

BUILDINGENERGY BOSTON

Zero Energy Modular at Scale: Factories, Builders, and Design Professionals Wanted

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Curated by Asher Greenberg and Anna Heath

Northeast Sustainable Energy Association (NESEA)
March 28, 2023



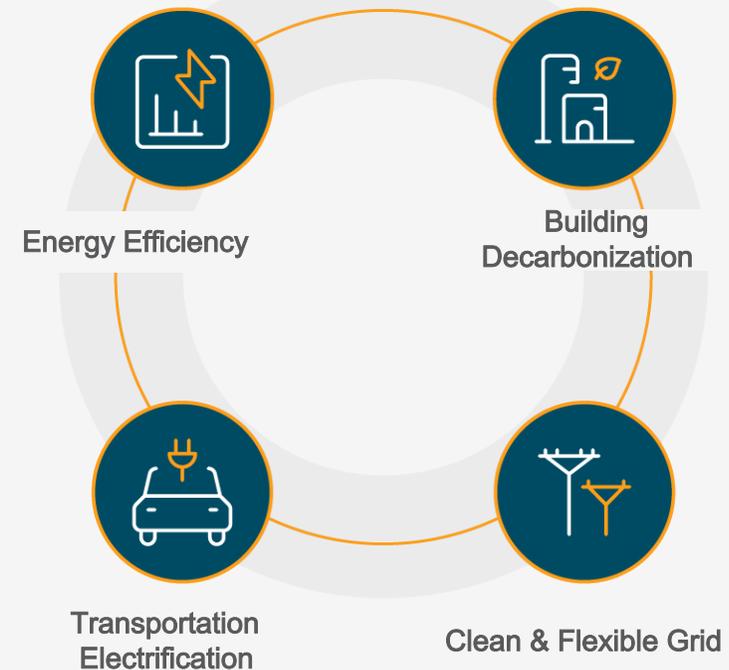
Zero Energy Modular at Scale

Factories, Builders, and Design Professionals Wanted

VEIC: High-impact energy solutions that decarbonize buildings, transportation, and utility grids, today.

- Nonprofit founded in 1986
- National consulting practice working across over 75% of the country
- Program design & implementation for award winning energy efficiency and clean energy programs

Making an impact





FROM A NATURAL DISASTER...

Zero Energy Modular

- Volumetric modular construction
- High performance envelop
- All-electric
- Solar PV sized to produce annual energy consumption
- Hundreds of unit deployed over the past decade



Factory-Built Variety



Mobile

- Pre-1976
- No code



Manufactured

- Post-1976
- HUD code just updated after 30yrs – launch May 2023



Volumetric Modular

- Meets local building & energy codes



Panelized

- Meets local building & energy codes

ZEM Housing Development Models

**Farmworker
Housing**



**Manufactured
Housing
Communities**

Multifamily



Homeownership

ZEM Housing & Commercial Development Models

Accessory Dwelling Units



Photo by Vermod



Photo by WheelPad

House Additions

Community Building

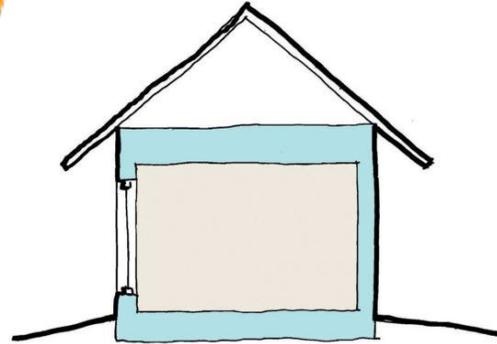


Photo by Todd Beltz

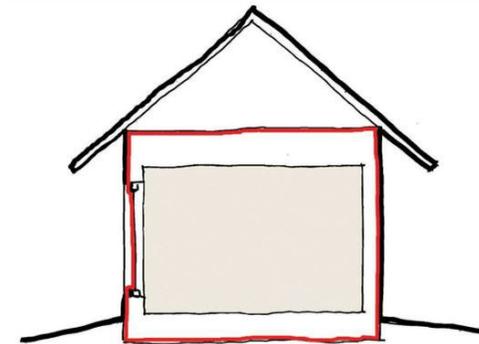


ZEM Classroom

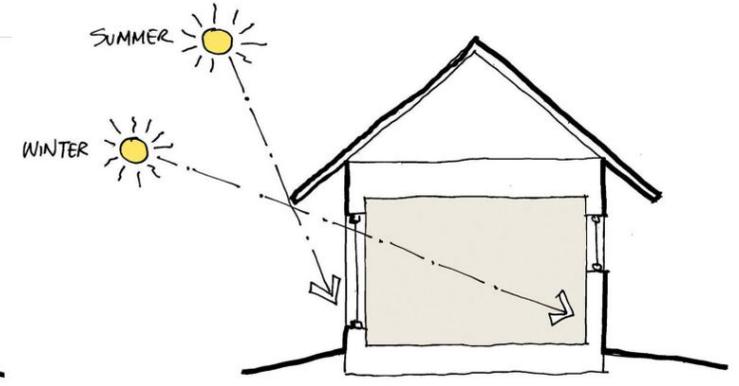
High Performance Standard



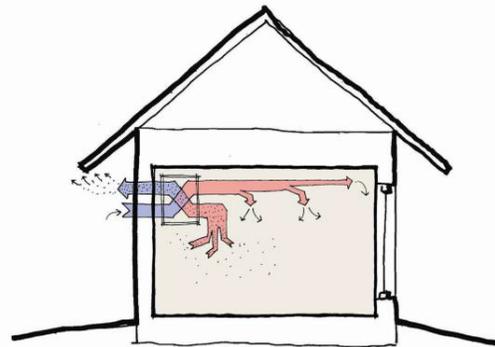
SUPER INSULATED



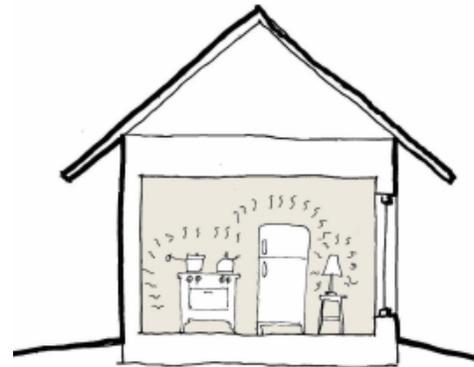
AIRTIGHT



HIGH PERFORMANCE WINDOWS



FRESH AIR VENTILATION



ENERGY STAR



Modular vs Stick Built



Modular

- Safe and comfortable space for worker, protected from weather variability
- Better organized workplace
- Materials protected from sun and weather
- Overall lower costs when production process is streamlined
- Material can be bought in higher volume and lower cost, with offseason pricing in the winter
- Workforce can be specialized in fewer skills
- Quicker turn around time
- Less material waste
- Homeowner saves on construction loan and insurance

Stick Built

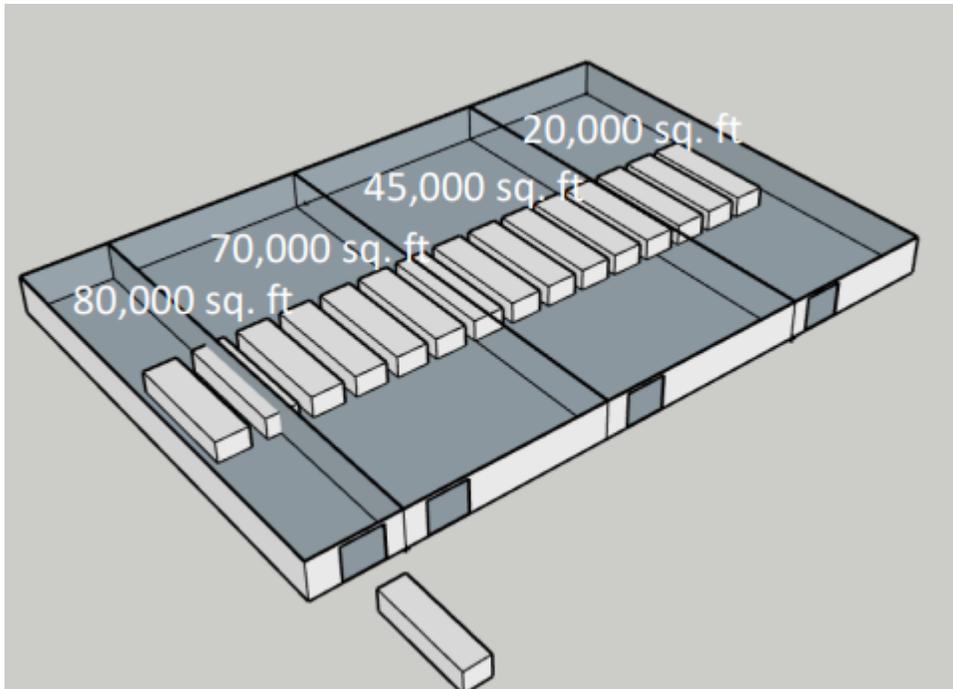
- Daily set-up and clean-up adds to construction time
- Crews spend more time moving equipment and material
- Vulnerable to weather events and vandalism during construction
- Custom build can mean higher costs for materials and labor
- Crews must typically have a comprehensive skillset
- Construction times are longer
- More waste in the construction stream

Climate Controlled Environment



Preferred Building Systems— Claremont, NH

Climate Controlled Environment



Sidesaddle Assembly Line Layout



Champion-Skyline – Sangerfield, NY

Thermal Envelope



Thermal Envelope

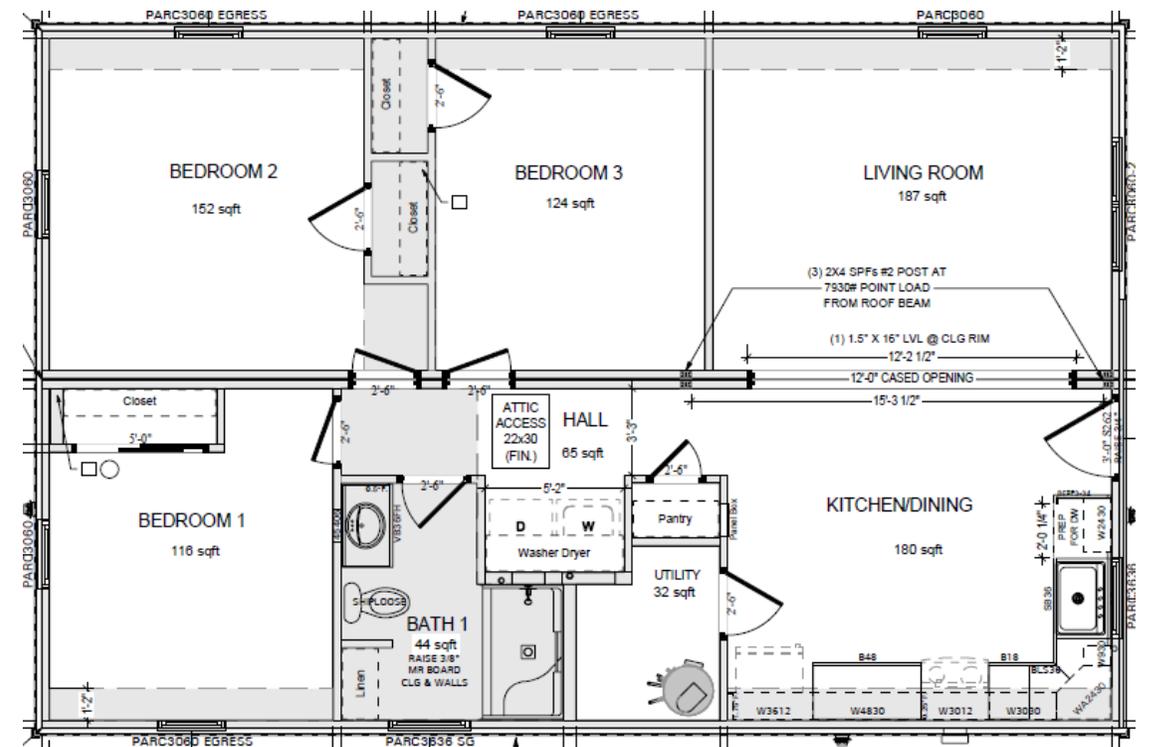


Simplifying HVAC Design & Installation

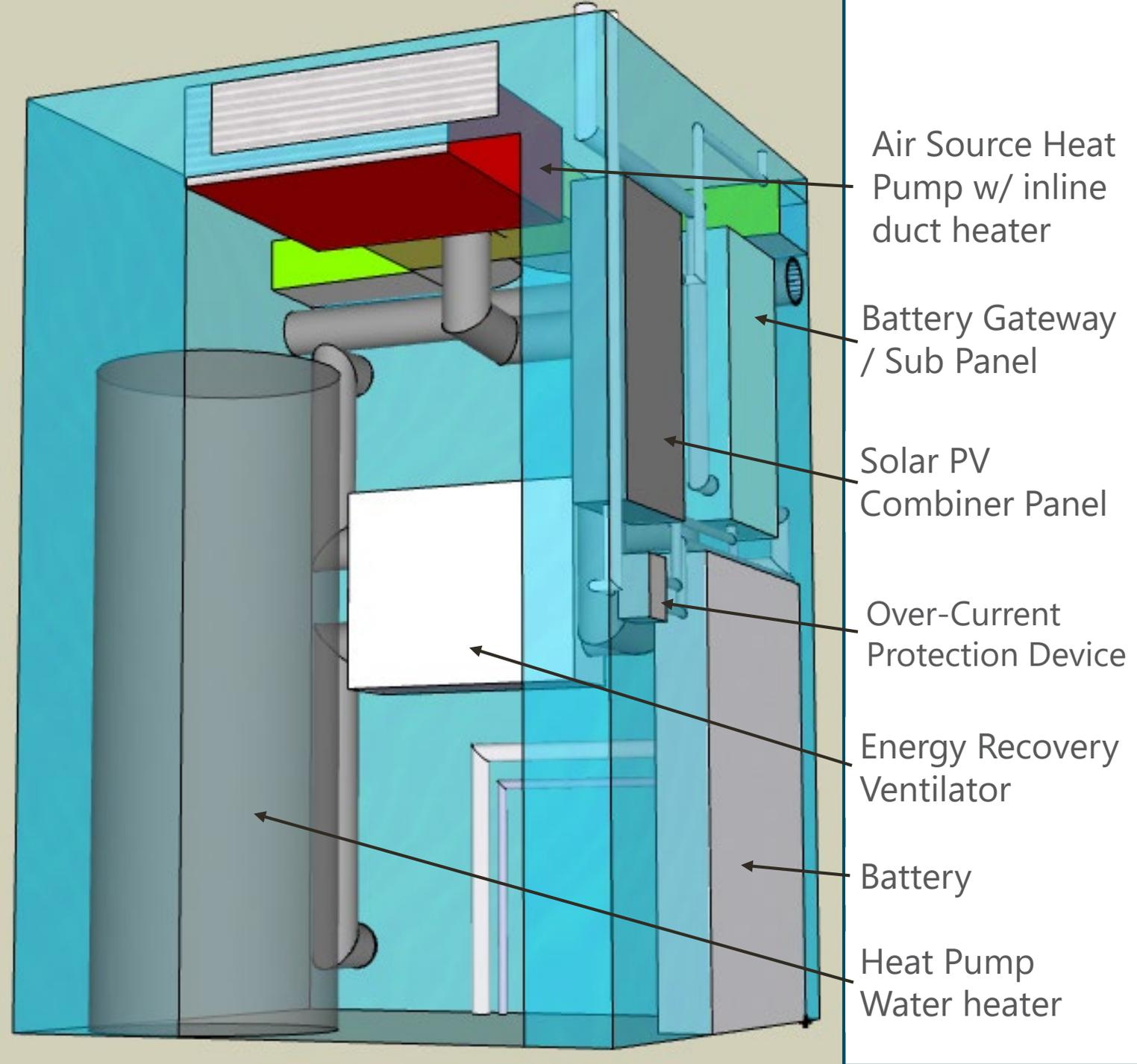
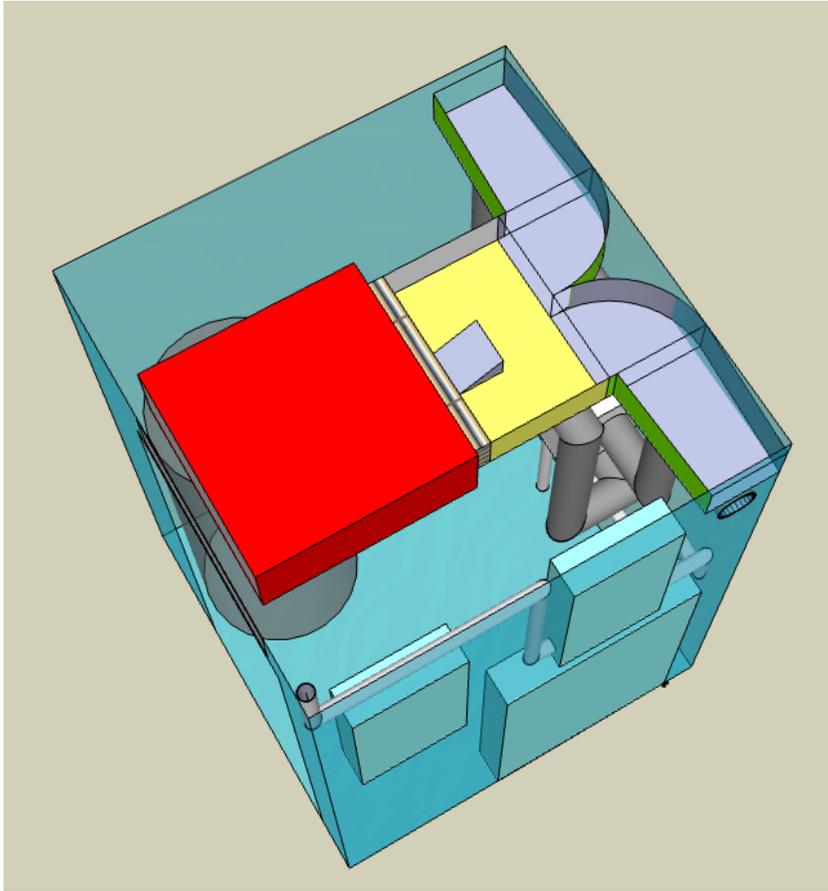
Typical ZEM home – 26' x 40'

3-Bedroom, 1-Bathroom with open
Kitchen, Living, & Dining Room.

5' X 5' Mechanical Room in Conditioned
Living Space



Energy Exchange Pod



Factory-Installed HVAC - House

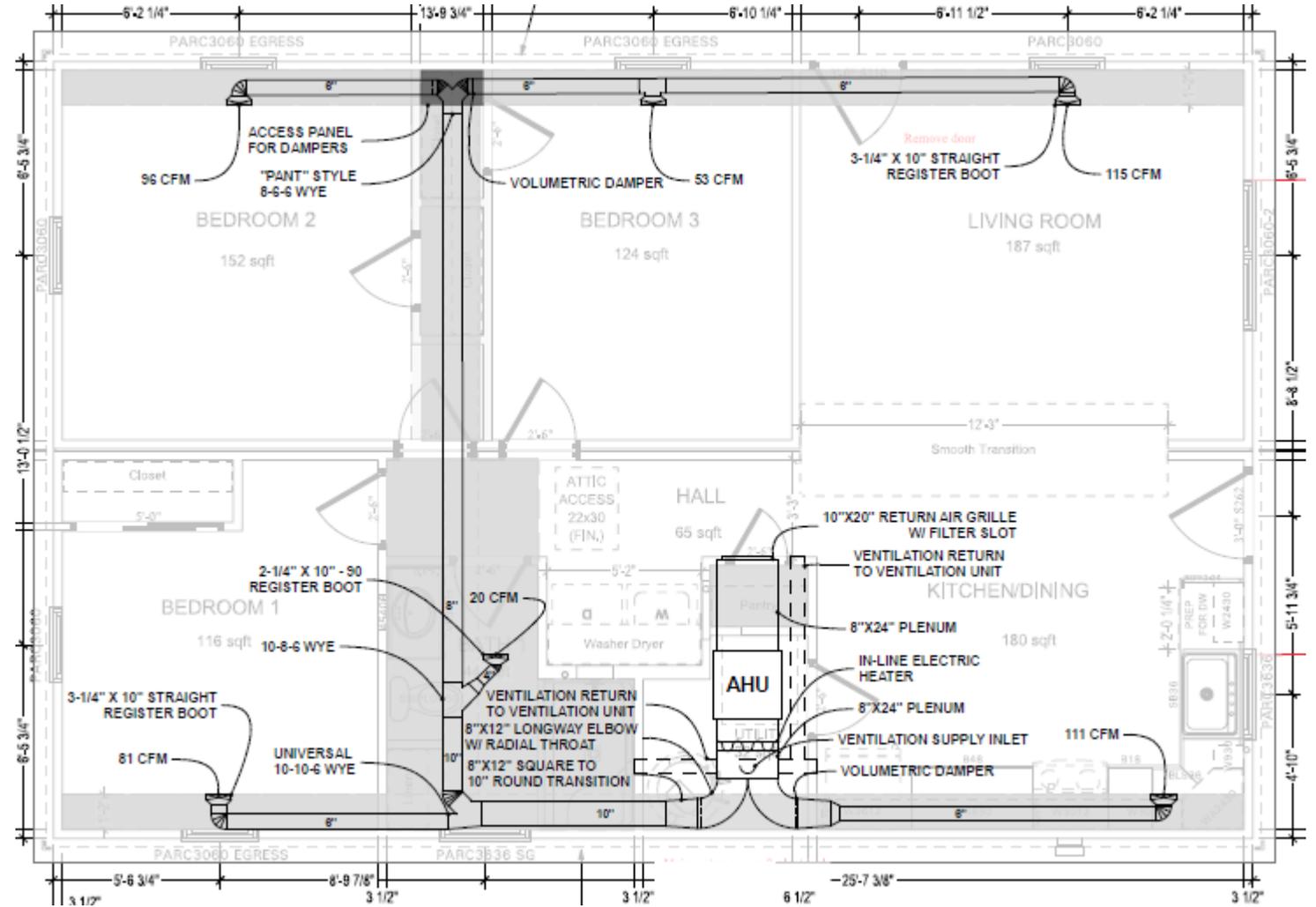


Figure from Conor Dennehy, National Renewable Energy Laboratory

Factory-Installed HVAC – Multi-Family Apartment

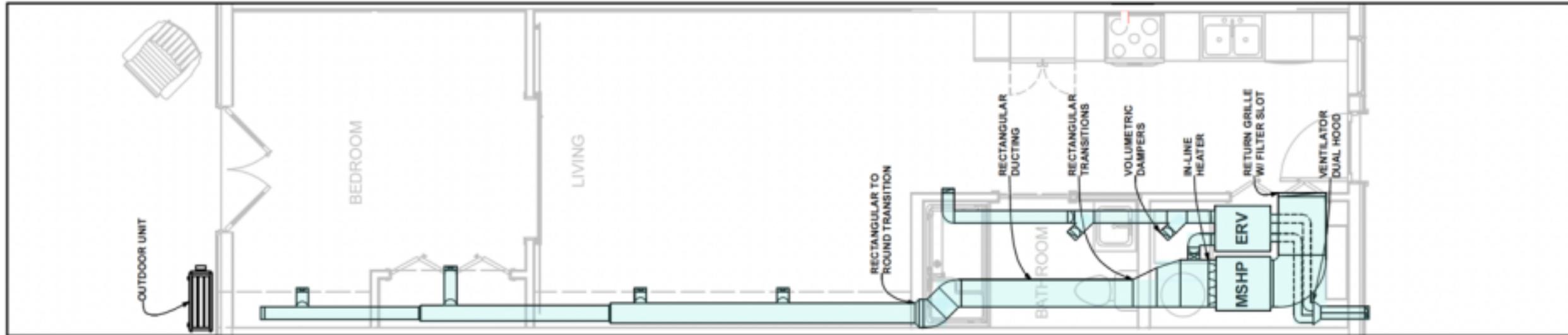


Figure from Conor Dennehy, National Renewable Energy Laboratory



House delivered and set with HVAC already commissioned at factory.



Mobile Home Replacement

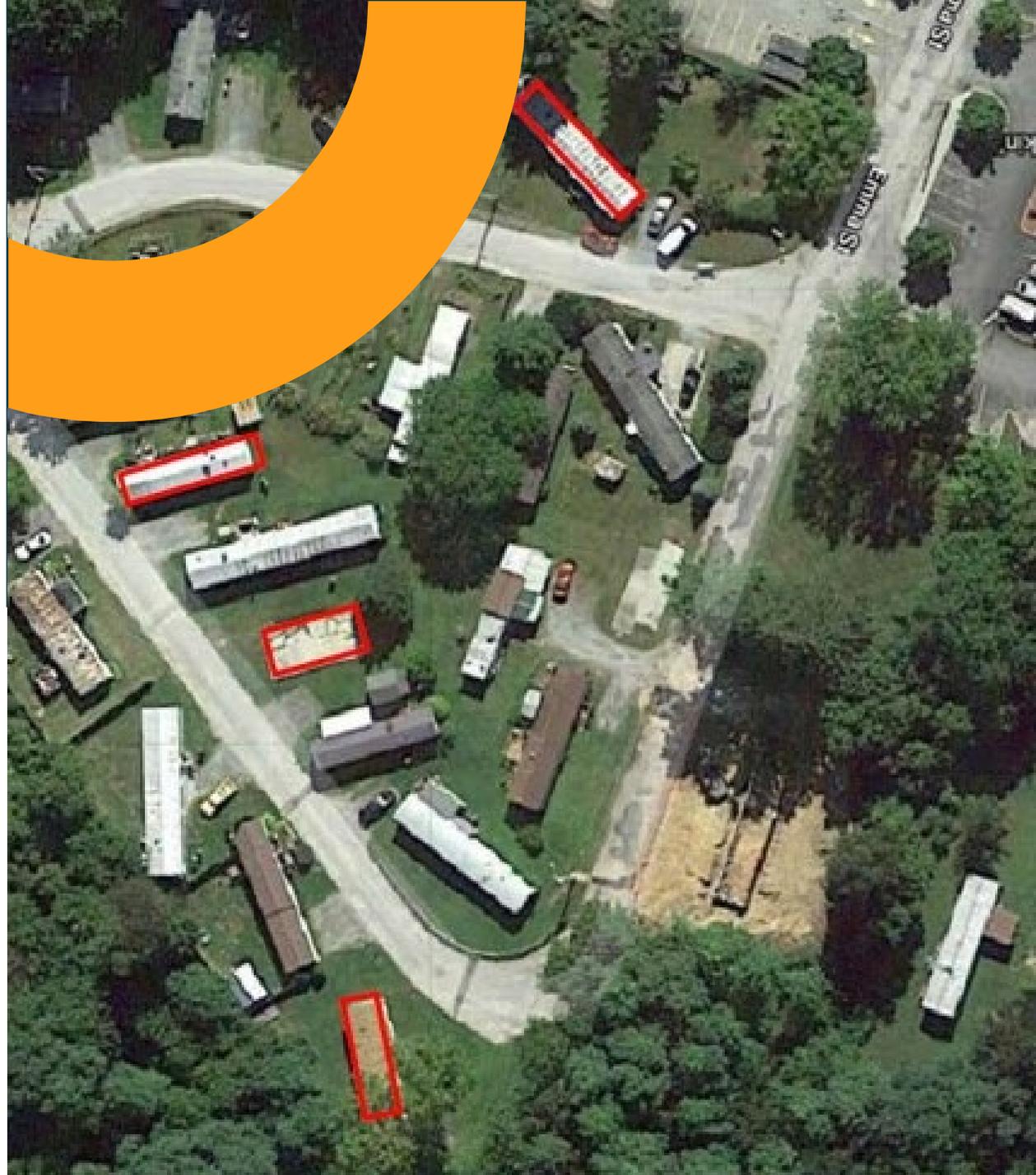


Mobile Home Replacement

Re-defining affordable housing

Delivering zero energy, high performance modular homes to vacant lots in existing, non-profit owned mobile home parks.

Each home is custom designed to optimize the site available. Homes are sold to income-qualified buyers and offered as low-income rental units, owned by park owner.

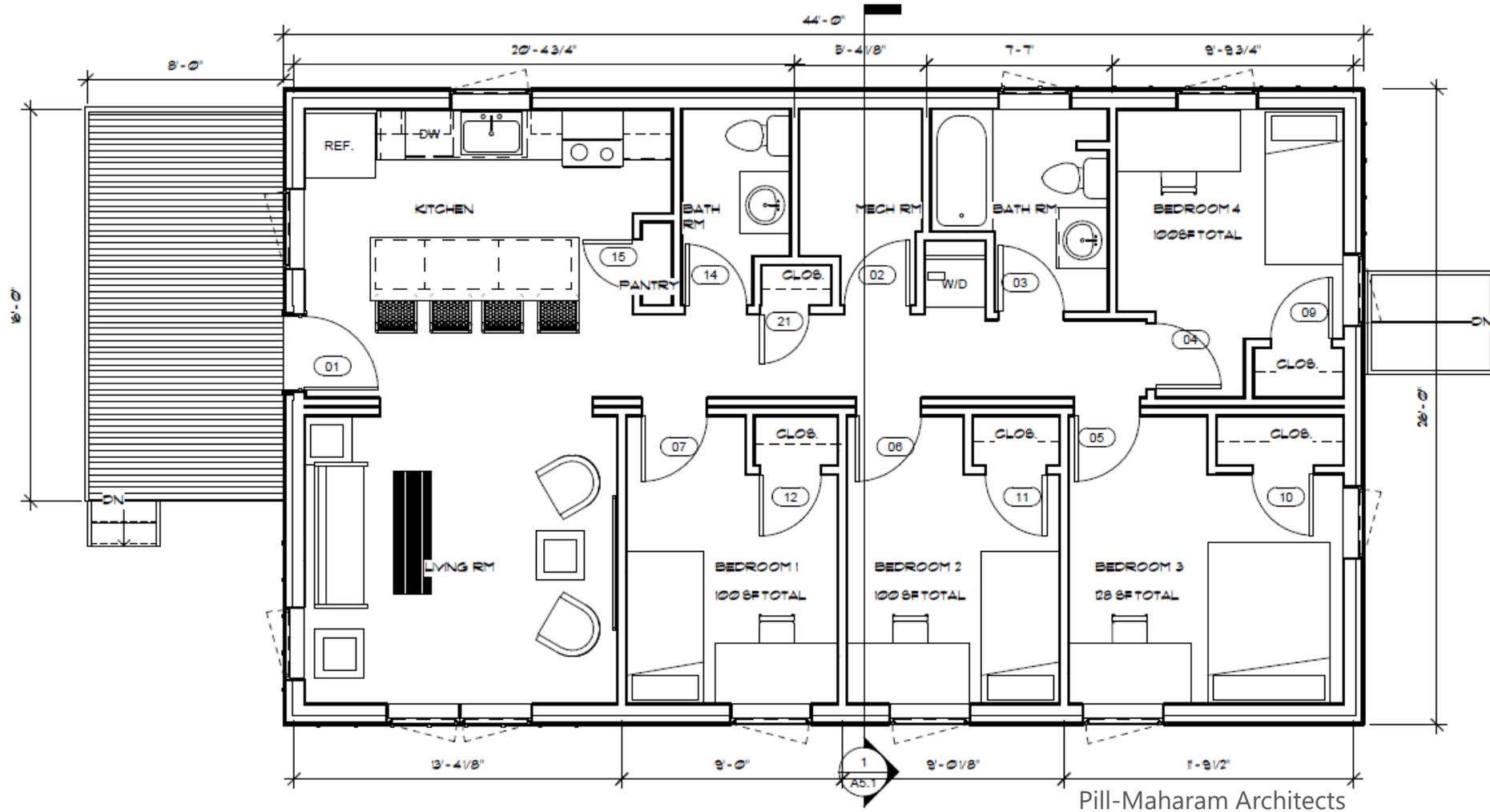


Farmworker Housing

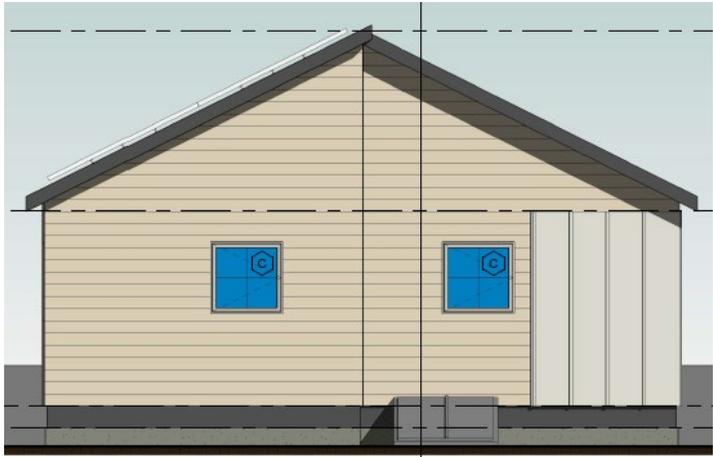
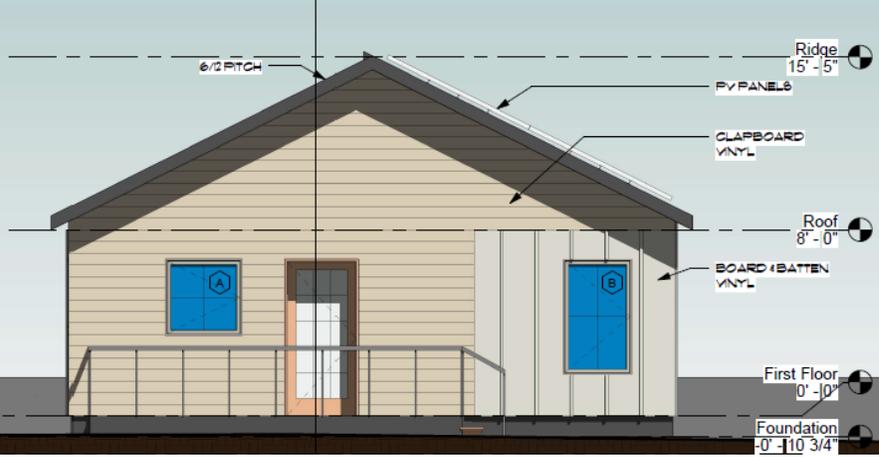


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Farmworker Housing



Farmworker Housing



Pill-Maharam Architects

Multifamily



Multifamily

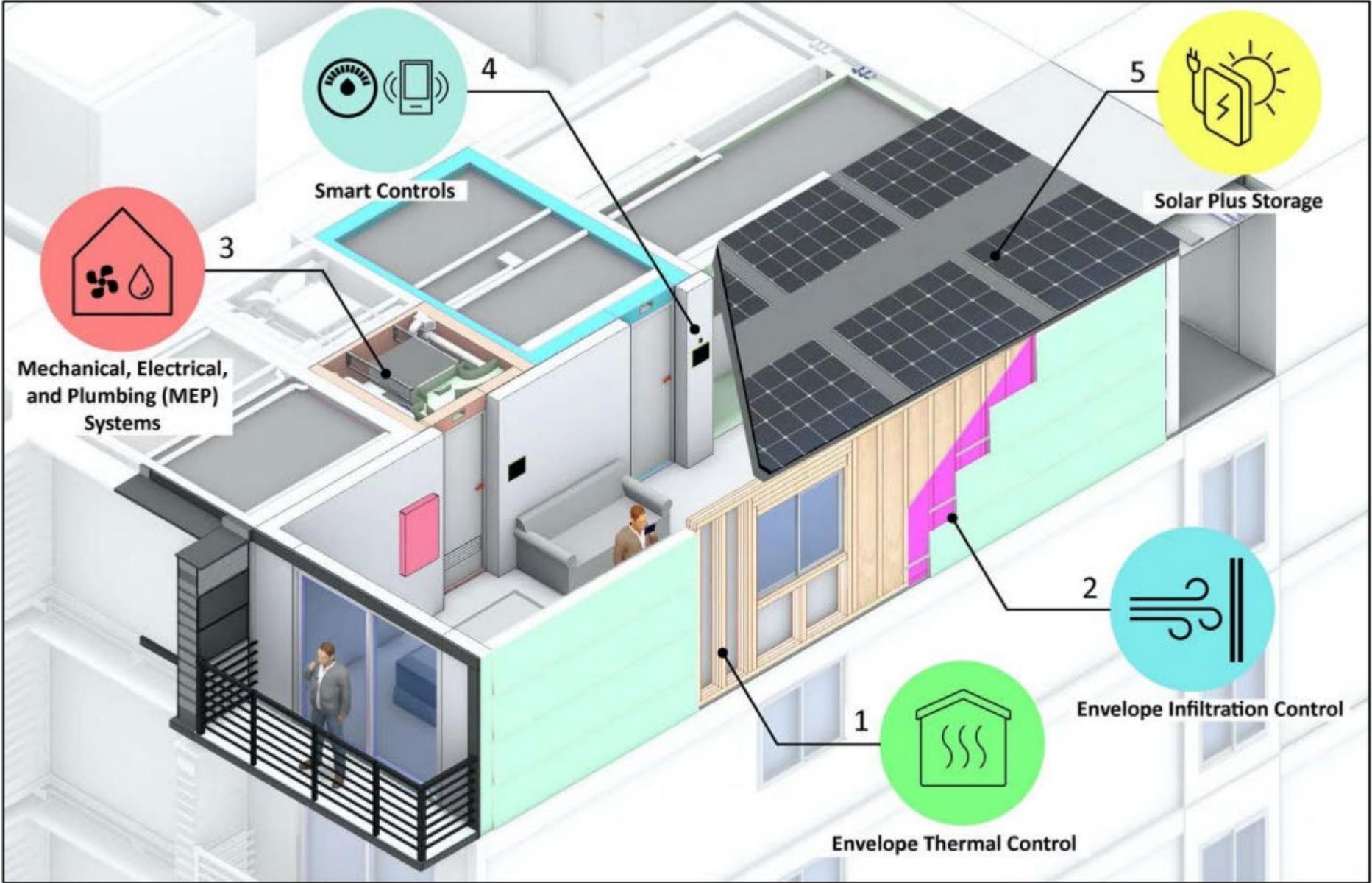


Figure 2. An ideal NZE modular housing unit for multifamily buildings as an output of the EMOD method by NREL and partners. *Source:* NREL.

Multifamily /

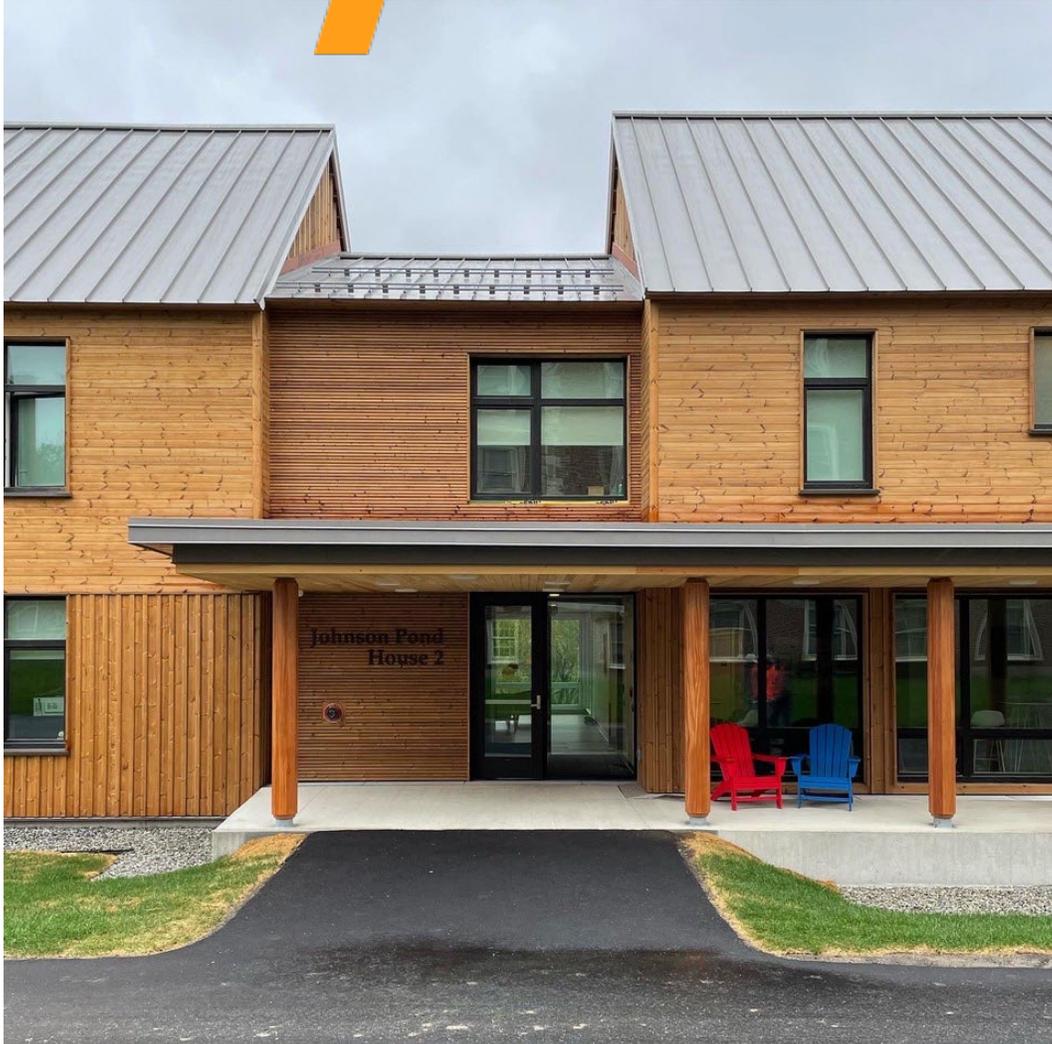


Solar Home Factory

Dorms



Dorms



Kaplan Thompson Architects

Commercial



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Photo by Todd Beltz

Commercial

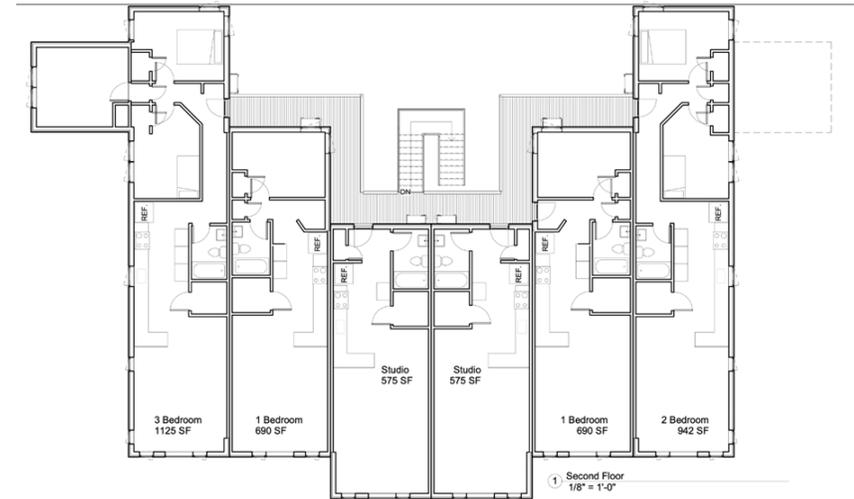


Photos by Todd Beltz

Program design guide for optimized modular multifamily.

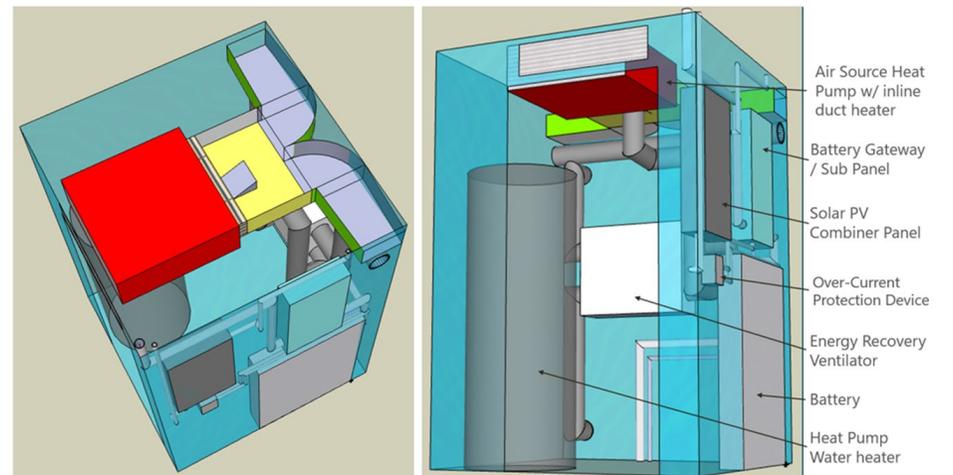
- Maximize work in the factory
- Minimize plumbing and HVAC penetrations
- Modularize living unit
- Modularize HVAC

Multifamily floor plan one unit one module



Pill-Maharam Architects

Energy Exchange Pod



HUD Cooperative Research in Housing Technologies

Resilient Homes Meet Resilient Power Systems- Optimizing Factory Installed Solar + Storage

Identify the value proposition of offering solar+storage as a factory-built option

- Assess process efficiency of incorporating solar + storage into existing factory. Characterize the market in terms of opportunities, readiness, and potential obstacles for adoption
- VEIC, NREL, LSU
- Final Report (2023)



Lessons Learned

Modular from Day 1 and more planning

- More work up front to execute, not less
- Everything has to be designed, there is almost no field decisions
- Need more upfront funding to execute pre-development work
- Design for modular from first drawings
- Detailed construction management (CM) planning is critical i.e. weather protection on larger scale multifamily



Scaling Up

- Demonstration projects need to be deployed in the various housing/commercial spaces
- Design projects with modular in mind, working alongside factory-built housing experts
- Create repeatable design solutions for various building types i.e. multifamily, single family detached, commercial (ZEM classrooms)
- Increase number of factories - Zero Energy Modular Factory Initiative - <https://www.veic.org/clients-results/reports/zero-energy-modular-factory-initiative>



ZEM Pre-K – St. Albans City, VT



Thank you!



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