

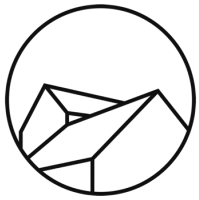
BUILDINGENERGY BOSTON

Scale Up/Carbon Down: A Regenerative Approach to the Housing and Climate Crises

**Andrew Frederick, Croft
Alan Gibson, GO Logic LLC**

Curated by Greg Bossie

Northeast Sustainable Energy Association (NESEA) | March 21, 2025



Croft

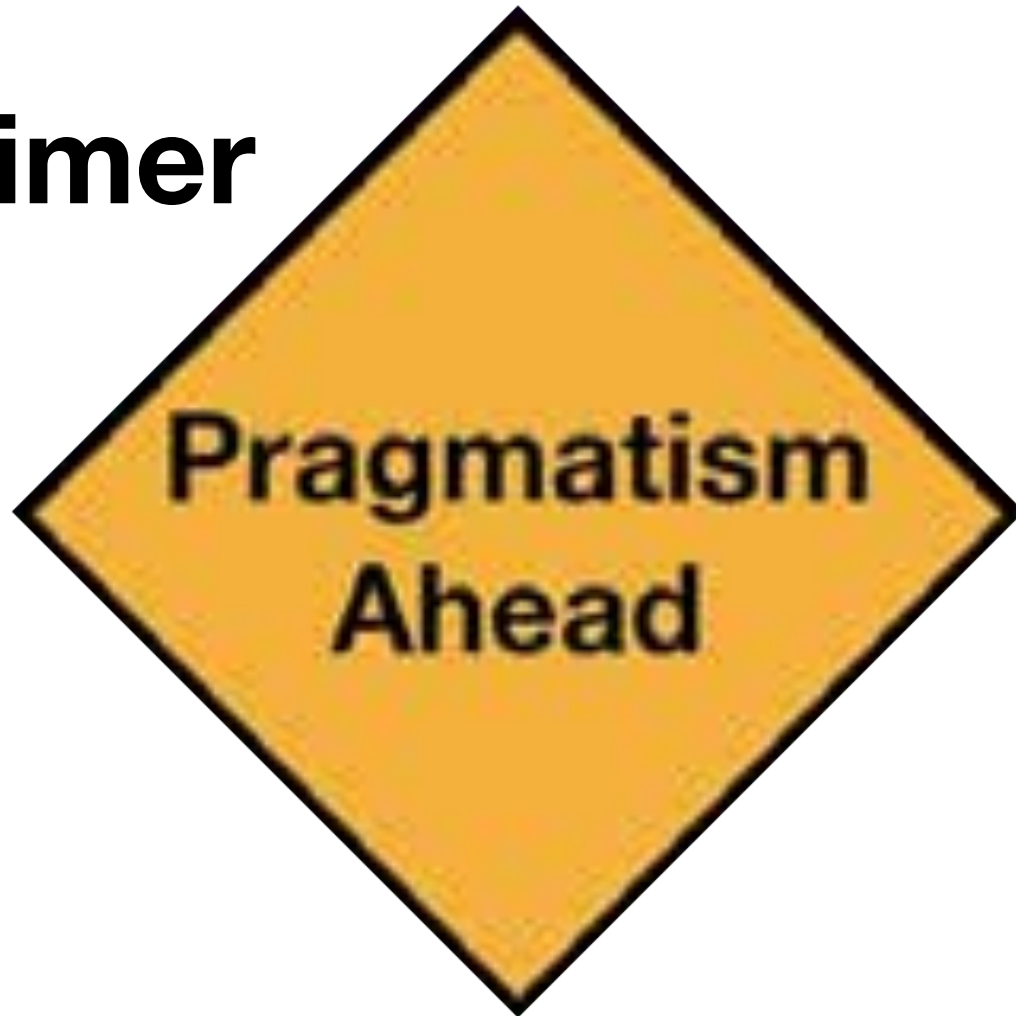


GO-LOGIC

SCALE UP / CARBON DOWN

**A regenerative approach to the housing
and climate crises**

Disclaimer



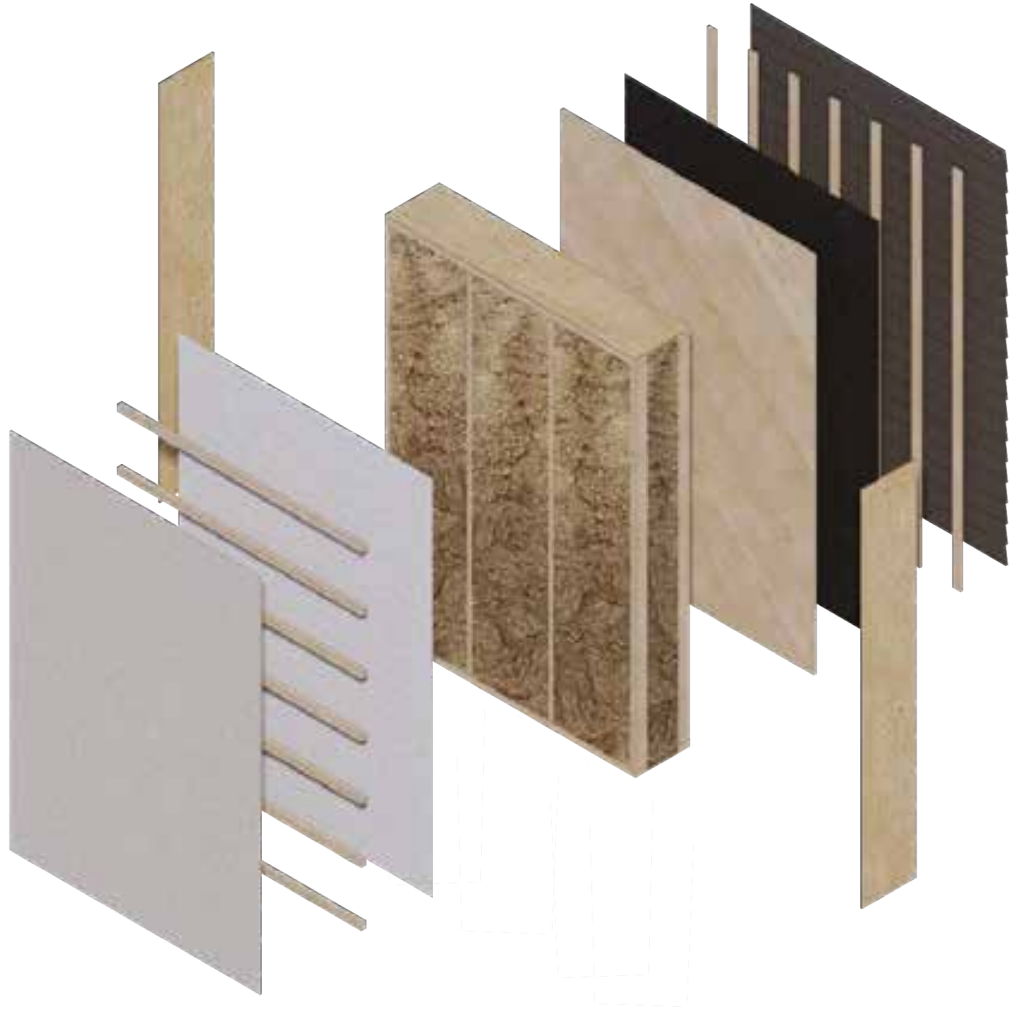
Disclaimer #2

This is a thought experiment. It's intended to be provocative.





- Founded 2020, Rockland ME
- Panelized prefab
- All natural materials
- Secure own supply chain
- Untapped partnerships
- Appropriate Tech
- Minimal processing, lots of plants



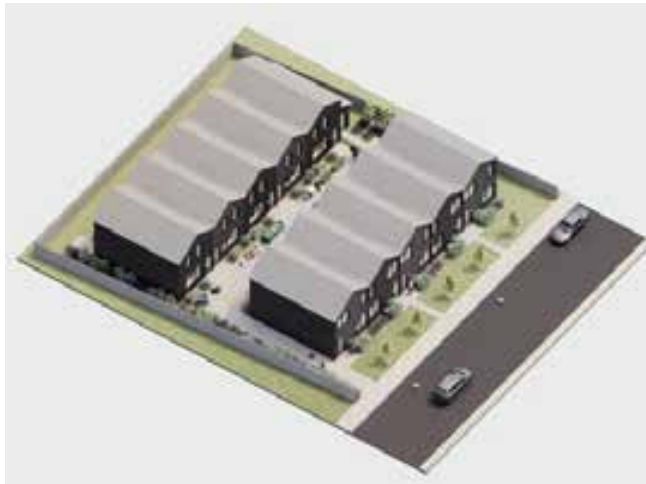


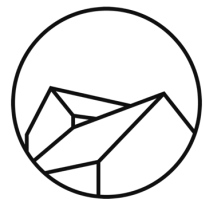
Kit-based prefab
System with biogenic
materials



MultiFamily & Rowhouse collaborations

- SF, MF, commercial, industrial, retrofit - mostly with Massachusetts firm Primary Projects
- “Agnostic” panelization system: carbon-storing materials are priority!





Croft

*A carbon-capture company whose
byproducts are food and housing.*





GO Logic LLC is a 45-person design and construction firm and panel manufacturer in Maine, committed to designing and building passive structures throughout the Northeast. Founded in 2008 by builder Alan Gibson and architect Matthew O'Malia.





GO·LOGIC
DESIGN + CONSTRUCTION

THE GO HOME by GO LOGIC



GO LOGIC

Commitment to

- PH-level performance
- Low-carbon materials
- Our Employees

1600 Model Home



1700 Model Home



Ecovillage
36-family complex of
Near-Zero structures



Fortin Residence

Winner of Phius Source-Zero Award 2021





A Roadmap for the Future of Housing Production in Maine

January 2025

By 2030

Maine gov: “84,000 units needed”

A Roadmap for the Future of Housing Production in Maine

Maine's climate goals: 45% reduction in GGE by 2030; 80% by 2050

January 2025

In a world where buildings are 40% of our annual climate impact...

Future of Housing Report 2024/2025

83 pages,

1 mention of environment:

Suggesting that environmental reviews should be "expedited" in the case that projects show economic growth potential.

0 mentions of carbon reduction needed, climate impact of buildings. 1 general callout to PassivhausMaine as a reference for "implementing low carbon building practices"

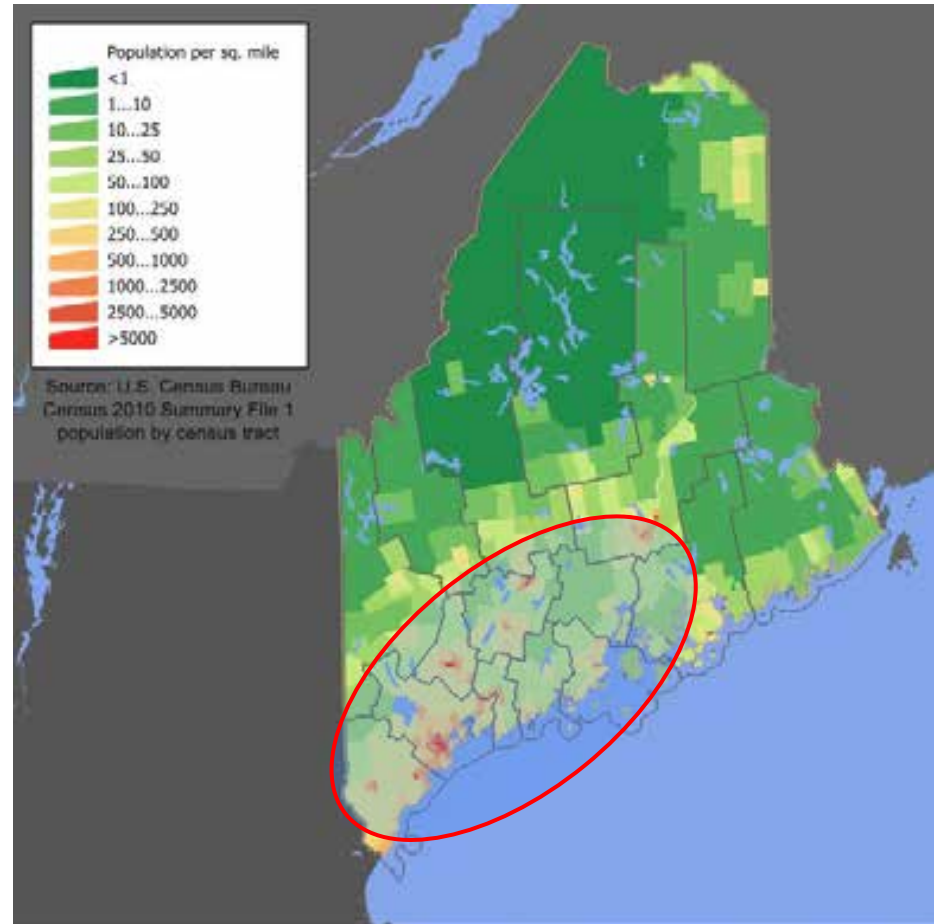
Meanwhile..."**We are on the brink of an irreversible climate disaster**" –Oxford Academic, 2024

Maine gov: "84,000 units needed"

(also Maine gov: "also somehow become carbon neutral at the same time, across every sector of the economy. oh, make housing cheaper, too. But create good paying jobs.")

Maine

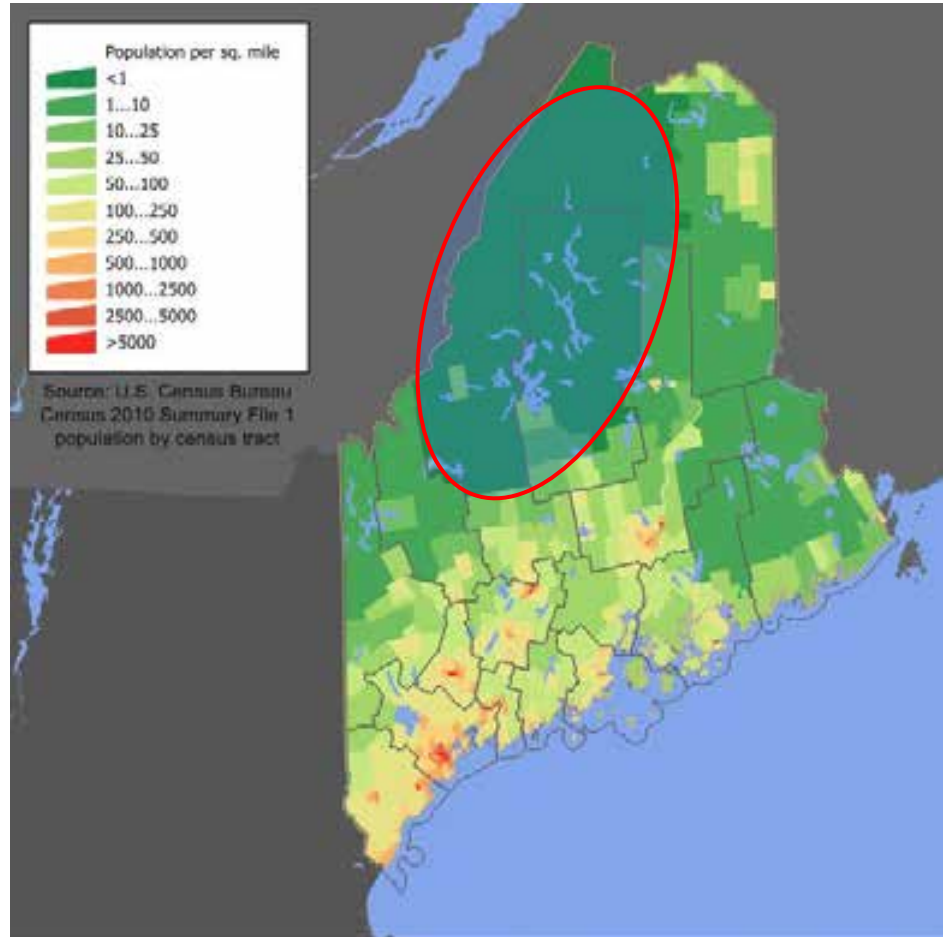
- It's really big
- It doesn't have many people, relatively speaking: 1.4 MM
- 3/4 of the population is in the southern 1/3 of the state
- Biggest population growth is 65 and older



Maine

And we have this glorious region where there should be no people.

Maine is the most forested state in the US at 83%



Highlights of the Study



1) Streamline Processes and Build Public Capacity

Expand the capacity of State and municipal government to plan for, approve and provide infrastructure for new homes by providing technical assistance and by streamlining State and municipal processes, building codes and land use laws.



2) Incentivize Production and Increase Transparency

Use incentives and increased transparency to promote the development of homes in growth areas in collaboration with municipalities.



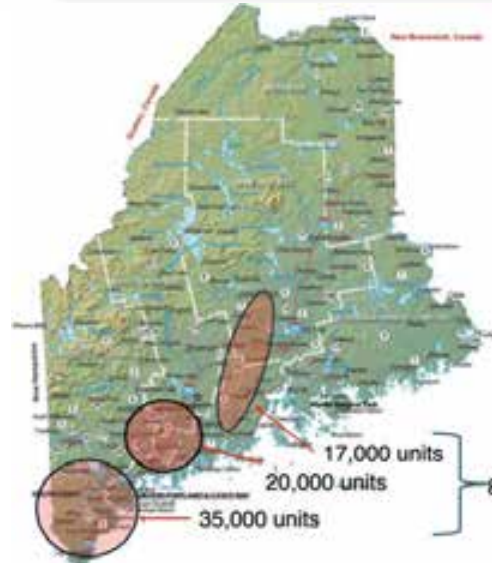
3) Strengthen the Private Sector

Invest in recruitment and retention of workers in construction and skilled trades, engage employers to support workforce housing development, and explore opportunities to adopt innovations that reduce costs.

Housing Production Barriers in Maine



A Roadmap for the Future of Housing Production in Maine | BRMA



Highlights of the Study

This is a
structural
problem



Housing Production Barriers in Maine



A Roadmap for the Future of Housing Production in Maine | 2024



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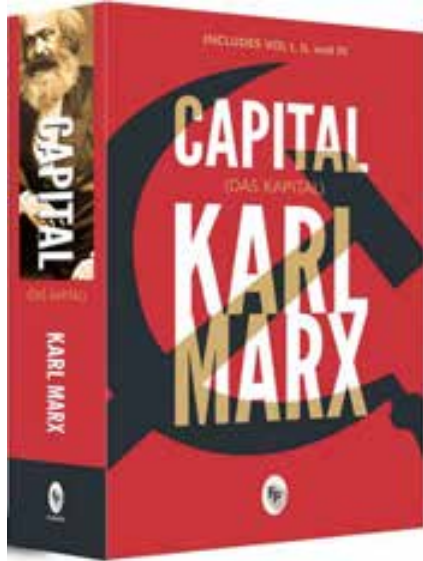
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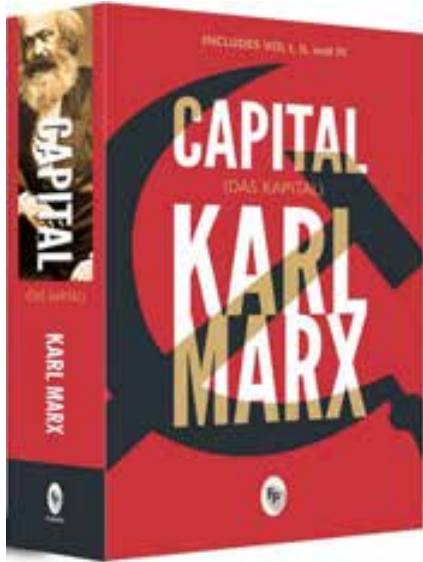
Capitalism



It's given developed countries a high standard of living but also:

- **massive income and wealth inequality (in the US)**
- **economic instability without Keynesian interventions**

Capitalism and Housing



Housing is a basic human right which should not be used as an investment strategy, for speculation, or be commodified.

Climate Disaster

Untold Human Suffering in Pictures



BioScience, Volume 74, Issue 12, December 2024, Pages 812–824, <https://doi.org/10.1093/biosci/biae087>

The content of this slide may be subject to copyright: please see the slide notes for details.

Housing is a basic human right



Economic
dislocation



Destruction by war



Loss by climate
catastrophe

Failure of the Regulatory System and “Free Market”

- **Rather than building houses (which costs money), the State encourages housing through tax incentives (which lowers revenue)**
 - **Tax cuts are politically acceptable over more spending**
 - **Low-income housing tax credits go to wealthy investors**
- **Incentives for single-family homes (mortgage-interest deduction)**
- **Obsession with “free market” solutions**

We subsidize people (tax credits, housing vouchers) rather than construction. We need more focus on supply rather than demand.

Failure of the Regulatory System and “Free Market”

Obsession with
single-family homes



Elm Trails subdivision from Lennar Homes in San Antonio. Josh Spector for The New York Times

Yard South, South Portland

NIMBYism

- Mixed use on industrial site—former shipyard
- Proposed 1,000 residential units
- Shot down by opponents



Yard South, South Portland

A spokesperson for the Nimbys said,
“We’re not opposed to development there, but we would prefer marine or waterfront development.”

Portland Press Herald, November 5, 2024



Conceptual rendering of Yard South's zoning massing model that shows buildings that step up in height from the Fore River to Madison Street and step back from Bug Light Park.

Rendering by Neoscape. Image property of Yard South LLC

We’ve lost the ability to think collectively about the needs of society.

Centralized, Planned Economies Build Houses

China: Special Economic Zones

Shenzhen



Xiong'an, China, 170,000 housing units so far. 5,000,000 eventually



IMAGE: EYEVINE

European Socialism

- **Private ownership of the means of production**
- **Taxes directed toward better social services, education, transportation, planning, and housing**
- **Way more egalitarian**



Or Vienna

**60% of residents live in
social housing**

+

**43% of all housing is
rent-controlled**

**= 8% of household income
goes to housing, versus
30% in US**



Social Housing

- **Government underwrites housing construction**
- **Remains affordable by law**

Outlawed in the US since 1998

Faircloth Amendment:

This amendment, passed in 1998, caps the number of public housing units at their 1999 level, preventing any net increase in the public housing stock.



Social Housing in
Vienna

This has been tried in the US. Good effort,
not great results: The “Projects”



What if we were a little more intentional with planning...

- “Upzone” land for greater density
- Identify economic zones to encourage development
- Build infrastructure
- Order housing from regional building centers



Strategically located factories and logistics hubs

- Identify locations
- Match the factories to the need
- Refocus the industry to support this delivery method



Vivazz, Mieres Social Housing—Asturias, Spain

Belfast Cohousing and Ecovillage

36 units/60 people/6-acre built area

Self-financed



Phius-level performance; net-zero with PV

\$160/sq ft, 2011-2014

Make it all carbon-neutral, or better yet, storing

1. **Phius Standard-- brings operational energy to the lowest practical level**
 - 2-5% upfront cost increase repeatedly demonstrated
 - Climate-specific, just like other energy standards
 - Renewables on site or off-site to meet source energy target

2. **Upfront Carbon**
 - Biogenic materials
 - Renewable processes



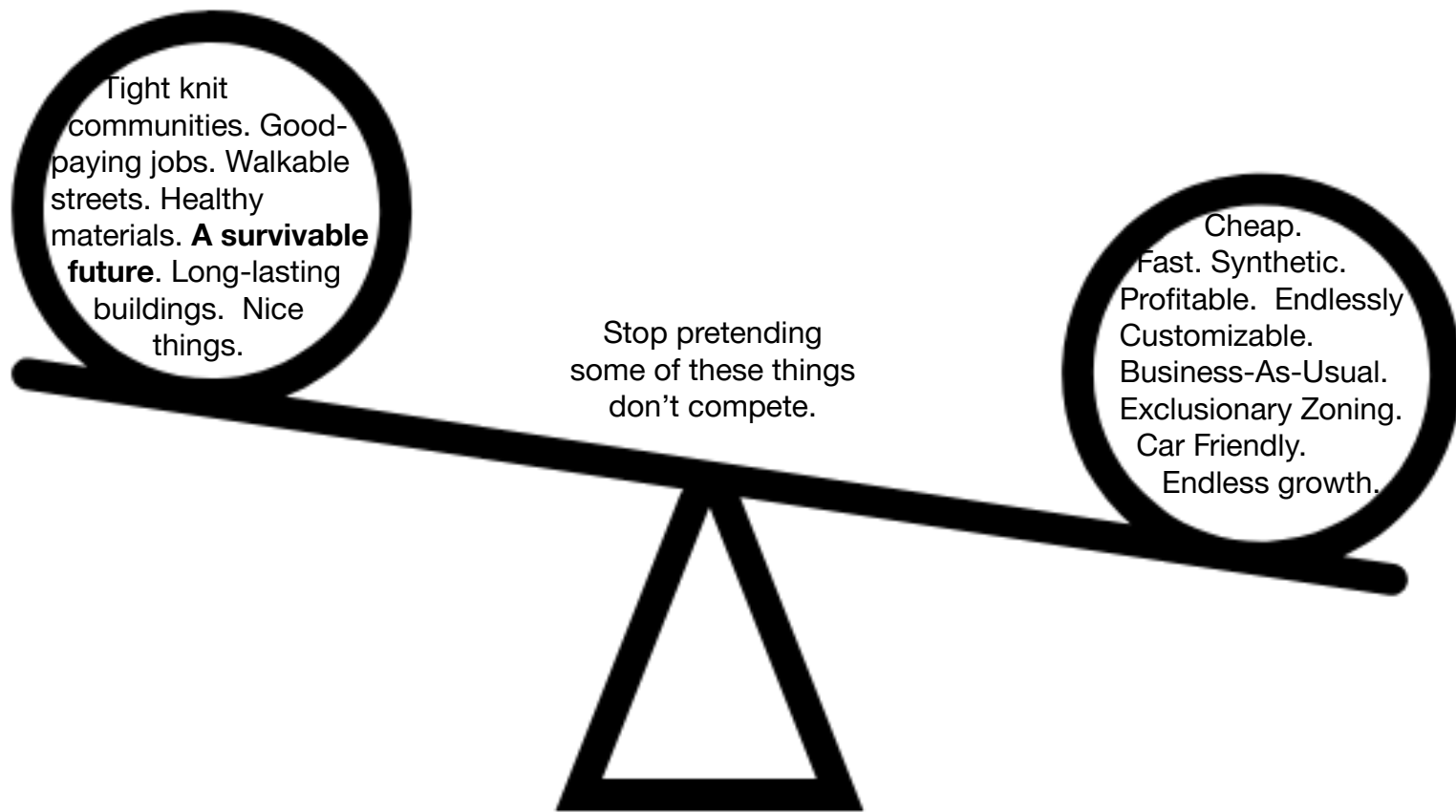
Solutions

- Think bigger—build new towns, expand existing ones
- Elect the right people who can make the case for State-funded housing

Lots of examples of successfully planned new cities, like Astana, Kazakhstan!



What do we honestly want?



Sequence of Solutions

Approvals

Funding

Education & Workforce Training

Operations/Logistics

Construction

Aftermath/Audit

Approvals

Current permitting timeline:

2.8 months per 20+ unit project

Streamlining could be... “improved”

Most U.S. projects controlled by cranky individuals on a power trip

Zoning is deeply rooted in race and class divisions

84k units/20 units per project $\approx$ 4,200 discrete buildings

4,200 X 450 hours per = 1.89M hours of mental capital

1.89M/2,000 hour workyear = 945 years

/50 people = 18.9 years to complete permitting

84k units built by 2030?

How about

84k units approved by 2044?

Approvals

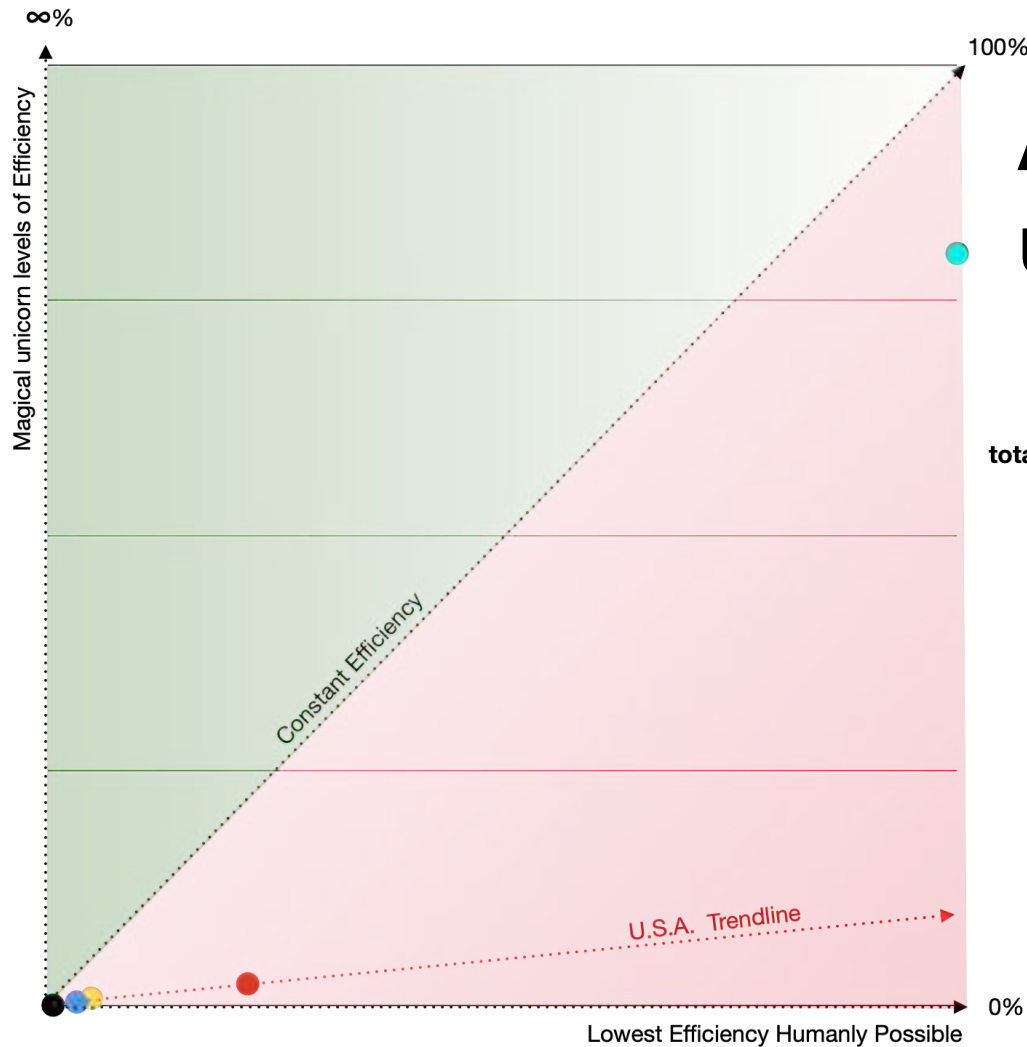
Solutions:

- **Bundle permits into “Template-Backed Approval Securities” to motivate companies’ investment**
- **Tiered restriction:**
 - **Ex:**
 - 100% approval for *system* tier and *module* tier
 - Form/aesthetic, finishes, services subject to planning/municipal review
- **Default is**



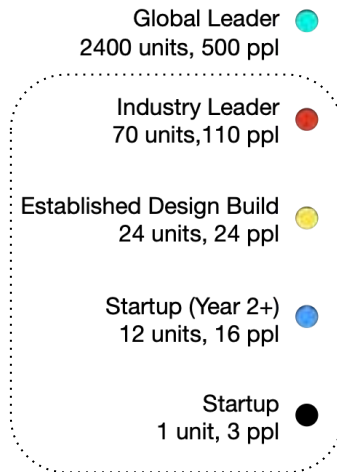
Ex. TIERS

1. USE/ZONING
2. SYSTEM
3. MODULE
4. FORM
5. FINISH
6. SERVICE



Ambition will not go unpunished.

throughput
total hours worked across company



← U.S. Based



Currently Approved

Yep, looks good.

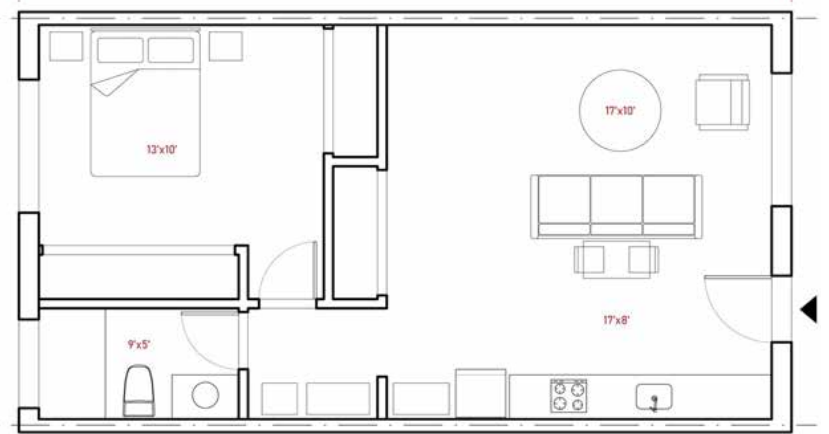
Funding

What it will definitely cost. (It just will. Sorry.)

Dispelling the tech myth

Who can/should pay, and

When



Example 640 ft² dwelling unit

Funding

It will be \$130k per unit to build these.

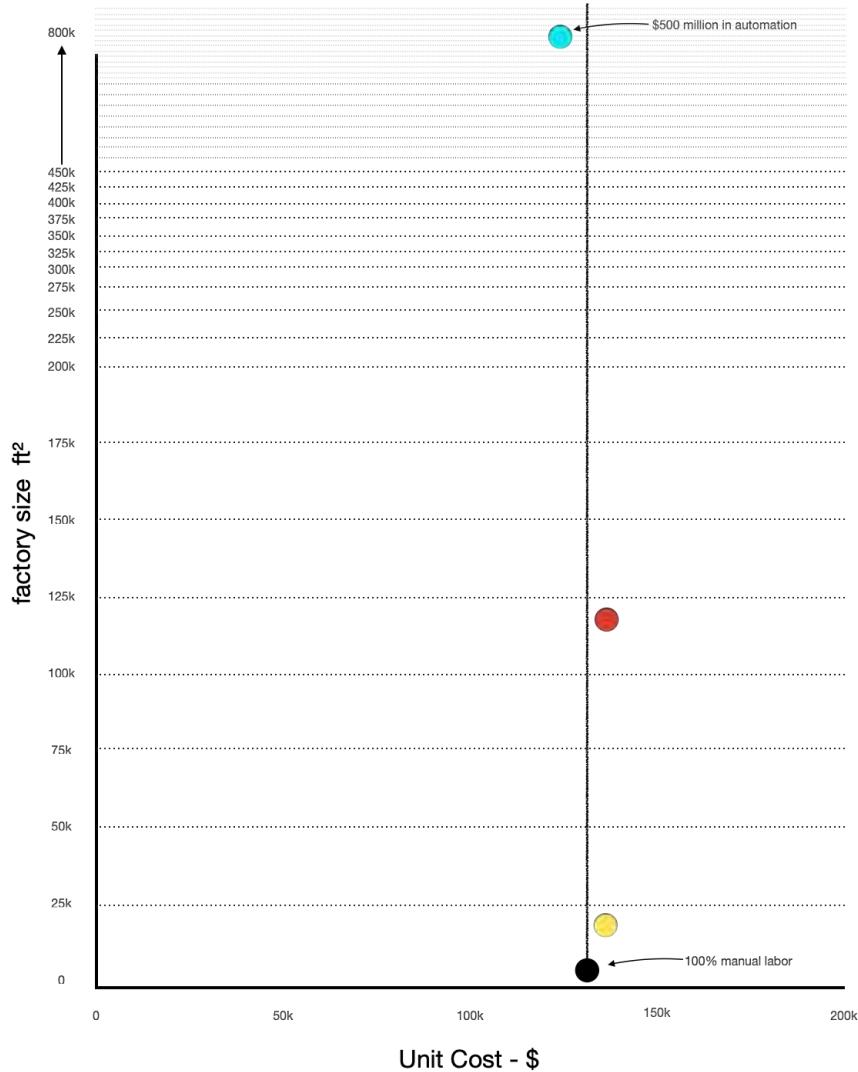
(Hold your horses, we'll explain.)

X 84k units = \$11 billion in cost to whoever builds these

Best case scenario, shell is 50% of cost =

\$22 billion outlay.





We know the cost.

Anyone who tells you
otherwise is:

1. A huckster.
2. Inexperienced.
3. Adorably delusional.

(There exists a cost floor,
and it is about \$130,000)

Startup
Established Design Build
Industry Leader
Global Leader





Building for Tomorrow

Recommendations for addressing
Massachusetts' housing crisis
February 2025

Modular homes can be built up to two times faster than traditional stick-built homes **and provide major cost savings.**²³

McKinsey
& Company

**Modular construction:
From projects to
products**

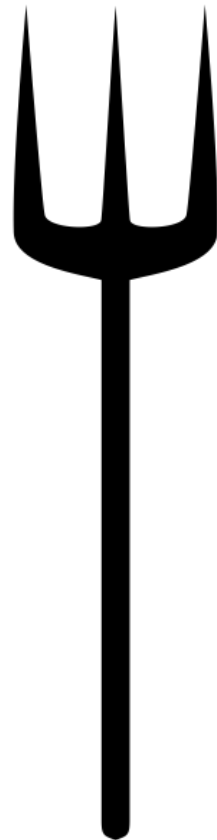
June 18, 2019 | Report

“The modular approach also has the potential to yield **significant cost savings**, although that is **still more the exception than the norm today.**”

How to pay for housing?

While we're dreaming:

- **Maximum Wage Law & Blanket Wealth Tax**
- **Every dollar above \$1 billion taxed at 100%**
- **Affects 806 individual U.S. citizens**
- **Net = \$ enough to build housing in all 50 United States of America, plus 68 more imaginary states.**



Source: McKinsey Institute for Black
Economic Mobility

Investing in housing: Unlocking economic
mobility for Black families and all Americans
(<https://www.mckinsey.com/bem/our-insights/investing-in-housing-unlocking-economic-mobility-for-black-families-and-all-americans>)

And... why tax the living daylight out of those in the economic stratosphere?

Source: Housing Constraints and Spatial Misallocation,
Chang-Tai Hsieh Enrico Moretti

* Source: McKinsey Institute for Black Economic Mobility
Investing in housing: Unlocking economic mobility for
Black families and all Americans
(<https://www.mckinsey.com/bem/our-insights/investing-in-housing-unlocking-economic-mobility-for-black-families-and-all-americans>)

“A lack of housing may have lowered aggregate US GDP growth by up to 36 percent between 1964 and 2009.”

Achieving housing goals could add \$2 trillion to the economy in a single decade.*

1. We heavily tax just 0.0002% of the population, guarantee *some* permitting & subsidize build at rate of \$2.2b per 6 month interval direct to housing providers.

And/Or

2. We continue to let the “free market work its wonders”

And/Or

3. Novel partnership needed between GCs, prefab mfrs, (and lending institutions for financial guardrails) on Crowd/Co-Op funded Housing- there's “money on the table”!



Education & Training

- Hands vs. Robots
- Simplicity





Beeps or Peeps



AUTOMATE

Consolidates into megafactories

Increased energy req's

Requires novel equipment, scale-up time

Funnels \$ into few selected manufacturers (linear)

Creates sustained need for throughput to pay off investment (hard to “dial back”)

Consumptive, noisy, smelly: not a good neighbor.

Consistency & speed requires perfect execution

Industrial production narrows product offerings - needs repeatability

TRAIN & HIRE

Mycorrhizal skill building, decentralizes permitting & production

Runs on green energy (food)

Immediately actionable

Direct investment into workers, who can then afford housing (cyclical)

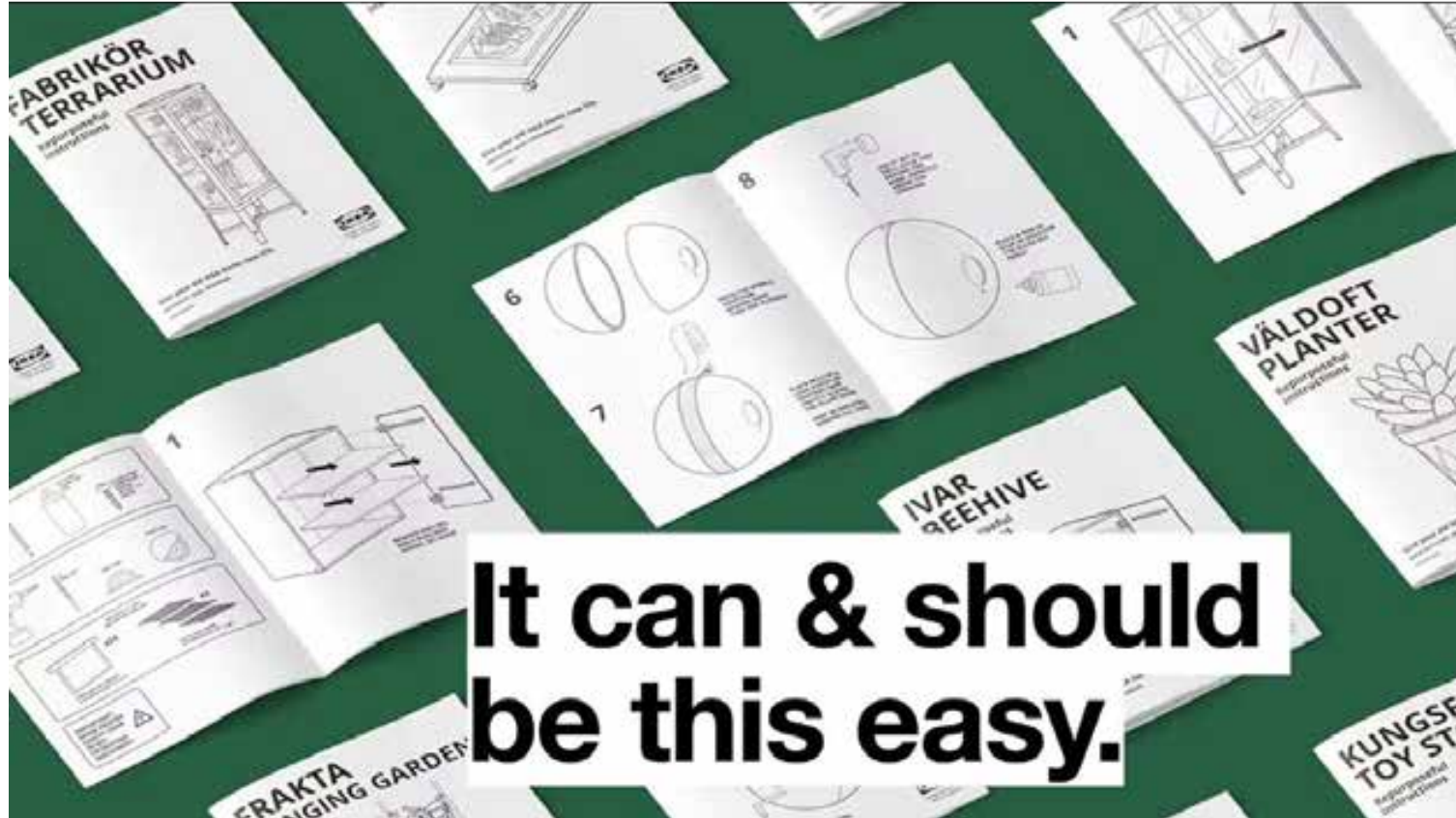
Can go on vacation for a bit, and then get to work renovating all the crappy buildings we just spent a century making.

Slightly less consumptive, noisy, and smelly. Mostly okay neighbor, sometimes.

“Snowshoe effect” on quality control

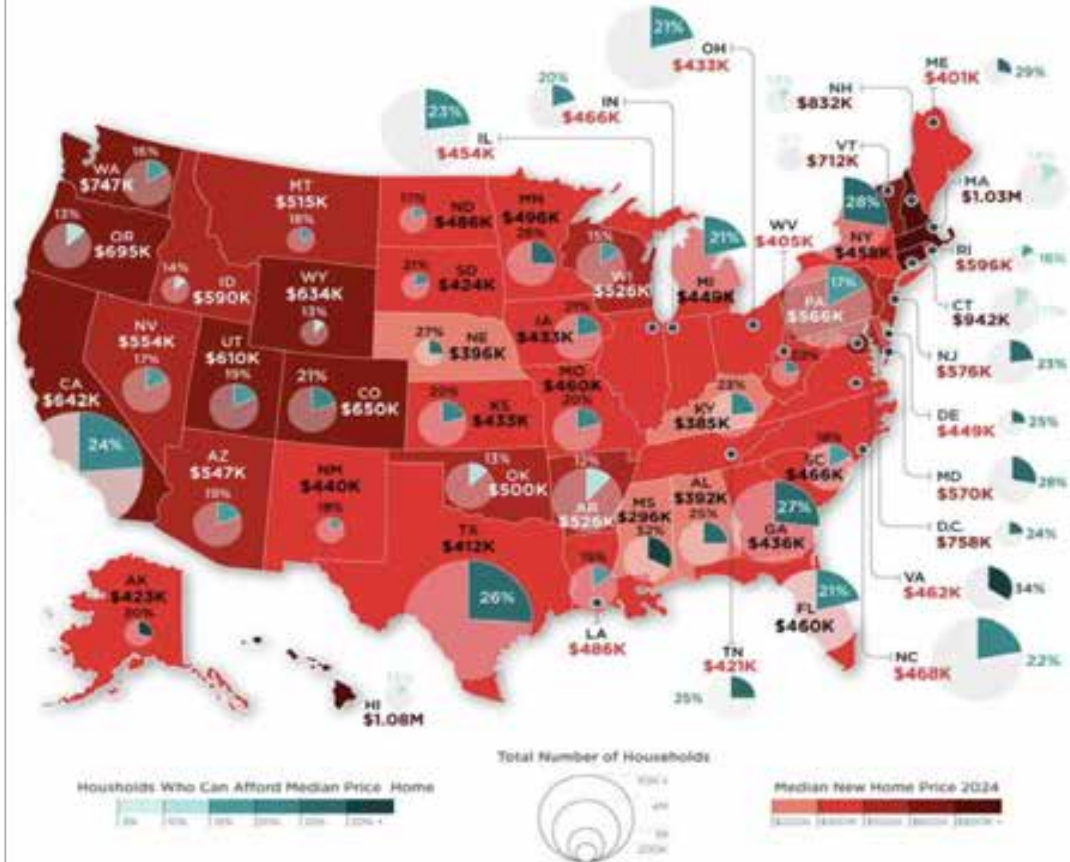
People are smart and beautiful and can solve problems

Education/Training



Affordability

Home Affordability in the U.S.
Median New Home Price & Percentage of Households Who Can Afford It



Article & Sources:

<https://howmuch.net/articles/home-affordability-in-the-us>
National Association of Home Builders - <https://www.nahb.org/>

Affordability

Median household income Maine = \$70,000

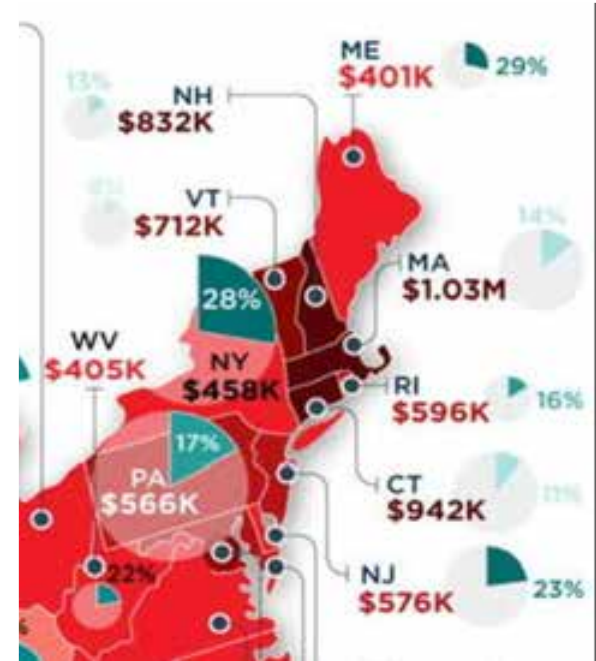
What price house can someone earning \$70,000 afford

$\$70,000 / 12 = \$5,833/\text{mo}$

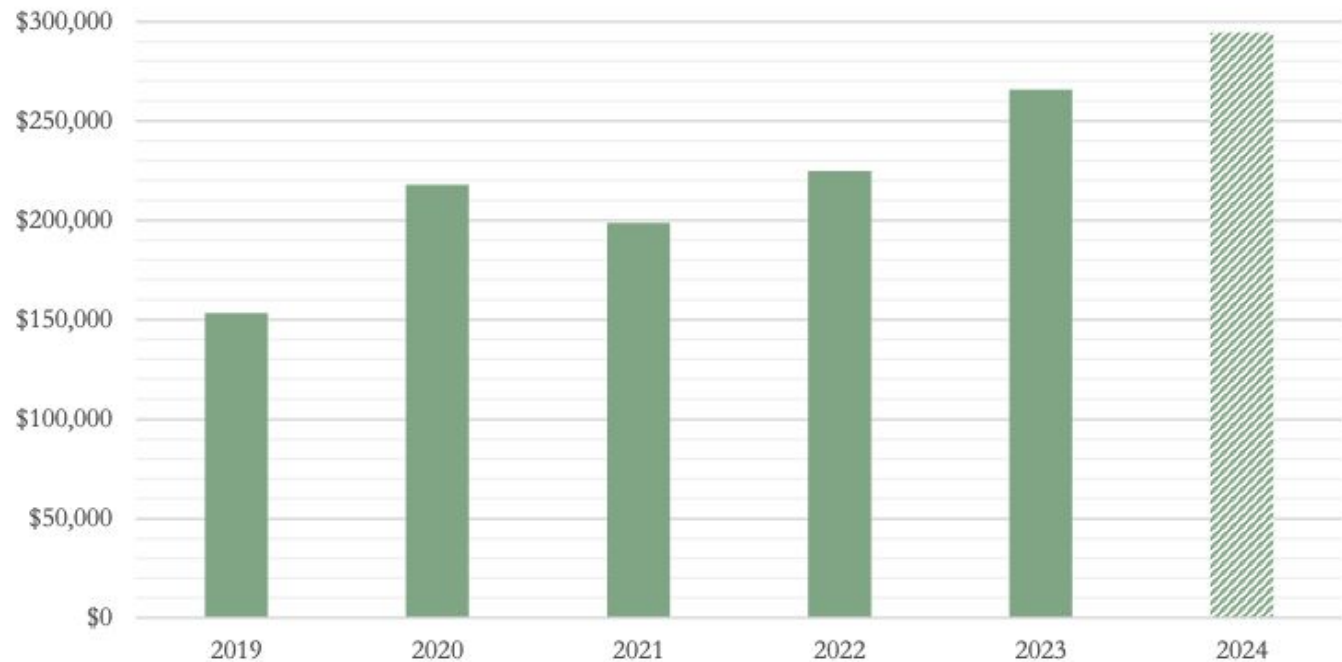
$\$5,833 \times 0.3 = \$1,750/\text{mo}$

Answer: a \$340,000 house (including land + site work)

Median house cost Maine = \$400,000



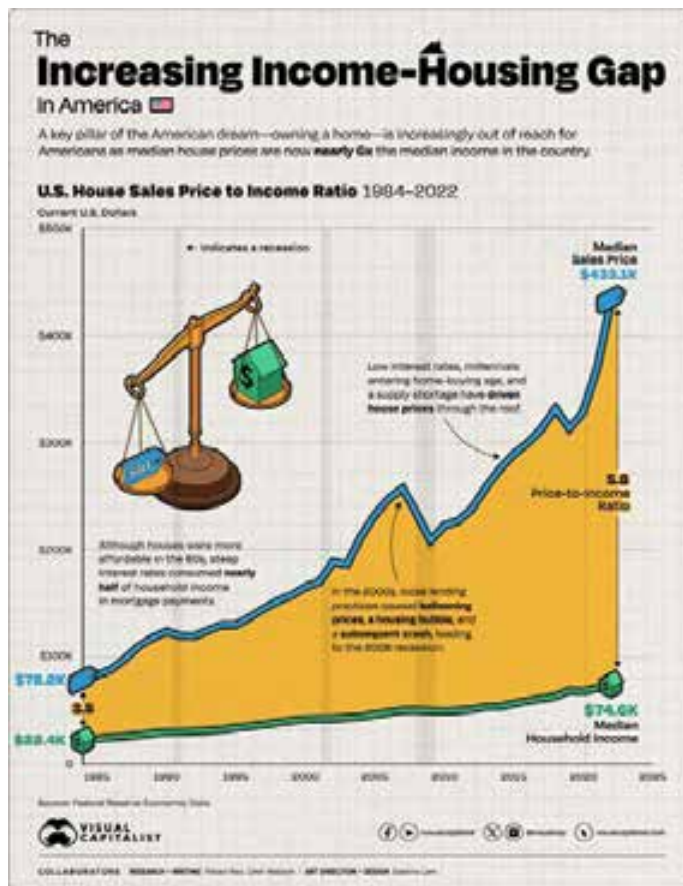
Total Development Cost per Unit



Source: Maine State Housing

This is not the fault of the construction industry.

We can't magically make it cheaper.



Source: Sebrina Lam, Visual Capitalist

1,400-sq. ft. GO Home
\$650,000+land+sitework

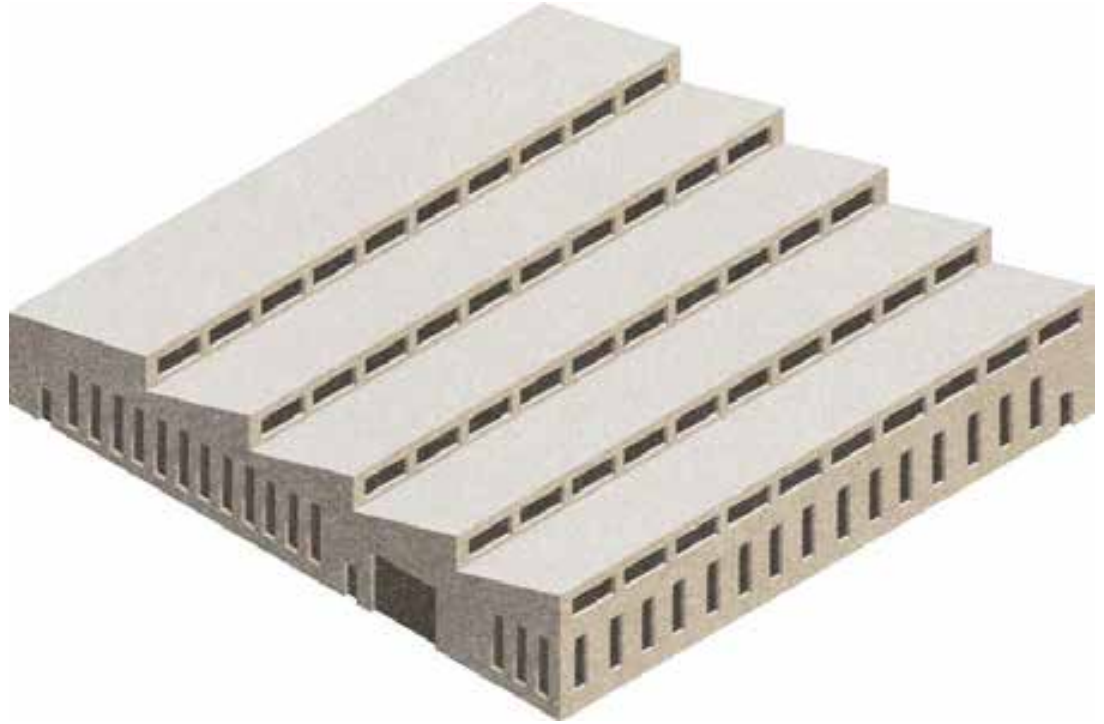


Operations/Logistics

Operations/Logistics

**Factory
Deployment**

**Supply chains &
Resources**



The Numbers Break-Down

84,000 housing units in 5 years

That's 16,800 per year, which is:

- 16,800 SF houses
- 1,400 12-unit buildings
- 350 48-unit buildings
- 140 120-unit buildings

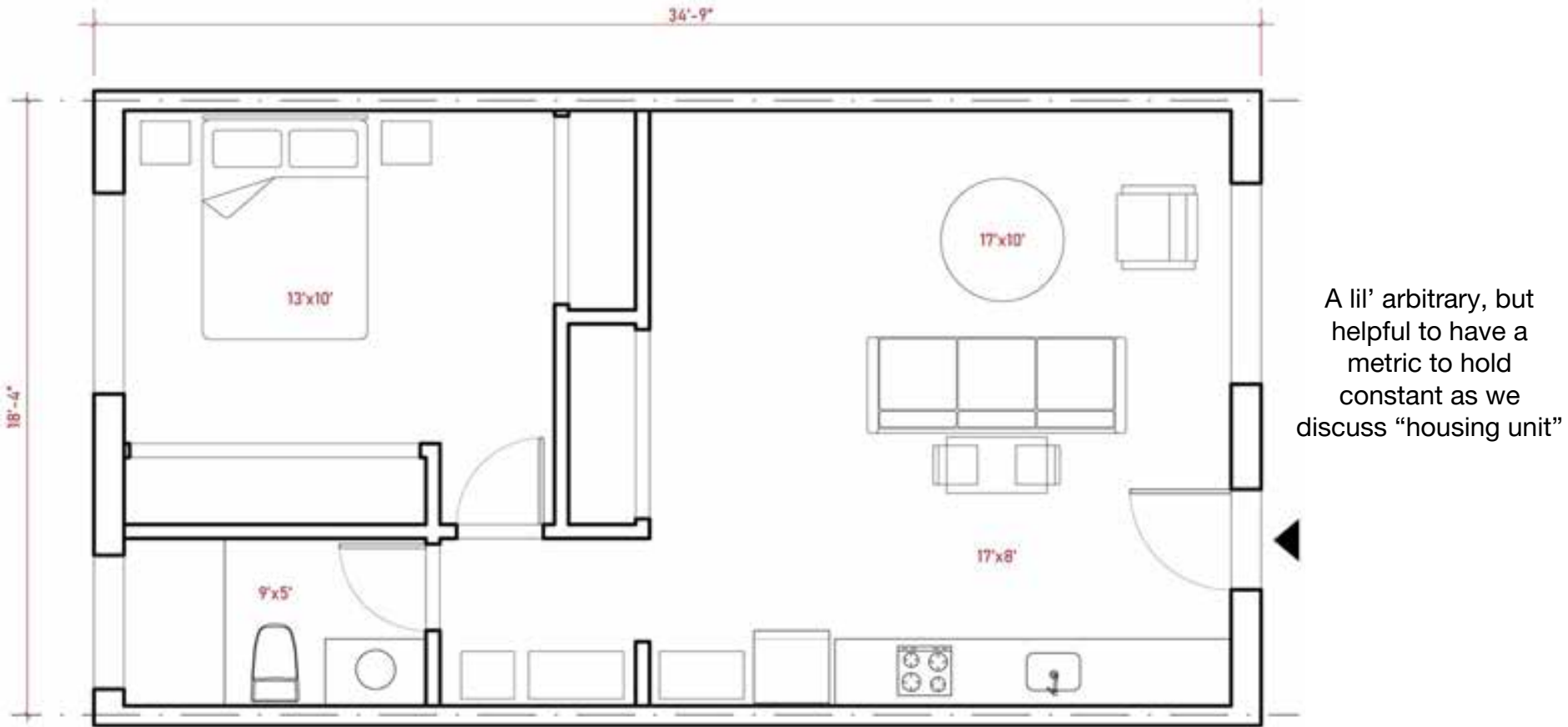
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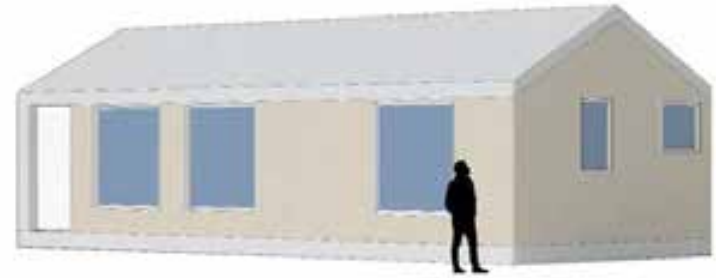
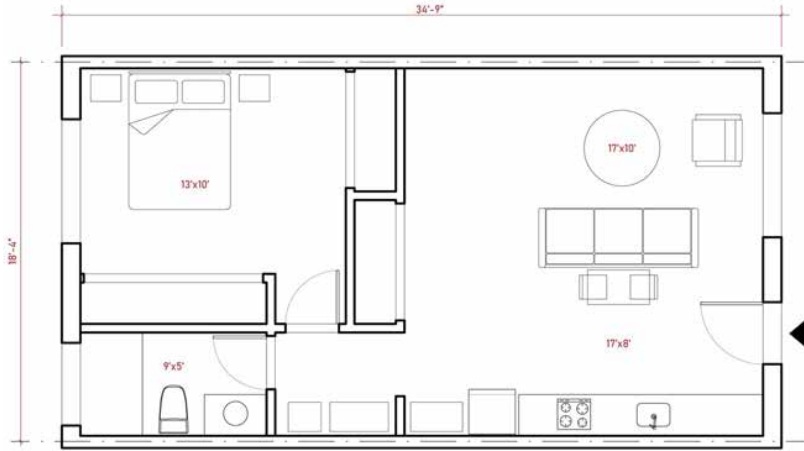
That's 16,800 per year, which is:

- 16,800 SF houses
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Maine built 775 affordable housing units in 2024



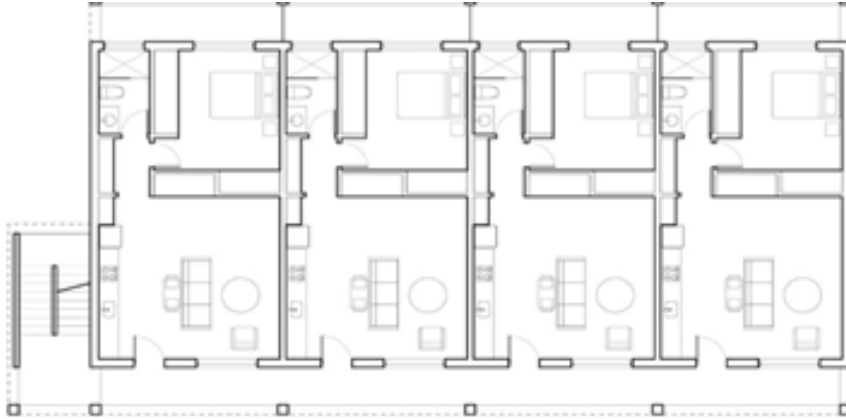
640 ft² dwelling unit

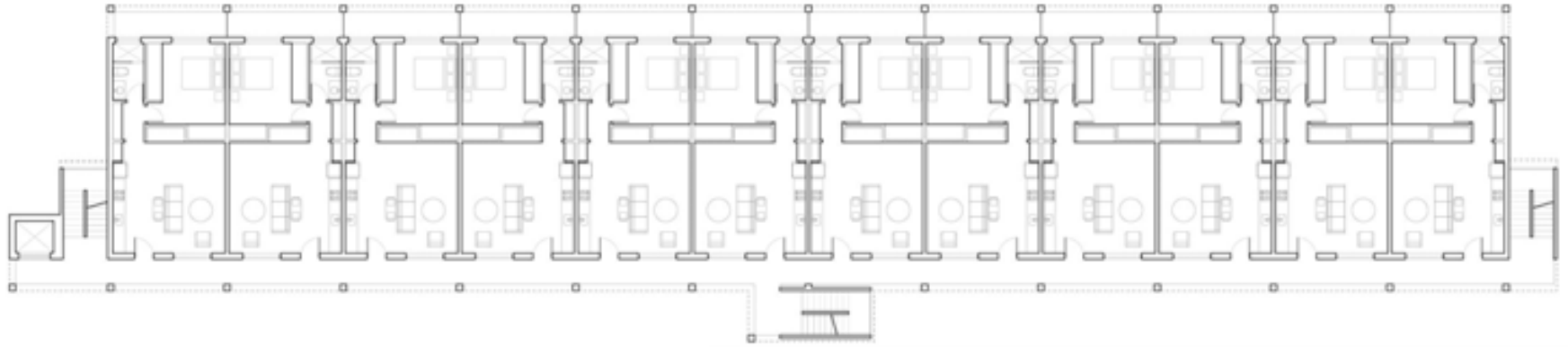


640 ft² dwelling unit

...we also need 2 and 3-bedroom layouts

**In a group of 4, 3 stories, single stair
12 units**



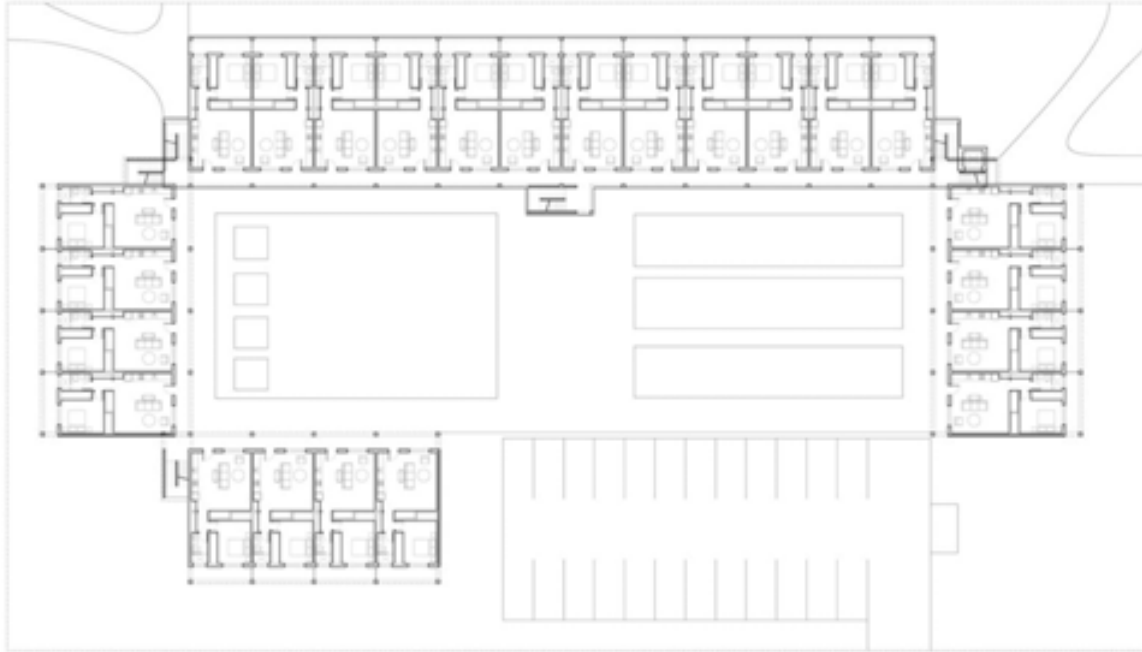


**12 units per floor, 4 floors
48 unit building**

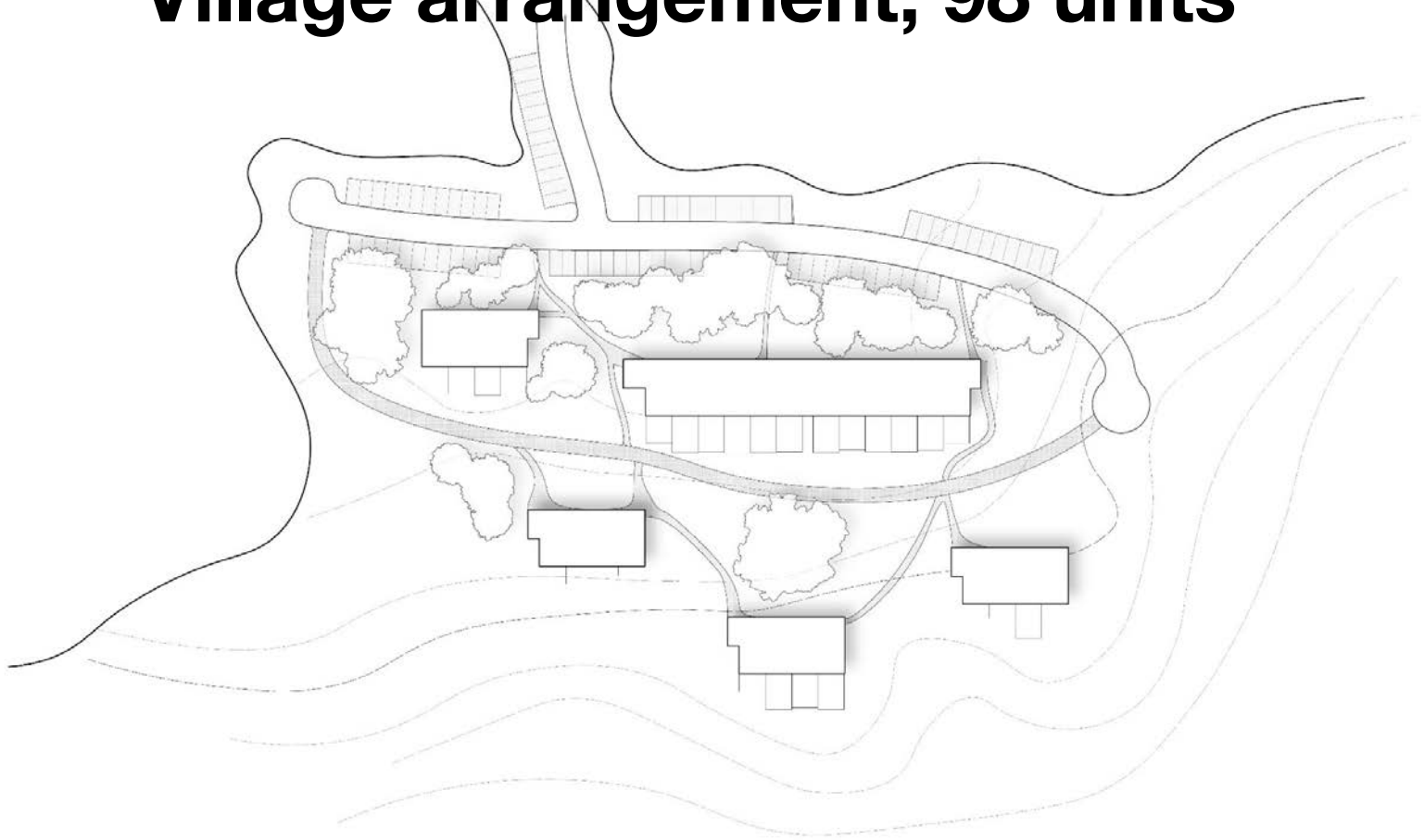
**Can this be
pre-engineered and
approved?**



Courtyard arrangement–98 units



Village arrangement, 98 units



What will it cost?

Building Size	32,000 sq. ft
Cost/sq. ft	\$300
Building Cost	\$9,600,000
Site work/Utilities	\$1,000,000
Soft Costs	\$300,000
Profit / Contingency	10%
Total Project Cost	\$11,990,000



48-unit building

(We need to build 350 of these each year...)

What will they all cost?

Total Project Cost	\$11,990,000
Cost per Unit	\$249,792
Cost of 72 factories	\$217,612,500
Cost of all Units/Year	\$4,196,500,000
Cost of 84,000 units	\$21,200,112,500



48-unit building

(The cost of 72 factories is 1% of the total cost)

What will they all cost?

Total Project Cost	\$11,990,000
Cost per Unit	\$249,792
Cost of 72 factories	\$217,612,500
Cost of all Units/Year	\$4,196,500,000
Cost of 84,000 units	\$21,200,112,500



48-unit building

What Elon Musk earns in 7 months

But they don't need to be built for free. People will pay for them.

In conclusion, this is doable if we think at this scale and provide a modicum of front-end funding to get the flywheel spinning and *actually plan*.

i.e.

We would happily build panels for these buildings 24/7 if they had places to land.

How do we build them all?





We've got one idea...

Construction

Construction

Options in typology

Priorities: zoom way, way, WAY out.

Materials

Why it should probably be prefab

Typology Pathways

Decisions, decisions...



Single Family Home

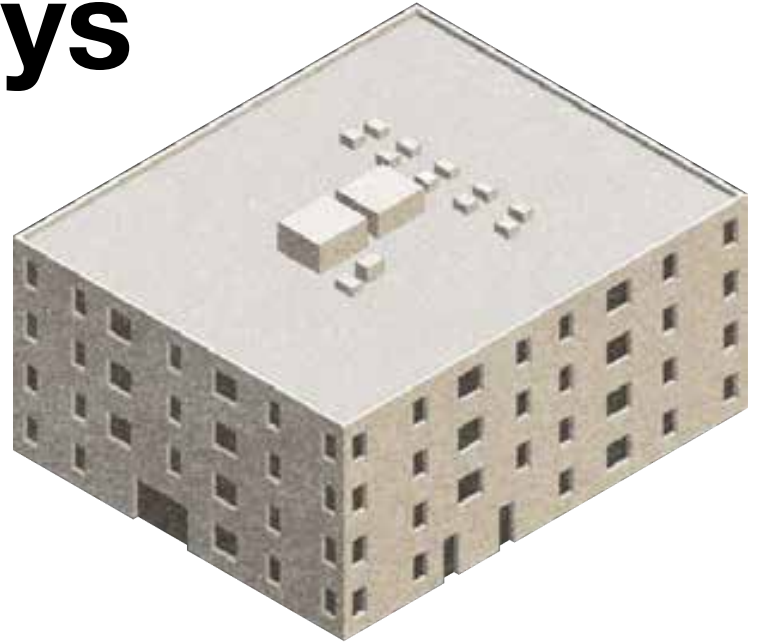
1233 ft³ WALL
900 ft³ ROOF
130 ft² GLAZING



Rowhome

822 ft³ WALL
600 ft³ ROOF
130 ft² GLAZING

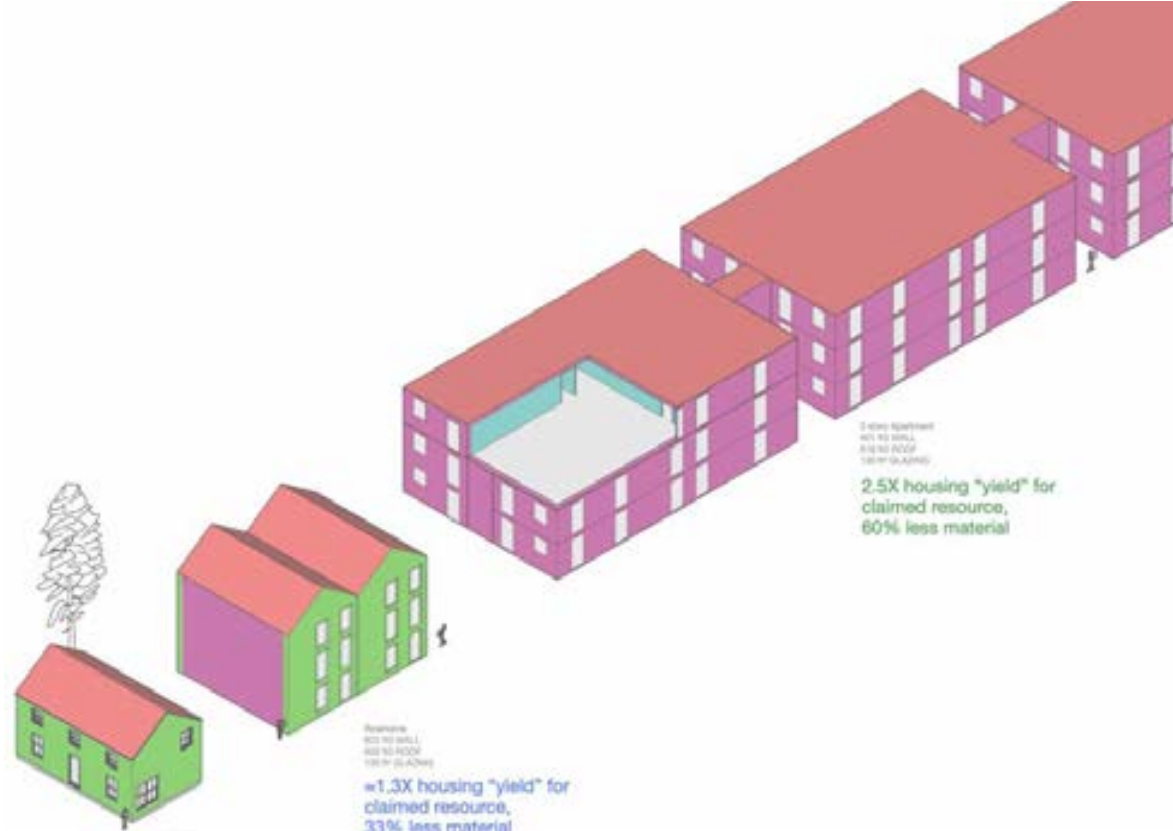
33% more housing
for claimed resource



Apartment

401 ft³ WALL
618 ft³ ROOF
130 ft² GLAZING

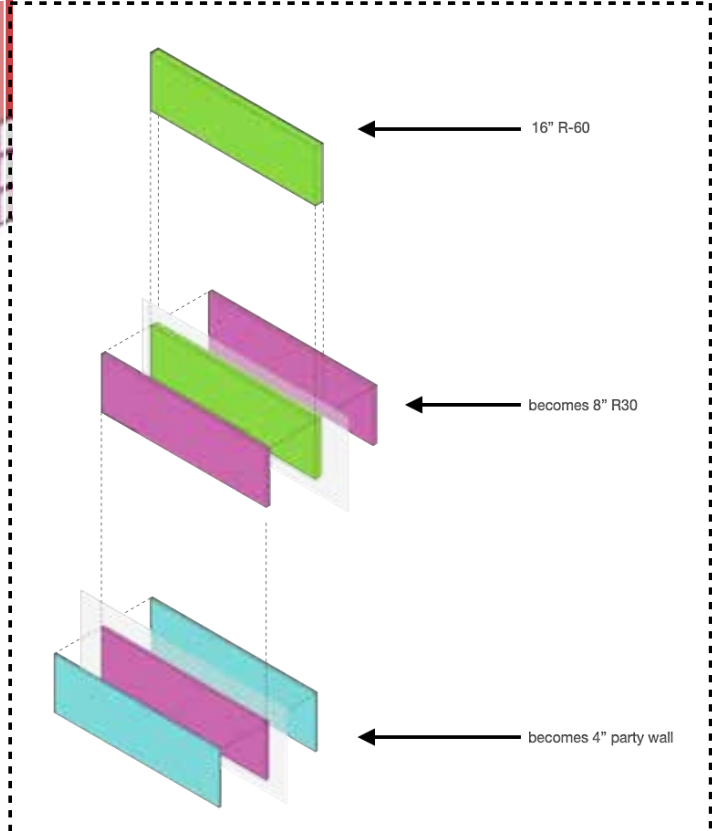
150% more housing
for claimed resource



SFH
1233 R3 WALL
900 R3 ROOF
130 R1 GLAZING

Resource
900 R3 WALL
400 R3 ROOF
130 R1 GLAZING

2 story apartment
400 R3 WALL
400 R3 ROOF
130 R1 GLAZING



Crank Up The Volume

Typology influences "envelope demand" to achieve
Passive house performance of sample dwelling unit

What we know:

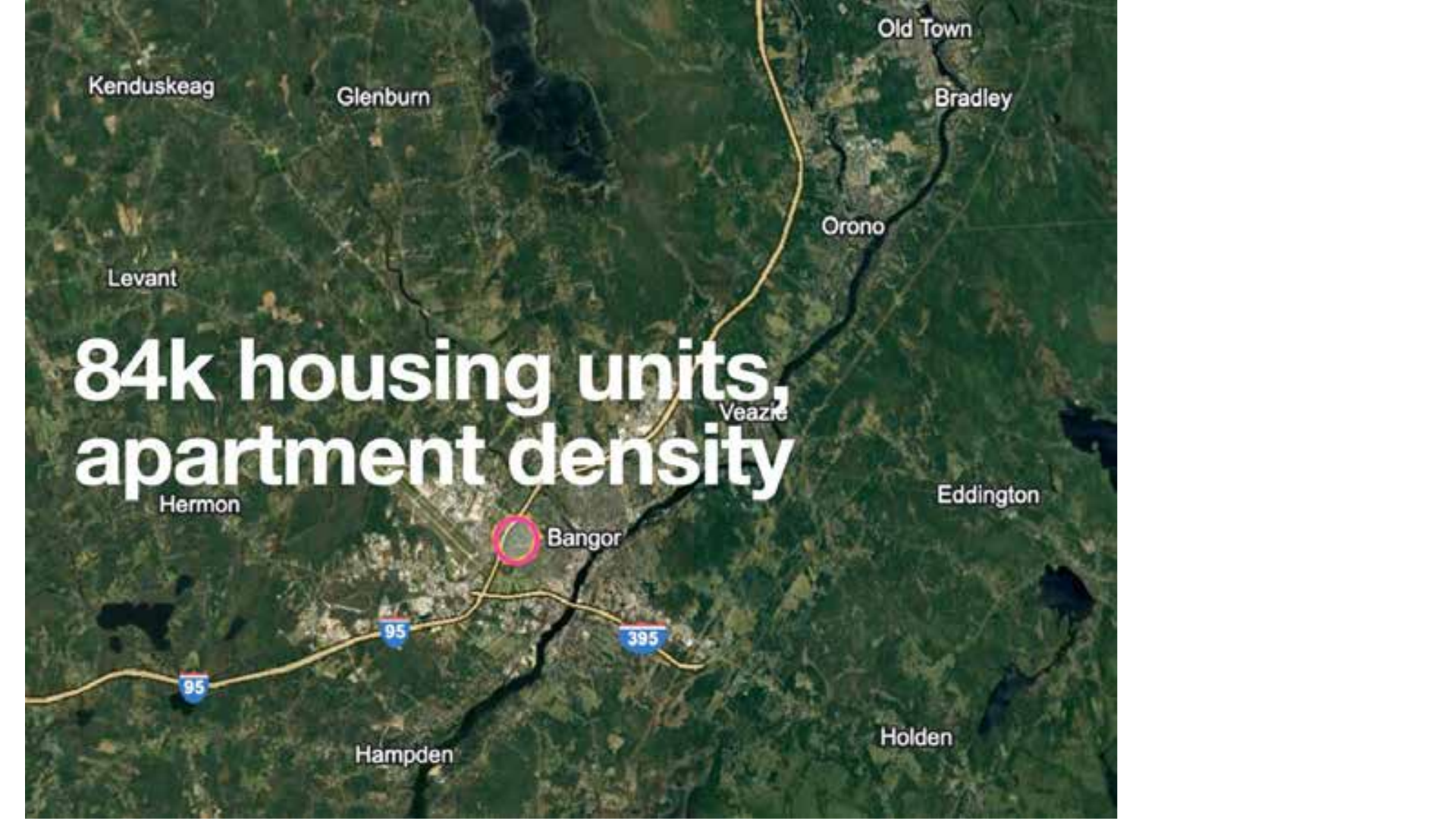
- AEC industry does not exist in a vacuum
- Our design decisions create “lock in” for generations- so don't waste resources building garbage we'll have to rebuild later.
- Think:

biggest (development pattern)

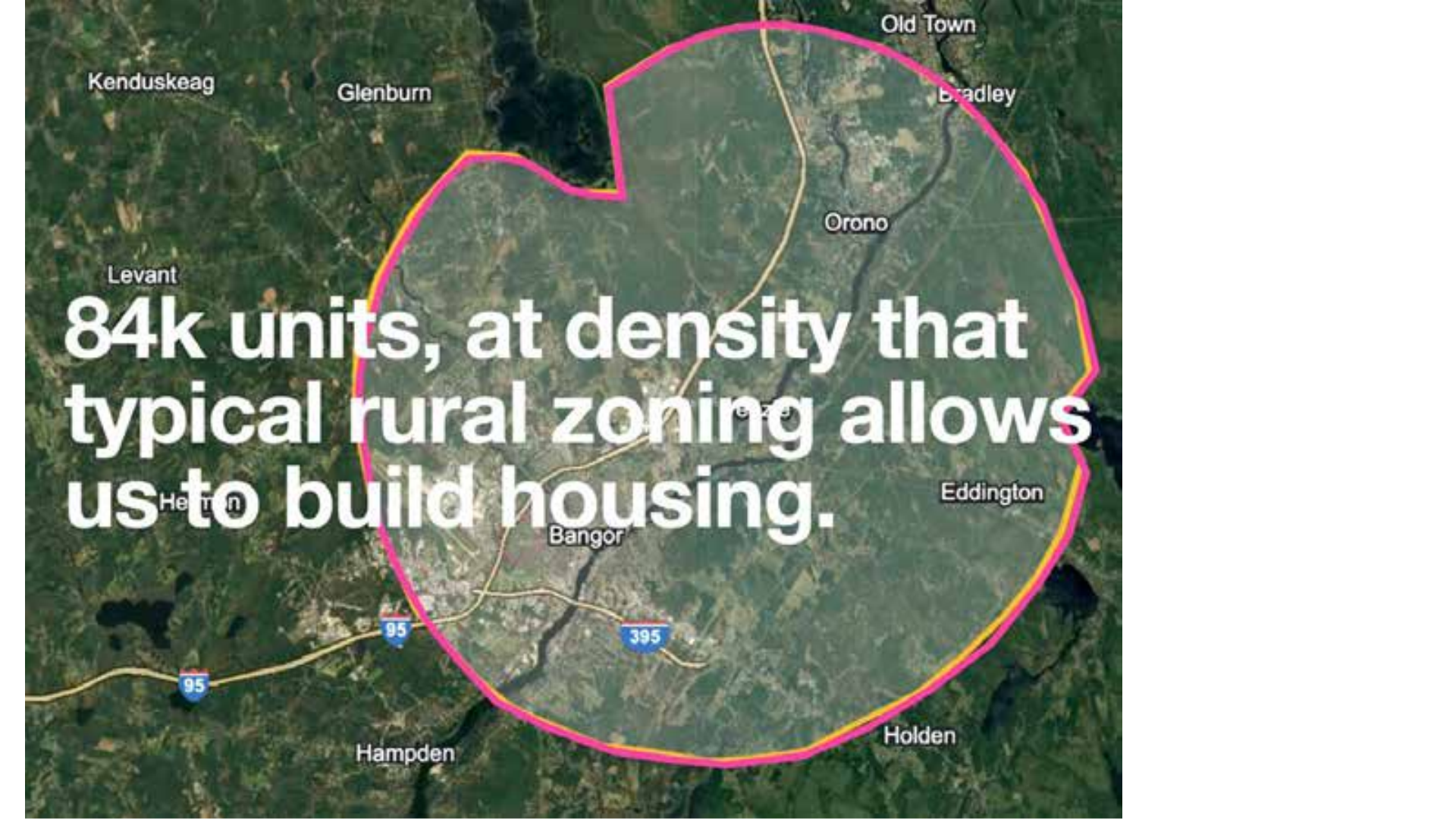
bigger(materials & supply chains)

big (building typology)

not so big at all (performance of the building itself)



**84k housing units,
apartment density**



**84k units, at density that
typical rural zoning allows
us to build housing.**

**Cushing,
Maine
1 unit/acre
maximum**



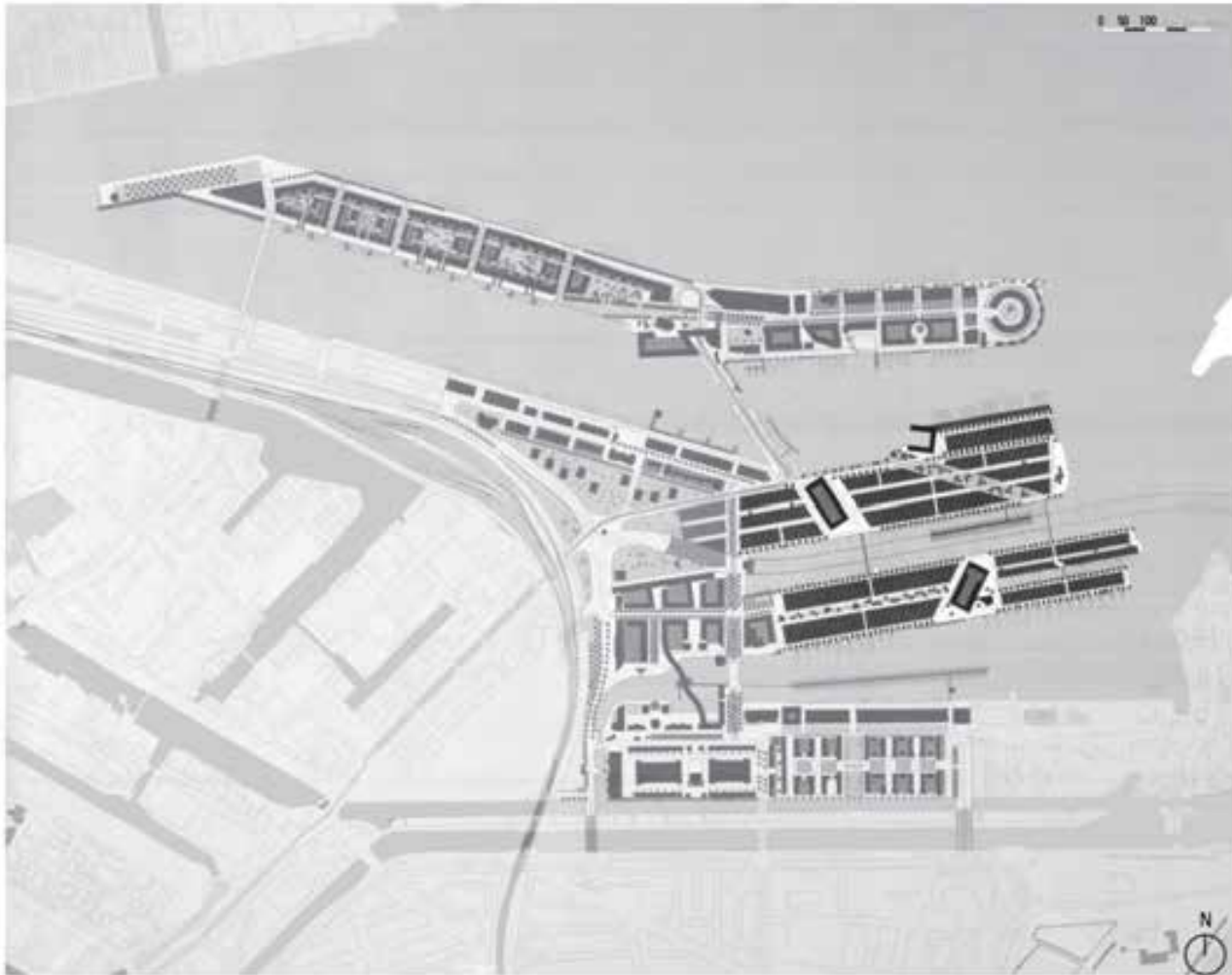
**Loneliness-Epidemic-
Inducing “town”**

Cluster/Village

**Canterbury
Shaker
Village**

**>100
“units”/acre**



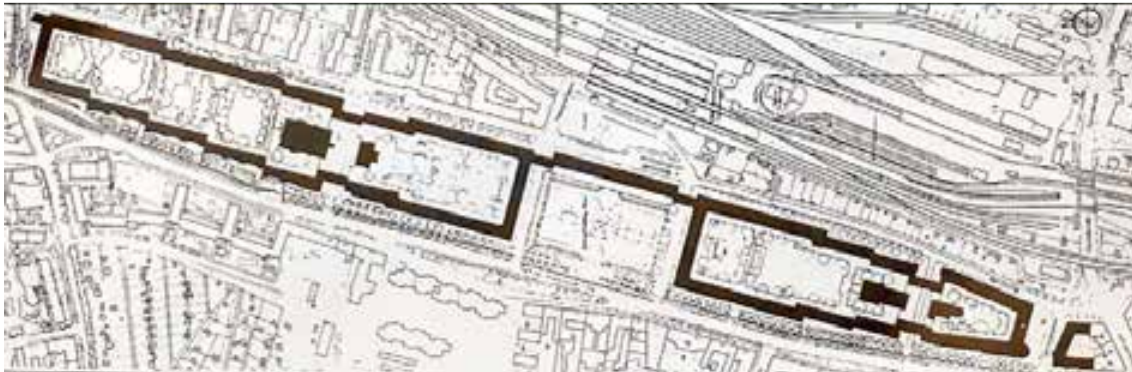


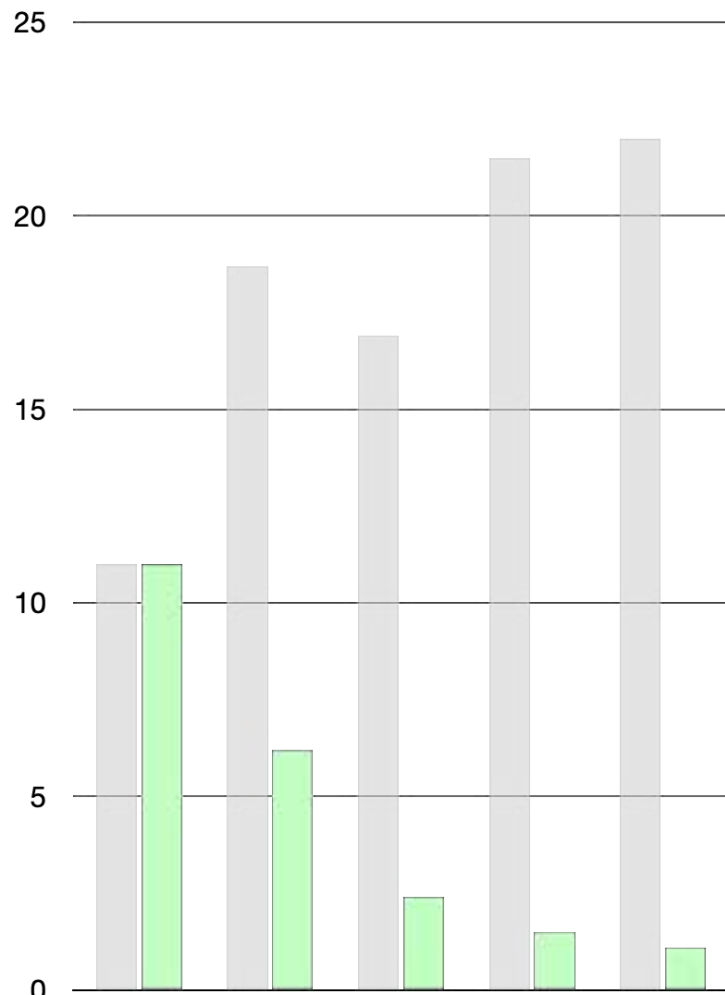
Rowhouse
Sporenburg
Amsterdam
2500 units
250 units/acre



Karl Marx Hof Vienna 282/units acre

11 hectares,
82% greenspace





Join hands: housing more people under one roof rapidly speeds per-dwelling-unit construction timelines

10X faster per unit to build 20+ unit multifamily vs single-family

**If *speed is the priority*,
nothing will top multifamily.**

Source: NAHB 'Eye On Housing' 2023
<https://eyehousing.org/2024/09/apartment-construction-time-averaged-20-months-in-2023/>

Total Construction Time
in months



Months per unit

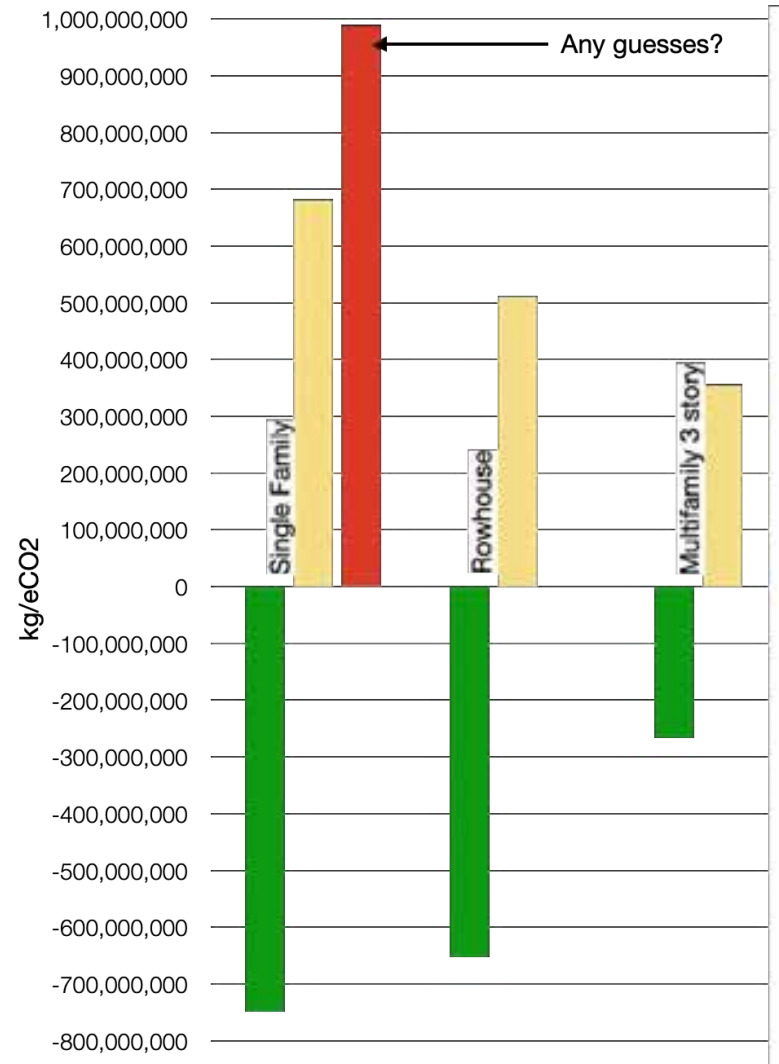


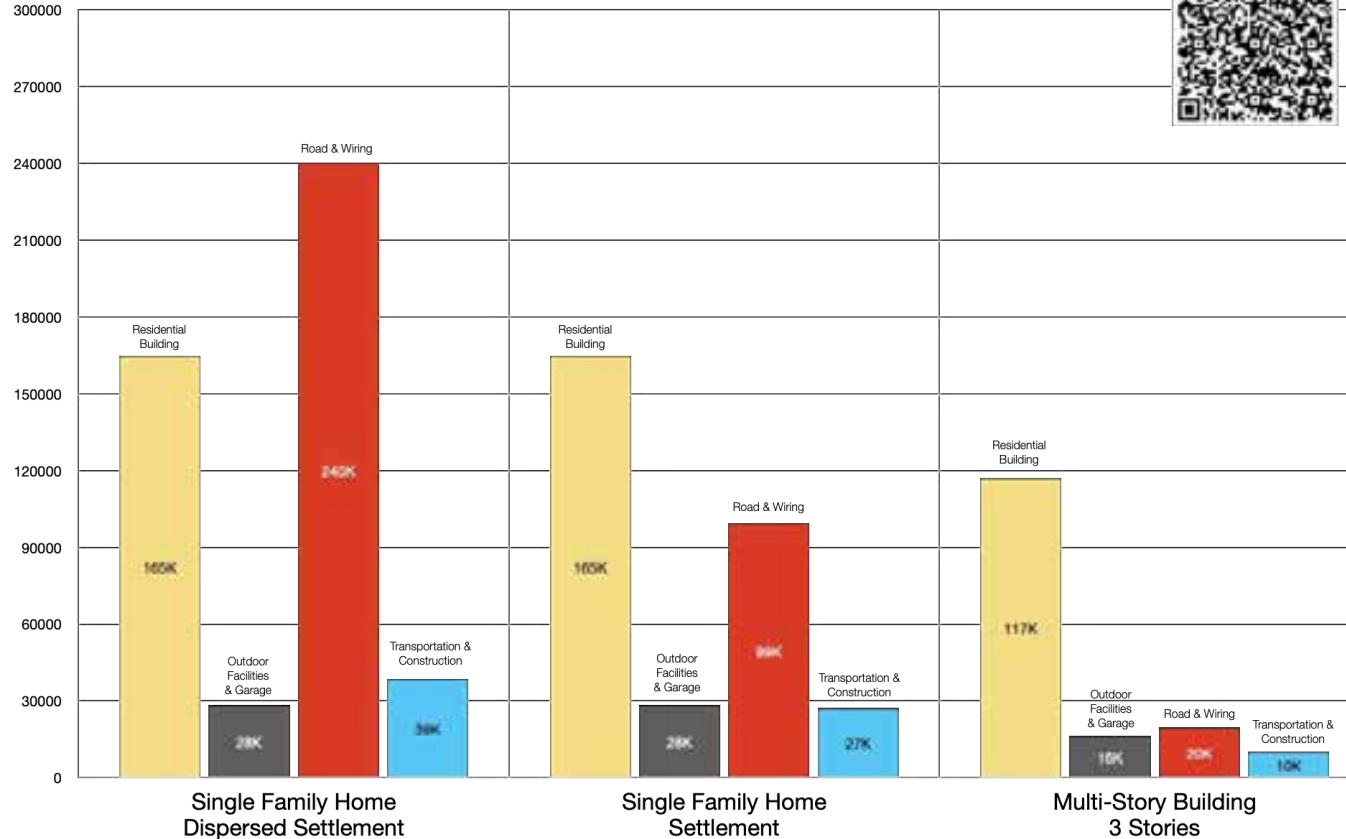
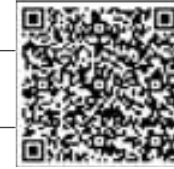
Embodied/ “Upfront” Emissions

84,000 homes (pick your poison)

50% **reduction** in business-as-usual
by changing building type

More than 100% *inversion* by
changing materials - if **Carbon
Capture** is priority- cluster more,
smaller, plant-based buildings into
dense villages *with shared
infrastructure*.





Basically...
Do anything
except what
we do right
now.

← assumes addtl 100m access road

Check your work, too.

<https://www.zersiedelt.at/grey-energy-calculator-settlements/>





We cannot solve our building problem until we solve our *settlement pattern* problem.
Green building is a bandaid on this bulls**t

**One barrel of oil contains the energy equivalent of
23,000 hours of human labor**



**That's 11.5 years of work.
Current Market Value: \$78**



From how we
extract resources,

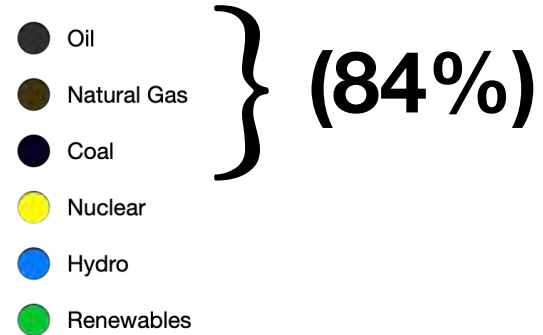


To how we transport and
manufacture goods from them,



To how we treat those resources
when we are “finished” with them...

The bulk of our energy comes from fossil fuels

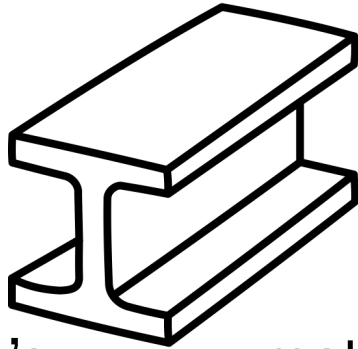


Source: Statistical Review of World Energy (www.energyinst.org)

So...when we design a building, made from materials, pulled freely from the earth & manufactured with that energy, there is “unseen oil” behind every kilogram of material on the jobsite.

So how much oil is in your material?

Total # Megajoules in your

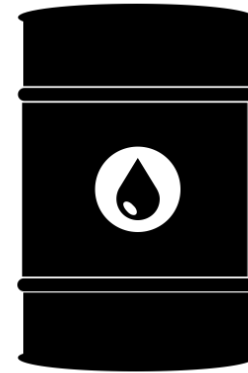


building's

materials

=

#



@ ~5800 MJ

?

Per Barrel





Los Angeles



Pikeville, Kentucky



Quebec City



Tauli, Spain



Foroglio, Switzerland

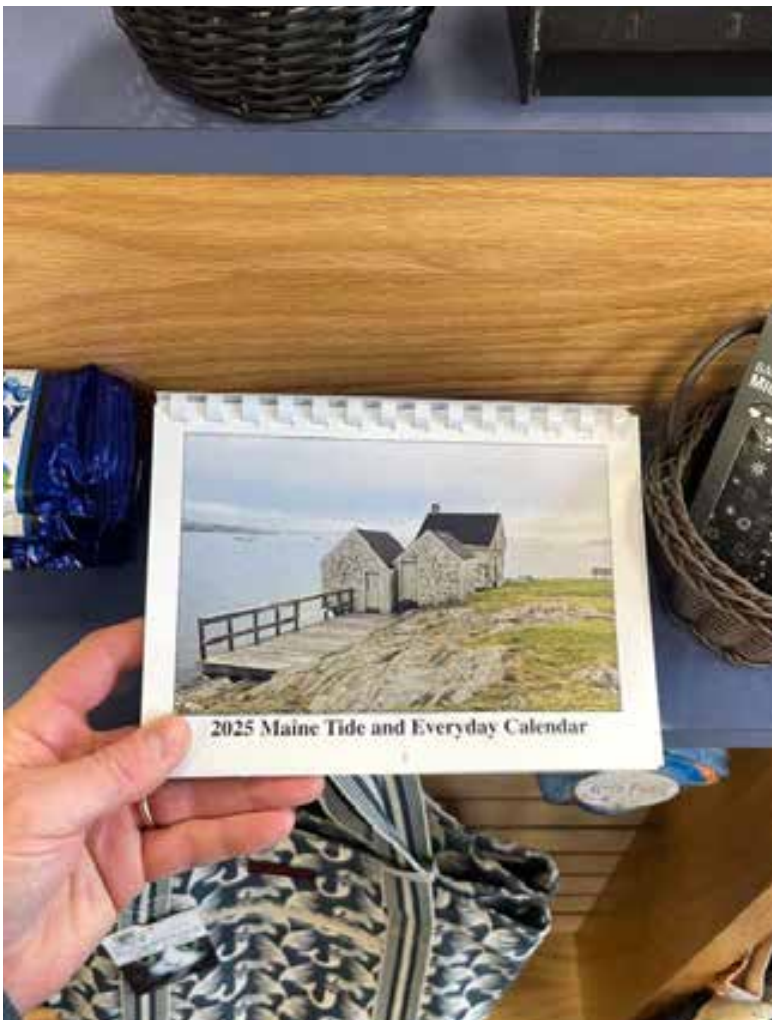


Staithe, North Yorkshire

Petronormative

adj.

of, relating to, or based on the attitude that the utility made possible through consumption of fossil fuels— through intention, ignorance, or apathy— is the only normal and natural expression of a civilized life.



2024

Maine:

The State of Denial

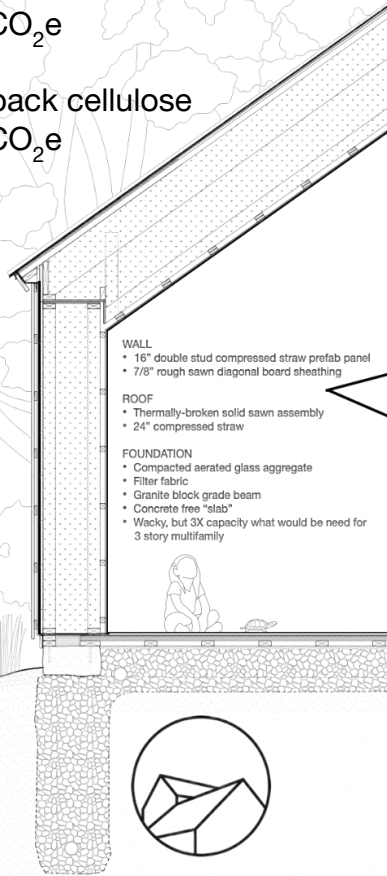


**Material (waste)=
energy (waste)=
oil (burned)=**

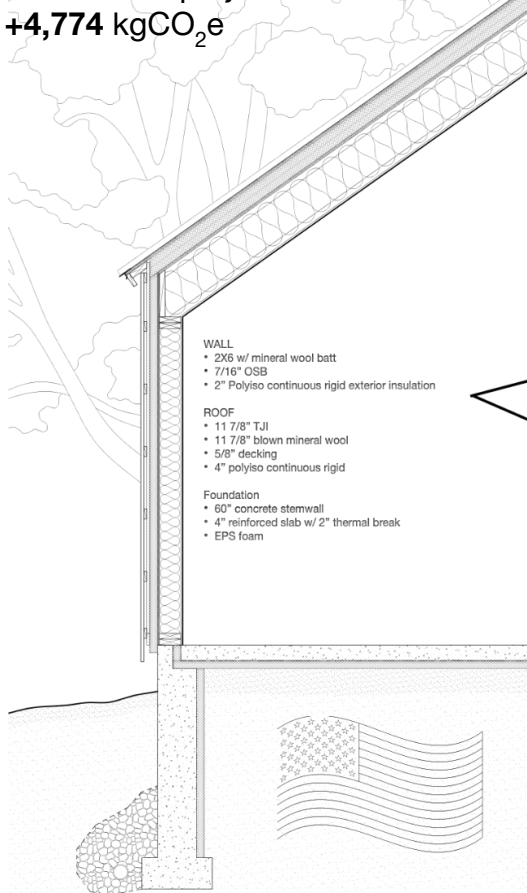


Sample BEAM calc
w/ compressed straw:
-8,915 kgCO₂e

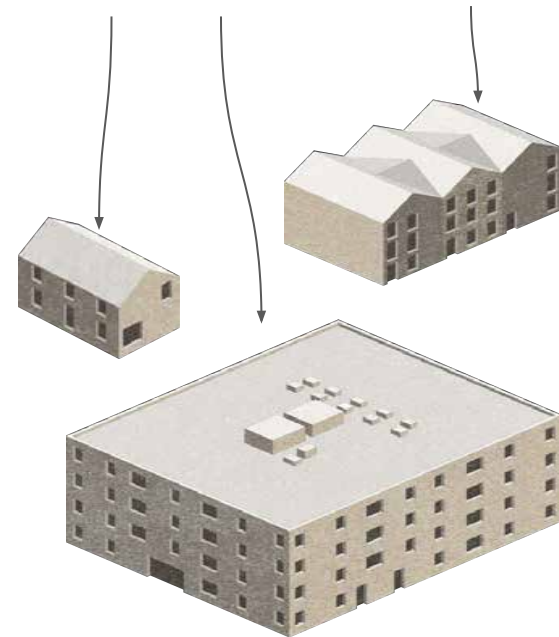
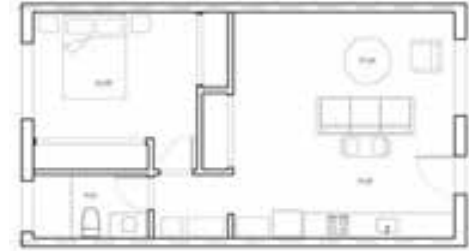
w/ dense pack cellulose
-1,645 kgCO₂e

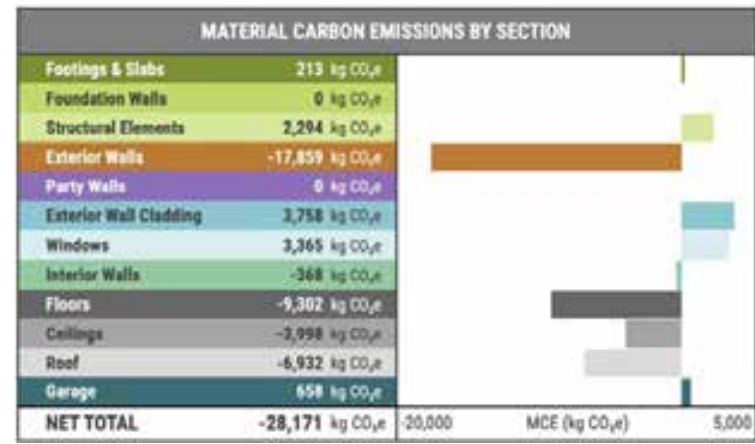


Sample BEAM calc
w/ mineral wool & polyiso:
+4,774 kgCO₂e



X84,000





-31 Tons CO₂e @ \$339k



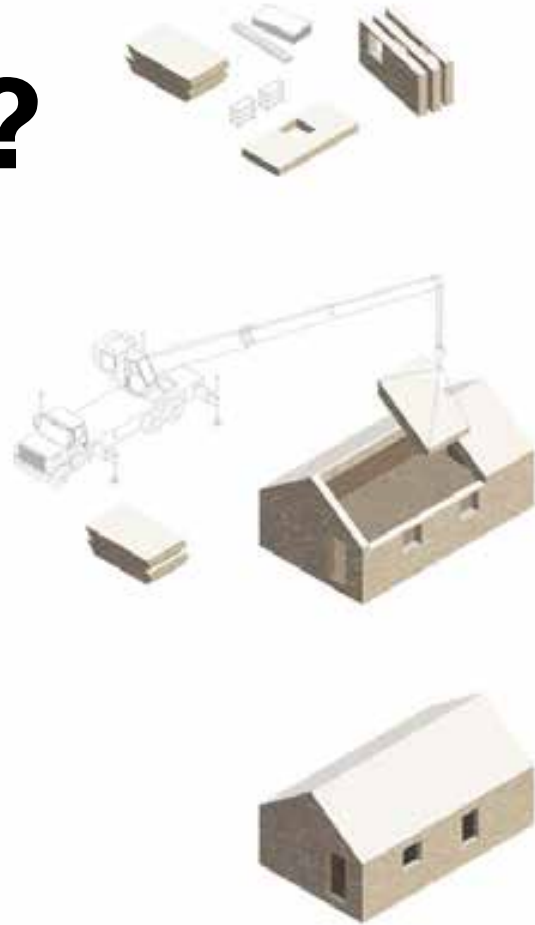
BY THE NUMBERS

How do we deliver on this promise?



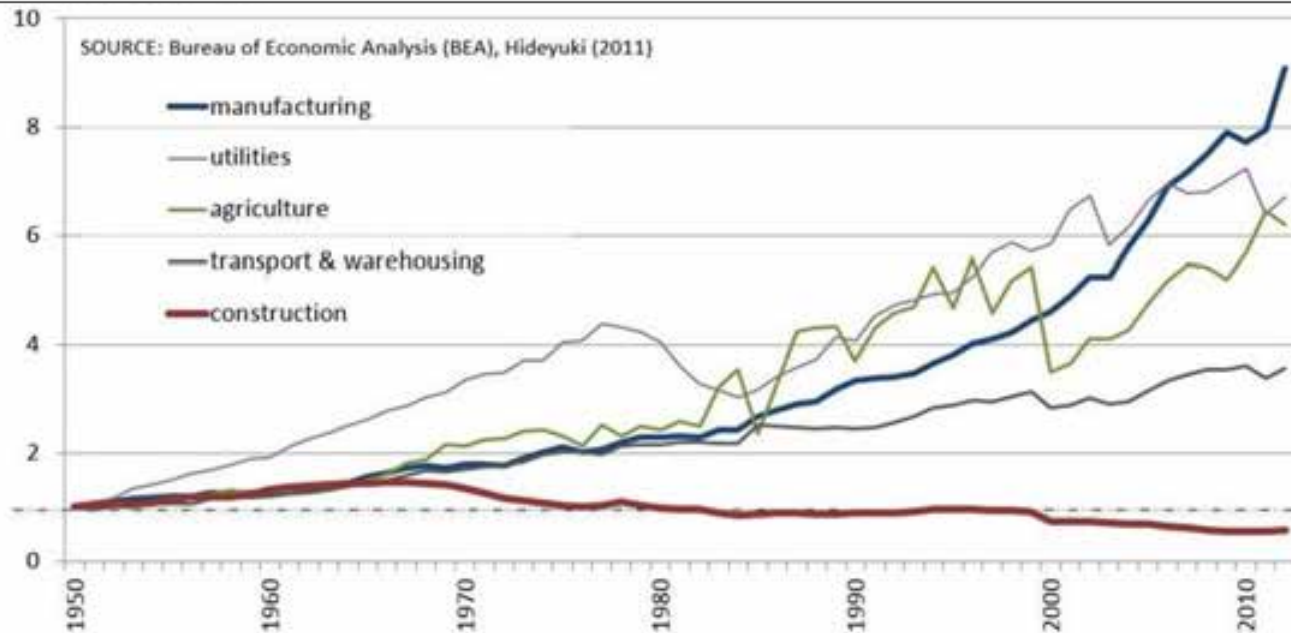
Then Why Prefab?

- Panelized prefab allows for rapid onsite assembly, fewer weather delays
- Allows overlap of envelope production and foundation install
- $\approx 1\text{k ft}^2$ per day erected
- More inviting to workforce
- High degree of precision baked in
- Building envelopes can be closed to weather in as little as one day
- Panelized prefab is aesthetically “agnostic” - you can have historic, modern...similar to how you can make anything you want out of legos!
- Working at fixed location means its easier to build a supply chain for unconventional, incred



Construction Productivity 1950-2012

Relative to other industries



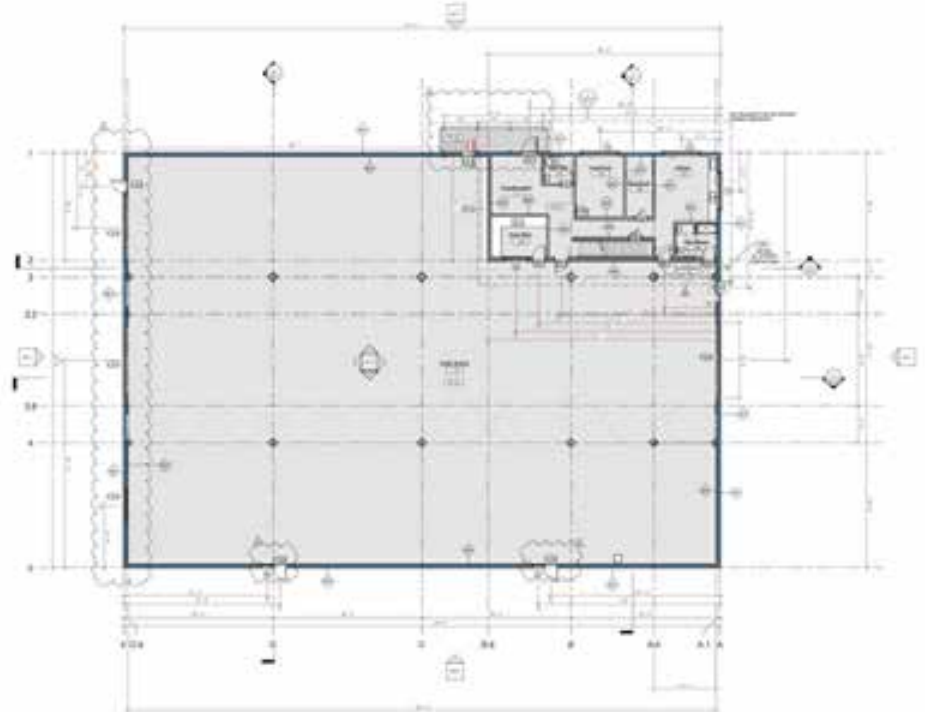
Off-site panelized construction—is this a model?

Case Study: GO Logic shop/factory/office, Belfast, Maine



Off-site panelized construction—is this a model?

13,000 sq. ft. production
3,000 sq. ft. office



Off-site panelized construction—is this a model?

13,000 sq. ft. production
3,000 sq. ft. office

Investment: \$2.5MM building
\$350,000 equipment

- Overhead crane
- Electric forklift
- Automated saw
- Framing tables

no robots



PHIUS CERTIFIED + 50 KW SOLAR ARRAY

ZERO-CARBON PRODUCTION?

(Can't say it's low-carbon construction,
although it is mostly a wood building)









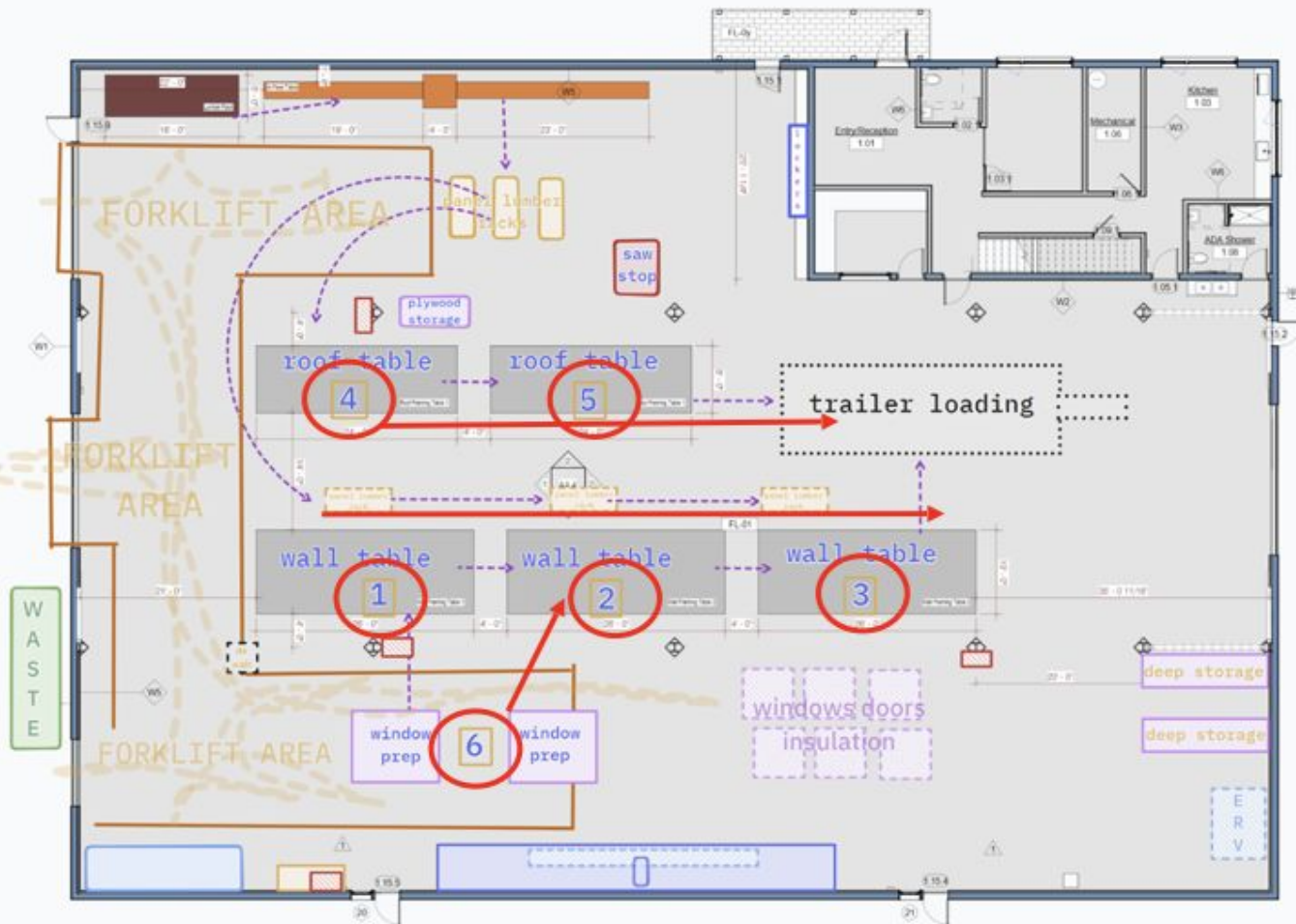




Modular Multi-Family

- High level of finish
- Need to be fully waterproofed
- Logistically challenging





Off-site panelized construction– is this a model?

- Best utilizes people resource
- Centralized location
- Indoors
- Safer
- Better for training
- More predictable scheduling



Envelope Production by the Numbers

For 350 48-unit buildings in a year

HOURS PER YEAR FOR 1 BUILDING SHELL	6,218	IN FACTORY
NUMBER OF WORKERS NEEDED FOR 350 48-UNIT BUILDINGS	1,088	FULL-TIME, SKILLED JOBS!
NUMBER OF CARPENTERS IN MAINE	5,000	A GUESS
NUMBER OF FACTORIES NEEDED	72	THE SIZE OF GO LOGIC'S
NUMBER OF 48-UNIT BUILDINGS GO LOGIC COULD DO IN A YEAR	5	345 LEFT TO DO

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NUMBER OF FACTORIES NEEDED	70	THE SIZE OF GO LOGIC'S
NUMBER OF 48-UNIT BUILDINGS GO LOGIC COULD DO IN A YEAR	5	345 LEFT TO DO

NUMBER OF SINGLE-FAMILY SHELLS GO LOGIC HOPES TO BUILD THIS YEAR: 20

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NUMBER OF SINGLE-FAMILY SHELLS GO LOGIC HOPES TO BUILD THIS YEAR: 20

NUMBER OF UNITS IN MULTI-FAMILY THE SAME FACTORY COULD DO: 230

WHY? SURFACE AREA + REPETITION

- Insulated envelope area of single-family detached 640-sq. ft. unit: **2,002** sq.ft.
- Insulated envelope of one 640-sq. ft. unit in a 48-unit building: **1,031** sq. ft.

That's about half, and half is a lot less. And repetition and standardization makes bigger, simpler buildings WAY more efficient.

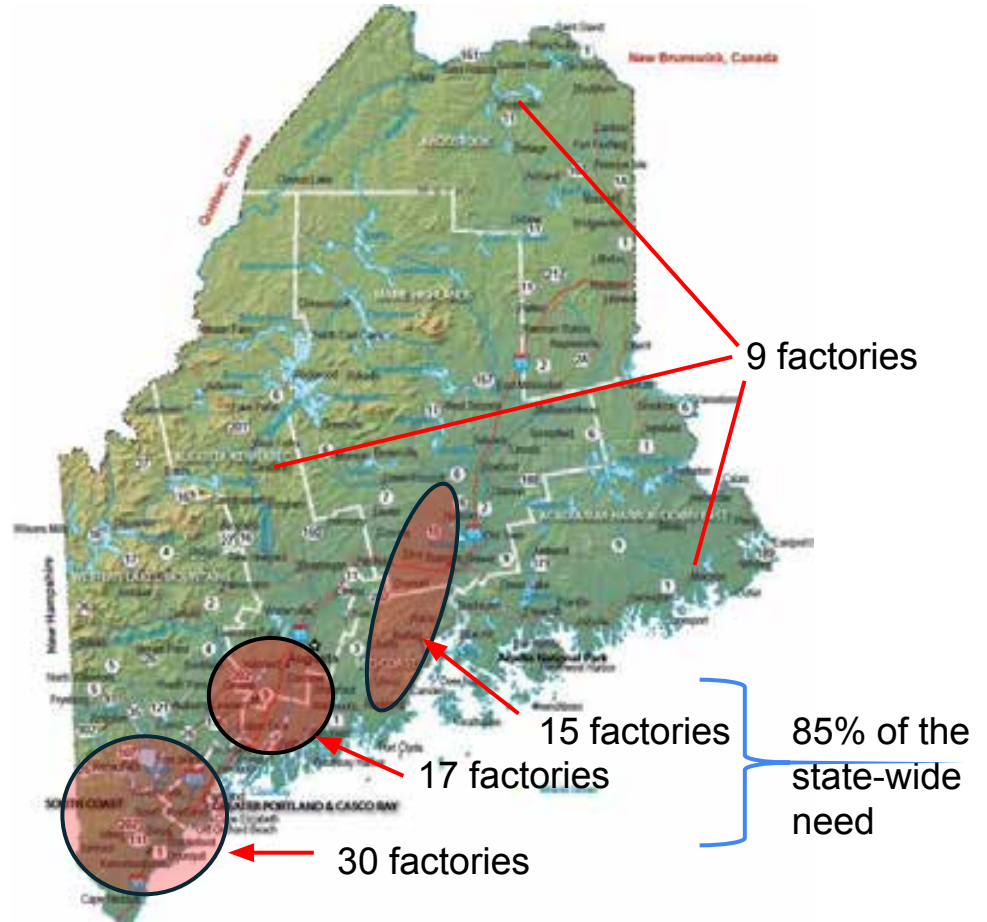


20 SF homes vs 230 units in MF
Same amount of human effort

How many factories do we need, and where do we put them?

72 Factories needed

Put them where we need the houses

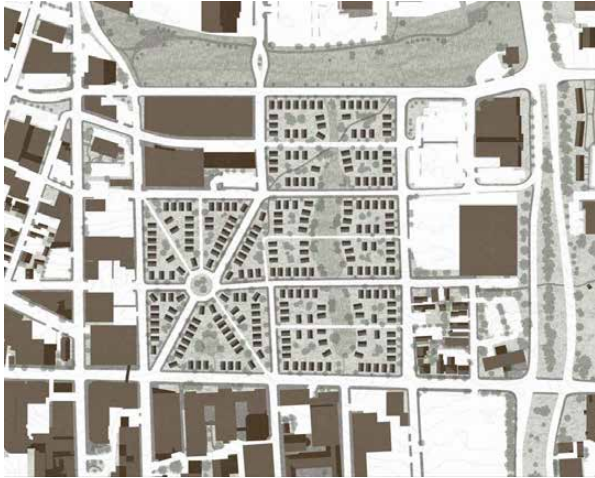


Aftermath & Audit

- **Pretend it's 2030 and we made it!** (just for a second. We're already 4,000 units behind schedule)
- **Tradeoffs**
- **Yes/And-ism...housing is connected to everything else.**
- **Workforce Diversion**

500 units of housing, same site. What future did we choose?

SFH

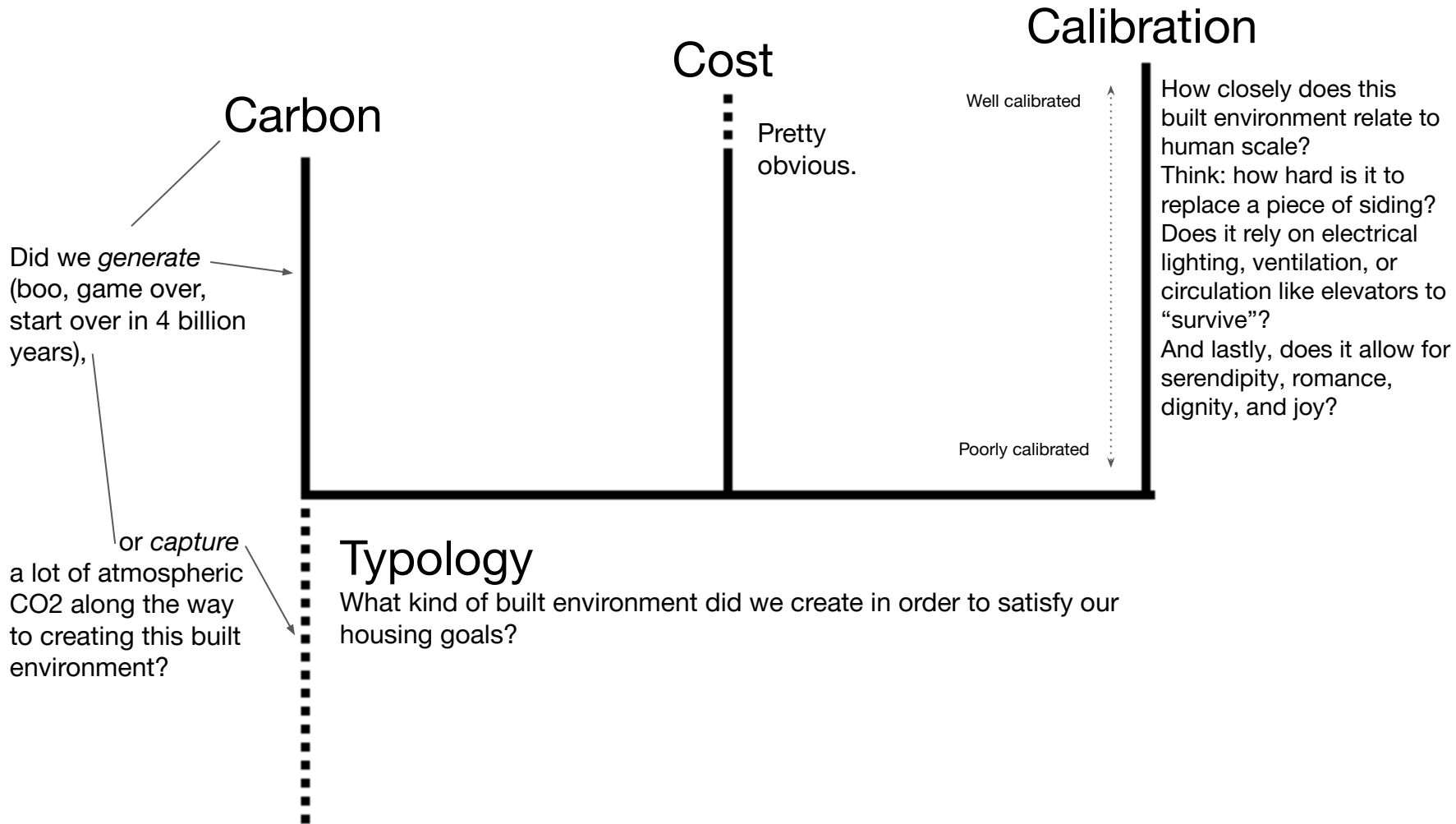


ROW



APT





Nowheresville, USA



No one wants this,
right?

RIGHT?

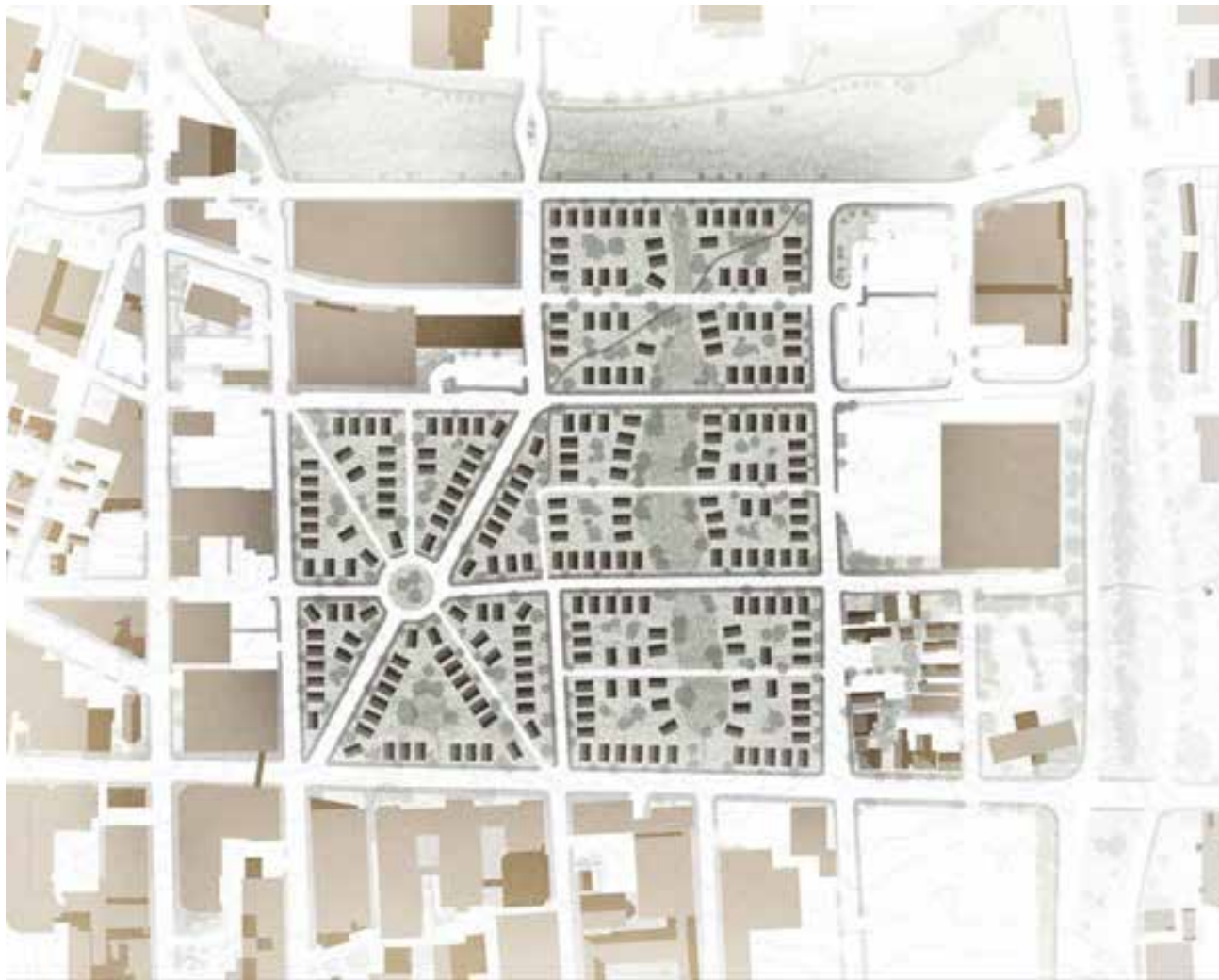


Carbon

Cost

Calibration

Current Scenario

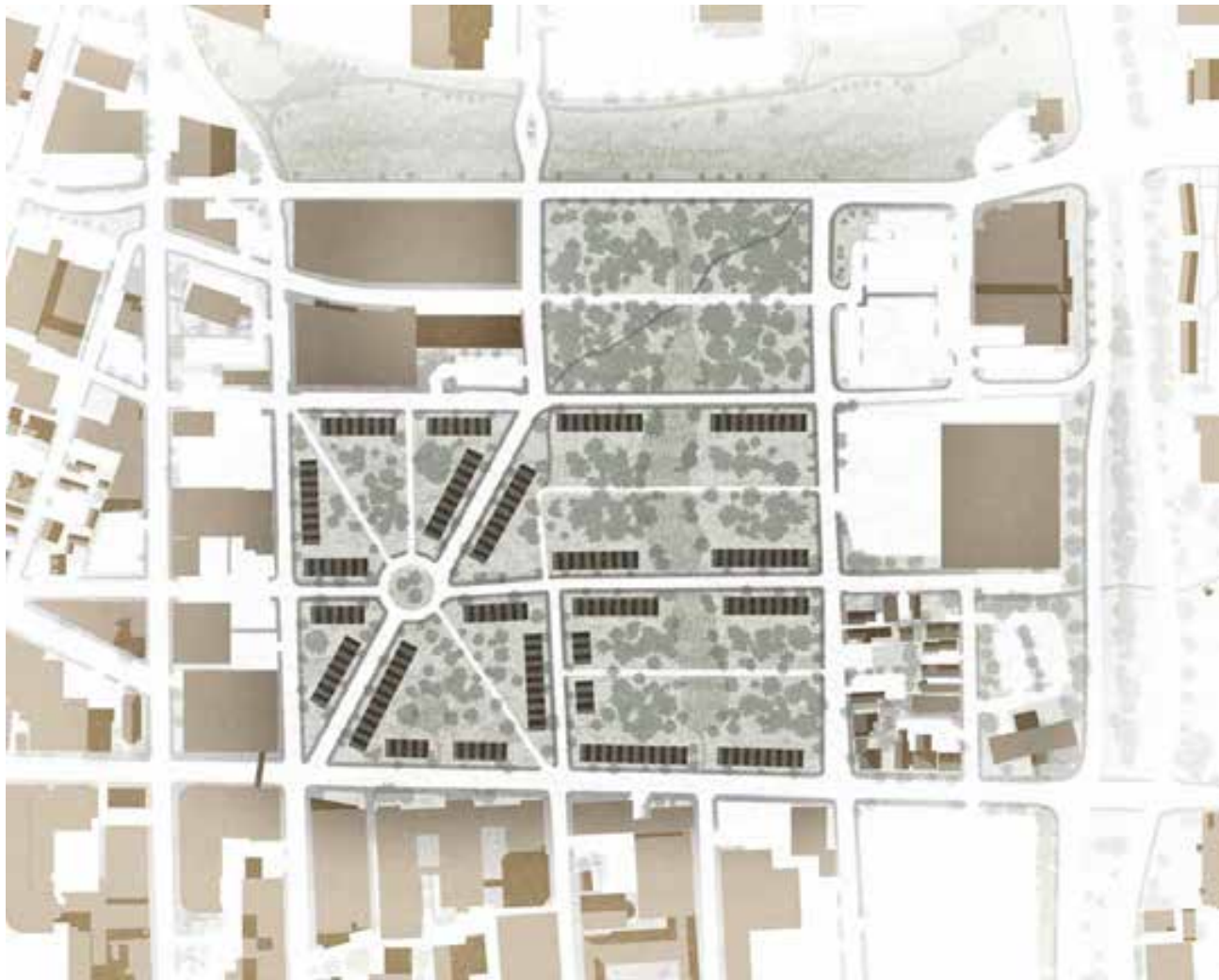


Carbon

Cost

Calibration

Cluster/Village
SFH

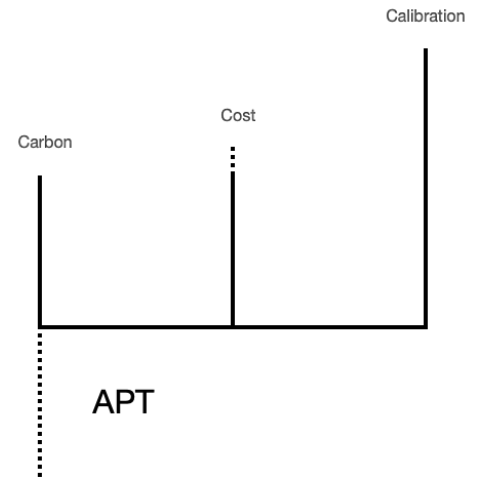
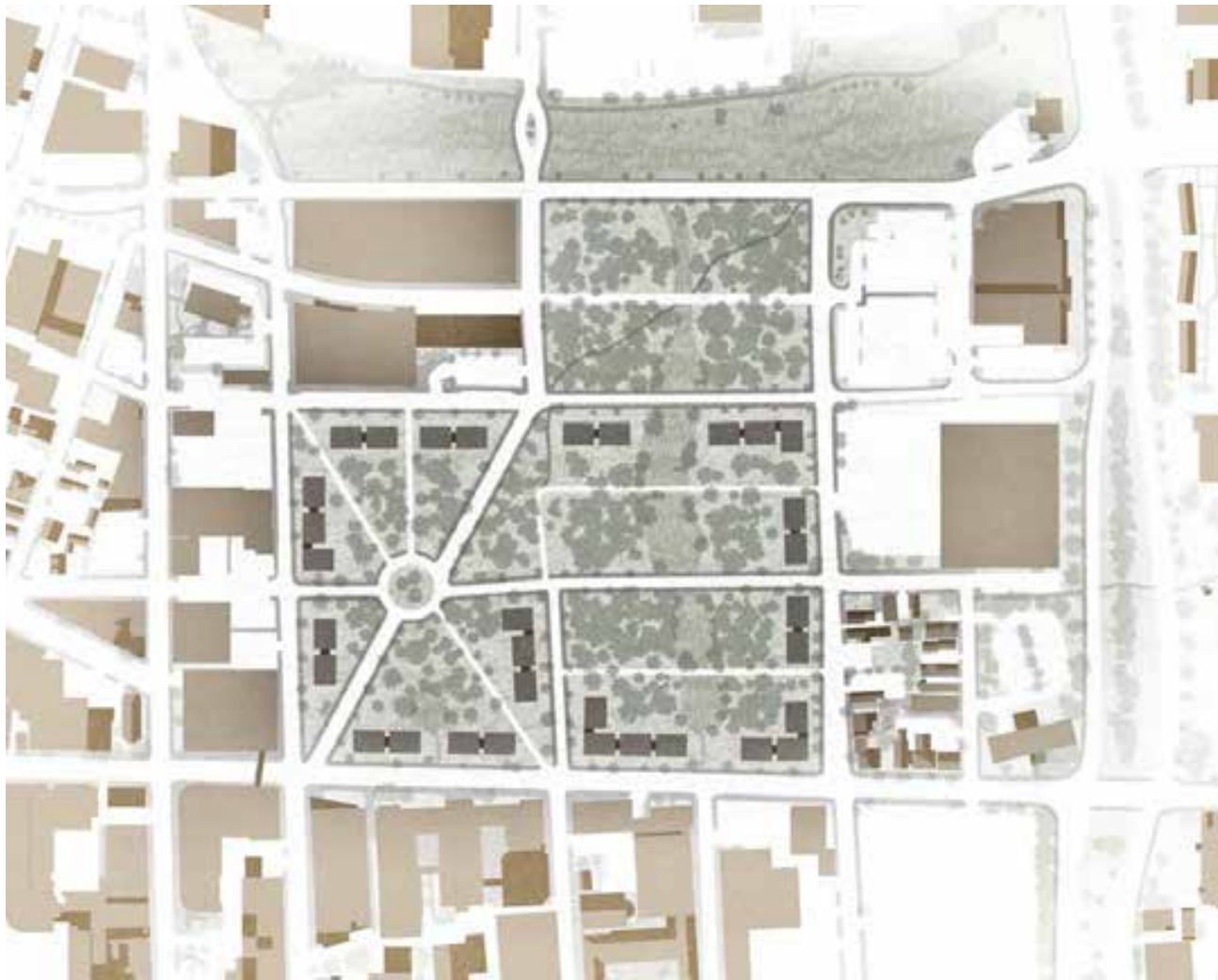


Carbon

Cost

Calibration

Rowhouse



Like EQ sliders-

we must decide which parts we want to emphasize and which we want to diminish, but we can't pretend we aren't controlling the mix.





**Thank
You!**

