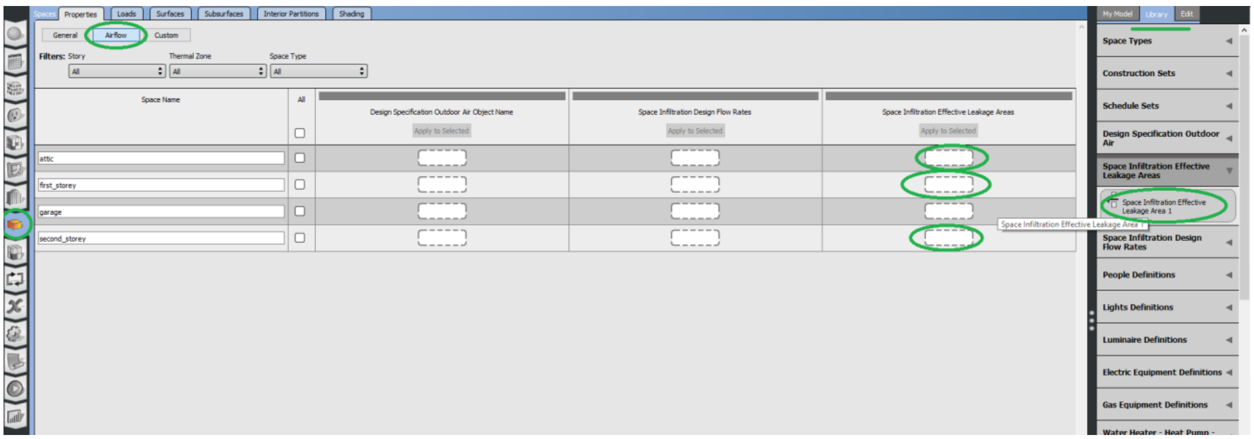
OpenStudio: HVAC

1. Add weather and climate info
    a) Weather file (.epw) - CAN_ON_Ottawa-Macdonald-Cartier.Intl.AP.716280_CWEC2016
    b) Design day (.ddy) - CAN_ON_Ottawa-Macdonald-Cartier.Intl.AP.716280_CWEC2016.ddy
    c) More locations
        i. https://energyplus.net/weather
        ii. https://climate.weather.gc.ca/prods_servs/engineering_e.html
2. (add infiltration object – it's an internal load object, not HVAC)
    a) Oddly, **Infiltration** objects can only be made by dragging an infiltration object from the library, and then editing the inputs



Whole building ELA = 134 cm², assume cracks/gaps, evenly distributed based on volume

Zone	**Volume (m³)**	**ELA (cm²)**
Attic	259.01	51
First_storey	199.14	40
Second_storey	217.92	43

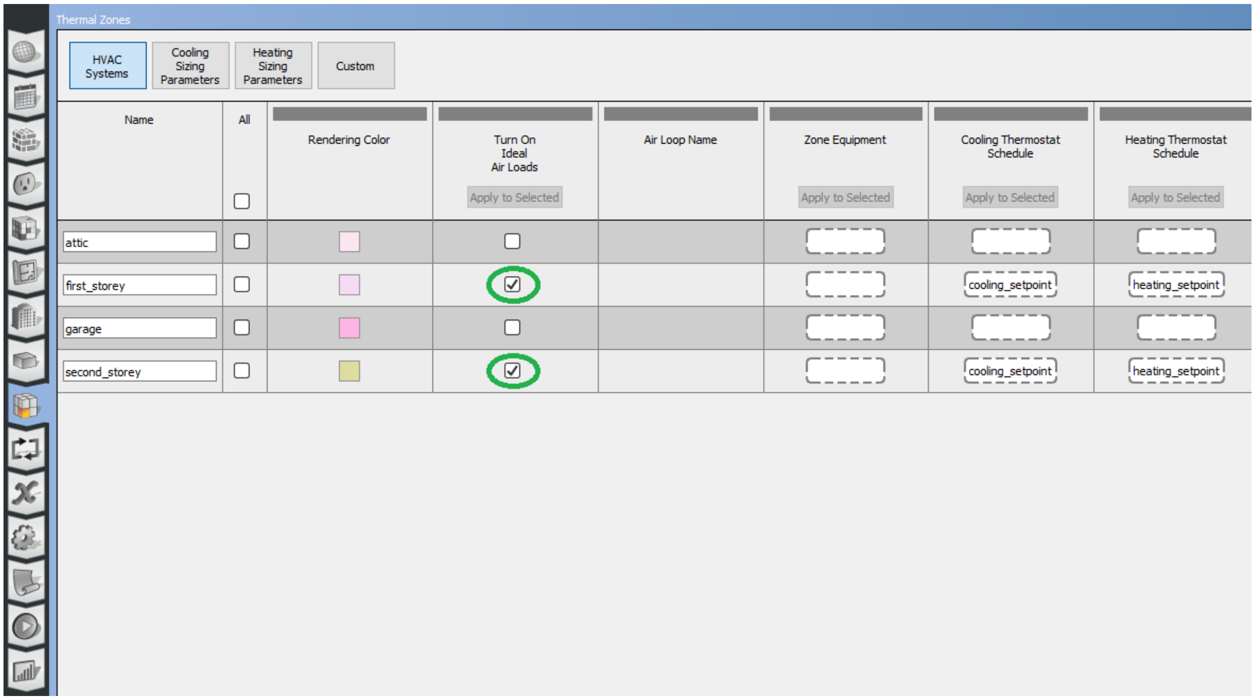
$$2 - storey\ house: C_s - 0.00029$$

$$shelter\ class - 3: C_w - 0.000231$$

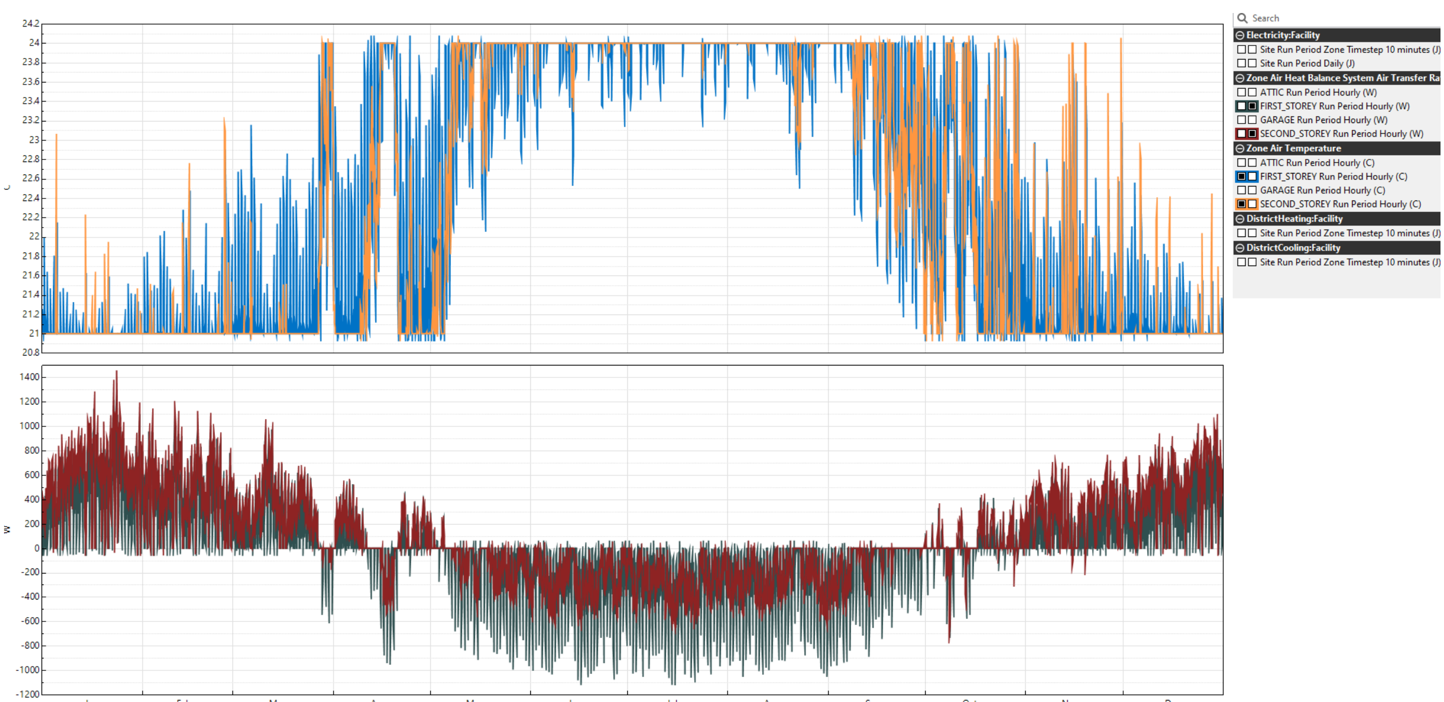
    b) Add an always on schedule in the **Loads** tab (where the other internal gain objects are located)
3. Add thermostat – first and second storey only
   By default, OpenStudio creates a dual setpoint thermostat; at all times, the cooling and heating setpoints are active and form upper (cooling setpoint) and lower (heating setpoint) limits for the zone temperature.
    a) Create two schedules (Temperature, continuous)
        i. heating setpoint of 21 °C
        ii. cooling setpoint 24°C
    b) In the thermal zones tab , drop the heating and cooling setpoints under their respective thermostat schedule columns

4. Turn on Ideal Air Loads
    a) At every timestep, the load of each zone is estimated, and then the ideal air system will supply as much air at the supply air temperature (default 50°C and 13°C for heating and cooling respectively) needed to meet the demand.

b) The ideal air system is used to estimate the heating/cooling demand of a zone/building. Based on the current zone temperature and the heating & cooling setpoint. No outdoor air; actual zone load.

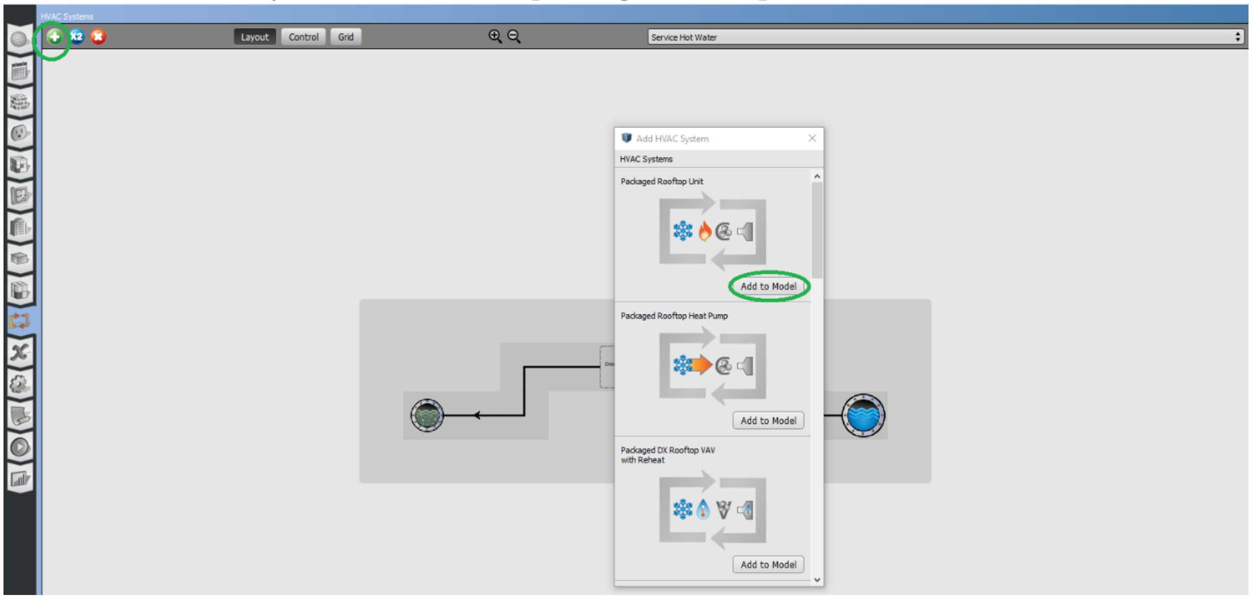


c) Select output variables
- o Zone air heat balance system air transfer rate
- o Zone air temperature

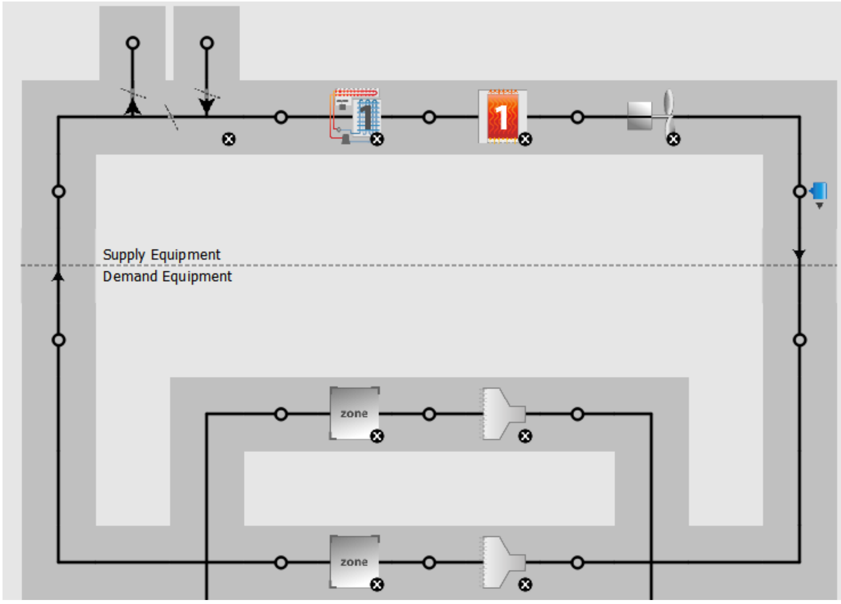


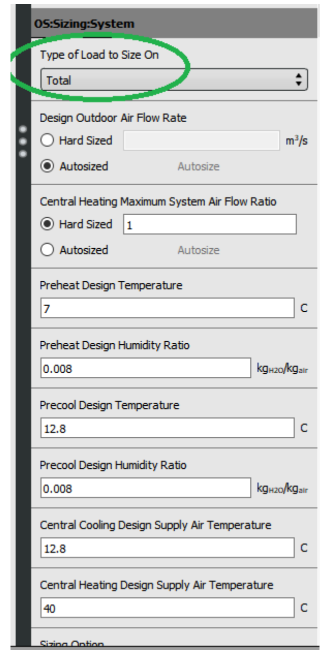
d) Review output table
   i. Total energy
   ii. End use
   iii. Setpoint not met

5. Remove the ideal system and add a “packaged rooftop unit”



a) Remove sizing period simulation runs
b) Add the thermal zone to the demand side of the air loop (by default, the **Control zone** in the **SetpointManager:SingleZone:Reheat** () object should be the **first_storey**)
c) Set heater efficiency to 96% and cooling coil COP to 3
d) Set the outdoor air system’s controller’ outdoor air flowrate to **0**.
e) Run the simulation and compare the results to the ideal system. Are the results different?
f) Set the outdoor air system’s controller’ outdoor air flowrate to **Autosized**.
g) Add **Design Specification Outdoor Air Objects** (based on ASHRAE 62.1)
    i. outdoor air per person flowrate – 0.0035 m^3/s/person
    ii. outdoor air per area flowrate – 0.00015 m/s
h) Set the system to size the **Total** load in the **Sizing:System** object (access it by clicking on the dotted line between the **Supply Equipment** and **Demand Equipment** in the air loop

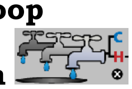




6. Run the simulation and validate the HVAC results
    a) The energy results in the End Use Table doesn't seem out of the ordinary until you review the number of unmet hours ("Not met hours"). There is a bunch of hours where the cooling and heating setpoints aren't met because the first storey is the control zone and the second storey is the slave zone. The HVAC is controlled to turn on and off according to the needs of the first storey, which is usually appreciably thermally different from the second storey, so they're out of step from each other.
7. Switch **SetpointManager:SingleZone:Reheat** to **SetpointManager:Coldest** by selecting it from the Library tab on the right (scroll down until you start to see SetpointManager objects)
    a) Set the min and max to 13°C and 40°C, respectively
        - Heating mode
            - Assume max flowrate
            - Calculates the setpoint required by each zone
            - Selects the highest setpoint
            - The result is the lowest setpoint temperature possible to meet all zones
        - Cooling mode
            - Uses minimum setpoint temperature
8. Add ERV, defrost air method: exhaust air recirculation

OpenStudio:Adding domestic hot water

1. Create water load profile (schedule)
2. Create hot water temperature target – constant 60°C (schedule)

3. Create a **Water Use Equipment Definition** object in the **internal gains**  tab
4. Peak flowrate 0.000083 m³/s
    a) Drag and drop the hot water temperature target schedule
    b) In the **HVAC**  tab, create a new **Service Hot Water Plant Loop**
        i. On the demand side, click on the **Water Use Connection** 

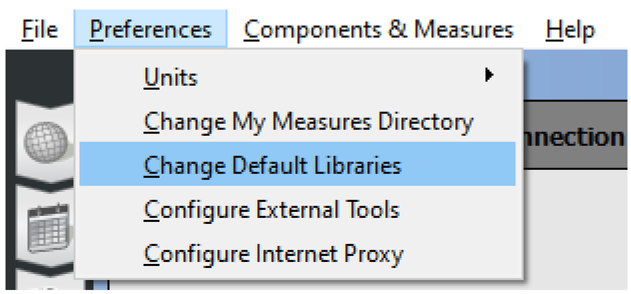
ii. Delete the existing **Water Use Equipment Definition** 

iii. Drag the **Water Use Equipment Definition** created in step c into the empty spot

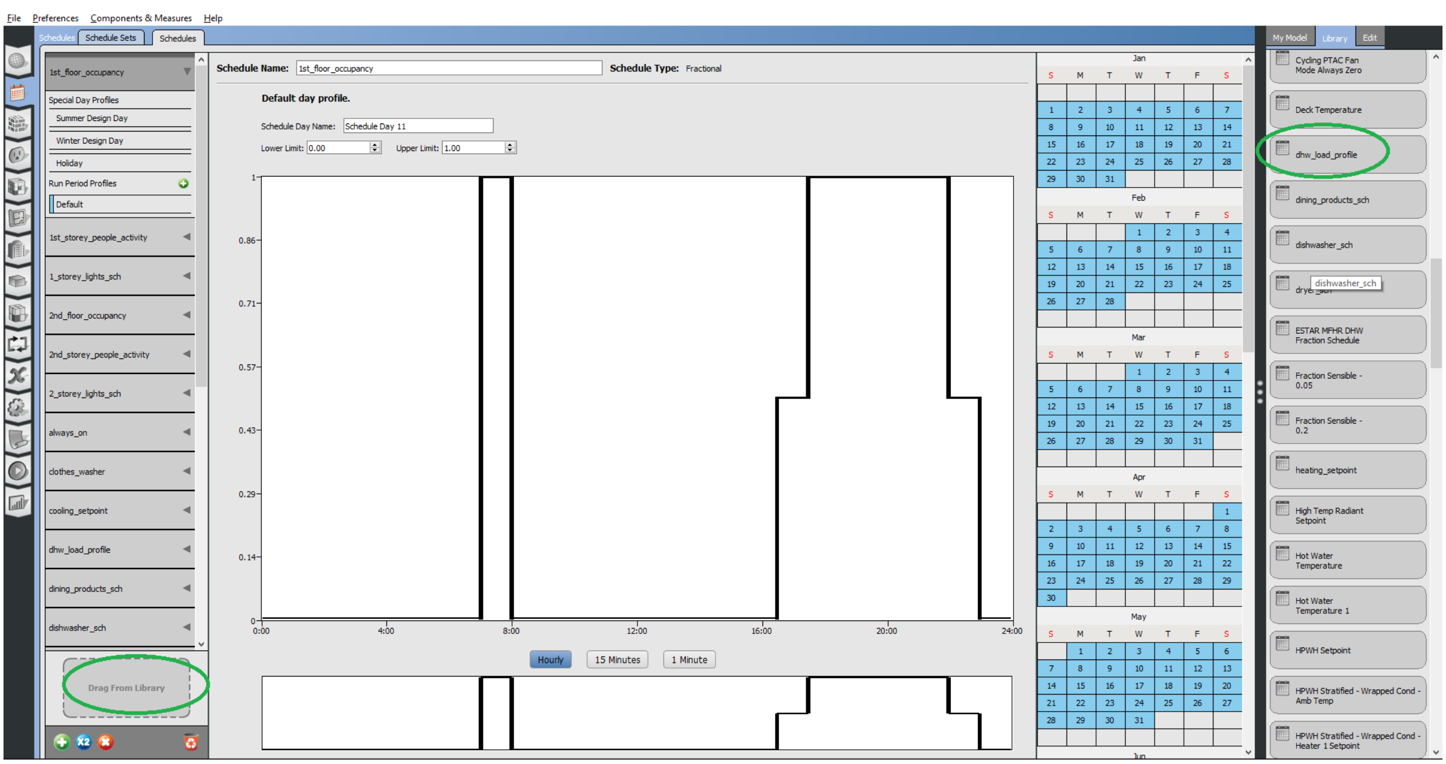
iv. Select location and rate fraction schedule

5. Normally, the **Flow Rate Fraction Schedule Name** is a schedule created by the user depict the DHW load profile. However, given the tedious nature of defining a schedule, this has been provided in the **dhw_load_profile.osm**.

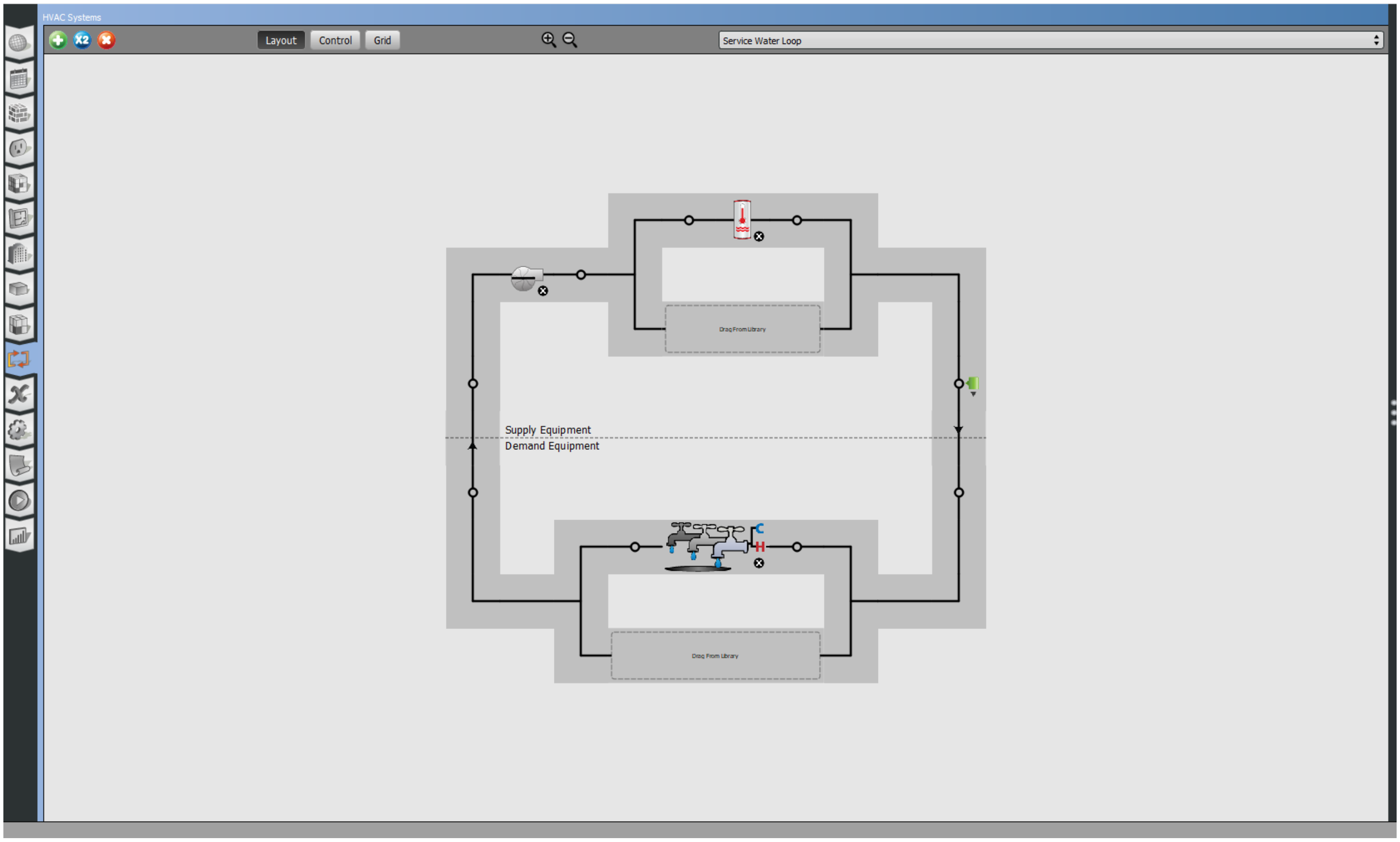
   a) Navigate to the menu and select **Change Default Libraries** and add **dhw_load_profile.osm** as a library.



   b) Navigate to the **schedule** tab and from the Library, drag the dhw_load_profile schedule into Empty box on the lower left corner of the screen – this schedule now exists in this .osm.



c) Back in the **HVAC** tab, navigate to the **Service Water Loop**. It should look like this:



d) Select the water heater  and set the following parameters:

i. Volume to autosize
ii. Deadband 2
iii. Heating capacity to 4 kW
iv. Fuel type to electricity
v. Thermal efficiency to 1
vi. On & off cycle parasitic fuel consumption to 0 (Pilot light, electronic control)
vii. Ambient temperature indicator to ThermalZone
viii. Ambient temperature thermal zone name to first_storey
ix. On/off cycle loss coefficient to ambient temperature
    a. Default 6 W/K is appropriate for a large tank
    b. For this exercise, 1.3 W/K is used for Skin loss, UA- factor (part of UEF, SL metric)
x. Loss fraction to ambient, 1 = all to zone
xi. Pump head ~ 200/300 Pa for a house
xii. OS:Waterheater:sizing (keep scrolling down until you see this object in the WaterHeater
    a. Time for tank recovery – rule of thumb 2 hours for electric, 1 hour for gas

In the end, overall total energy use intensity (TEUI – annual energy consumption of the house divided by floor area) ~ 62 kWh/m^2 → very low.

Things to take note of

…look at PPT