Missouri University of Science and Technology

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON 2015

THE NEST HOME

Primary Faculty Contact:
Heath Pickerill
Missouri Local Technical Assistance Program
Civil, Architectural, and Environmental Engineering
pickerillh@mst.edu

Primary Student Contact:
Mary Puleo
School of Engineering
Environmental Engineering
mep346@mst.edu

Jury Narratives

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Architecture Narrative

Design Concept

The Nest Home is designed to comfortably and conveniently meet the needs of a single family and allow for easy modification of its base design to suit other demographics. The use of locally-sourced, repurposed, and recycled materials within the home's structure and interior design is modeled after the natural behavior of wild birds, whose nests are similarly constructed with materials reclaimed from their surroundings. The Nest Home's architecture serves as a real-world example of how innovative and attractive a home built of repurposed materials can be if the designers are allowed to think outside the box.

As you approach the Nest Home, you will immediately notice the wood siding on the exterior giving it a warm and rustic appearance. This wood is sourced from scrapped freight pallets and now helps create a beautiful home instead of rotting away in a landfill or scrapyard. This siding conceals three decommissioned steel shipping containers likewise saved from a fate of slow decomposition and outgassing in an anonymous dump site.

The reclaimed containers are the Nest Home's most prominent example of material upcycling in our design. Transcending recycling and repurposing, upcycling is the reuse of a discarded object in such a way as to create a product of higher quality or value than the original. The most recognizable feature of an upcycled material is how minimally it is processed before implementation in its new product-role. Typically, the upcycled material retains much of its original form and appearance after being converted. The advantage upcycling provides over recycling is that significantly less energy is expended adapting the materials to their new uses. To understand the significance of this distinction consider that steel recycling is said, on average, to reduce water pollution by 70 percent and air pollution by 80 percent compared to the manufacturing of new steel. This means the environment is spared the remaining pollution associated with recycling these containers and the other steel used in the foundation. More material is saved from the landfill in the form of denim fiber insulation made from recycled blue jeans and other clothing. This material helps to provide sound dampening for the spacious interior, more effectively than traditional fiberglass insulation, and even offers superior fire resistance.

The execution of this design concept does not end with the structure itself. Interior fixtures and features were chosen based on their ability to be sourced from recycled or repurposed/upcycled materials. The light over the dining room table is made from an upcycled well-wheel that lends a charming accent to the space. The floors of the bedrooms and office are re-surfaced container floors, the floor of the kitchen is surfaced with ecofriendly cork, and the adjacent carpeting is composed of recycled fishing nets. The concrete kitchen counters are inlaid with fragmented glass from bottles collected at our university, giving color to the surface without the need for surfactants or stains. Those countertops sit upon cabinets purchased from a local secondhand shop and refurbished by the team for their new life in the Nest Home.

Every aspect of the Nest Home's architecture is designed to demonstrate the practical application of building with unconventional materials while showcasing the potential for these materials to perform at least as well, if not better, than their newly manufactured counterparts. Our philosophy is to make net-zero homes using environmentally responsible practices combined with creative innovation and artistic expression. The Nest Home is a testament to that philosophy.

Conventional Challenges, Unconventional Solutions

The Nest Home takes a radical departure from the realm of traditional container home design by adopting an open floorplan in a non-rectangular geometry, which provides ample communal and private space for as many as four occupants. Gently inclined steel ramps coupled with plentiful deck space provide wheelchair access, while the spacious landings at the points of entrance and egress assure ease of maneuvering through the doorways. If desired, a staircase may be added to the side of the decks, allowing for direct access to the landing without the need to travel the length of the ramp. The rear deck is outfitted with a canvas shade and shielded from the southern side of the house by the mechanical room, ensuring the midday sun will not spoil a patio lunch despite the deck's positioning at the eastern edge of the house. In addition to aligning with our guiding principle of environmental responsibility, the recycled wood exterior combines with the hydroponic gardens integrated along the exterior and offers a warm, inviting presentation reminiscent of woodland cabins, creating a feeling of tranquility.

The interior floorplan is a deconstructed triangle design. Using this arrangement maximizes functional square footage while the narrowest area, or "top" of the triangle is situated at the northern face and enclosed with a glass wall, expanding the boundary of the living area. At the top of the wall, windows open in response to data managed by the automation system to regulate air flow as conditions change within and outside the house. This helps the HVAC system keep the interior temperature constant. These floor-to-ceiling windows flood the living room and kitchen with natural light, reducing the need for interior lighting during daytime hours. The roof sweeps upward from south-to-north meeting the glass wall at its highest point, further expanding the narrowest point of the floorplan. Additionally, this orientation allows the glass wall to remain shielded from direct sunlight, letting the natural light to be used in summer months without excessive heat entering the space. The modules composing the bedrooms and office are all seamlessly incorporated into the borders of the main living area, eliminating the need for hallways or other internal partition walls, maintaining full expansion of the living space while retaining the privacy growing family members need. The final expansion of the interior is achieved by setting the entrances into their own glass walls.

Great care was taken to ensure a smooth flow of both traffic and interior accents throughout the Nest Home. Strategically selected areas of the containers were left exposed and finished on the interior. The juxtaposition of steel walls and wood-accented ceilings offers an appealing contrast of materials along with a complementary color scheme that helps to create the all-important sense of comfort needed for any family to enjoy their space together. A non-partitioned dining area allows shared family time even when meal schedules do not overlap and provides a convenient space to set up extra tables or chairs to accommodate a small to moderate sized guest list. The kitchen island creates a small partition for the resident cook to establish a boundary for their work area without intruding into the common space and allows room for the cook to work effectively and comfortably. Even the intrusion of the washer and dryer is minimized by its regulation to an alcove in the bathroom and the selection of a stacked unit.

Deliberate Selection, Thoughtful Use

The team spared no effort in its attempt to ensure anything drawing a current from the home's power supply was the correct size for the target demographic as well as the home. All appliances featured in the home are either energy star-rated or specifically selected due to their ability to strike the needed balance between efficiency and output. Lighting is provided using LED bulbs, giving longer life and consuming less power than any other light source. Ceiling fans move air along the gradient from the short, wide end of the house to the taller, narrow end which creates steady ventilation as needed to assist the HVAC system in controlling the internal environment. Spray foam insulation fills the cavities between exterior and interior walls, working in tandem with the denim fiber

insulation to provide thermal barriers and echo-absorption for the living space. Even the paint used in the mechanical room was selected because it helps the system components to be visualized more easily when the light is turned on despite its windowless construction.

The team set out to create a unique and cohesive home where function and beauty are well-integrated throughout the entire design. Careful consideration was given not just to creating and implementing the most efficient systems of resource management within the home, but also the comfort and happiness of the residents. Each architectural detail is different, but all are linked by the common theme of using reclaimed materials. From the color scheme and material choice that facilitate relaxation to the use of spatial relations and everything in between, the Nest Home shows how imaginative solutions to ordinary problems can result in a masterpiece.

Communications Narrative

Overview

The strategy of the team's communications program is threefold. First, we seek to raise general awareness about the importance of sustainable engineering in general and smart living in particular. Second, we want to demonstrate that living sustainably and responsibly is not a terribly complicated affair. Finally, the team is working to start a different kind of discussion with regard to the environment. A discussion where sensationalism and obfuscation are replaced by clear, concise rational communication of logical ideas. A discussion in which conventional problems are addressed with unconventional thinking.

Raising Awareness

The Nest Home is an example of easy-to-follow ways to begin living sustainably in your own home. The most important message the team seeks to share is that little actions make a big difference. An old Chinese proverb reads, "A journey of 1,000 miles begins with but a single step." The team has made this concept the spearhead of their communications campaign by highlighting as many convenient examples of small actions with large impacts. The use of "Did You Know?" signs throughout the house, coupled with the more in-depth information given on the signs outside of the house appeals specifically to families and makes a powerful impact of suggestion followed by reinforcement.

It's the Little Things

Many members on the team have lost count of how many times they've heard someone say, "The problems are so vast, what difference does anything I do make?" The team has developed a collective answer to that question in which we unanimously agree upon:

"The problems are vast because of a trillion little things."

The team believes in a feedback loop within the minds of many people who feel a strong sense of environmental stewardship, but are overwhelmed by the magnitude of the existing environmental situation when they stop to behold it. This phenomenon of despair has paradoxically resulted in these same environmentally aware people becoming active contributors to the very situation causing them grief to begin with. The literature within the handout and the signage is carefully coordinated to strategically deliver and reinforce a message of personal empowerment and ecological conscience to the visitors of the Nest Home.

Change the Discussion

The very first sign that visitors will see upon queuing up to visit the Nest Home is our "Winds of Change" sign. This sign is designed to be thought-provoking by challenging the readers to consider the climate change debate from a different perspective. The perspective of fish, in fact, as the sign explicitly likens the human race to fish in an aquarium. It is our hope that those who take time to read the sign will at least stop and think about the ideas presented, or at most share their feelings with others around them about those ideas. The team believes the discussions surrounding climate change lost all productive value when both sides began attempting to definitively prove the other was wrong, and both sides took to more and more underhanded and intellectually dishonest tactics in order to strengthen their following. The result of these efforts is the gridlock and bickering

we see today when it comes to discussion of sensible approaches to environmental sustainability, and it is this gridlock we hope to begin changing, one mind at a time.

Measures of Success

The most obvious measure of success will be in how many enthusiastic debates, monologues, guffaws of disbelief, and comments of support the team receives over the course of each day. If every team member had just one thoughtful conversation with someone who had told them they had never realized how simple environmental responsibility can be, or even a cordial disagreement with a passionate individual, the first part and second parts of the overall strategy could be considered a success with 150 new people either on board or at least actively thinking about why they disagree with an idea that they'd never considered before. For a metric of success on the third point, the team is making use of an interactive tent facing decathlete way and encouraging people to come up and write their thoughts at that moment about whatever they might like. What we hope to see is some chalk artists and thoughtful, original quotes on responsible living as a sign that we have begun to change the discussion surrounding the question of environmentally-friendly living by opening it up to the general public.

Engineering Narrative

Background

Since the beginning of this project, the team's engineers have worked closely with their colleagues in architecture and communications to ensure the Nest Home would be capable of functioning in the roles for which it is designed and do so in an aesthetically pleasing manner. The team realizes that a house is not a home unless the engineering systems maintaining it are effective, reliable, and non-intrusive to the home's décor. Approaching the project from this perspective has yielded a house that combines cutting-edge modern living with classic rustic accents and delivers efficient comfort to its occupants.

Many challenges were presented to the team once the decision was made to proceed with developing a design that would both accommodate a family as well as allow relatively easy expansion of the base structure. Not only did the living space need to be maximized, but the systems of the home needed to be sized correctly for the dimensions of the home and also have the ability to easily adapt to additional demand on the resources created by growing families, along with a vehicle being charged from the solar array. This gave us an opportunity to apply innovative thinking to our project, as the question of how to mount a 24-panel array in a suitable orientation upon a 1000 square foot container home guided us to the deconstructed triangle as a potential floorplan. As this design was considered, the architects noticed the opportunity to incorporate a sloped ceiling as a means to open up the living space while the engineers developed their final roof design to give the solar panels the needed angle of orientation to the sun. This was the first of many instances where engineering and aesthetics would come together and solve any design challenges effectively.

Although power generation is a significant consideration for any net-zero home, it is not the only important one for this project. Structural and architectural engineers on the team worked closely together and with licensed Professional Engineers to ensure that the house could be safely transported and reliably reassembled. The decision to use shipping containers offered the advantage of allowing the Nest Home to fit easily onto five standard freight trailers, eliminating the need for oversized travel provisions and their associated costs and safety hazards, while the steel foundation reduces warping and makes the house transportable.

Engineering Controls

The raised ceiling and northern glass wall of the main living area serve as two of the Nest Home's simplest and most important design features contributing to overall energy efficiency and comfort. During hotter months, this design acts as a funnel that gathers hot air up and away from the living area. Because hot air always rises, and the narrowest point of the living space is the highest, while the widest point is the lowest, the movement of air along the ceiling is naturally more forceful and facilitates passive air flow. The top row of windows on the glass wall are controlled via motors connected to the automation system. When these windows open, the heat collected at the high point is vented and ceiling fans help facilitate the natural flow of air through the room. Conversely, in colder months, the windows stay closed and the hot air is trapped, but still able to move freely inside the home, spreading heat evenly to all the rooms and further easing the burden placed on the HVAC system. The use of Structural Insulated Panels (SIPs) on the roof creates an extremely effective thermal barrier adding another layer of passive climate control to the home year-round.

In addition to being an integral part of both engineering's climate control strategy as well as architecture's open floorplan goals, the northern glass wall is the lynchpin of the Nest Home's light-harvesting capabilities. Due to the combination of a northern orientation and careful positioning, the glass wall is shielded from direct sunlight, allowing most of the sunlight in while keeping much of the heat out. Because this design allows a comfortable temperature to be maintained without drawing a shade over the glass wall, the living space can be flooded with natural light every day of the year, minimizing the need for interior lighting during daylight hours. Additional windows situated under overhangs on the southern face and glass encasement around the entrances allow more sunlight into the home while continuing to minimize the interior's exposure to heat radiation.

Solar Thermal

The solar thermal system uses only the radiant energy from the sun to directly heat potable water via a solar powered pump system. It is an easily installed and simple to maintain feature in a home water system. The interior of the solar thermal panels are made of materials that are resistant to freeze damage, an important consideration in Missouri's temperate climate where winters can occasionally be quite harsh. Additionally, the cross-linked polyethylene (PEX) tubing used for the plumbing system offers superior protection over traditional copper and rigid PVC pipes against freezing, as they are able to expand with the water inside up to twice their operating dimensions before suffering permanent damage. This helps keep water flowing even as temperatures drop below freezing on the roof where the panels are mounted. Coupled with the freeze-resistant materials comprising the interior of the solar thermal panels, this design allows year-round solar water heating, eliminating a significant source of energy consumption especially within a family home in which multiple showers and/or baths might be run in a 24-hour period.

Solar Power

All the electricity used in the Nest Home is provided by 24 LG 3001C-B3 solar panels on top of the south-facing angled roof in a 4x6 array connected in two parallel branches of 12 panels each. The DC rating of this array is 7.2 kW and each panel is outfitted with an LG micro AC inverter delivering usable power to the home at a total AC rating of 6.84 kW. Use of this system eliminates the need for bulky DC wiring at the panels, allowing for much simpler installation, increasing energy efficiency, and protecting the home from the associated hazards of numerous DC cables in a small area. This size array was determined following considerations given to the demands of the home, hours of viable sunlight available on average daily in Missouri, while the orientation of the house and elevation of the roof took into account the sun's angle of declination relative to Rolla, Missouri. The Nest Home's power generation array is capable of providing enough power for all the family's needs in addition to charging an electric vehicle for daily driving.

Plumbing

The pressurized plumbing system within the Nest Home is built using PEX tubing, while the primary gravity-assist drain lines are rigid PVC pipes. The chosen materials eliminate the need for internal soldering of plumbing connections and the associated health and safety hazards associated with their installation while also providing significant advantages over conventional copper/plastic systems. The first advantage enjoyed by the team is the ease of installing PEX tubing. Far fewer fittings are required, as this tubing can be turned around 90 degree corners without the need for additional fittings and sections of tubing unrolled from spools can be installed in long runs without the need for couplings. The system is also resistant to common problems plaguing

copper and plastic pipe, such as scale build-up, freeze-breakage, and even noise of flowing water. PEX also insulates better than other pipes which adds to the energy efficiency of the home.

The advantages of PEX material are put to good use in the home's greywater system. Collecting runoff from the bathroom sink, shower, and laundry machine, the greywater system treats the runoff through a series of filters ultimately rendering it code-compliant for use as source water in the home's three hydroponic gardens. This water may also be used in the reservoir tank of the toilet, reducing water consumption by as much as 27% in addition to the water saved for use in the gardens.

HVAC/Thermal Envelope

A variable speed air handling unit (AHU) was selected following a detailed analysis of all relevant factors with respect to the home's final location and estimated energy balance (See Appendices A-C). The variable speed feature increases service life, but the real innovation in this system is the energy recovery ventilation system (ERV). This system mixes exhaust and inlet air flows in order to reduce the load the AHU must handle. As an example, if the air outside is 100 degrees Fahrenheit (F) and the exhaust flow is 75 degrees F at the outlet, the unit would normally need to perform enough work to change the temperature of the inlet air 25 degrees. By mixing the exhaust flow with the inlet flow, the fresh air is pre-cooled and the unit is performing less work, saving energy and further extending its service life. The remainder of the thermal envelope is maintained via closed-cell foam insulation and engineering design controls.

Passive Controls

Overhangs provide shade to windows exposed to direct sunlight; such windows are made as small as is feasible while still providing an open environment. The glass wall on the north face contributes to a positive energy balance through the use of natural light without direct exposure to the radiating heat of the sun. Closed-cell foam creates the primary thermal barrier between interior and exterior and ensures air leaks are minimal to nonexistent in the outer walls.

Lighting and Appliances

The lighting within the Nest Home utilizes dimmable LED sources extensively throughout the home. In addition to saving between 70%-90% relative to standard incandescent or halogen bulbs, these lights contribute miniscule amounts of heat with negligible effects on the integrity of the thermal envelope. Use of dimmable sources allows fine-tuning of lighting levels to achieve optimal efficiency in all levels of ambient lighting. All appliances in the home were selected with consideration given to striking a comfortable balance between efficiency and functionality. To that end, the equipment chosen was selected for Energy Star ratings or other emergent characteristics indicating superiority over competing products.

Electric Vehicle

The estimated impact of the electric vehicle, a Nissan Leaf, was calculated assuming seven total commuting tasks at 35 miles each. Based on the average cost (USD) of $540 per 15,000 EV miles and $0.12 per kWh, the vehicle is estimated to have an impact of 73.5 kWh on the energy supply system over the course of the 10-day competition.

Home Automation

The home automation system is a key component to unlocking the highest potential efficiency of the Nest Home. Automation is connected to all the electrical and mechanical systems of the house and is equipped with predictive software that makes adjustments to the lighting, HVAC, and ventilator windows in real time. The automation engineers elected to use a Loxone integrated communications system to maintain the precision control needed to achieve maximum energy savings while maintaining the thermal envelope at a user-defined preference. Many factors helped this system stand out above the many competing products available. The manufacturer's design is wired to allow the easy incorporation of third-party technology solutions and the company is continuously updating its product lines, ensuring any expansion of the home can be accommodated with compatible system parts. Finally, most automation systems considered were only supported properly on European voltages, while the Loxone system is operable on both US and EU standard electrical voltages.

The highest levels of efficiency will be achieved if the automation system is allowed full control over the engineering systems with which it is integrated. As the predictive software receives forecast information regarding weather conditions it makes real-time and even pre-emptive adjustments to the elements of the climate control system, a particularly useful quality in the Missouri climate during seasonal transitions in which operating the AC during the day and the furnace at night is a regular occurrence. Should the family so desire, manual control of the entire home can be accessed via tablet, smartphone or other data access device. Users can also view and track their energy usage trends, and the system will use these trends to continue improving efficiency of the home as it maintains the thermal envelope, essentially "learning" how to provide comfort to the residents at the lowest cost over time.

Climate Analysis

The team performed a detailed regional climate analysis for the Nest Home's permanent physical location following the competition using most recent ASHRE data available. See Appendix A.

Energy Balance Analysis

The team performed a detailed analysis of the integrated systems of the home and sought to reduce energy consumption using innovative means to preserve optimal levels of convenience and comfort. See appendix B.

System Sizing Analysis

The team performed a detailed load analysis and, also using information obtained in the climate analysis, selected system components based on their ability to operate continuously within their optimal efficiency ranges. See Appendix C

Design and Testing of Unique Technology

The team designed its own greywater system and assembled it from components selected for their ability to provide optimal functionality. See Appendix D

Expected Performance

See Appendix E for team's assessment.

Appendix A

Climate Assessment

Design of the climate control systems within the Nest Home was guided by a thorough assessment of the local Rolla/Vichy, Missouri region using 2013 ASHRAE data. The cooling system was designed to meet the ASHRAE 0.4% design condition for both wet and dry bulb loads, keeping the interior temperature at 75° F and 50% relative humidity during the cooling months, with the most energy intensive cooling month occurring in July. The heating system was designed to ASHRAE's 99.6% standard and has a target temperature of 5.6° F and mean coincidental wet-bulb of 9.2° F. This system is designed to keep the inside of the home at 72° F during the heating months, with the most energy intensive heating month occurring in January.

FIGURE 1: ASHRAE 2013 REGIONAL DATA FOR ROLLA/VICHY

2013 ASHRAE Handbook - Fundamentals (IP) © 2013 ASHRAE, Inc.

ROLLA/VICHY AIRPORT, MO, USA WMO#: **724456**

Lat: **38.13N** Long: **91.77W** Elev: **1138** StdP: **14.1** Time Zone: **-6 (NAC)** Period: **96-10** WBAN: **13997**

Annual Heating and Humidification Design Conditions

Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB	
			99.6%			99%			0.4%		1%			
	99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
1	5.6	11.2	-2.2	5.1	9.2	1.8	6.3	12.7	25.4	41.4	23.6	41.2	8.8	300

(1)

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB	
		0.4%		1%		2%		0.4%		1%		2%			
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
(2) 7	19.7	95.1	75.2	91.5	75.1	89.3	74.5	78.3	88.9	77.2	87.7	75.8	85.7	9.2	230 (2)

Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Hours
0.4%			1%			2%			0.4%		1%		2%		8 to 4 &
DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB	55/69
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
(3) 75.2	138.0	84.6	73.6	130.5	82.6	72.7	126.7	81.4	42.7	89.0	41.4	87.6	40.0	85.8	692 (3)

Extreme Annual Design Conditions

Appendix B

Energy Balance Analysis

The team maximized the potential for positive energy gains throughout all areas and disciplines of the design. The most immediately measurable benefits are seen in the innovations belonging to the mechanical systems. Solar thermal alone has the potential to reduce energy usage by up to 17% relative to a conventional system of the same size. Use of ASHRAE sec 62.2 compliant, variable-speed energy recovery ventilation equipment and water pumps selected specifically for their ability to minimize power usage despite restrictive system curves drive down energy usage even further.

Appendix C

System Sizing Analysis

A load analysis was performed using radiant time series calculations per ASHRAE 2013 standards for climate control systems. Indoor conditions for the home also designed to most current ASHRAE recommendations for energy efficient comfort. Electrical system sizing estimation was performed using the NREL system advisor model (SAM) software suite and comparing the results to the PV Watts software suite. After running the simulations, both programs returned similar results, inspiring confidence that a 7kW array would produce all the energy the Nest Home requires.

Appendix D

Unique Technology Design and Testing

The greywater system was designed by the team to support up to five people and remain maintenance free for up to a year. A triple-filtration system combined with a first-pass strainer help process the greywater quickly for use throughout the house. The system has been tested out as waterproof and odor-proof. It has also met the requirements for adequate flow rates given the pumps selected to operate the home's water distribution system.

Appendix E

Expected House Performance Discussion

Given the careful attention to detail the team has paid the project since its conception, along with innovations in passive design, wise selection of materials and appliances, thorough vetting of the engineering systems included in the home, and the continuing testing still ongoing until the house is disassembled, the team is confident they have built a house that will, at minimum, perform as advertised and at best, exceed our expectations.

Market Appeal Narrative

The Nest Home is targeted toward professional couples with one or two children. They may be newly working in their careers or firmly established, with a college education and a mid-to-high income. The design is suited to function as both a primary residence and a vacation destination, depending on the needs of the client. As those needs change over time, the Nest Home is designed to conveniently adapt and grow to meet those changes.

The use of steel shipping containers as the structure allows the bulk of the home to be transported by truck without the restrictions associated with non-standard loads, even after full prefabrication is complete. This means the client may choose between the options of building on-site or prefabrication at far more convenience and significantly less expense than would otherwise be possible. Do-it-yourself (DIY) features such as the concrete countertops in the kitchen save money and allow the option of customizing the interior accents with unique personal flair.

The Nest Home was designed to be more than a solar-powered house, it was designed to be a home. While the idea of off-grid living is appealing to many, an integrated, intuitive, and user-friendly home automation system is what helps take the Nest Home from ultra-efficient to ultra-comfortable and efficient living. A greywater system helps conserve water by capturing runoff from the shower, bathroom sink, and laundry machine. The runoff is treated through a triple filter system, rendering it code-compliant for use as source water in the hydroponic gardens, providing fresh food for the family.

The home automation system uses an intuitive software to process real-time weather updates and adjust the mechanical and electrical systems of the home to optimal levels instantly, leaving the residents free to enjoy the well-engineered comfort of their home as lights are automatically dimmed during times of ample natural light, or the HVAC system is adjusted preemptively as a cold front moves in to the region. Even though the design and construction of the Nest Home all but assure that net-zero living could be achieved without an automation system, the fact that a working parent never needs to worry about a window being left open in the rain or a light being left on needlessly is a valuable comfort asset this house has to offer its target demographic. Top off this list of benefits with convenient manual control of the house via smartphone or tablet, and the system gives the residents unsurpassed control of their comfort.

Other comfort assets offered by the Nest Home include a cleverly designed open floorplan that virtually eliminates interior partitions and combines an upward sloping roof with a glass wall to create an informal solarium within the main living space. For privacy, two container modules are positioned opposite each other to form the bedrooms and an office without encroaching on the communal area. A kitchen island creates a seamless partial border between the dining area and the kitchen, allowing room to work safely and traffic to flow without bottlenecking. The built-in secretary desk offers an additional place to work from when the office is in use, a perfect feature for busy professional couples.

Just as all the materials used to construct the Nest Home are family and eco-friendly, so too is all the installed equipment expansion- and user-friendly. The plumbing system is designed using low-maintenance PEX tubing. The homeowner can rest easy knowing that a sudden cold snap freezing the water lines won't yield the potentially catastrophic results encountered when copper or PVC lines freeze unexpectedly. The solar thermal panels are composed of freeze-resistant material that works with the PEX tubing to ensure the flow of solar-heated water in the house is maintained even when temperatures outside fall to below freezing. The Loxone

home automation system was specifically chosen for its direct compatibility with standard US electrical power grids as well as the manufacturer's aggressive product-line innovation and development which ensures if the home is ever added on to, that the home automation system will be able to keep up.

For professional working families looking for a way to comfortably experience off-grid sustainable living, the Nest Home offers an incredible opportunity at a fair market value of an estimated $300,000. A reasonable investment for a home that can be built and transported almost anywhere without special freight precautions, and then set up and provide its residents with nearly everything they need, from food and water to shelter and comfort.