SUSTAINABLE URBAN GUEST HOUSE

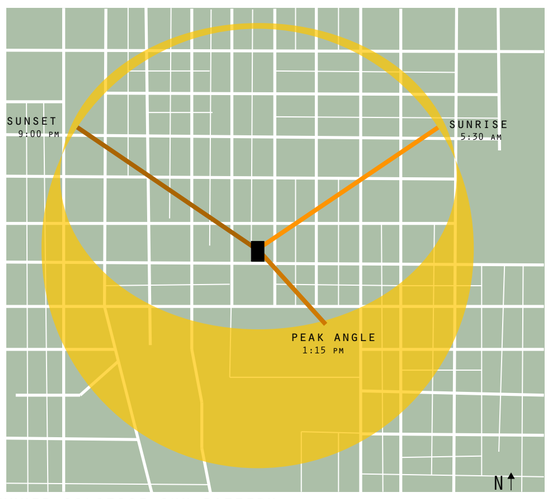
JILL KELLETT // SOC 304 //D'ARMAN // FALL 2019

Location: 18th and Mill St. Eugene, Oregon

PROJECT BRIEF:

This creative project aims to combine two fields of study: architecture and sociology of the environment. The amount of energy people and communities use is a pressing problem that requires innovative design solutions to severely reduce carbon emissions. The leading contributor to carbon emissions in America is the building industry. But with new research and design innovations, there is hope to build more sustainable buildings.

This project aims to provide a simple house model that incorporates a breadth of design strategies/technologies that minimize the embodied energy within the materials, energy required to complete the process, and energy required for users to live.



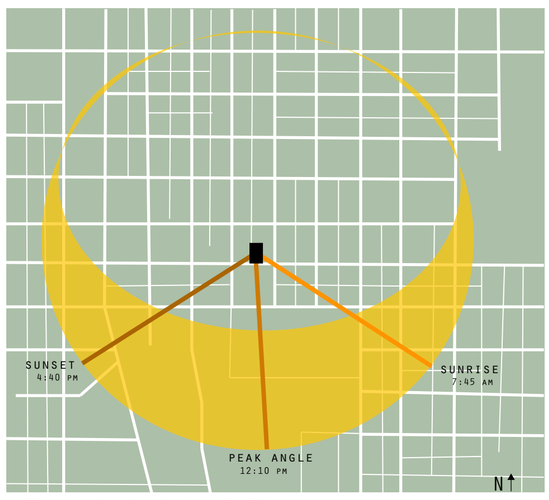
SUMMER SOLSTICE SUN PATTERN

ABOUT THE SITE

The climate of Eugene consists of hot, sunny summers and rainy, grey winters. This means that designing for daylight and passive heating and cooling is extremely important.

Winter sunlight is scarce, so designing ways for daylight to enter at low angles is key to saving energy on heat.

Summer light is abundant, so designing overhangs that keep the sun's heat out will cut down on cooling costs.



WINTER SOLSTICE SUN PATTERN

DESIGN IMPLICATIONS

Glazing on the north side should be abundant for indirect light.

Glazing on the east side should be limited to avoid morning glare in the bedroom.

Glazing on the south side should have shading devices to prohibit summer heat gain, but allow for winter heat gain and daylight.

Glazing on the west side should be limited to avoid evening glare in the kitchen.

KEY RESEARCH POINTS

Passive Cooling:

"Well-designed sun control and shading devices, either as part of a building or separately places from a building facade, can dramatically reduce builing peak heat gaina nd cooling requirements and improve the natural lighting quality of building interiors. The design of effective shading devices will depend on the solar orientation of a particular building facade." (Mohammad)

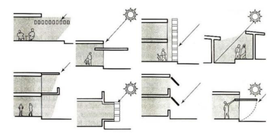


Figure 1. Different types of shading devices.

Choosing Insulation for Energy Savings:

Structural Insulated Panels (SIPs)
"The major components of SIPs, foam and oriented strand board (OSB), take less energy and raw materials to produce than other structural building systems. And while building professionals already rely on SIPs for energy efficiency, new advances in the panels will further enhance insulation throughout a building envelope." (Sims)

Green Roofs:

How do they work? This diagram (Stroud) shows the construction of a green roofs and the benefits of insulation and water collection.

Precedent Studies:

Alvar Aalto's Summer House was extremely site-oriented. He focused on views and the relationship between the house and it's envornment. The end result is a healthy and relaxing home integrated with nature that also took into consideration many sustainable practices. (Guimaraes)

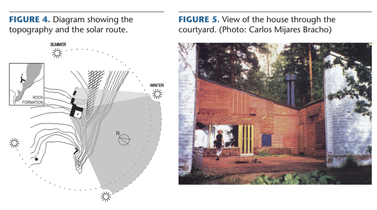
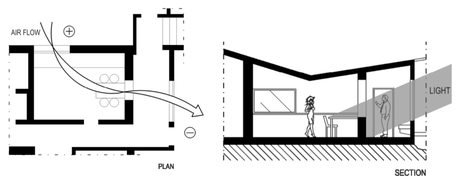
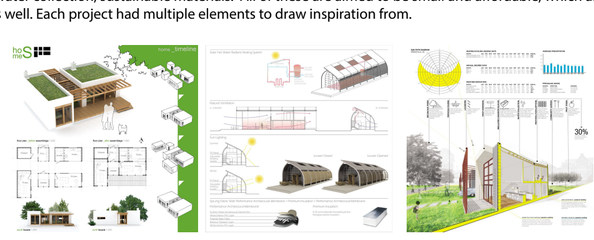


FIGURE 4. Diagram showing the topography and the solar route.

FIGURE 5. View of the house through the courtyard. (Photo: Carlos Mijares Bracho)



Habitat for Humanity's Sustainable Home Design Competition produced some incredible student work. Many of the winners used combined techniques of modularity, water collection, sustainable materials. All of these are aimed to be small and affordable, which are two factors this project hopes to acheive as well. Each project had multiple elements to draw inspiration from.



CONNECTIONS TO SOCIOLOGY

Between sociology of communitites and the environment, energy is a big theme that has been studied from many angles. In our class, we discussed where energy comes from and how it affects the people who live in energy production areas. In Oregon, 40% of our power is hydroelectric, 30% is coal, and 17% is natural gas.

The Northwest is an amazing place that combines coastal cliffs, snowy glaciers, protected forests, and sandy desert plains. Because of the access to natural phenomena, the culture of the Northwest has created a norm in which people spend their free time outdoors. The systematic protection of natural landscapes in Oregon and Washington has trickled down to create communities that value their natural surroundings.

Although Oregon's energy may be more sustainable than many coal regions in America, there are still monumental impacts that energy usage and production have on communities here. Transportation accounts for about 38% of Oregon's 2016 energy consumption. "This includes personal, passenger, and commercial vehicle fuels, both on and off the roads, plus airplanes, boats, barges, ships, and trains. Nearly all transportation-related sources of energy are imported from out of state for in-state use." (Oregon.gov) When it comes to the amount of money Oregonians pay for energy, the cost of transportation fuels makes up about half. And 35% of Oregon's 2016 energy consumption was used for electricity.

Learning more about how much non-renewable energy Oregonians use for transportation and electricity helped start this project off on the right foot. This project uses innovative design techniques to reduce the embodied energy within building products (including transportation) and reduce the energy needed to live in the home over time. By experiencing new innovations like a green roof, passive ventilation, and controlled heat gain, users and community members become more in touch with how they use their energy. Together, these create a better relationship between users and their environment.

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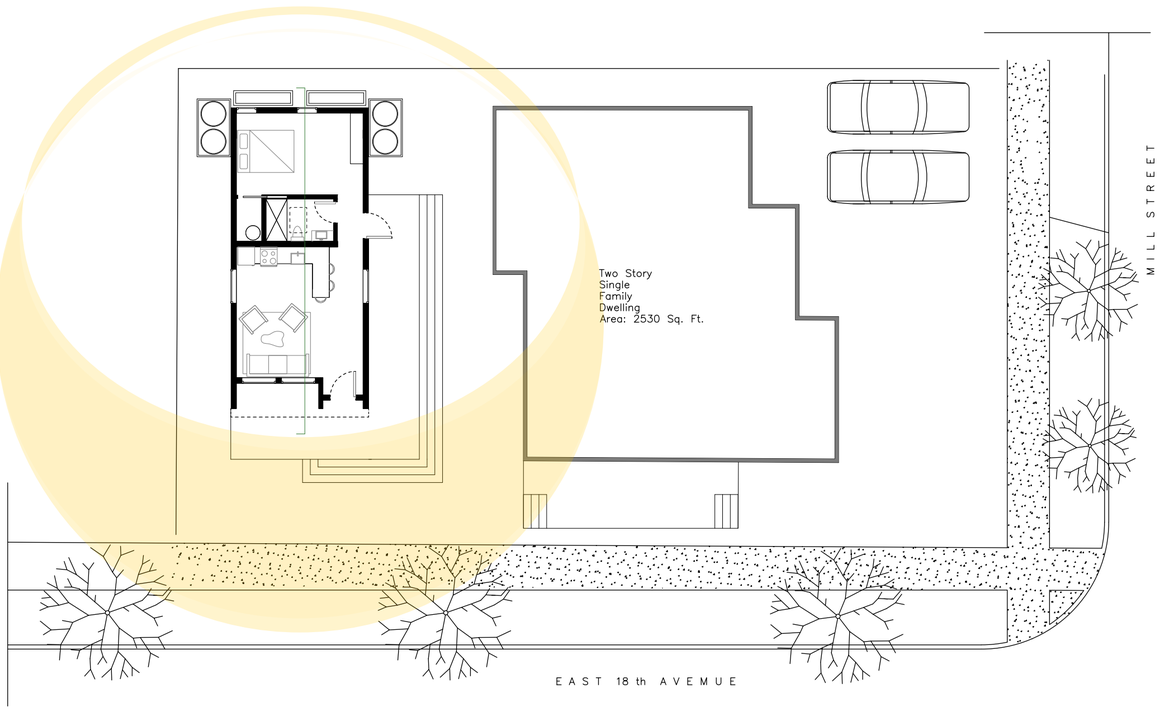
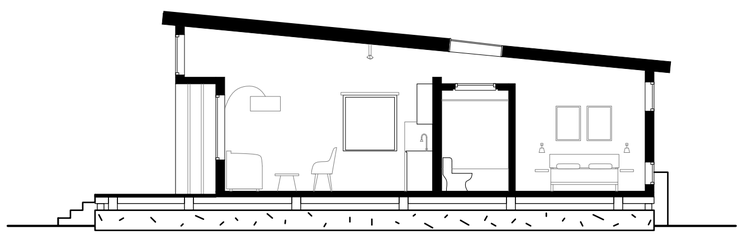
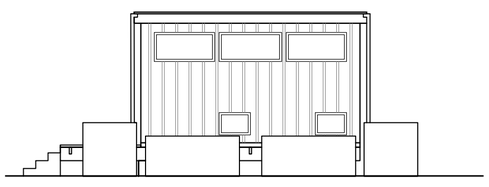


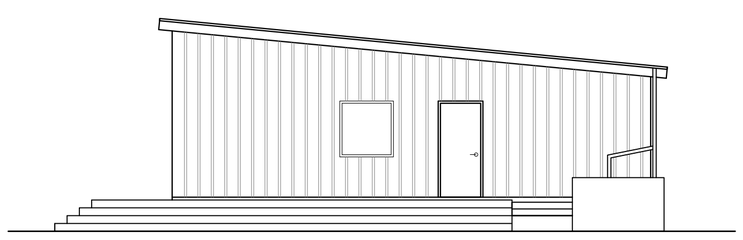
FLOOR PLAN ON SITE



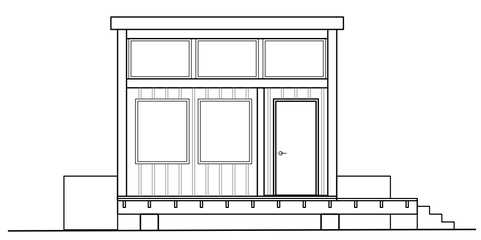
LONGITUDINAL SECTION
1/8" = 1'



NORTH ELEVATION
1/8" = 1'



EAST ELEVATION
1/8" = 1'



SOUTH ELEVATION
1/8" = 1'

DAYLIGHT STRATEGIES

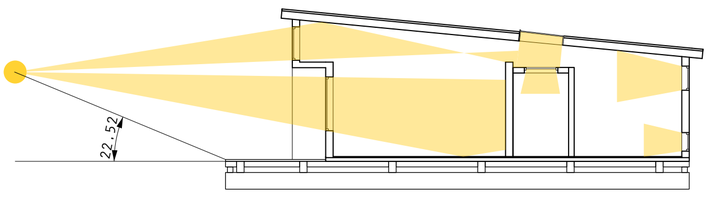
To maximize daylight and heat gain on the south facade in the winter, large windows allow light to enter high and low. The overhang of the roof and inset wall allow the low sun angle to penetrate 25 feet into the main living space.

To minimize heat gain in the summer, the overhangs block over half of the sun's light on the south side. The light that does enter the space is at a limited angle so it doesn't penetrate deep into the space.

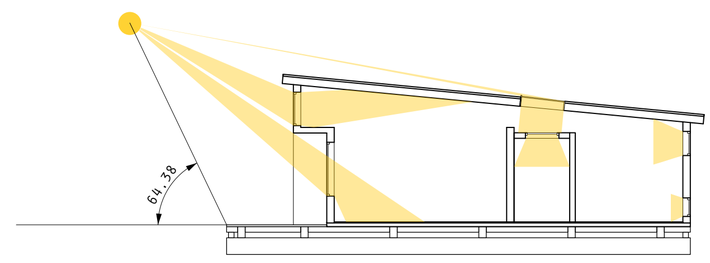
Automated shades on the south windows respond to daylight levels outside to raise and lower. They help reduce glare for users, but also minimize heat gain which decreases energy usage and costs in the summer.

A skylight above the bathroom allows natural light into the center of the house, which in turn reduces energy used for electric lighting.

Low and high windows on the north side reduce glare for users and keep the light dim in the bedroom.



WINTER SOLSTICE DAYLIGHT DIAGRAM



SUMMER SOLSTICE DAYLIGHT DIAGRAM

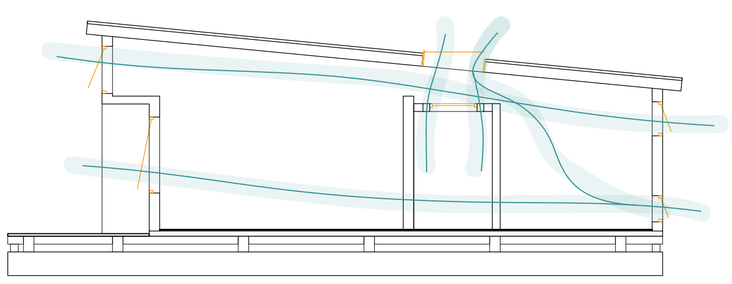
PASSIVE HEATING AND COOLING

Passive cooling is a technique used to cool a space using the natural flow of hot and cold air. Since heat rises, the idea is to bring cool air in low and allow it to exit the space high on the other end.

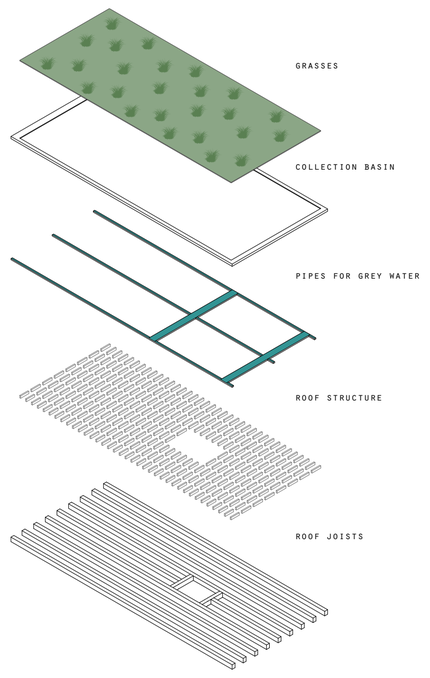
This design uses cool air from the north side and brings it in low windows in the bedroom. The air travels through the hallway or over the bathroom walls and exits through the living room windows or the skylight. Heat and humidity from the bathroom can exit through the skylights to prevent mold and moisture.

The green roof acts as a cooling agent and an insulator. In the summer, the plants keep heat from the sun out, and in the winter they insulate the space inside.

Insluation is an important factor in retaining heat and cooling. However, many insulation types are high in embodied carbon and are not sustainable materials. This project uses Structural Insulated Panels (SIPs) as insulation because they are made with partially renewable resources, have the ability to drastically reduce the waste generated during construction, and they have a high insulation value.



PASSIVE COOLING DIAGRAM

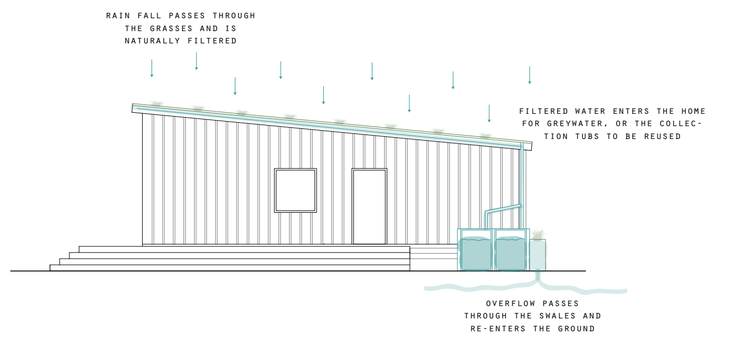


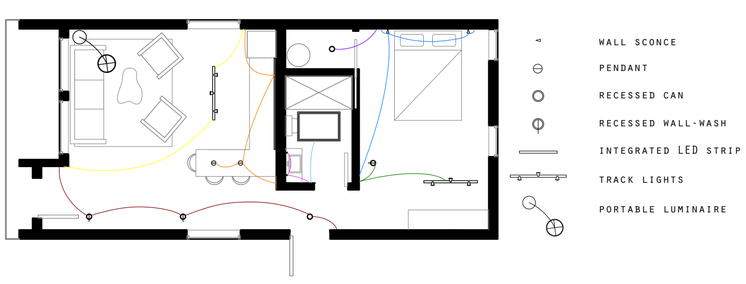
WATER RECYLCING

Green roofs and swales are ways for buildings to collect water and filter it before it re-enters the groundwater. Plants and grasses naturally filter nitrates and bacteria out of contaminated water. Buildings can use a collection system below the plant layer to collect and reuse partially filtered water as greywater in the home.

The angle of the roof uses gravity to control the water flow. This design collects water to reuse in the toilet, and also collects water in barrels outside to use for gardening. Water overflow can fall into the swales behind the house, filtering it before it re-enters the groundwater.

The green roof also acts as insulation for the home by blocking heat gain through the roof. Most insulations are not made of sustainable matierals, so using natural plants is a way to severely decrease the embodied energy of the matierals used.





REFLECTED CEILING AND LIGHTING PLAN
1/8" = 1'

ENERGY USE

Energy star appliances and LED bulbs are two ways for all users to decrease their energy use and costs.

The strategic use of electric lighting is perhaps the most important way to reduce user energy. This lighting plan shows how grouping lights on different switches allows for more control over light usage. By having multiple zones, users only use the amount of light (and energy) they need at any given time.

Lights should also be on timers and sensors that automatically turn off lights at night or when there is sufficient daylight. This house maximizes daylighting which reduces energy use since the house will be comfortably lit most of the day.

Lighting can also have a huge affect on human health. Using bulbs that transition from cool to warm throughout the day is proven to improve sleep, circadian cycles, and stress levels.