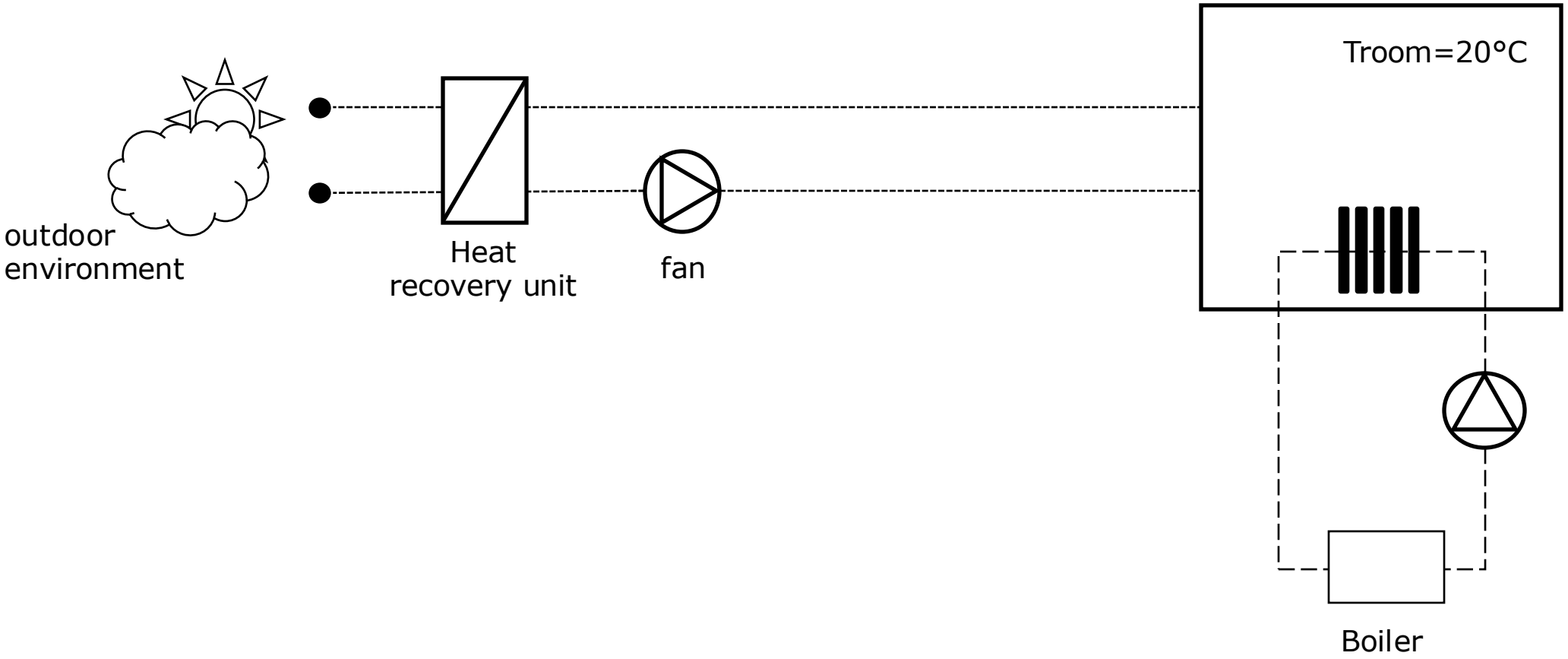
Final assignment

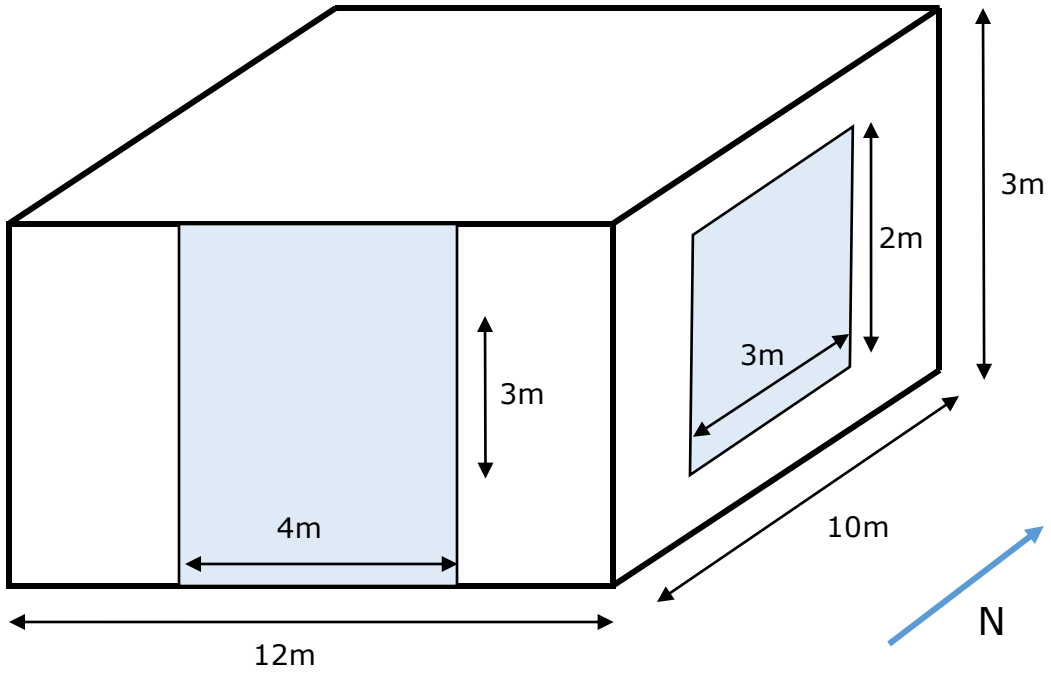
It is required to submit a short report in order to receive the course diploma (3ECTS)! Please follow the slides through the four steps in order to prepare the report. The report should include a combination of text, images of the Modelica models, and plots.



NOTE: If you're not interested in receiving the course diploma, you are not required to submit the report.

Assumptions and hints:

Room:
- Use the ISO13790 model from the Buildings Library
- The room has four exterior wall, a roof and a floor. Constructions details are shown in the table



Exterior wall

U-value = 0.25 W/m^{2}K

Roof

U-value = 0.15 W/m^{2}K

Floor

U-value = 0.11 W/m^{2}K
b = 0.5

Windows
U-value = 0.9 W/m^{2}K
g-factor = 0.5
Frame fraction = 0.01

Internal gains (sensible)
From 00:00 to 8:00 = 600 W
From 8:00 to 18:00 = 240 W
From 18:00 to 24:00 = 600 W

Weather file
Chicago

Air change rate
0.4 h^{-1}

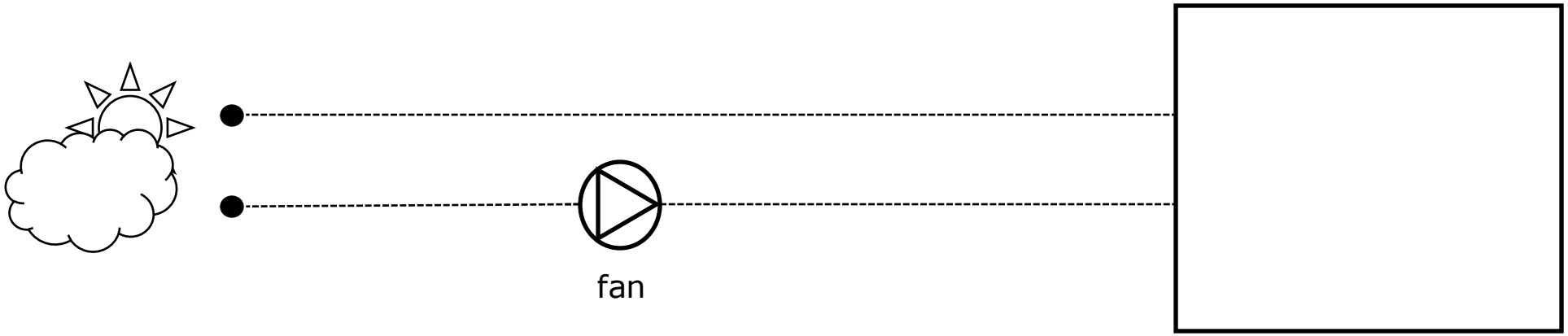
Building mass
Medium

Heat transfer coefficient
3.45 W/m^{2}k

STEP 1: Plot the indoor air temperature in the room from day 0 to day 31 (January). What's the minimum air temperature in the room?

Assumptions and hints:

Add a ventilation system with a constant supply of air mass flow rate of 0.05 kg/s



STEP 2: Plot the indoor air temperature in the room. What’s the minimum air temperature in the room?

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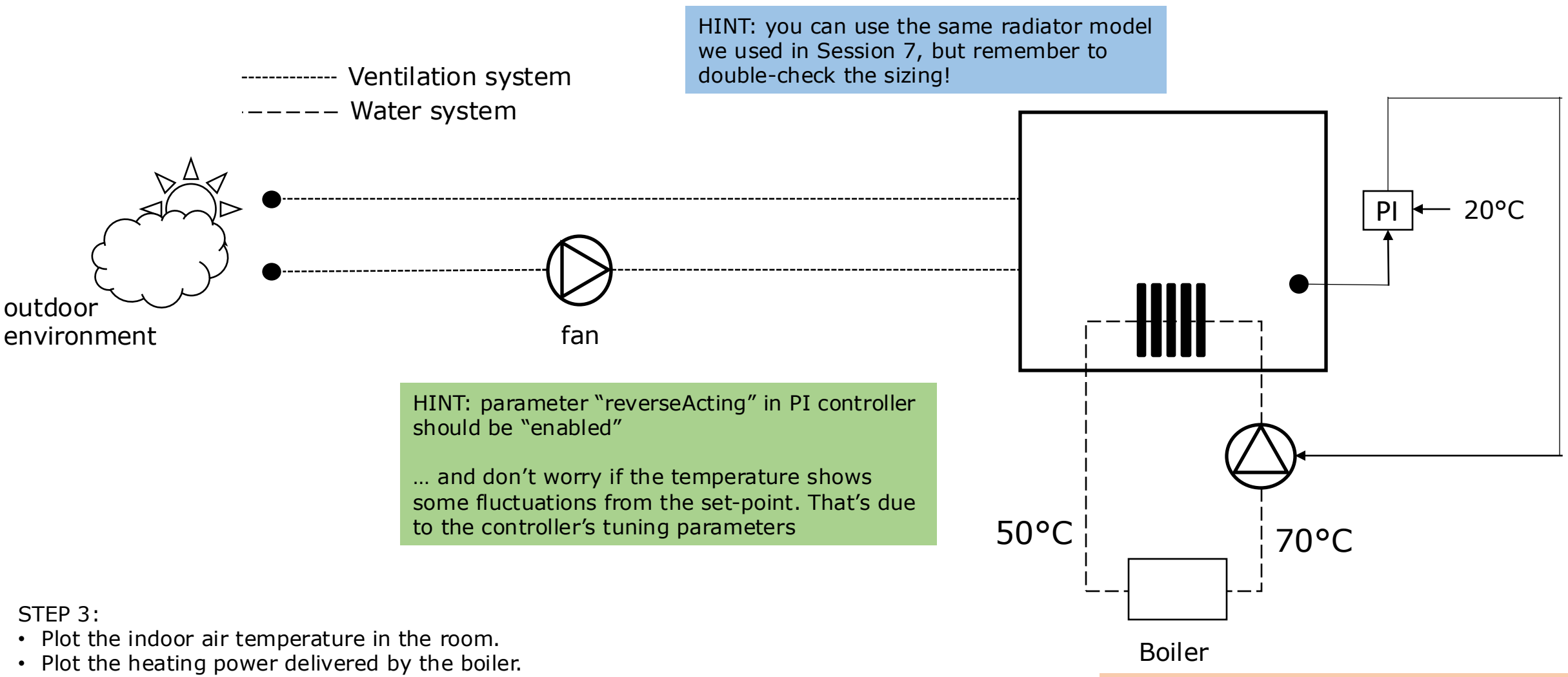
Add a heating system with a radiator (Tsup=70°C, Tret, 50°C) to keep indoor air temperature at 20°C. Assume a Q_nom = 7kW for sizing the system. Use a PI controller to vary the water mass flow rate.

HINT: you can use the same radiator model we used in Session 7, but remember to double-check the sizing!



HINT: parameter "reverseActing" in PI controller should be "enabled"

… and don't worry if the temperature shows some fluctuations from the set-point. That's due to the controller's tuning parameters

STEP 3:

- Plot the indoor air temperature in the room.
- Plot the heating power delivered by the boiler.
- Calculate the heating energy use in kWh

HINT: Use the following model as boiler Buildings.Fluid.HeatExchangers.Heater_T

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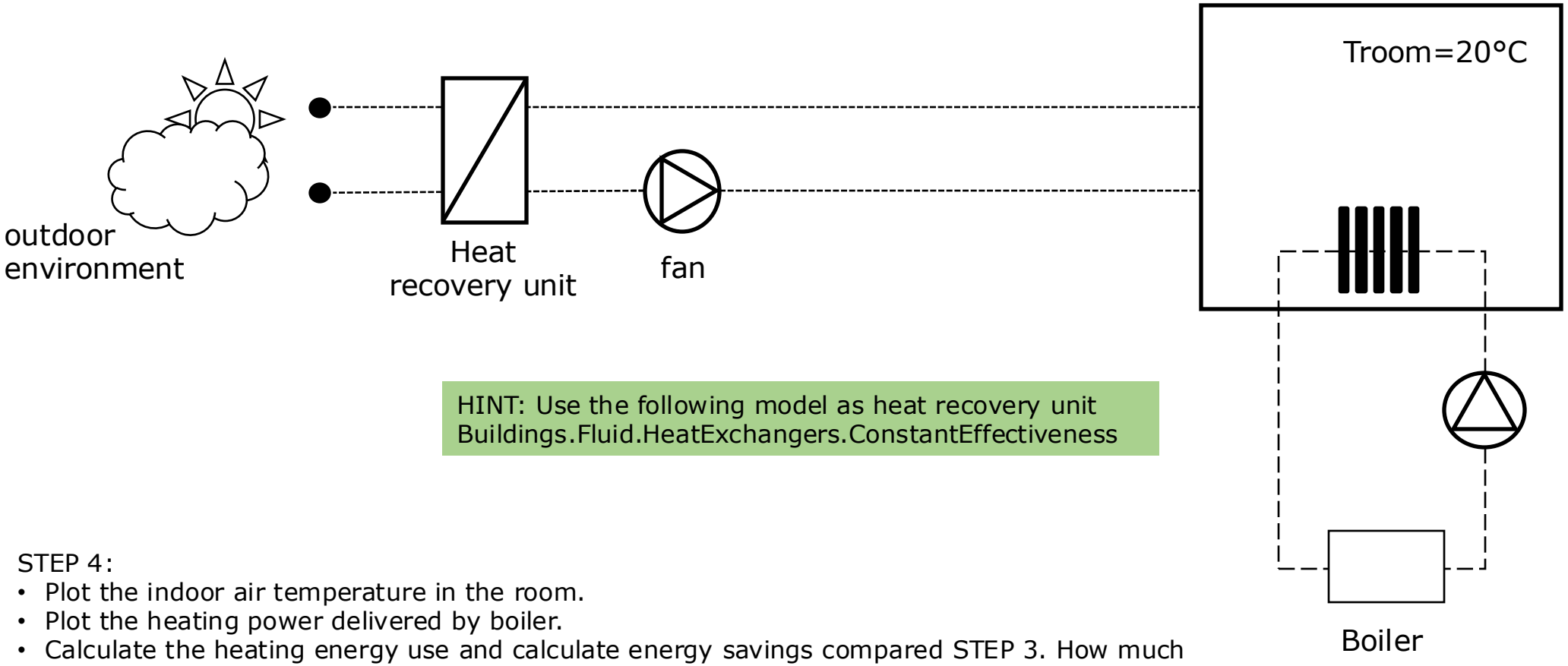
Add a heat recovery unit with effectiveness of 0.8



HINT: Use the following model as heat recovery unit
Buildings.Fluid.HeatExchangers.ConstantEffectiveness

STEP 4:

- Plot the indoor air temperature in the room.
- Plot the heating power delivered by boiler.
- Calculate the heating energy use and calculate energy savings compared STEP 3. How much energy do we save by adding the heat recovery unit?

SOLUTIONS

I haven’t solved the assignment myself (on purpose!), so the results below are average values from previous years’ students. If your results fall within this range, you can assume they’re likely acceptable 🙂

STEP1: Minimum temperature between -1 and -4°C

STEP2: Minimum temperature with ventilation system between -5 and -9°C

STEP3: Heating energy use between 2100 and 2300 kWh

STEP4: Heating energy use with heat recovery unit between 1300 and 1600 kWh / Savings approx. 700-800 kWh