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

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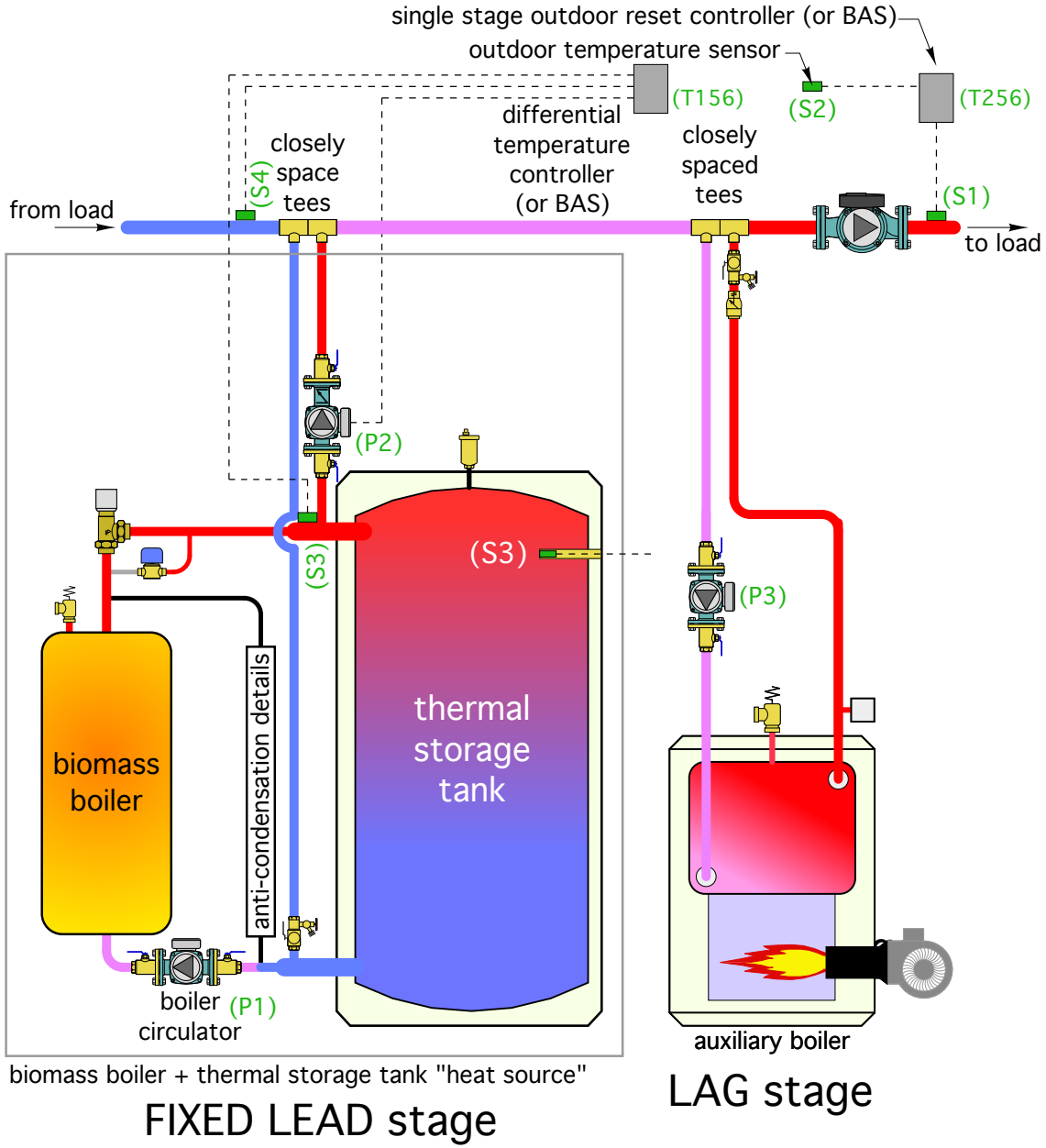
Moderated by:

Sue Dougherty
Program Manager - Renewable Heat NY
NYSERDA
sue.dougherty@nyserda.ny.gov

presented by:

John Siegenthaler, P.E., ASHRAE member
Principal, Appropriate Designs
Holland Patent, NY
www.hydronicpros.com



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

Session description: Most hydronic heating systems that have pellet boilers also have auxiliary boilers. The objective is to supply heat from the pellet boiler, or its associated thermal storage tank, and supplement that heat input when necessary to maintain adequate supply water temperature to the distribution system.

It's also important to prevent heat generated by the auxiliary boiler from being inadvertently added to the thermal storage tank.

This webinar presents a simple and inexpensive method using off-the-shelf controllers to meet these control requirements. The logic underlying this control method can also be implemented in large system applications using building automation systems (BAS).

Learning objectives:

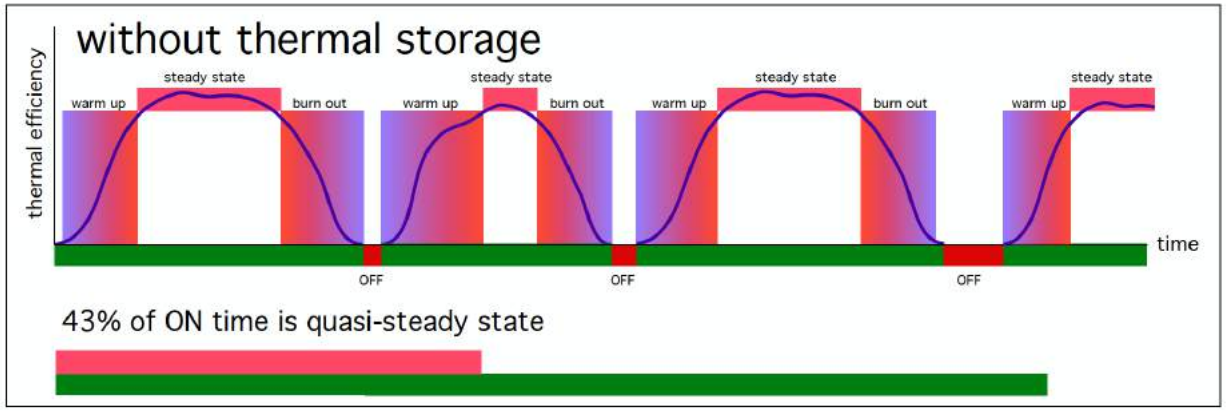
1. Understand the basic topology of a hydronic heating system using a pellet boiler and auxiliary boiler.

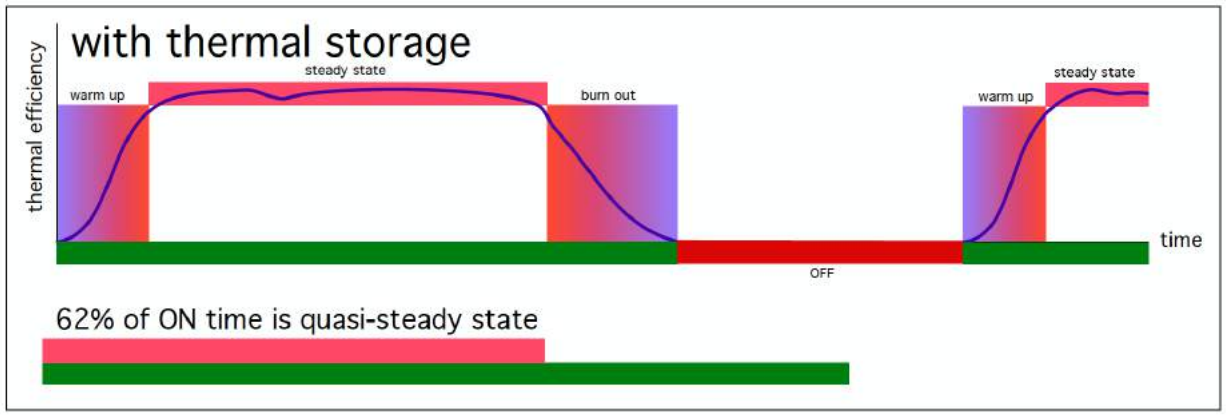
2. Understand the negative issues associated with "backfeeding" thermal storage with heat from the auxiliary boiler.

3. See how a differential temperature controller (or equivalent BAS logic) can correct the problem.

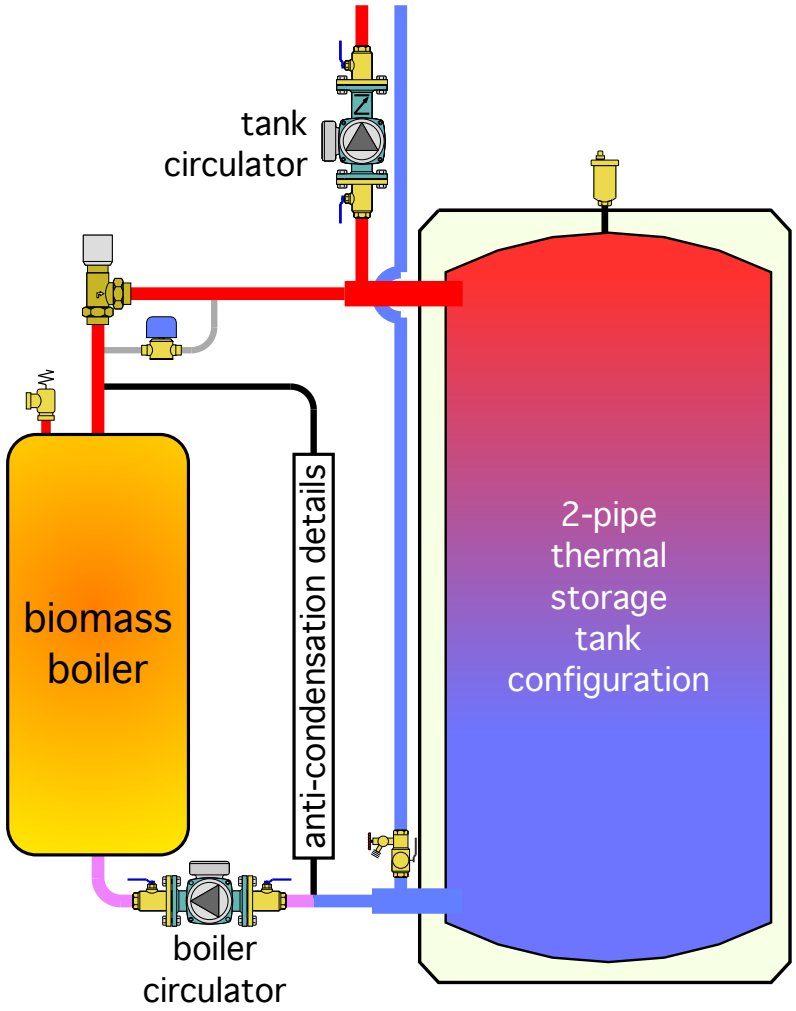
4. Explain use of a simple outdoor reset controller + differential temperature controller to manage heat delivery to load.

To achieve **high thermal efficiency** and **low emissions**, pellet boilers should operate with long on-cycles, followed by long off-cycles. *(suggest 3 hr run time per start)*





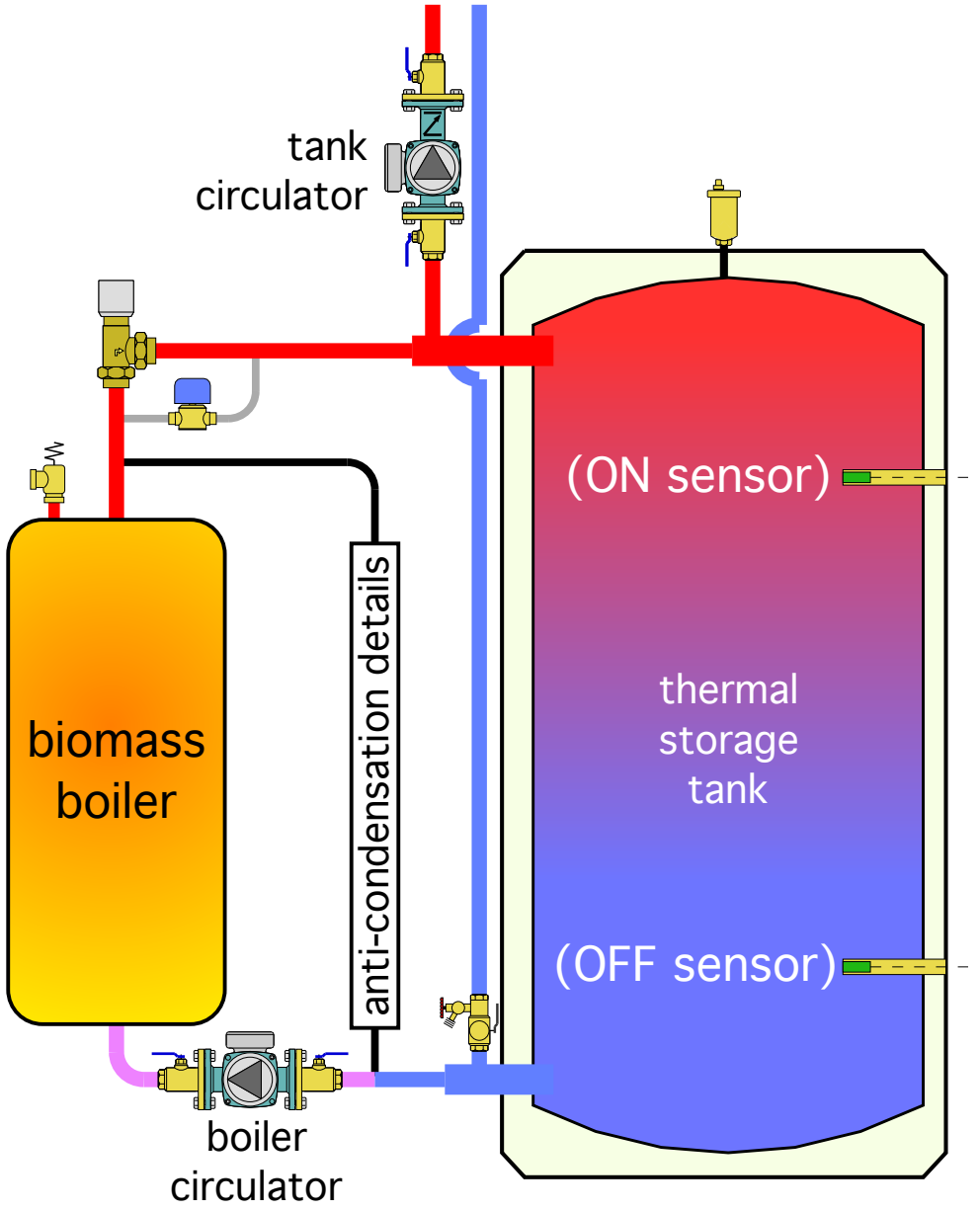
In most applications, pellet boilers require substantial thermal storage *(typically 2 gallons / 1000 Btu/hr boiler output)* to achieve these long operating cycles.



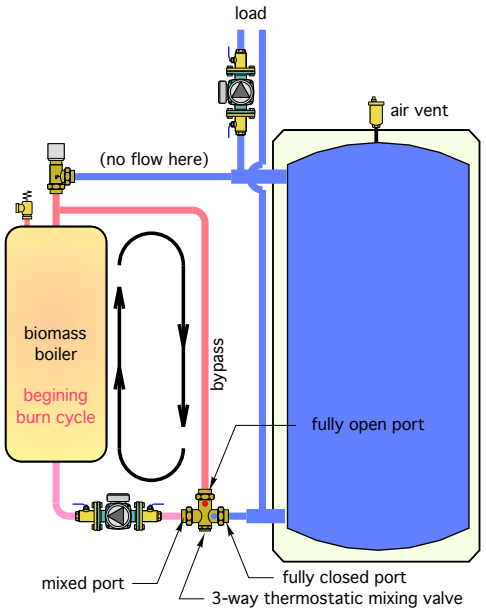
A typical pellet boiler is turned on and off based on temperatures in thermal storage. **(It operates independently of "calls" for heat from zone thermostats)**

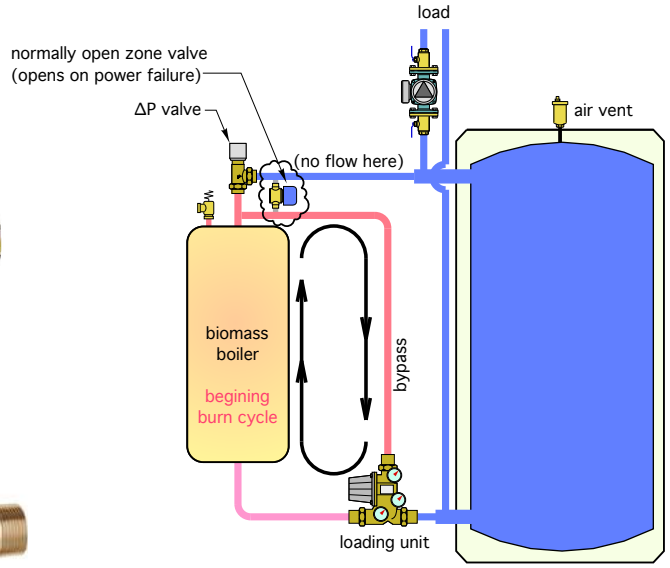
Boiler is turned on when the UPPER tank sensor drops to or below some lower temperature limit (determined by setpoint or outdoor reset).

Boiler is turned OFF when the LOWER tank sensor climbs to some upper temperature limit (determined by setpoint).

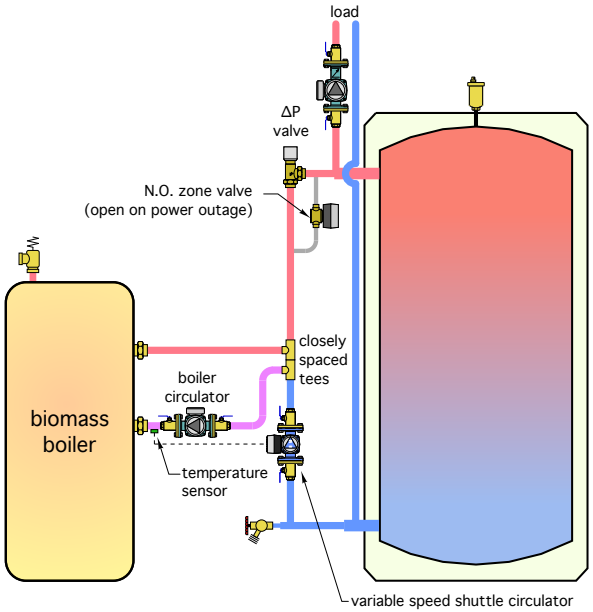


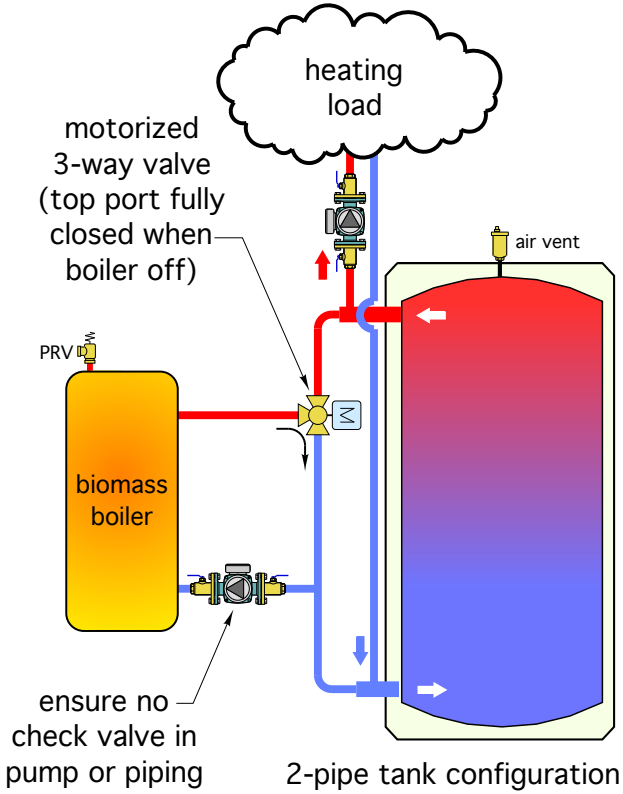
Options for anti-condensation control



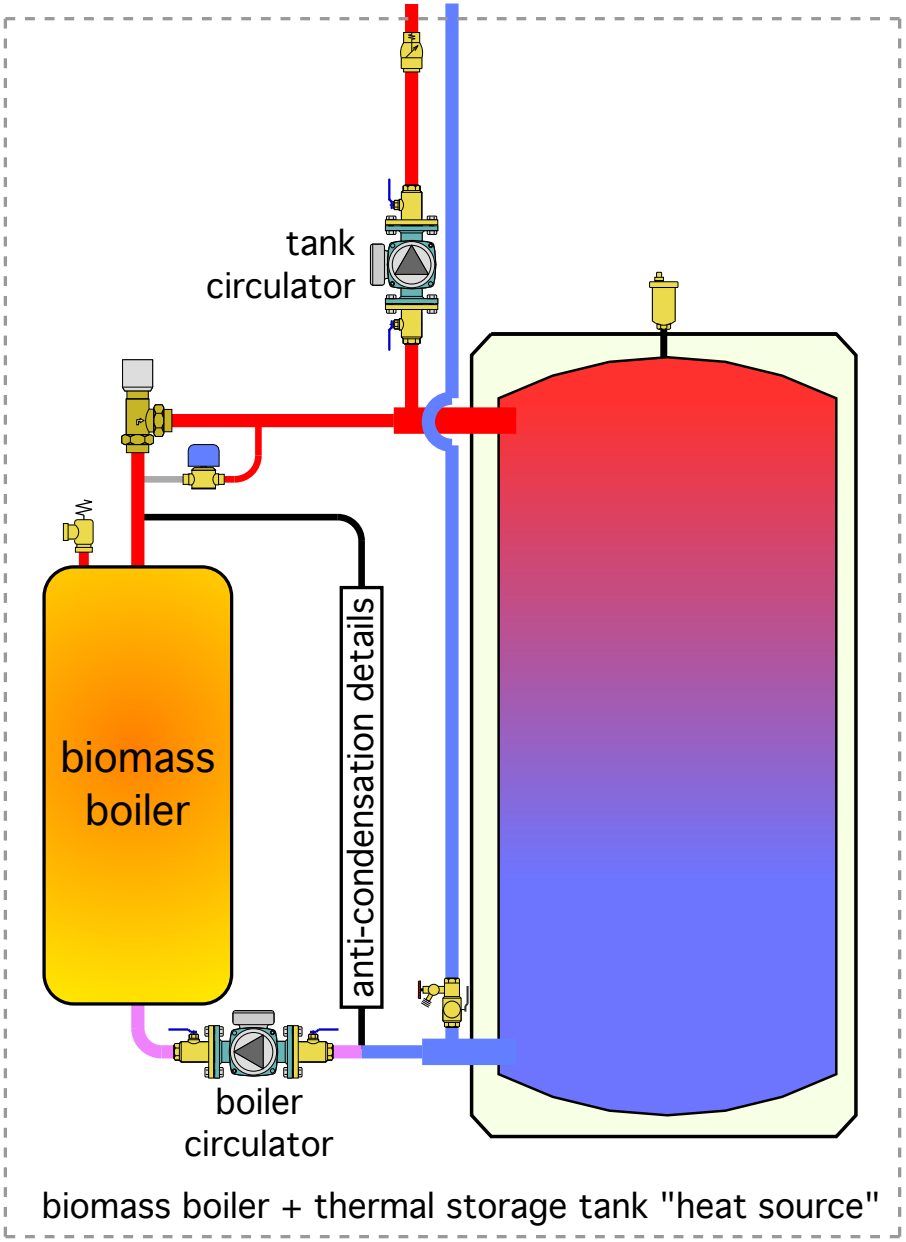


examples of loading units





Think of the pellet boiler, combined with thermal storage as a “heat source” device



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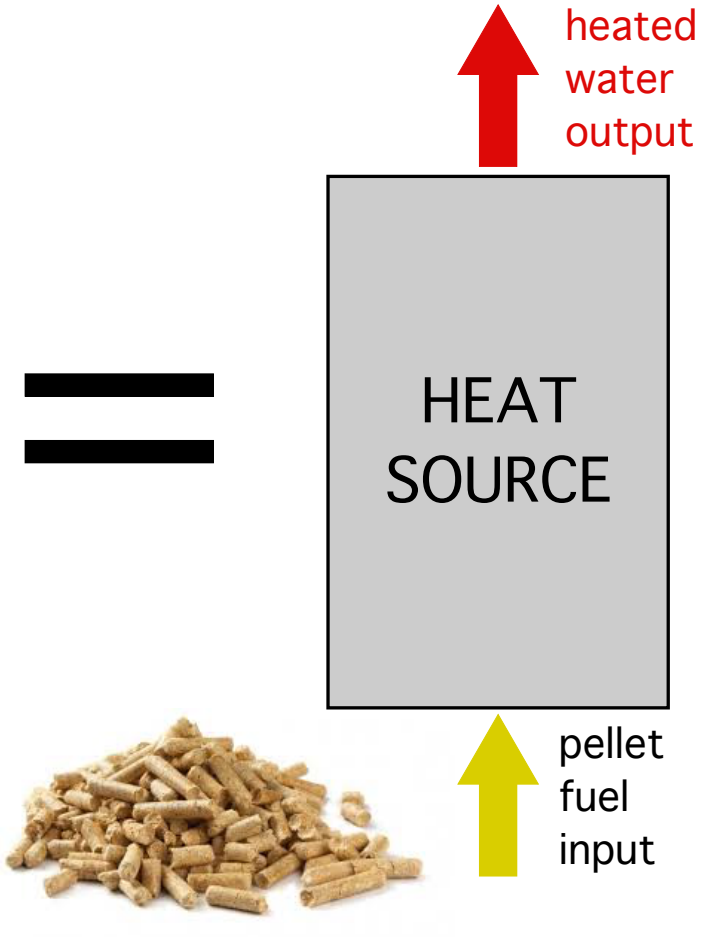


A typical “lead/lag” multiple boiler application

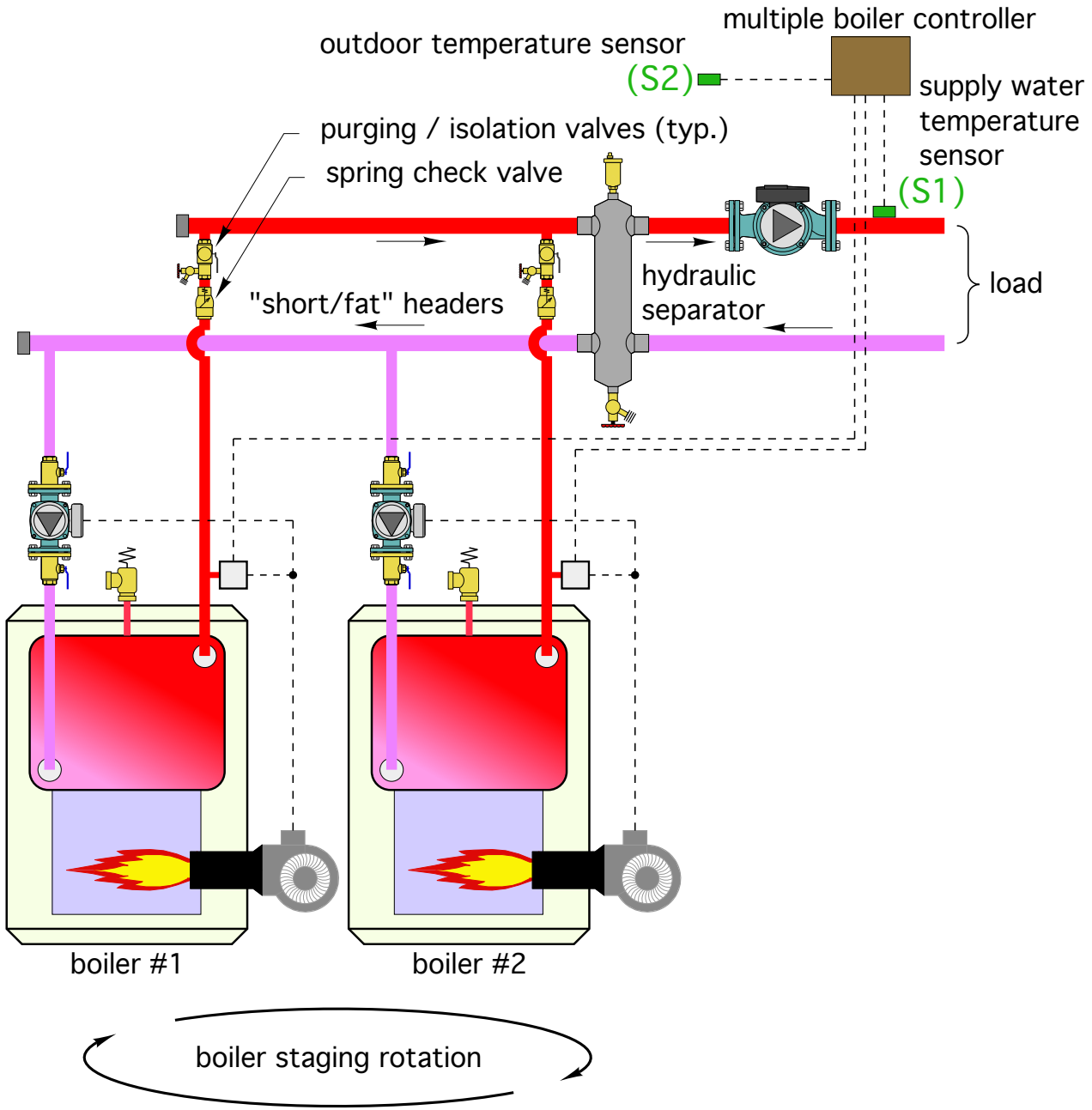
Boiler controller measures supply water temperature at sensor (S1), and compares it to the “target” supply water temperature.

If temperature at (S1) is lower than target temperature, one boiler is fired.

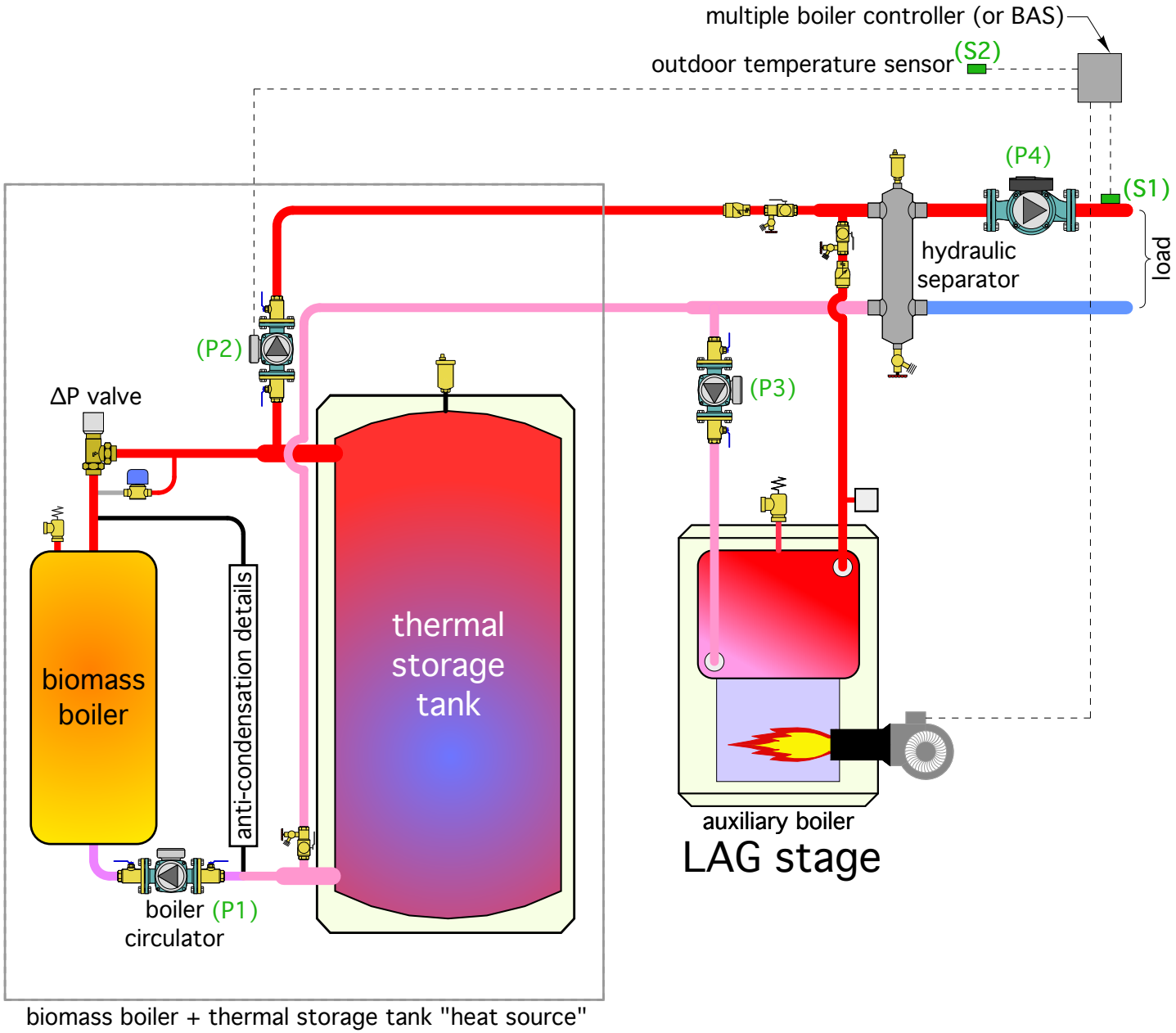
Boiler controller then uses PID logic to determine if more heat input is need. If it is, the other boiler is fired.

When all boilers are identical, the boiler controller typically “rotates” the firing order to create about the same run time for each boiler.

If boilers are different, one is designated as the “fixed lead” boiler, the other as the “lag” boiler.

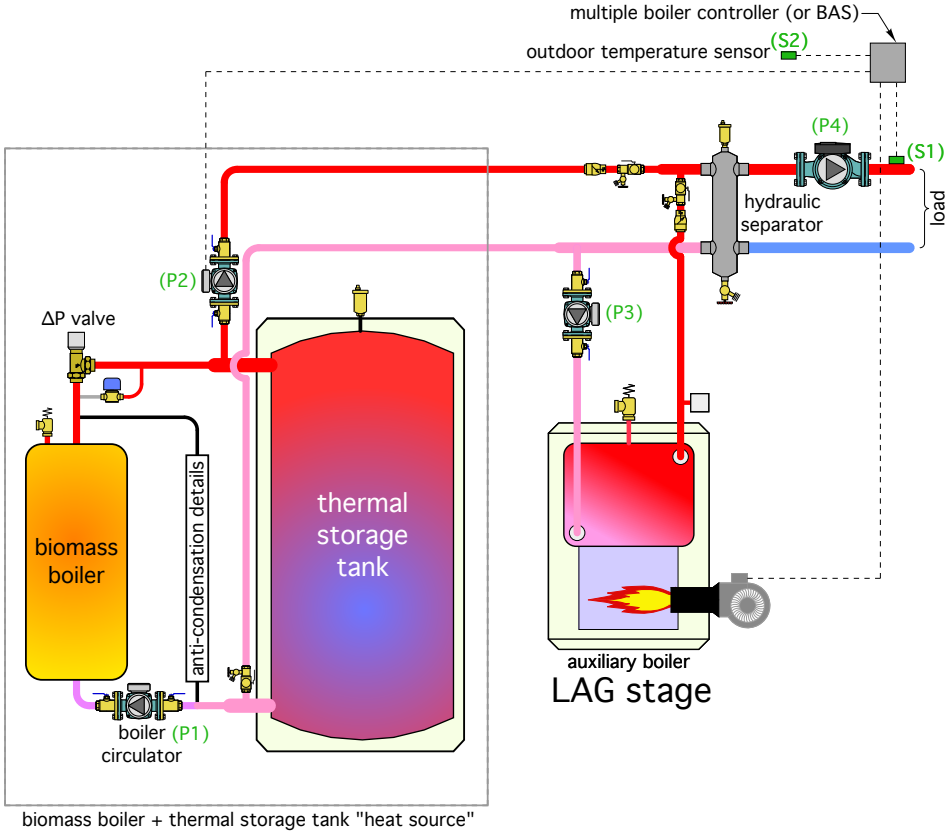


It’s “intuitive” for designers to create systems where the biomass boiler is treated as a “fixed lead” stage, and the auxiliary boiler is the “lag” stage.

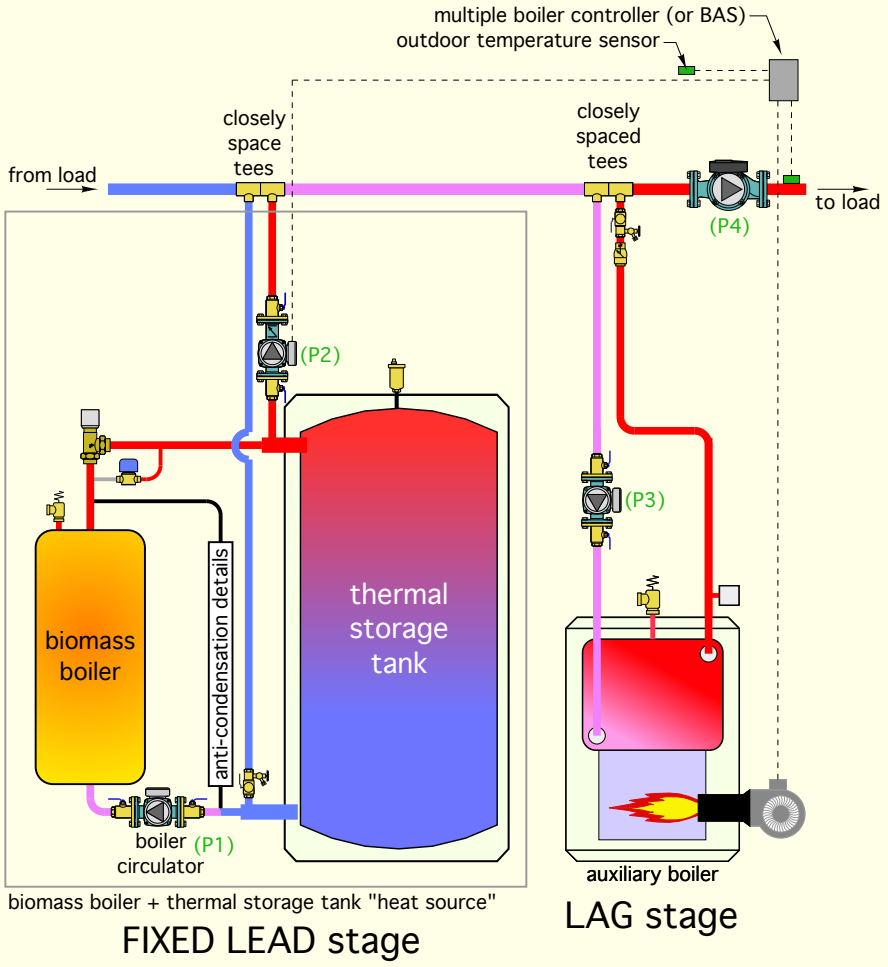


Both piping schemes provide hydraulic separation of all circulators

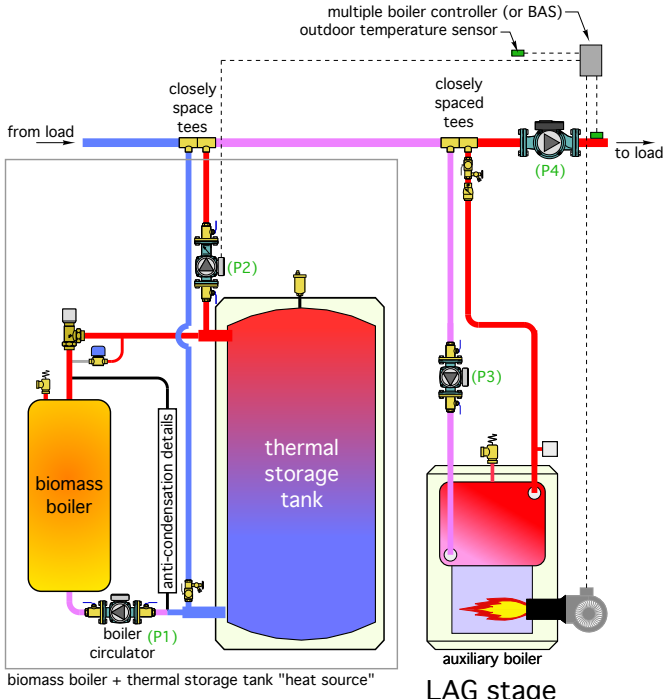
If combined flow rate of tank circulator (P2) and aux boiler circulator (P3) was greater than load flow rate there is some mixing inside the hydraulic separator. This would slightly increase return water temperature to the lower tank connection, which negatively impacts temperature stratification.



With this arrangement ***(and proper controls)*** energy added by aux boiler can be kept out of thermal storage. Assuming (P2) flow rate ≤ (P4) flow rate, the coolest water is returned to the lower tank connection.



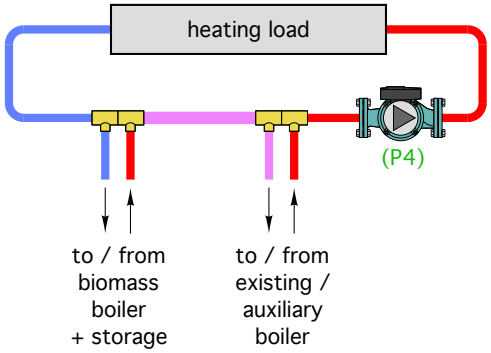
Options for the distribution system

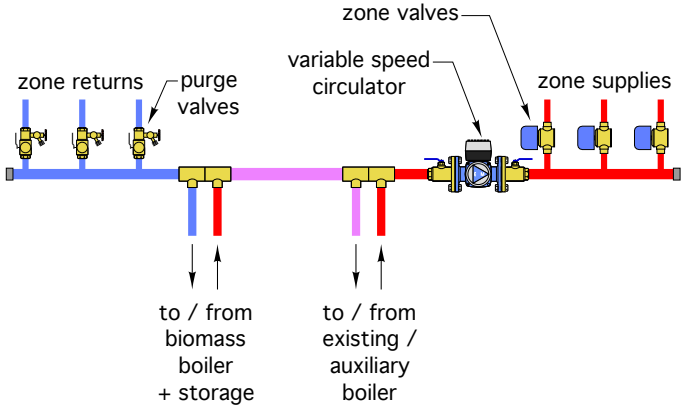


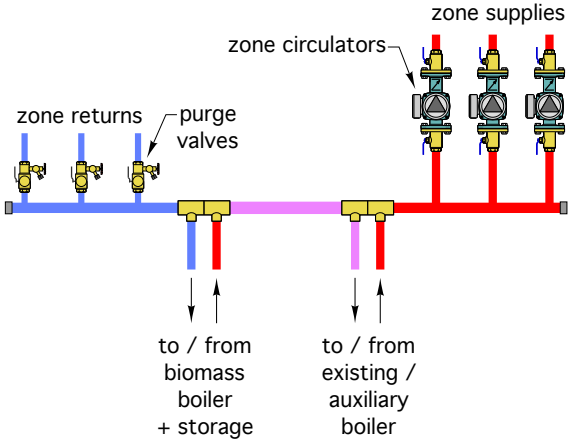
biomass boiler + thermal storage tank "heat source"

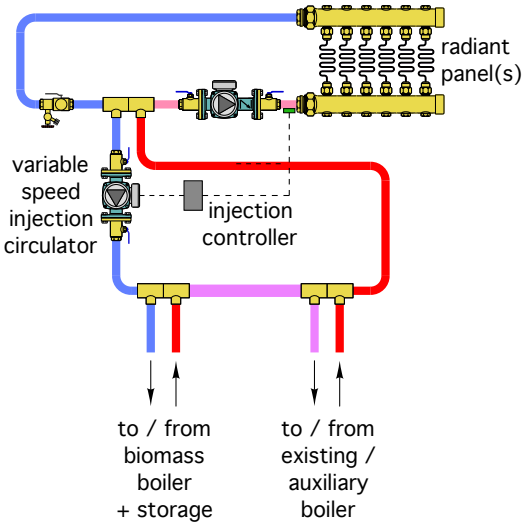
FIXED LEAD stage

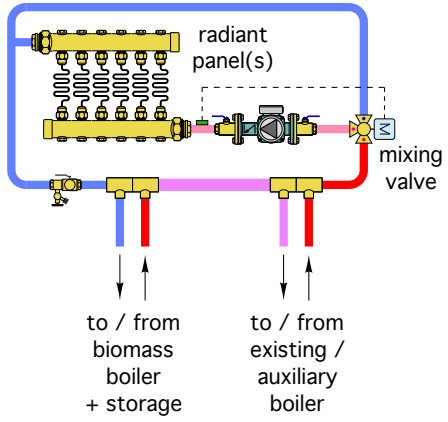
LAG stage



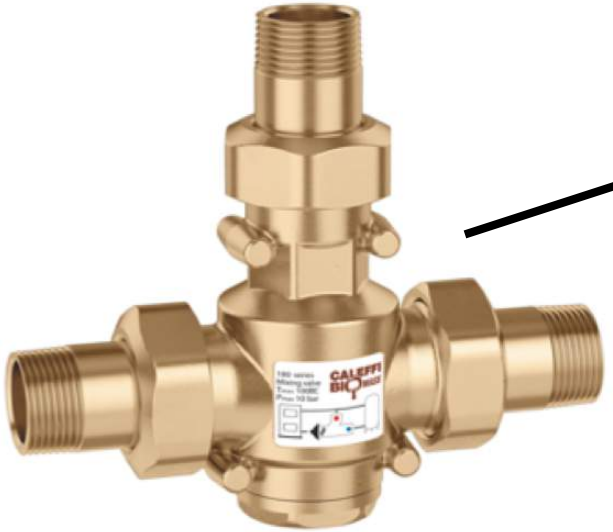


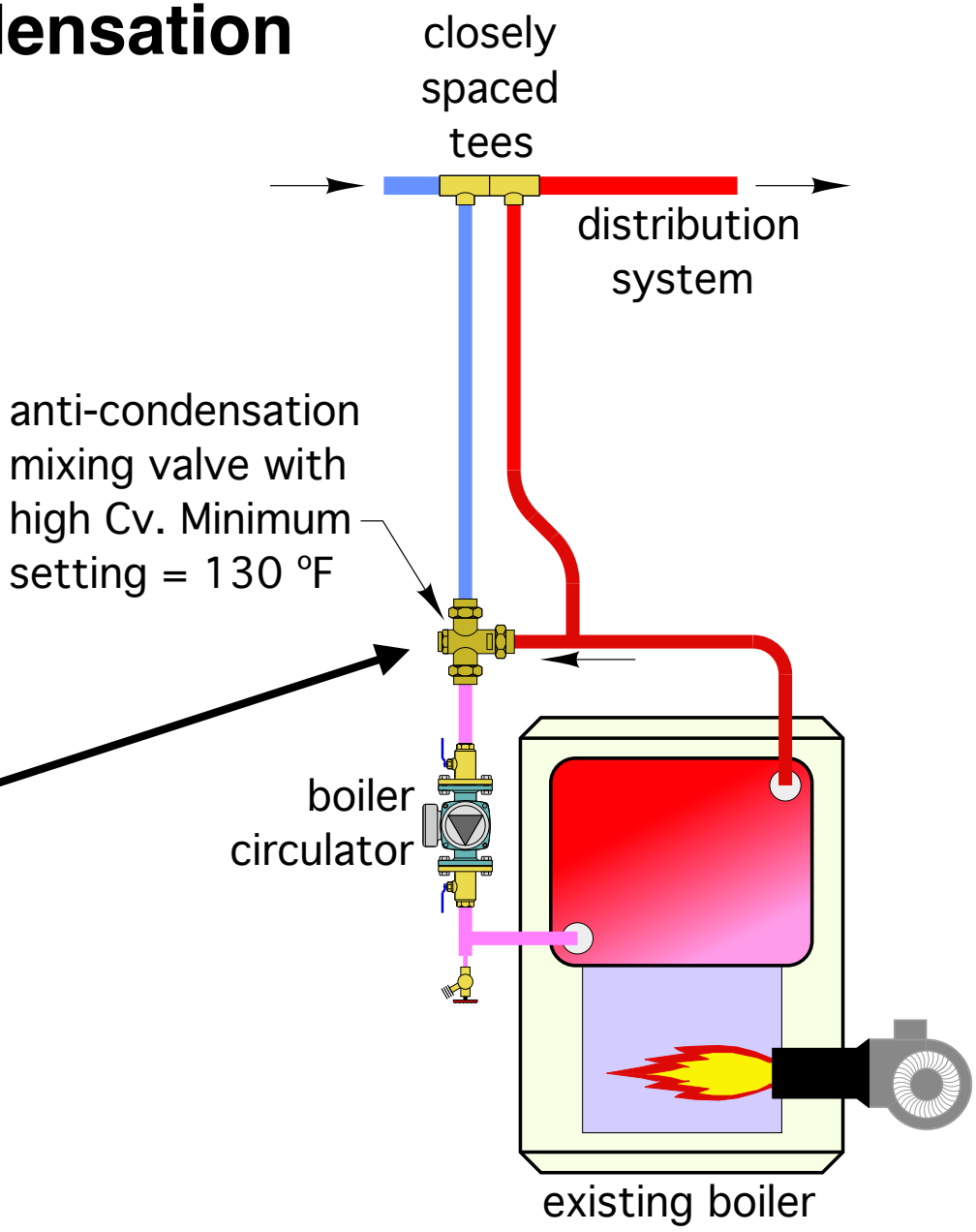






If distribution system uses low water temperature (< 130 °F) don't forget to protect the aux boiler against sustained flue gas condensation





The glitch…

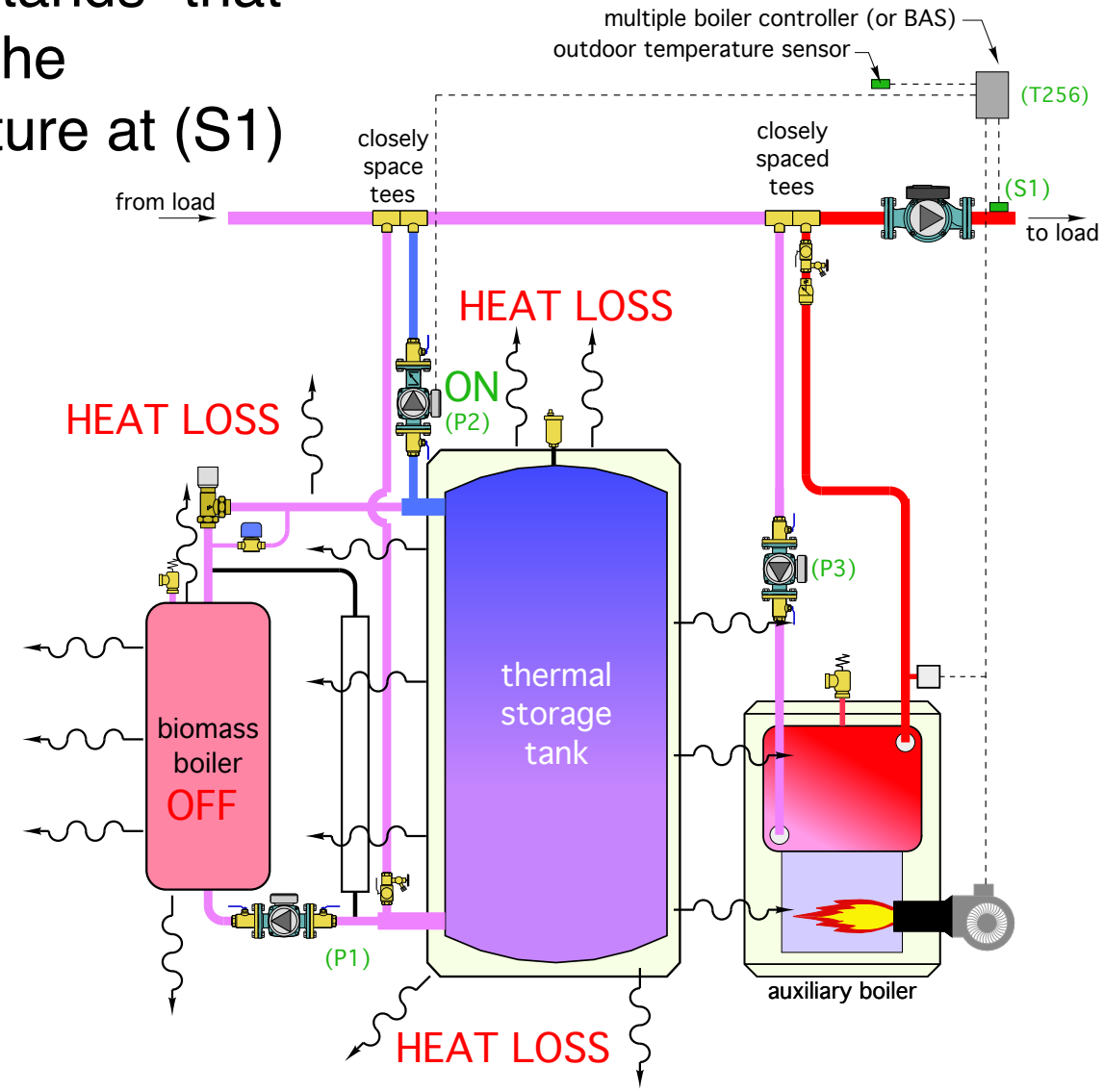
A standard multiple boiler controller “doesn’t know” if the biomass boiler is *offline*, due to a fault, or if the tank is cooler than the minimum “useable” temperature of the distribution system.

The boiler controller only “understands” that the fix lead stage is not creating the necessary supply water temperature at (S1)

The boiler controller turns on stage 2, and keeps stage 1 on.

The result: The circulator creating flow between the tank and system remains on.

Heat produced by the auxiliary boiler is inadvertently carried into thermal storage, increasing heat loss to surrounding space.



In a conventional multiple boiler system the added heat loss created by flow of heated water through an unfired boiler - ***while not desirable*** - doesn't create substantial heat loss:

Most conventional boilers use either sealed combustion or have automatic flue dampers that close whenever the boiler is off. ***NOT the case with biomass boilers.***

Most conventional multiple boiler systems do not have larger thermal storage tanks. ***Lots of added surface area for heat loss.***

4000 gallon thermal storage tank (before insulation)

1200 gallon thermal storage tank

This really happens…

This really happens…

When visited in March 2017:

- pellet boiler had been off for about 1 month awaiting service
- tank-to-load circulator was running
- boiler-to-tank circulator off at service switch, but on at BAS output
- tank temperature about 145 ºF, all heat coming from electric aux boiler
- If boiler-to-tank circulator had not been manually switched off, 145 ºF water would be circulating through boiler, creating jacket heat loss, and convective air currents up flue *(no flue dampers on pellet boilers).*

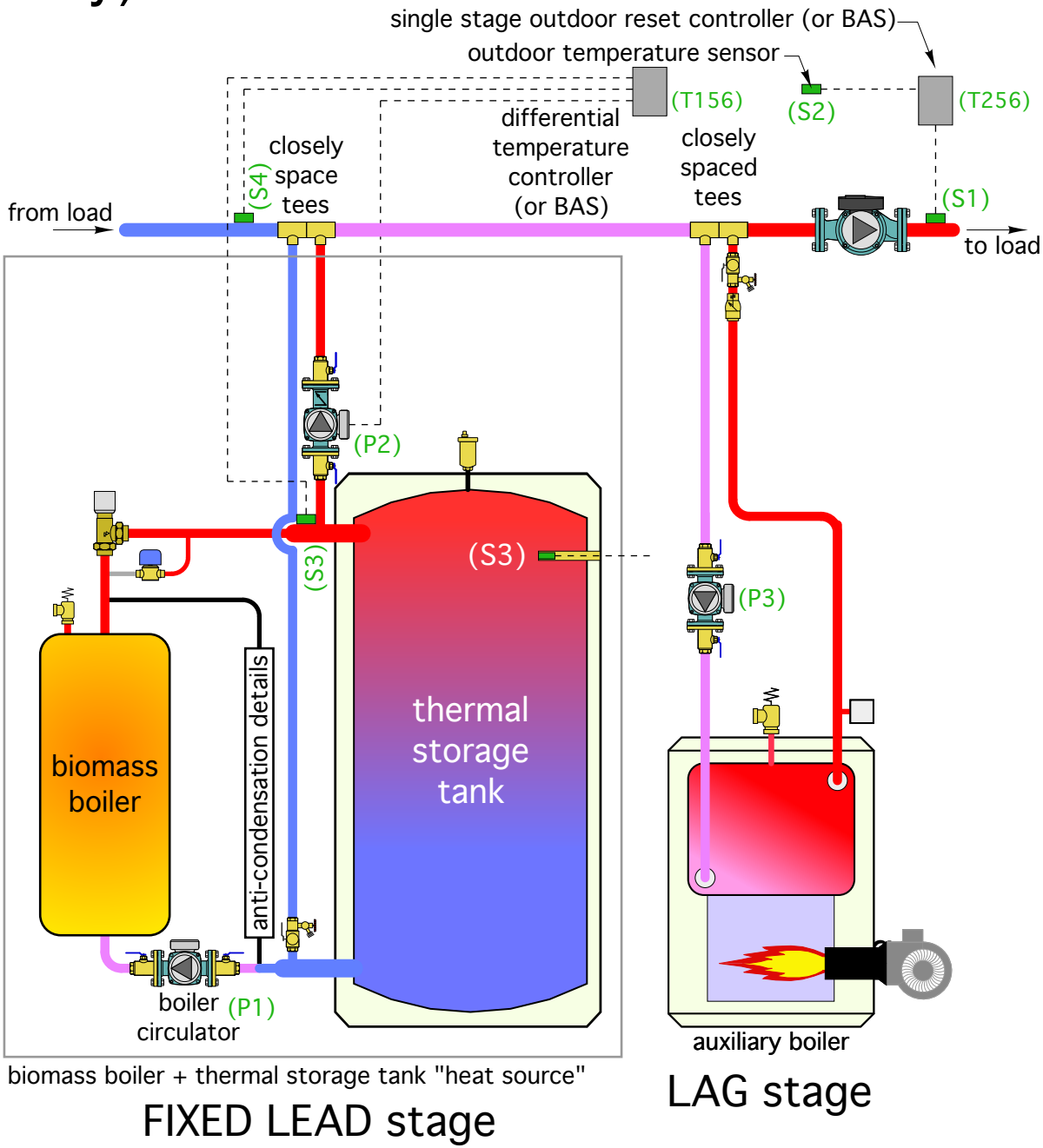
The solution is a simple *differential temperature controller* (or equivalent BAS functionality)

Compare the temperature at the upper tank header (S3) to the return temperature of the distribution system (S4).

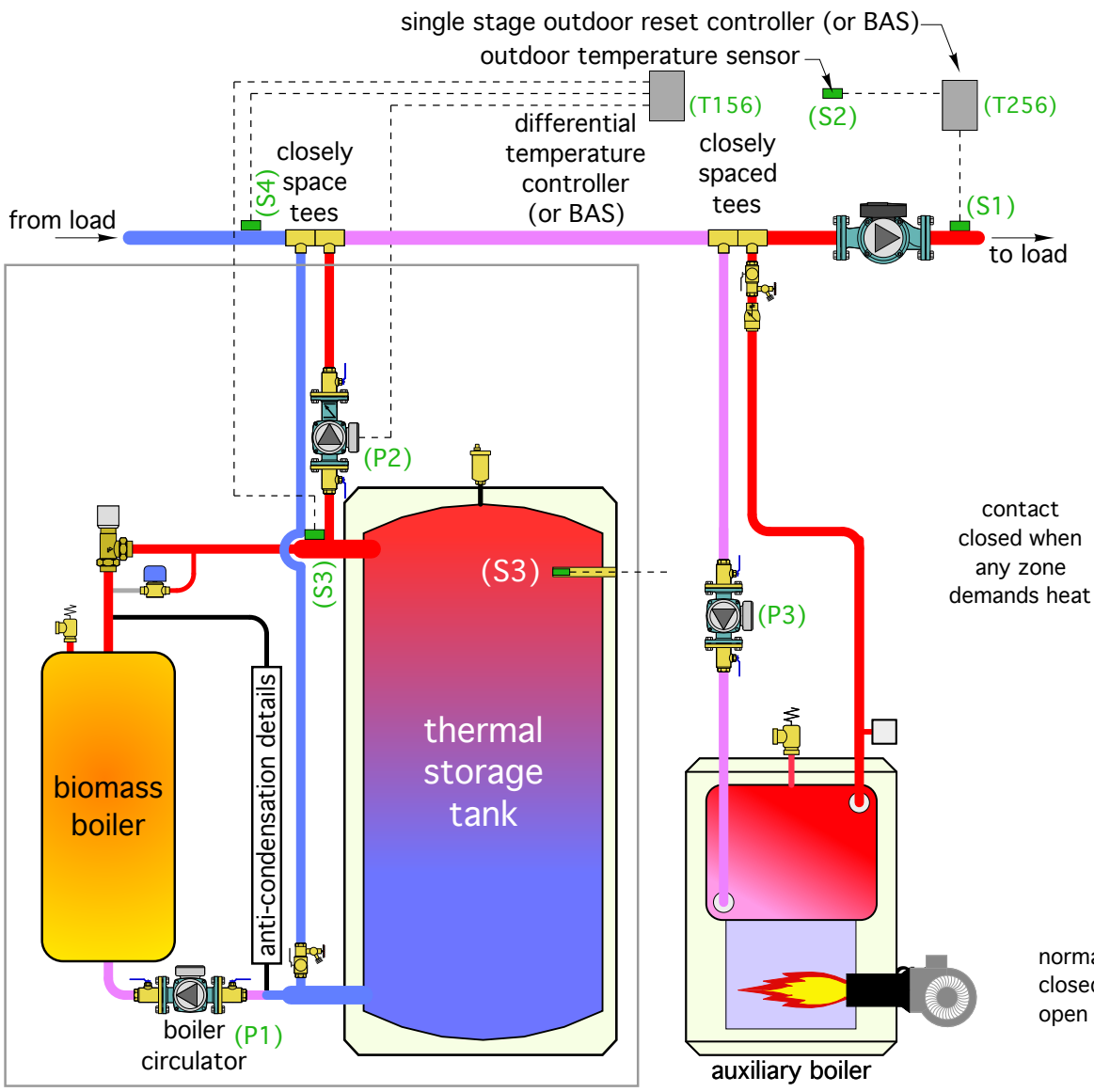
Circulator (P2) (tank to load) is only allowed to run when the tank can make a positive energy contribution to the system.

IF (S3) ≤ (S4) + 3 °F, THEN (P2) is OFF

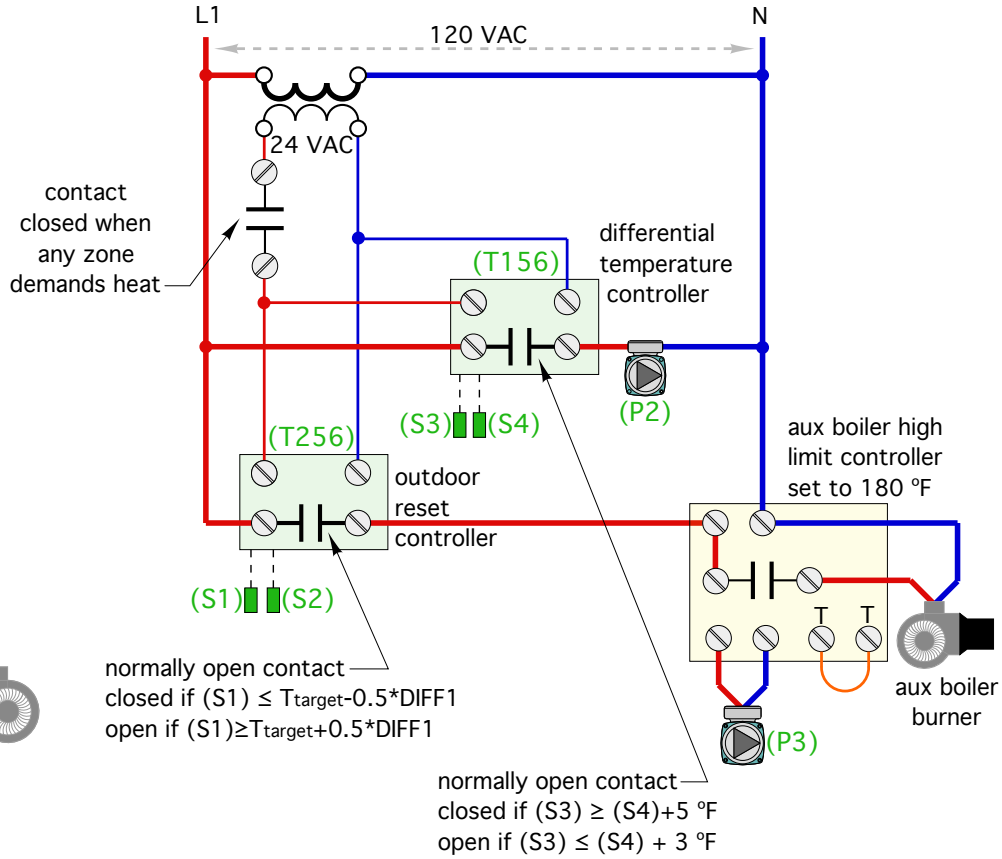
IF (S3) ≥ (S4) + 5 °F THEN (P2) is ON



Using two simple, inexpensive controllers to manage heat flow to load

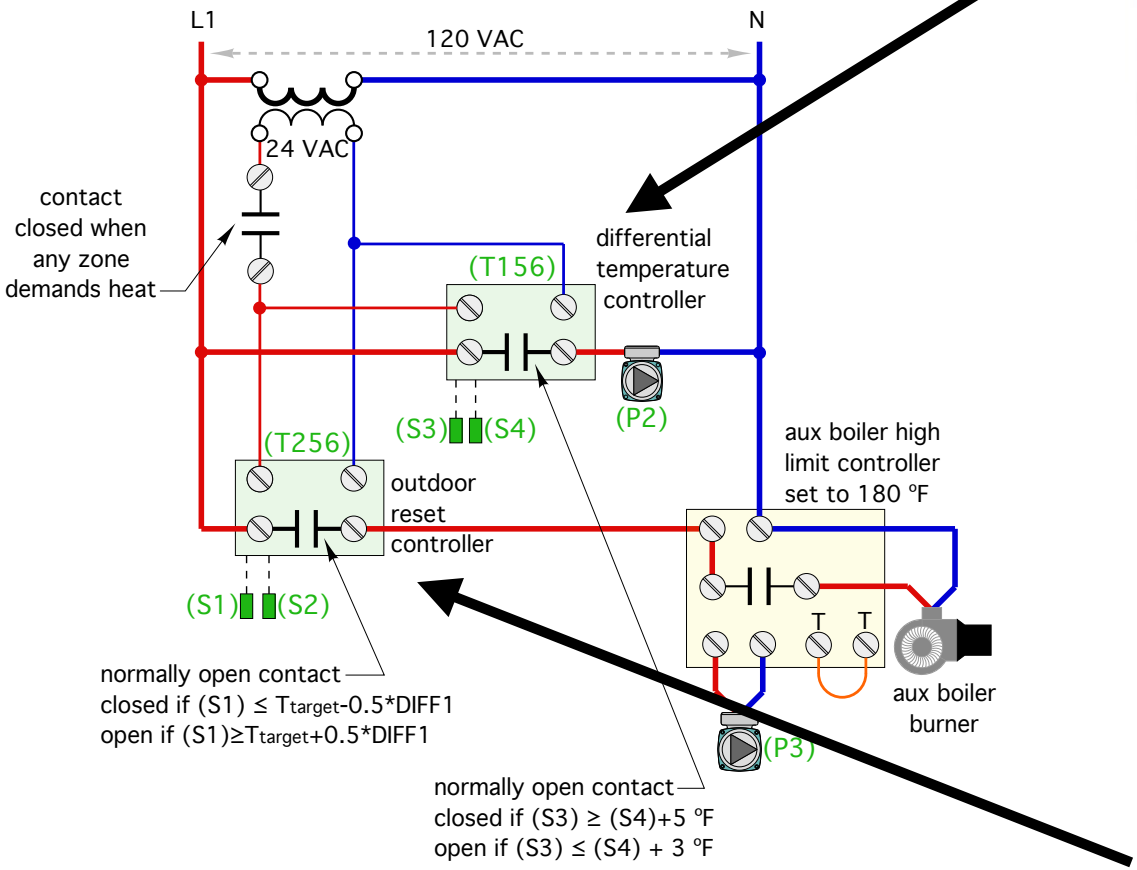


Circuitry to manage heat input to distribution system



Using two simple, inexpensive controllers to manage heat flow to load

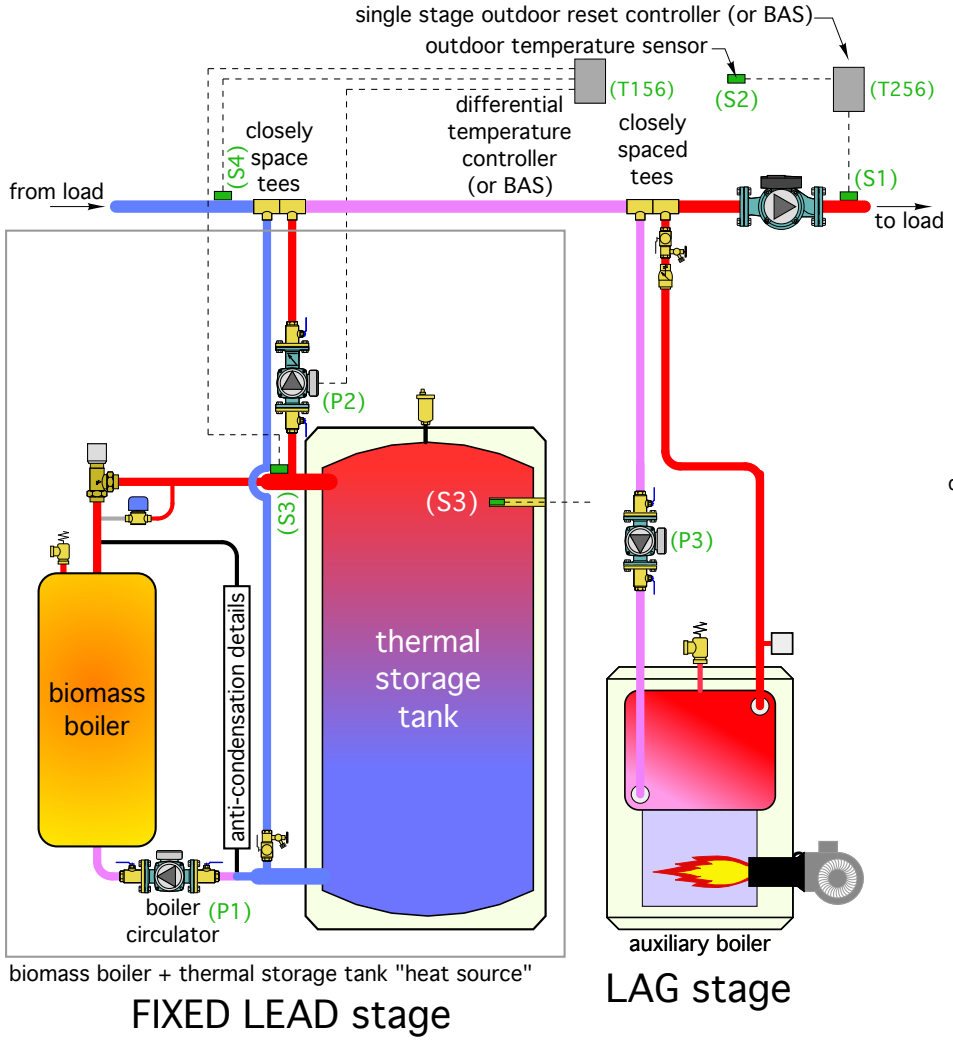
Circuitry to manage heat input to distribution system

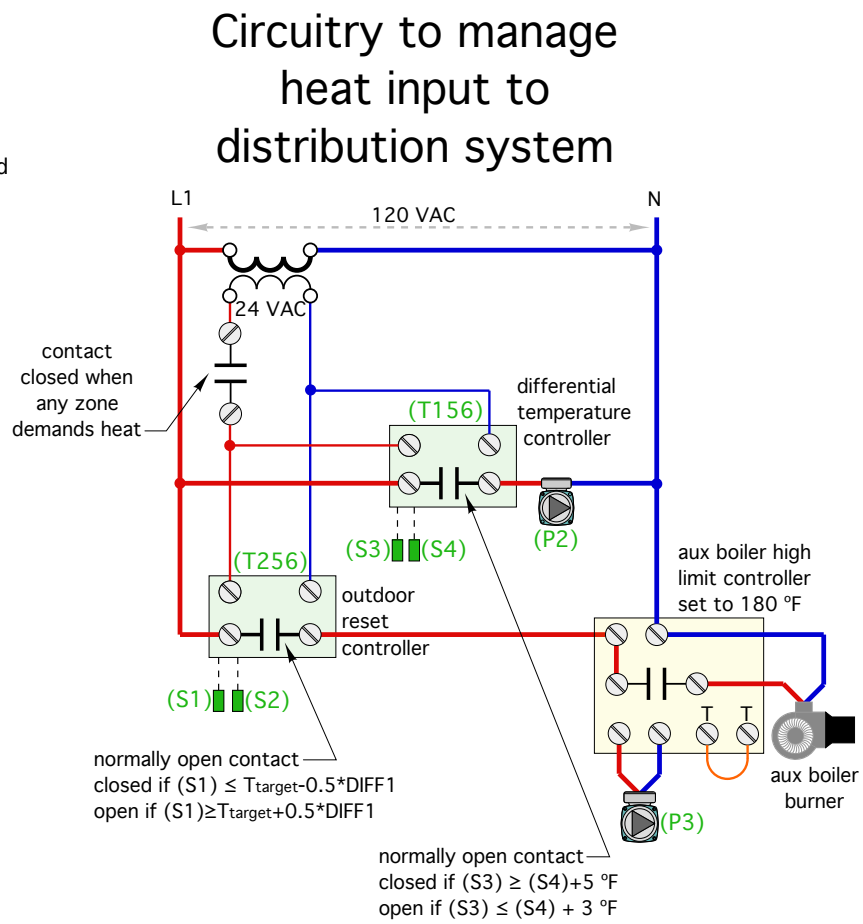


tekmar 256 differential temperature controller ($195)

tekmar 256 outdoor reset controller ($157)

Using two simple, inexpensive controllers to manage heat flow to load

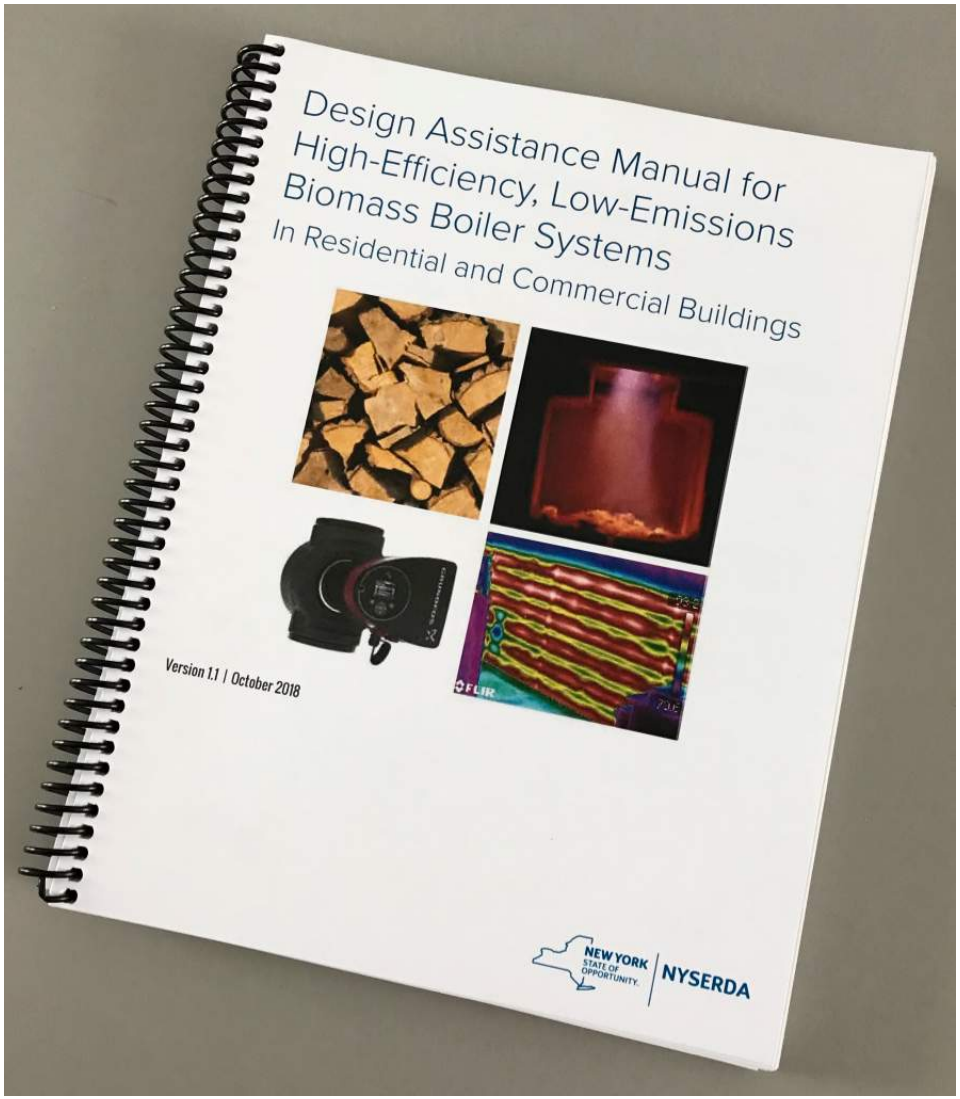




- The auxiliary boiler cannot operate until the supply water temperature to heating load is slightly below minimum supply temperature determined based on outdoor reset control settings.

- The tank circulator (P2) is only allowed to run when the tank can make a positive energy contribution to the system.

Design Assistance Manual
for High Efficiency Low Emissions Biomass Boiler Systems



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Thanks for attending today's webinar

RHNY 2019 training opportunities

Check the Renewable Heat NY website (under training opportunities) for latest information on scheduled events.

October 2019 8:00 a.m. – 5:00 p.m., 7 AIA/PDH education credits
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Questions ?

John Siegenthaler, P.E.
Principal, Appropriate Designs
Holland Patent, NY
www.hydronicpros.com
e-mail: siggy0269@gmail.com