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

Peter Schneider (VEIC)

Curated by Asher Greenberg and Anna Heath

Northeast Sustainable Energy Association (NESEA)
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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
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

VEIC
ZEM Housing & Commercial Development Models
High Performance Standard

SUPER INSULATED

AIRTIGHT

HIGH PERFORMANCE WINDOWS

FRESH AIR VENTILATION

ENERGY STAR

AR&T Architects
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
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

- Air Source Heat Pump w/ inline duct heater
- Battery Gateway / Sub Panel
- Solar PV Combiner Panel
- Over-Current Protection Device
- Battery
- Heat Pump Water heater
- Energy Recovery Ventilator
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
Farmworker Housing
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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
Commercial

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
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)


ZEM Pre-K – St. Albans City, VT
Thank you!

Peter Schneider
Senior Consultant
VEIC

pschneider@veic.org

www.veic.org