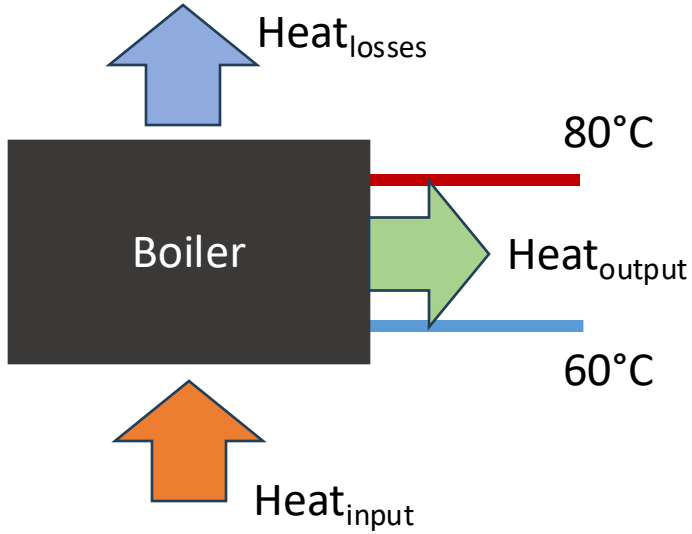
Modelica-based simulation of building and district energy systems

SESSION 12 – District heating system: Part II

Alessandro Maccarini

SESSION 12 – District heating system: Part II

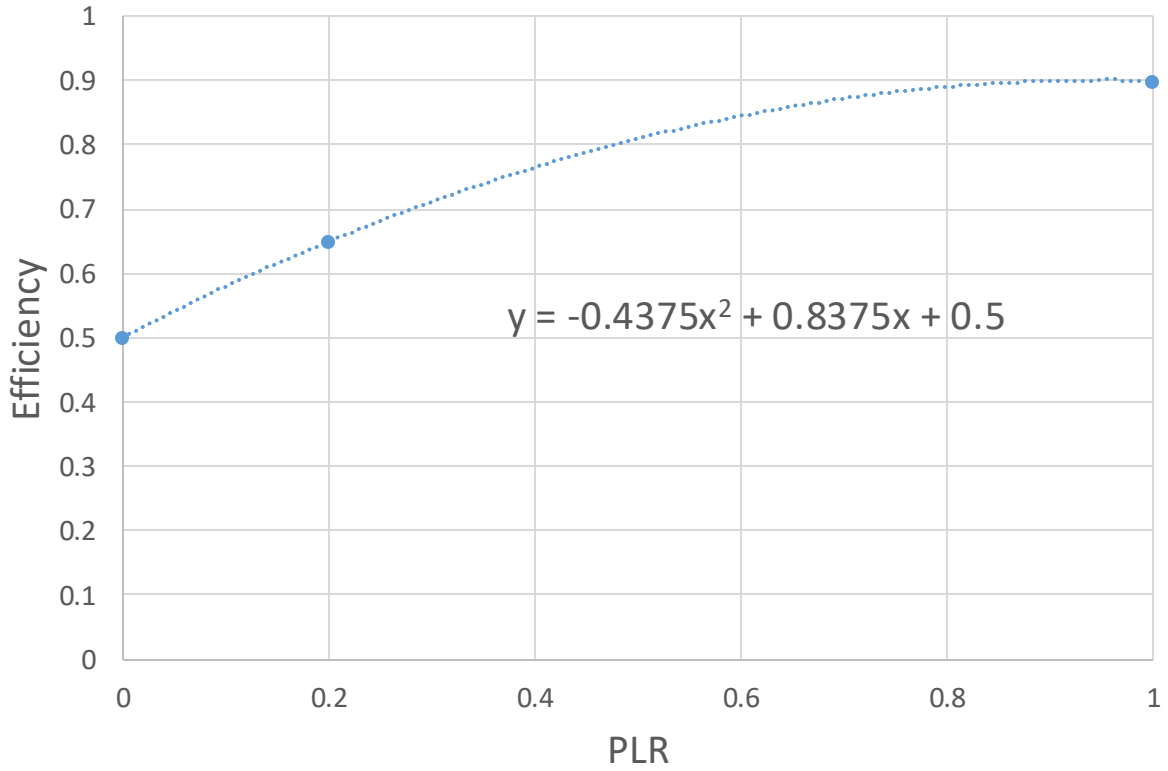
STE3: To create a more detailed model of the thermal plant (boiler)



$$Heat_{input} = \frac{Heat_{output}}{\varepsilon}$$

$$\varepsilon = f(Part\ Load\ Ratio)$$

$$PLR = \frac{Boiler\ actual\ load}{Boiler\ nominal\ load}$$



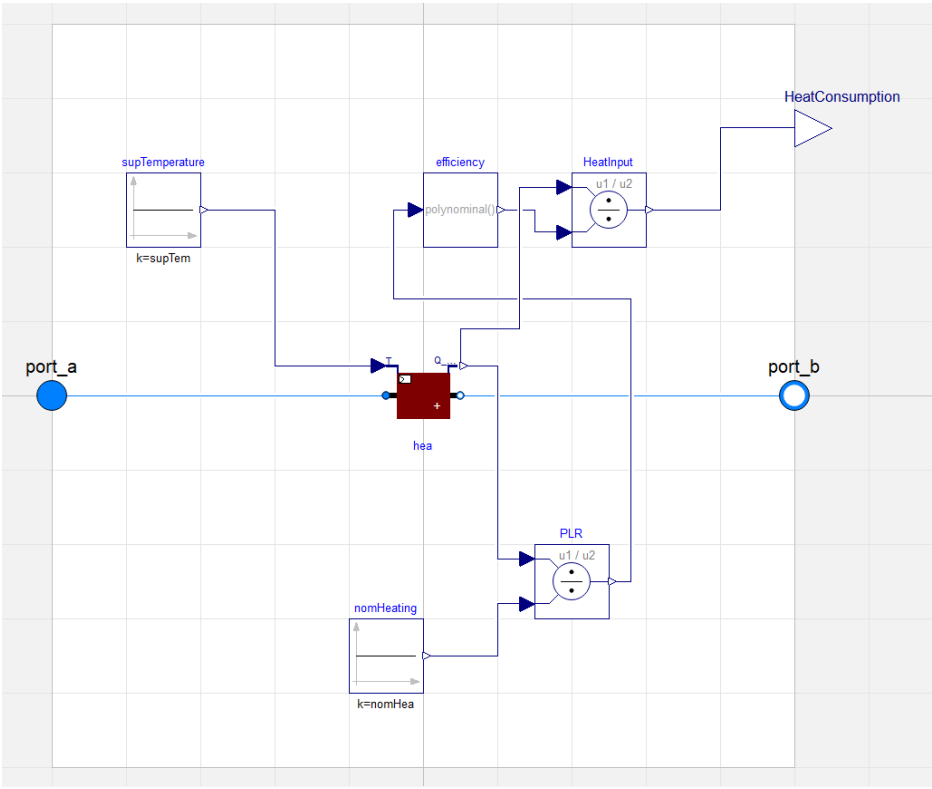
SESSION 12 – District heating system: Part II

STE3: To create a more detailed model of the thermal plant (boiler)

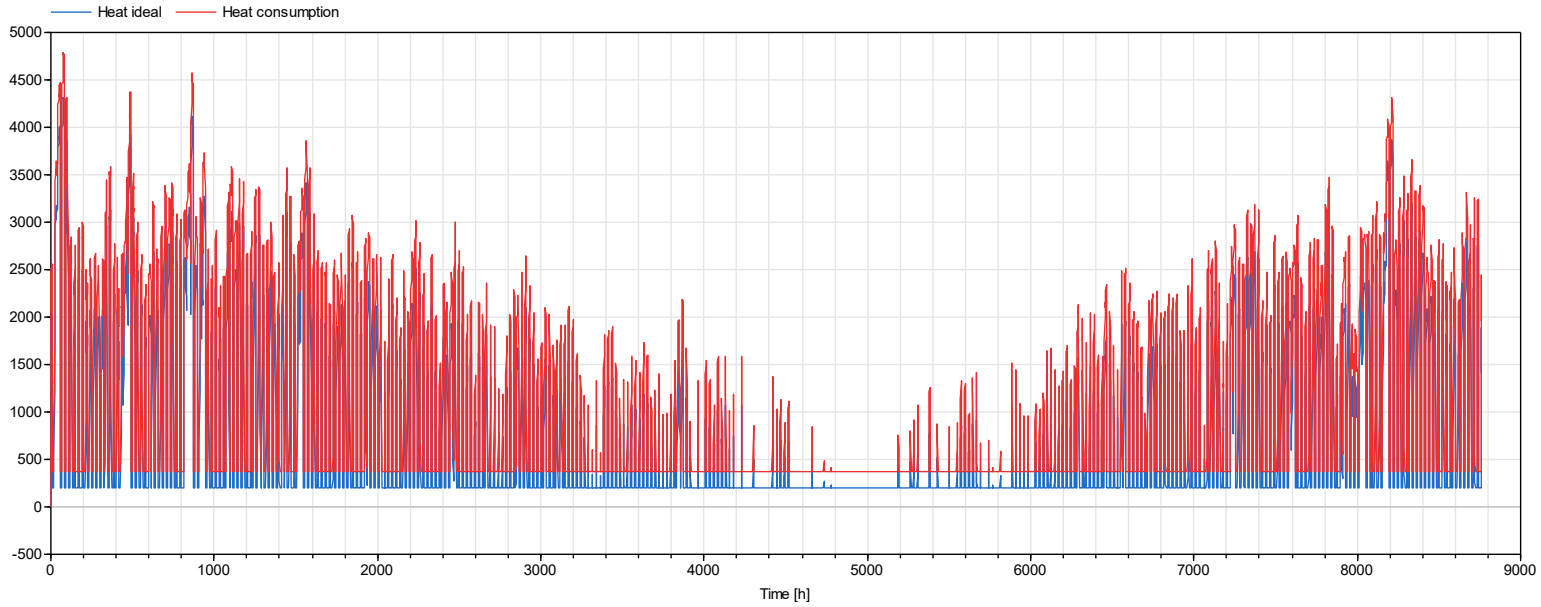
1. In the package Components, create a new model called **ThermalPlant**
2. Drag and drop the following blocks:

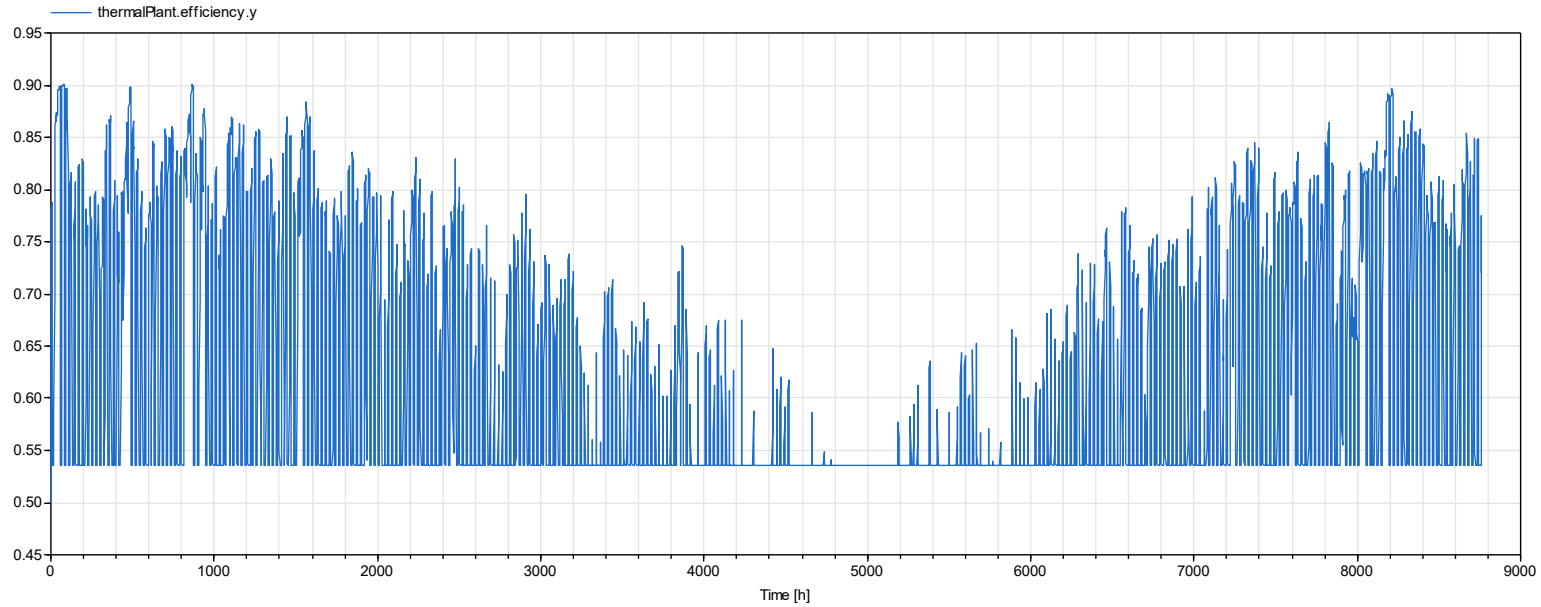
   - `Modelica.Blocks.Math.Division (2)`
   - `Modelica.Blocks.Sources.Constant (2)`
   - `Modelica.Blocks.Interfaces.RealOutput (1)`
   - `Buildings.Fluid.HeatExchangers.Heater_T (1)`
   - `Modelica.Fluid.Interfaces.FluidPort_a (1)`
   - `Modelica.Fluid.Interfaces.FluidPort_b (1)`
   - `Buildings.Utilities.Math.Polynomial (1)`

3. Connect the components according to the figure.
4. Create three parameters (in text editor):
   - nomHea: nominal heat flow rate [W]
   - m_flow_nom: nominal mass flow rate [kg/s]
   - supTem: supply water temperature [°C]
5. Assign the right parameters to the right blocks
6. Read the documentation about *Buildings.Utilities.Math.Polynomial* and provide the right values to the parameter.
7. Assign a value = 100 Pa to dp_nominal in *Heater_T*
8. Duplicate Experiment1 and call the new model **Experiment2**
9. Replace the ideal heater with the thermal plant
10. Assign reasonable values to the parameters of the thermal plant model
11. Simulate the model for one year and plot "Heat ideal", "Heat consumption" and efficiency.



SESSION 12 – District heating system: Part II



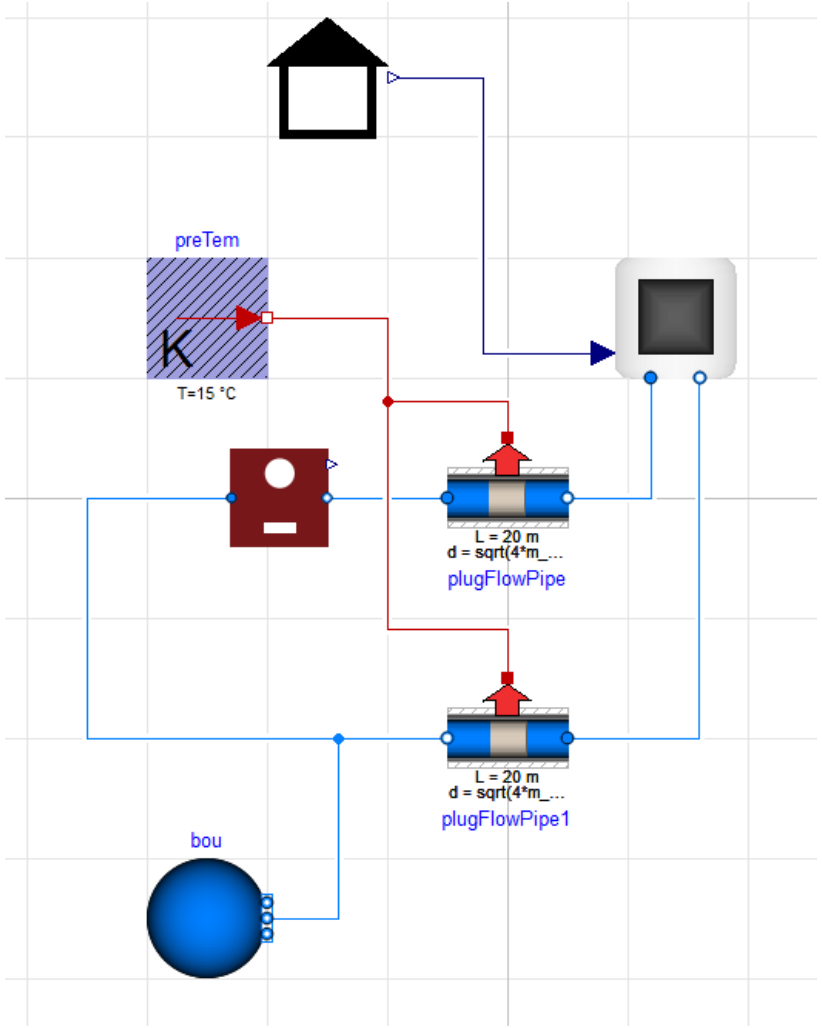


SESSION 12 – District heating system: Part II

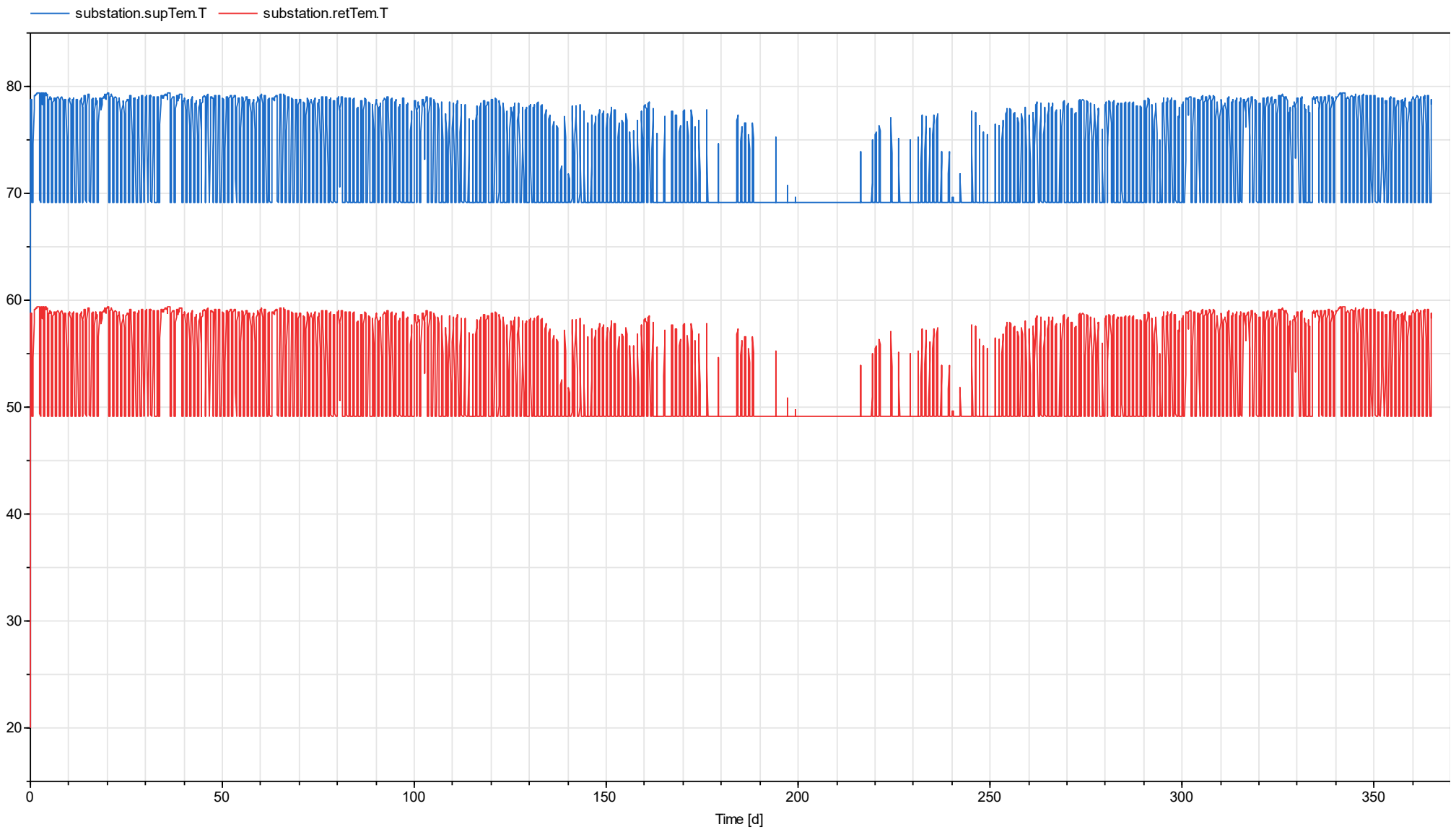
STE4: To add a piping distribution network with ground heat losses

1. Duplicate Experiment2 and call the new model **Experiment3**
2. Drag and drop the following components:
   - `Buildings.Fluid.FixedResistances.PlugFlowPipe(2)`
   - `Buildings.HeatTransfer.Sources.FixedTemperature(1)`

3. Connect the components according to the figure.
4. Set a ground temperature of 15°C
5. Set the following values to the parameters in the pipes:
   - Medium = water
   - m_flow_nominal = 0.05 kg/s
   - v_nominal = 0.15 m/s
   - length = 20 m
   - dIns = 0.2 m
   - kIns = 0.04 W/mK
6. Simulate the model for one year and plot supply and return temperatures

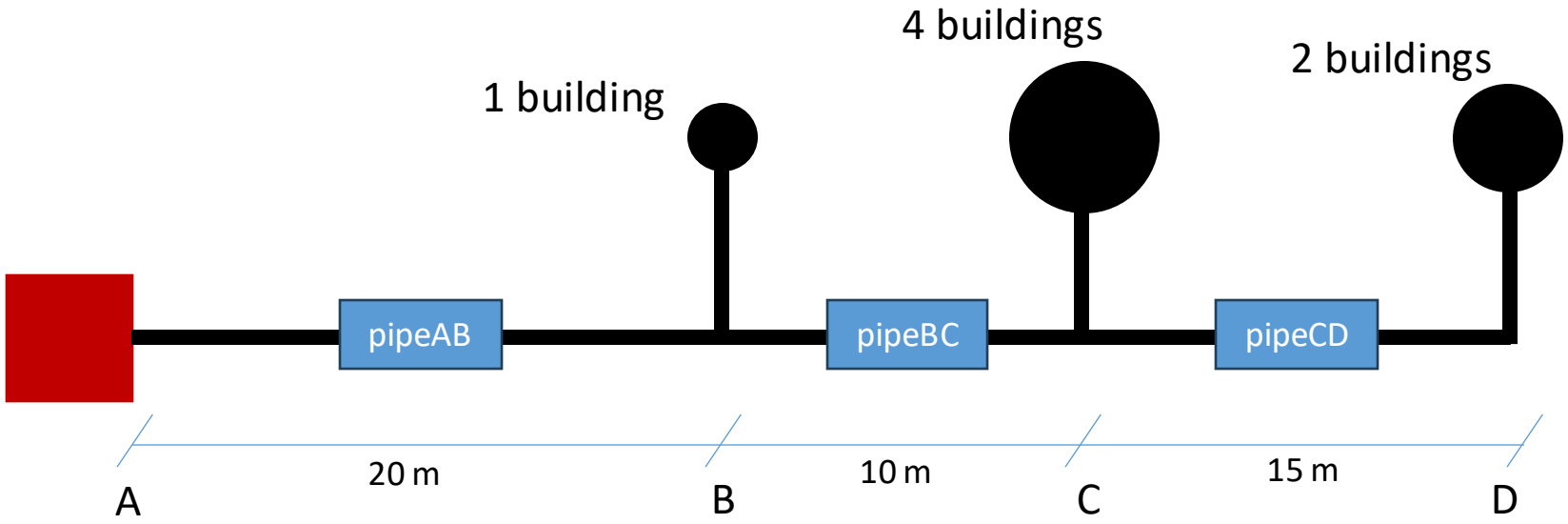


SESSION 12 – District heating system: Part II

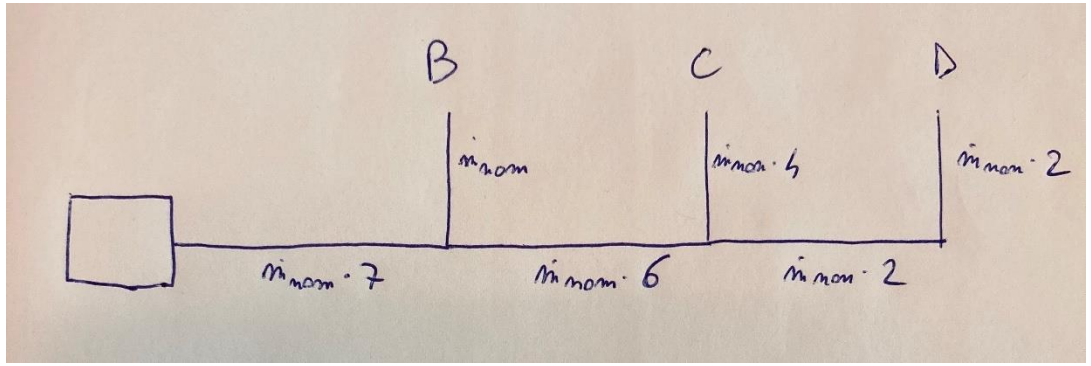


SESSION 12 – District heating system: Part II

STE4: To add additional (cluster of) buildings

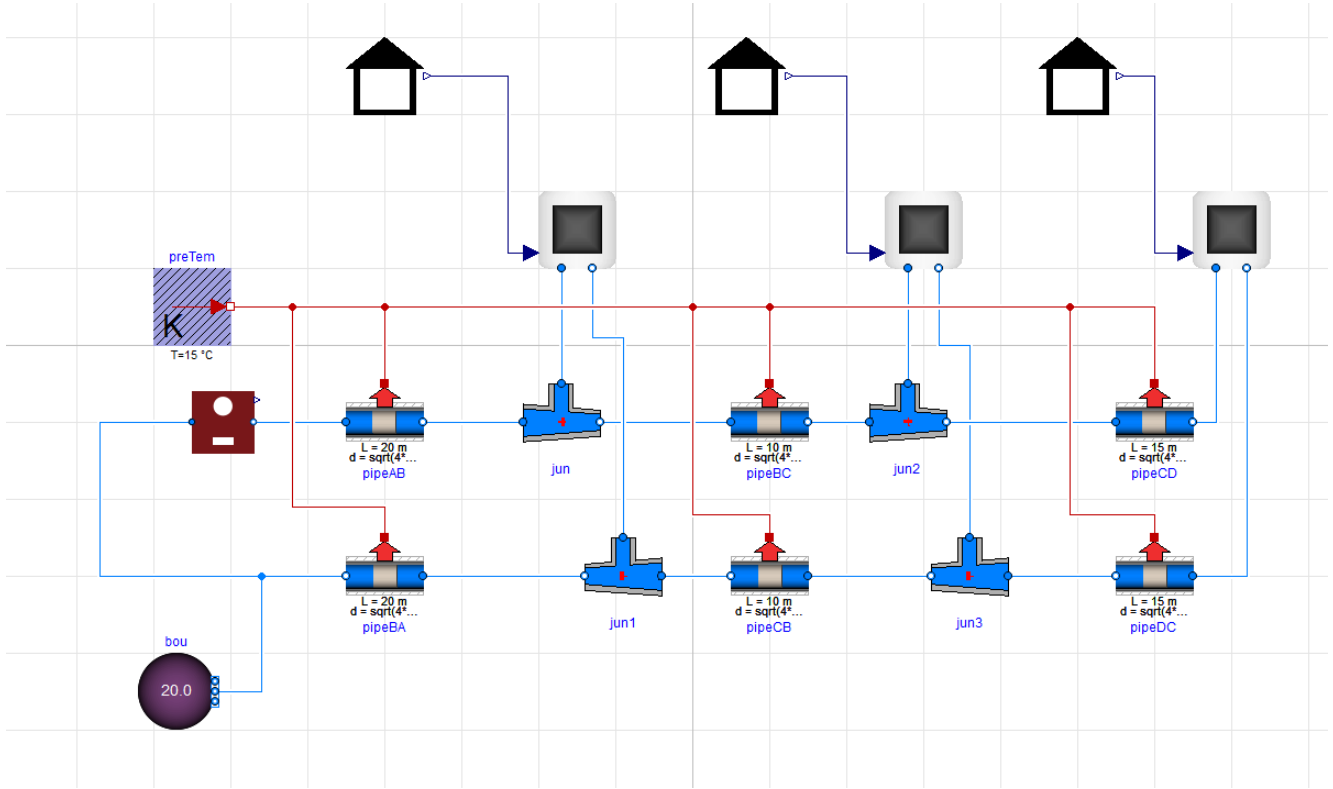


SESSION 12 – District heating system: Part II



STEP4: To add additional (cluster of) buildings

1. Duplicate Experiment3 and call the new model **Experiment4**
2. Drag and drop the following components:
   - `Buildings.Fluid.FixedResistances.PlugFlowPipe(4)`
   - `Buildings.Fluid.FixedResistances.Junction (4)`
3. Connect the components according the figure
4. Assign the correct *length* to the new pipes.
5. Assign the correct *m_flow_nominal* to old and new pipes (see figure)
6. For the junctions, use the following:
   - *m_flow_nominal* = {1,1,1}
   - *dp_nominal* = {0,0,0}
7. Assign the correct values for parameters *m_flow_nominal* and *nomHea* in thermal plant and *m_flow_nominal* in substations
8. Simulate the model for one year
9. Plot the diameters of pipes and check that pipeAB > pipeBC > pipeCD
10. Plot the supply and return water temperatures
11. Calculate the annual heating energy consumption (you need to add an integrator and connect it to the thermal plant)



SESSION 12 – District heating system: Part II