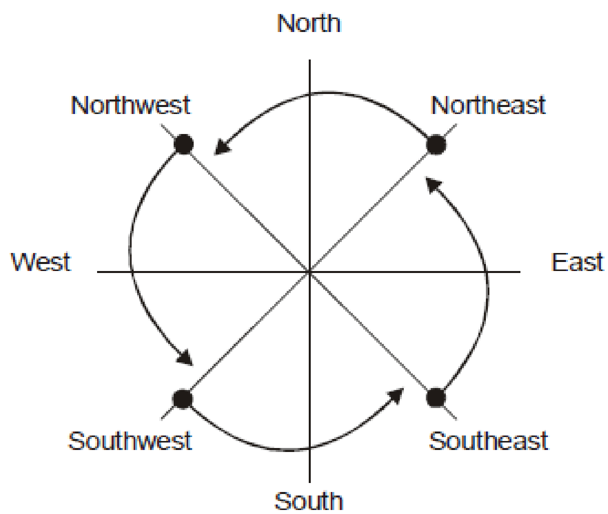
Task 2:
Energy Performance
Documentation

2A - Window-to-Wall Ratio

Calculate the window-to-wall ratio for each elevation and the entire building. The window-to-wall ratio of a building is the percentage of its facade taken up by light-transmitting glazing surfaces, including windows and translucent surfaces such as glass bricks. It does not include glass surfaces used ornamentally or as opaque cladding, which do not provide transparency to the interior. Only facade surfaces are counted in the ratio, and not roof surfaces.

Here is the procedure for classifying facades that do not face a cardinal direction. In general, any orientation within 45° of true north, east, south, or west should be assigned to that orientation. If the orientation is exactly at 45° of a cardinal orientation, use the diagram at right to classify the direction of the façade. For example, an east-facing surface cannot face exactly northeast, but it can face exactly southeast. If the surface were facing exactly northeast, it would be considered north-facing.

As the window-to-wall calculation is a ratio, you may enter area in square feet or meters.



North

Step 1: Total area of light transmitting glazing surfaces on north facade: 7692.15 SF

Step 2: Total area of north façade: 30271 SF

Window-to-wall ratio of north façade = number from step 1 / number from step 2 = .25

East

Step 1: Total area of light transmitting glazing surfaces on east facade: 7216.44 SF

Step 2: Total area of east façade: 26096 SF

Window-to-wall ratio of east façade = number from step 1 / number from step 2 = .28

South

Step 1: Total area of light transmitting glazing surfaces on south facade: 2920.96 SF

Step 2: Total area of south façade: 17433 SF

Window-to-wall ratio of south façade = number from step 1 / number from step 2 = .17

West

Step 1: Total area of light transmitting glazing surfaces on west facade: 6527.54 SF

Step 2: Total area of west façade: 19555 SF

Window-to-wall ratio of west façade = number from step 1 / number from step 2 = ,33

Total Building Window-to-Wall Ratio

Step 1: Light transmitting glazing$_{total}$ = step one$_{north}$ + step one$_{east}$ + step one$_{south}$ + step one$_{west}$ = 24357 SF

Step 2: Façade area$_{total}$ = step two$_{north}$ + step two$_{east}$ + step two$_{south}$ + step two$_{west}$ = 93355 SF

Total window-to-wall ratio = number from step 1 / number from step 2 = .26

2B - Window Openings and Window Shading

In the space below, describe the design approach at window openings to regulating incoming light and heat from the sun. Briefly describe the type of window and glass used on the east, south, west, and north elevations and the performance numbers targeted for U-factor, solar heat gain coefficient (SHGC), and visible transmittance.

Type of window and glass:

North: 2-Pane Low E window
East/West: 3-Pane Fritted window
South: 3-Pane Tinted window

East facing
U-factor: .3; SHGC: .25; Visible Transmittance: .42

South facing
U-factor: .35; SHGC: .25; Visible Transmittance: .42

West facing
U-factor: .30; SHGC: .25; Visible Transmittance: .42

North facing
U-factor: .40; SHGC: .25; Visible Transmittance: .42

If you included a projecting shading device(s) or a window reveal, include a diagram of a representative residential window on the south and the west elevations showing shadows cast at the dates and times shown below. These studies should be for ”solar time' rather than “clock time.” (In solar time 12 noon represents the moment when the sun is due south and at the highest point in the sky it will reach that day.) Impose a 1'-0” grid on the window to make it possible for jurors to see the percent shading achieved at each time.

While there are a number of software tools that can be used to accurately cast shadows,it is straightforward to do this analysis in SketchUp, a free software tool.

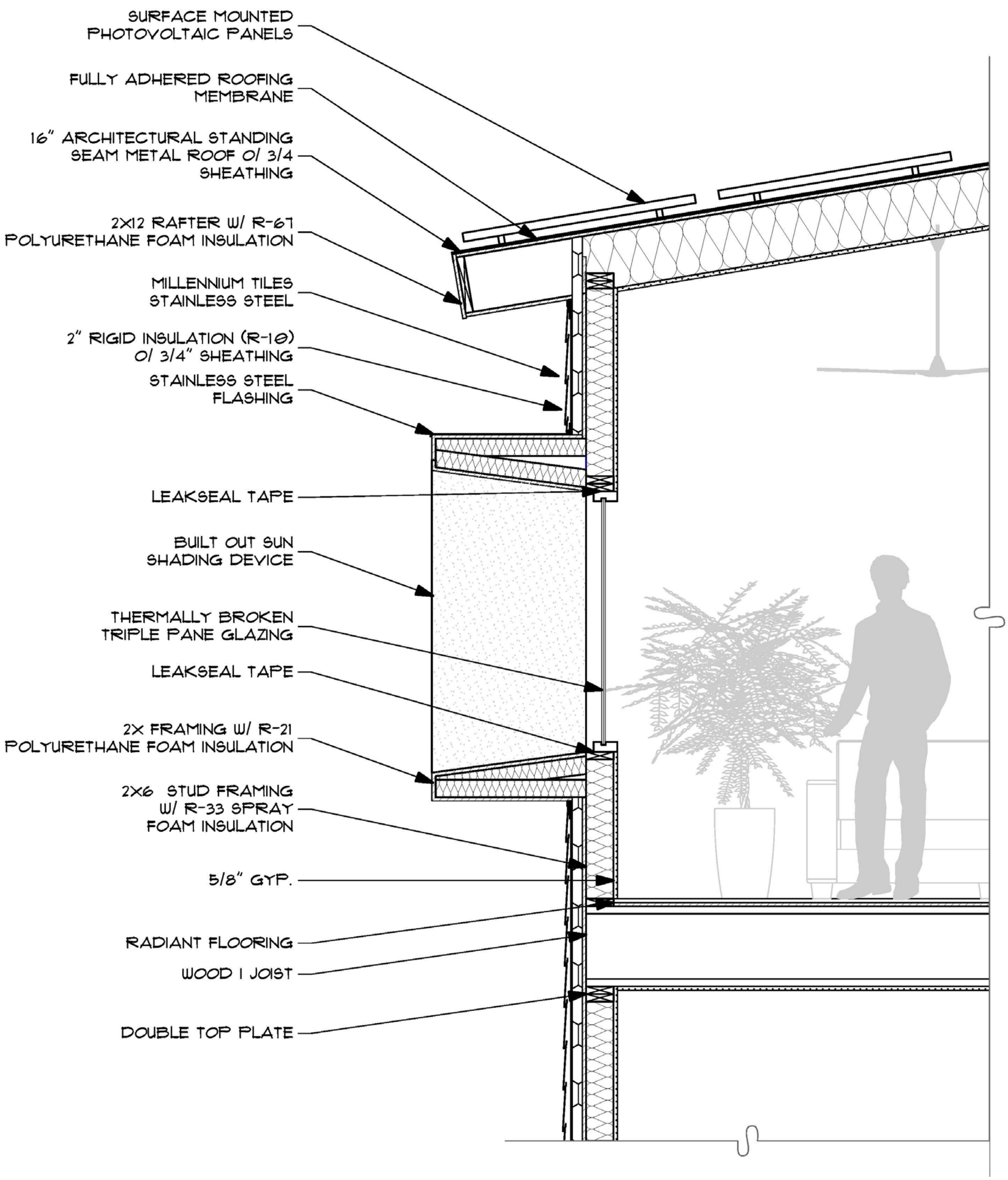
South Elevation:

December 21:	9 am, 12 noon, 3 pm
March/September 21:	8 am, 10 am, 12 noon, 2 pm, 4 pm
June 21:	9 am, 12 noon, 3 pm

West Elevation:

December 21:	3 pm
March/September 21:	2 pm, 4 pm
June 21:	3 pm, 5 pm

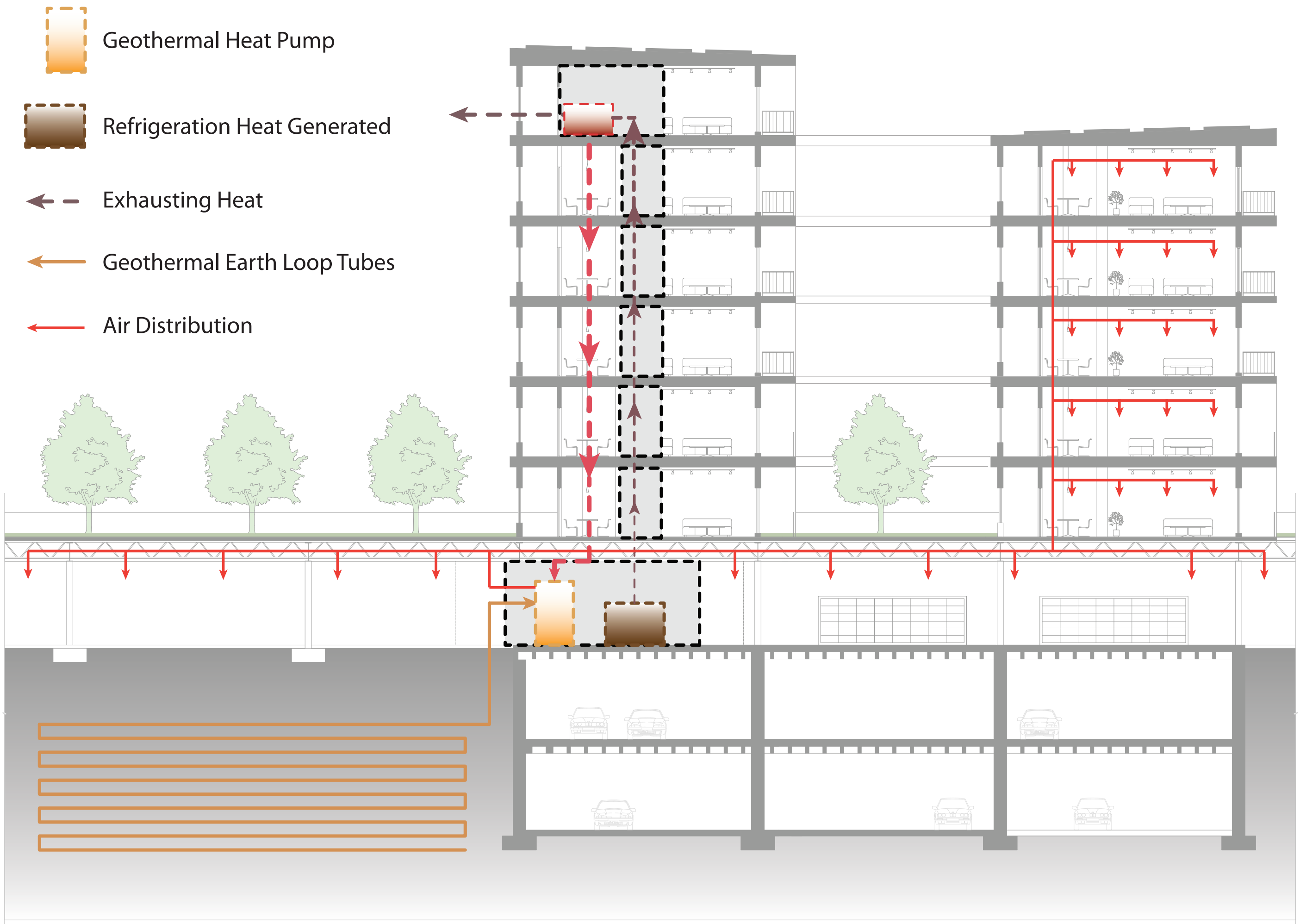
2C - Building Enclosure Details



2C - Building Enclosure Details

The detailed enclosure is typical for both residential towers on both Parcel 1 and Parcel 2. In order to reach net zero, it is imperative that the building enclosure is well insulated and thermally broken. The exterior walls are 2x6 stud framing with R-33 spray foam insulation with R-10 rigid insulation giving the entire wall an R-43 value. Because the majority of heat enters and exits buildings through the roof construction, our roof is composed in such a way to indoor. The roof is composed of 11.25 inches of polyurethane foam insulation for a total of R-67. Where the wall and roof construction meet is thermally tight from the exterior and the window is composed of triple glazing with thermally broken sill (LeakSeal tape) to ensure that the enclosure is air tight to allow for maximum efficiency for maintaining ideal indoor air environment.

2D - Description and Diagram of Whole Building Heating and Cooling System

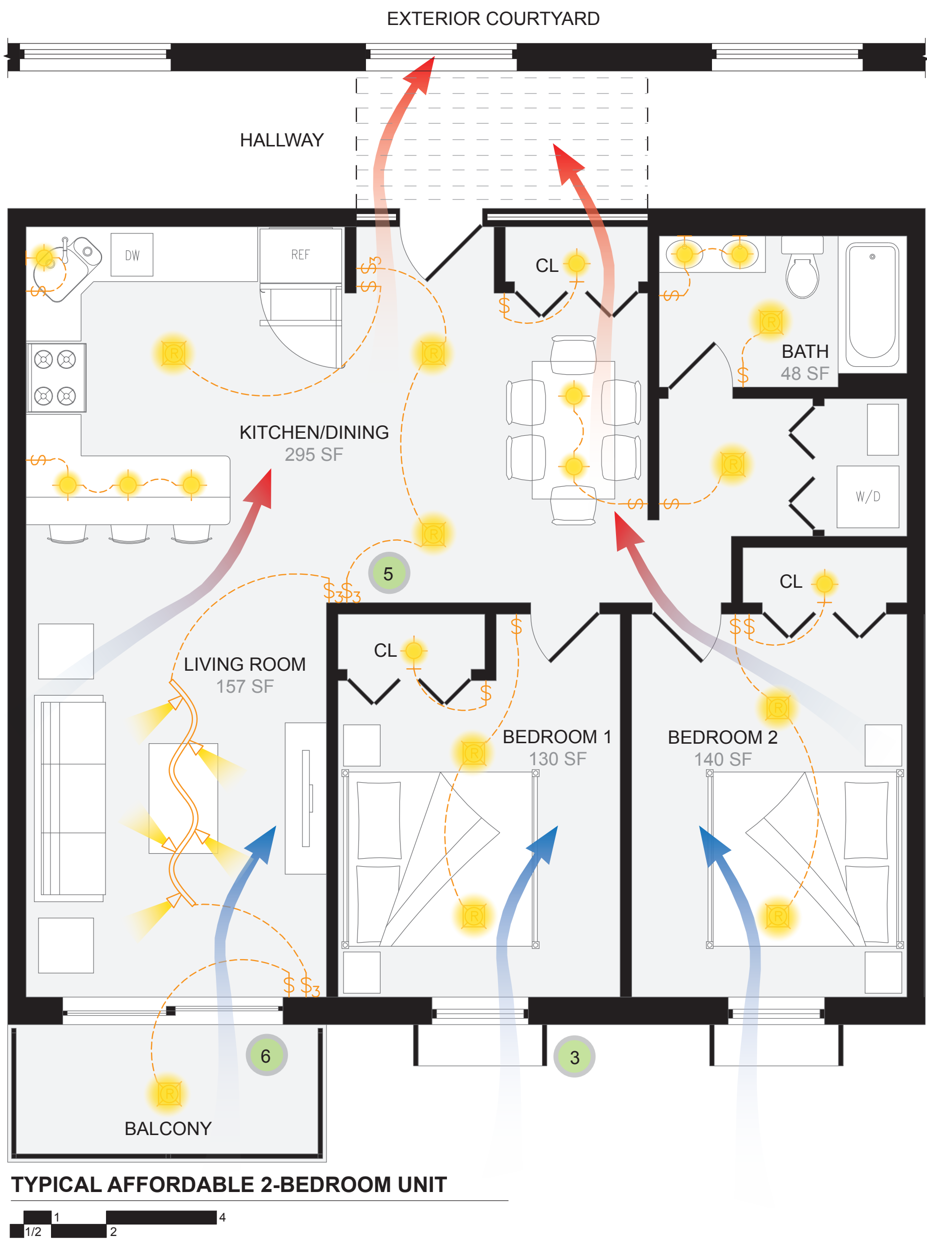


2D - Description and Diagram of Whole Building Heating and Cooling System

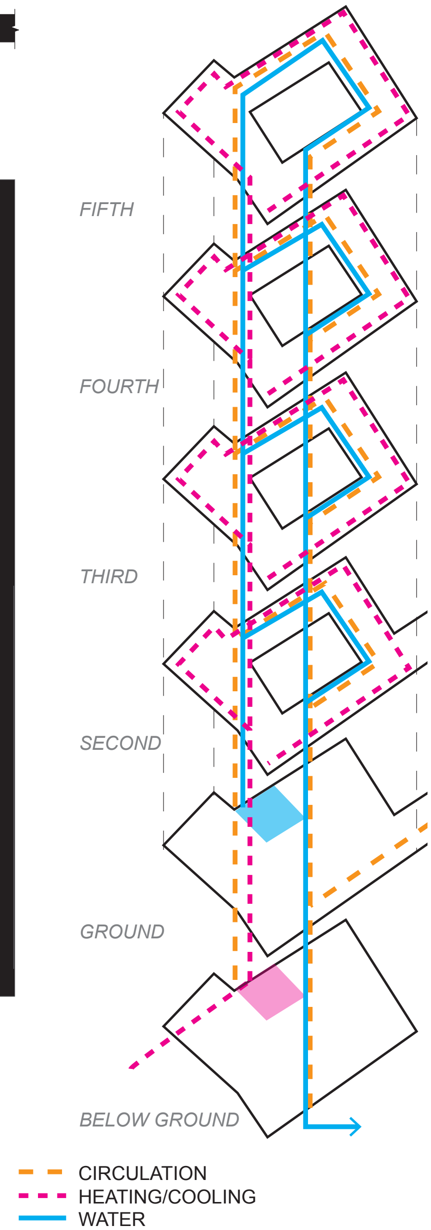
Both residential towers will employ an integrated geothermal system that utilizes the stable temperature of the ground as a starting point to condition air that will circulate through the building. The closed loop horizontal ground heat exchangers are buried below the grade where the ground temperature is a stable 55 degrees Fahrenheit. Water is then circulated through the loop and becomes pre conditioned to the temperature of the ground before reaching the geothermal heat pump. The geothermal heat pump then has air that is about 55 degrees Fahrenheit and can condition it appropriately depending on the season and circulate it throughout the building. The advantage here is that instead of taking in 20 degree air in the winter and having to condition it to 72 degrees, it only needs to be heated 17 degrees from the temperature that is extracted from the ground loop thus greatly reducing the energy necessary to condition the air.

Because the grocery employs robust refrigeration equipment, a great deal of heat is generated that is typically exhausted to the exterior of the building however this is a great resource to harness to aid in the heating of the building. Heat from the refrigeration equipment as well as through bathroom ventilation will be contained in a duct system where it will travel up through the building to an enthalpy wheel. An enthalpy wheel is an energy recovery system that extracts the heat from air that needs to be exhausted so that this heat can be used within the building for another purpose. Once the heat is extracted, the remaining air can be exhausted appropriately. Similarly to the geothermal system, by harnessing this heat in an energy recovery system, less stress is placed on the heat pump to condition air thus reducing the amount of energy used by the HVAC system in its entirety.

2E - Description and Diagrammatic Sketch of Residential Unit Systems



TYPICAL AFFORDABLE 2-BEDROOM UNIT



2E - Description and Diagrammatic Sketch of Residential Unit Systems

Parcel 1

The building on Parcel 1 that contains affordable housing units and a childcare facility utilizes several sustainable strategies as it addresses space heating and cooling, ventilation, and water heating in each residential unit. Space heating and cooling for residential units is handled in a few different ways. The building is heated and cooled by a geothermal system. The geothermal system consists of a series of buried pipes that condition outdoor air to ground temperature. Depending on the season, the air is further heated or cooled by a geothermal heat pump and then distributed to residential units and common spaces in the building. Geothermal heating and cooling is more energy efficient than a conventional system because it utilizes the constant temperature of the ground as a base temperature from which to heat or cool. In addition to geothermal, vegetated roofs are a cooling strategy utilized in this building because plants on the roof help insulate the building.

Natural ventilation occurs in each residential unit through operable windows. The opening of windows in each unit allows air to enter, pass through, and exit through windows on the opposite side. Cross ventilation is the result of the air movement and additionally helps cool the unit.

Each residential unit in the building has access to hot water. Water is heated through a solar water heating system where hot water panels are fastened to the roof and south-facing walls of the building. Water passes through the panels and is heated by the sun. The heated water is then stored in tanks within the building and distributed to faucets on each floor when needed by residents.

2E - Description and Diagrammatic Sketch of Residential Unit Systems

Parcel 2

The building on Parcel 2 that contains market rate housing and a grocery store utilizes the same sustainable systems to heat, cool, ventilate, and provide hot water to each residential unit as the building on Parcel 1. These systems include geothermal wells and a geothermal heat pump for heating and cooling, operable windows that provide cooling and cross ventilation to residential units, vegetated roofs for thermal insulation, and a solar water heating system.

The difference between Parcel 1 and Parcel 2 is that Parcel 2 includes an existing market structure. The waste heat from the refrigeration system of the existing market will be utilized in the heating and cooling of the new housing units. An enthalpy wheel will be implemented to facilitate this process. In the cooling season, rejected heat from the refrigeration system is sent into the exhaust airstream, causing the air to cool the condenser coil which then cools air coming in from outside. In the heating season, the opposite process occurs and waste heat from the refrigeration system is used to heat incoming air, thus reducing the amount of energy required to heat and cool the building's units.

2F - Renewable Energy

Parcel 1

	Annual Energy Consumption (kBTU)	Annual Energy Use per Gross Internal Area (kBTU/ft^2)	Annual CO2 Production (lbsCO^2)	Annual Utility Cost	Annual Space Cooling (kBTU)	Annual Space Heating (kBTU)	Annual Space Cooling (kBTU)	Annual Grid Fuel Used (kBTU)
Baseline Concept	1776717	41	318217	$86,535	270130	150986	270130	710654
Rainwater Storage	1776717	41	318217	$86,415	270130	150986	270130	710654
Cross Ventilation	1473585	34	251234	$65,431	134971	150973	134971	710654
Solar Water Heating	1445629	33	279712	$83,624	270130	150986	270130	379566
Solar PV	1260020	29	204043	$50,192	270130	150986	270130	710654
Geothermal Wells	1747652	40	311795	$84,587	270130	121921	270130	710654

Parcel 2

	Annual Energy Consumption (kBTU)	Annual Energy Use per Gross Internal Area (kBTU/ft^2)	Annual CO2 Production (lbsCO^2)	Annual Utility Cost	Annual Space Cooling (kBTU)	Annual Space Heating (kBTU)	Annual Space Cooling (kBTU)	Annual Grid Fuel Used (kBTU)
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The buildings on site meet the target demands for each building use. The strategies applied, additional to the baseline design, decreased the annual energy consumption by 67% and has decreased the CO2 production by 71%. These strategies do not currently bring the building to Net Zero Energy. However, the assumption is that these strategies are currently set to a minimum. There is opportunity to increase these minimums so strategies' systems run at optimal efficiency.

Sefaira was the software program used to calculate these strategies and systems. This program provided a baseline standard of how to evaluate and understand the building design and sustainable strategies.

2G - Occupant Behavior

Gateway Residences provides a one of a kind living environment from the community roof gardens, extensive geothermal, photovoltaic, and energy recovery systems to the rainwater collection strategies and storm water management. It is a one of a kind building that brings to the forefront issues of environmental stewardship and sustainable lifestyle choices. The building will boast of its sustainable features and act as a teaching tool for the residents about how the building utilizes the most of natural resources and how their lifestyle choices can restore what has been lost to the built environment. Due to the building's net zero status, residents will see traces of the building's unique features through general day to day life living there however the greatest intervention will be seen through personal energy use monitoring in each residential unit. This will consist of a small screen that tracks the energy and water use of the individual units so residents will be able to see how their lifestyle choices affect the energy use in their units. They will be able to see the amount that they pay monthly for services as well as how their energy consumption compares to the average unit use and to the total building energy use. While the building strives to operate solely on the energy it produces, the greater impact will come through user education and the lifestyle changes they make as a result of their time at Gateway Residences that will surely lead to a greater environmental impact than simply the one the building makes on its own.