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Regenerative Refugee Housing: Creating Temporary Housing with Low Environmental Impact

Erika Guldner

Regenerative Refugee Housing

creating temporary housing with low environmental impact

Erika Guldner
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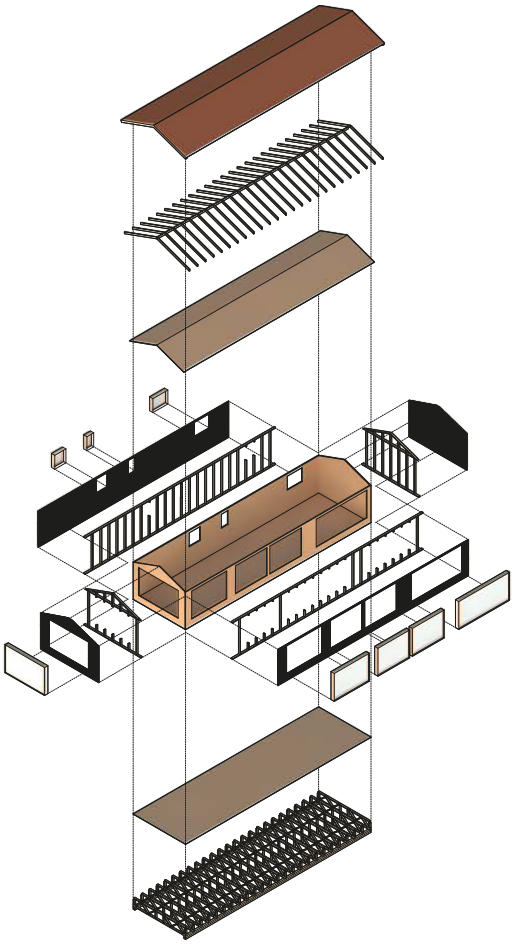
Thesis 2017



Abstract

The total biomass of ants on earth is greater than the total biomass of humans, yet no “pollution” or ecological degradation results from their activities- William McDonough. The scale of human consumption is not the problem, so reducing industrial output is not the solution. The redesign of industrial production, so that it regenerates nature rather than depleting and degrading it, is the solution.

My interest in creating a high performing building, which creates no waste, and educates and involves the user led me to look further into each of these topics. My method of research, was to look at precedents which dealt with these three categories.

Refugee settlements often have a negative environmental impact; by promoting options for sustainable development from the outset, this can be avoided. A plan for a refugee settlement was made, along with a plan for the individual residential units. To expedite the construction process, units were divided into components. These components could be easily assembled on site. Once the refugee settlement is no longer needed, components can be used for other purposes, such as, affordable housing or the components themselves can be broken down to be either recycled or used for other purposes.

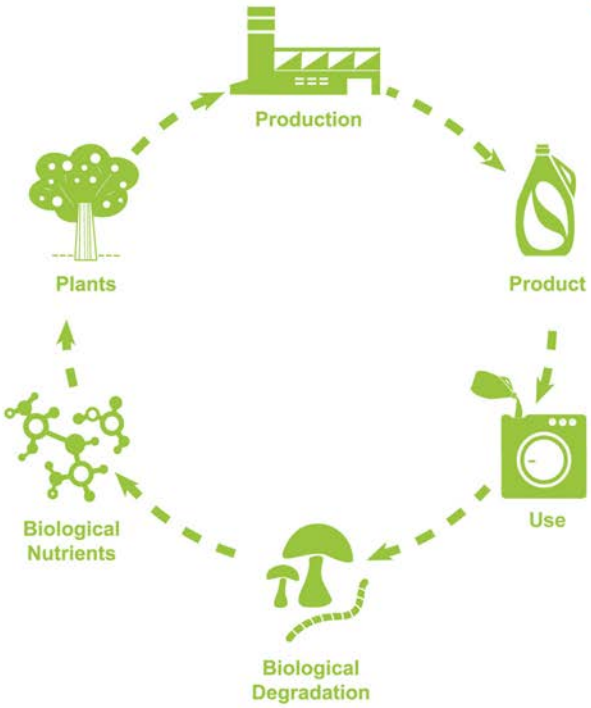
Contents

Cradle 2 Cradle

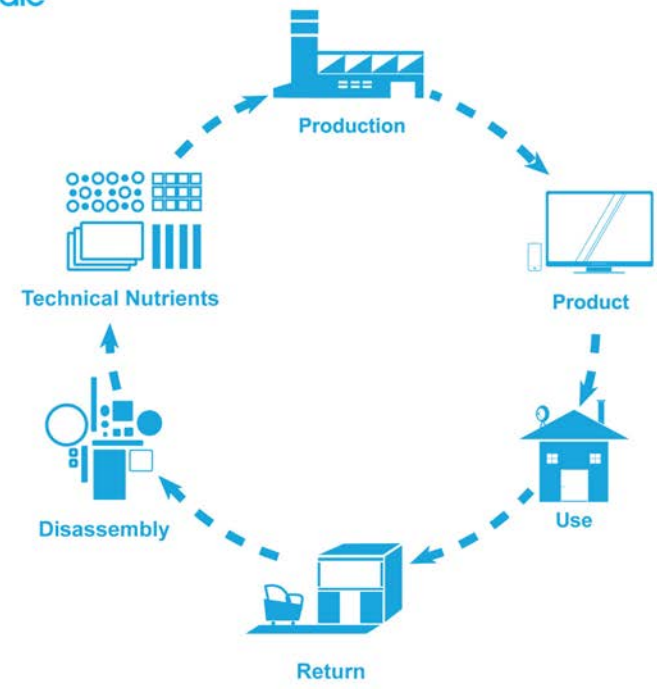
Cradle 2 Cradle is the name of a philosophy which, with inspiration from nature's ecosystems, rethinks the way we make our products and buildings. Instead of conceiving our products from raw product to waste we must conceive the whole lifetime of the product as a cycle where nothing goes to waste and the things we use can even contrib- ute surplus to the production system. This is done by using biological and technical nutrient cycles. Recycling through this system requires two different circles. Products can be composed either of materials that biodegrade and become food for biological cycles, or of technical materials that stay in their closed loop technical cycles, in which they continually circulate as valuable nutrients for industry.

image: Wikipedia.com

cradletocradle®



Biological Cycle
for Products for consumption



Technical Cycle
for Products for Service

William McDonough - ICEhouse

William McDonough + Partners and McDonough Innovation showcased a new structure in Davos, Switzerland for the 2016 World Economic Forum annual meeting. ICEhouse™ (Innovation for the Circular Economy house) was designed to demonstrate the positive design framework used in Cradle to Cradle designs, the sustainable development goals of the United Nations, and the reuse of resources implicit in the circular economy.

The ICEhouse, Circular Economy and Cradle to Cradle
The ICEhouse is primarily made of four materials: aluminum (the structural frame), polymer, aerogel, and Nylon 6. These four materials are assembled in ways that allow them to be easily disassembled and reused in another location. As defined technical nutrients, at the end of their use cycles they can be returned to industry and endlessly remanufactured into new products with no loss in material quality. They are all either Cradle to Cradle Certified™ or in the process of becoming certified.

Mr. McDonough looked to create a simple, flexible structural system that can be erected quickly and that is made of locally available materials wherever the structure is deployed. The patent-pending structure is comprised of simple elements connected using simple tools. This special Davos version uses aluminum for the frame material, but research is currently underway for using other feedstocks as well such as plastics and bamboo. The walls and roof structure were assembled on-site by a crew of four workers in just a few days; the entire structure was completed in nine days.

Temporary structures that are easy to assemble could help resolve Europe's space issues.
The refugee crisis adds additional challenges to the preservation of affordable housing in Europe, there is a higher-than-ever demand for attractive, inexpensive and somewhat temporary housing.

All photos: "ICEhouse" *William McDonough + Partners*. 2016. http://www.mcdonoughpartners.com/projects/icehouse/.

Cradle to Cradle house in the Netherlands

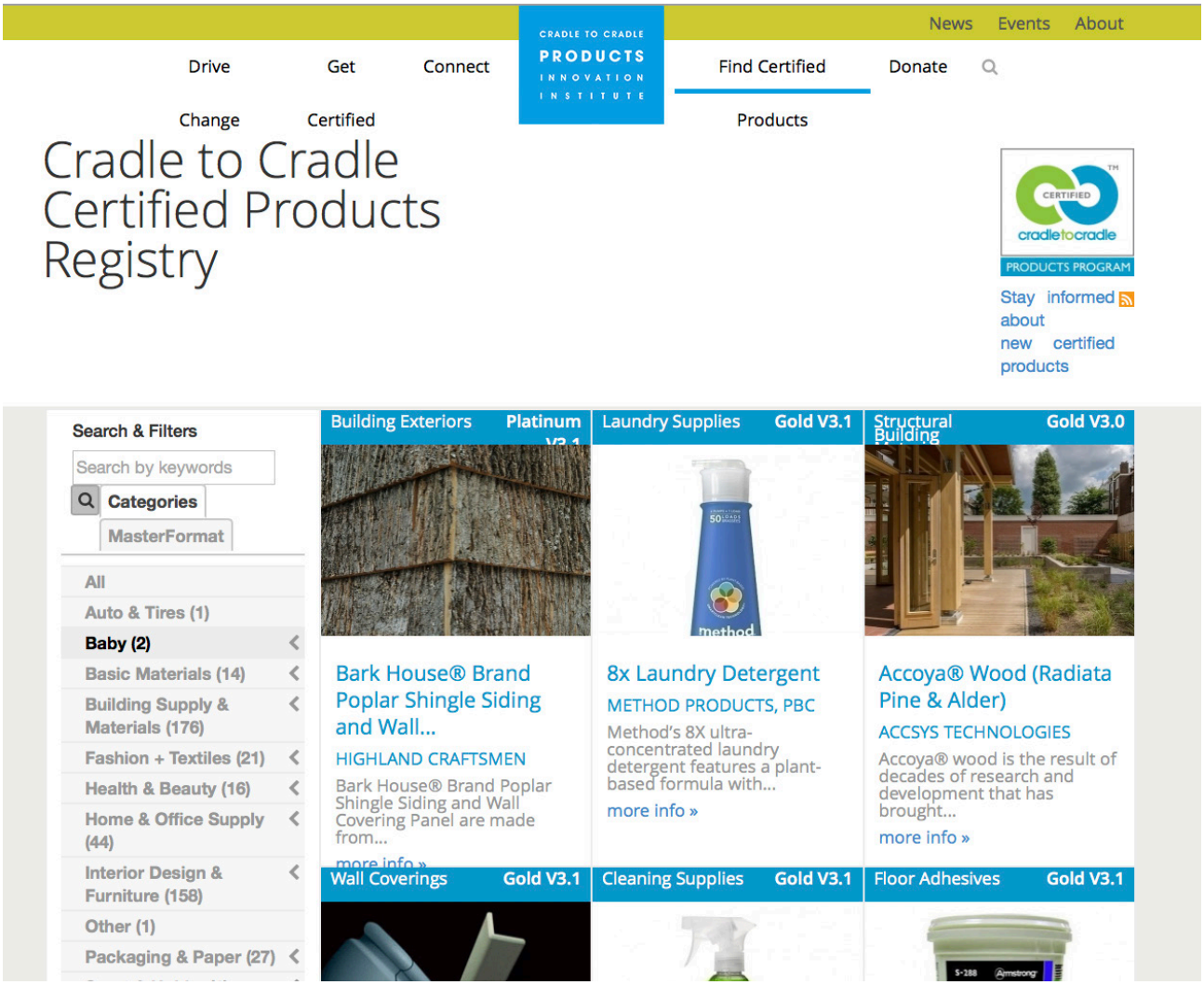
Architect Jouke Post created one of the few existing Cradle to Cradle homes and the first in the Netherlands. The house used renewable energy and non-toxic building materials to position the residence with principles of Cradle to Cradle. Although the home follows Cradle to Cradle criteria, it is only affordable for an affluent family. This exemplifies the need for affordable options, which could popularize the use of Cradle to Cradle.

All photos: Gibson, Eleanor"Jouke Post uses Cradle to Cradle principles to build family house in the Netherlands"*dezeen.com* 14 February 2017, https://www.dezeen.com/2017/02/14/first-cradle-to-cradle-house-netherlands-xx-architecten-rconiko-architecten/.

Cradle to Cradle Products Innovation Institute

An important difference between the Cradle to Cradle design paradigm and many other approaches to achieve a sustainable world is the elaborate and well-developed certification framework. Cradle to Cradle is not only a philosophy on sustainability, but it has its own framework for certifying compliant products. This framework is mainly intended to support companies creating Cradle to Cradle products. A certification can be considered a reward for the achieved results. For certification, products are evaluated against criteria from five distinct categories; material health, material reutilization, renewable energy, water stewardship and social fairness. Important within the category material health is the applied ABC-X assessment methodology, classifying materials based on chemical risk and recyclability in biological and technical cycles. Resulting scores include A, B, C, X or Grey (unknown) and determine to a large extent the actual certification level. Overall, the certification framework is not merely a pass/fail model, instead it incorporates the concept of continuous improvement. The level of product certification depends on the scoring on the previous mentioned criteria categories, resulting in a basic level to start with, up to the platinum level for complete Cradle to Cradle compliant products. The certification framework is designed to be applicable to materials, sub-assemblies and finished products. This scope is not limited to specific industries or product types. As a result of the certification process companies can obtain a certification mark for their Cradle to Cradle product. This mark, expressing the certification level, and can be displayed on the product.

Those assessing Cradle to Cradle products are mainly materials experts, and tend to focus on products materials qualities instead of innovations. Companies should be encouraged to develop together and communicate about collaboration. Cradle to Cradle assessment institutes should shift their focus more towards acting as a knowledge platform and intermediates between different product developers and manufacturers. Then it will be much easier for companies interested in Cradle to Cradle developments to meet, interact and cooperate. Cradle to Cradle philosophy is a solid and holistic theory on sustainable circular development, aiming for eco- effectiveness. It inspires companies and product developers to search for innovative solutions to achieve a more sustainable world.



All images:"Cradle to Cradle Certified Products Registry"*Cradle to Cradle Products Innovation Institute* http://www.c2ccertified.org/products/registry.

High Performative Systems

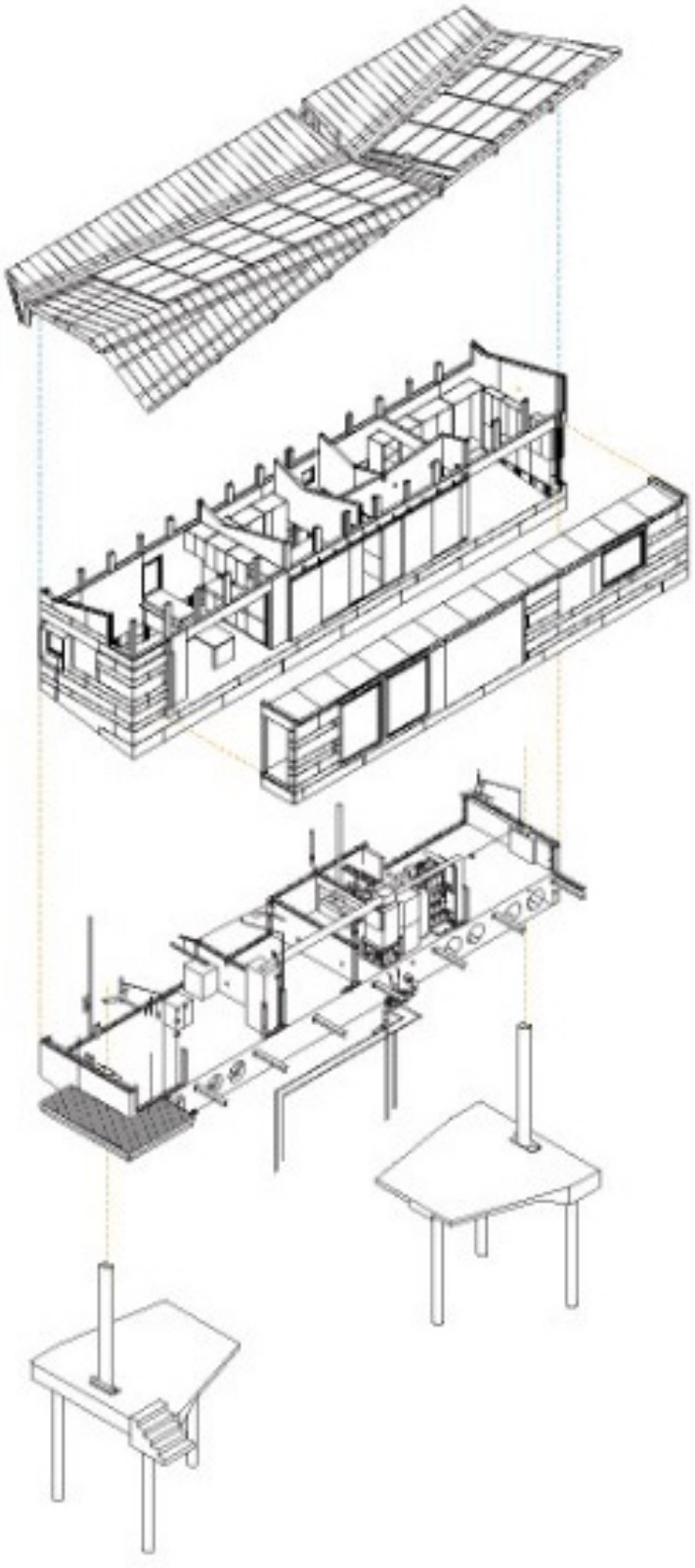
By looking at several precedents of high performing homes, I found the most successful designs combined passive design with energy efficient systems, such as, Solar power generation, rainwater collection, efficient systems (such as low energy appliances), high-grade fixtures (which will provide more durability), geothermal heating, quality windows, heat pump hot water heaters, and well-sealed insulation. The following precedents illustrate this.

The Float House- Morphosis Architects

The FLOAT House was developed for the needs of families in New Orleans's Lower Ninth Ward. It is a prototype for prefabricated, affordable housing that can be adapted to the needs of flood zones worldwide. It can sustain its own water and power needs and can be manufactured cheaply enough to function as affordable housing.

Although the FLOAT house is mass produced, it retains New Orleans's unique cultural context through the use of its formal qualities. The shotgun house is the indigenous typology of the Lower Ninth Ward. Like a typical shotgun house, the FLOAT house sits atop a raised base. The base or "chassis" holds all mechanical, electrical, plumbing, and sustainable systems and floats in case of flooding.

The FLOAT house is assembled on-site from pre-fabricated components. The chassis is a single prefabricated unit of expanded polystyrene foam coated in glass fiber reinforced concrete, with all required electrical, mechanical and plumbing systems pre-installed. Panelized walls, windows, interior finishes and roof are prefabricated, to be assembled on-site along with the installation of fixtures and appliances. Modern mass production and traditional site construction are combined to reduce cost, guarantee quality, and reduce waste.

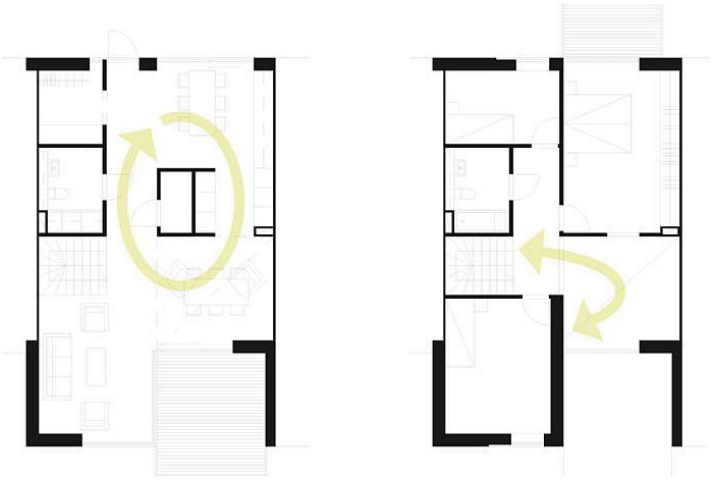


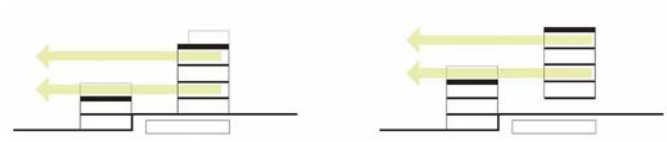
All photos: Baan, Iwan"The FLOAT House - Make it Right / Morphosis Architects"*archdaily.com* 2009, http://www.archdaily.com/259629/make-it-right-house-morphosis-architects.

Sustainable Town Houses - C. F. Moller Architects

Eighteen sustainable town houses were designed for the area of Norra Djurgaardsstaden in Stockholm by C.F. Moller Architects. The townhouses were designed in a former industrial area located next to a nature reserve. Their objective was to transform the area into a new high-profile environmental area. The housing district aims to adapt to global climate changes, in order to no longer make use of fossil fuels by 2030. The energy consumption is minimized by the massing of the buildings. The staggering of the townhouses maximizes views and daylight. Intelligent lighting and solar panels are used for heating and heat recovery.

The townhouses will feature green roofs and a landscaped pond, which collect rainwater, convert CO2 and provide fertile ground for biodiversity. The sustainable approach is continuous through the building's life cycle – from construction phase to operational phase and a possible later decomposition phase.





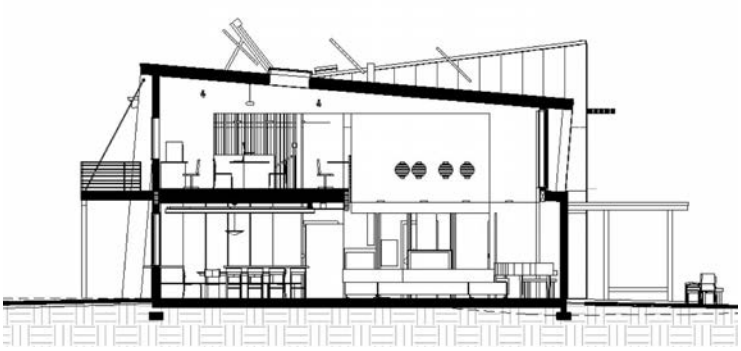
All photos: C.F. Moller Architects"ZENHOUSES, HIGH-PROFILE ENVIRONMENTAL DEVELOPMENT"*cfmoller.com* 2010,http://www.cfmoller.com/p/-en/Zenhusene-Norra-Djurgaardsstaden-i2708.html

Green Concept Home - Modus V Studio Architects

The "Green Concept Home" is an environmentally friendly and sustainable home built by wife and husband team David Huang and Millie Leung. They looked to move society towards more sustainable living by providing their research, design, preparation and construction through a website www.greenconcepthome.com. Free educational public tours were provided during construction.

Many concepts of green design were implemented – including structural insulated panels, rainwater harvesting system, solar hot water heater, tank less hot water heater, heat recovery ventilator, radiant floor heating, solar orientation, Energy Star appliances, Energy Star metal roof, Energy star windows, low-flow water fixtures, no VOC paints, renewable and environmentally friendly materials and drought-tolerant landscaping. In addition, the majority of the waste during construction was recycled.

Living spaces are arranged in such a way to promote sustainable usage. The house is shaped like an "H", one side is designated for "public" spaces such as living room, kitchen, dining room and office. The other side is designated for "private" spaces such as all of the bedrooms, guest room, mechanical room and garage. This allows for separation of heating zones and an acoustic barrier between the noisier part of the house and the private spaces.



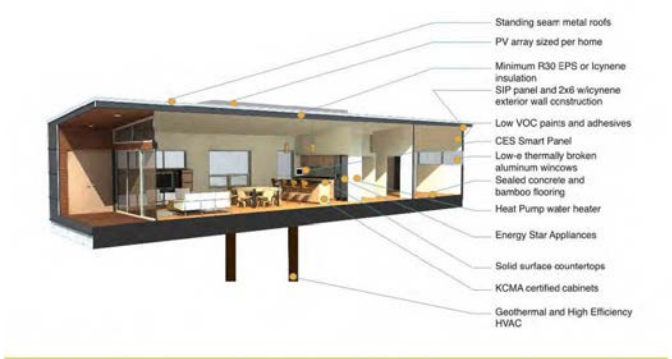
UPPER FLOOR

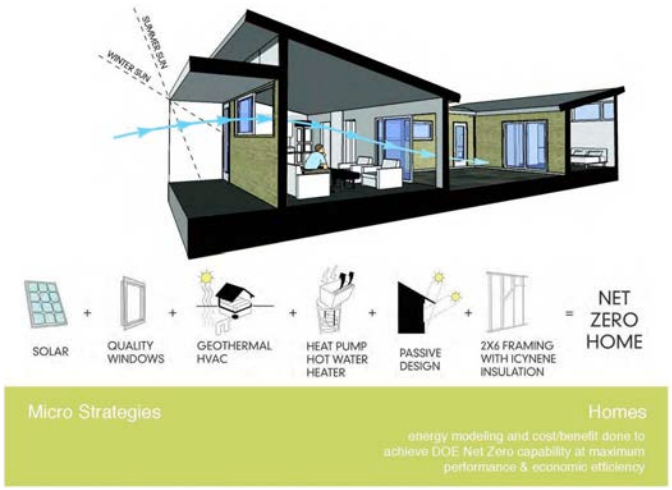
MAIN FLOOR

All photos: Leung, Millie"Green Concept Home / Modus V Studio Architects"*archdaily.com* 2010, http://www.archdaily.com/135212/green-concept-home-modus-v-studio-architects

SOL: The Net-Zero Community - KRDB

SOL – Solutions Oriented Living – is a model development of a sustainable community that integrates social, economic and ecological components to create a holistic community. The development is a medium density, single-family in-fill project in central east Austin. It incorporates a significant portion of low income and affordable housing. The development is 5.5 acres developed into 38 lots composed of 40 units ranging from 550 sf to 1800 sf. The units are arranged around a central pocket park and all have access to outdoor space. The landscaping is considerate of Austin's climate, all of which was chosen for its tolerance to periods of drought. The project also incorporates a sub-grade bio-filtration facility. Passive design was used in all of the homes. Energy modeling helped develop systems to ensure the homes were developed with the right components of SIPS panels, geothermal energy and building materials. The process aimed to reach net zero energy use as well as obtaining the most economical solution for building.





All images: KRDB"SOL: The Net-Zero Community in Austin, Texas / KRDB"*archdaily.com* 2010, http://www.archdaily.com/210187/sol-the-net-zero-community-in-austin-texas-krdb

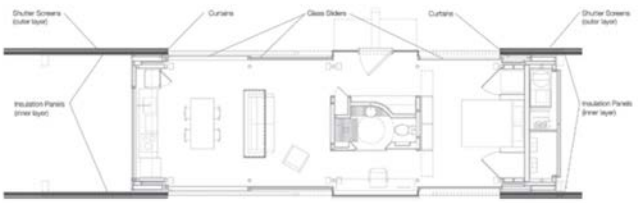
User Involvement

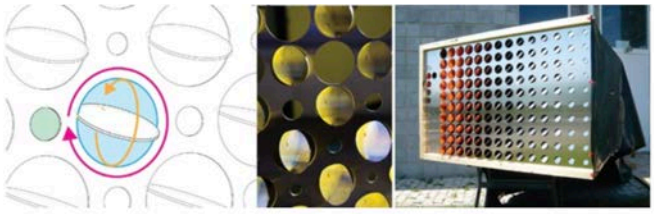
Projects which involve and educate the user in the energy conservation process could change the user's habits and behaviors. In addition, designs influenced by the user's routine can influence the elevated experience of an energy saving home.

Lumenhaus and the Eclipsis Sun Control System

The Lumenhaus was exhibited at the Solar Decathlon. The Eclipsis Sun Control System was created to keep sun off the building façade and reduce heat transfer to the interior. Two layers were used to control this. One was a stainless-steel sheet metal assembly patterned with a geometry of circular laser-cut openings and folded tabs that operate as a shutter with four functions: keeping the summer sun off of the façade, offering degrees of privacy while maintaining contact with the outside, refracting rays of sunlight that intensify and enrich the space, as well as promote air flow and cross ventilation. The second layer, an innovative wall assembly of two polycarbonate panels filled with nanogel insulation, contains light, literally and phenomenally. The double wall section transmits translucent light to the interior of the house while providing thermal insulation of R-24 resistance value. The house to does not need to use electric light from sunrise to sunset.

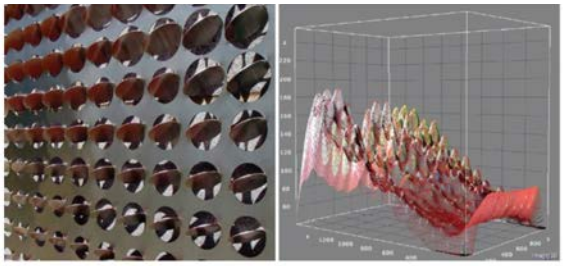
An algorithmic logic was developed to coordinate the screen's perforations with both the building's program and the sun's movement. Circular openings were calibrated based on the need of privacy or required clear views. For example, a typical morning routine in the home was analyzed. As the occupant begins his or her day privacy is provided in the bed, as they rise up greater views are offered to the outside through larger openings. As the occupant moves to the kitchen they are offered with the clearest view to the outside.

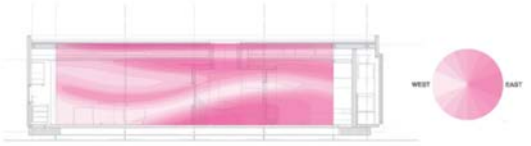




4.1.6
(Left) Diagram showing the variables of size, axis and degree of tab rotation. (Right) Testing rig and first prototype of rotated tabs

4.1.7
Full-scale working prototype of Eclipsis screen design with rotated tabs

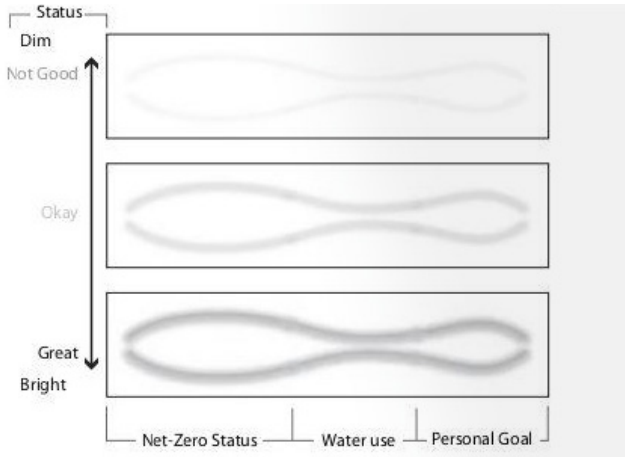




All photos: Dunay, Robert, et al. "Lumenhaus and the Eclipsis Sun Control System." Design and Construction of High-Performance Homes, Building Envelopes, Renewable Energies and Integrated Practice, edited by Franca Trubiano, Routledge, 2013, 234-237.

North House

The North House, a design research project was exhibited at the Solar Decathlon in 2009. The design was able to produce net positive energy through the coordination of all building systems through automation servers which managed priorities of heating and cooling for occupant comfort and the optimization of energy performance. A series of LED rope lights were placed behind the kitchen backsplash and glow with different intensity in different zones according to net energy consumption.

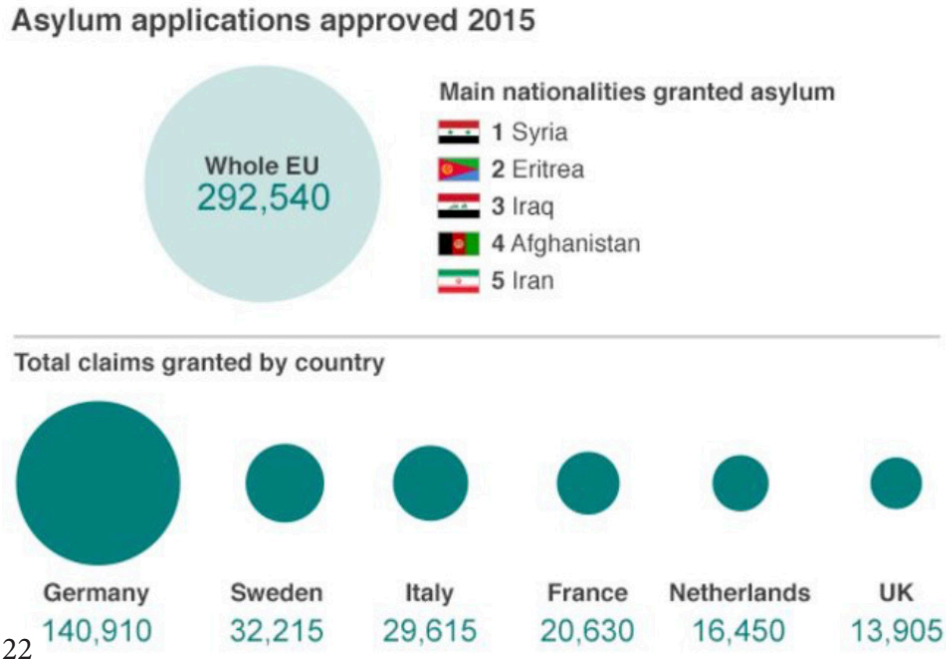


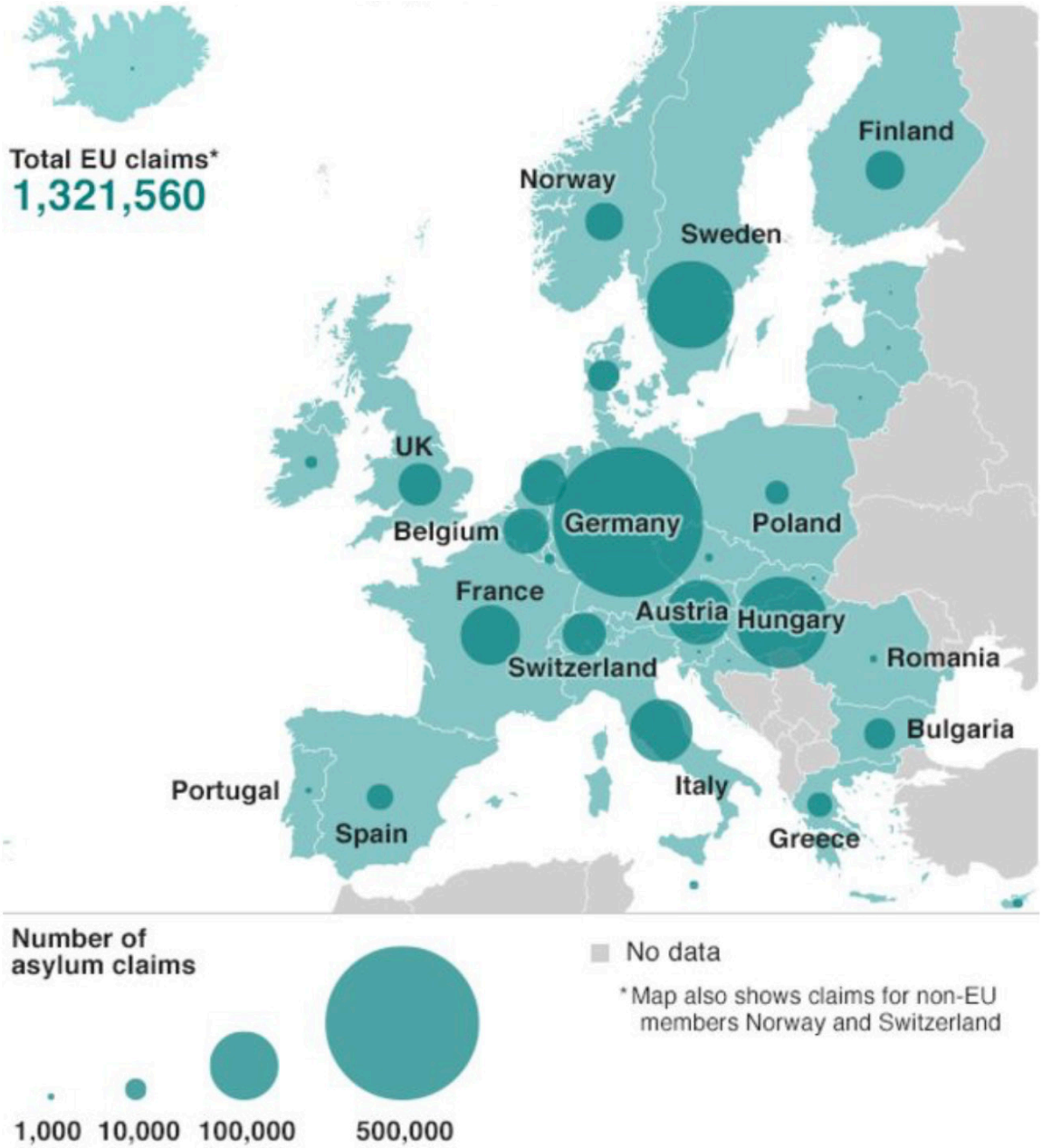
All photos: Thun, Geoffrey, et al. "Climate-Responsive Envelope and Control System." Design and Construction of High-Performance Homes, Building Envelopes, Renewable Energies and Integrated Practice, edited by Franca Trubiano, Routledge, 2013, 264-280.

Syrian Refugee Housing Crisis

While some only live in the camps for a couple of months, others have been in the camps for six years or more. The camp is an "in-between" place; the rooms are bare, divided by thin sheets, allowing very few or no belongings. Refugees change their country, go through a strange journey and are then stuck in an uncomfortable location. Although the camp is not closed, it is difficult for the refugees to interact with the local people. "It's not closed, you can go out, but you feel somehow that you're treated like a different thing. But after you are out of the camp, it's normal. Those feelings start to fade away." (Genova 2).

An estimated 11 million Syrians have fled their homes since the outbreak of civil war in March 2011. The majority have sought refuge in neighboring countries such as Turkey, Lebanon and Egypt, while 6.6 million are displaced within Syria itself, according to the United Nations High Commissioner for Refugees. Just over one million have requested asylum within Europe. Germany, with more than 300,000 cumulated applications, and Sweden, with 100,000, are the E.U.'s top receiving countries.





Images: Eurostat,"Migrant crisis: Migration to Europe explained in seven charts"*bbc.com* 2016, http://www.bbc.com/news/world-europe-34131911

Syrian Refugee Environmental Impact

Refugee settlements often have negative impacts on the environment. Temporary settlements "often occur in environmentally sensitive areas" where there are large areas of "open" land, such as near national parks, forest reserves, or agriculturally marginal areas. Additionally, the size of these camps has a larger impact on the environment. Refugees often stay in their asylum countries for long periods of time, having a prolonged impact on the environment.

The UNCHR, which is tasked with addressing the environmental effects and impacts on refugees and the affected areas, notes that the most significant problems include: "deforestation, soil erosion, and depletion and pollution of water resources." Not only do the refugees have a negative impact on the environment, but the environmental deterioration has an adverse impact on refugees. For instance, the resulting low-quality water from an overload on the system can cause the spread of disease. Similarly, deforestation from cutting down local trees for firewood can force women and children to walk further to acquire wood leaving them vulnerable to assault, can result in illness from lower cooking times for boiling water, and can lead to malnutrition due to the sale of rations for cooking fuel. The environmental impacts also affect "the social and economic welfare of local communities following the arrival…of refugees. These too may impact the environment, altering the rate and extent of local services available to people."Reversing this environmental harm is often costly and impractical; therefore, limiting the damage and "promoting options for sustainable development" from the outset is essential."

Images: Balogh, Laszlo."Europe's refugee crisis: Trash trail left behind by asylum seekers upsets locals"*rt.com* 2015, https://www.rt.com/news/314983-europe-refugee-crisis-discontent/

Tempelhof Airport, Berlin

The Tempelhof Airport in Berlin is now one of the largest refugee shelters in Germany. Back in October of 2015 16,000 or more refugees were arriving at the border of Bavaria each night. The fire brigade, the police, even the army, and the volunteers worked to accommodate the arriving refugees, while only having three hours to organize the hangar. The living arrangements haven't changed much since then, the 52-foot-high hangars where up to 800 refugees are currently housed provide sparse 270-square-foot spaces sectioned off by temporary screens. Six double bunk beds sleeping 12 are squeezed into these spaces with no extra space. "It's not space designed for living," Constanze Döll, a spokeswoman, noted of Tempelhof Projekt, the city agency that is responsible for the overall development. "It's an aircraft hangar." There is minimal privacy, no doors, there's a constant noise in the hall and people-live there like that for weeks and months. There living situation is not only unlivable, but it is also costing 20,000 euros a day.

Angela Merkel's asylum restriction packages, and the closure of borders in Europe, have reduced the flow: around 12,200 people have sought asylum in the nation's capital so far this year, a fraction of the 80,000 that came in 2015. Last November, the average daily intake was 554 - now it is 31.

After a transfer, asylum seekers sometimes have to live in camps even though they should be provided with their own flat or at least a shared one. The city's shortage of affordable housing has exacerbated the problem. Searching for a flat in Berlin is hard enough for Berliners; being a refugee adds an extra layer of bureaucracy that makes it tough even for the most patient of landlords to accept them.

Berlin is looking to close the hangars as a mass refugee shelter by 2017. City Planners are currently looking into erecting prefab housing for refugees in Tempelhof outside of the hangars.

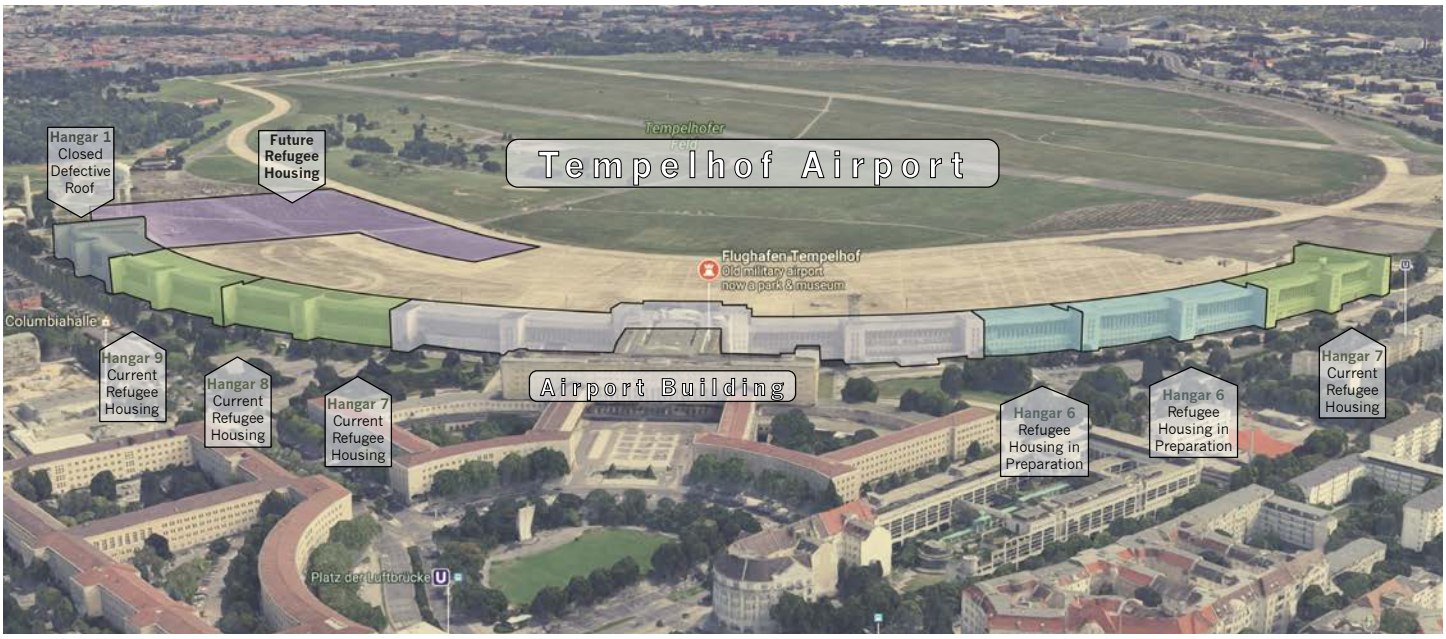
Images: Welters, Gordon"Tempelhof Airport, Once a Lifeline for Berliners, Reprises Role for Refugees"*nytimes.com* 2016, https://www.nytimes.com/2016/02/11/world/europe/tempelhof-airport-once-a-lifeline-for-berliners-reprises-role-for-refugees.html?_r=0

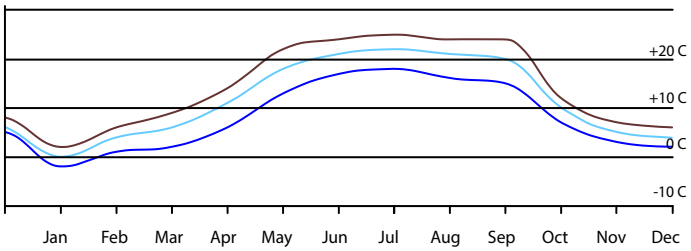

Putin


A8
BA
PAK

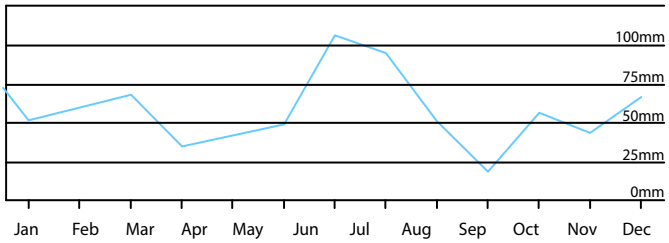
Tempelhof Airport Site Analysis

The below map shows the hangars currently used as refugee housing and where the proposed refugee settlement is to be located. The graphs indicate Berlin's average temperature and precipitation. Berlin has a cold climate, with consistent rainfall.



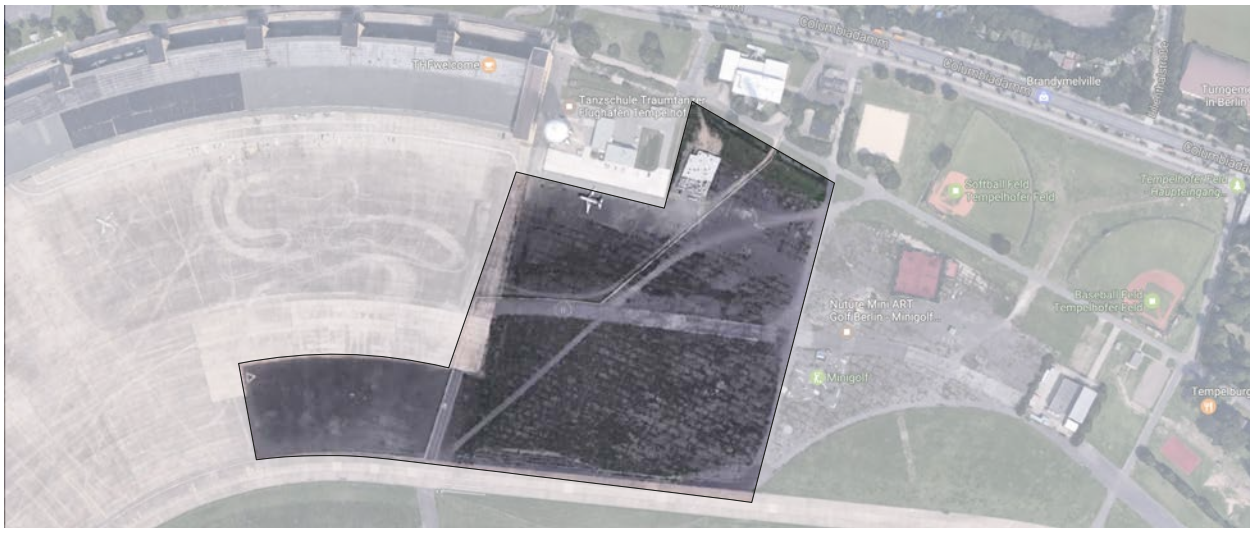


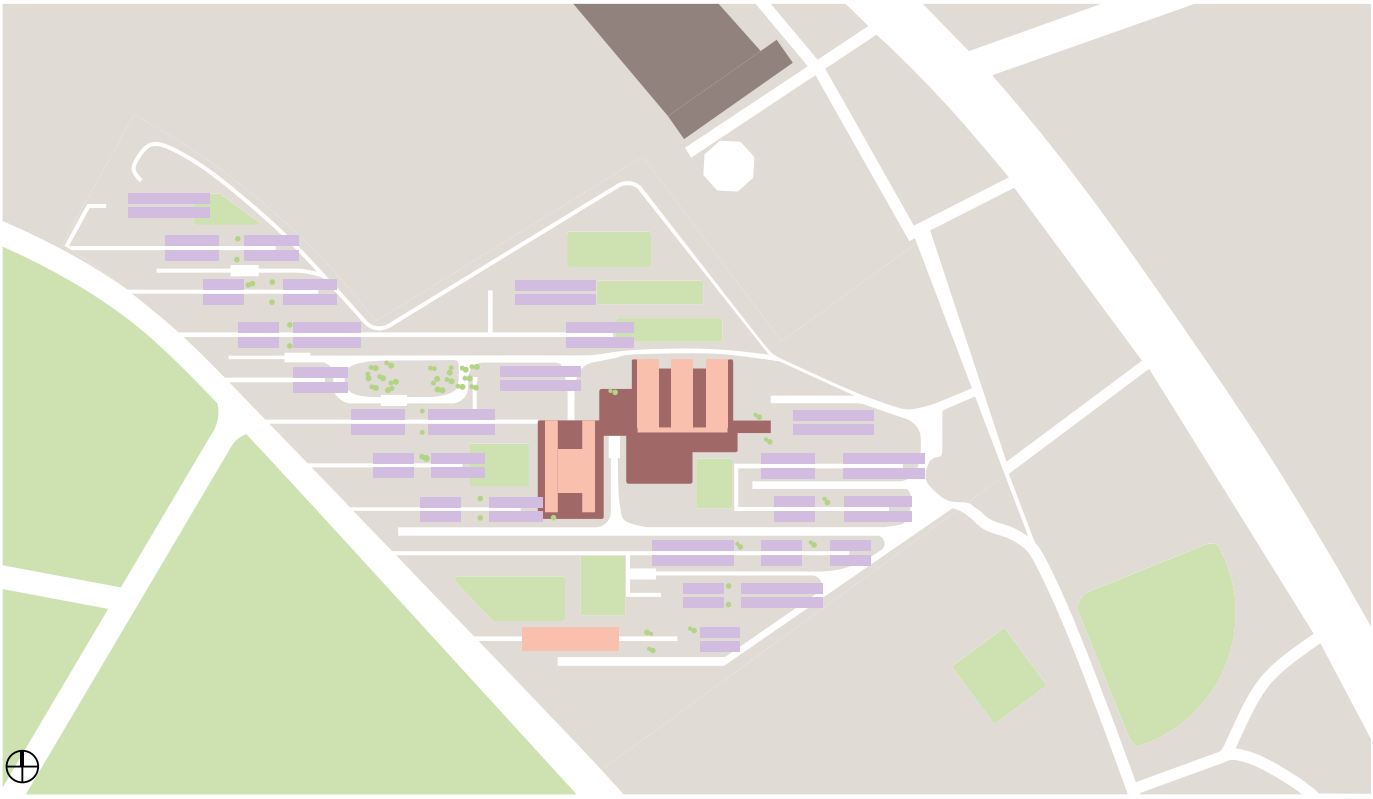
Max Temp (C) Min Temp (C) Avg Temp (C)



Rain (mm)

Images produced by Author
Data from us.worldweatheronline.com

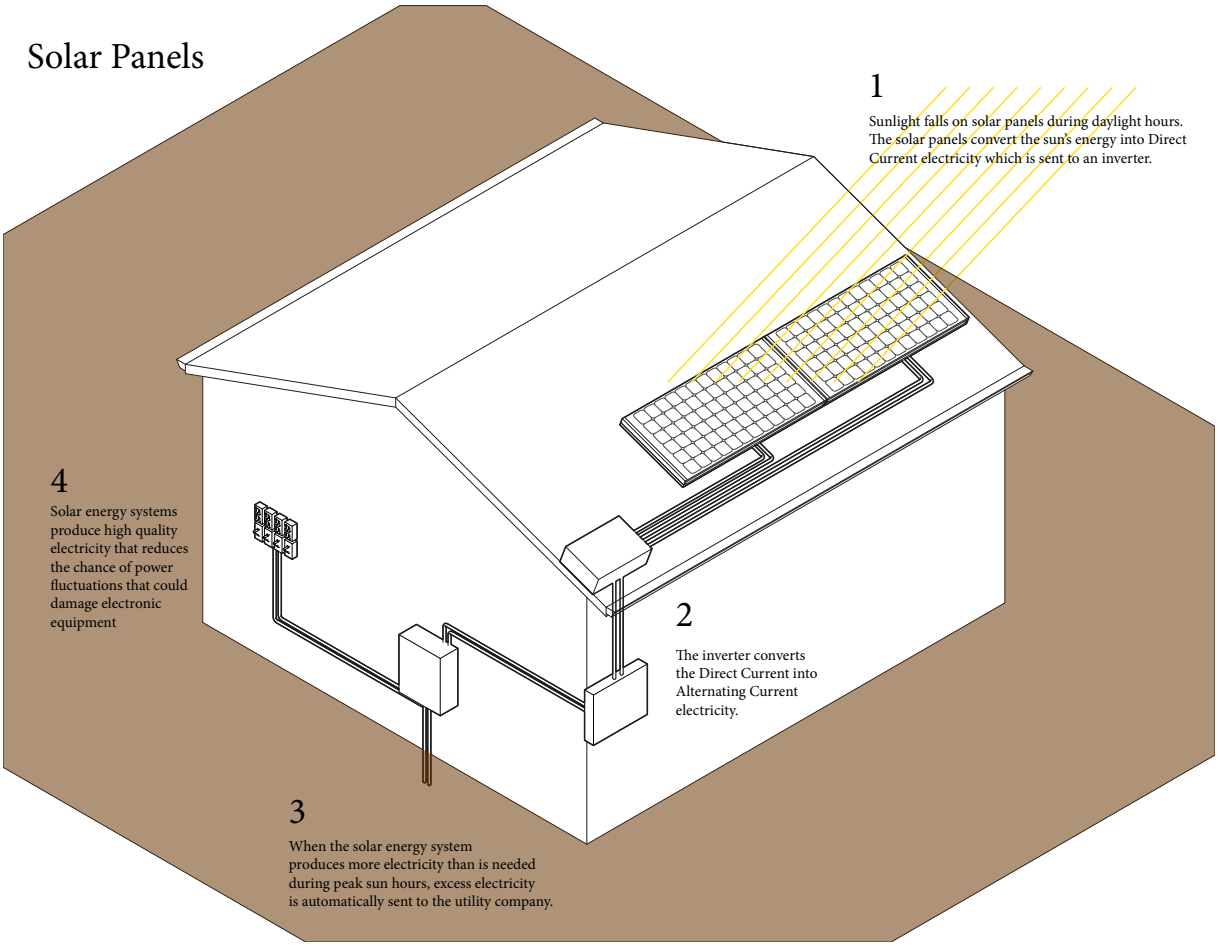




Tempelhof Airport
Administration / School / Eatery
Refugee Housing

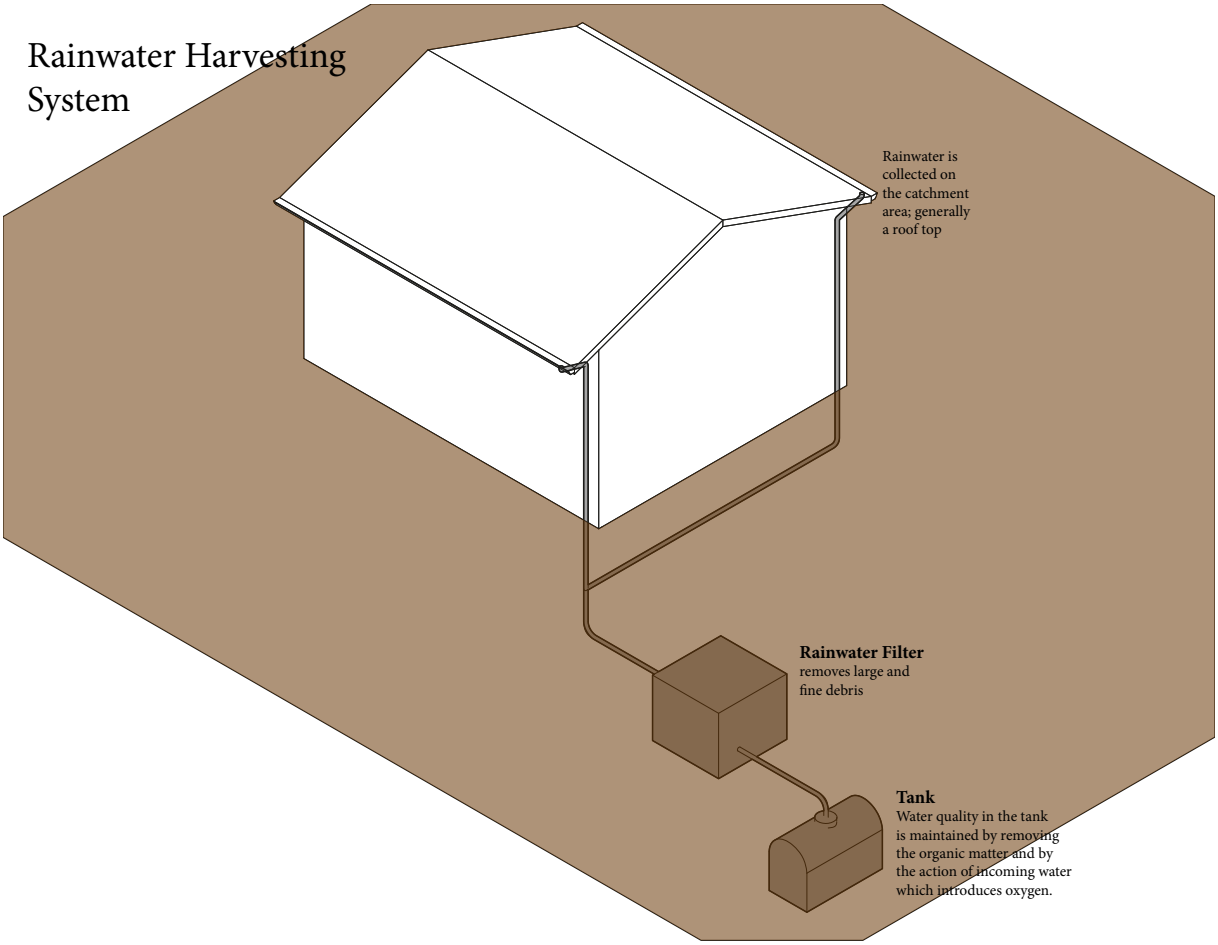
Energy Efficient Systems

Systems such as solar panels, rainwater collectors, and geothermal heating would be useful for this type of climate.



Images produced by Author

Rainwater Harvesting System

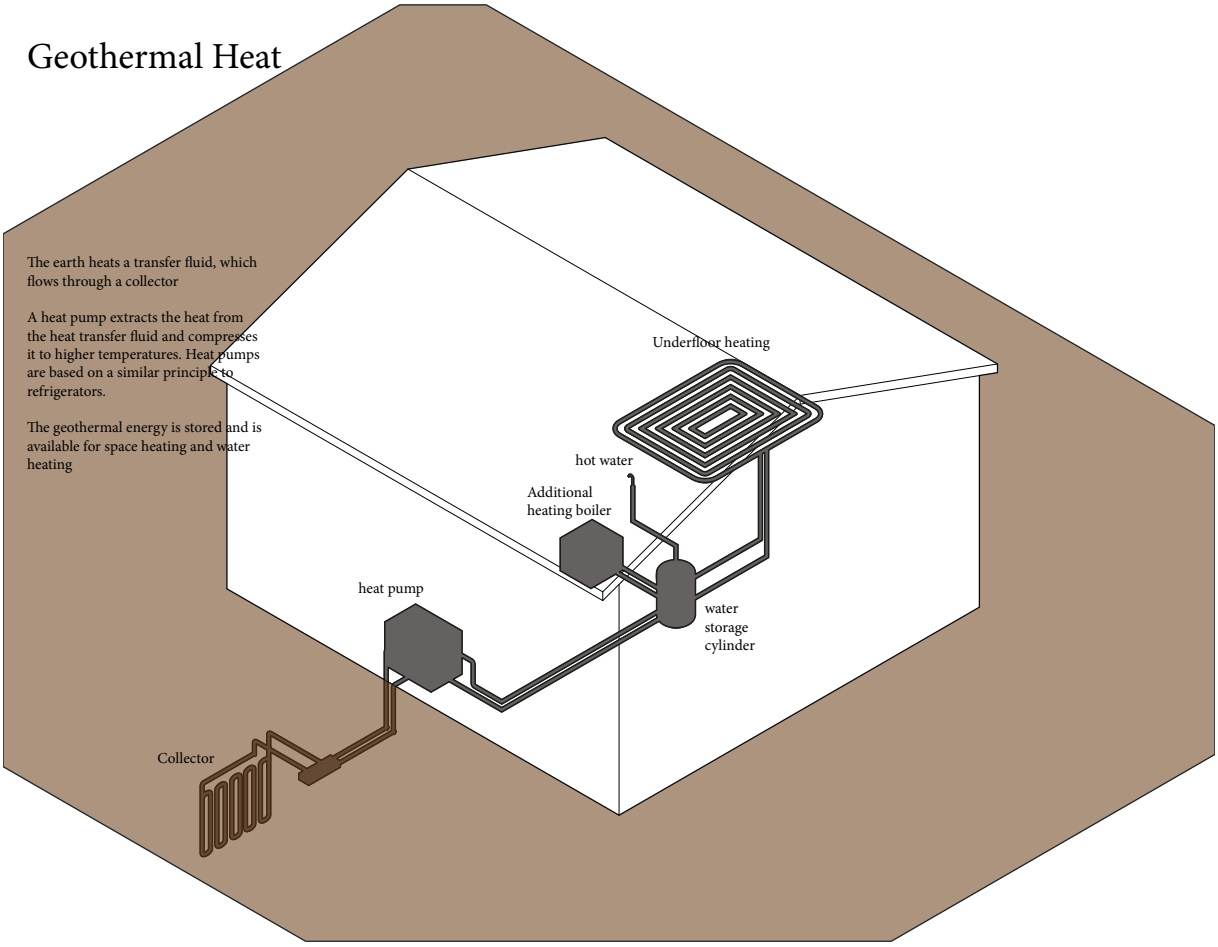


Geothermal Heat

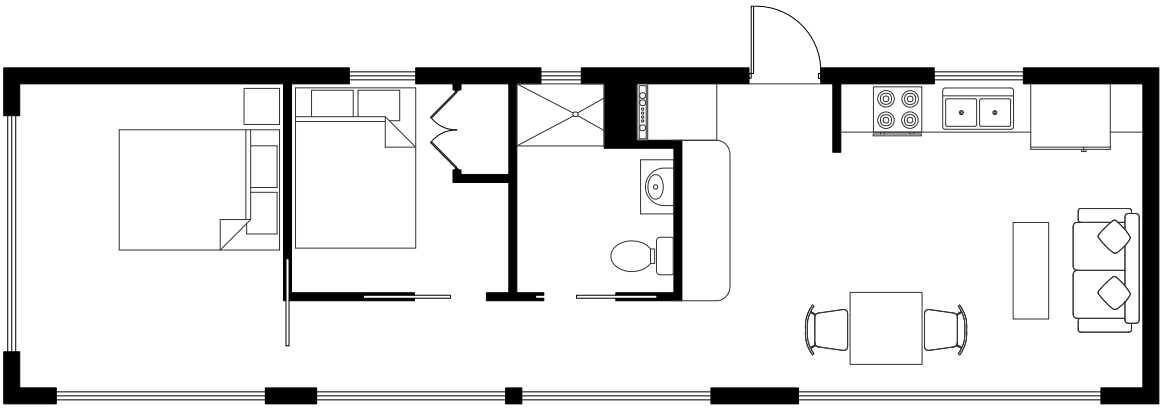
The earth heats a transfer fluid, which flows through a collector

A heat pump extracts the heat from the heat transfer fluid and compresses it to higher temperatures. Heat pumps are based on a similar principle to refrigerators.

The geothermal energy is stored and is available for space heating and water heating



Unit Floor Plan



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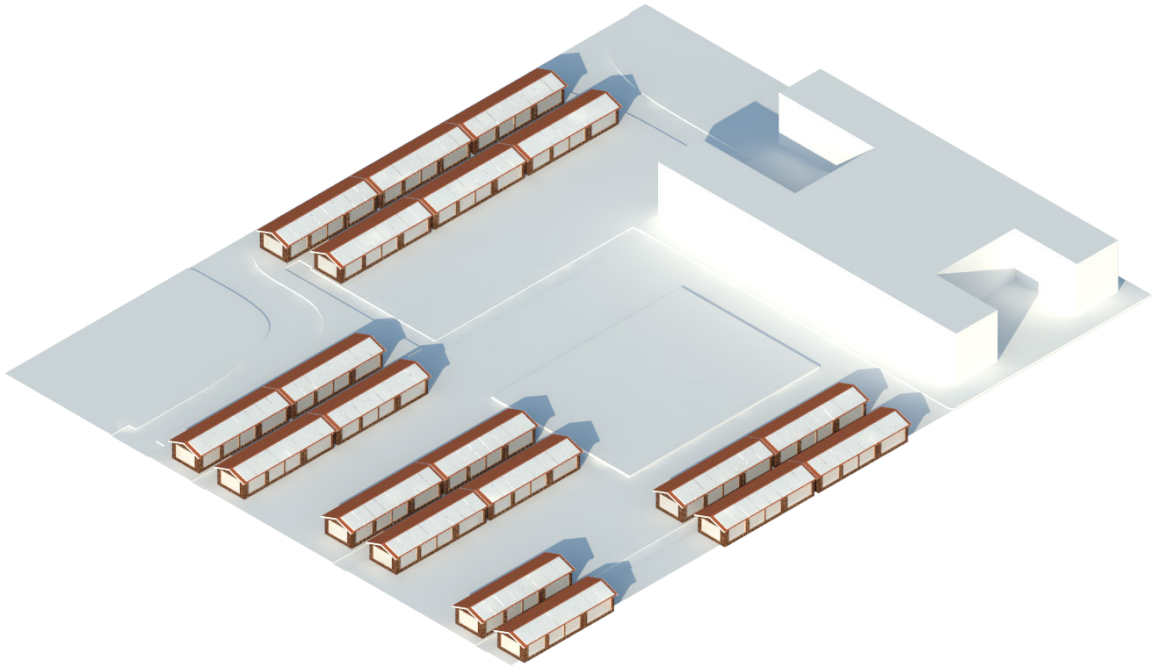
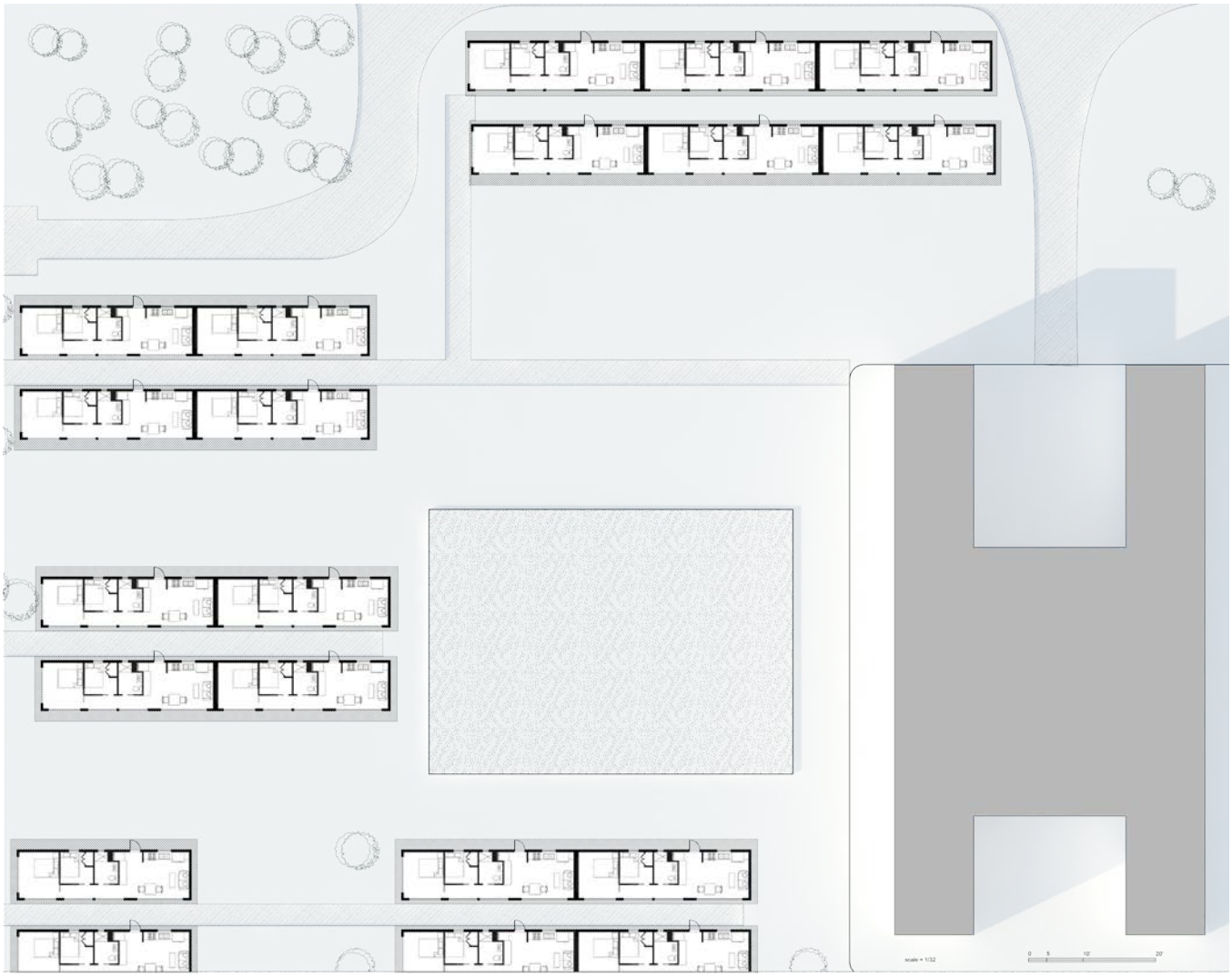
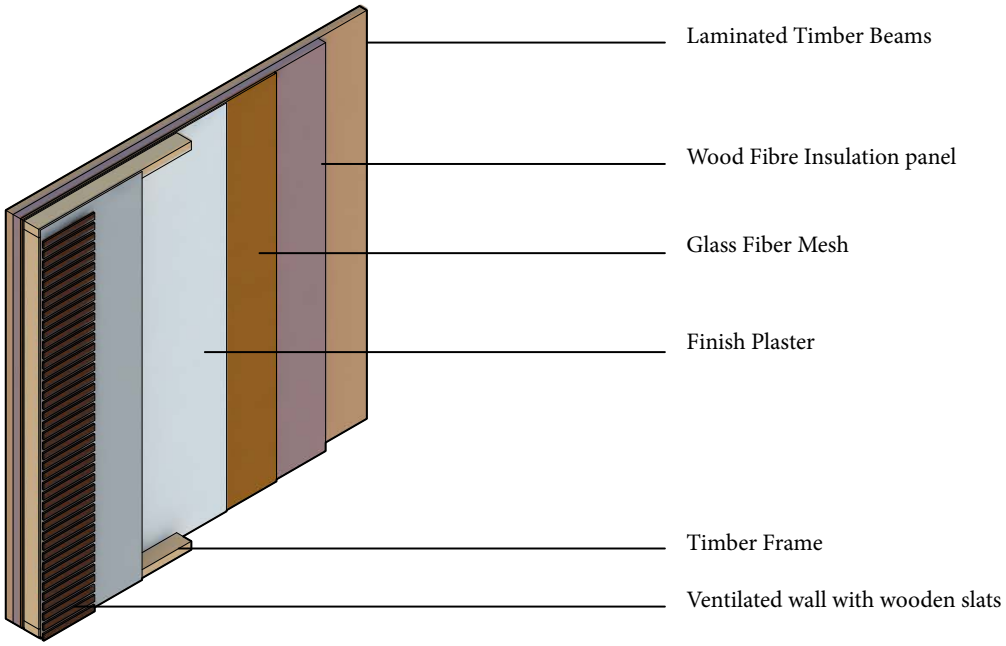




Components

The housing is designed to be both temporary and permanent. It would be prefabricated using materials with low environmental impact, focusing on high insulation. The unit would be broken down into components. This unit includes roof wall and floor components. Once the refugee settlement is no longer needed components can be reassembled in another location to be used for another purpose, such as, affordable housing. If components can no longer be used they can be recycled. The components are then broken down by materials and can either biodegrade or be used in other construction.

Wall Component



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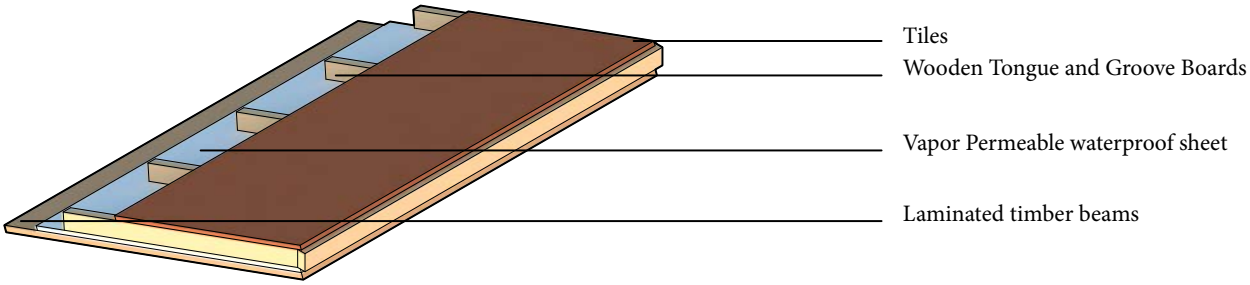
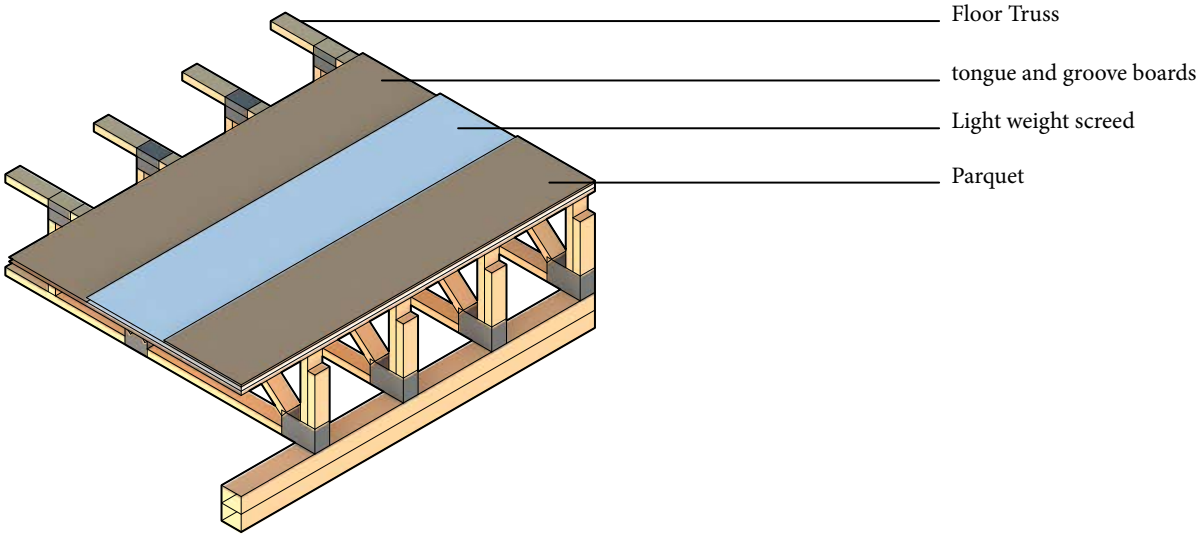
Roof Component

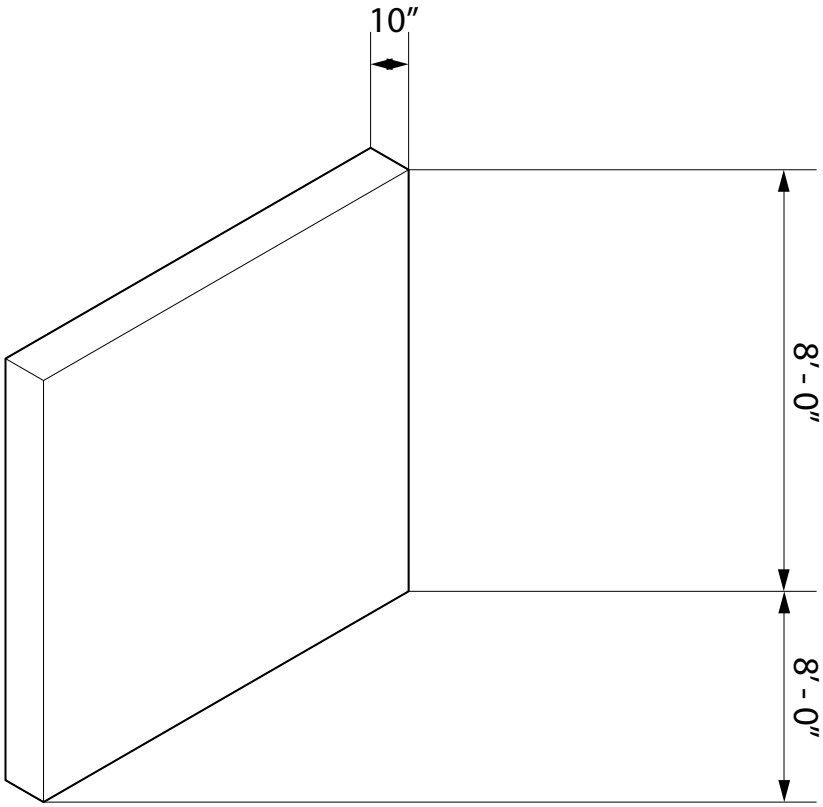


Floor Component



Dimensions

Wall Component



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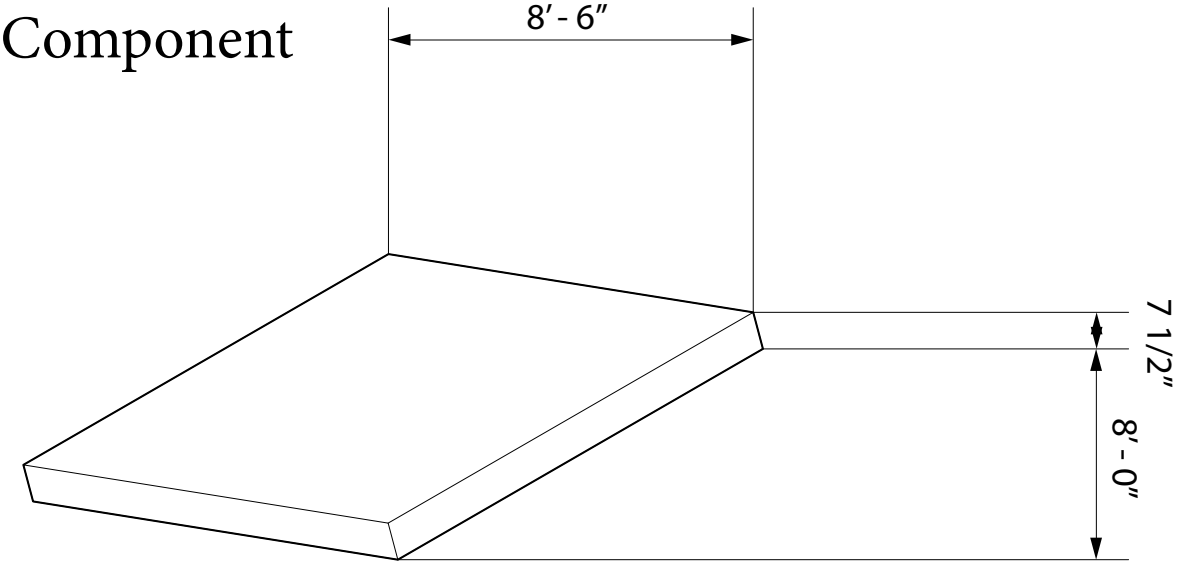
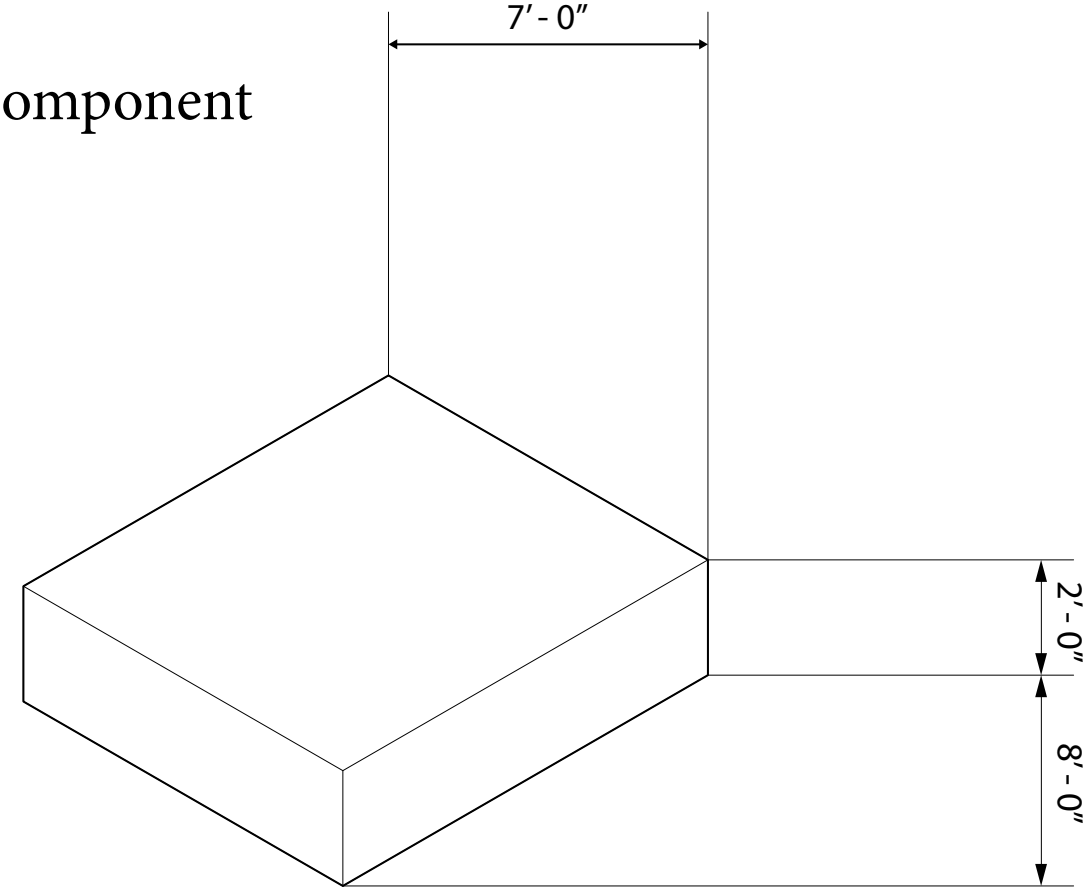
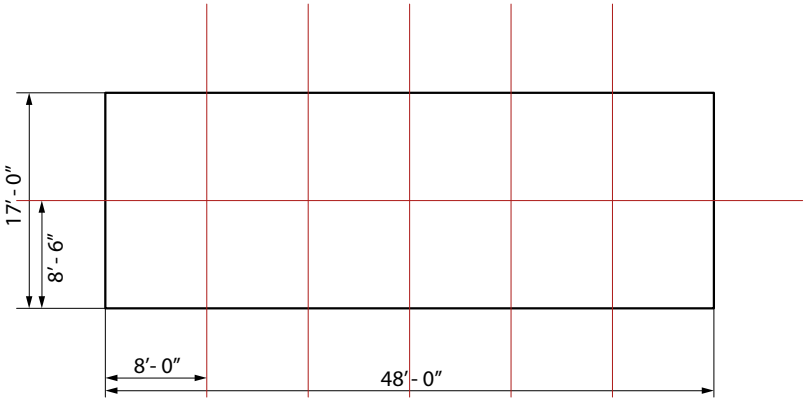
Roof Component



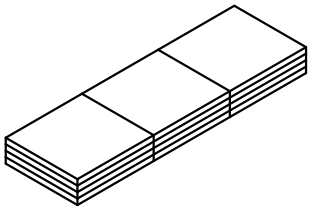
Floor Component



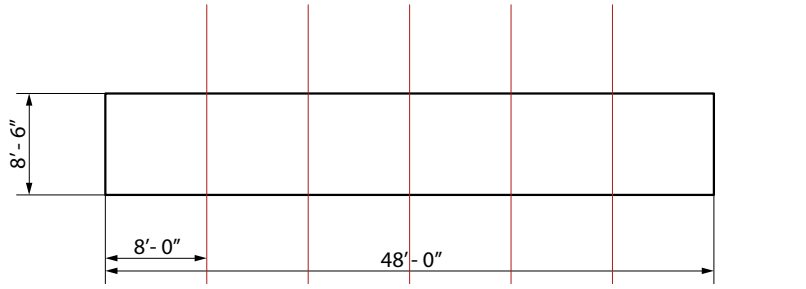
Units to Components



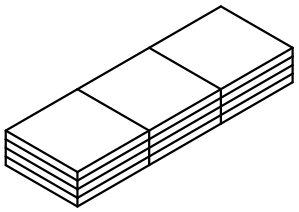
Roof sections



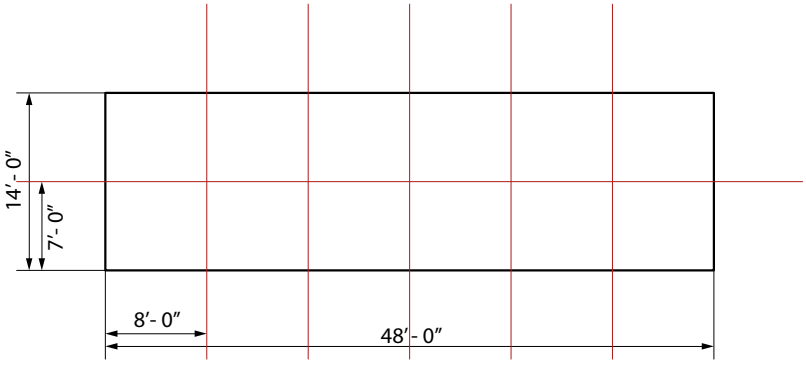
12 Long roof components = 1 unit



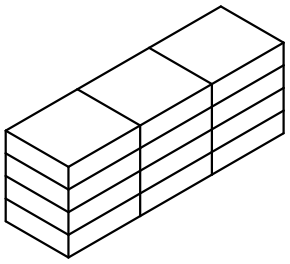
Long Wall sections



12 Long wall components = 1 unit

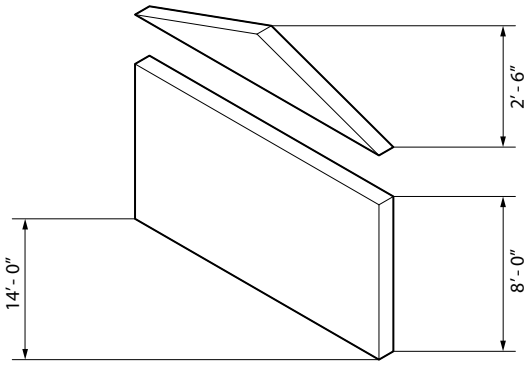


Floor sections

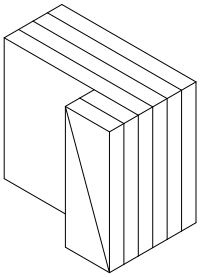


12 floor components = 1 unit

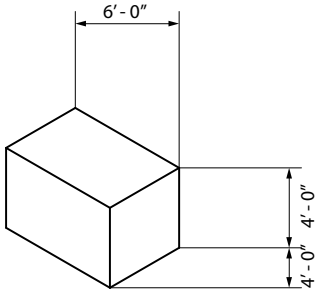
Images produced by Author



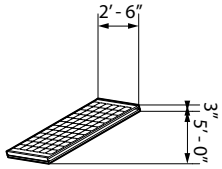
Short Side Walls



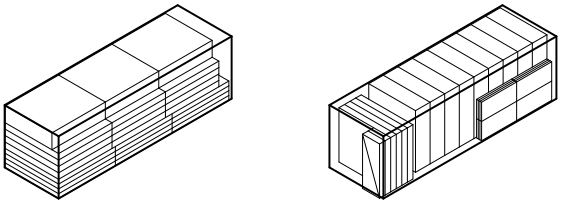
6 Short Side wall components = 1 unit



High Performing Systems

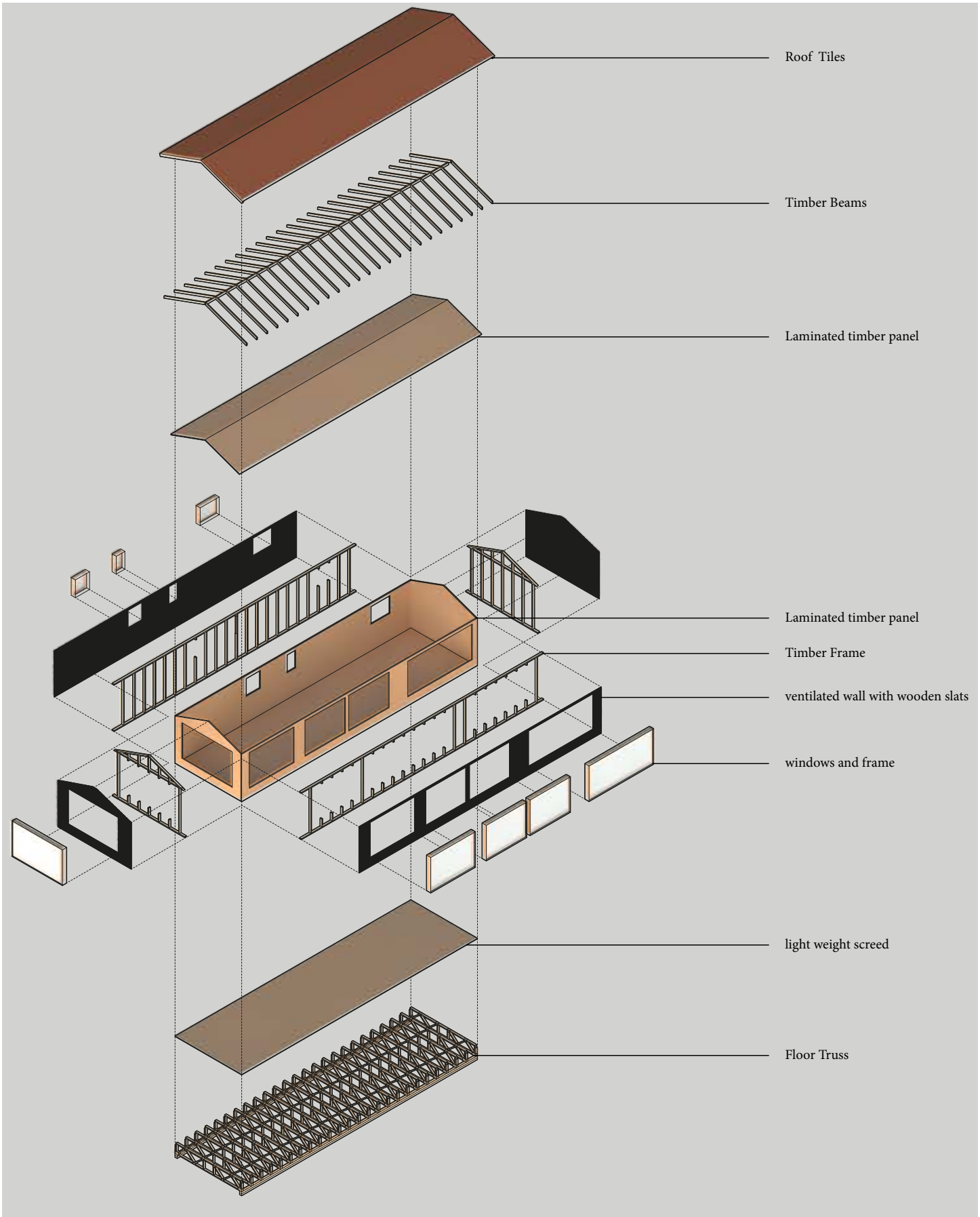


24 PV Panels



2 Delivery Trucks 8' x 25' x 8'

It takes approximately two large trucks 8'x25'x8' to deliver all of the components to the site



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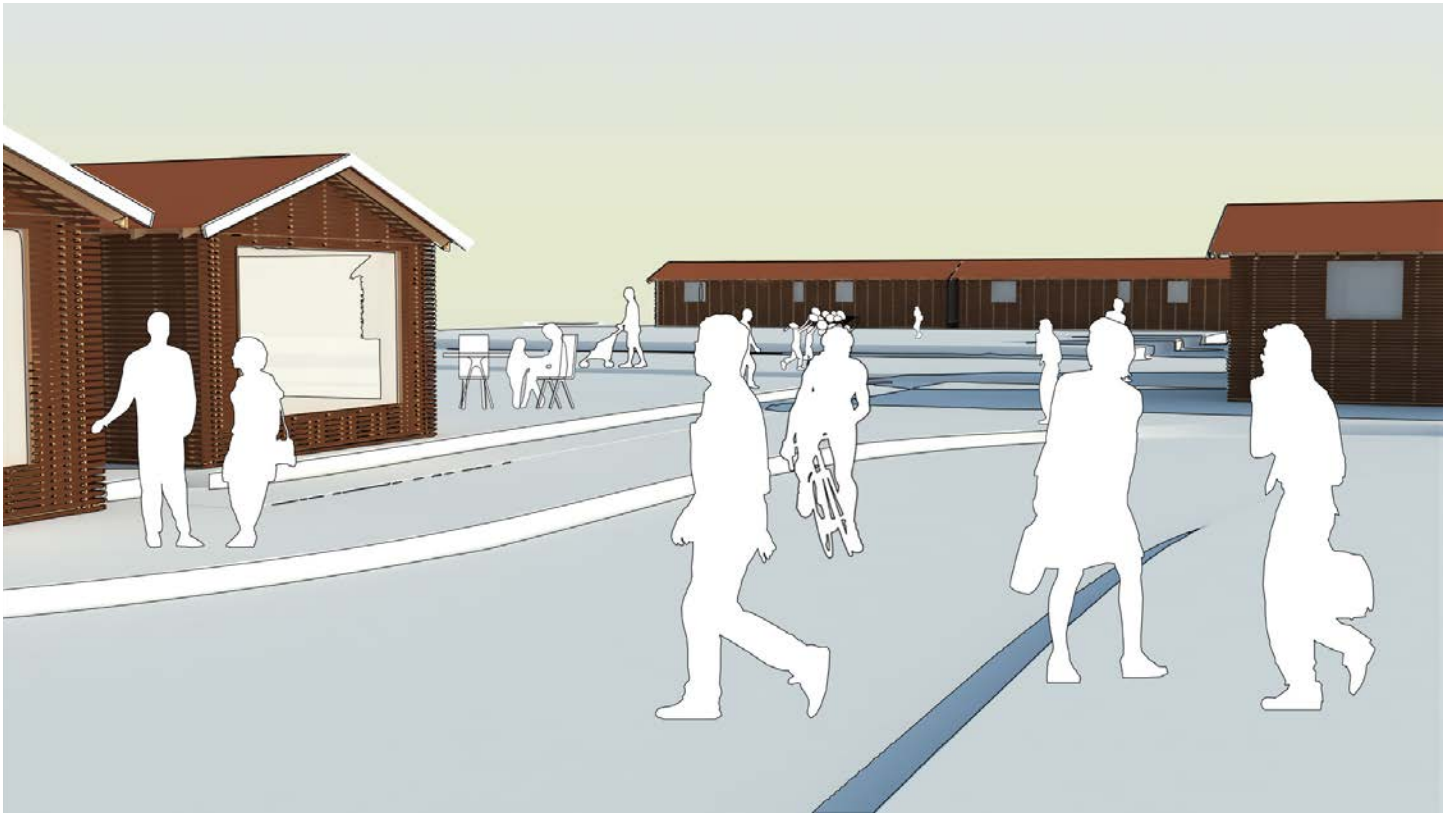

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