MARKET ANALYSIS
D8 SUBMISSION

University of Wyoming (UWYO)
U.S. Department of Energy
Solar Decathlon Build Challenge
2023

Table of Contents

Introduction

The goal of this house is to not be eccentric but efficient, comfortable, durable, and high performance. We believe that a well designed, engineered, and constructed Zero-energy home will appeal to a wide market in Wyoming. Currently there is nothing like this available in our state for people looking to buy homes, so we are truly at the frontier. We can market the house with comfort, quality, and design, but in addition we can sell people on the idea that you can have a better home (and more valuable) for the same monthly payment as a typical home plus utility bills. The energy efficiency and production can translate into owning more for the same monthly price.

Through years of work around the State, our team, (including the builder) feels we have a solid understanding of what people want and are willing to pay extra for. The builder also has a keen understanding of his region and the clients and potential clients for the site. This house is intended to be sold as a high-end speculative home after completion, targeting innovative people of any age or background. This design is intended to invoke a new style of living, heightened from the typical Wyoming (and American) household.

Attainable Sustainability – It is apparent that the world is changing. That it is time to create a more sustainable way of living, a more sustainable life, and our life begins in our homes. While we recognize the need for change in the building industry. It is not always so apparent to the average homeowner. We are here to change this.

We are striving to show both homeowners and contractors that a sustainable home is attainable without sacrificing form or function. Advancements in technology have made it easier to get costs comparable to industry standards, with results that are anything but standard. Advancements do not only stop with technology; designs have had a significant improvement in the appearance of visible systems. In our house's case, it is what is hidden behind the gypsum and concrete that stands out.

It is said best by Morgan Toye with Timshel Construction: “The best part of the house is something you cannot see” and we could not agree more. Becoming knowledgeable about sustainable building is a challenge initially. There are lots of integrated parts, extra steps, and sometimes steps you have never experienced before, and this steep learning curve of systems can be

overwhelming. However, the good news is that resources are abundant, these processes are easier to follow and understand, and when plans that spell it out for you are laid in front of you, it is just like any other home.

The Wind River house will set an example, it will give contractors a new perspective on sustainable building and that it is just like any other build. It gives them the confidence to tackle these projects. It gives people the confidence that their home will be more efficient while providing the same aesthetic as a traditional building. It is because of the advancements made in technology and design that sustainability is more attainable than ever.

Buildability

According to the US Census Bureau, from 2010–20, the number of available housing units in the Lander area (Fremont County) decreased by 2.2%, compared to the Wyoming state average which increased by 3.8% [1]. Due to rising housing supply shortages, unpredictable costs associated with custom homes, and lack of affordable, entry-level homes, prospective homeowners are flocking toward spec homes. They are affordable, timesaving, and do not have the associated unpredictable costs of custom homes. However, one of the downsides of spec homes, especially for contractors, is that market needs or trends could change before the property is ready to sell. Contractors, therefore, need to anticipate the future of the market. Timshel Construction foresees that Zero-energy homes will be at the forefront of market needs in the immediate future.

Where spec homes intersect with Zero-energy homes there are unique opportunities to test the boundaries and acceptance of sustainability. Prospective homeowners may not be as familiar with sustainable building techniques as contractors and the initial risks associated with incorporating such technology in custom-built homes could be prohibitive. However, with spec homes, prospective home buyers do not have to bear the brunt of any perceived risks.

However, there is a lack of general contractors that specialize in the construction of Zero-energy homes. According to Nicole Tysvaer, the CEO of Symbi Homes, the technology exists, but there is a shortage of human resources to market, educate and install this new technology [2].

The Zero-energy home movement, especially in Wyoming needs the injection of resources to market and educate this new technology. Our team believes that one way to do this is to show that it can be done, to show that sustainable homes are attainable. Therefore, buildability is key, especially with spec Zero-energy homes. Contractors need to be convinced that it can be profitably done. The Wind River home takes this first step. Our team worked with the contractor in making design decisions, but the construction techniques and materials used are standard practice for homes in the Lander area with the addition of the necessary technology that makes it a net zero home. The drawings and documentation provided to our local contractor were easy to follow, replicable, and buildable, evident by the completion of the project with little to no changes.

Figure 1. Standard construction techniques easily reproducible by local contractors

As a further nod towards sustainability and buildability, we made use of reclaimed wood from the local Mullen Fire for cladding the Wind River home. For insulation, we made use of Zip System Sheathing which has been widely adopted in many parts of the US as an alternative to plywood and other sheathing options. It is easy to install and provides water, thermal, and air resistance all in one application, saving builders time and money. We also selected chrome finishes for the building's plumbing, being durable enough to stand up to Lander's hard water. It is also attractive, stylish, cost-effective, and easy to maintain.

Through the Wind River home, we have also anticipated avenues to impact the buildability of future Zero-energy homes in the Lander area. A review of

existing buildings on the market in the local area shows that most of the homes use forced air gas or electric baseboard for heating (Figure 2).

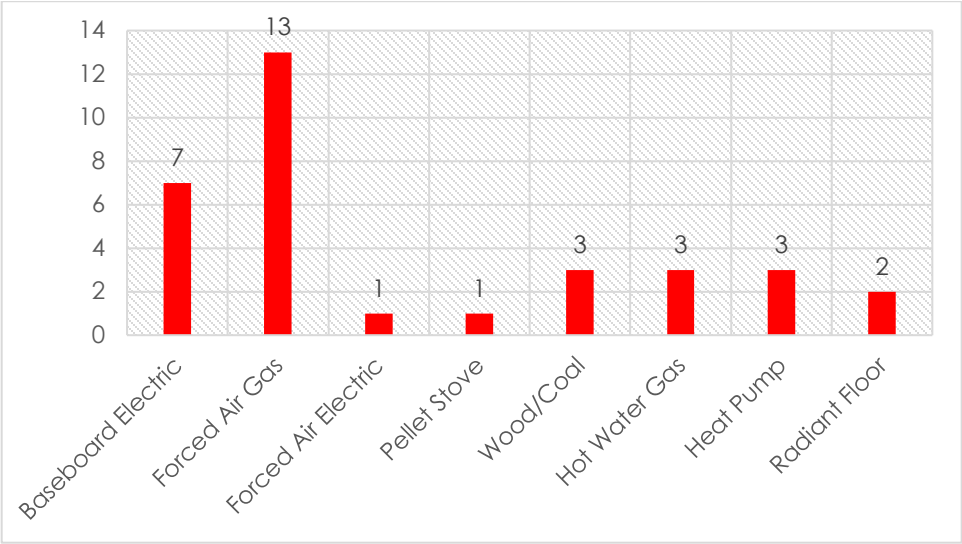

Figure 2. Heating systems for recent listings in the Lander Area [3, 4]

Therefore, this project aims to make heat pump systems popular among contractors in the area. Our local contractor shared some of his experiences with us, in convincing fellow contractors that the heat pump-based HVAC system works and can be easily implemented. In taking any perceived risks of installing innovative systems like the heat pump, we see this home as an example to others that it works, and it alleviates any initial aversion. We believe this is a fundamental but important step in buildability for the implementation of heat pumps and radiant floor heating/cooling systems in future buildings in the Lander area.

Affordability and Cost Effectiveness

The most expensive part of building a zero-energy home is the 10-15% extra in upfront costs of the systems. This higher upfront costs deter new home builders from using these systems. Higher costs come from several factors. The first being the envelope of the home. The home is 'superinsulated' and an Aerobarrier was applied as well in addition to the triple pane windows, which all work together to improve the heat and cooling loss of the home. In turn this reduces the heating and cooling cost because no unwanted conditioned air leaves the home.

A second factor in the additional costs is the MEP systems to help circulate and condition the fresh air into the home. The CERV system supplies and filters the air and controls the moisture content of the air. Each of this variables are important to control to ensure comfort for the occupant especially because of the tightness of the home. The heat pump and radiant in-floor heating work together to heat the home without the use of any fuels. Specifically, the radiant in-floor heating reduces the heating costs because occupants are closest to the source of the heat and therefore feel warmer. In turn there is a reduction in the need to further heat the home. In the summertime the heat pump also acts as a cooling system without the additional cost of a separate system and again, providing more occupant comfort.

The final addition to the upfront cost of the building is the solar panels and battery backup system. However, these systems allow for the homeowner to independently generate green energy and store it in case of a loss of power.

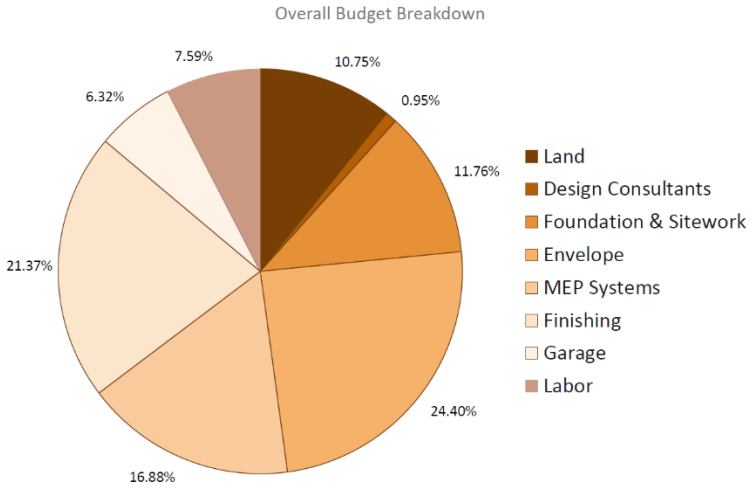

Figure 3. Overall Budget Breakdown

Our initial project budget was estimated at $162 per square foot of the home. However due to COVID, inflation and the overall market price of materials, the project budget increased 56% from the estimate. The overall cost breakdown can be seen in Figure 3. Overall Budget Breakdownand give

the distribution of the budget. The cost per square foot does not include the land.

Market Analysis

Who is moving to rural Wyoming, and why? According to *Business Insider,* "retirees are flocking to Wyoming" in part because there is no personal or

Figure 4 Lander Main Street. Photo: Jessie Webb, Webb Media Solutions

corporate income tax in the state, and it has one of the lowest sales tax rates in the country [5]. According to the *Associated Press,* many younger families moved to Wyoming during the COVID-19 pandemic for cultural and political reasons [6].

Lander is an attraction to young couples because of the rich cultural history, entertainment, and proximity to outdoor recreational activities such as rock climbing and skiing. Wyomingites have dubbed this as the "Mini Jackson Hole". People who move to Lander are often recent college graduates, retired couples, and out-of-state outdoor enthusiasts, which are our target market.

Table 1. Summary of Demographics

Summary of Demographics

Site	Lander, Wyoming
Client demographic	Aged between late 30-50s
Household Income	$150,000

This home was targeted for retired individuals or as a forever home for a family. For this target market, the cost of operation and maintenance is easily manageable. However, this property could be used as an Airbnb home and it would return approximately $225 per night, depending on the time of year. Lander is an appealing community to those who consider themselves outdoor enthusiasts and retired individuals.

According to a local mortgage company, typical mortgage seekers in this area have an individual income ranging between $65-70,000 and couples between $100-120,000. Our home build cost is approximately $800,000, using this value a couple or individual would need to make $150,000 per year in gross income. This calculation was performed by a local mortgage lender in the area using the following parameters:

- 5% down
- 1 active credit card
- Considers for insurance & taxes
- 30-year term
- 6% APR
- 45% debt-to-income ratio

This minimum amount to afford this home would change depending on each client interested in this house and their circumstances. However, the mortgage lender determined these parameters based on the average loan parameters by Lander residents.

Lander residents have also created the Lander Climate Action Network (LCAN) whose mission is to reduce carbon emissions within the city through their commitment to renewable resources, community engagement, and economic viability. LCAN members are passionate and welcoming to all members and especially to those who are new residents and whose goals align with the organization.

Marketing Zero-energy

The advantage of working with a builder like Timshel Construction is their facility for building energy-efficient and Zero-energy homes. Working with UW faculty, Cory Toye and his team have built several of these in Central Wyoming for private clients. The Wind River house represents the next step in the evolution of this partnership. Through these experiences, Timshel has developed a clear understanding of the types of people who are seeking energy-efficient and zero-energy homes in Wyoming.

Figure 5. Zero-energy house near Shoshoni, Wyoming, designed by UW faculty lead Jon Gardzelewski, AIA, and built by Timshel Construction.

The principal marketing message is: ***Who wouldn't like to have zero (or very low) monthly energy bills?*** This includes:

- A net-positive electricity bill (saving about $2,200/year)
- No propane or natural gas bill (saving about $770/year)
- No gasoline costs for electric vehicles (saving about $3,200/year)

A secondary marketing message is: ***Who wouldn't like energy independence?*** The Wind River homebuyer will not be subject to future escalations in energy prices, will not be vulnerable to supply disruptions, and more philosophically, will not be beholden to powerful corporations.

A home which has many upgraded systems is naturally going to cost more. However, in total, these systems will not only save the homeowner money but also help them live a happy and fulfilling lifestyle. The easiest of these to quantify is saving money through utility bills.

Most homes in rural locations in Wyoming are heated using propane, which, depending on the size of the house, residents typically use between 1500-2000 gallons (about 7570.82 L) of propane during heating months. Due to a colder winter than normal, this number will likely be higher than normal. In the town of Lander, there are two major propane companies, Pirate Propane which charges $3.04/gal. Our home heating system has eliminated the need for propane or natural gas for heating leading to average savings of $5057.5 every year. According to the Energy Information Administration, in 2021 the average residential utility customer used 1022 kWh per month for a comparative-sized home. This would bring the total average monthly bill to $64.29 per month, which would be a total savings of $771.43 per year. This number is a typical home with no solar or electric vehicle charging.

A Livable Design

We developed the program with Timshel Construction based on their deep understanding of the expectations of homebuyers. Wind River's livability offers a safe and functional living space that support this understanding of market expectations, helping to provide the occupants with an enjoyable place to live while helping to encourage them to use fewer resources than a typical homeowner.

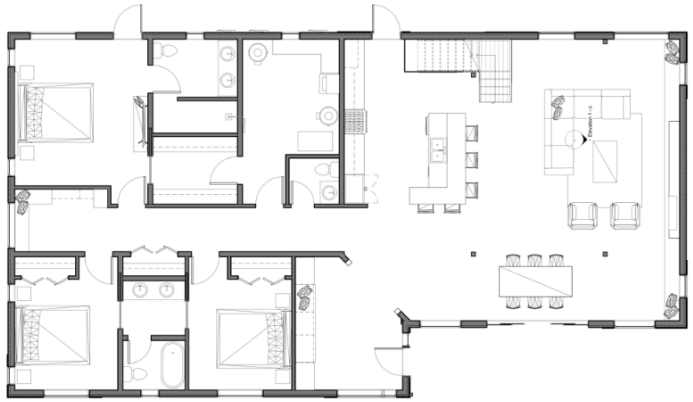

Figure 6. Ground floor plan

Starting with safety, we looked at risks that our potential buyer may face. A U.S. Department of Energy report showing the energy sector risk profile in Wyoming found that the most common natural hazard in Wyoming is thunderstorms and lightning, which occur once every 4 days on average from March to October. Once October hits, the second most common natural hazard in Wyoming begins. This consists of winter storms and extreme cold, which occurs once every 9.3 days on average until March when thunderstorms

and lightning begin again [7]. These storms cause major damage to power lines leading to power outages that are not an atypical occurrence for a Wyoming resident.

Figure 7. KiloVault HAB Energy Storage System used when off grid.

The KiloVault HAB backup battery system was selected to combat this risk and is used if the grid goes down, allowing the occupant to carry on with their regular tasks and allowing the home to continue to supply energy to every system. Supplied by solar panels, energy will be used from the battery banks when off-grid and panels no longer receive solar energy. This could be at night or in high cloud coverage. A house as integrated as this will rely on other systems when one fails. It is also because of passive solar that this house will continue to stay warm during the day. To make that heat last as long as possible, an efficient envelope is relied upon, helping to retain the heat. This requires less demand from the radiant floor heating and less demand from the backup batteries. All these systems work together to keep the owner safe, but they also enable them to carry on with their day just as they would when the grid was up.

Another aspect of functionality is the site's location. The site is atop a hill, up above a floodplain, nestled next to a berm that helps protect the home from the Wyoming winds. The home faces 15° east of the south axis so that most solar gain in the morning till late afternoon. It was designed this way because evening thunderstorms as mentioned are frequent and can create clouds blocking out the sun for the remainder of the evening. This design additionally protects the front of the house from crosswinds coming from the west, all while allowing for optimal natural ventilation through the home.

Not only does the site's location offer functionality, but it also creates an enjoyable environment to live in. The home is situated where outside of any south-facing windows, Red Canyon can be seen for miles. The abundance of windows allows for incredible natural light, and its large sliding doors to the front porch allow you to bring the outside in. Because the house is located so close to the Wind River Range, this area is perfect for our target audience who are outdoor enthusiasts, enjoying skiing, hiking, or even rock-climbing and its proximity to town is what helps taking the kids to soccer in the fully charged

electric vehicle a little bit easier.

Figure 8 Sunset over Red Canyon. Photo: Scott Copeland

This home is packaged to look like a "Minimal Mountain Modern" style home, a home you would find in many new Wyoming communities. However, this home carries unique attributes through its design, construction, and functionality not seen with typical houses, even of this style. It's a common misconception that homes paving the way for Zero-energy resemble characteristics you would find in a spaceship. Though those homes are unique and can be cool, it either is too expensive to design, a typical contractor can't build it, or it isn't what the homeowner wants.

Figure 9. Wind River Great Room featuring fireplace and built in shelving.

Wind River features a double height great room with a loft and offers 3 bedrooms - 2.5 bathrooms in an open floor plan layout, meaning that people in the kitchen can communicate with those in the living and dining areas. In 2020, Fixr's survey from the expert opinion of 50 top professionals in the construction industry attained data on single-family home construction and remodeling trends [8]. 90% favored an open floor plan, suggesting that constructors focus on this style.

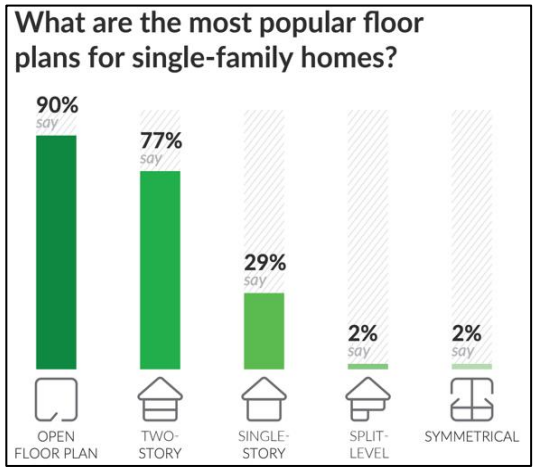

Figure 10. Fixr survey results, showing popularity of open floor plan.

Livability is also evident in the creature comforts of the home as seen in the main entry, which is treated almost as a 'mud room'. This is based on rural Wyoming living, where everyday life demands a space to remove your coat and boots. This room also has a large south-facing window—it will be a favorite spot for pets. The wood archway is a familiar Western form and gives the home an enlarged sense of arrival.

The book nook nestled at the end of the hallway offers a relaxing escape from the busy great room and provides a designated space where if you're not getting lost in your book, you're getting lost in the vast landscape and view of the Wind River Range. These creature comforts are what contribute to a happy and fulfilling lifestyle.

In terms of accessibility, 88.6% of the home's spaces are accessible. Fixr also received information on accessibility with regards to aging in place and concluded that 54% said that future personal use was the reason they considered adding ADA modifications such as grab rails and ramps to their home which can all be easily installed in this home's future. We want to cater to the population that wants to prepare for the future which is why we have included ADA-compliant appliances like the range, washer, and dryer.

Often homes that are built with sustainability in mind are not targeted toward growing families. Given that our demographic is in the specific age range that couples consider raising a family, we designed our home to be able to easily sustain a family comfortably, while being conscious of the high resource demand that more family members bring. To help the homeowner use fewer resources, we looked at what items are used every day and incorporated more sustainable options in their place. The U.S. Energy Policy Act of 1992 requires faucets to have a maximum flow rate of 2.5 gallons per minute. This home incorporates faucets ranging from 1.8-1.2 gpm, reducing water flow usage by an average of 40%.

A decrease in outdoor water use is attributed to the use of native plant species in landscape design. Our heat pump radiant floor system is another energy-efficient system contributing to a decrease in energy usage. The three independent zones of the heat pump system give more control to the occupants as different zones will gain more passive heat than others, allowing the system to operate as efficiently as possible, saving electricity and money while simultaneously increasing comfort.

Scalability

There is not much data on Zero-energy housing in the US, although, according to the New York Times, a nonprofit group Team Zero estimates that at least 24,500 homes in the US have achieved zero energy performance [9]. In addition, the department of energy has certified about 8,656 homes as net zero ready. Given that buildings account for 40% of energy use and emissions in the US, net zero homes offer a significant opportunity to reduce energy use and emissions [10]. But the only way such an opportunity can be maximized is if it aligns with market trends. Is net zero housing and elements that contribute to a home being net zero perceived as having a positive influence on the US market?

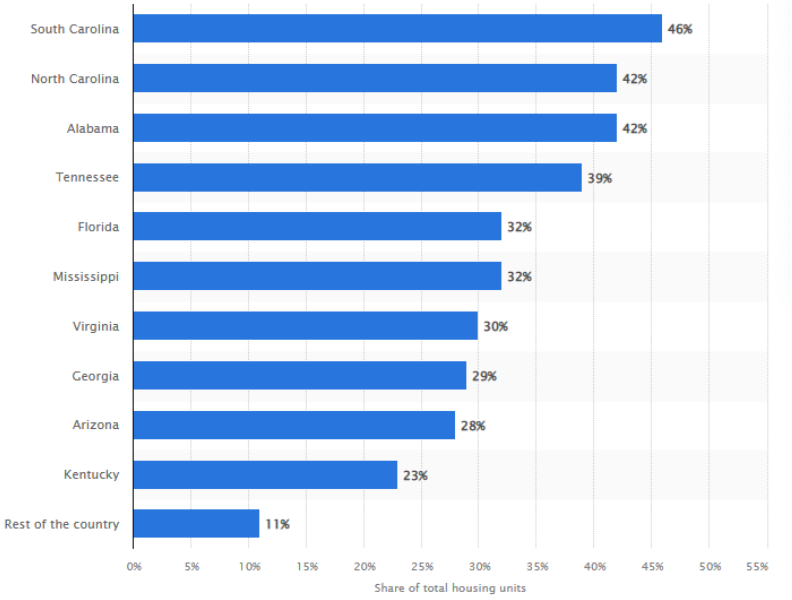

Figure 11. Share of housing units using central heat pumps in the US as of 2020, by state [13]

An important part of Zero-energy housing is its heating and cooling systems. In the Wind River home, this functionality is performed by air-source heat pumps. According to the International Energy Agency (IEA), heat pump sales increased by more than 13% globally in 2021. Sales in the US were up by 15%, second only to the European market (up by 35%). Air-source heat pumps made up more than 60% of global sales [11]. However, if we break it down further, as of 2020, 17.5 million homes across the US had heat pumps installed. The three states with the highest share of households using heat pumps compared to other types of air conditioning systems were South Carolina (46%), North Carolina (42%), and Alabama (42%). In general, the southern states dwarf the rest of the country, accounting for a greater share of total housing units with heat pumps installed (**Error! Reference source not found.**) [12].

The second region in terms of market growth for residential heat pumps is the western US [14]. Therefore, being a state from this region, there is an opportunity to impact the US market for heat pumps in this region. The Wind River home seeks to do just that. Cory, our contractor, told us that due to this and other projects he has been involved in with using the heat pump system, one of his suppliers in nearby Colorado now sells heat pump systems. Therefore, in demonstrating that this technology works for this region, we are playing our little part in growing the market for heat pumps in the western US. A huge draw is the dual functionality of heat pumps for heating and cooling without changing the system, especially in places that experience all four seasons. If other contractors can see the success of homes like the Wind River home, it would increase their willingness to adopt heat pump systems in their builds which would have a positive impact on the market and industry.

A crucial component of the Zero-energy home is its energy generation which is mostly accomplished by rooftop solar. With a solar PV price decline of 52% over the past 10 years, solar PV, especially for residential homes, has seen consistent growth in five consecutive quarters from 2021 [15]. With recent legislation signed into law by President Joe Biden, granting a 30% solar tax credit, the pace of residential solar adoption in the US does not appear to be slowing down anytime soon. The western US leads the nation in terms of the percentage of residential (8.9%) and commercial (3.8%) buildings generating electricity from small-scale solar arrays in 2020 [16]. Therefore, the Wind River Home is also part of a region setting the pace for residential solar, and being a spec home, we see a further advantage of easily scaling this up for the Lander area.

The design of our home is no different from a traditional home in the Lander area, even though it is a net zero home. This makes it easy for contractors to be able to adapt and reproduce elements of the design in other builds. The Wind River home is already generating interest among other local

contractors, and we see it as an opportunity to create attention and drive competition towards energy-efficient, cost-effective, spec home design among contractors in the area. Like most of the standard homes built in the Lander area, not many make use of prefabricated, off-site construction techniques. However, we did make use of off-site construction techniques for the awning and deck of the Wind River home. In adhering to standard building techniques prevalent in the Lander area, we seek to show that the Wind River home is comparable to any standard, traditional, Lander home, except for being net zero.

Figure 12. Rooftop Solar PV installation at the Wind River home

At a time of rapid growth in residential solar in the US juxtaposed with the attempt at a legislative level to reduce the incentives for rooftop solar in the state of Wyoming, we see the Wind River home as a perfect beacon of net zero housing that could have both an immediate and long-term impact in the marketplace. In 2020, Fixr carried out a survey seeking the expert opinion of 50 top professionals in the construction industry, gathering relevant data on single-family home construction and remodeling trends [8].

In terms of style, an open floor plan was the most popular choice, with the attraction of an outdoor kitchen. The Wind River home boasts a cozy open-plan kitchen/dining/living room space and a deck that opens out to a spacious backyard for cooking and entertaining guests. Older millennials between the ages of 33-40 years old, followed by Gen X were the customers that had the most interest in sustainable and green building design. This is within our target market. Minimizing energy consumption, indoor air quality improvement, and tight building envelope where the top three sustainable features people were most likely to want to be included in their homes in the next year. The Wind River home provides all these features. Our team believes the Wind River home is the right home at the right moment in time.

Innovation

As time goes on and innovative technology gets popular, not only does this allow for the evolution of better more efficient products, but for the average consumer, it allows them to obtain these amazing technologies at an affordable price. One characteristic that this home shows the public is attainable sustainability. This idea that sustainability isn't too far out of the grasp of the public. It's also not too far for contractors, and with the right help, sustainability can be built into every home with very little deviation in cost or scope from a traditional build.

Attainable sustainability is a concept that our team tried hard to embody, showing that for simple everyday items like toilets, faucets, appliances, and even finishes, there is a more sustainable product that can be easily swapped. It's our goal to show the public that you can incorporate these practices into any new or even existing homes, allowing you to use fewer resources, which is not only better for the planet but your pocket too. If you find that even just one part of the house, like solar panels, is something you want to add to your new or existing home, then we've done our job.

Our home being a spec house offers the advantage of taking the guesswork out of all the home's innovative features, like what heating system is used, what solar panels to go with, and even what appliances are used. Not only does this take away the stress of figuring out what systems work best with other systems, but it can also be advantageous to the buyer, helping to identify new innovative features that would never have been thought of. Often, the building envelope of a home is neglected when considering options to be customized if a customer is building a custom home. The SPEC house may not have the exact drywall texture that you wanted, however, it gave you a building envelope that could retain the heat generated by passive solar significantly longer than a standard envelope. This may be something the buyer doesn't find useful, that is until it's time to pay the first utility bill.

Marble became a topic of discussion with this home but seeing that it not only costs significantly more than an option like butcher block but also had a greater environmental impact due to mining techniques and shipping, it gave the contractor power to make the sustainable decision for the buyer to go with something less expensive. This did two things, it enabled the home to be more sustainable overall, and it gave us the flexibility to use the money that would otherwise be spent on something that you use to prepare food, with something more impactful like upgrading systems such as solar panels. SPEC homes offer advantages to the buyer in ways they would never think, but it also gives contractors the power to make sustainable choices for the new owner.

We want to pave the way for what we believe the future of sustainable building to look like. To us, it looks like having at home electric vehicle charging stations to adapt to the future of automation. It's the simple idea of collecting the energy your home's solar panels produce so that when severe weather hits, you'll be prepared. It can even be as small of a modification as using native plant species to decrease water usage for landscaping. These ideas are something that everyone can incorporate into any home, not just new builds, with off-the-shelf materials.

To design a home with more standard materials allows for shorter lead times and those standard materials when used in conjunction with sustainable building practices creates a home that is not only enjoyable to live in but is functional and serves a purpose. It is inspiring to others and its homes like this that are not a science experiment, but a real-world practical sustainable home, that are going to have an impact on the future of homes not just in the U.S., but the world.

References

1. US Census Bureau. *2020 Population and Housing State Data*. 2021 [cited 2023 March 4]; Available from: https://www.census.gov/library/visualizations/interactive/2020-population-and-housing-state-data.html.
2. Moody, C. *Renovation With a Purpose: A D.C. Home Gets a Big Eco-Friendly Overhaul*. 2022.
3. Zillow. [cited 2023 February 25]; Available from: https://www.zillow.com/lander-wy/.
4. Realtor. [cited 2023 February 25]; Available from: https://www.realtor.com/realestateandhomes-search/Lander_WY.
5. Liz Knueven. *Forget Florida — with no income tax, good healthcare, and national parks, retirees are flocking to Wyoming*. 2020 [cited 2023 March 27]; Available from: https://www.businessinsider.com/personal-finance/wyoming-retirement-destination-low-taxes-healthcare-nature.
6. Jake Goodrick. *Moves to Wyoming pick up during COVID-19 pandemic*. 2021 [cited 2023 March 27]; Available from: https://apnews.com/article/north-carolina-gillette-wyoming-coronavirus-pandemic-covid-19-pandemic-681e809c0a21d41c075861d7277c518a.
7. US Department of Energy, *State of Wyoming Energy Sector Risk Profile*. 2016.
8. FIXR, *Single-Family Home Construction and Remodeling Trends*. 2020.
9. Margolies, J. *Energy-Efficient Isn't Enough, So Homes Go 'Net Zero'*. 2021.
10. U.S. Energy Information Administration (EIA). *How much energy is consumed in U.S. residential and commercial buildings?* 2019 [cited 2019 October 2]; Available from: https://www.eia.gov/tools/faqs/faq.php?id=86&t=1.
11. IEA, *Heat Pumps*. 2022.
12. Statista, *Percentage of households using central heat pumps in the U.S. 2020, by state*, S.R. Department, Editor. 2023.
13. Statista. *Share of housing units using central heat pumps in the United States as of 2020, by state*. 2023 [cited 2023 March 16]; Available from: https://www.statista.com/statistics/1327164/share-of-households-unsing-central-heat-pumps-by-state-us/.
14. Buildings Hub *Trends in Residential Heat Pump Adoption in the United States*. 2022.
15. Solar Energy Industries Association (SEIA), *Solar Data Cheat Sheet*. 2022.
16. U.S. Energy Information Administration (EIA), *Homes and buildings in the West and Northeast have the largest share of small-scale solar*. 2022.