

Design Thesis - ReStacks

by

Benjamin Perryman

The Ohio State University, 2018

Submitted to the Center of Real Estate in partial fulfillment of the requirements for the degree of

Master of Science in Real Estate Development

at the

Massachusetts Institute of Technology

June 2023

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Submitted to the Center for Real Estate on May 8, 2023 in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Real Estate Development

ABSTRACT

ReStacks is a full-service real estate development company that specializes in the construction and management of modular garages and accessory dwelling units. This design thesis explores how garages and accessory dwelling units can become sustainable infrastructure for housing, transportation, and the sharing economy in the car-dependent urban geography of Columbus, OH.

With growing concern about climate change and household economics, interests sometimes compete. While affordable housing and homeownership have become increasingly inaccessible, construction and the built environment represent over 40% of global fossil fuel emissions. Meanwhile, many existing homeowners can't afford upgrading their homes and transportation to reduce their contribution to those emissions.

In many Columbus neighborhoods, there are opportunities to address these challenges. Behind single-family homes, there are long-reaching alley systems which are lined with vacant lots and defunct infrastructure. Initially used for the storage of livestock and carriages, many of these alleys fell into disrepair after the introduction of gas-powered cars. Through partnership with homeowners, ReStacks has begun building modular garages and accessory dwelling units to introduce cost-effective and ecologically-sensitive infrastructure for affordable housing, electric vehicles, and the sharing economy; high utility in a small footprint.

ReStacks' design philosophy was derived from the concept of three-pronged sustainability and its approach involves dissecting the social, economic, and ecological dimensions of intervention to provide more diverse value for consumers, local economies, and the environment. The core principal of its business strategy is to drive market-value through overlapping, sustainable benefit. This document will highlight the design progression of ReStacks' modular garages and accessory dwelling units as well as explore their potential profitability and impact.

Thesis Supervisor: Svafa Grönfeldt

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re|s+acks



re|s⁺acks

Studio+

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Benjamin Perryman

The Ohio State University, May 5, 2018

Submitted to the Center of Real Estate in partial fulfillment of the requirements for the degree of

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at the

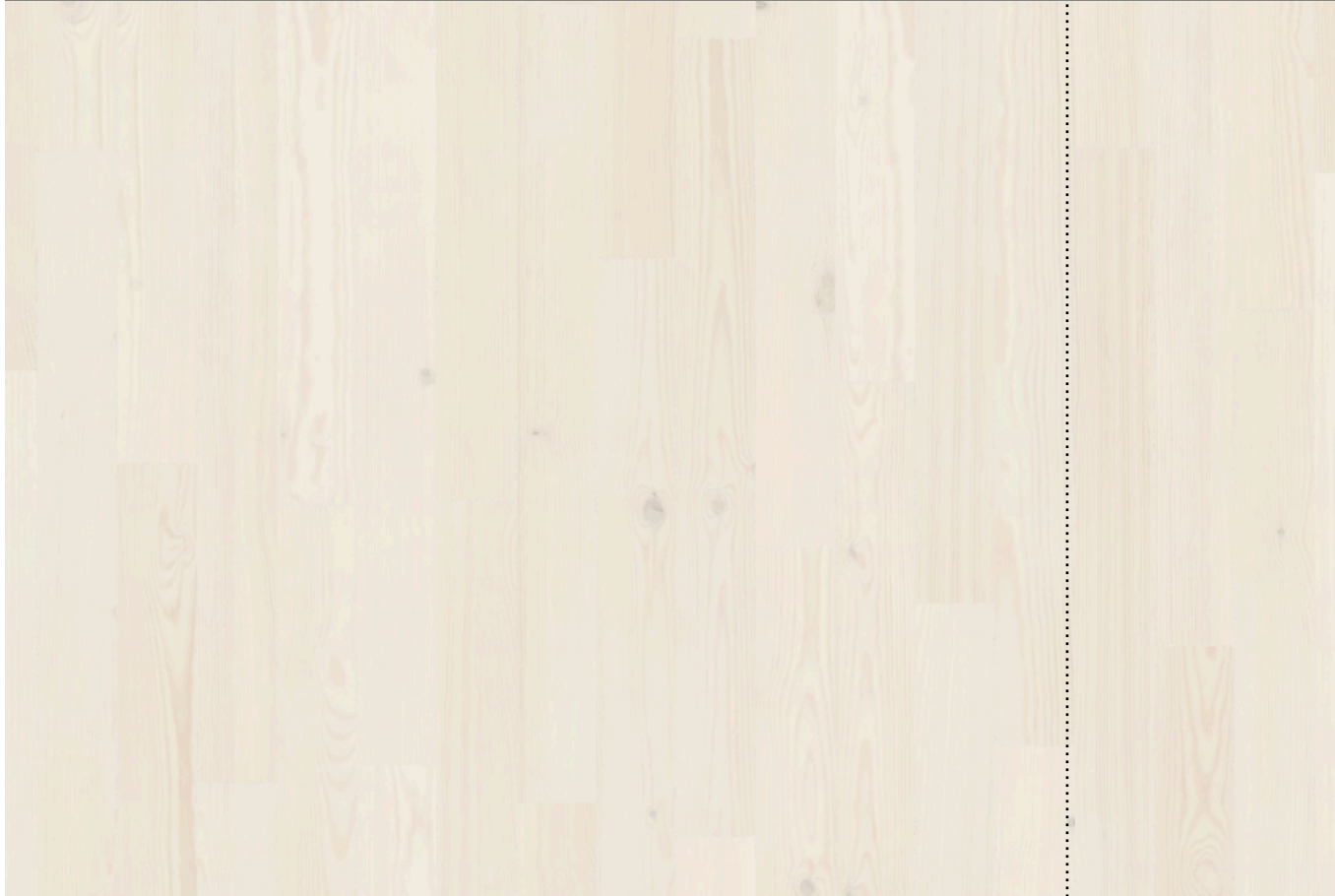
Massachusetts Institute of Technology

June 2023

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re|s+acks

Studio+

“Alma is a 75 year-old woman who has owned her home in a rapidly gentrifying neighborhood for over 20 years. She lives on social security and has no mortgage, but her property taxes have been increasing as the neighborhood has become more expensive. She’s already seen some of her neighbors experience tax foreclosure and have to move. Living on a fixed income, she expects that she will have to move soon. That was until she learned about ReStacks. After calling, she discovered that our apartments can be rented to produce passive income, easily financed with little to no income, and installed on short timelines. Alma immediately applied and she was quickly approved for the loan which was obtained through the equity in her home. Less than a month later, Alma had a utility-free, car-charging garage, and a studio sitting on the alley behind her home. The appeal of car-charging and utility-free living allowed Alma to rent her new studio promptly and she collected her first rent check just in time to pay her refinanced mortgage. She used her residual income to purchase an EV and the improvements to her property qualified her home for a tax abatement. With her extra income and abated property tax, Alma’s fears of foreclosure disappeared.”



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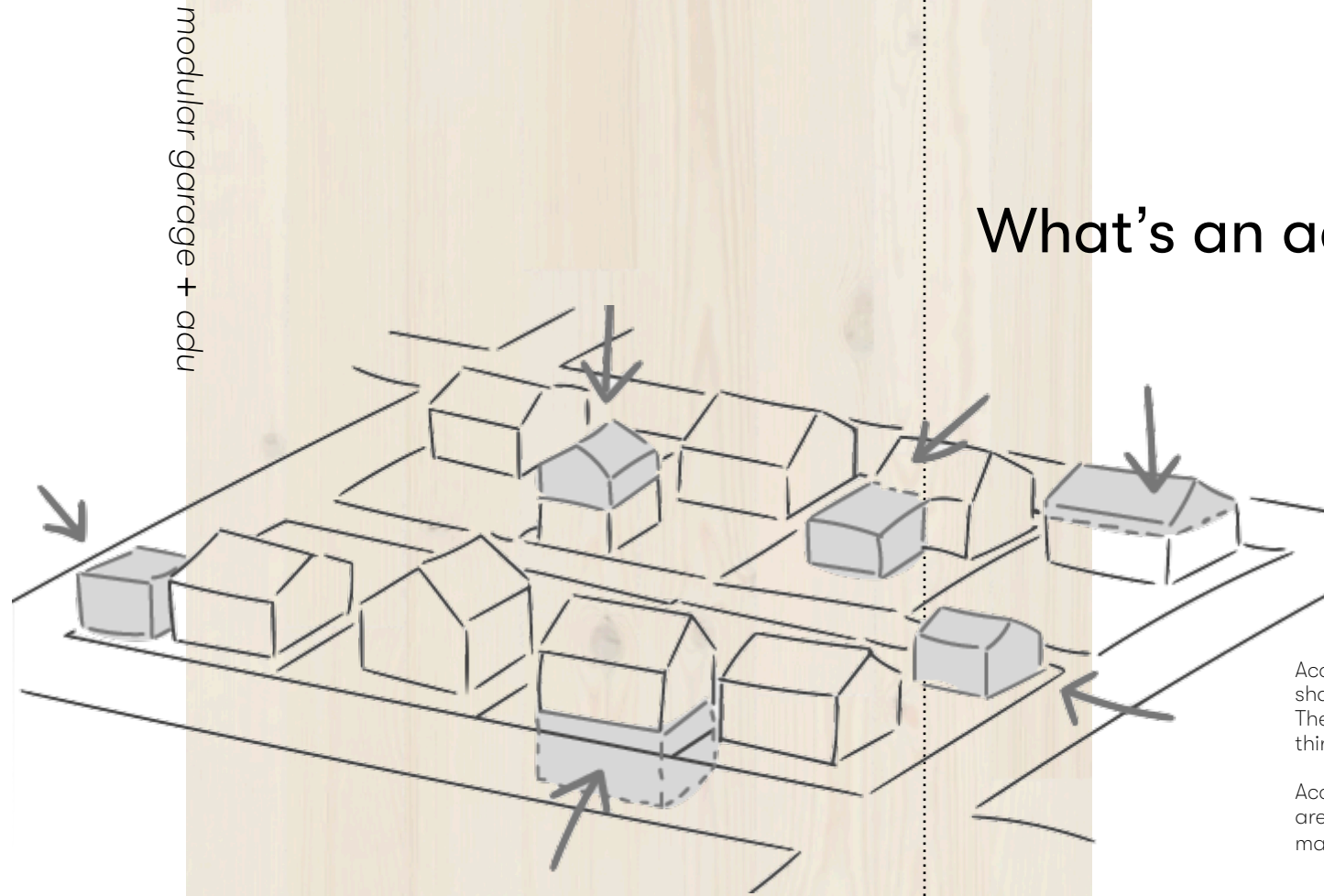
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introduction |

What's an adu?



Accessory Dwelling Units

Accessory dwelling units, or ADUs, are secondary residential units that share property with a primary dwelling such as a single-family home. They can be attached or detached and be located in basements, on third floors, in backyards, or anywhere they can fit.

Accessory dwelling units have faced legal challenges in the past but are becoming embraced by state and local legislatures due to their many benefits, such as:

1. Increased Housing Options
2. Rental Income
3. Multi-Generational Living
4. Increased Property Value
5. Sustainable Living
6. Flexibility

At ReStacks we plan to provide studio apartment ADUs above garages which we will refer to as a "Studio+".

Just a garage, right?

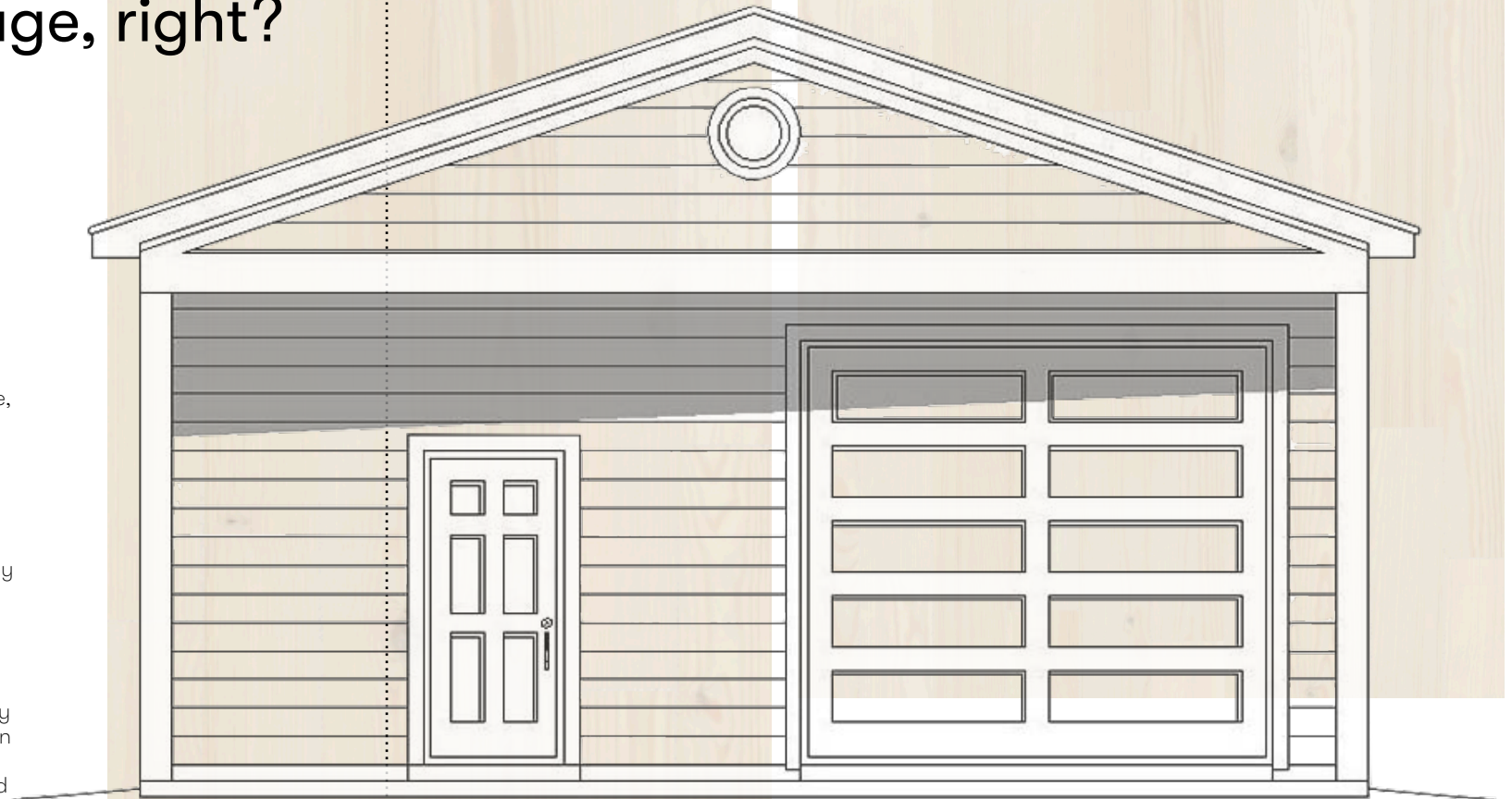
...not exactly.

The history of garages and single-family homes is closely intertwined, as garages have become a ubiquitous feature of American homes since the rise of the gas-powered car in the early 20th century. Before, homes were designed without garages or driveways because transportation, typically, involved horses, bicycles, or walking. However, some homeowners constructed simple barns or carriage houses to store their livestock, carriages, bicycles, etc.

It wasn't until the 1920s and 1930s that garages became a standard feature for new single-family homes. The rise of the garage was closely tied to the suburbanization of America, as families began to move away from cities and into newly developed subdivisions. Single-family homes in these suburbs were designed to accommodate cars, with attached or detached garages and driveways.

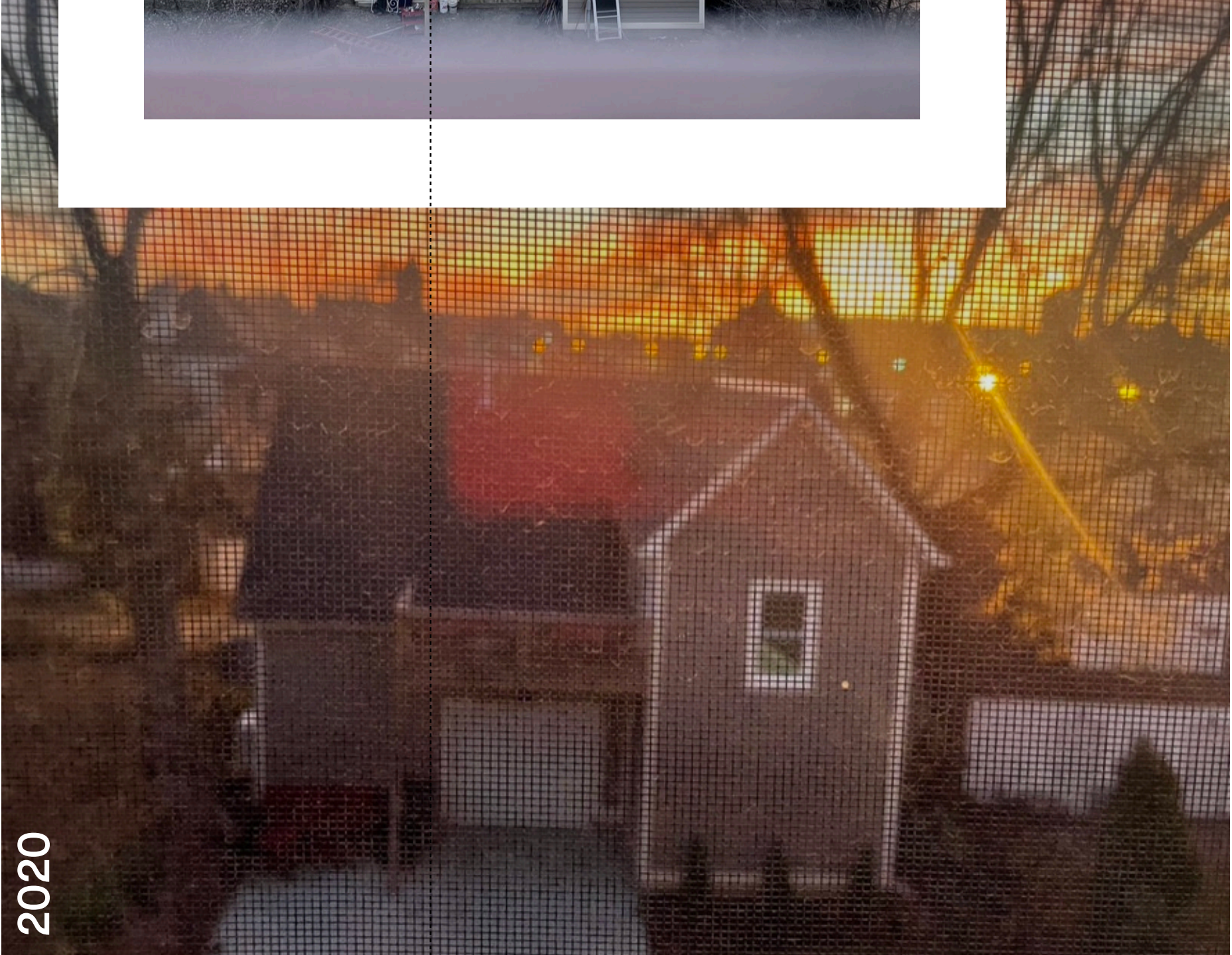
On the other hand, many car-dependent urban areas have never fully integrated garages into their urban landscapes. While these areas can rarely accommodate attached garages, many have significant numbers of small vacant lots, which used to be filled with livestock and carriages. And only a fraction have been replaced by garages.

As much of our society transitions to electric vehicles, these spaces will become essential in our fight against climate change. Unlike gas cars, which can be parked on the street and filled at a station, EVs need to be charged and their batteries need to be protected from the weather. The small urban spaces that were once needed for feeding livestock will soon again become essential; this time for EV-filled garages.

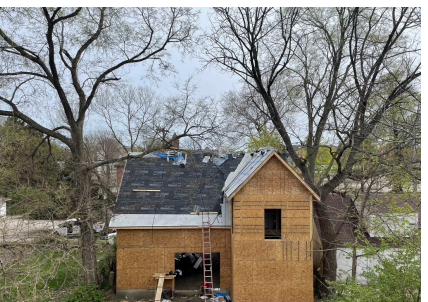


Credit
Body

Did you know Apple, Google, Amazon, Microsoft and Disney were all founded in a garage?



2020



2020

In the Fall of 2019, my father and I had an idea. After staring at a huge parking pad in his backyard, which clearly used to have a garage, a decision was needed to be made. We noticed several of his neighbors had carriage houses, or garages with ADUs built above them, and we decided that we should build one, too.

This turned out to be more complicated than expected. One might assume that if your neighbor has something in their backyard, it would be legal for you to do the same, but that was not the case. Many of the structures that his neighbors had were 50 to 100 years old, preceding the current zoning code.

After a few months of planning, we received approval from Columbus City Council for a zoning variance, just in time for approval before the COVID-19 shutdown.

It became a perfect distraction from what was to come during 2020 and beyond. And something we didn't know at the time was that my sister would be moving home for med school in a matter of months and that we were actually building a home for her.

I moved to Massachusetts for grad school as she was moving to Ohio, but I took that experience with me. While my sister was settling into her new home, I began thinking about how more of these could be delivered to more people and with added utility.

By the fall of 2021, my first semester at MIT, our team formed and applied to the DesignX accelerator. This, ultimately, became ReStacks, a company with an ambitious plan to convert thousands of parking pads into housing and integrate hundreds of underutilized alleys back into their communities — creating infrastructure for the age of sustainability.





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3 years experience
in real estate
development

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research on
"bridging social
capital" and mixed
income housing

team

sustainability |



40%

of all fossil fuel emissions can be attributed to construction + the built environment

sustainability

driving value through values

After starting our first ADU in 2020, our expectations about what would come next were low. Despite long construction resumes, neither my father or I had, previously, built a carriage house and, frankly, it could have been a one-off, hobby project.

However, something happened. In the summer of 2021, my Jeep Wrangler broke down and I was faced with a question, "What should I replace it with, gas or EV?" It's a simple question on the surface. But in practice, it's a question that's been plaguing people across the car-dependent world. I decided to buy an EV.

The primary reason that people gravitate towards EVs is climate change. However, unlike gas-powered vehicles, EVs have extra considerations, like storage, charging, maintenance, and economics. This is the reason, it can take consumers significantly longer to make an EV purchase decision compared to a traditional gas-powered car.

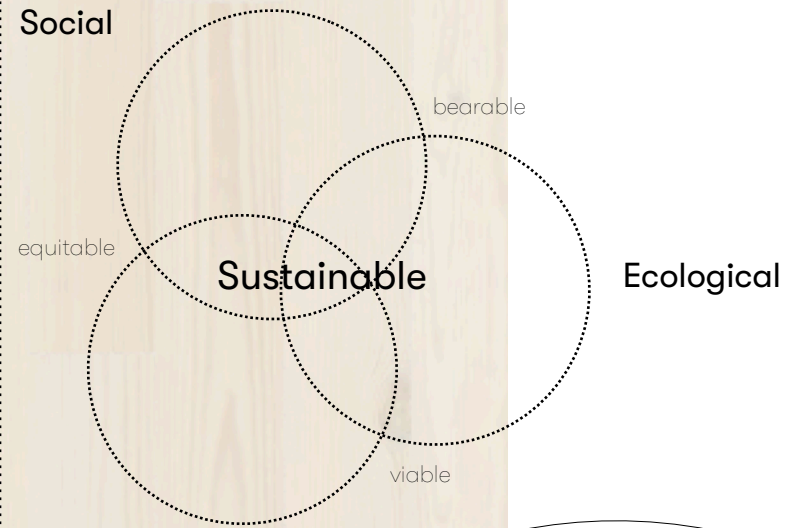
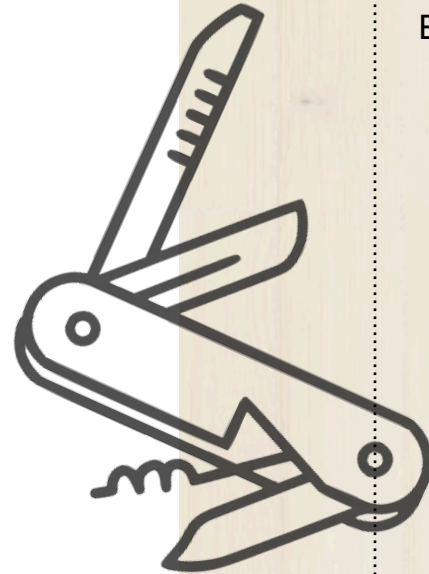
When I finally made my purchase, I was confronted with the challenges of EV ownership. I struggled to find adequate charging access, lost sleep over where the electricity was coming

from, and worried about the extra cost. Then I realized something.

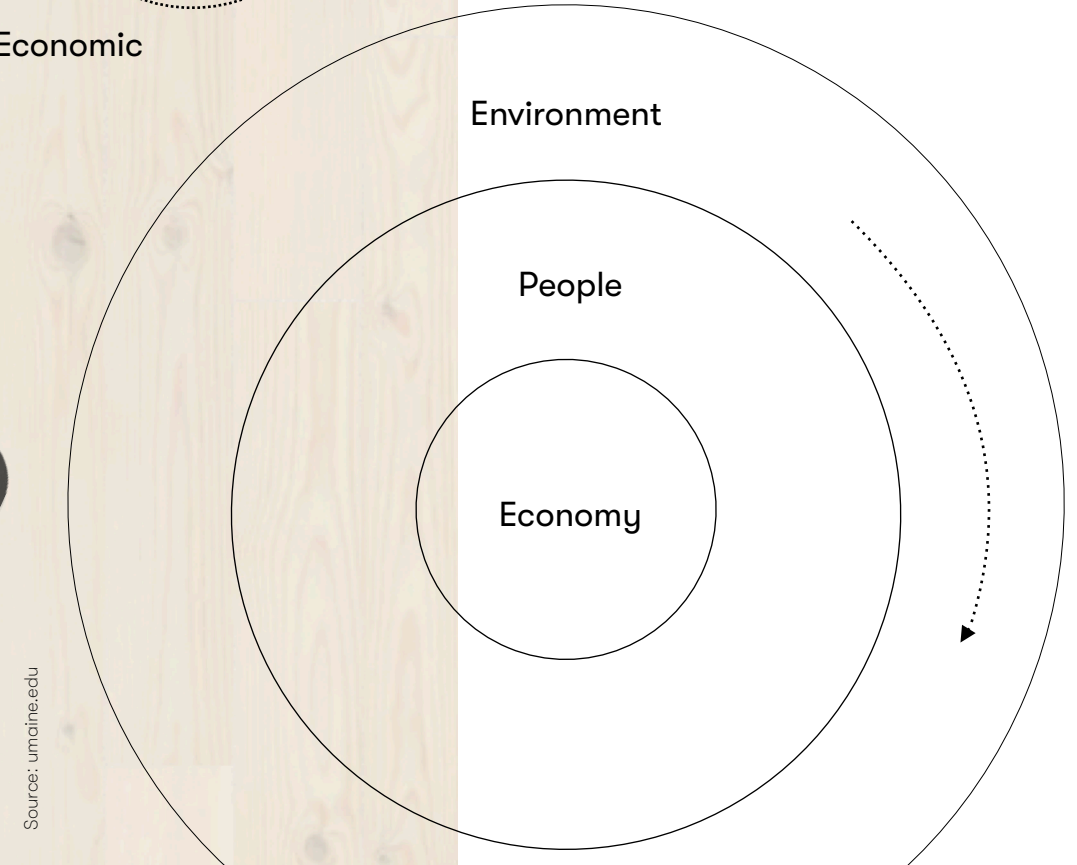
I had already been aware of how a carriage house could supplement the cost of homeownership. However, in the midst of my transportation woes, it became apparent that a carriage house with could be even more with solar panels and an EV charger — a sustainability Swiss-Army knife, making a person's home, transportation, and energy both cleaner and more affordable. The promise of sustainability super-charged a backyard COVID project into a potential economic powerhouse.

Through a focus on multi-pronged sustainability, ReStacks' concept becomes more than the sum of its parts. For that reason, sustainability has remained at the forefront of our design and business decisions, delivering value through greater social, economic, and ecological parity.

ReStacks is a Swiss-army knife



Economic



Source: umaine.edu

market |

CMH

Columbus, OH

Photo: <https://column.us/jsp/area.org/projects/the-peninsula/>



Columbus, OH

Hey Siri... tell me about Columbus

"Columbus is the capital and most populous city in the U.S. state of Ohio. With a 2020 census population of 905,748, it is the 14th-most populous city in the U.S., the second-most populous city in the Midwest after Chicago, and the third-most populous U.S. state capital. Columbus is the county seat of Franklin County; it also extends into Delaware and Fairfield counties.[9] It is the core city of the Columbus metropolitan area, which encompasses 10 counties in central Ohio. It had a population of 2,138,926 in 2020, making it the largest metropolitan entirely in Ohio and 32nd-largest city in the U.S.

Columbus originated as numerous Native American settlements on the banks of the Scioto River. Franklinton, now a city neighborhood, was the first European settlement, laid out in 1797. The city was founded in 1812 at the confluence of the Scioto and Olentangy rivers, and laid out to become the state capital. The city was named for Italian explorer Christopher Columbus. The city assumed the function of state capital in 1816 and county seat in 1824. Amid steady years of growth and industrialization, the city has experienced numerous floods and recessions. Beginning in the 1950s, Columbus began to experience significant growth; it became the largest city in Ohio in land and population by the early 1990s. The 1990s and 2000s saw redevelopment in numerous city neighborhoods, including Downtown.

The city has a diverse economy based on education, government, insurance, banking, defense, aviation, food, clothes, logistics, steel, energy, medical research, health care, hospitality, retail and technology. The metropolitan area is home to the Battelle Memorial Institute, the world's largest private research and development foundation; Chemical Abstracts Service, the world's largest clearinghouse of chemical information; and the Ohio State University, one of the largest universities in the United States. As of 2022, the Greater Columbus area is home to the headquarters of six corporations in the U.S. Fortune 500: Cardinal Health, American Electric Power, L Brands, Nationwide, Bread Financial and Huntington Bancshares."

Source: Wikipedia



Photo: <https://www.midwestliving.com/travel/ohio/columbus-ohio/36-hours-columbus-ohio/>

real estate + tech



Columbus has well-established real estate and tech sectors, so strong that the professional soccer team was even named after a construction crew.

While it may not be the first place someone thinks of when they think about tech, Columbus has made large strides to be attractive to the tech industry, too.

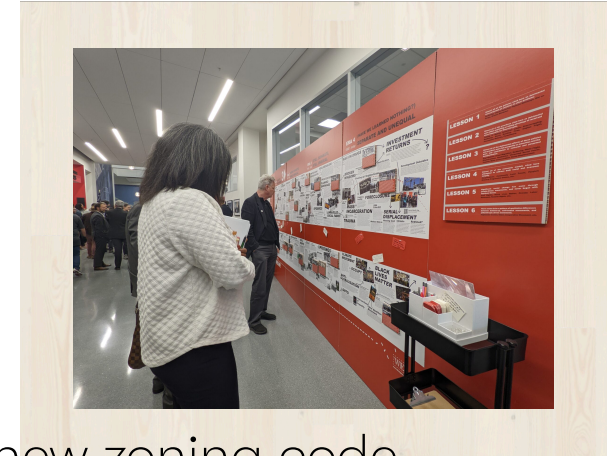
Columbus is convenient, with a relatively low cost of living, and a young educated workforce. This has given the region an advantage in attracting both growing and established tech companies such as lower.com and Intel, which in 2021 announced a \$20 billion investment planned for Central Ohio; it's breaking ground this year.

Photo:

policy vs supply

10,000

number of ADUs that can be built in Columbus, OH



new zoning code

According to a development study done by Nationwide Children's Hospital, Columbus has the capacity to support at least 10,000 ADUs. However, that comes with a caveat; they aren't legal. In Columbus, most single-family homes aren't zoned for ADUs and, therefore, they require a zoning variance which needs to be approved by both a neighborhood commission and City Council. While these proposals are rarely rejected, they can add several months of wait time, as well as additional fees.

Fortunately, that will be changing soon. In the fall of 2022, the City of Columbus, announced plans for an all encompassing overhaul of the city's zoning code. Within this, there is a general confidence that ADUs by-right will be on that agenda. This, ultimately, means that in the near future, ReStacks will be able to begin delivering ADUs without administrative burden.

design |

setting + functionality



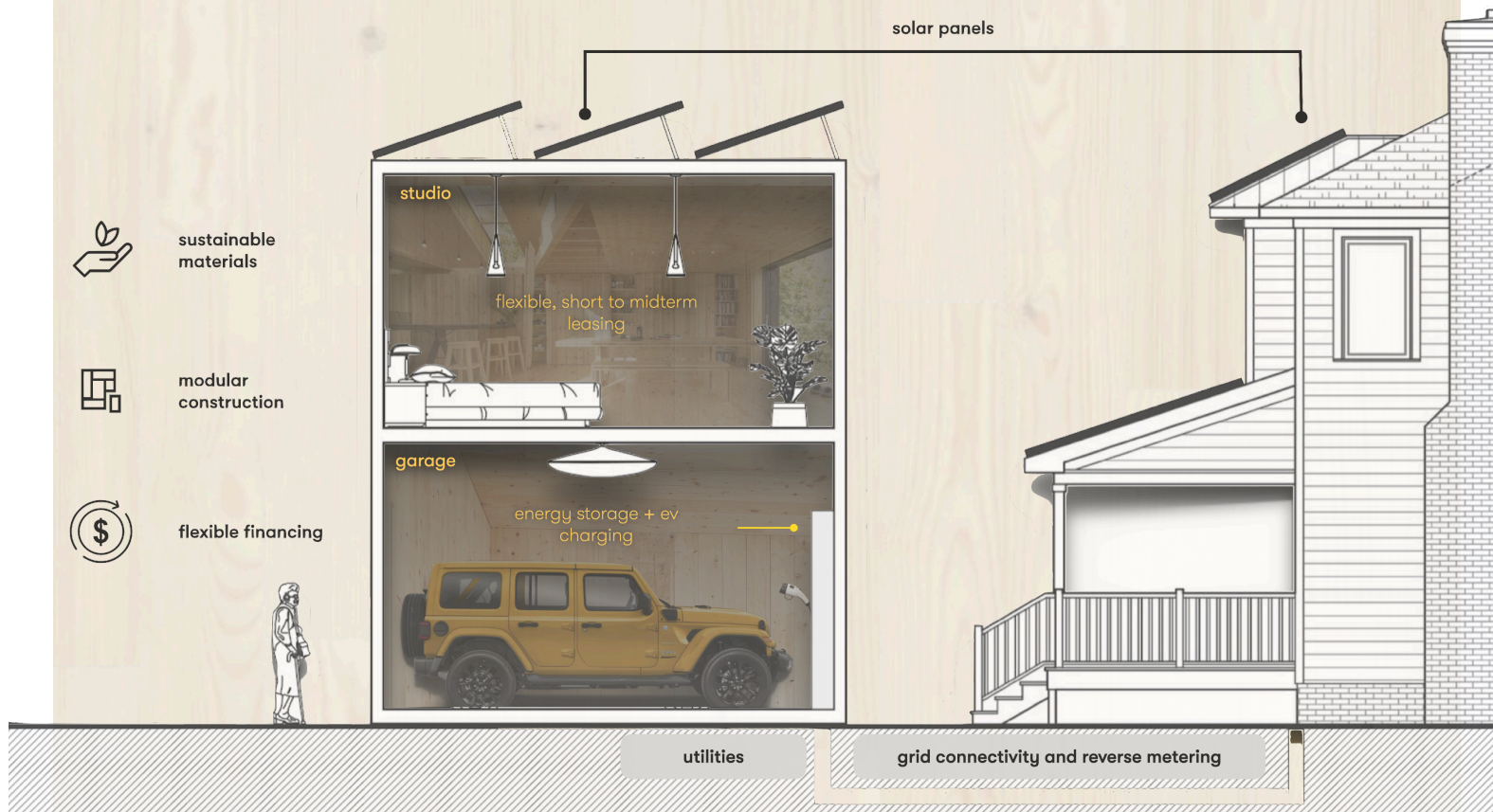
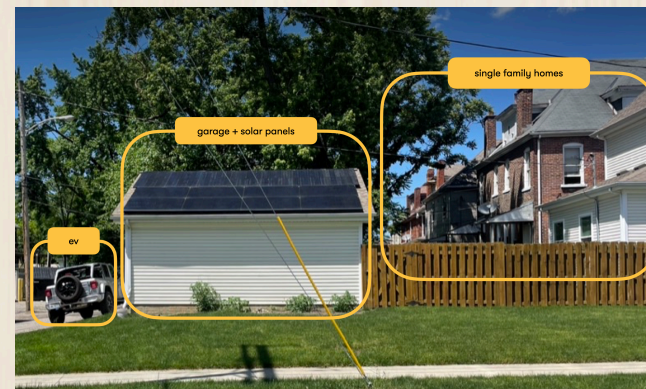
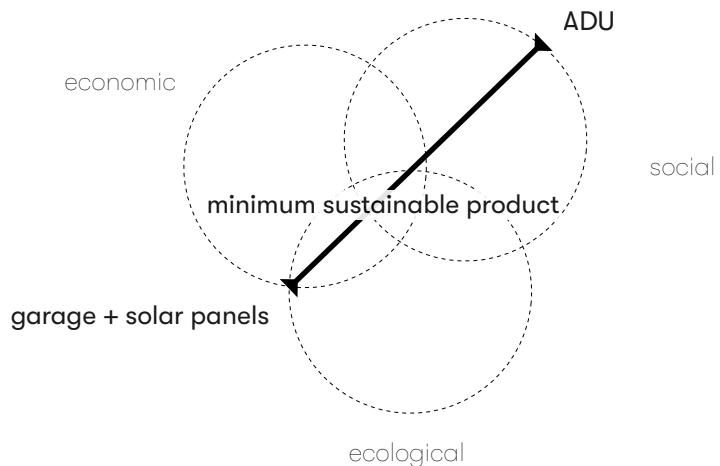
setting + functionality

When ReStacks began to plan an intervention, we had to establish a design criteria that would guide us toward an ideal form. The model of three-pronged sustainability provided an excellent starting point, but the alleys in Columbus required closer examination to uncover what functionality and services would best serve them.

After interviewing community members and exploring these spaces for ourselves, it was clear that there were plenty of elements that could be improved. In the long-run, this will provide many avenues for business growth, but we needed to pare down our immediate focus to a minimum viable product.

In the tech start-up world, minimum viable product, or MVP, refers to the most simple product or service that can be taken to market and scaled. However, the word "viable," according to the three-pronged sustainability model, refers to something that is economically or environmentally positive while possibly lacking social benefit.

What we found is that a minimum "viable" product already existed: garages with solar panels which lacked the social benefit of added housing. We needed a minimum "sustainable" product. Our minimum sustainable product is a garage, an ADU, and solar panels in one adaptable package so expanded services can be accommodated over time.



material

500M

tons of construction debris produced annually in the US

Source: Matt Felleit (2022), Exploring Modular Homes Cheapies: Pátn ra Naí. [re|stacks](#)
Photo: MIT News



reusable material is everywhere

“AfterStock lowers construction costs and saves carbon emissions by facilitating the sale of reused building components for implementation in new projects.”

Source: designx.mit.edu/venture_team/afterstock/

In construction, material consideration has, historically, been an afterthought. We want to change that with ReStacks. There are thousands of dilapidated or unserviceable garages across central Ohio and we plan to replace them with our ADUs. However, this calls for a pause.

Many of the structures that we will demolish have reusable materials, such as blocks, doors, and windows, which can reduce the material cost of future projects.

Before bringing new material to our sites, will direct all of our salvageable waste to AfterStock, another MIT start-up, that will provide a market place for reusable construction material.

AfterStock

■ ■ MIT
 ■ ■ DESIGN
 ■ ■ X

structure

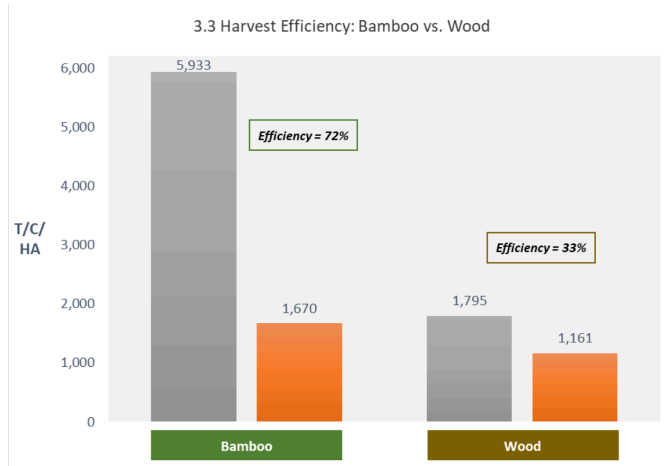
2X

bamboo can be farmed twice as efficiently as lumber

BamCore

"BamCore is a California-based company that specializes in designing and manufacturing sustainable building materials using bamboo. The company's products include structural insulated panels (SIPs), which are used in building construction to provide strong and energy-efficient walls, roofs, and floors.

In addition to their sustainability benefits, BamCore's SIPs offer other advantages such as faster and easier installation, reduced waste, and improved indoor air quality. The company's products have been used in a variety of residential and commercial building projects across the United States, including homes, schools, and offices."



Source: bamcore.com



Body

process

modular + prefab construction

The ReStacks team is comprised of students, researchers, and professionals who have contributed their individual work to make something greater.

In the Fall of 2021, one of our team members, Myles Sampson, conducted a case study and research project that explored methods for modular and prefabricated housing utilizing sustainable and reused material.

This work has been foundational to our design efforts as well as to configuring our production process. There are many similarities between his design and what we have developed.

To the left is a paper used as a source by Myles, in addition to an excerpt from his work.



Modular and Prefabricated Housing: Literature Scan of Ideas, Innovations, and Considerations to Improve Affordability, Efficiency, and Quality

Produced by:
BC Housing
Manufactured Housing Association of BC
Real Estate Institute of BC

2014



Source: BC Housing

MODULAR SHIPPING CONTAINER HOUSE

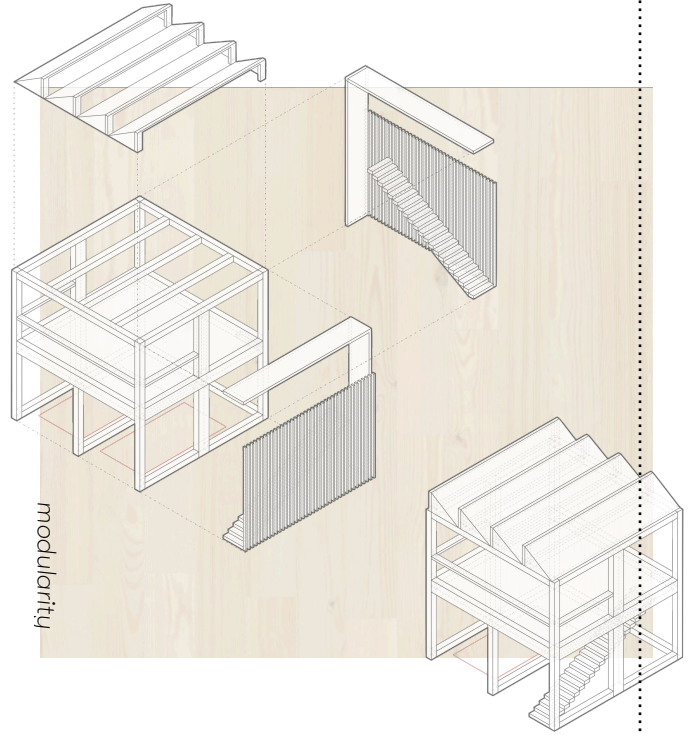
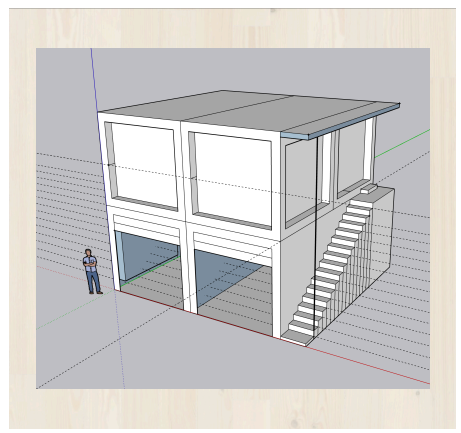
Massachusetts Institute of Technology
Individual
Cambridge, MA

In the rural south, accommodations for modern living need to be re-evaluated. With technological advances, the archetypal shotgun house with wood frame construction will not cut it. What formal typologies can improve the housing stock in the rural south? With sustainability in mind, the reuse of shipping containers and wood pallets can create new forms of housing for Athens, Georgia. Current trends in housing in Athens, Georgia, show that there are around 10,000 housing units with many of the houses being five-bedroom units with a value greater than \$5000 and less than 1000sqft. With cost in mind, the design looks to give consumers in the area the best price possible.

The use of shipping containers as the basic design allows for various configurations for a lot size. The use of shipping containers as a building module allow for sustainable communities to develop while achieving cost savings through economies of scale. The design of this modular house combines shipping containers, standard stud construction, wood panel finishes and CLT to create a new approach to the modular shipping container home design. The design proposal is an open two-story home with a convertible second level for additional programming. This preliminary study in the modular design of houses set the stage for the research in the MIT Design-X backed startup Re-Stacks.

form

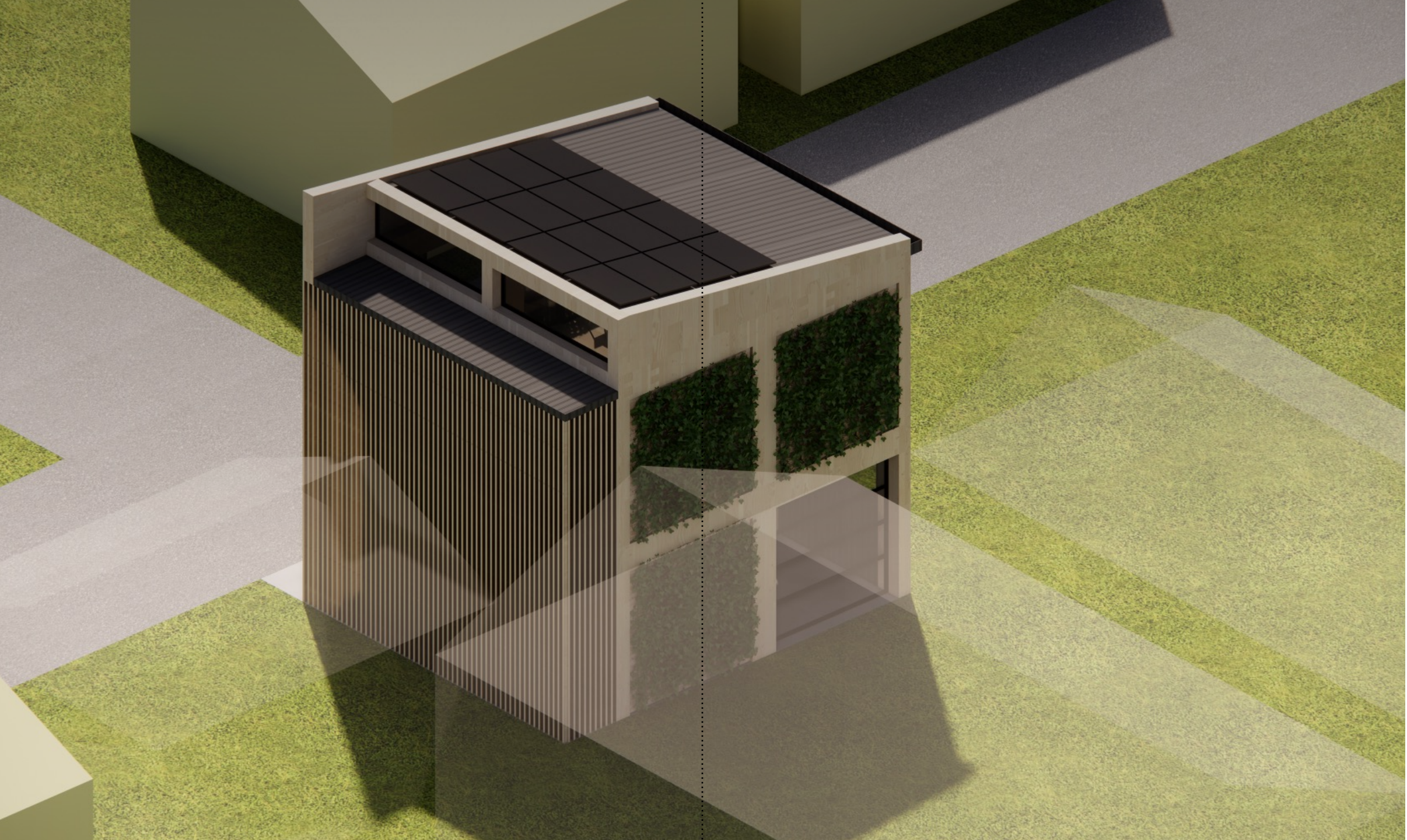
While seeking the right form for the modular studio +, we went through an iterative design process which included CAD, drawing, illustration and toys.



modularity

Studio+





customization

ReStacks will offer a wide variety of customization options.

Roofing, siding, doors and windows will have several finishes from which homeowners can choose, whether they want a toned-down palette to match their home or bold and modern colors to energize their backyard.

Additionally, we have given extensive thought to interior finishes. We plan to, also, give homeowners interior options. The primary interior finish will consist of various forms of sustainable wood which can make any decor feel at home. Furthermore, homeowners will be able to select from a variety of built-in furniture and smart home accessories.

Studio + floor plans can be adapted to accommodate:

- Apartment Living
- Short Term Rentals
- Home Offices
- Exercise Rooms
- Music Studios
- And More

Photo: faster.com

Photo: domifp.com

built-in furniture and smart home options



Photo: denoutdoors.com

services |

Mortgages

the ReStacks model

“Refinance your home as a duplex”

ReStacks plans to use mortgage refinancing as the primary vehicle for selling garages and ADUs. When a customer purchases a Studio+, they will have their home equity deducted from the unit price of the structure and have the remaining balance added to the balance of their original home mortgage. Finally, they will receive a new home mortgage. The terms will reflect those of a duplex mortgage with a lease from ReStacks. ReStacks will then sublease the studio and one garage bay with the other saved for the homeowner.

Benefits of this can include:

1. Improved Financing Terms
2. Increased Property Value
3. Passive Rental Income
4. Tax Abatements and Deductions
5. Greater Rates of Equity Growth

What's the benefit of offering property management?

Property management can ensure value delivery for homeowners and offer added communal value. It will:

Insure the value of duplex mortgages; allowing access to more favorable financing terms and more attainable passive income for homeowners.

Insulate relationships between homeowners and ADU residents by taking on the responsibility of leasing, rent collection, and maintenance.

And, finally, property management will enable a broader range of services than a homeowner-landlord would be able to provide alone. This will provide an additional stream of revenue for ReStacks to leverage.



A sharing-economy platform

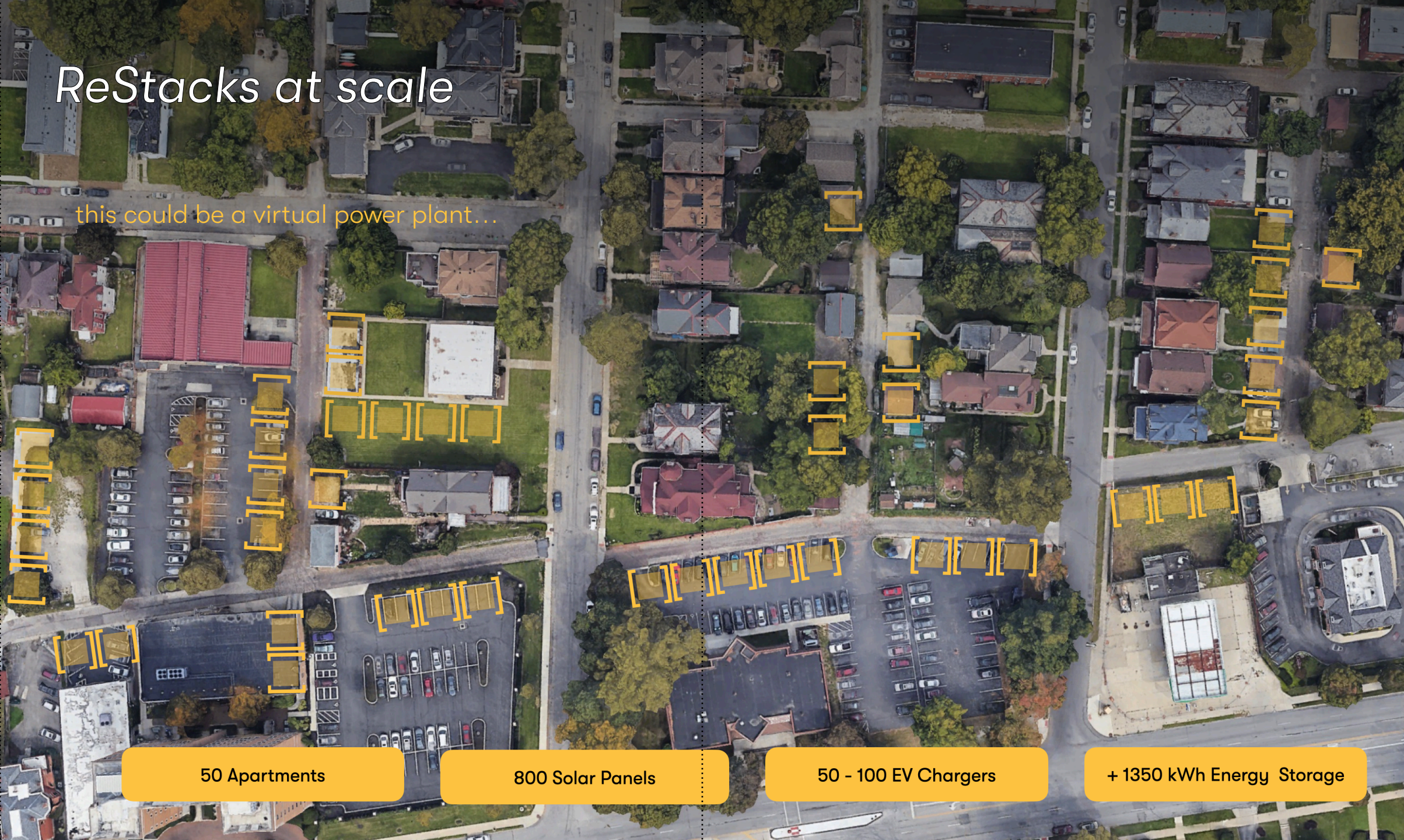


ReStacks at scale

Property management will enable ReStacks to become a sharing-economy platform. We can connect our garages and ADUs to the community while allowing homeowners to receive passive income via the services we provide. We will integrate a suite of services over time. The main channel of contact for sales, finance, leasing, maintenance, and charging will be a web app.

ReStacks at scale

this could be a virtual power plant...



50 Apartments

800 Solar Panels

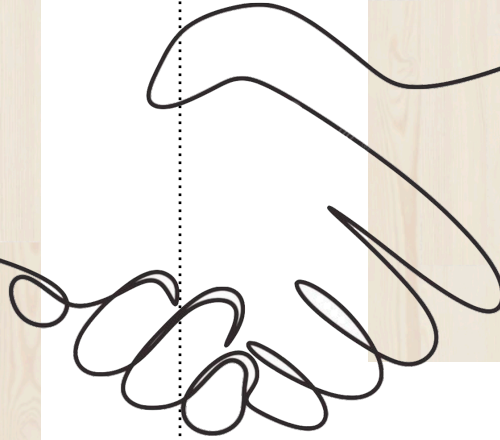
50 - 100 EV Chargers

+ 1350 kWh Energy Storage

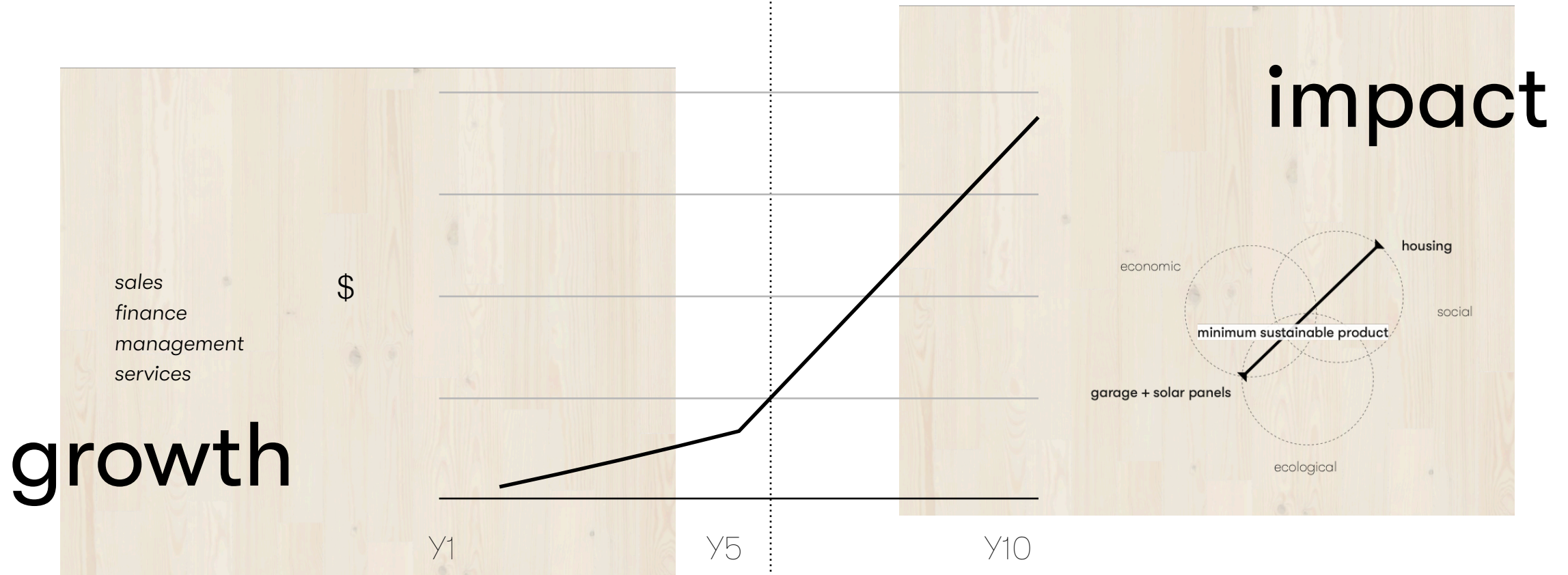
conclusion |

growth

impact



Financially viable and high impact



The "hockey stick" financial projection, shown above, depicts ReStacks' revenue potential from 2024 to 2033. Year 1 through Year 5 depicts growth only within the Columbus market, while Years 6 through 10 depict a steep trajectory driven by expansion to additional markets. Based on an average unit price of \$150,000 USD, these revenues only include sales and property management. However, expanding to adjacent opportunities could further increase ReStacks' revenues growth. Expansion opportunities could include anything from mortgage securitization to a virtual power plant.

re|s⁺acks