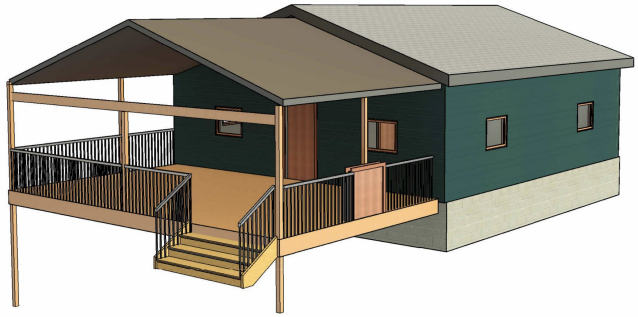
High Country Retrofit

Solar Decathlon | US Department of Energy
ASU Goldfinches | Retrofit Housing Division
Project Summary 4/4/2023

Appalachian STATE UNIVERSITY



Project Summary

The Goldfinch Retrofit Team from Appalachian State University is a group comprised of a balanced body of students from the Building Science and Interior Design majors responding to the housing crisis in Boone, North Carolina. Our town, once a quiet, vacation community, has seen rapid population growth that has caused housing costs to skyrocket. As more students fill up apartments, Boone locals have had to move out of town or into old, rundown vacation homes—many that were never intended for permanent residency . We devised a plan to take those dilapidated, inefficient houses and rejuvenate them by overhauling the envelope and updating systems to create a comfortable, high performance home, starting with our client's home.

Our client, Sarah Grady, is a construction manager for Habitat for Humanity and an Appalachian State University alumna. We worked with her to create a fluid retrofit design that fit her specific needs and can also be applied to similar homes. Our goal was to find a viable and effective blanket solution to many homeowners' problems that will greatly benefit our community in the future and become the local standard for retrofits.

Design Strategy

Sustainability - We worked to find the best designs, materials and equipment that will ensure energy efficiency. Our main focuses—a tight thermal envelope, an effective HVAC system and energy-saving appliances—are based on the Phius Core Revive standards to certify a high performance home.

Durability - Our material selection and system design is greatly influenced by Boone's abnormal climate. Our town sees high intensity wind storms and heavy snowfall in the winters, high humidity and mold during the shoulder seasons, and above-average rainfall throughout the year. We aimed to keep this home in pristine condition even with years of punishment through resistant exterior siding and impervious envelope barriers.

Equitability - Nothing discussed so far matters if the design choices we make cannot be afforded by our client. Every single proposal will be heavily scrutinized to make sure it is the most cost-effective it can be. Not only did we focus on making sure the retrofit is as inexpensive as possible, but we also strived to greatly cut her cost of living with our aforementioned sustainability strategy.

Comfort - Many times, redesigns can take away the familiar and comforting feeling that something—especially a home—holds. We realized that no matter how high performance our house is, it's useless if no one wants to live in it. Aesthetics for both the exterior and interior were carefully planned out as structural decisions were made.

Flexibility - Although we started with only one client, our goal with this project was to create a solution for many in the area who face the same issues. We wanted to create a design that conformed to our client's needs and achieved everything she hoped for, and also one that can be replicated with only slight modifications in lieu of other residents' needs.

Project Data

Client:	Sarah Grady
Location:	Boone, NC
Climate Zone:	5A (Western NC Mtns)
Lot Size:	21,780 sq. ft
Building Size:	700 sq. ft
Avg. Utility Cost:	$130/year
Avg. Carbon Emission:	5.6 tons
Target Cost:	$60,000

Technical Specifications

	Existing	Planned
Wall R-Value	R-11	R-40
Floor R-Value	R-15	R-30
Roof R-Value	R-26	R-60
Window U-Value	0.45	0.17
Window SHGC	0.5	0.23
EUI	79.15 kBTU/ft^2	-0.68 kBTU/ft^2
WWR	7.8%	7.8%
Target HERS Score (w/o PV): <50 (w/ PV): -5		
HVAC - Electric Mini-Split Heating/Cooling; 6,000 BTU; 33.1 SEER		

Project Highlights

Architecture - To maintain symmetry with the surrounding community, we chose engineered wood lap siding for the cladding and corrugated metal for the roof. We are replacing all windows in the home with Alpen Tyrol series 6 windows and installing a ThermaTru fiberglass insulated front door–the only entrance to the home. In the interior, we fully renovated the bathroom, adding water sense features, and replaced the fridge and range with their ENERGY STAR counterparts.

Engineering - As a retrofit, we utilized the existing structure, focusing solely on improving the envelope and its subsequent barriers. The existing engineering is a 2”x4” wall assembly with a 2”x4” roof truss system with a CMU Foundation wall and poured concrete footers. To seal and waterproof the home, we are covering the structure in continuous Huber ZIP Sheathing and then attaching continuous insulation to that. To handle bulk moisture, we are installing a rainscreen behind the cladding.

Market Analysis - Our team was retrofitting a two-bedroom, one-bathroom house located in Boone, North Carolina, where the medium home value now sits a little under $500,000 and nearly 1 in 4 people are in poverty. We crafted our budget based on those statistics and our client’s constraints to find the best materials for an energy- and cost-efficient home.

Durability and Resilience - All materials selected for the retrofit were done so for their long lifespans and requirement for minimal maintenance; most requiring only annual upkeep. The most important barrier to the elements—the siding—has a projected lifespan of sixty years. Most vendors that sell these services and materials provide a lengthy warranty allowing for ease of replacement. The metal roof and engineered wood siding are very robust, allowing for continual exposure to the elements for decades and little damage to the material itself; It furthermore allows for continual protection of the envelope and control layers. The crawlspace was encapsulated with a water/vapor barrier and a dehumidifier placed inside to reduce the risk of moisture damage to the structure due to the region’s humid and rainy summers.

Embodied Environmental Impact - We selected materials which prioritized low energy consumption in the manufacturing process as well as found local sources for as many materials as possible. Recycled, local and pre-existing materials all contributed to minimizing the carbon footprint of our project. A life-cycle assessment was utilized to guide low carbon impact material selection. Our design targeted the use of the Goldfinch score to support a design of low carbon and maximum energy performance. The final count for all materials added is 4,257 Kg CO_2e.

Integrated performance - The Gold Finch Score is a scoring rubric we developed for whole house system integration. It takes into account Budget, Energy Ratings, and Life Cycle Analysis of each material. Each subsection has a weighted scoring attached to it, i.e. affordability has a greater impact on the final score than does locality. This allowed us to seamlessly compare envelope options while taking into account all aspects of the building and design process.

Occupant Experience - We listened to our client’s wants and needs to ensure we did our best to provide her with the comfort and luxury that an ideal home should have. The inhabitants will benefit from all sustainable elements we added - such as the addition of the Alpen TR-6 triple pane window - that can withstand any obstacle she has faced during the changing seasons. The features we used are high performing, energy efficient materials that will help the client feel safe and comfortable in her own home, while also providing economical and environmental benefits to her lifestyle. The newly air-sealed structure, along with a superior HVAC System, dramatically increased air quality within the home while simultaneously driving down energy bills.

Comfort and Environmental Quality - The comfort of the retrofit begins with the mechanicals. We have ensured that our ductless mini split system is properly sized according to our calculated heating and cooling load, which means that it will provide optimal comfort without wasting energy. Furthermore, we included a Broan energy recovery ventilator (ERV) as well as a Broan inline supply fan enclosed in the attic. The ERV provides fresh air to the main area and exhausts stale air from the bedrooms. Meanwhile, the inline supply fan circulates conditioned air from the living area passing through a MERV 13 filter and supplies it to the bedrooms. Ultimately, we recognized the interdependencies of these three systems to create an environment that is healthy and comfortable.

Energy Performance - We started our project by assessing the home's current energy performance by doing a residential energy assessment. Our team performed a blower door test and utilized thermal imaging to determine the biggest faults in the envelope. Current appliances and systems were also vetted. Our starting HERS rating was 104; our proposed designs aim to bring it down into the mid 40s. This was achieved by replacing the fridge, water heater, and dishwasher with Energy Star equivalents, putting in triple-pane windows, removing the antiquated oil furnace and creating an air-tight barrier that will reach below a 1.0 ACH 50. After all of these improvements in conjunction with solar production, we achieved a HERS of -6. Furthermore, we looked into becoming involved in community solar to get our design to net-zero and achieve the highest Gold Finch Score.