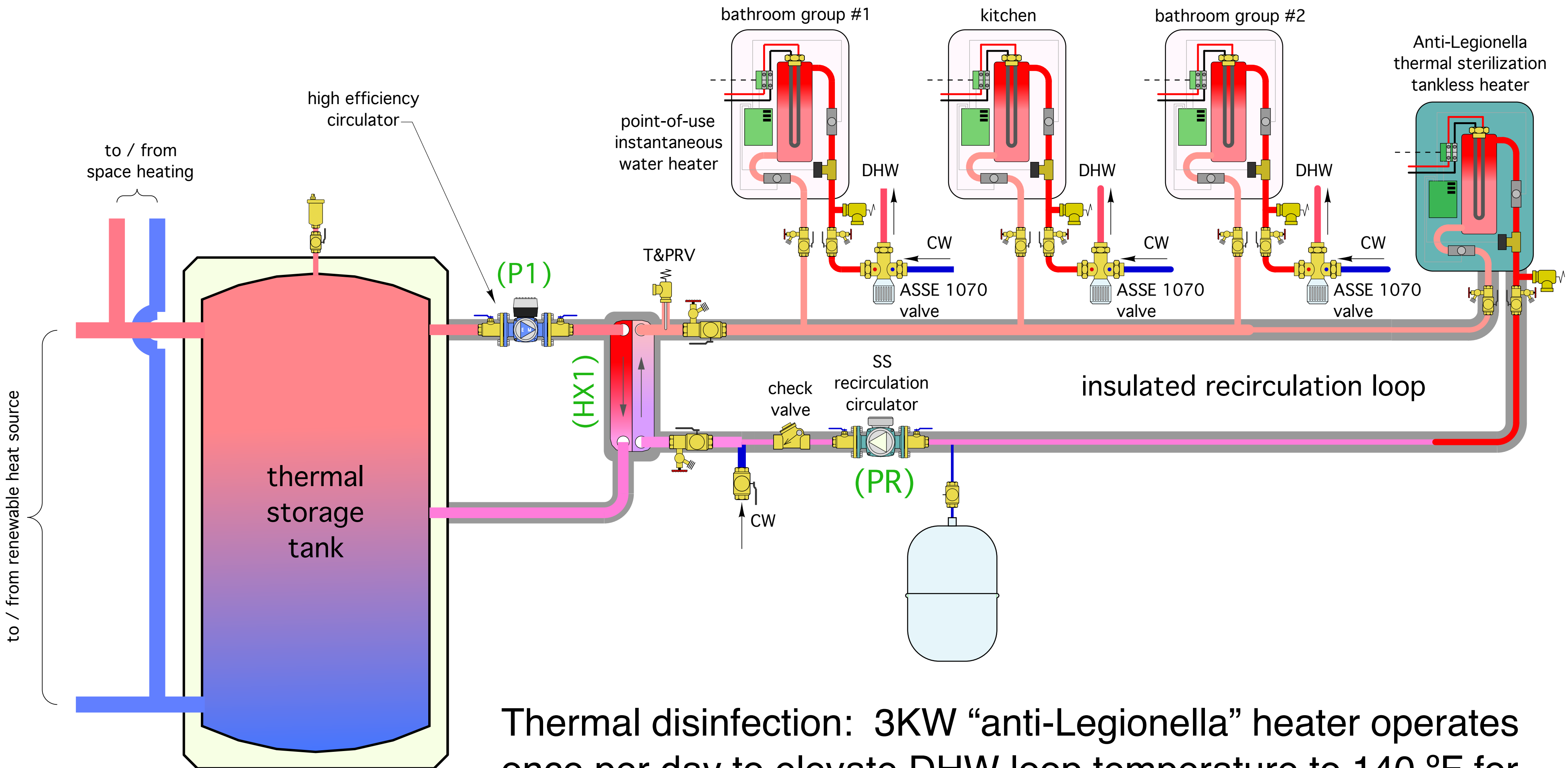
Some ETWH have a safety switch that cannot be set higher than 140 ºF.

This could cause automatic shut down of the ETWH

Solution:Add 2nd thermostatic valve if the high limit switch can't be set higher than 140 ºF.



Adding recirculation and anti-Legionella details…



Thermal disinfection: 3KW “anti-Legionella” heater operates once per day to elevate DHW loop temperature to 140 °F for 30 minutes. This cycle is typically at night.

Fixture temperature limited to 120°F by ASSE 1017 thermostatic mixing valves.

RHNY Incentives

<table>
<tr><th>Program</th><th>System Type</th><th colspan="2">Installation Incentive</th><th colspan="3">Additional Incentive</th></tr>
<tr><td rowspan="3">Small Biomass Boiler</td><td>Advanced Cordwood Boiler with Thermal Storage</td><td colspan="2">25% installed cost
($7,000 maximum)</td><td>-</td><td rowspan="5">Recycling

$5,000/unit for old indoor/ outdoor wood boiler
<u>or</u>
$2,500/unit for old wood furnace</td><td>-</td></tr>
<tr><td rowspan="2">Small Pellet Boiler with Thermal Storage</td><td>≤120 kBtu/h
(35 kW)</td><td>45% installed cost
($16,000 maximum)</td><td rowspan="4">Thermal Storage Adder

$5/gal for each gal above the minimum thermal storage requirement</td><td>-</td></tr>
<tr><td>≤300 kBtu/h
(88 kW)</td><td>45% installed cost
($36,000 maximum)</td><td>-</td></tr>
<tr><td rowspan="2">Large Biomass Boiler</td><td>Large Pellet Boiler with Thermal Storage</td><td rowspan="2">>300 kBtu/h
(88 kW)</td><td>65% installed cost
($325,000 maximum)</td><td rowspan="2">Emission Control System

$40,000</td></tr>
<tr><td>Tandem Pellet Boiler with Thermal Storage</td><td>75% installed cost
($450,000 maximum)</td></tr>
<tr><td>Residential Pellet Stove</td><td>Pellet Stove</td><td colspan="2">$1,500
($2,000 for income qualified residents)</td><td>-</td><td>Recycling

$500
(income qualified residents only)</td><td>-</td></tr>
</table>

LMI Incentives - Boilers

Program	System Type		Market Rate Installation Incentive	LMI Installation Incentive
Small Biomass Boiler	Advanced Cordwood Boiler with Thermal Storage		25% installed cost ($7,000 maximum)	65% installed cost ($18,000 maximum)
	Small Pellet Boiler with Thermal Storage	≤120 kBtu/h (35 kW)	45% installed cost ($16,000 maximum)	65% installed cost ($23,000 maximum)

For more information:

- "Google" Renewable Heat NY
- contact Sue Dougherty at NYSERDA sue.dougherty@nyserda.ny.gov

Future online training opportunities

September 17 / 1:00-2:00 PM
Topic: Control concepts for hydronic systems using renewable energy heat sources (part 1)
Description: The controls used in hydronic heating systems supplied by renewable energy heat sources, such as biomass boiler, heat pumps, and solar thermal collectors have proven to be an area in which installers have some difficulty. This webinar will emphasize “universal” control concepts used in these systems, and shows how they are implemented with off-the-shelf hardware. Specific topics include: Basic switch and relay logic, setpoint temperature control, staging control, differential temperature control, and sensor mounting.

October 29 / 1:00-2:00 PM
Topic: Control concepts for hydronic systems using renewable energy heat sources (part 2)
Description: This webinar will be a continuation of the September 17th discussion. It will discuss Outdoor reset control, mixing control, designing control systems using ladder diagrams, and present examples of complete control systems.

November 12 / 1:00-2:00 PM
Topic: Case study - Pellet boiler system at the NYSDEC boat maintenance facility at Lake George
DescriptionThe NYSDEC boat service facility at Lake George uses a pellet boiler as the primary heat source for a floor heating system. This webinar exams the details used in this system, including fuel supply, boiler, thermal storage, and the distribution system. It will also discuss some of the monitored performance for the system, and some of the initial challenges met in fine tuning system operation.

All training is provided free

Register here:

https://www.nyserda.ny.gov/All-Programs/Programs/Become-a-Contractor/Renewable-Heating-and-Cooling/Renewable-Heat-NY-Contractors

QUESTIONS ?