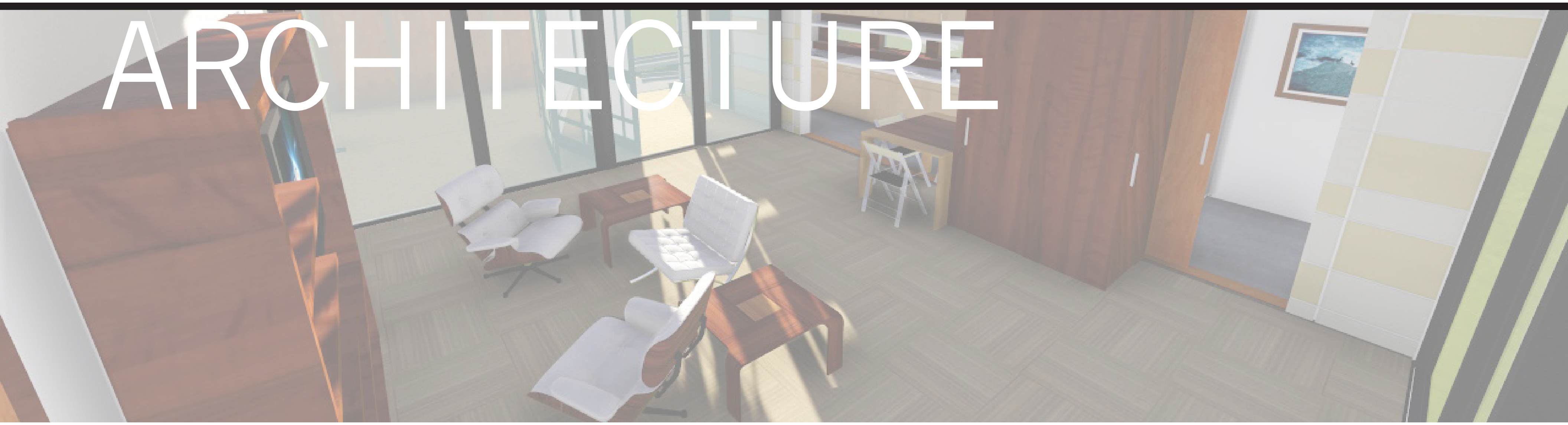
Crowder College - Drury University

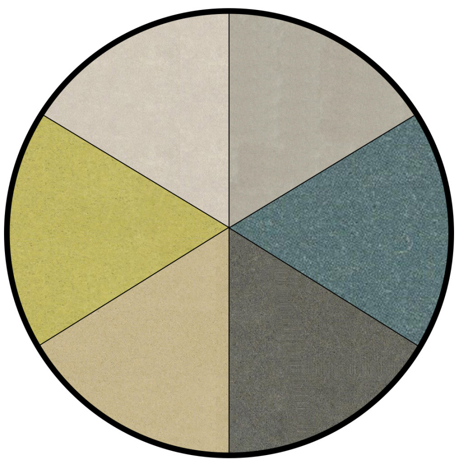
ShelteR[3]

respond recover resist

Jury Narrative

ARCHITECTURE





The primary colors create a sense of serenity and calmness

Inspiration and Design

The Joplin tornado of 2011, which killed 161 people and destroyed $2.8 billion worth of property, inspired us to build ShelteR3 (“Shelter Cubed”), the state-of-the-art, solar-powered, disaster-resilient home. The R3 – Respond, Recover, Resist – stands for our unique design philosophy. In the event of a disaster, ShelteR3 can be quickly shipped to the target site, conveniently reconfigured, and promptly put to use according to the scenario’s demands.

In the event of a tornadic disaster, ShelteR3 can accelerate the region’s recovery in an affordable manner. As the diagram demonstrates, the house can be quickly transported to the affected site in two modules (fig. 1). Fully equipped with amenities like kitchen, bath, living spaces, and independent power facilities for heating and lighting, it can be conveniently assembled to function either as a disaster response command center or disaster relief housing (fig. 2). Once the surrounding conditions stabilize, the two modules of the house can be expanded to form a spacious, sustainable, permanent residence that is prepared to resist future disasters (fig. 3).

When a storm strikes, the residents can conveniently switch to a disaster-resistance mode in which the doors close and seal the house, thus keeping the interior safe from damage the flying debris would otherwise cause. In this way, the entire house becomes a storm shelter. In addition to keeping life and property within its premises safe, ShelteR3 also helps the surrounding region minimize damages. The components of ShelteR3 do not become part of the flying debris, thereby reducing debris mass and the consequent damages to surrounding structures. This also reduces future costs of rebuilding the affected site and the volume of debris sent to landfills.

Formal simplicity is both a practical and an aesthetic response to disaster resilience. In high winds, simple objects perform best at staying put in one piece. Soffits, angled roofs, and any complexity in the envelope create opportunities for winds to “grab on to” and exert stress. Articulated as they are, the clean, precise lines seen in the building cladding and on the fence reinforce this notion of simplicity while helping to make the house’s scale more intimate.

A central living space opens up to the street and yard with a gracious deck that extends the living area, blurring the distinction between inside and out, making a small house feel much larger. On the street side, the deck turns up to form a bench, marking the boundary between public and private. In the back of the house, the deck ends in a cabinet containing electrical equipment, creating a privacy fence, creating privacy with backyard neighbors. A series of wind and debris shields fortified with 1/2” Lexan fold to the center when not in use. In juxtaposition with the center, side units containing bedrooms, kitchen, and bath have low ceilings and minimal openings, lending a sense of strength, security, and privacy for the family.

The transformable Resource Furniture blends with the interiors and maintains openness while enabling the house to easily accommodate 10 to 12 people. Large sliding doors and screens optimize light and ventilation. The rooftop solar power system and energy-efficient appliances ensure the availability of an independent energy source and maintain perfect energy balance in the house at all times. The LED lights used in the house add to the beauty while being attentive to sustainable energy consumption. The interiors create a calming and invigorating effect for the residents.

Rather than conventional walls and doors, built-in cabinetry is used to separate spaces while organizing the entertainment center, housing HVAC equipment, and providing storage. Detailing these cabinets to float just below the bottom of doorways and separating them from the floor with a reveal help make the inside feel larger by eliminating distinct boundaries found in typical house planning. Deeper than normal kitchen cabinets maximize storage and create a shelf above the counter for small appliances, keeping the counter clear for food preparation and cooking. Wall-to-wall storage units with beds that fold away during the day provide efficient, flexible storage options essential to a small house.

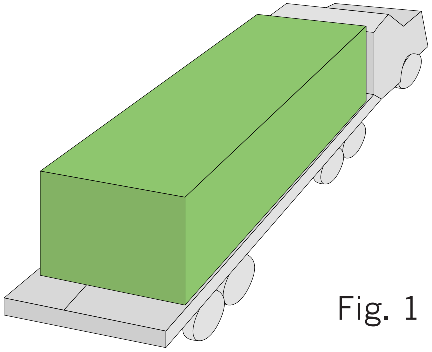


Fig. 1

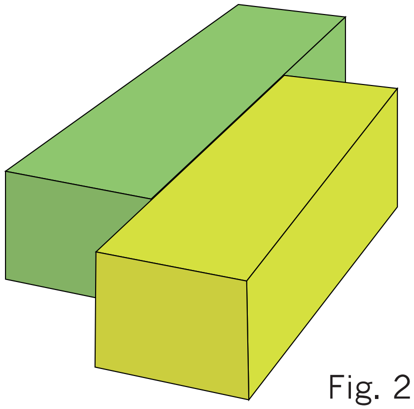


Fig. 2

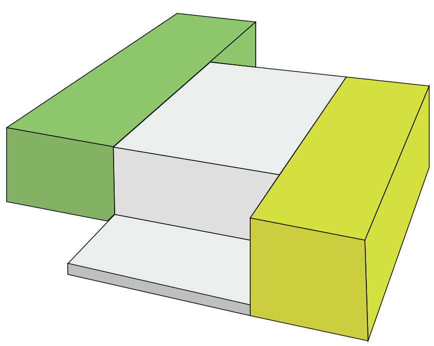
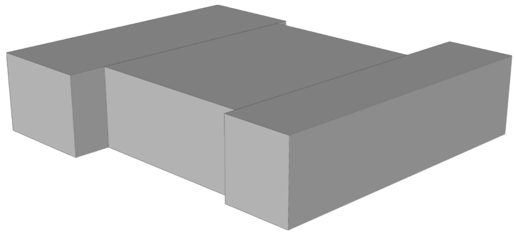


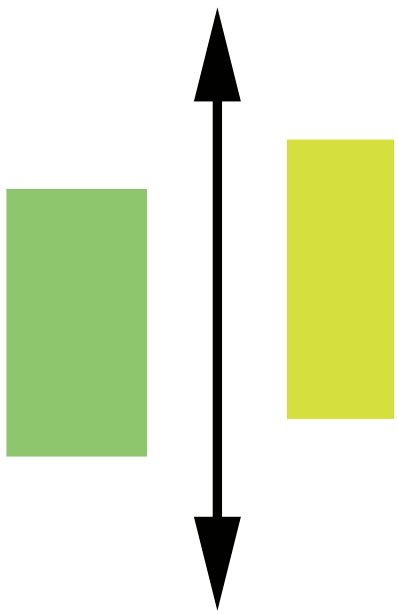
Fig. 3



Formal Simplicity

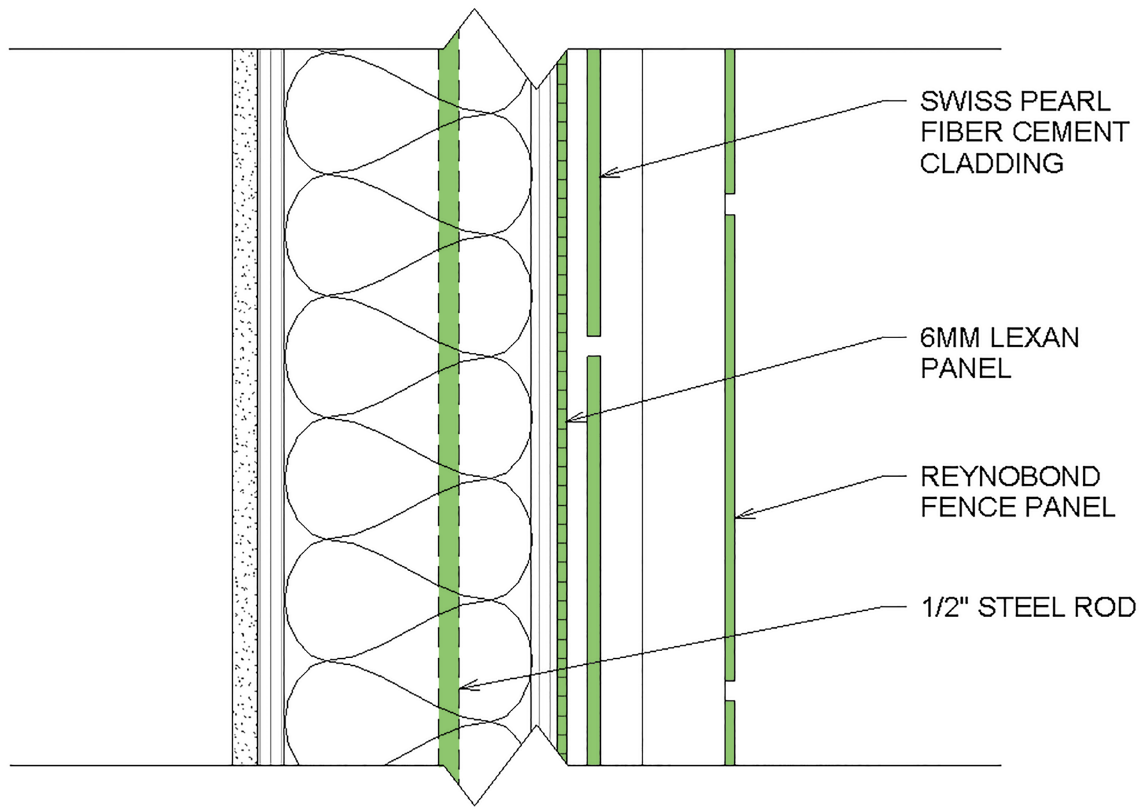
Major Features

The multi layered, super-resistant shear wall assembly of ShelteR3 is one of the biggest technological innovations of the house. The innermost Zipwall layer is strengthened by a Lexan Polycarbonate Layer, which is enveloped by Swisspearl fiber cement cladding. This is further surrounded by Reynobond with Ecoclean composite aluminum fence, which provides another layer of protection. Additionally, the house has an ultra-strong core. ShelteR3 uses 2x6 wood studs spaced at 12" on center instead of standard 2x4 wood studs spaced at 16" on center, making the house's skeletal frame much stronger than that of traditional houses made from similar materials. A steel chassis and vertical rods 4' on center aid in wind load resistance. Each individual part contributes to the greater whole.



Middle House Section Extenstion

Layers of Protection



WALLS: The 5/8” Zipwall wall and floor sheathing creates a weather-tight water barrier. Every 4 feet, 1/2” steel rods connect the steel floor chassis to the walls and the roof. In addition, the house uses a 1/4” Lexan polycarbonate layer and Swisspearl fiber cement cladding on its walls, which make it resistant to large projectiles.

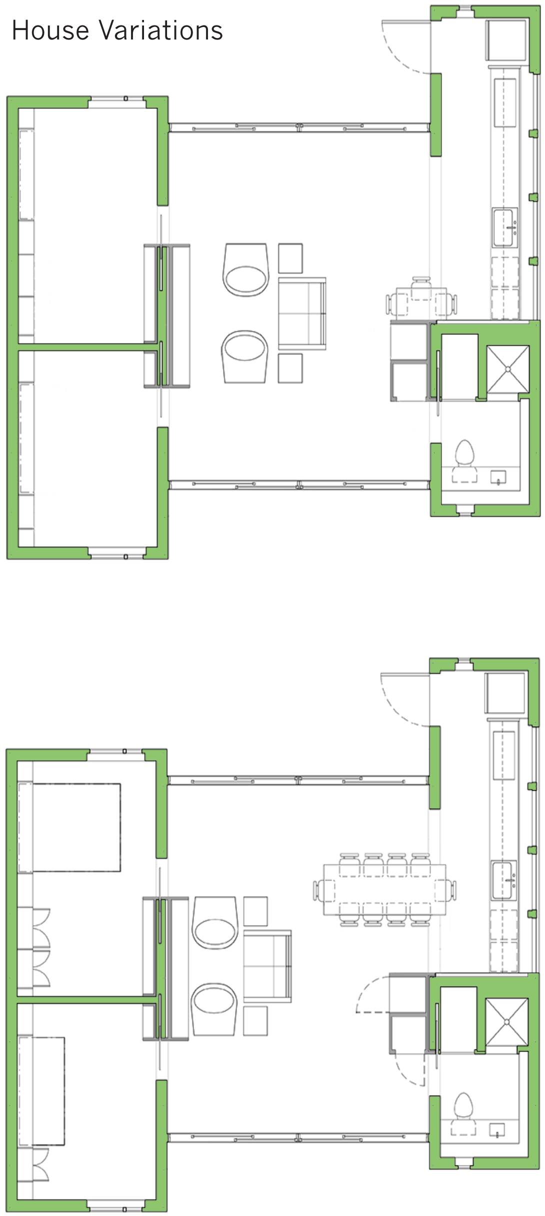
FENCE: The multi-layered walls of ShelteR3 are surrounded by impact resistant, Reynobond with Ecoclean composite aluminum fence. The material is not only extremely strong but also very easy to maintain. The fence contains self-cleaning material that eliminates the need for homeowners to spend time and effort on cleaning.

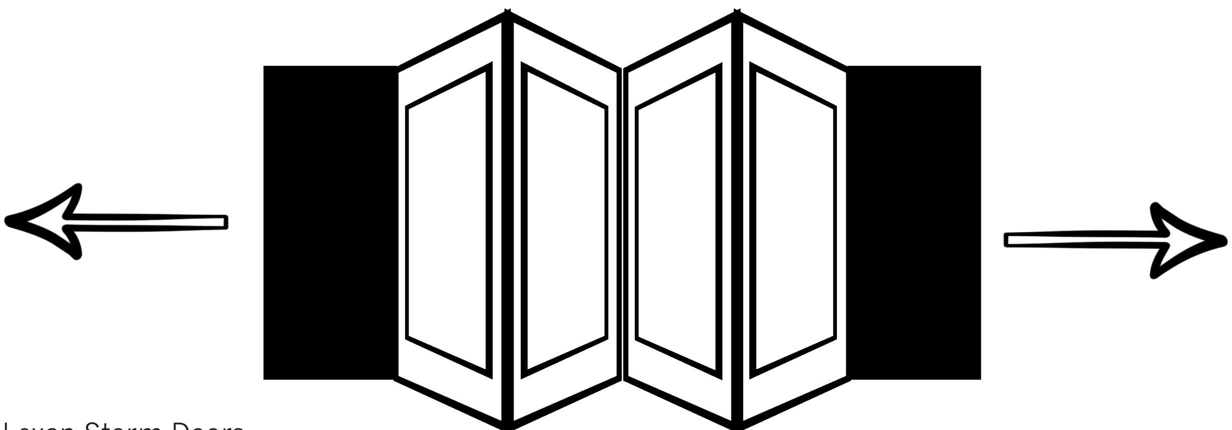
FLOOR: The Zipwall floor and wall sheathing is glued and screwed to wood studs at every 3”. Double rim wood joist floor framing in the modules is bolted to a steel channel chassis every 1 foot on center to create a very strong and rigid floor.

ROOF: The roof is enclosed by parapets on all sides. These parapets prevent winds from rushing underneath the rooftop solar panels and lifting them off, and protects them from straight line winds and flying storm debris. Structures such as eaves, which often help winds pull off roofs, are also absent. As a result, the roof of ShelteR3 stays intact during high-speed wind conditions, unlike traditional roofs which are often torn off by updraft.

Lexan Storm Doors: Strong protective doors open and close to provide protection during storms and light and air control during nice weather. The translucent Lexan core of the doors allows sight lines through the protective barrier keeping the interior living space light and open even during the worst of storms.

House Variations





Lexan Storm Doors

MARKET APPEAL

ShelteR^3 (Respond, Recover, Resist) is designed for folks living in the tornado alley of the Midwest or any area where significant storms threaten lives and structures. ShelteR^3 is a solar powered, disaster resilient home able to withstand the high winds and debris impact of tornadic storms.

This home takes sustainability to a new level. Rather than adding a storm shelter to a backyard, basement, garage, or closet, ShelteR^3 takes a holistic approach to safety by making the entire home disaster resistant. With this approach, no materials from our home will become a missile than can threaten neighbors' property and no home building materials will be added to the typical debris field created in a storm's wake. After the 2011 tornado in Joplin, Missouri, 3 million cubic yards of debris were sent to landfills. Our approach to whole-house storm resistance will appeal to homeowners by providing a sense of security while inspiring architects and home builders to create more sustainable housing that helps preserve the planet.

The premise of ShelteR^3 - Respond, Recover, and Resist- is simple: Our structure can be mobilized by FEMA in order to Respond to a community in the event of natural disaster. When the structure is no longer needed for response operations, it can become permanent housing for a community as it Recovers from a storm's devastation. Finally, as a home, it serves as a dependable structure that can Resist future storms, keeping families safe.
The versatility of the ShelteR^3 design makes it a desirable structure for three key markets: 1) government and disaster relief response agencies, 2) young families and 3) mature

couples. ShelteR^3 is transportable and transformable, making it is perfect as a disaster response command center or disaster relief housing. The house can be quickly transported to an affected site in two modules and is fully equipped with amenities like kitchen, bath, bed, and living spaces, making it marketable to agencies such as FEMA for relief housing. The same modules outfitted with kitchen, bath, bed and office space can be marketed to AmeriCorps and the American Red Cross as a disaster response command center. Independent power provided by solar panels on the roof make these versions of ShelteR^3 perfect for relief organizations and displaced families in disaster-hit areas where power could take weeks to restore. Once the community begins to recover, the two modules of the house can be expanded to form a spacious, sustainable, permanent residence that is prepared to resist future disasters. ShelteR^3 is an elegant and potentially permanent alternative to traditional relief housing.

The potential for our structure to serve as home makes it particularly attractive to a young family, consisting of two parents and a small child, living in tornado- prone areas such as Missouri, Oklahoma, Arkansas, Texas, and Georgia. Our design was inspired by the destruction left behind by the EF5 in Joplin on May 22, 2011. Mature couples seeking to downsize after raising their families will appreciate the ease of maintenance that comes with a smaller space. They will also be attracted to the security and low utility and insurance expenses associated with a disaster resistant, solar powered home.

Built before a storm strikes, the full version of the home offers a beautiful and functional living environment that responds to the needs of a family that wants to be prepared for disaster. The bright, open interior, cool and calming color pallet, and the simple yet delightful architectural detailing provide a sense of wonder and renewal to the residents of the home. The large center living space extends onto two large decks, providing ample space to enjoy the company of family and friends. Residents will appreciate the calm provided by protected private living spaces and storm resistant features.

The construction of the home is of typical, off-the-shelf materials common to builders across the country, such as 2x6 wood framing studs, steel rods and readily available cladding. This makes the home easy to replicate by local labor forces across the country. The added feature of disaster resilience would appeal to potential clients of home builders and architects. The design of the home is intended to be instructive, providing builders and homeowners alike an example of how to build to resist future disasters.
As storms become stronger and more frequent each year, there is an increasing market for disaster resilient homes. The good news – ShelteR^3 has already proven its marketability. Our team's structure has been purchased by woman in Joplin, the city that serves as our

1,200
Tornados per year

60
Deaths per year

$

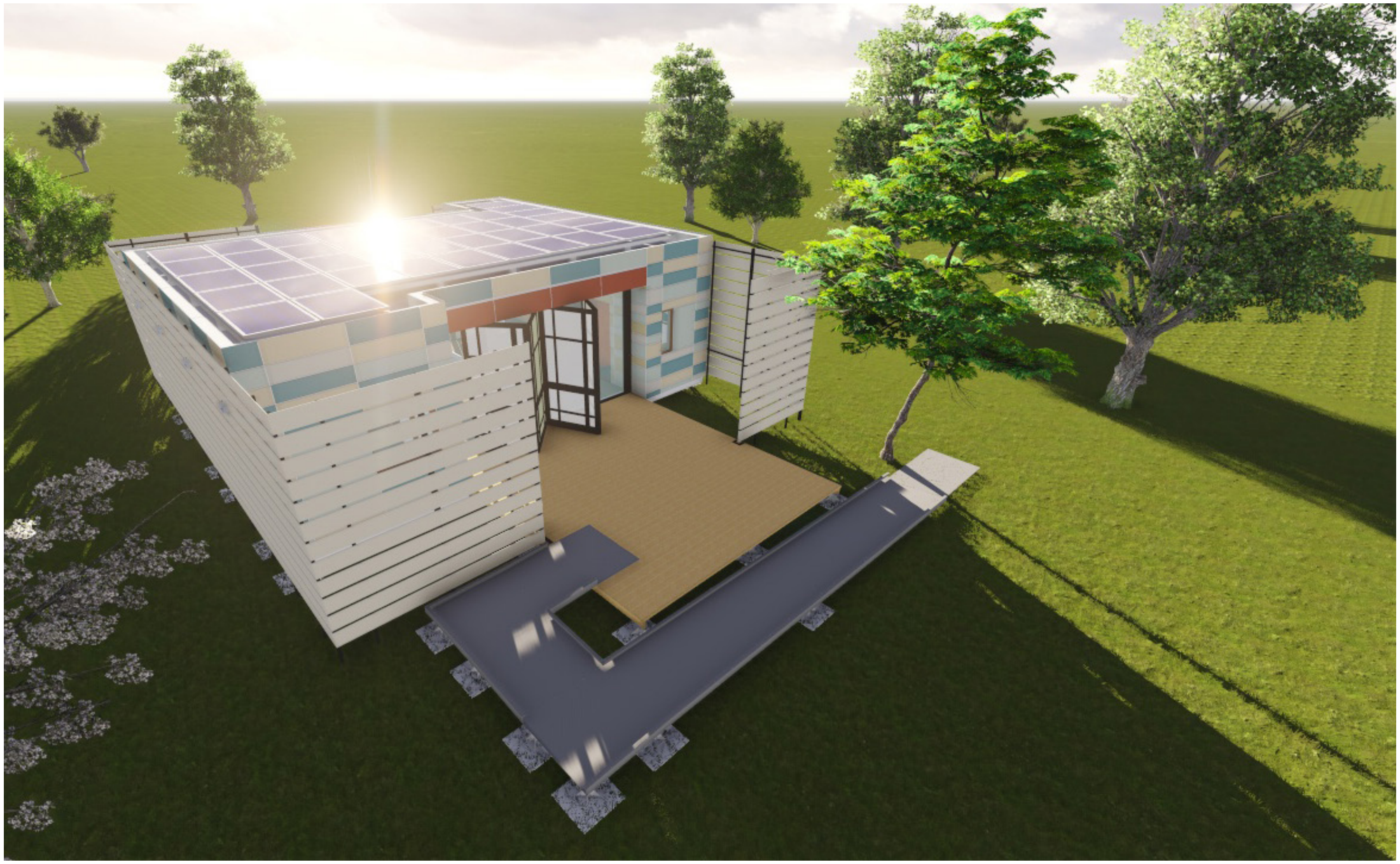
$400 mil
In damages per year

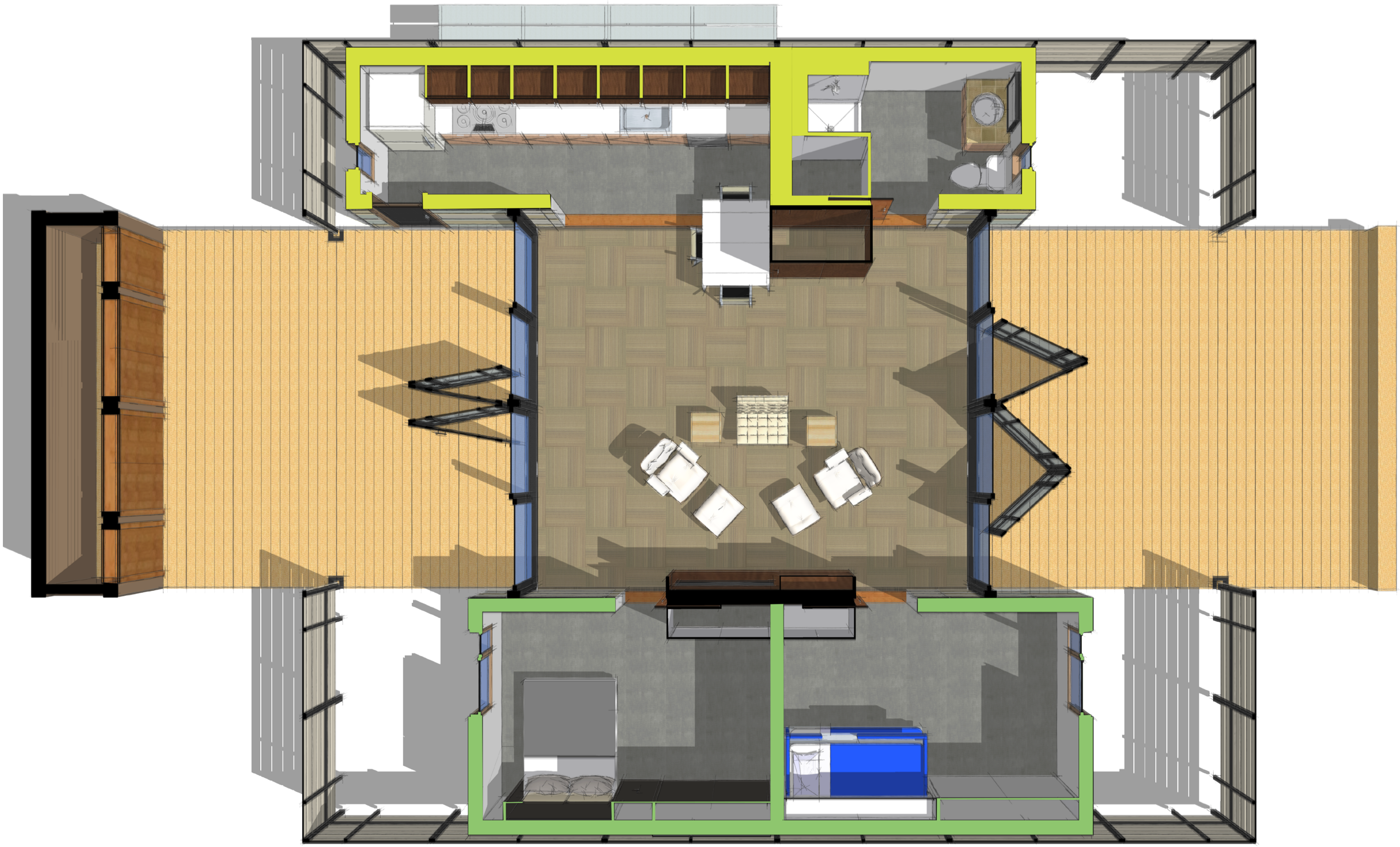
inspiration. We are confident community leaders and homeowners throughout the Midwest will embrace the ShelteR³ design and its promise to Respond, Recover, and Resist.

Quinoa
Very high in fiber and protein

Caulifower
Very high in vitamins and potassium

Soap Plant
Used to create shampoo and body soap





ENGINEERING

In the aftermath of a devastating storm, persons who have been affected by the disaster are more often than not, left without shelter. This has been a problem for mankind since the dawn of civilization; until now. The Crowder Drury Solar Decathlon team has developed and engineered a solution to this dilemma. Now, mankind will never have to be without Shelter again. Our team has devised a three tiered system simply named Shelter3. Shelter3 is a mobile living structure that will provide comfort and safety to those left without a home or place to live in the wake of a tornado. The three tiers of the concept are: Respond, Recover, and Resist. Our team wants to help communities Respond to the natural disaster, help the community Recover, and Resist any future storms from leaving individuals and families without shelter again.

Our first tier goal is to provide immediate response to a natural disaster. To be as rapid as possible, our structure is a modular design in nature consisting of two units that are easily transported to disaster areas. In order to make our response effective we engineered the shelter to be as self-sustaining as possible.

Our simple, yet unique design of our home consists of two modules. A “dry” module that is primarily bedroom and office space with coaxial and network access, and a “wet” module that is the kitchen and bathroom areas of the house. Together, they create a comfortable living space for families who have lost their homes or an efficient disaster response command center for agencies like FEMA, AmeriCorps or the American Red Cross. These modules are designed to fit on flat bed trailers and are thus, transportable which allows for a rapid response. They set up quickly from the flat bed trailers using either a crane or a patented Binkley system that consists of hydraulic jacks, rollers, and crossbeams to move the modules. The design also ensures for a long life and reuse of the modules. Each module has a steel chassis and roof that has been painted to handle long life outdoors. The exterior plywood is a professional grade ZIP system and the subfloor is all Advantech that is 2 layers thick. The plumbing for the domestic water is all PEX tubing to prevent leaks and cracks in the changing weather and environments. “Resilient” flooring and carpet tiles are engineered for a long life application and fit perfectly into our design.

Proper response in emergency situations means being prepared for areas that may not have electrical power. Our shelter is prepared for that very situation. Once it has been set in place, Shelter3 can be self-sustainable. We will have a Solar PV system to provide power to the house. Our design includes a 14kW system with panels that are rated to output at 80% at 25 years, and our inverters have a 10 year manufacturer warranty. All equipment for the PV system is outdoor rated and includes a battery backup option using Sunny Island inverters if necessary. SunPower solar panels with Sunny Boy inverters. 97% efficient inverters. The panels are 21.5% efficient. The estimated daily output for the Joplin, MO area on an annual basis is 48kWh. To help ensure that enough power will be produced to run the home, we have included all energy efficient devices and appliances, all LED lighting, top of the line Daikin Mini Split HVAC systems with NEST thermostats, and an instant hot water heater. The appliances are all ENERGY STAR rated. Both modules have a single mini split to provide more control over the HVAC of the home. The NEST thermostats improve the HVAC systems as well, which will also help save energy. Using an instant hot water heater rather than a traditional water heater not only saves space, but cuts standby losses and allows for easier plumbing systems of the home.

The unique design of the plumbing system takes into account the domestic supply and waste lines needed for proper operation of a shelter. As mentioned before, the plumbing is all in a single “wet” module. For the DWV (Drain, Waste, Ventilation) lines, a basic approach was taken. We installed PVC pipe with all the proper vents and drains in a manner that would allow it all to drain to a central tank or area outside of the home. For the incoming water, we wanted to make hookup as easy and simple as possible. In response and recovery mode, the water can be provided from a tank with an “on-demand” style pump. One end of the garden hose is connected to the external hose bib of the house and the other is connected to the pump and water storage container. That is the simple way of providing water for the residents. When the structure has moved from recovery mode into resist mode and permanent placement is occurring, the plumbers can attach the incoming water line at the PVC coupling under the house. An access panel is provided and a ball valve that is accessible underneath a kitchen cabinet can be opened and the house will have a domestic water connection once again.

Proper response to any natural disaster is unique for every situation. Our Response tier of the Shelter3 home is only the beginning to recovery. It takes time, action, and execution to Recover from the tragic event and that is our second tier. To help the community recover, our shelter can be used as a command center or emergency housing. It can also be set up for a long term and permanent home as well. Whatever the use is, it is a comfortable living environment that can help individuals feel safe and secure when they need it most.
When both modules have been set in place, it provides immediate protection from the weather and the essential rooms needed for necessary day to day activities. A kitchen, a bathroom, and two bedrooms allow for a team of professionals and volunteers to help a community recover. By using a separate exterior cabinet to house the inverters and other essential solar PV equipment, the structure has the ability to provide a community with a micro grid for when power lines and transformers are out of service. By keeping the exterior cabinet separate from the structure, individual cabinets can be brought in to provide more energy storage and a larger grid.

Typical House uses

10,908 kWh

per year

Our House uses

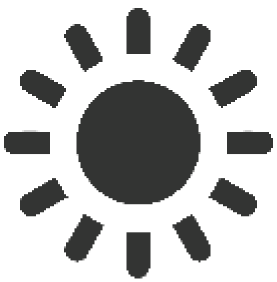
7,401 kWh

per year

While using Shelter3 as a command center or as emergency housing we wanted to make sure the residents were comfortable. To achieve that we included dimmable LED lighting, NEST thermostats for easy control of the HVAC, instant water heater as a space saving feature, a fan in the living area for proper air circulation, and a systematic approach to the home electrical circuits.

As both teams are close to the Joplin, MO area, we understand that natural disasters occur in the same areas more often than not. This is why we developed our third and final tier: Resist. Our team wanted to create a structure that could resist future disasters. Specifically high wind storms and tornadoes. Our design incorporates a 7” C-Channel chassis with ½” steel rods running from roof to floor to resist wind loads, and keep the roof from separating from the walls. A layer of polycarbonate skin and hurricane rated windows protect the inhabitants from debris projectiles during a storm. The polycarbonate skin is a layer of 6mm thick Lexan. Most notably used in bulletproof glass. This keeps residents safe from flying debris from entering the home. It also adds a slight R-value to the home. The polycarbonate is used as shutters for the sliding doors of the expanded living space area as well. As an extra layer of protection an impact resistant, self-cleaning aluminum fence envelops the house. The fence paneling is made of a material called Reynobond, which meets hurricane testing standards for the state of Florida. It provides the first layer of protection for the home. Engineering the house this way should allow it to stand up to 250 mph winds and the projectiles of storms similar to the EF5 2011 Joplin, Missouri tornado.

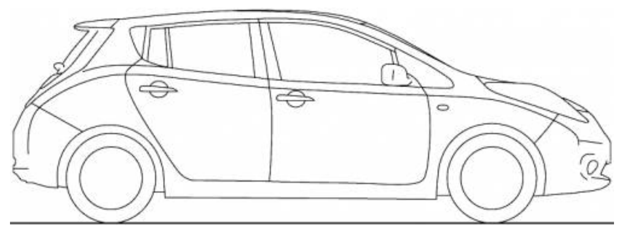
Our three tier design for ShelteR³ is what we believe to be a leap forward in the advancement of rapid response shelters, a more sustainable approach to the way a community recovers after a natural disaster and the new standard for storm resistant housing. By sticking with our 3 tiers from the beginning the Crowder/Drury Solar Decathlon team has designed and engineered the future of mobile, energy efficient, defensive home living.



Our Solar

PV system

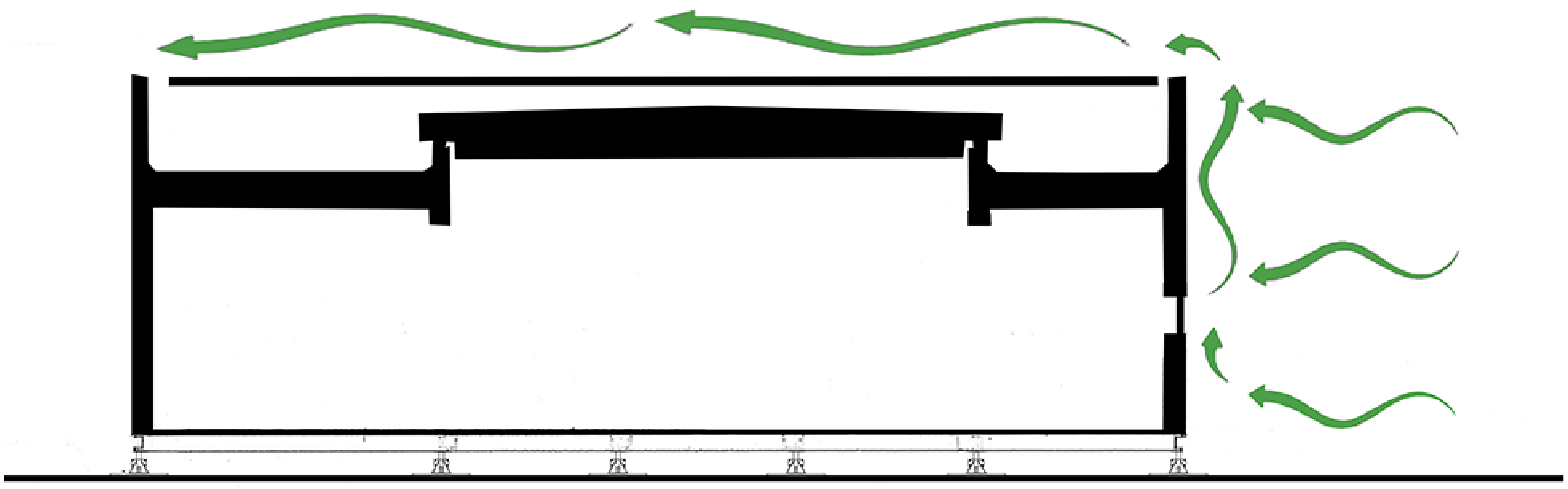
14 kW



Nissan Leaf

.3 kWh

per mile



Climate Analysis

The climate in southern California is vastly different from the Midwest due to lower humidity and fewer heating degree days. Although California is much warmer all year round and a home will not require as much heating, a home in Joplin, Missouri will require far more heat. The climate analysis our team has put together consists of TMY3 data retrieved from NREL, and Excel reports from a Weather Underground affiliate. This information, along with the estimated R-value of our home, and data from our HVAC mini split units has allowed us to understand how our home will need to be heated and cooled in Irvine, California, and Joplin, Missouri.

Heating Degree Days are indicators of household energy consumption for space heating. It was found that for an average outdoor temperature of 65 degrees Fahrenheit, most buildings require heat to maintain a 70 degree temperature inside. Cooling Degree Days are the opposite and are a measure of how much it takes to cool to maintain a 70 degree temperature inside the home.

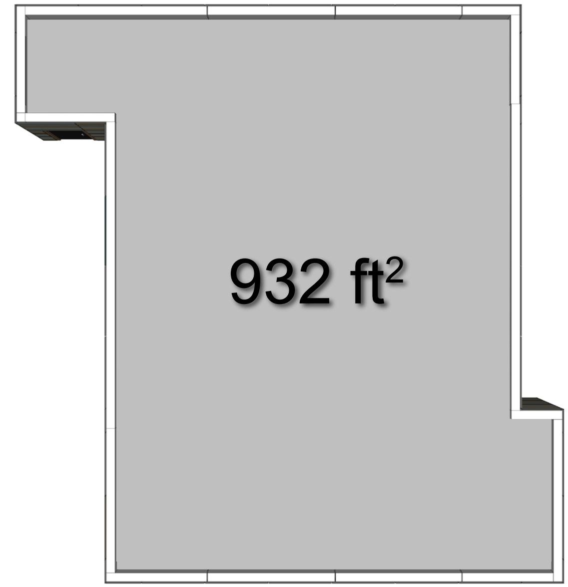
In the Appendix labeled “TMY3 Data”, we have provided typical meteorological year data for Long Beach, California and Springfield, Missouri. These are the closest cities to Irvine and Joplin with TMY3 data. From the reports we can see that Long Beach has a yearly average total of 794 HDD and 667 CDD, while Springfield has 2577 HDD and 733 CDD.
Using BizEE, an affiliate of Weather Underground, our team has generated more accurate reports. These reports give Irvine, California 730 HDD and 1753 CDD, while Joplin, Missouri has 4468 HDD and 1774 CDD. A month by month breakdown of these reports can be found in appendix “BizEE Reports”

A home will need to have proper insulation and a higher R-value than conventional homes. Even though our house is transportable and comes in multiple pieces for assembly, we are still able to maintain a higher than normal R-value. Our module walls have an R-value of 24.7, and the walls of the central living area are 21.7. More emphasis went into the design of our roofs and because of that we were able to achieve a staggering 69.8 R-Value for the module roofs and 47 for the roof of the central living area. With these better than average values we are able to keep the heat in our shelter.

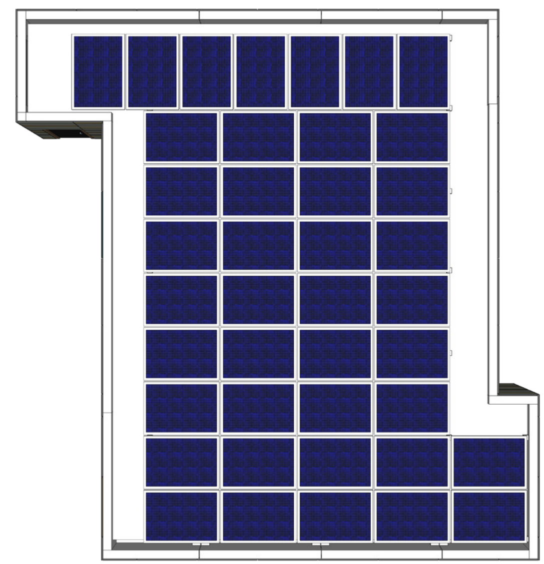
Having the Daiken HVAC mini-split system for our home we are using the top of the line heating and cooling technology available. Because we have two separate units we will have a more precise control of the areas of the home. These units, along with the high R-value of the home will allow our home to use less the normal power for heating and cooling

System Sizing Analysis

The system is designed to provide supplemental power when utility power in not accessible due to a major event. Therefore, we decided to maximize the amount of roof space available and place Photovoltaic or PV panels on the roof. With a roof area of 939 square feet, we will be able to fit 42 Sunpower 335W solar PV panels on the roof. Each PV panel is roughly 17.55 square feet, and in total will only take up a total 736 square feet and still leave us with an impressive 14.07kW solar energy system. The placement of the panels also allows for the system to mount independently of the center living section of the home. In the event of a natural disaster, we will have module independence where the modules will have its own set of solar panels. The unexpanded setup of Shelter3 has a total of 18 PV panels and a system size of 6.21kW. Images of the Shelter3 roof, with and without panels, can be found in figure "Solar Roof Plan".



Contest 7.5 Dishwasher			
Day	Time	Loads	kWh
12	8:00AM - 10:30AM	1	1.245
14	8:00AM - 10:30AM	1	1.245
16	2:00PM - 4:30PM	1	1.245
18	8:00AM - 10:30AM	1	1.245
19	8:00AM - 10:30AM	1	1.245
	TOTAL	**5**	**6.226**
Energy Guide	259kWh/year		
Wash Loads/year	208 Energy Star rated 4 loads per week		
kWh per load	1.245		



Wind Section

Energy Balance Analysis

We will achieve a net positive home using technologies in three ways. The first step in becoming net positive is to have personal power generation. In our case we are using solar power. The next step in self-sufficiency is using energy efficient appliances and devices. The third and biggest step is creating a home of high insulating value. The goal of Shelter3 is to not only be net positive but also use the bare minimum of power need for the Solar Decathlon competition. The total usage for Shelter3 in Irvine is an estimated 142.31 kWh.

Our home will have all energy star rated appliances and devices for the competition. The total estimated usage for the appliances contest for is 24.2 kWh. A breakdown of the appliances estimated usage can be found in appendix “Energy Usage by Appliance”.

The power needed for lighting, hot water, and electronics of our home has also been taken into account. The home has the most up to date electronics and lighting. Every light in the home is LED. The television and laptop computer are both energy star rated. To maximize the efficiency of hot water heating the home has an instantaneous hot water heater. The total estimated usage for the Home Life contest is 37.9 kWh. The estimated usage for all of these devices can be found in the appendix “Energy Usage for Home Life”.

With the 2015 Solar Decathlon requiring the use of an electric vehicle, our production of power must also be enough to accommodate the charging of an electric vehicle. Driving the total 175 miles will require a total of 52.5 kWh to charge the car back to a full battery. Information about the efficiency, charging rate, and kWh usage can be found under figure “Electric Car”

The Decathlon home will have a different power draw in Joplin than in the competition due to the number of occupants and the type of lifestyle they may live. Therefore, if we take the estimated usage from the competition week and multiply that for each week of the year we get an estimated yearly usage of 7,401 kWh. In 2013, the average annual electricity consumption for a U.S. residential utility customer was 10,908 kWh, an average of 909 kWh per month.

Using TYM3 data we can estimate the output of our Solar PV system for the competition in Irvine and the yearly output in Joplin. During the competition week we estimate our solar energy output to be 1,413 kWh. After the 2015 Solar Decathlon, the homes final resting place is Joplin, Missouri, which will have an estimated yearly output of 17,790 kWh. These estimates come directly from the NREL PVWatts website.

Knowing that we only have estimates, our team is confident that in the real world, our home will produce more than enough power needed and at the same time, our home is efficient enough to keep our usage under the set 175kWh for the competition.

Appendix -

Contest 8.3 Home Electronics					
Day	Time	Hrs	kWh	TV	kWh
12	7:30AM - 10:30AM	3	0.2322	Vizio E40-C2	27.4
13	7:30AM - 10:30AM	3	0.2322	Laptop	kWh
14	7:30AM - 10:30AM	3	0.2322	HP 13.1"	50
15	1:30PM - 6:30PM	5	0.387		
16	1:00PM - 7:00PM	6	0.4644		
17	11:00AM - 7:00PM	8	0.6192		
18	7:30AM - 10:30AM	3	0.2322		
19	7:30AM - 10:30AM	3	0.2322		
	TOTAL	34	2.6316		

Description:	Fahrenheit-based heating degree days for a base temperature of 65F	
Source:	www.degreedays.net (using temperature data from www.wunderground.com)	
Accuracy:	The "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)	
Station:	SANTA ANA WAYNE ORANGE CTY, CA, US (117.87W,33.68N)	
Station ID:	KSNA	
Month starting	Heating Degree Days	% Estimated
8/1/2014	0	0.5
9/1/2014	0	0.5
10/1/2014	4	0.06
11/1/2014	59	0
12/1/2014	142	0
1/1/2015	157	0
2/1/2015	82	0
3/1/2015	75	0.03
4/1/2015	97	0
5/1/2015	98	0
6/1/2015	15	0.2
7/1/2015	1	0.3
Total	730	

Description:	Fahrenheit-based cooling degree days for a base temperature of 65F	
Source:	www.degreedays.net (using temperature data from www.wunderground.com)	
Accuracy:	The "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)	
Station:	SANTA ANA WAYNE ORANGE CTY, CA, US (117.87W,33.68N)	
Station ID:	KSNA	
Month starting	CDD	% Estimated
8/1/2014	316	0.5
9/1/2014	370	0.5
10/1/2014	250	0.06
11/1/2014	123	0
12/1/2014	33	0
1/1/2015	63	0
2/1/2015	69	0
3/1/2015	122	0.03
4/1/2015	72	0
5/1/2015	26	0
6/1/2015	113	0.2
7/1/2015	196	0.3
Total	1753	

Contest 7.1/7.2 Fridge & Freezer			
	296 kWh/year	Energy Guide	
	kwh/day	0.810958904	
	kwh/hour	0.033789954	
Day	Time	Hrs	kWh
11	7:30PM -12:00AM	4.5	0.152054795
12	12:00AM - 10:30AM/ 11:00PM - 12:00AM	11.5	0.388584475
13	12:00AM - 10:30AM/ 7:30PM - 12:00AM	15	0.506849315
14	12:00AM - 10:30AM/ 7:30PM - 12:00AM	15	0.506849315
15	12:00AM - 12:00AM	24	0.810958904
16	12:00AM - 12:00AM	24	0.810958904
17	12:00AM - 12:00AM	24	0.810958904
18	12:00AM - 10:30AM/ 7:30PM - 12:00AM	15	0.506849315
19	12:00AM - 10:30AM	10.5	0.354794521
	TOTAL	143.5	4.85

Contest 8.1 Lighting			
Day	Time	Hrs	kWh
11	7:00PM - 11:00PM	4	0.6704
13	7:00PM - 11:00PM	4	0.6704
14	7:30PM - 10:30PM	3	0.5028
15	7:00PM - 11:00PM	4	0.6704
16	7:00PM - 11:00PM	4	0.6704
17	7:00PM - 11:00PM	4	0.6704
18	7:30PM - 10:30PM	3	0.5028
	TOTAL	26	4.36

Description:	Fahrenheit-based cooling degree days for a base temperature of 65F	
Source:	www.degreedays.net (using temperature data from www.wunderground.com)	
Accuracy:	The "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)	
Station:	JOPLIN REGIONAL AIRPORT, MO, US (94.50W,37.15N)	
Station ID:	KJLN	
Month starting	**Cooling Degree Days**	**% Estimated**
8/1/2014	461	0.2
9/1/2014	204	0.1
10/1/2014	71	0.06
11/1/2014	4	0
12/1/2014	0	0
1/1/2015	2	0.06
2/1/2015	2	0
3/1/2015	16	0
4/1/2015	52	0.07
5/1/2015	115	0.06
6/1/2015	368	0.1
7/1/2015	479	0.03
Total	**1774**	

Contest 9 Commuting			
Car		**kWh/Mile**	
2014 Nissan Leaf		0.3	
Day	**Time**	**Miles**	**kWh/Day**
12	8:00AM - 10:00AM	25	7.5
13	8:00AM - 10:00AM	25	7.5
14	8:30AM - 10:30AM	25	7.5
15	3:00PM - 5:00PM	25	7.5
16	1:30PM - 3:30PM	25	7.5
17	10:30AM - 12:30PM	25	7.5
18	8:00AM - 10:00AM	25	7.5
CONTEST TOTAL		**175**	**52.5**

Contest 8.2 Hot Water				
Day	**Time**	**Gallons**	**Energy in BTU**	**Energy in kWh**
12	8:30AM - 9:00AM	15	6598.5	1.933829457
13	8:30AM - 9:00AM/9:30AM - 10:00AM	30	13197	3.867658913
14	9:30AM - 10:00AM	15	6598.5	1.933829457
15	2:00PM - 2:30PM/3:30PM - 4:00PM/5:00PM - 5:30PM	45	19795.5	5.80148837
16	2:30PM - 3:00PM/3:30PM - 4:00PM/4:30PM - 5:00PM	45	19795.5	5.80148837
17	1:30PM - 2:00PM/2:30PM - 3:00PM/3:30PM - 4:00PM	45	19795.5	5.80148837
18	8:30AM - 9:00AM/9:30AM - 10:00AM	30	13197	3.867658913
19	9:30AM - 10:00AM	15	6598.5	1.933829457
	TOTAL	**240**	**105576**	**30.9412713**

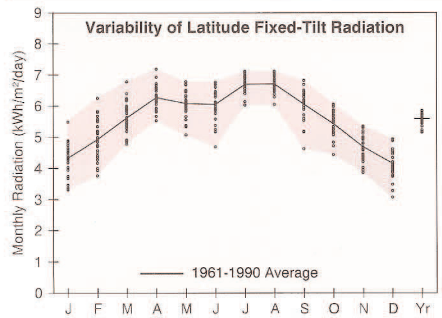
Description:	Fahrenheit-based heating degree days for a base temperature of 65F	
Source:	www.degreedays.net (using temperature data from www.wunderground.com)	
Accuracy:	The "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)	
Station:	JOPLIN REGIONAL AIRPORT, MO, US (94.50W,37.15N)	
Station ID:	KJLN	
Month starting	Heating Degree Days	% Estimated
8/1/2014	6	0.2
9/1/2014	58	0.1
10/1/2014	217	0.06
11/1/2014	691	0
12/1/2014	792	0
1/1/2015	921	0.06
2/1/2015	958	0
3/1/2015	519	0
4/1/2015	217	0.07
5/1/2015	83	0.06
6/1/2015	6	0.1
7/1/2015	0	0.03
Total	**4468**	

Contest 7.1/7.2 Fridge & Freezer			
	296 kWh/year	Energy Guide	
	kwh/day	0.810958904	
	kwh/hour	0.033789954	
Day	**Time**	**Hrs**	**kWh**
11	7:30PM -12:00AM	4.5	0.152054795
12	12:00AM - 10:30AM/ 11:00PM - 12:00AM	11.5	0.388584475
13	12:00AM - 10:30AM/ 7:30PM - 12:00AM	15	0.506849315
14	12:00AM - 10:30AM/ 7:30PM - 12:00AM	15	0.506849315
15	12:00AM - 12:00AM	24	0.810958904
16	12:00AM - 12:00AM	24	0.810958904
17	12:00AM - 12:00AM	24	0.810958904
18	12:00AM - 10:30AM/ 7:30PM - 12:00AM	15	0.506849315
19	12:00AM - 10:30AM	10.5	0.354794521
	TOTAL	**143.5**	**4.85**

Contest 7.5 Dishwasher			
Day	**Time**	**Loads**	**kWh**
12	8:00AM - 10:30AM	1	1.245
14	8:00AM - 10:30AM	1	1.245
16	2:00PM - 4:30PM	1	1.245
18	8:00AM - 10:30AM	1	1.245
19	8:00AM - 10:30AM	1	1.245
	TOTAL	**5**	**6.226**
Energy Guide	259kWh/year		
Wash Loads/year	208 Energy Star rated 4 loads per week		
kWh per load	1.245		

Contest 7.3/7.4 Washer & Dryer			
Day	**Time**	**Loads**	**kWh/Load**
12	7:30AM - 10:30AM	1	0.252403846
13	7:30AM - 10:30AM	1	0.252403846
14	7:30AM - 10:30AM	1	0.252403846
15	1:00PM - 7:00PM	2	0.252403846
17	10:30AM - 4:30PM	2	0.252403846
19	7:30AM - 10:30AM	1	0.252403846
	TOTAL	**8**	**1.51**
Power Usage	105 Kwh/year	Energy Guide	
Wash Loads/year	416	Energy Guide rated	
kWh per load	0.252403846	8 loads per week	

Contest 7.6 Cooking					
				100% Efficiency	**84% Efficiency**
Day	**Time**	**Lbs of Water**	**Energy in BTU**	**Energy in kWh**	**Energy in kWh**
13	8:00AM - 10:00AM	5	5732	1.679883374	1.948664714
14	8:00AM - 10:00AM	5	5732	1.679883374	1.948664714
16	5:00PM - 7:00PM	5	5732	1.679883374	1.948664714
17	11:30AM - 1:30PM & 4:30PM - 6:30PM	10	11317	3.316685301	3.847354949
19	8:30AM - 10:30AM	5	5732	1.679883374	1.948664714
	TOTAL	**30**	**34245**	**10.0362188**	**11.64**



Long Beach, CA

WBAN NO. 23129

LATITUDE: 33.82° N
LONGITUDE: 118.15° W
ELEVATION: 17 meters
MEAN PRESSURE: 1014 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.8	3.6	4.7	6.0	6.4	6.7	7.3	6.7	5.4	4.2	3.1	2.6	5.0
	Min/Max	2.3/3.3	2.9/4.3	4.1/5.6	5.3/6.8	5.4/7.2	5.2/7.5	6.5/7.7	6.1/7.1	4.3/5.9	3.6/4.6	2.8/3.5	2.1/2.9	4.6/5.2
Latitude -15	Average	3.8	4.5	5.4	6.4	6.4	6.5	7.2	6.9	6.0	5.0	4.1	3.6	5.5
	Min/Max	3.0/4.7	3.5/5.6	4.6/6.5	5.6/7.3	5.4/7.2	5.1/7.3	6.5/7.7	6.3/7.3	4.6/6.7	4.2/5.6	3.5/4.7	2.7/4.2	5.1/5.7
Latitude	Average	4.3	4.9	5.6	6.3	6.1	6.0	6.7	6.7	6.1	5.4	4.7	4.2	5.6
	Min/Max	3.3/5.5	3.8/6.3	4.8/6.8	5.5/7.2	5.1/6.8	4.7/6.8	6.0/7.1	6.1/7.1	4.6/6.8	4.4/6.1	3.9/5.3	3.1/4.9	5.2/5.9
Latitude +15	Average	4.6	5.1	5.5	5.8	5.4	5.2	5.8	6.1	5.8	5.5	5.0	4.5	5.4
	Min/Max	3.5/5.9	3.8/6.5	4.7/6.7	5.1/6.7	4.5/6.0	4.1/5.8	5.3/6.2	5.5/6.5	4.4/6.6	4.4/6.2	4.0/5.7	3.2/5.4	4.9/5.6
90	Average	4.1	4.1	3.8	3.2	2.5	2.2	2.4	3.0	3.7	4.2	4.3	4.1	3.4
	Min/Max	3.0/5.3	3.0/5.3	3.2/4.6	2.9/3.6	2.2/2.7	2.0/2.3	2.3/2.5	2.8/3.2	2.8/4.2	3.3/4.7	3.4/4.9	2.8/4.9	3.2/3.7

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	3.9	4.9	6.3	7.9	8.1	8.4	9.3	8.7	7.1	5.7	4.4	3.7	6.5
	Min/Max	3.0/5.0	3.8/6.3	5.3/7.9	6.7/9.4	6.5/9.4	6.1/9.8	8.0/10.2	7.8/9.3	5.2/8.0	4.6/6.4	3.6/5.0	2.7/4.4	6.0/6.9
Latitude -15	Average	4.7	5.6	6.8	8.2	8.1	8.3	9.3	8.9	7.6	6.3	5.1	4.4	6.9
	Min/Max	3.5/6.0	4.2/7.3	5.7/8.6	7.0/9.8	6.5/9.4	6.0/9.7	8.0/10.2	7.9/9.6	5.5/8.6	5.1/7.2	4.1/5.9	3.2/5.3	6.3/7.3
Latitude	Average	5.1	5.9	7.0	8.1	7.9	7.9	8.9	8.8	7.6	6.6	5.6	4.9	7.0
	Min/Max	3.7/6.6	4.4/7.8	5.8/8.8	6.9/9.8	6.3/9.1	5.7/9.3	7.7/9.8	7.8/9.4	5.5/8.7	5.3/7.6	4.4/6.5	3.4/5.9	6.4/7.4
Latitude +15	Average	5.3	6.0	6.9	7.8	7.4	7.4	8.3	8.3	7.5	6.7	5.8	5.1	6.9
	Min/Max	3.9/7.0	4.5/8.0	5.7/8.7	6.6/9.4	5.9/8.6	5.3/8.7	7.2/9.1	7.4/8.9	5.3/8.5	5.3/7.6	4.6/6.8	3.6/6.3	6.2/7.3

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	5.4	6.0	7.0	8.2	8.2	8.4	9.4	8.9	7.7	6.7	5.8	5.2	7.3
	Min/Max	3.9/7.1	4.5/8.0	5.8/8.8	7.0/9.8	6.6/9.5	6.1/9.9	8.1/10.3	8.0/9.6	5.5/8.7	5.3/7.6	4.6/6.8	3.6/6.4	6.6/7.7

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W	Average	3.2	3.3	3.5	4.1	4.0	4.2	5.2	4.8	4.0	3.7	3.5	3.2	3.9
Horiz Axis	Min/Max	2.0/4.6	2.1/4.9	2.6/5.1	3.2/5.5	2.7/5.1	2.0/5.4	4.1/5.9	3.9/5.5	2.2/4.8	2.6/4.5	2.5/4.3	1.8/4.2	3.3/4.3
1-Axis, N-S	Average	2.6	3.2	4.1	5.3	5.2	5.4	6.6	6.2	4.8	3.8	2.9	2.4	4.4
Horiz Axis	Min/Max	1.6/3.7	1.9/4.7	3.0/6.0	4.0/7.1	3.5/6.6	2.7/7.0	5.1/7.6	5.1/7.0	2.7/5.8	2.8/4.7	2.1/3.7	1.4/3.2	3.7/4.7
1-Axis, N-S	Average	3.5	4.0	4.6	5.4	5.0	5.0	6.2	6.2	5.3	4.6	3.9	3.4	4.8
Tilt=Latitude	Min/Max	2.2/5.1	2.4/5.9	3.4/6.7	4.1/7.4	3.3/6.3	2.5/6.6	4.8/7.2	5.1/7.0	2.9/6.3	3.3/5.6	2.8/4.9	2.0/4.5	4.1/5.2
2-Axis	Average	3.8	4.1	4.6	5.5	5.3	5.5	6.7	6.4	5.3	4.6	4.1	3.7	5.0
	Min/Max	2.3/5.4	2.5/6.1	3.4/6.7	4.2/7.5	3.5/6.7	2.7/7.1	5.2/7.7	5.2/7.2	2.9/6.3	3.3/5.7	2.9/5.2	2.1/4.8	4.2/5.4

Average Climatic Conditions

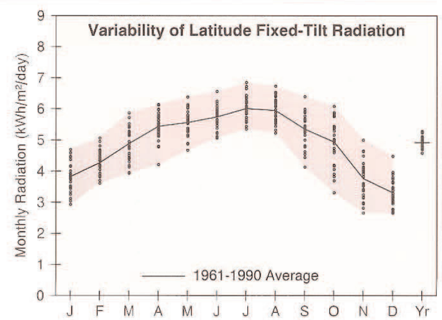
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	13.3	14.1	14.7	16.5	18.2	20.3	22.8	23.6	22.4	20.1	16.3	13.3	17.9
Daily Minimum Temp	7.2	8.3	9.4	11.0	13.5	15.4	17.4	18.2	17.1	14.3	10.2	7.2	12.4
Daily Maximum Temp	19.3	19.8	20.0	21.9	22.9	25.0	28.2	28.9	27.8	25.8	22.3	19.4	23.4
Record Minimum Temp	-3.9	0.6	0.6	3.3	4.4	8.3	10.6	11.1	10.0	3.9	1.1	-2.2	-3.9
Record Maximum Temp	32.8	32.8	36.7	40.6	39.4	42.8	41.7	40.6	43.3	43.9	38.3	33.3	43.9
HDD, Base 18.3°C	158	123	119	74	38	22	0	0	8	13	81	158	794
CDD, Base 18.3°C	0	3	7	19	35	80	142	164	132	67	19	0	667
Relative Humidity (%)	64	67	67	66	68	70	69	69	70	68	66	65	67
Wind Speed (m/s)	2.5	2.8	3.1	3.3	3.3	3.1	3.0	3.0	2.8	2.5	2.5	2.3	2.9

Springfield, MO

WBAN NO. 13995

LATITUDE: 37.23° N
LONGITUDE: 93.38° W
ELEVATION: 387 meters
MEAN PRESSURE: 972 millibars

STATION TYPE: Secondary



Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt ($kWh/m^2/day$), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.4	3.1	4.1	5.2	5.9	6.4	6.6	5.9	4.7	3.7	2.5	2.0	4.4
	Min/Max	2.0/2.7	2.8/3.4	3.4/4.7	4.2/5.8	5.0/6.7	5.7/7.4	5.9/7.5	5.3/6.6	3.8/5.4	2.7/4.3	2.0/3.0	1.8/2.4	4.2/4.6
Latitude -15	Average	3.4	3.9	4.7	5.6	5.9	6.2	6.5	6.2	5.3	4.6	3.4	2.9	4.9
	Min/Max	2.6/4.1	3.4/4.6	3.9/5.6	4.3/6.2	5.0/6.8	5.5/7.2	5.8/7.4	5.4/7.0	4.1/6.3	3.2/5.6	2.5/4.4	2.4/3.8	4.6/5.2
Latitude	Average	3.8	4.3	4.9	5.4	5.6	5.7	6.0	5.9	5.4	4.9	3.8	3.3	4.9
	Min/Max	2.9/4.7	3.6/5.1	3.9/5.9	4.2/6.1	4.7/6.4	5.1/6.6	5.3/6.8	5.2/6.7	4.1/6.4	3.3/6.1	2.7/5.0	2.7/4.5	4.6/5.3
Latitude +15	Average	4.1	4.4	4.8	5.0	4.9	5.0	5.2	5.4	5.1	5.0	3.9	3.5	4.7
	Min/Max	3.1/5.1	3.7/5.3	3.8/5.8	3.9/5.7	4.2/5.7	4.4/5.6	4.7/5.9	4.7/6.1	3.9/6.2	3.3/6.2	2.7/5.3	2.8/4.9	4.3/5.1
90	Average	3.7	3.7	3.5	3.0	2.5	2.3	2.5	3.0	3.4	3.9	3.4	3.3	3.2
	Min/Max	2.7/4.6	3.0/4.5	2.7/4.2	2.4/3.4	2.2/2.8	2.1/2.5	2.3/2.7	2.6/3.3	2.6/4.1	2.5/4.9	2.2/4.8	2.5/4.6	2.8/3.5

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis ($kWh/m^2/day$), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	3.4	4.2	5.4	6.8	7.6	8.3	8.7	7.9	6.3	5.1	3.5	2.8	5.9
	Min/Max	2.5/4.1	3.5/4.9	4.2/6.6	4.9/8.0	6.1/9.0	6.9/9.9	7.6/10.3	6.7/9.4	4.8/7.8	3.4/6.5	2.5/4.6	2.3/3.8	5.5/6.3
Latitude -15	Average	4.1	4.9	6.0	7.1	7.7	8.2	8.7	8.2	6.8	5.9	4.1	3.5	6.3
	Min/Max	3.0/5.1	4.0/5.8	4.5/7.3	5.1/8.4	6.1/9.1	6.9/9.8	7.6/10.3	6.9/9.7	5.1/8.5	3.8/7.4	2.8/5.6	2.7/4.8	5.8/6.8
Latitude	Average	4.5	5.1	6.1	7.1	7.5	7.9	8.4	8.0	6.9	6.1	4.4	3.8	6.3
	Min/Max	3.2/5.6	4.2/6.2	4.5/7.5	5.0/8.4	5.9/8.8	6.6/9.4	7.3/10.0	6.8/9.5	5.1/8.6	3.9/7.8	3.0/6.1	3.0/5.3	5.8/6.9
Latitude +15	Average	4.7	5.2	6.0	6.8	7.0	7.4	7.9	7.6	6.7	6.2	4.6	4.0	6.2
	Min/Max	3.4/5.9	4.2/6.4	4.4/7.4	4.8/8.0	5.5/8.3	6.2/8.8	6.8/9.3	6.4/9.1	4.9/8.4	3.8/7.9	3.0/6.4	3.1/5.7	5.6/6.7

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors ($kWh/m^2/day$), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	4.7	5.2	6.1	7.2	7.8	8.4	8.9	8.2	6.9	6.2	4.6	4.1	6.5
	Min/Max	3.4/5.9	4.2/6.4	4.6/7.5	5.1/8.4	6.2/9.2	7.0/10.1	7.7/10.5	6.9/9.7	5.1/8.6	3.9/7.9	3.0/6.4	3.1/5.7	6.0/7.1

Direct Beam Solar Radiation for Concentrating Collectors ($kWh/m^2/day$), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	2.8	2.7	2.9	3.3	3.6	4.0	4.3	4.0	3.3	3.4	2.7	2.4	3.3
	Min/Max	1.7/3.9	1.9/3.8	1.7/4.1	1.9/4.4	2.5/4.7	2.8/5.4	3.4/5.8	3.1/5.2	1.9/4.6	1.7/4.8	1.4/4.1	1.4/3.8	2.8/3.8
1-Axis, N-S Horiz Axis	Average	2.1	2.6	3.4	4.4	4.8	5.3	5.8	5.3	4.1	3.5	2.2	1.7	3.8
	Min/Max	1.2/3.0	1.8/3.5	1.9/4.6	2.4/5.8	3.3/6.2	3.7/7.2	4.5/7.8	4.1/6.9	2.5/5.8	1.8/5.0	1.2/3.5	0.9/2.8	3.3/4.3
1-Axis, N-S Tilt=Latitude	Average	3.1	3.3	3.9	4.6	4.6	5.0	5.5	5.3	4.6	4.3	3.0	2.6	4.2
	Min/Max	1.8/4.3	2.3/4.6	2.2/5.4	2.5/6.0	3.2/6.0	3.5/6.7	4.3/7.4	4.1/7.0	2.7/6.3	2.2/6.1	1.6/4.8	1.4/4.1	3.6/4.8
2-Axis	Average	3.3	3.4	3.9	4.6	4.9	5.4	5.9	5.5	4.6	4.4	3.2	2.8	4.3
	Min/Max	1.9/4.6	2.4/4.8	2.2/5.4	2.5/6.1	3.4/6.4	3.8/7.3	4.6/7.9	4.2/7.2	2.7/6.4	2.2/6.2	1.7/5.0	1.5/4.5	3.7/5.0

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-0.5	2.1	7.8	13.3	18.1	22.9	25.6	24.9	20.6	14.3	7.8	1.8	13.2
Daily Minimum Temp	-6.4	-3.9	1.3	6.7	11.8	16.6	19.2	18.3	14.3	7.7	1.9	-3.7	7.0
Daily Maximum Temp	5.4	7.9	14.1	19.9	24.4	29.1	32.0	31.4	26.8	21.0	13.7	7.4	19.4
Record Minimum Temp	-25.0	-27.2	-19.4	-7.8	-1.1	5.6	6.7	6.7	-0.6	-6.1	-15.6	-26.7	-27.2
Record Maximum Temp	24.4	27.2	30.6	33.9	33.9	38.3	45.0	41.1	40.0	33.9	26.7	25.0	45.0
HDD, Base 18.3°C	584	456	327	156	61	3	0	0	24	138	317	512	2577
CDD, Base 18.3°C	0	0	0	6	54	139	226	203	91	14	0	0	733
Relative Humidity (%)	68	69	65	65	71	72	70	70	73	68	70	71	69
Wind Speed (m/s)	4.9	4.9	5.4	5.0	4.2	3.8	3.4	3.5	3.8	4.2	4.6	4.8	4.4

COMMUNICATION

The Crowder-Drury team has created a communications strategy that emphasizes the home's distinctive features. We named our entry ShelteR3 (pronounced "shelter three") to highlight three design objectives. ShelteR3 provides attractive, comfortable, and energy self-sufficient housing with a twist. The R3 in our name refers to Respond, Recover, and Resist - terms that emphasize the versatility of our design. Our structure can be quickly deployed by first responders in the aftermath of a natural disaster. It can then help with recovery efforts by providing shelter with power before the power grid can be repaired. Finally, ShelteR3 contains multiple design features that allow it to resist storm damage and protect future residents.

By collaborating with a large group of students from across our campuses, we included individuals from 22 different majors, and this helped fuel a significant word-of-mouth buzz among students and faculty and within the community. Our inclusive strategy created interest and involvement, resulting in a strong team spirit that quickly spread to our various constituencies.

Key messaging has not only focused on trending solar innovations, like the Netherlands' solar roadways, but has also aimed at educating viewers about the horrifying power of tornados, and explaining how effective a solution ShelteR3 could be. We have also been committed to highlighting the resources available through the Department of Energy that support sustainable lifestyle choices. Our narrative has, as a result, developed into much more than a story about two universities building a solar-powered home. Rather, it has become a story about two campus communities, motivated by a real tragedy, that seek to meet a very real need that persists in the wake of the 2011 Joplin, Missouri tornado.

We used our website, social media, campus press releases, along with attendance at pertinent conferences, to publicize our project and people took notice. Our project has been featured in prominent print and broadcast media in our area (e.g., KY3, the Joplin Globe, The Springfield News-Leader, and The Nature of Cities).

Our public relations outreach emphasized our project's relevance to our audiences. We've taken our story to energy and design conferences across our state and beyond, including the Greenbuild conference in New Orleans. We also presented to our local community at a Safe and Sound event where thousands of Springfield, Missouri residents learned about products and materials that protect against natural disasters. Our communication has generated excitement among industry professionals, solar energy enthusiasts, and everyday homeowners. .

Our efforts have generated impressive electronic traffic. Shelter.Drury.edu was launched in August 2014 and has had about 10,000 visits from around the world. We have established our presence on various social media platforms, including Facebook, Twitter, YouTube, Instagram, and Pinterest—where we regularly post fresh content about our project and related matters of solar energy and storm information, share updates about construction and fundraising progress, and engage with audience members interested in our house. Our website's 90-second introductory video conveys the project's core goals and ideas clearly and concisely, and has received a positive response. Viewers have grasped our message immediately and have participated in a rich dialog about our goal and the methods we are using to achieve it.

Two of our highest performing posts on Facebook regarding the Decathlon itself and our specific entry garnered 7.6 thousand views with 248 clicks and 4.9 views and 175 clicks respectively, evidence of the impressive reach and engagement levels our communications team has achieved.

Our audiovisual presentation explains forcefully why our team is so personally involved by making clear the depth of the Joplin tragedy, revealing the complex design and engineering that lead to the idea's beautiful simplicity. We used both video and animation to help viewers understand what it is like to experience our home and its lasting impact on the environment.

SHELTER.DRURY.EDU

CROWDER & DRURY SOLAR

@CROWDERDRURYSOL

CROWDERDRURYSOLAR

CROWDER DRURY SOLAR

CROWDERDRURYSOLAR

Our signage has been designed to grab attention from afar and educates visitors as they move through and around the house. It includes statistics related to the 2011 Joplin tornado, and educates visitors in regards to the great need to add disaster resilience to sustainability goals.

We have adopted a clean and clear informative billboard approach to educate visitors and keep lines moving quickly so that we can successfully allow a greater number of visitors to tour our house. An “ask the expert” sign will be stationed at the end of the tour, away from traffic flow, allowing for longer questions while keeping the line moving. The bi-fold format of our brochure is designed to reflect the expansion of our house from response to recovery mode by unfolding to reveal the fully realized structure, while only depicting the recovery mode while folded up.

Our tour begins at the front ramp with the signage. A decathlete tour guide stationed there directs the visitors in while describing our story and inspiration, the Joplin tornado, and the frequency and intensity of tornadoes in our region, known as tornado alley. Next, visitors on the front deck learn about solar energy and our wind and impact resistant design. Inside, we provide information about our whole-school approach to the competition and the sustainable attributes of ShelteR3. On the back deck, visitors hear about and get an up-close look at solar inverters. To facilitate management, each tour guide will provide simple answers to questions while encouraging visitors to proceed outside to our “Ask the Expert station” for longer and more technical questions. This station (with a person wearing an “Ask the Expert” vest) is located in the yard of the home in an area that allows visitor traffic to keep flowing.

From our project design and our public outreach, to our integrative approach to team building and to the construction of the house itself, every aspect of our communications strategy has embodied the unique nature of our entry in the 2015 Solar Decathlon. Our solar home has the added capability to Respond, Recover, and Resist.

Crowder Drury Website