

**SPARC
HOUSE**

**PROJECT
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01

ADDRESSING LOCAL CHALLENGES TO SPARC GREATER CHANGE

Through competing in the U.S. Department of Energy Solar Decathlon 2020 Build Challenge, the University of Colorado Boulder Solar Decathlon Team aims to confront the housing attainability crisis and construction challenges faced in mountain towns across the nation.



Designed for both panelized and volumetric prefabrication, and incorporating an attached rent-able unit, high-efficiency systems, energy recovery methods, and rooftop photovoltaics, the zero energy SPARC House will serve as a replicable example of high performance and attainable mountain town housing. The five design pillars of the SPARC House include Sustainability, Performance, Attainability, Resilience, and Community.



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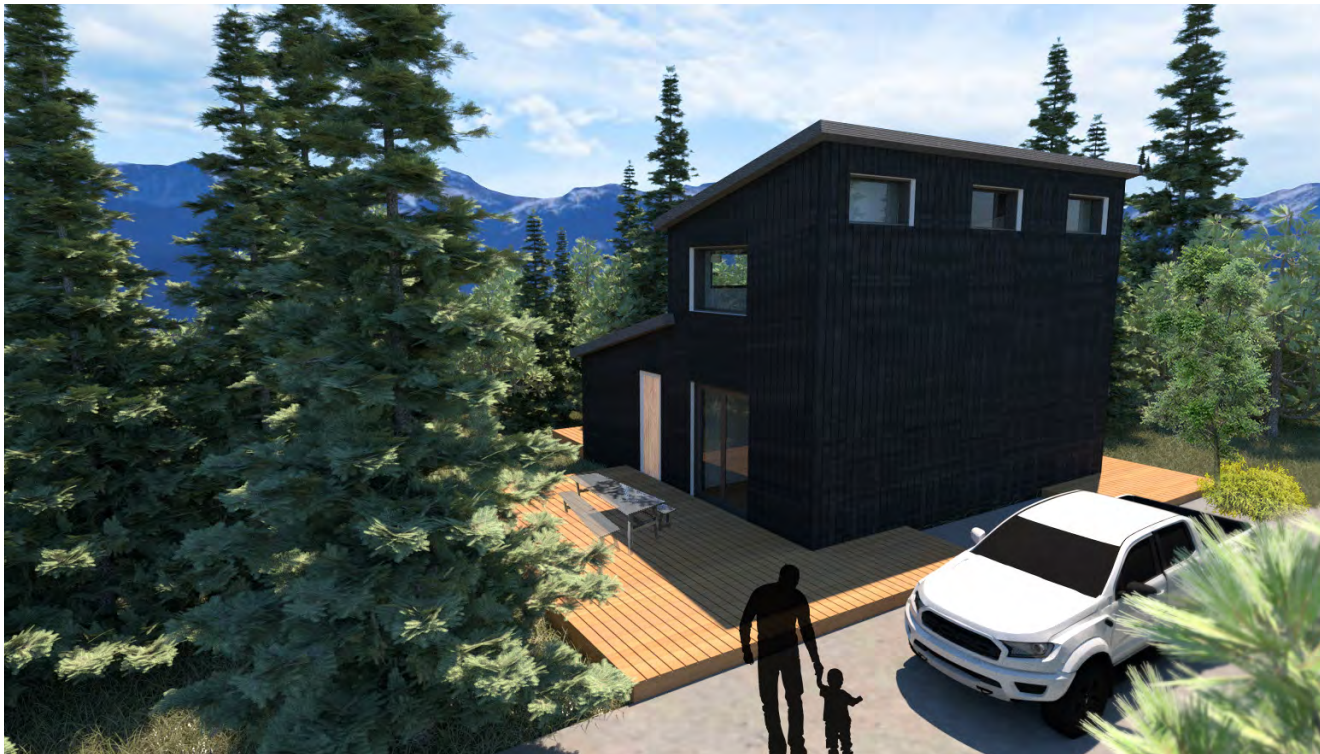
CHALLENGES IN MOUNTAIN TOWNS AND BEYOND

Mountain towns face unique construction challenges that lead to increased housing costs, which negatively affects local communities. The cold climate causes a short building season, the second house market leads to skilled labor shortages, and land is expensive, which creates a market that is

not conducive to builders targeting the single-family, working-class demographic, a demographic that is imperative to the health of the communities. The housing attainability crisis is amplified in these communities as locals are being displaced and seasonal workers are left without options.

In parallel, the CU Boulder team recognizes that climate change is an urgent crisis. Buildings contribute to 40 percent of annual energy use in the United States, creating a real opportunity for the residential construction sector to make an impact. Traditional building design, construction methods, and acquisition models must be reevaluated to reduce negative environmental impacts now.

The SPARC House aims to serve as a model for residential construction that, compared to industry standards, produces less carbon emissions, pollution, and waste, while being more energy efficient – all at a comparable cost. The CU Boulder team sees an opportunity to address issues of social inequity in mountain towns while minimizing environmental harm.



PILLARS OF DESIGN

Sustainability



Social Equity

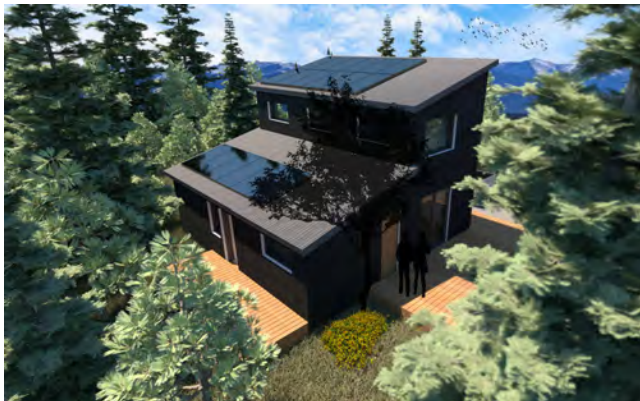


Environmental Protection



Economic Prosperity

The triple bottom line of sustainability was fundamental in the development of our design philosophy, and is thus our first pillar of design. The remaining four pillars are rooted in its foundation. Our team recognizes the importance of addressing all three principles of sustainability: economic prosperity, social equity, and environmental protection.



Performance



Passive Design



Active Design

High energy performance is critical to reducing the home's environmental impact and achieving our goal of attainable mountain living, which includes low operating costs for homeowners. Design strategies include a small land footprint, highly insulated, air-tight structure, natural ventilation and daylighting, orientation-tuned glazing with a low window-to-wall-ratio on the north facade, high efficiency equipment, zone-based ductless mini-split heat pumps, an energy recovery ventilator, a heat pump water heater, maximum power point tracking on the solar panels, and a central control system to engage occupants in easy operation of the house.

Attainability



Prefab Construction



ADU

To promote attainability, the SPARC House is designed to leverage prefabrication construction methods and, with the addition of the rentable accessory dwelling unit (ADU), bring in supplemental income to homeowners while offering more affordable rent options to seasonal dwellers than what is otherwise commonly available in mountain towns.



Resilience



Demand
Response



BAS

The SPARC House will demonstrate the concept of resilience in several ways including grid islanding capability, battery storage, on-site energy generation, demand response capability, and a Building Automation System that can proactively control the space to an optimal electric demand profile. Climate change threatens grid reliability. With demand response functions, the SPARC House can react to signals from the utility and reduce stress on the grid when requested.

Additionally, the building envelope is made of low global warming potential options such as a wood structure, wood cladding, and sheep's wool insulation.

The materials are durable and will require minimal maintenance over time, and can be repaired with relative ease.



Community



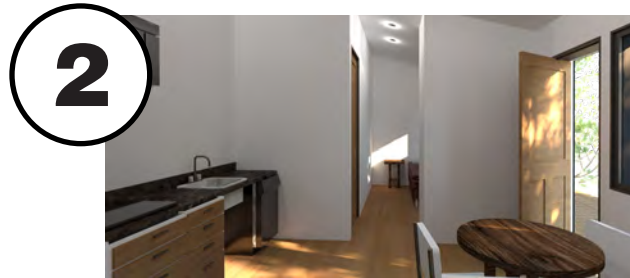
ADU

The SPARC House's ADU provides a multifaceted solution to the displacement of seasonal and year-round service workers in mountain towns. First, the approach creates more rent-able living spaces and strengthens communities by meeting the needs of members of society that may not be able to afford typical living costs but play an integral role in shaping local economies. Second, long-term rental fosters interaction and communication within towns, promoting the development of new relationships and unified neighborhoods. With the adoption of the SPARC House, mountain towns will be able to showcase the power of sustainable housing and sustainable communities.

INTERIOR DESIGN AND VIEW-BY-VIEW WALKTHROUGH



This view displays the home as you walk into the home through the double door on the rear. In this shot you can clearly see the kitchen layout and finishes.



The view shown here is of the ADU from the kitchen side. Towards the back of the space is the bedroom and bathroom. This would ideally be a space for one person.



This is a view from the landing on the staircase. You can see more of the furniture in this main space from this angle, including a couch and table.



This is a view from the upstairs of the home. From here you can clearly see the office space with plenty of natural light. To the left is the master bedroom and bathroom.

THE SPARC MARKET

Mountain communities face multifaceted challenges due to their unique location. Harsh weather conditions create the need for resilient building systems and materials, and winter tourism causes a drastic seasonal influx of residents needing rental housing. Using traditional on-site construction methods, costs are high and schedules are often delayed, stifling development to keep up with the demand. The housing market lacks attainable options for the following key demographics: seasonal workers, first-time home buyers, and permanent residents. Without stable housing options for these demographics, local economies suffer as businesses struggle to hold staff.

The SPARC House addresses the needs of the affected demographics in several ways. The attached Accessory Dwelling

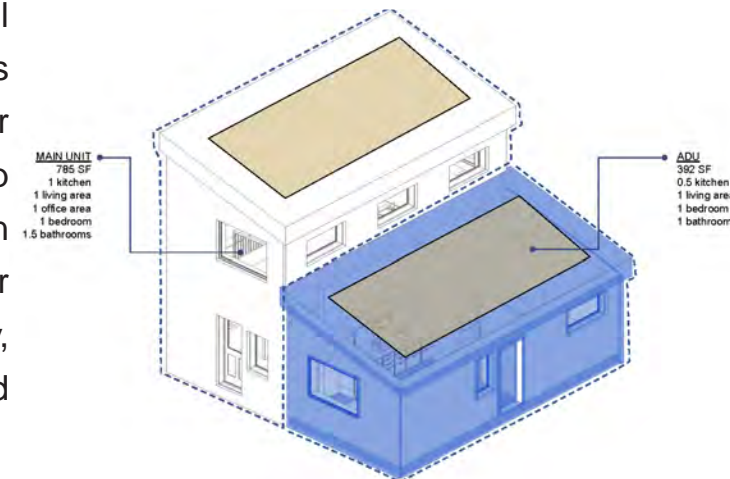
unit can serve as stable rental housing for seasonal workers and generate essential income that helps first-time home buyers and year-round residents pay a mortgage. With a space-efficient, multi-use floor plan, the SPARC House achieves flexibility as the household grows. In addition to renting the ADU out to seasonal-workers, it can be used by the full-time residents, transforming the house into a cohesive 2-bedroom house, or it can be used for a relative aging in place.

With energy modeling and thoughtful design, the SPARC House consumes less energy than standard similar homes and is powered by rooftop solar photovoltaics, avoiding mountain community utility costs that can be higher than the national average. Additionally, smart systems reduce maintenance and

recovery costs, reducing the effective price of the home. The SPARC House is a model of an attainable, resilient, and efficient home that meets the needs of all of its residents.

SPARC House

- 1,177ft²
- 1.5 Kitchens
- 2 Living Areas
- 1 Office Area
- 2 Bedrooms
- 2.5 Bathrooms



MODULARITY AND THE IMPACT OF AN ADU

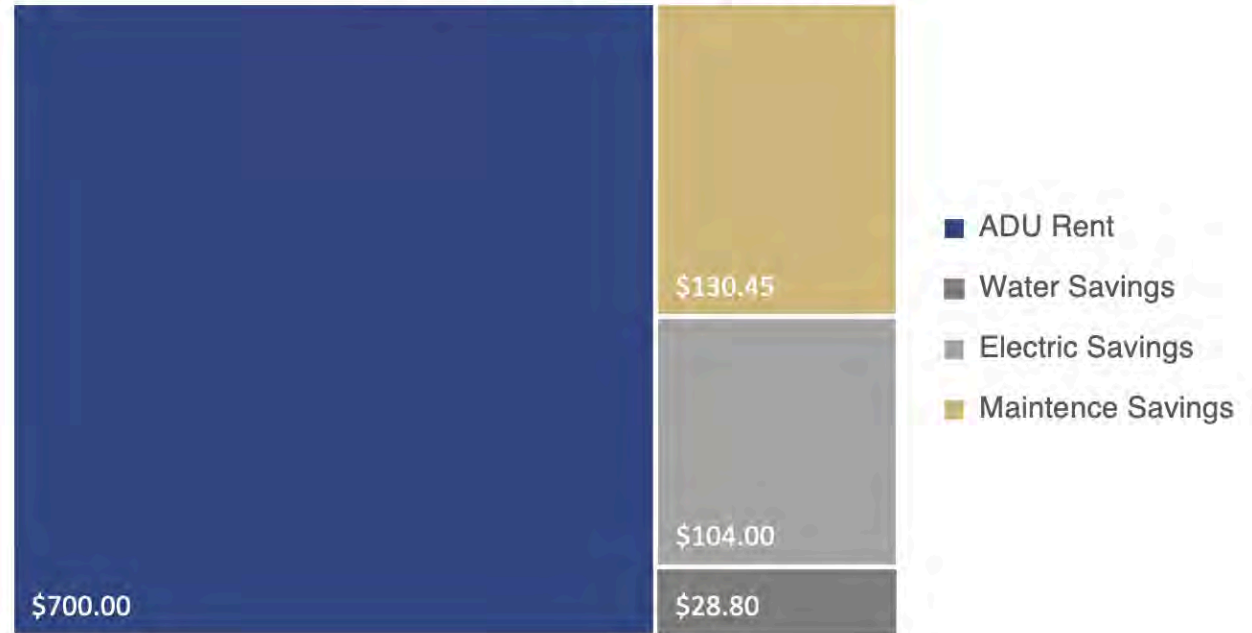
The SPARC House addresses mountain town construction issues in unique and practical ways. One aspect that sets this home apart is the addition of an Accessory Dwelling Unit (ADU). The ADU combats the housing affordability crisis seen in mountain towns on two fronts: 1) by creating revenue for the homeowner and 2) by providing affordable, quality housing for seasonal workers of mountain communities.

With the rent-able ADU, the SPARC House strengthens the local community by providing housing for locals who cannot afford the median home price. This stimulates the local economy through encouraging local investment and increasing the number of people working and spending money in mountain towns year-round. The ADU also provides passive income for the homeowner, thereby reducing the price of the home.

Additionally, factory construction is key to the SPARC House. The modular design of the house allows for the construction to be prefabricated in a factory. Factory prefabrication reduces overall material waste and litter. Through the use of controlled environments and

technology, it is easier to measure and cut only needed materials, use excess materials on other projects and properly dispose of debris. Prefabrication also allows for a shorter timeline than on-site construction and reduces disturbance to the surrounding

Total Monthly Savings- \$963.25



environment associated with construction activities such as noise, material/tool storage, and high personnel traffic as well as weather delays.

The SPARC House design is intended to be produced in high-volume in a prefab construction facility. Mass prefabrication lowers construction costs



by reducing build time through efficient, streamlined, and controlled processes. On top of being panelized, the home is designed for transportation in volumetric modules. Integrating the systems and interiors into modules that can be prefabricated can improve quality and consistency, and when streamlined, this method can greatly reduce the construction timeline.

In the case of mountain towns where the cost of land can be high, smaller building footprints save money on both land and foundation and require less demolition in the surrounding natural environment. Through a two-story design, we save money in these areas without sacrificing space and, with a square footprint, orientation can be tuned on various lots to tailor photovoltaic production, solar gain, and views.

ADU Revenue



Payback Period:
11.2 years
 (Compare to a Standard 30 year loan)

COLD CLIMATE RESILIENCY

Cold Climate HVAC

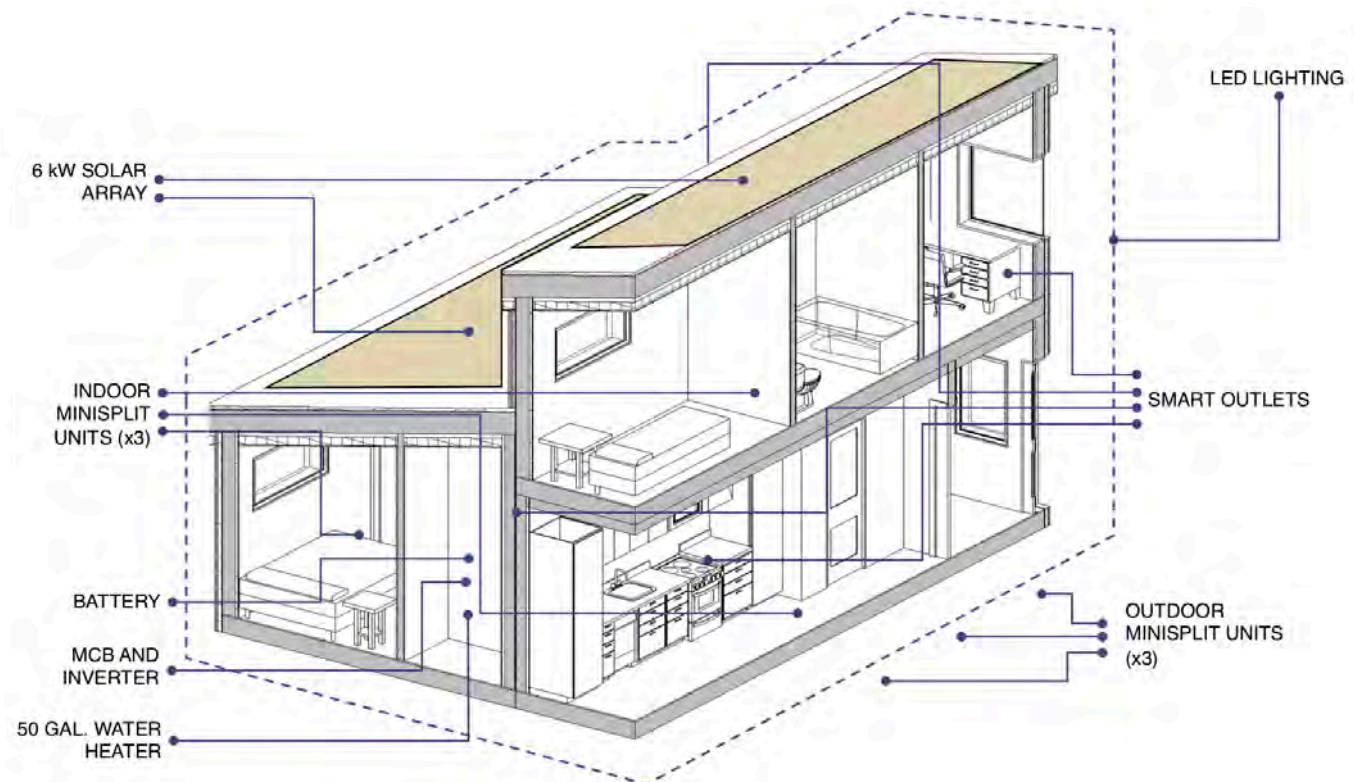
As part of a cold and dry climate (IECC climate zone 6B), Fraser poses a particular challenge for mechanical heating and ventilation design. The envelope design and construction is designed to protect the house from unintentional outdoor air infiltration but the required ventilation still introduces an overwhelming amount of cold air. To mitigate the load on the mini-split system an air-to-air heat exchanger or energy recovery ventilator (ERV) is used to reclaim both heat and moisture from the exhaust air.

Inside the house, three indoor units direct air within critical zones and act as an additional temperature control. These three units are fed by three distinct outdoor units. By sizing three smaller outdoor units we are able to ensure the units operate with high efficiency during

the majority of hours with non-extreme temperatures and remain operational for a larger range of heating and cooling loads. Should the outdoor temperature drop too low for these units to work, emergency heat is supplied by electric resistance baseboards.

Demand Response

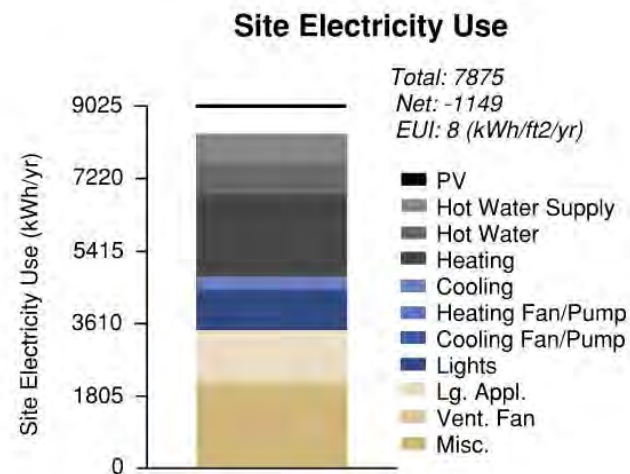
The SPARC House is designed to not only be an energy efficient house through passive design choices such as wall construction and glazing placement, but a smart home that leverages its active systems to push and pull electricity from



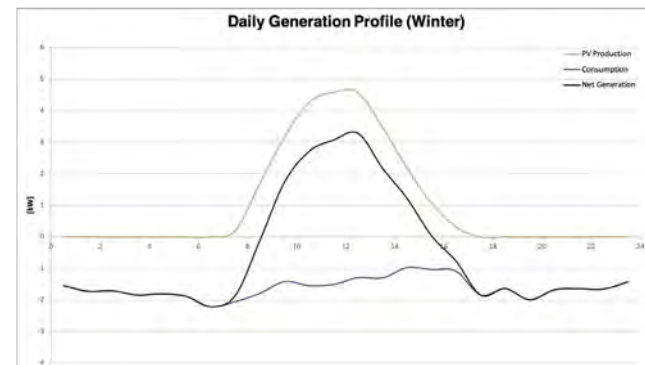
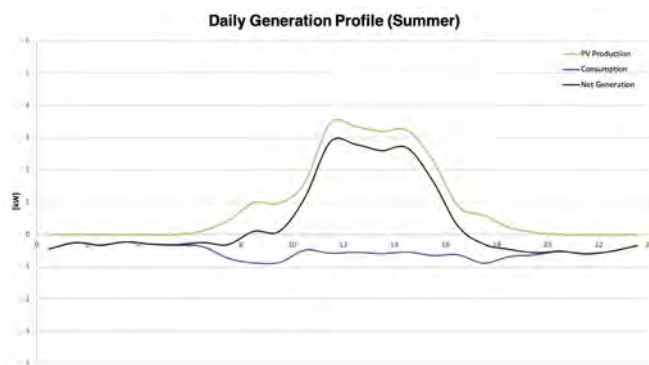
the grid when it is most beneficial for the community. Through the implementation of a Building Automation System (BAS), the house is designed to minimize power mismatch and energy storage in the home battery. The BAS reads information from the current state of the house and utility grid requests in order to control active systems such as HVAC, lighting, and battery energy storage. The BAS integration means that the SPARC House easily and automatically responds to requests from occupants and the electric grid to keep the owners comfortable and to ease strain on the power grid when necessary.

The BAS will enhance occupant comfort by controlling loads such as lighting and HVAC during normal operation in response to time of day, daylight availability, and setpoints. During

periods of complete isolation from the electric grid and low generation SPARC House will operate on reduced setpoint schedules until the utility comes back online or solar generation is restored. Electric loads that do not have or require BAS override will be monitored for energy consumption at the circuit level to alert the owners to irregularities in operation.



Daily Energy Consumption vs. Production



LOOKING AHEAD

Our project had a tangible impact from the start of the competition. From the beginning, our team worked with clients to design a home to meet the needs of their lifestyle. While they provided input and thoughts about the design of the home, they gave our team creative freedom to design the home, knowing that

their needs will be the center of our design. Both individuals have worked in the renewable energy and energy use industry, providing a mutually beneficial relationship between client and team. After the home is completed in Fraser, Colorado our clients will permanently live in the home, year round.



The town of Fraser and its town council representatives are active voices in our design and construction process and, with their recent adoption of a 200 square foot minimum ADU allowance, are well positioned to help the owners carry the message and example forward in the community. The team and the owners plan to continuously monitor the house performance over time to offer insight about successes and lessons learned for future iterations of the design. Our team is proud to build a home that will meet the needs of our clients and provide a case study for the future of residential construction in mountain communities.