

Architecture

U.S Department of Energy

Solar Decathlon 2023

Build Competition



University of Colorado Boulder Team

03/28/2023

Introduction

Affordable Housing is changing. As our societal needs change, grow and adapt, so will every other aspect of our lives. The main challenges that our generation faces are climate change-related dangers, population growth (and, therefore, more vertical living quarters), and highly efficient systems to mitigate energy use. To combat these challenges, our outreach is to redefine housing for the greater front range region by creating a model of efficiency and comfortability. Our mission is there for threefold:

- 1) Raise Awareness in the community on sustainable building solutions
- 2) Train the next generation of building professionals on sustainable building solutions
- 3) Create a higher standard of affordable housing focused on energy efficiency, occupant health, long-term resiliency, and repeatability.

The Canopy is a cutting edge, energy efficient home that takes us from Net-Zero energy to Energy Independence.

Architectural Background

The Canopy is in Boulder, Colorado in the Ponderosa Community. The Ponderosa community is a diverse, tight-knit community in north Boulder. After catastrophic flooding in 2013, the city of Boulder purchased the community to preserve a Long-term affordability. Ponderosa is an underdeveloped location that is within the 25-year flood plan of one of Boulders' many creeks. Habitat For Humanity built to build over 30 dwelling units in Ponderosa over the next ten years to provide adequate housing and replace the flood-devastated trailer homes The CU Boulder Solar Decathlon team saw this as an opportunity to partner with the City of Boulder and Habitat for Humanity to prove that efficient, affordable housing is obtainable and repeatable.

Not only has this community been constantly plagued by flooding, but just south of Ponderosa not 20 minutes away, the Marshal Fire (the most destructive fire in Colorado History) took place. The site and building that our team chose gave us our initial limitations. We had a very small property line, one that the original building design was already leaning on. We knew this was going to be an issue as not only did we have to increase our plan and envelope, but also include a sufficient rooftop overhang to properly protect the interior from the harsh summer sun. Within the home itself we had to reanalyze the fenestration on the façade of our building, reevaluate the structural systems and reorganize the original home's plan to ultimately utilize passive design strategies and optimize user comfort. A major aspect within the ponderosa community was a lack of storage space. The people of the ponderosa community have lived here for generations and have accumulated memories and tokens. However, in their current living situations they don't have the ability to store their belongings inside their homes.

Upon taking on our partnership with habitat for humanity, we had our "pick of the litter", we had the opportunity to choose between any of the 5 different types of units to modify, and redesign: a single floor two-bedroom ADA home, a carriage home, duplex's, and triplex's. The CU-Boulder team chose the Carriage House as our site and home. Why? Carriage homes are famously known for their inefficiency but are becoming increasingly popular in the front range region as they increase storage and garage space while keeping the same footprint on the surrounding land. This building also allows us to take advantage of the height the carriage house offers and orients us toward the south to best capture the sun for our photovoltaic panels.

Architectural Goals – Integrating Design

Architecturally, this site was interesting. Unlike many of the other projects, we didn't get to design our form since we are adapting our site from a pre-existing plan. It almost seemed like we were trying to design as an adaptive reuse project, since our form and site were already planned and approved. In fact, we didn't want to change the form, because we wanted our home to blend in with the rest of the community homes, so as not to stand out or to be "special". You know the saying "Form Follows Function" as in you develop your function and program first and then create your form around that. Well instead this project was "Stuff your function into the form" even though the expected functions of our house seemed to increase tenfold from the original functions. These issues and challenges were something that needed to be addressed, not simply because this is our site, but so we can teach future generation builders on how the same forms and ideas of average buildings can be redesigned to be a beacon of self-sustainability and efficiency. So, our main architectural goals are these:

- 1) Creating a Robust and Efficient Envelope
- 2) Increase Occupant Health and Experience
- 3) Energy Efficiency for Low-Cost Utility
- 4) Resiliency in weather and climate related incidents
- 5) Repeatability for production in affordable housing

Design Strategies

Layout

We reconfigured the original layout to optimize natural light, wind flow, circulation through the home, and occupant experience. It was also redesigned to create a shared, one wet wall where all of the major home HVAC and plumbing fixtures can travel. We also reevaluated the structure and lost space in the previous design, where there was an attic with a 10' tall wall that was restructured into a loft.



Integrating Passive Design and Engineering

We reevaluated the fenestration of the building and location of openings to best utilize the orientation of the home and its position with the summer and winter sun. During the winter the average temperature hovers around 30 degrees Fahrenheit and with an average wind speed of 17 mph. During the summer the average temperature is 78 degrees Fahrenheit and an average windspeed is about 6 mph. By extending the overhang on the northern side and increasing the size of the windows on the north side we can regulate the amount of sunlight and passive heating in the summer and winter. The windows were also placed to capture and direct wind from the southwest mountains to get cross ventilation and convection cooling in the home. We also switched out the single and double hung windows for triple pan fixed or casement windows to ensure our interior does not lose energy. The windows in the loft create a more Pleasant Ambient light in the bedrooms while increasing the value of the space.



The loft was designed in order to increase the storage capacity it the house by 80 sq.ft. The kitchen was designed down to the fraction in order to maximize overhead storage and cabinet space while creating a more open and accessible plan.