Communications Material for the Solar Decathlon

An Honors Thesis (HONR 499)

By

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February 2013

Expected Date of Graduation
May 2013
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Abstract

The United States Department of Energy hosts an international competition every other year in which teams of college students research, design, and build a house entirely run on solar energy. This bi-annual competition, known as the Solar Decathlon, as there are ten competitions each house competes in during the weeklong event, has become very popular and allows students to showcase their design and building skills and for companies to display their newest sustainable technologies. Ball State University, the University of Louisville, and the University of Kentucky joined together to participate in the 2013 Solar Decathlon in Irvine, California. Together, the team designed and built the Phoenix House, which just like the mythical bird, rises from the ashes to bring new life; in this case, from the ashes of tornados and other natural disasters to provide shelter for victims. Initial inspiration came from the tornado that struck Henryville, Indiana and destroyed much of the town.

One of the ten competitions that each team competes in is communications. The communications competition covers several different areas, including a team website, social media websites, information displayed on the team’s competition site explaining the details of the house, scale models, and other forms of media that help communicate the team’s message and design. This is a key aspect of the competition, as it generates interest in the team’s entry and the competition as a whole, informs the public of about the design of the house, and allows the public to interact with the team and to ask questions.
Acknowledgements

I would like to thank Dr. George Elvin for advising me through this project, both as an honors mentor and as a studio professor. The help, guidance, and feedback throughout the project was of great help and I will always appreciate what I gained during this project.

I would like to thank Patrick, who was essential to the communications project and was very supportive throughout this long project.
In the Fall of 2011, the College of Architecture and Planning at Ball State University announced its involvement in the upcoming Solar Decathlon competition, which will take place in the Fall of 2013. The Architecture Department also released that it will be partnering with the University of Louisville and the University of Kentucky and create a joint entry into the competition. The competition is held every other year at a common site and is sponsored by the United States Department of Energy. After an early application process, twenty teams from around the world are invited to design and build a home entirely run on solar energy. These teams then transport these homes to the competition site, where they are available for the public to tour and also compete head to head in ten different competitions to determine which house is the winner.

As an architecture student in the Fall of 2011, I participated in the initial research and design related to the Solar Decathlon project. This included looking at past competitions, traveling to Washington D.C. to tour the homes that were in the 2011 competition, and working in conjunction with the rest of my studio to come up with fourteen different ideas for our teams entry. In the Spring of 2012, I helped with reviews as the design was further developed and helped in the initial design of the team website. Starting in the Fall of 2012 and continuing through the conclusion of the competition in the Fall of 2013, I have been named lead web designer and communications task group leader at Ball State. This entails continuing work on the website, coordinating social media platforms, and communicating with the team in Louisville about communications details.

For my Honors Thesis, I worked to produce communications material for the team. In addition to working on the team website, I am now working to produce communications drawings. These drawings are explanatory diagrams that graphically show how specific systems work in the house. Examples of these are diagrams showing the HVAC ductwork, how water is recycled, how the house is transported, and many others. These drawings are an essential piece of the communications competition and are important in helping the public understand the house. Finally, I will also create a scale model of the house out of bass wood to be displayed inside the house on the competition site. Similar to the diagrammatic drawings, this model will help the team explain to the public the design of the house.

The objective of this work is to provide the drawings and materials for the communications team to display both on the website and at the competition site for the public to see. These drawings are essential to explain how the house operates and to show the amount of work and design that went into the house. The final outcome will be this series of drawings and short descriptions to be used for the Solar Decathlon Competition.

The Phoenix House, which is the name of the entry for Team Kentuckiana comprised of Ball State, University of Louisville, and University of Kentucky, gets its name from the legend of the bird for which it is named after and which rises from the ashes to create new life. Just as the bird does this, so too does that Phoenix House as it was inspired by the recent tragedy in Henryville, Indiana when the town was severely damaged in a tornado. The house is meant to rise from these ashes and to provide life for the victims of similar tragedies to come.

In order to function as a disaster relief housing option, the Phoenix House must be mobile, energy efficient, have market appeal to fit into any neighborhood, be reasonably priced, and have
options for future expansion. This is a challenging list of items that the team set forth for itself to attempt to solve, and would only consider the project successful if possible solutions to each of these were implemented. Since the house must be built on one site and transported to the competition site, it already must be partially mobile. The Phoenix House will be built in Louisville, Kentucky and then shipped to Irvine, California for the competition. As the diagram showing the houses set up explains, the house can fit onto two flatbed trucks and can be unloaded from them on any site. This could allow multiple houses to be transported to the site of a disaster just days after the event occurs and provide shelter faster than is typically provided. By creating a mobile solution, it serves both the competition and the larger goal of disaster relief housing.

One of the sustainable features that the Phoenix House incorporates is the use of water collection and filtration. This is done in two different ways, both of which can be seen on the water recycling diagram. The first way is from rain water on the roof. By using a butterfly roof, meaning that both roofs pitch toward the center of the house, it allows for a single gutter to collect all of the water that falls on the house's footprint and store it in tanks below the deck. The rest of the water is grey water, meaning it comes from appliances within the house, specifically from the kitchen and bathroom sinks, the shower, and the dishwasher. This ensures that all of the water used by occupants is not wasted for daily use, but is used then collected in the same tanks as the rain water. From these collection tanks, the water passes into four consecutive planters that filter out particles from the grey water and allow the water to be used to water other plants around the house. This can be seen in the following diagram.

In the diagram showing the planters, the grey water enters the first and tallest planter at the bottom of the container. It slowly rises up as more water follows behind it and passes through rock and plant material until it reaches the top. Once at the top of the tank, the water spills into an overflow valve and into the bottom of the next tank. This repeats over the four tanks, all of which have similar plants in them, until it is through the fourth tank after which it can be used to water other planters around the house. By collecting and reusing both rain and grey water, it allows for the Phoenix House to keep plants, native vegetation, or even a private garden without having to draw water specifically for these plants. In addition, this water could pass through a more rigorous filter and be drunk in emergency situations, such as during a disaster situation.

In the plantings diagram, the vegetation around the Phoenix House is highlighted to show the amount of vegetation surrounding the house. This helps provide a more private experience for users by adding some natural separation and offers quick set up of these plants to be implemented in the setup of the house. These planter boxes also allow users to plant their own garden to grow their own food, which could greatly aid occupants during emergency situations.

Inside of the house, the team chose highly efficient appliances throughout the house. This creates a twofold approach in becoming more energy efficient as the house both creates its own electricity from the solar panels and also reduces the amount required to run the house. By doing this, it allows the Phoenix House to achieve a net zero energy rating more easily as less energy needs to be produced. In addition, the appliances chosen are also smart appliances and are wired to a central computer so they can communicate with each other. Since these appliances communicate with each other and can receive information on how much energy is being produced at any point in time, they can delay turning themselves on in order to create a more efficient time table. That is to say, if there is not
enough energy being produced at a given time, or if too many appliances are running at the same time, they will work together to save energy by delaying turning appliances on. This overrides human habits and creates an efficient schedule for the appliances to save energy.

The solar array used in the Phoenix House was specifically designed to meet the loads within the house and guarantee that it would achieve a net zero energy rating. The calculations were based on the amount of electricity needed, the square footage of roof available in which to place solar panels, the angle of the roof, and many other factors. The roof on which the solar array is located is pitched more steeply so the sun’s rays will strike it more directly and increase its efficiency. It is also located on the longer of the two modules to increase the square footage available to collect electricity. This was all taken into account in order to calculate the solar array necessary for the Phoenix House.

Another component within the Phoenix House is the HVAC system, or the system controlling the central air inside the house. Just as with all other components in the home, it is highly efficient and is closely monitored because one of the competitions involves achieving a specific temperature and humidity so occupants are comfortable inside. Since there are two modules which are connected on site, the ductwork must run underneath the floor and be connected on the competition site. This is achieved by adding removable floor panels so the team has access to these ducts on site. The air is supplied along the two outside walls and moves through the modules towards the shared common wall between them. By moving from outside to inside, the treated air is supplied to the most extreme temperature difference first and the less harsh area in the middle of the house last. This air flow is more efficient than reversing this process and helps the house achieve its net zero energy rating.

The Phoenix House was constructed using structurally insulated panels, or SIPs, which is essentially two pieces of plywood on either side of a thick sheet of rigid insulation. SIPs have a very high insulation rating allowing them to retain heat easily, and are also prefabricated which allows for an accelerated construction schedule. By creating a house with a high insulation rating, less hot or cold air escapes (depending on the season) and so less air needs to be conditioned inside the house to keep it at a comfortable temperature. In doing this, less energy is required to heat and cool the home and it is easier to achieve a net zero energy status. The architectural section through the Phoenix House is a drawing which essentially cuts straight through all the walls in a straight line in order to understand how the building was constructed. In the Phoenix House section drawing, it shows both modules being cut through and a series of call outs enlarging details of the construction methods used to create the home. In these details, the SIPs can be seen, as well as a multitude of other details about the construction and structure of the house. This shows the public what is inside of the walls of the house, which gives them a better understanding of the house as a whole.

Since the Phoenix House’s goal is to provide either temporary or permanent housing solutions following a natural disaster, it was the assumption of the team that it would be deployed in an area where future disasters may strike again. Since the focus of the house is tornados in the Midwest, the team set out to provide some protection against future tornados to protect the occupants of the house. This is shown in the drawing describing the safe room, which in the case of the Phoenix House is the bathroom. The trellises around the bathroom which support vines act as a first line of defense, stopping or slowing down flying debris. The walls of the bathroom have been reinforced and the window is shatter resistant to help protect anyone within. Finally, the entire room can be strapped down to
prevent it from being overturned in high winds. These details can be easily missed, as they are subtle design decisions to help protect those inside.

In order to transport the Phoenix House from Louisville to Irvine required much forethought from the team, as there are limits to the size of what can be shipped that distance. In order for the taller module to fit underneath overpasses, the roof can be rotated to a lower position to decrease its shipping height. The limit on the width of the modules forced the team to have two separate pieces to be joined on site. Most importantly, the terrain and varying heights of overpasses made the team choose a specific route out to the competition site. This takes the pieces on a more southern route through multiple states to its final location. This diagram shows the distance the house must travel, as Team Kentuckiana is one of the farthest from the competition site this year.

The final communications drawing describes the tour route within the house that visitors will pass through during the competition. This allows the public to see which way they will travel and where the team members will be standing to offer information and answer questions. While this is not as important as some of the other drawings, it does give visitors advanced notice as to the route they will travel through the house.

These twelve drawings were all chosen because they offer specific information that will help both the public and the judges understand the thought process, design decisions, and inner workings of the Phoenix House. The information represented in these drawings also relates to the ten competitions that the house will compete in during the course of the event and can visually show how the house is working during these competitions. The style of the drawings is a ghosted view of the house with the roof removed and elements related to each drawing highlighted in the Phoenix orange. Architects use this style to show visually where in the house the elements are and how they relate to the house as a whole. This was a learning experience in how to produce these drawings and how to manipulate the computer programs to produce what is necessary to create the drawings as well. This new skill will serve me well as I begin to move into my professional career.

The diagram drawings created are physical pieces that will be displayed both at the competition site and in other locations, such as the website. The website is different in that anyone can see it at any time and must represent all aspects of the house at all times. The diagrams will eventually be used on the website to help the public understand the house via the website, but for privacy reasons have not been posted yet. The other information on the website, however, is just as important in keeping the public up to date on the team's progress, telling the story that inspired the house, and other relevant information. Finally, it links to all of the team's social media sites, allowing the public access to these as well. In terms of the communication competition, it is one of the most important pieces that the judges will look at, as it is the central hub for all information and links to other sources and sites.

The team chose to use a wordpress based website, as it has a large variety of features but is easy to add to, update, and can be changed very quickly. Wordpress has recently become more popular amongst designers for its flexibility and speed, which made it an easy choice for the team. A vote was then taken on the theme for the website, and the final choice was made because it had the ability to create team pages, offered image sliders, and matched the colors of the Phoenix House logo. It was proven to be a good choice for theme and fit the needs of the competition.

The home page for the website gives users a preview of the house by showcasing images of what the house will look like. There is a sliding set of images at the top of the page that houses
renderings of what the house will look like and the team hard at work. These images are the first thing that users will see when arriving at the site, and by using high quality renderings, it allows for an initial understanding of what the house will look like through representations of the house. These renderings show how big each space is, the materials being used, how users can interact with the space, how the space is lit, and other details of the house. In addition to showing these details, they are also flashy, and draw users farther into the website where they can find more information about the house.

Also on the home page is the walkthrough video created by the team. This short video provides moving pictures through the house allowing viewers to experience how it feels to move through the house and experience the different areas of the house. In addition to this added feature, there is also a narration that goes with the video that provides information to the viewer about the house, its features, the story that inspired it, and other details. Finally, this is a shortened version of what the team will present inside the actual house on the competition site in California.

Moving past the home page to other areas of the website, the design is set up to follow the ten competitions that the house will participate in. The design page begins to show how the house works and the competition page describes each of the ten competitions to the public. These pages together offer information on how the house has been designed in order to contend in each of the ten areas. These competitions are broken into two categories, judged competitions, which are scored by a panel of judges, and measured competitions, which measures certain outputs of the house. The judged competitions are architecture, looking at the design of the house, market appeal, describing the ability of the house to sell on the market, engineering, which deals with how the systems and structure were designed, communications, which has already been described, and affordability, which estimates the worth of the house and how affordable it would be to the general public. The measured contests are comfort zone, which measures the temperature and humidity inside the house ensuring a comfortable level, hot water, in which the house must produce a specified amount of hot water and a specific temperature, appliances, which measures the output and functionality of the appliances within the house, home entertainment, which requires the team to host others during the competition to show that it can host events, and energy balance, which evaluates the amount of energy the house is using versus producing. These competitions were kept in mind when setting up the website and are described so the public can understand how the competition works. In addition, they help structure how the design of the house is described so that viewers will see how the house functions for each of these competitions. This is another reason why the twelve diagram drawings were chosen, as they fulfill this desire to describe how the house works in these different competitions.

The team page and sponsors page allows the public to see the people behind the project and begin to meet team members. The team page is also being linked to the social media sites as they have begun a series of student spotlight features, in which a team member is described and a short personal questionnaire is displayed. This is a personal touch from the team to show the public who is really working on the project, as it is entirely designed, built, and run by students. Similarly, the sponsors page shows the corporations or individuals who have donated time, energy, and money to the project to assist the students in their work. The house could not be built without them and they are key to the success of the project. Further, it shows the public which companies support the Solar Decathlon and sustainable design.
The news page gives quick updates on the status of the project and where in the process the team currently is. The stories posted here are short and updated more frequently than the rest of the site, so the public can keep up with the latest news. Some of the recent stories include information about the groundbreaking ceremony that recently took place, details about how the construction will proceed, and other such stories. This gives the team a location to update the public outside of social media.

The final page included on the website is for an art competition that the team is currently hosting for pieces that will be displayed in the house during the competition. By opening up the interior decorating to the students of the universities, it gives students a unique opportunity to add pieces to the house, ensures creative and one of a kind pieces will be created, and allows the pieces to match the theme and design of the house. This is a creative way the team is trying to bring the rest of the students at the three universities into the project and even offers a reward for the pieces that will be included in the house.

As stated, the overall goal of the website is to inform the public of the details of the house and to offer information about how the house will perform specifically in each competition. These details were laid out on the website to allow the public to easily flow back and forth through these pages. While I have had some work on websites in the past, this was the most extensive work I have done on a website in my career. This is a skill that not all architects have but can be very useful, as everyone and everything has a website now. Understanding how to create a website and what content needs to be included is something I am sure I will continue to use in the future.

The final element produced for the communications competition was a scale model of the house constructed out of bass wood. This model is a representation of the final house at a scale of one half inch in the model being equal to one foot in real life. Those outside of architecture tend to greatly enjoy these models, as they can see the overall design and layout of the house in a scaled version in front of them. It is easy for designers to use these models to point out design features, spatial relations, and specific features of their designs. This model will be used at the competition site to aid the team in explaining the design and message of the house to the public as they tour through the full size house.

The first step in creating a scale model such as this is to transfer the design to pieces to be cut out by the laser cutter. This is a slow process done by creating a new three dimensional model on the computer that is made of individual pieces instead of representing the actual construction. That is to say, it represents the construction of the scale model instead of the full size house. These pieces are then laid out flat in order to determine the amount of material necessary to create the model. This ensures that a minimum amount of material is wasted and time and money are saved. Once these sheets are produced, construction of the model can begin.

The drawings of the pieces of the model are then inserted into the computer attached to the laser cutter and material is placed inside as well. The program is run, and the cutter follows the outline of the shapes on the computer producing all of the pieces required for the model. Once this has been accomplished, the pieces simply need to be glued together and the model is complete. It took about two weeks to create the cut sheets and another week to assemble all of the pieces together into the final model. Pictures of the model were taken and shown in this binder.

The experience of working to produce communications material was different than other studio work I have worked on during my time at Ball State. This project was to take a design that other
students created and explain to a public audience who may have no experience with the project or with architecture how the how works and why the team made the decisions it made. It was a new challenge, and required a different thinking process than what we normally have as architects. Typically, we design a project and have an opportunity to present the work to either a panel or a client who tend to be familiar with the project or with the design process. However, in the case of the solar decathlon, the team will not always have time to present all the information nor will everyone be familiar with how the project runs. This means that everything produced from this project has to explain design decisions clearly and concisely, which is an interesting challenge which I enjoyed undertaking.

Working with communications is also something that few architecture students have the opportunity to do in school, since there is typically no marketing involved in a studio project. However, in the professional world, projects need to be displayed, communicated, and explained constantly in order to sell the project. Gaining experience by having to produce these drawings and work to market the house is an invaluable experience that will give me skills I will need as I progress in my career and which are difficult to find opportunities to gain in school. Finally, it was also valuable to learn new processes within computer programs to produce the drawings, website, and model.
Website Screenshots

Home Page

The Phoenix House

University of Louisville

KENTUCKY

U.S. Department of Energy

NREL

Join Team Kentuckiana

Are you a UofL, UK, or UK student interested in green technology, business planning, graphic design, communications, architecture, or engineering? Email taylor@kentuckiana.org to get involved!

Recent News:
Construction Kick-Off
April 16, 2016
Groundbreaking Ceremony
April 16, 2016

Investor Relations and Sponsors

Let's build the dream together.
Contact our Investment Sponsorship Coordinator at sponsors@ukentuckiana.org

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ArtCompetition | Summer
Design

The Phoenix House is a symbol of renewal, born from destruction. Survivors of natural disasters have a vision for the future, and the Phoenix House will provide a new home in the ashes. The Phoenix rises from the ashes, just as this phoenix rises from the ashes, so too will people rise from disaster to begin a new life from the ashes.

The Phoenix House is a permanent sustainable construction design prototype that can be quickly deployed to the families that lost their homes to disaster. These homes will be producing their own power and drinking their own water. The Phoenix House will be placed in the community, enhancing it. It will be connected, and the distributed generation of sustainable power will improve the infrastructure and community with a much more robust and green infrastructure.

Jonf Tichnacka
Are you a U.S. or UK student interested in green technology, business planning, graphic design, communication, architecture, or engineering? Visit the PhoenixHouseUK.org to get involved.

Recent News
Construction Kick-Off Report
March 3, 2013
Groundbreaking Ceremony
March 3, 2013

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Contact: info@phoenixhouseuk.org
Coordinator: info@phoenixhouseuk.org

Web site: phoenixhouseuk.org

Join Team Kentucky

Apply as a Left, RSSU or UK student interested in green technology, business planning, graphic design, communication, architecture, or engineering? Email kentucky1@kentucky1.org to get involved!

Recent News
Construction Has Begun

Groundbreaking Ceremony
March 2015

Investor Relations and Sponsors
Let's build the dream together.
Contact our Investment/Sponsorship Coordinator at sponsor@teamkentucky.org

For more information, visit
kentucky1@kentucky1.org

U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

GREAT PARK

THE PHOENIX HOUSE

U.S. Department of Energy Solar Decathlon

The U.S. Department of Energy Solar Decathlon is an annual nationwide competition that challenges teams to design, build, and field solar-powered homes. The Solar Decathlon 2013 will be held at the Colorado Springs World View Park in Aurora, Colorado from October 26-13, 2013.

Contests
The competition includes 10 contests, each worth 100 points:
- Architecture
- Market Appeal
- Engineering
- Communications
- Affordability
- Education
- Net Power
- Originality
- Home Improvement
- Energy Analysis
Team Kentuckiana

Team Kentuckiana comprises students and faculty mentors from three universities: University of Louisville, Ball State University, and University of Kentucky. The University of Louisville provided engineering, business, and communication expertise; Ball State University provided architecture and construction management expertise; and the University of Kentucky provided competition expertise and financial support.

University of Louisville

University of Louisville students from the college of Engineering, the College of Business, and the College of Arts and Sciences, in collaboration with Solar Decathlon, provided support to the project from the beginning.

Ball State University

Ball State University provided the team with extensive knowledge of architectural design and construction management. The students bring a unique academic perspective to the design. They are well versed in architectural design and will provide the projects with interior design and drawings. Students from Ball State’s Construction Management program will build the construction of the Phoenix house.

University of Kentucky

The University of Kentucky competed in Solar Decathlon 2013. They are bringing their previous competitive experience to the team. The start mentors at the University of Kentucky support both engineering and design efforts.

US Department of Energy, NREL

Join Team Kentuckiana

Are you a Lea, BSU, or UK student interested in green technology, business planning, graphic design, communication, architecture, or engineering? Email kitty@teamkentuckiana.org to get involved.

Recent News

Construction Has Begun on April 7th

Groundbreaking Ceremony on April 12th

Investor Relations and Sponsorship

Let’s build the dream together.

Contact our investment/sponsorship coordinator at:

equipment@teamkentuckiana.org
News

Construction Kick-Off

The project kick-off is scheduled for February 26, 2015. The meet-and-greet will take place from 2:30 to 3:00 p.m. on the Phoenix House site. Participants can tour the site or enjoy refreshments at the NREL lab. The event will begin with an introduction speech at the site before a Q&A session with the project team.

SOLAR ENERGY

U.S. Department of Energy X NREL

Solar Decathlon

Join Team Kentucky! Announced last week, the University of Kentucky is preparing to enter the Solar Decathlon. The project kick-off is scheduled for February 26, 2015. The meet-and-greet will take place from 2:30 to 3:00 p.m. on the Phoenix House site. Participants can tour the site or enjoy refreshments at the NREL lab. The event will begin with an introduction speech at the site before a Q&A session with the project team.
Art Competition Page

Art Competition

Competition Guidelines

All artists, regardless of age, are encouraged to submit works of art that convey the Phoenix's symbol of rebirth and transformation through artistic expression. The works submitted must be original and must not have been sold, rented, or otherwise transferred from the artist to any other party. All artwork must be on display at the exhibition. The works for sale must also comply with the competition rules.

The competition is open to artists of any age. All works of art submitted for consideration must be original creations of the submitted artist. Artists must submit their artwork electronically. The works must be evaluated by a panel of judges, and the winners will be announced at the exhibition's opening.

Dee Dees

Art Competition Rules

Entry Requirements:

- Artwork must be original and must not have been sold, rented, or otherwise transferred from the artist to any other party.
- All artwork must be on display at the exhibition.
- Works for sale must also comply with the competition rules.

Artists:

- Must submit electronic artwork.

Registration:

Artists must register online to enter the competition. The registration process includes submitting a digital copy of the artwork and a brief description of the artwork.

Judging:

- A panel of judges will evaluate the artwork based on creativity, technical skill, and adherence to the competition rules.

Awards:

- Winning artists will receive cash prizes and a public recognition.

Contact Information:

For more information, please contact the Art Competition Coordinator at info@artcompetition.com.
Water is pumped from the tanks below the deck of the house to the first planter box, which is also the tallest one. From this initial tank, it passes through three additional ones, the last one being the largest. These tanks filter the grey water from the house so it can be reused.

1. The water enters each planter at the lowest point of the box and travels upwards. Once the water level exceeds a certain point, it travels through an overflow valve into the next planter box. By using this system, it allows the design to only use a single pump to circulate water, which is more energy efficient.

2. As the water is traveling upwards in each of the planter boxes, it is passing through a mixture of rock and organic material. This acts as a large filter, preventing major particles and matter from moving through the system. This is the first step in the process to reuse the grey water.

3. As the water is passing through the rock, it is also being cleaned by the roots of the plants in the boxes as well. These aquatic plants pull out additional particles and contaminants from the grey water. Over the course of all four tanks, this process is enough to reuse the water in other planter boxes.

4. Once through the filtration system, the water is then used in other planter boxes around the house. This means that the Phoenix House does not need to draw water for the sole purpose of watering plants. Instead, there can be native plants or even a garden around the house that is completely dependent on water that has already been used.
Smart Appliances

When high rates arise, this laundry pair will save you money while getting your clothes dry.

This profile refrigerator can reduce energy use on demand and delay defrosts to inexpensive rate periods.

Cooking energy is reduced and with dual cavities, that range cal preference the smaller upper oven.

The water heater can switch to heat-pump mode and modify temperature settings during high rates.

The dishwasher is aware of expensive rate periods and can wait to run when energy costs are lower.
The solar array being used by the Phoenix House is rated at 7,149W. This is lower than many of the houses in past solar decathlon competitions. This is possible through the use of highly efficient insulation and appliances. By using efficient products in all these categories, it allows for a smaller array to be used.

The solar array is 400 square feet in size. This was the area calculated to produce enough energy to achieve set performance. Similar to the energy rating, the size of the array is also smaller than most in previous competitions. This was possible through the efficiency achieved in the Phoenix House.

The butterfly roof is angled at 37.5 degrees to collect sun at different times of day and over all four seasons. The house was designed for southern Indiana or northern Kentucky, which is how the angle was calculated. This is specific to the Phoenix House, and is the optimal angle for the house to compete in the competition.

By using two sets of solar panels, it allows them to be wired separately. This is a fail safe, so if a problem arises it will allow the other array to operate and produce electricity. This also allows for more common panels to be used by increasing the area of the array on the roof.

The panels are hard wired to the utility room, with a fail safe switch that can end the flow of electricity in case of an emergency. It also creates one central location for the central panel and converters.
Ductwork was kept to a minimum to increase efficiency by decreasing the amount of heat lost through the ducts. This was done by using only four main branches, two supply and two return. Air circulates from the outside of the house to the inside wall that connects the two modules.

All of the HYBO components are in the utility room or hidden underneath the floor. This helps to insulate all of these components and also allows them to travel shorter distances. This means that during the on-site set up, connection/ will be made by using removable floor panels to have access to these components.

Since the utility room is in module one, it means that the HYBO system will have to be connected on site between the two modules. The ductwork for both modules will be installed during construction, and simply connected together on site. Because the system as a whole is very efficient, it makes up for any loss from this connection.

To meet code and provide a good indoor air quality, the HYBO systems changes over the air inside the house four times per hour. This allows air to pass through filters and the rest of the system frequently to maintain high air quality. This also helps heat or cool the space quickly to compete in the comfort zone competition.

The return air duct runs along the shared wall where the two modules meet. This helps to regulate air circulation inside the house and provide a common location for the return ducts. This also ensures that the treated air runs along the outside walls first, then moves to interior spaces after this.
The safe room is located in the bathroom of the Phoenix House. The bathroom was chosen because it is in multiple zones, which could be deployed individually in a disaster situation and because it is traditionally considered the safest room in the house.

The first defense against a tornado comes from the trellis and vines growing around the bathroom. This structure and plant material help to stop or slow down flying debits in a tornado and hopefully prevent it from ever reaching the bathroom. This was intended to be an exterior shield as well as provide a private space outdoors.

The bathroom walls were constructed differently from the rest of the house. They have been reinforced to withstand high wind loads and flying debris to keep occupants safe inside. This room is also anchored to the ground to prevent it from being overthrown. While it has been reinforced, the wall thickness remains the same to hide this.

The bathroom contains a small overhead window to let light in during the day, which has a high shatter rating, ensuring that even if it is hit straight on with flying debris, it will keep occupants inside safe. While most safe rooms do not have windows, the team thought it was important to the design to include one.