

Tiny house heating and (warm) water supply system

System components

The system consists of the following components:

- Tankless propane heater (mainly heating + backup warm water supply)
- Water tank with an electric heating element (mainly warm water supply + heating during less cold months)
- Radiant hydronic floor
- Rainwater storage
- Control unit
- Manifolds and collectors (incl. valves, pumps, sensors etc.)

Figure 1 below shows the P&ID of the heating and warm water supply system. Red lines indicate hot/warm water, blue lines indicate cold water, pale red lines indicate warm water recirculation (return), black lines indicate bypasses, dashed green lines indicate power supply/signal communication.

In addition to that, several exemplary operation scenarios are placed at the end of the document, demonstrating different desired functional capabilities of the system. Not all possible scenarios are shown.

The main idea behind the current design is to maximize the efficiency of the heating and warm water supply system and to optimize the setup for a tiny house. It is aimed to utilize the available solar power to the maximum, and to use the propane heater as a booster at times when the available solar power is limited, to compensate for the insufficient water temperature.

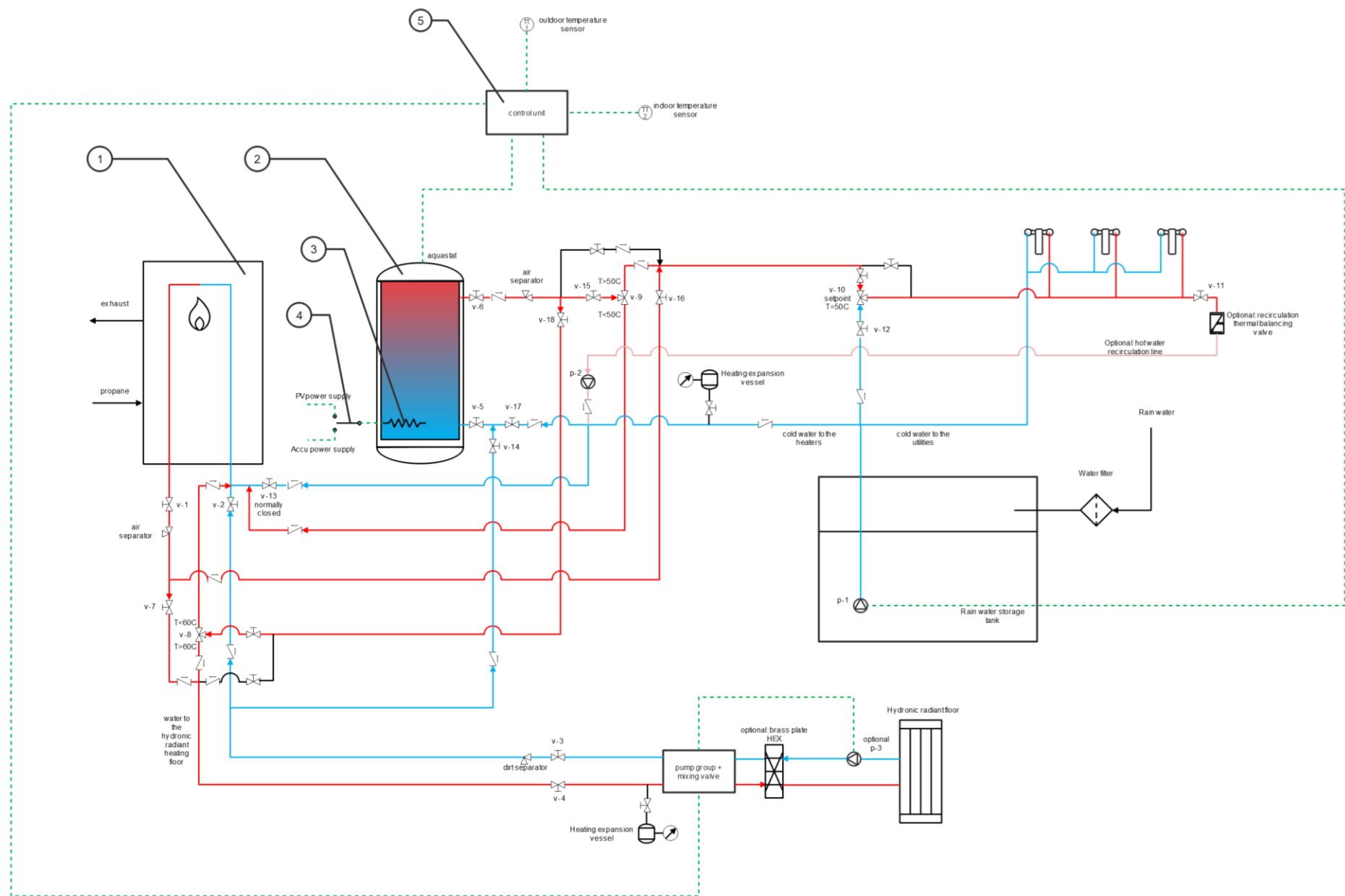


Figure 1: P&ID of the tiny house heating and warm water supply system

Propane heater

The propane heater (1 in Figure 1) is purposed mainly for heating during cold months and for backup on demand warm water supply, when the heating element (3 in Figure 1) of the water tank (2 in Figure 1) is not able to provide the required heating capacity due to the lack of solar power and/or utilization of high volumes of warm water in short period of time.

Water tank with Electric Water Heater Element

The water tank (2 in Figure 1) with an electric heating element (3 in Figure 1) serves mainly as a warm water buffer. The main power source is 24/48 Vdc supplied by Li batteries. Additionally, a preprogrammed switch (4 in Figure 1) allows to store excess solar energy generated by the solar panels in the form of heat, when the batteries are full. Besides the warm water supply to the house utilities (kitchen tap, bathroom tap, shower) the secondary purpose of the water tank is to provide heating during moderately cold weather, when the utilization of the propane heater can be avoided.

Diverging valve (warm water contour)

The diverging valve (v-9 in Figure 1) is required to provide warm water of set temperature (say 50C). When the water temperature in the water tank is sufficient (see Scenario 1 in Example scenarios), it will be supplied directly to the house water utilities. If the temperature of the water is below a certain setpoint value (see Scenario 2 in Example scenarios), it will be diverted to the propane heater for heating up to the propane heat point temperature (say 60C) after which it will be supplied to the house water utilities.

Diverging valve (heating contour)

The diverging valve (v-8) has exactly the same function as the v-9 valve but purposed for the heating contour. So again, if the temperature of the water stored in the water tank is sufficient (above the v-8 setpoint value - see Scenario 3 in Example scenarios) it will be supplied directly to the heating contour and will be circulated by means of the pump of the hydronic floor pump group (at the bottom in Figure 1). If the temperature is insufficient (see Scenario 4 in Example scenarios), it will be guided by the valve to the propane heater first, where it will be heated prior to the supply into the heating loop.

Recirculation

The recirculation pump (p-2 in Figure 1) coupled with the recirculation thermal balancing valve (top right in Figure 1) will ensure that the water in the warm water supply line is always warm (i.e. above certain setpoint value) by periodically circulating it back to the water tank and/or the propane heater.

Pump group

The pump group with a mixing valve (at the bottom in Figure 1) ensure hot water supply to the hydronic floor loop. Brass plate heat exchanger can be considered to isolate the hydronic floor loop from the rest of the system. In that case, an additional circulation pump (p-3) will be required.

Control unit

The control unit or the control panel is considered to automate the process of providing the heat and warm water to the house and make it more efficient. Some of the functionalities of the control unit include reading temperature values from the temperature sensors (TT1, TT2 in Figure 1), control of the pumps, providing user interface for setting the desired room temperature etc.

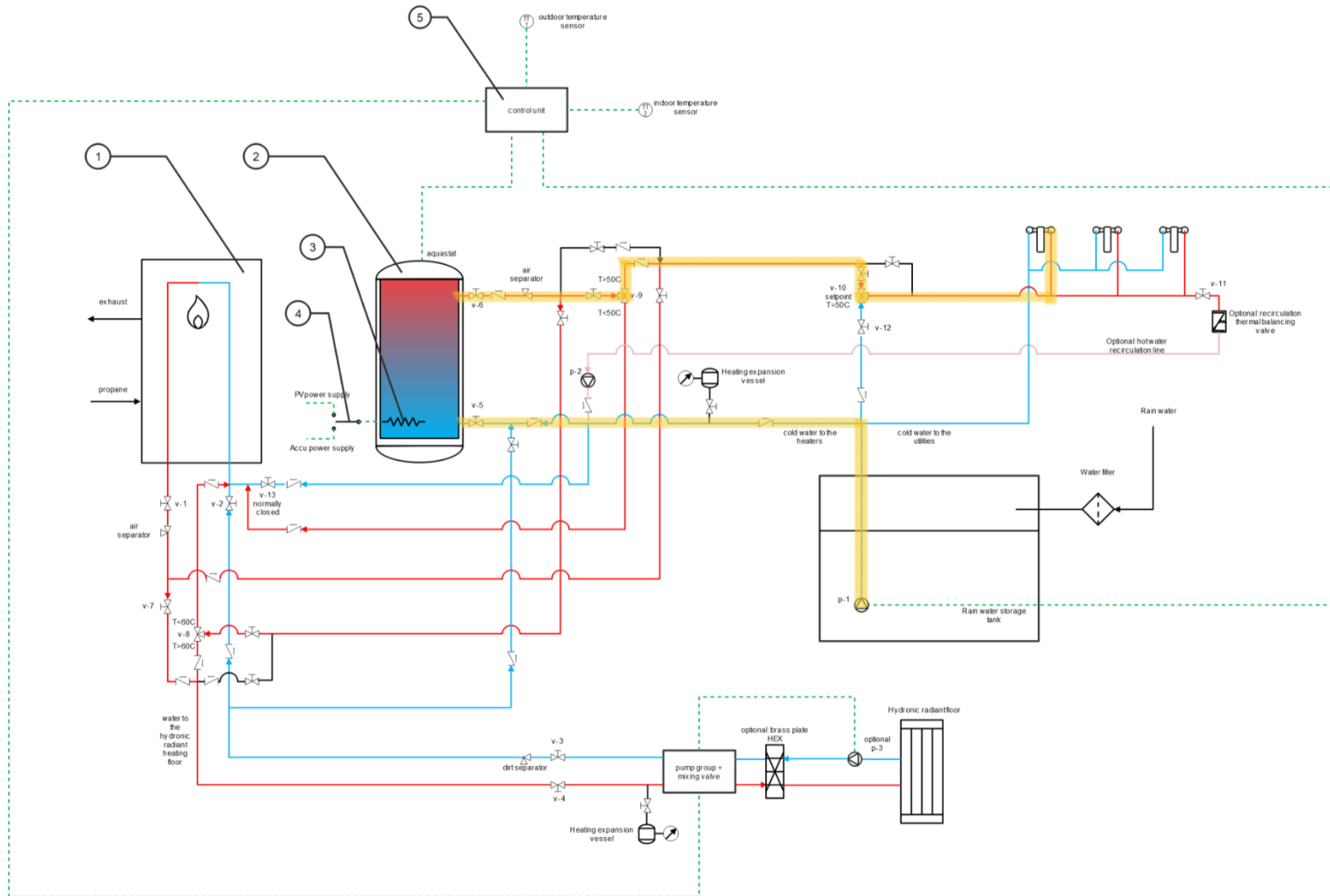
BOM¹

#	Component	Model	Comment
1.	Tankless propane heater	Rheem RTG-84XLN-1 Eccotemp EL22i Rinnai V65eP	
2.	Water tank	Fothermo PVB-80	
3.	Diverging and mixing valve (v-8, v-9, v-10)	Caleffi	
4.	Hydronic floor pump group	Wilo Stratos Para 30/1-8 Watts	
5.	Recirculation thermal balancing valve	Caleffi	
6.	Recirculation pump	t.b.d.	
7.	Main supply pump	Elpumps	
8.	Control unit	Bruli or similar	

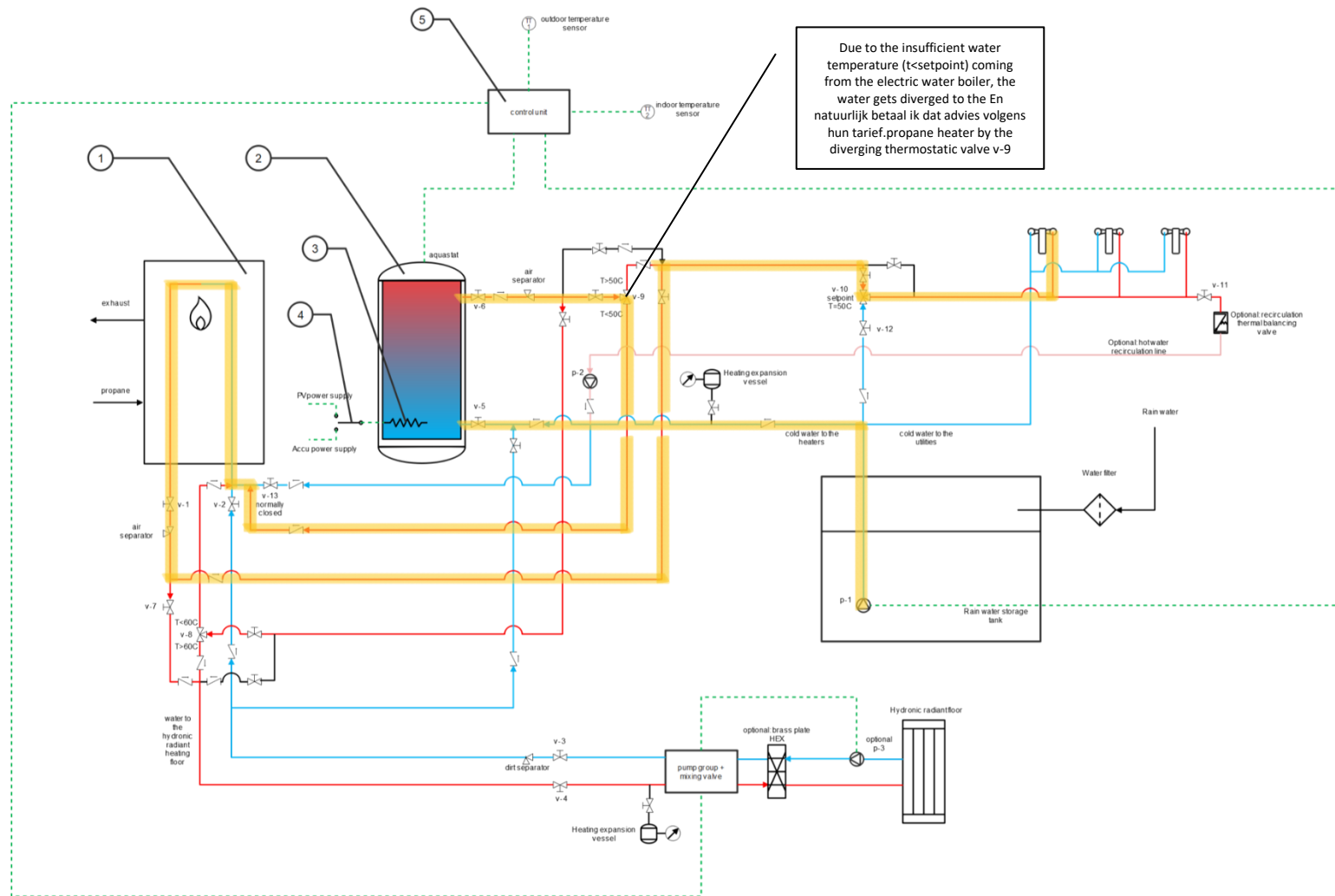
¹ Components of other brands can be considered with similar performance parameters

Example scenarios

Scenario 1: Warm water supply in case of sufficient water temperature in the water tank

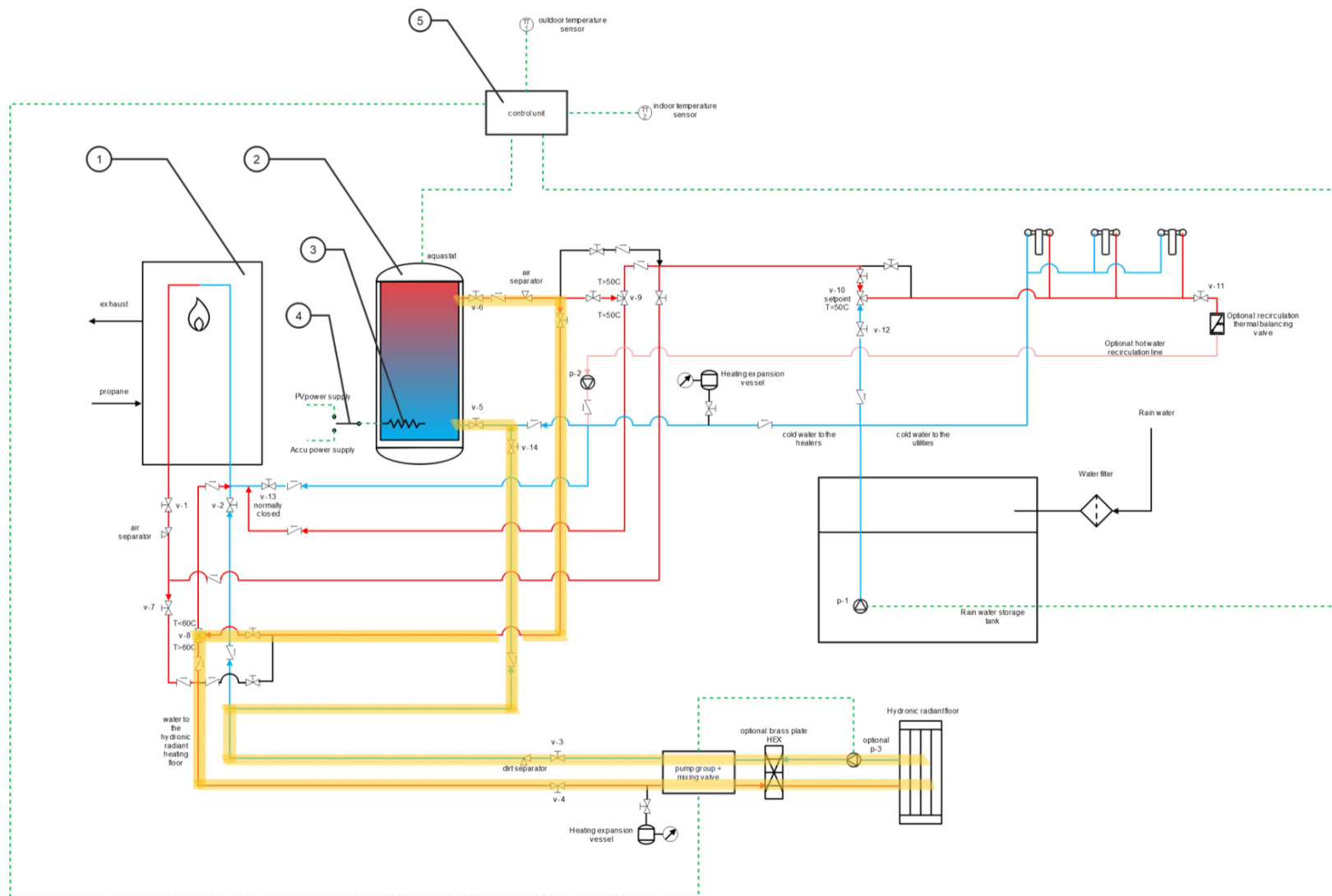


Scenario 2: Warm water supply in case of insufficient water temperature in the water tank²

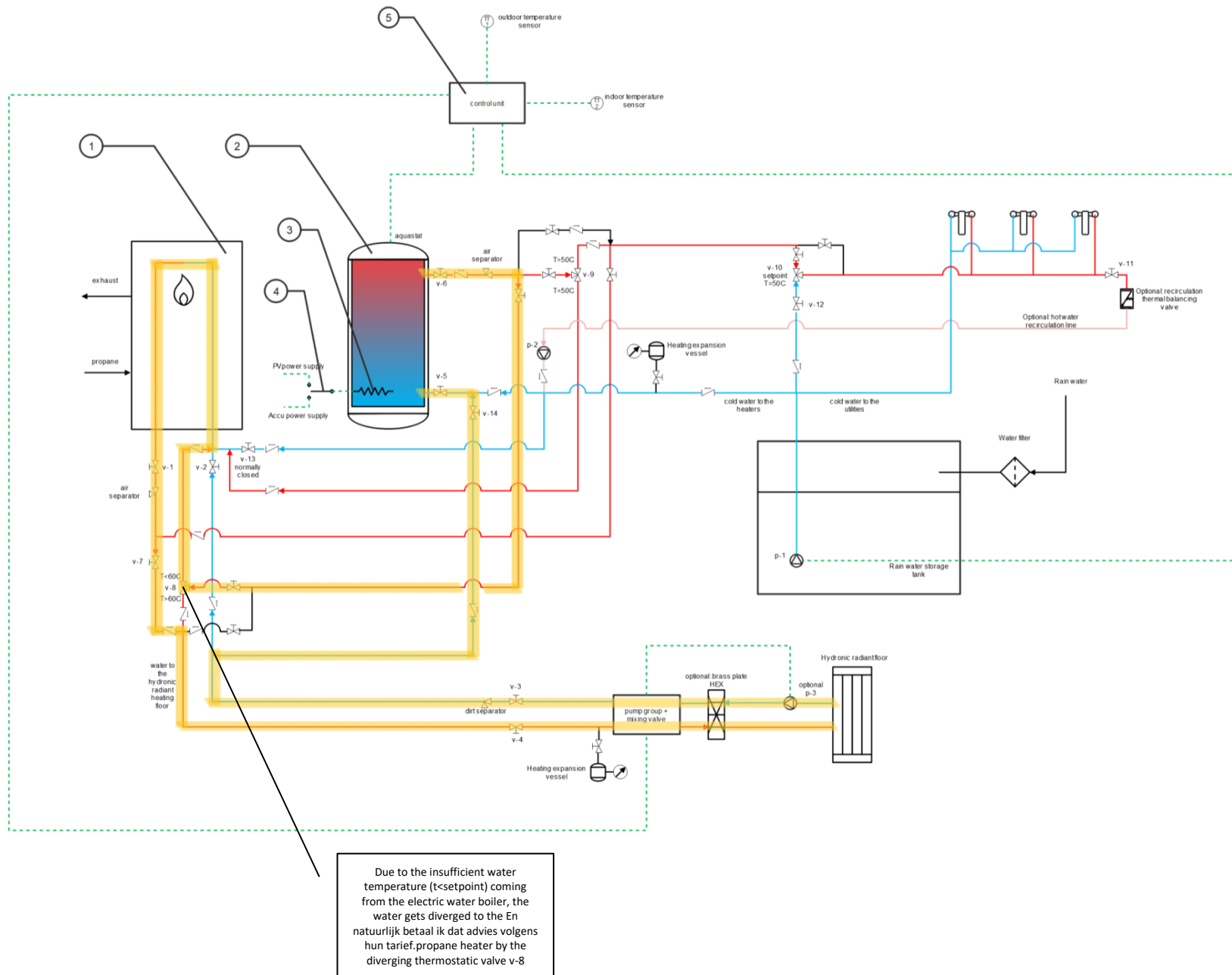


² It is possible in this scenario that water (say $< 50\text{C}$) instead of going via the v-9 diverging valve will rather go via the v-8, but this is not critical

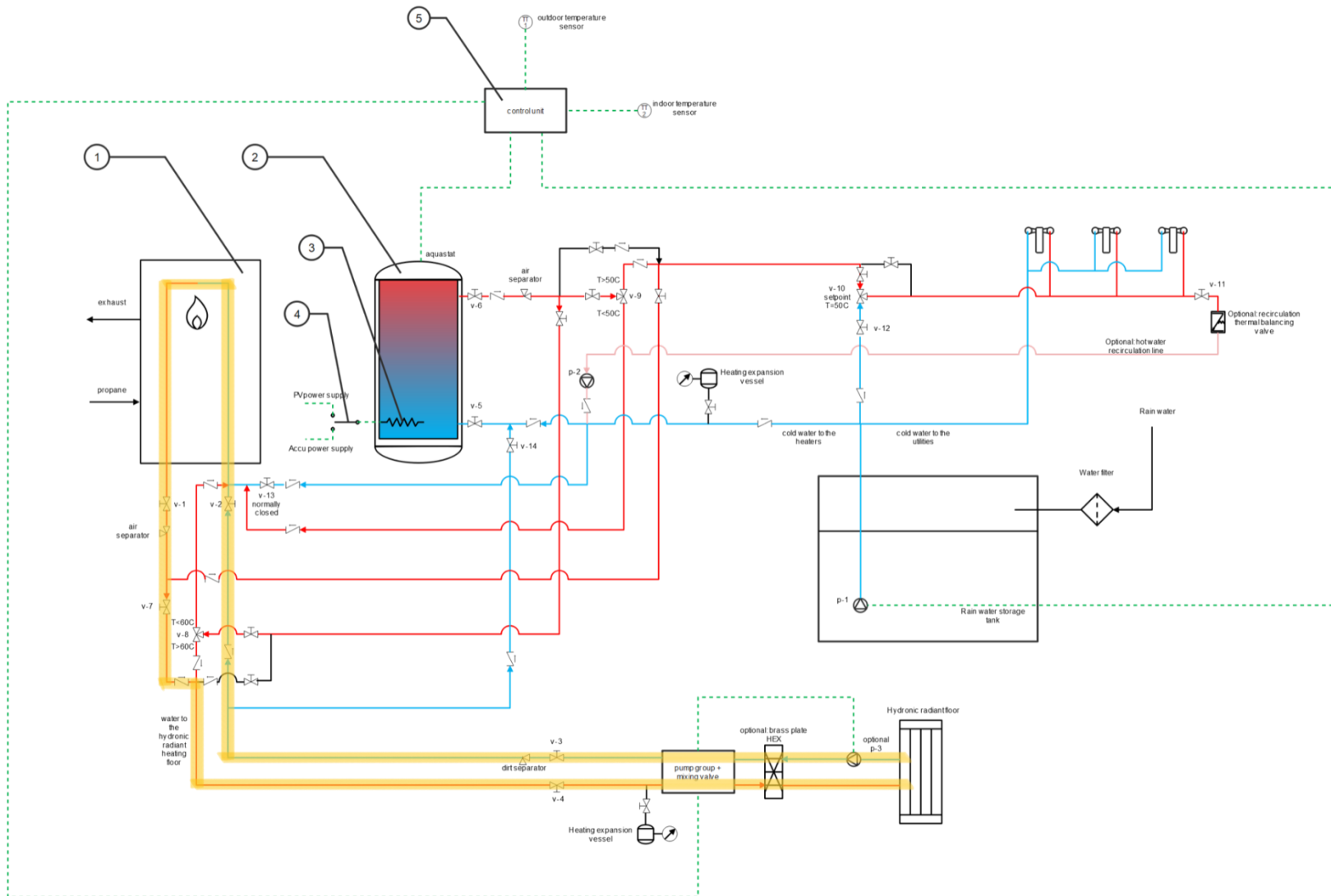
Scenario 3: Heating in case of sufficient water temperature in the water tank (v-2 is closed)



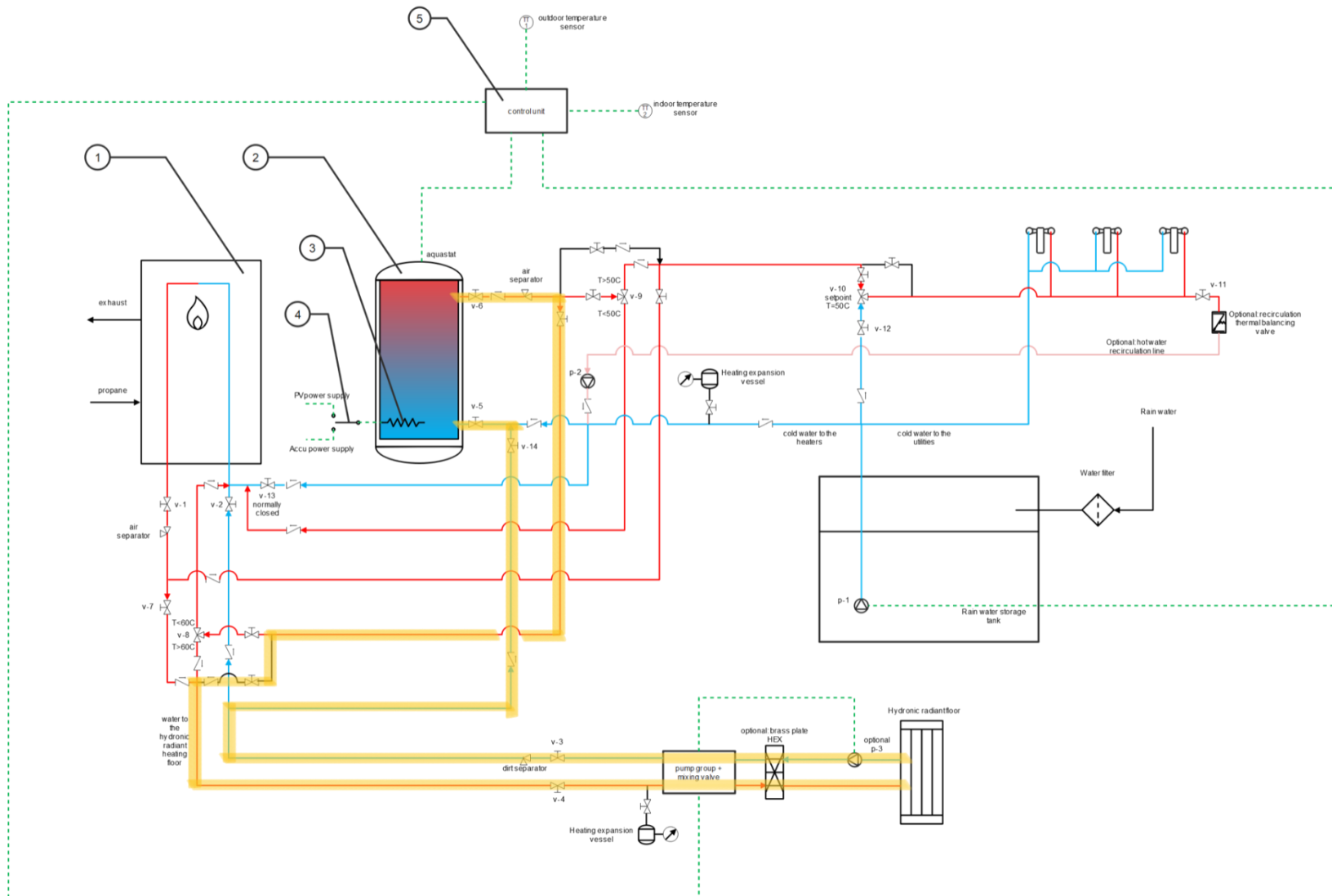
Scenario 4: Heating in case of insufficient water temperature in the water tank (v-2 is closed)



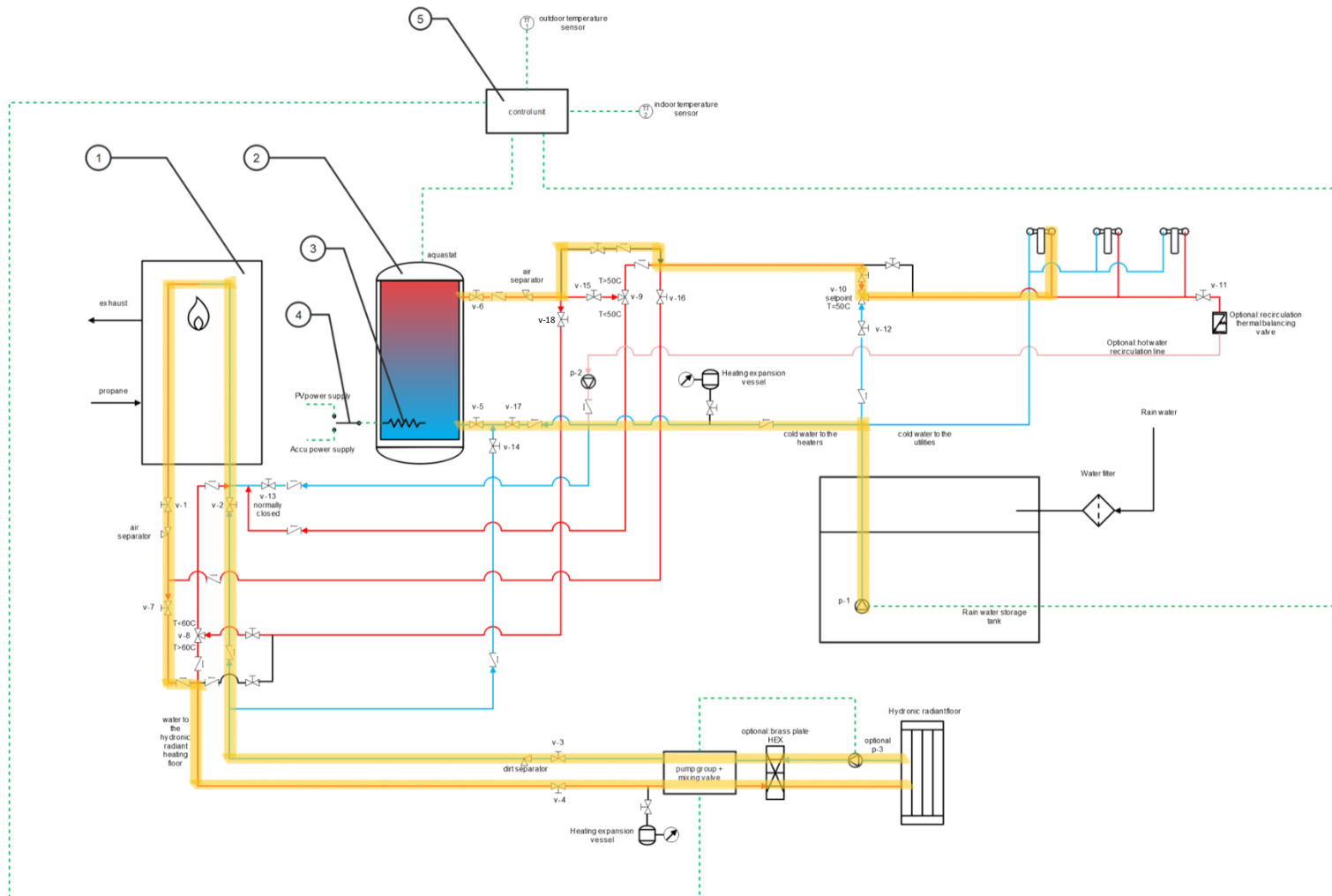
Scenario 5: Bypass heating by means of the propane heater (v-14 is closed, v-2 is open)



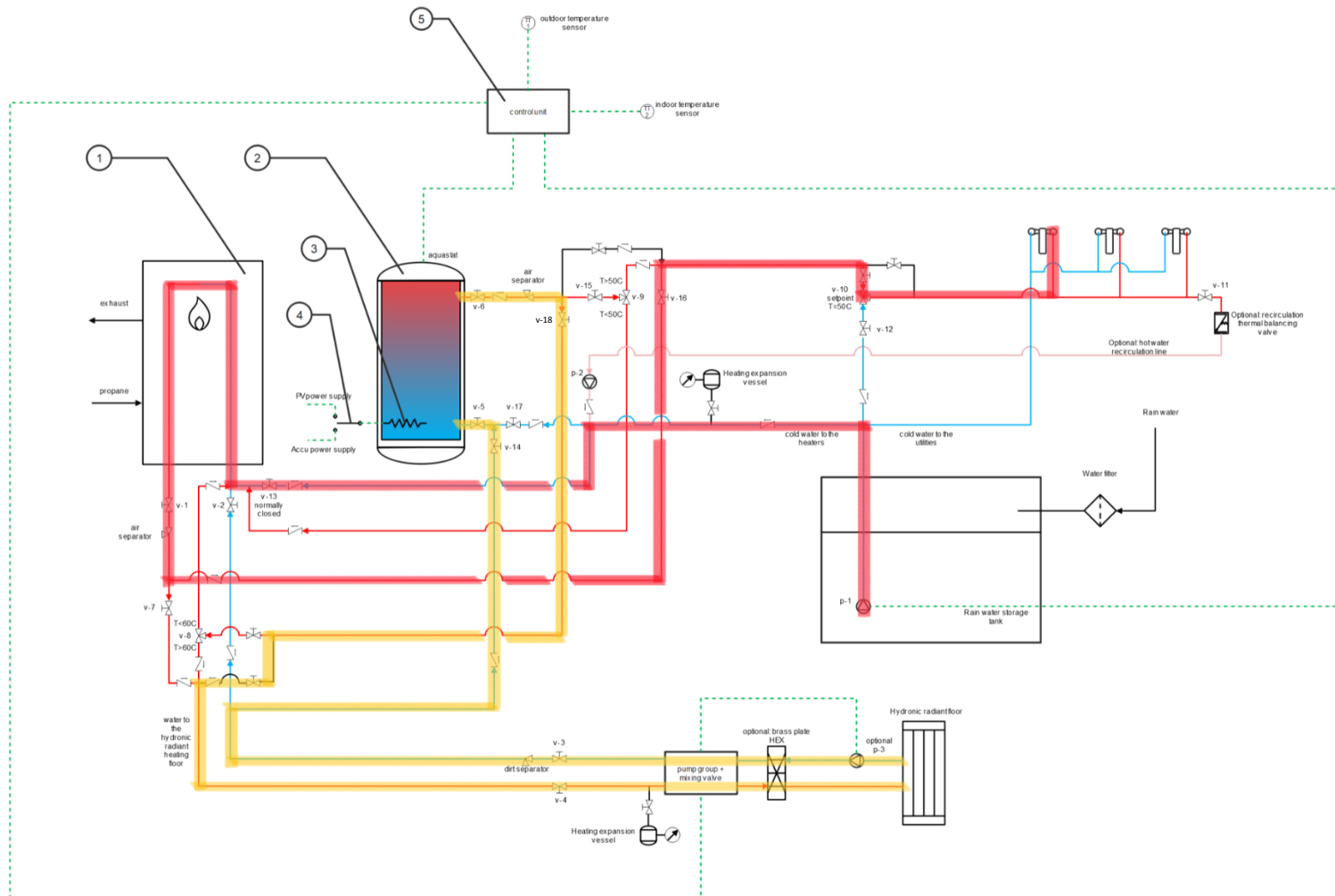
Scenario 6: Bypass heating by means of the water tank



Scenario 7: Independent operation: water tank for warm water supply, propane heater for heating (v-14 closed, v-16 closed v-18 closed)



Scenario 8: Inversed independent operation: water tank for heating, propane heater warm water supply (v-7 closed, v-13 open, v-15 closed, v-17 closed)³



³ It is unlikely that the system will be operated in this setup, this scenario is given just as an example