High Performance Mobile Home Replacement

a project of Vermont Housing & Conservation Board and Efficiency Vermont

In partnership with: Vermod, CVOEO, University of Vermont Community Development and Applied Economics, High Meadows Fund, and Vermont Community Foundation

Trailer Parks Lure Wall Street Investors Looking for Double-Wide Returns

By Anthony Effinger and Katherine Burton | Apr 10, 2014 12:01 AM ET | **26 Comments** **Email** **Print**

"It's expensive to be poor," Shlachter says.

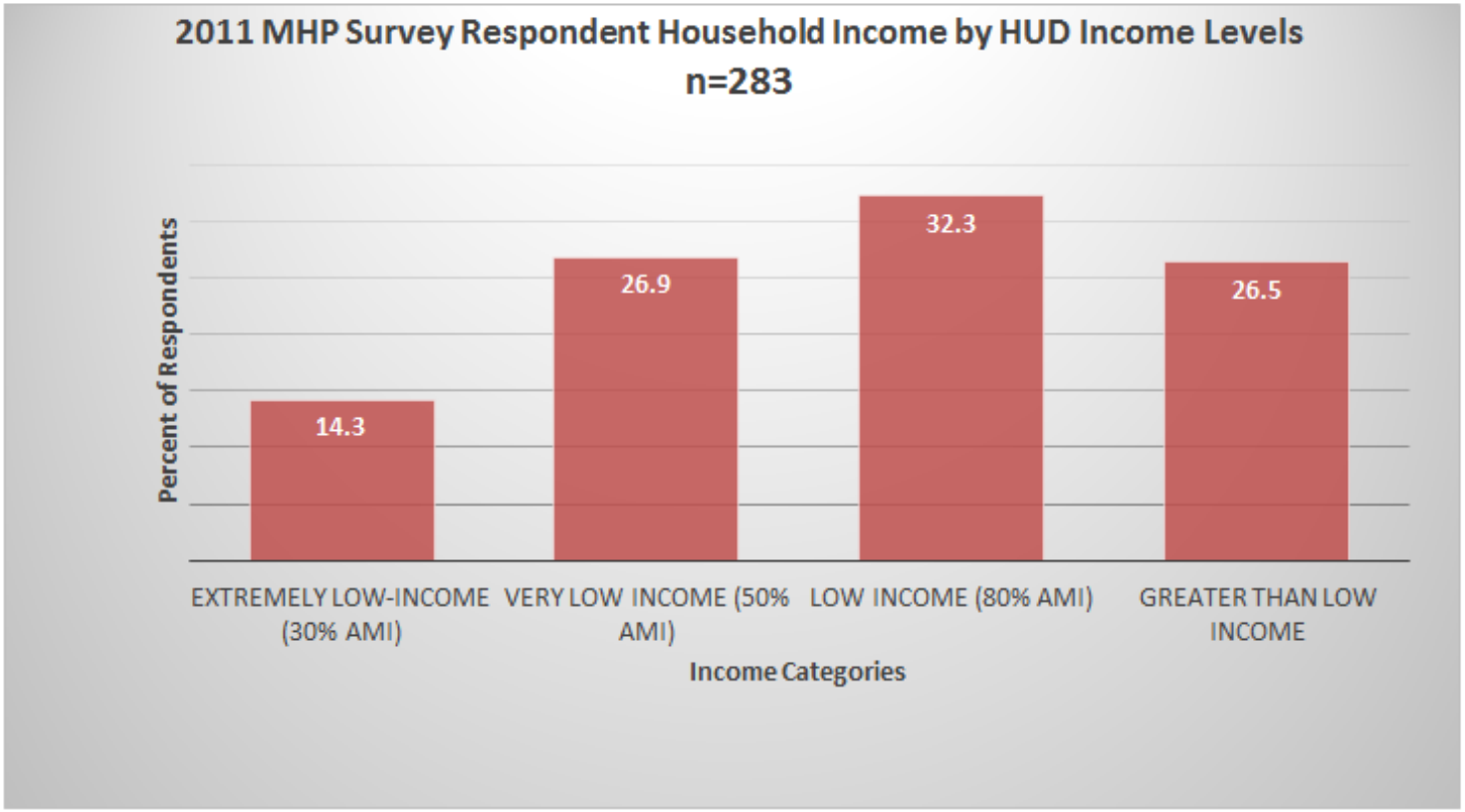
Photographer: Nolan Conway/Bloomberg Markets Magazine

Manufactured Homes in Vermont

	Manufactured Homes in VT
In Mobile Home Parks	7,194
On Private Land	15,124
Pre-1976	23%
1976-1993	46%
1994-Present	31%

MH Residents in Vermont

VT Mobile Home Park Resident Demographics



~ 14% would be considered to be "extremely low income" according to HUD Area Median Income guidelines

Source: Baker, D., Hamshaw, K., and Woodward, S. Presented at the 2013 VT Emergency Management Conference
Data from 2011 UVM Survey of 363 residents in 127 Vermont mobile home parks

Cost of Homes & Ability to Pay

High Performance Home on purchased land

	MSA	Southern VT	Wash-Lam-Add	Orange-Windsor	NEK	VT
Median lot cost	$119,000	$ 47,000	$ 59,500	$ 36,000	$ 30,000	$ 55,000
Site work and foundation	$ 47,775					
Vermod Home cost	$ 107,000					
Vermod Total Price	$273,775	$201,775	$214,275	$190,775	$184,775	$209,775
Income required to afford Vermod*	**$ 81,309**	**$ 60,106**	**$ 63,834**	**$ 56,824**	**$ 55,219**	**$ 62,641**

*For homes on purchased land, assumes a 30-year fixed rate mortgage with 5% down payment and average VT insurance, taxes, closing costs and interest rates. Estimated income required to afford home is based on 30% housing cost-income affordability ratio.

Cost of Homes & Ability to Pay

Vermod in MH park	State-wide averages
Average monthly lot rent	$ 270
Site work and foundation	$ 24,275
Home cost	$ 107,000
Total Price	$ 131,545
Income required to afford home*	**$ 40,193**

For homes on rented lot in MH park, assumes average state-wide monthly lot rent in total annual housing costs. Estimated income required to afford home is based on 30% housing cost-income affordability ratio.

Existing Manufactured Homes

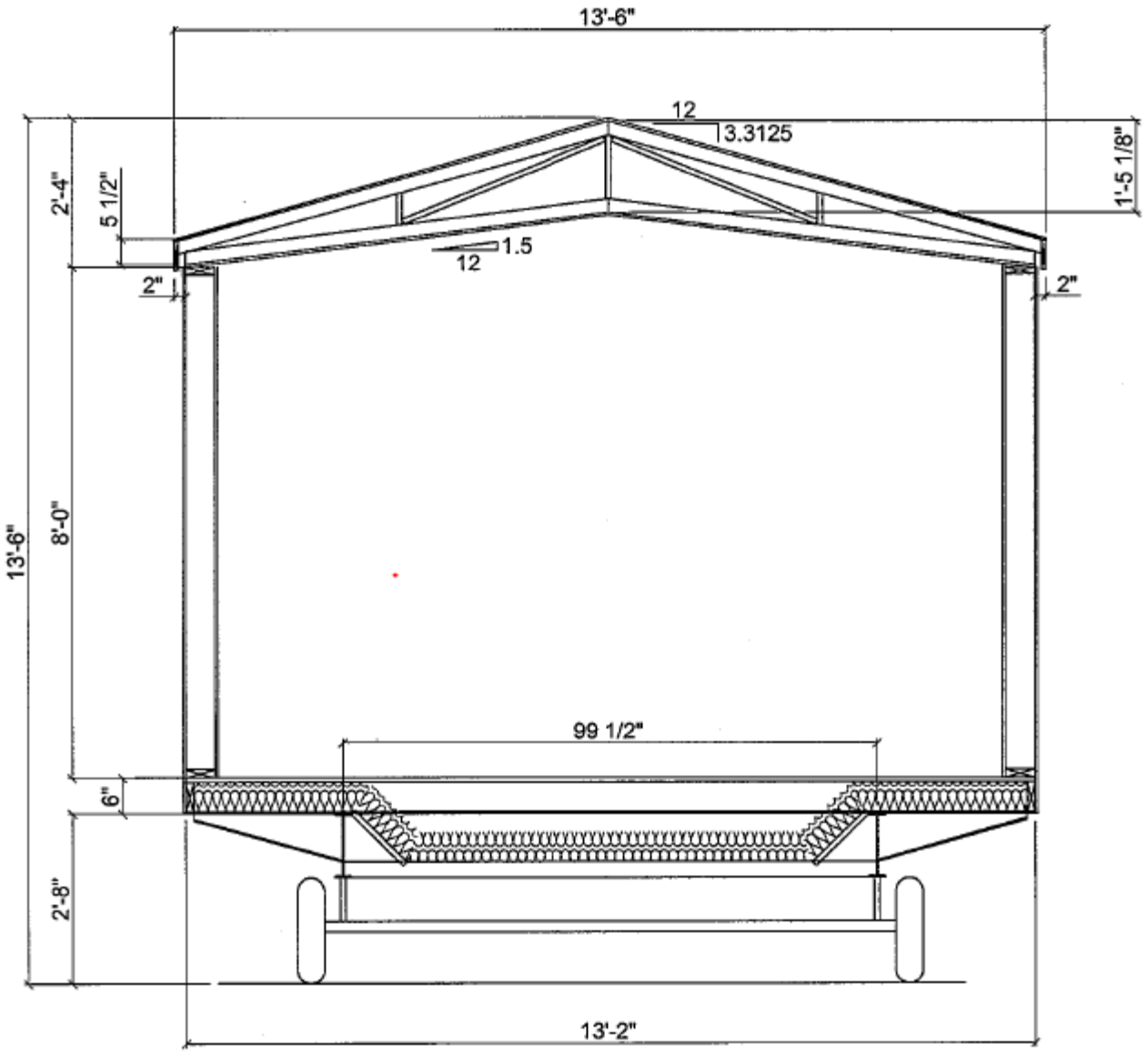
Manufactured Homes and Energy

- Spend **66%** more of their household income on energy than residents of stick built housing
- Pay **2x** as much per square foot for energy as owners of detached homes
- LIHEAP historically provided **50%** more assistance per square foot to manufactured housing residents

New and Existing Manufactured Housing

- Manufactured Housing Construction Safety Standards (MHCSS) is the “preemptive code” and typically less than state site built codes;
- Durability issues associated with poor design details and materials lead to high maintenance costs and structure deterioration;
- High off-gassing materials and poor ventilation leads to unhealthy indoor air quality;
- Not designed for Northern climates so high energy costs and comfort issues.

New and Existing Manufactured Housing



Catalyst to Action

"Tropical Storm Irene: Irene Spares Big Cities, but Vermont Sees Huge Floods"

– Huffington Post

"Raging Water in Vermont From Hurricane Irene"

– Weather Channel

USAToday.com

- 438 mobile homeowners were eligible for FEMA assistance
- 129 mobile homes required complete demolition or removal

Key Partners Come Together

- High Meadows Fund
- Vermont Housing and Conservation Board
- Efficiency Vermont
- Vermont Housing and Finance Agency
- CVOEO
- UVM
- Champlain Housing Trust
- Other Statewide Regional Partners

MANUFACTURED HOUSING INNOVATION PROJECT

http://www.vhcb.org/mhip/

Manufactured Housing Innovation Pilot Project

Focus: 10 HP units targeted at single wide mobile home replacement market

Major Funders: High Meadows Fund, VHCB, Efficiency Vermont, VHFA Tax Credit Program

Project Management: VHCB and Efficiency Vermont

Design Team: Pill-Maharam Architects, Artisan Engineering, VERMOD Homes

Construction Partner: VERMOD Homes, Wilder,

Mobile Home Replacement High Performance Approach

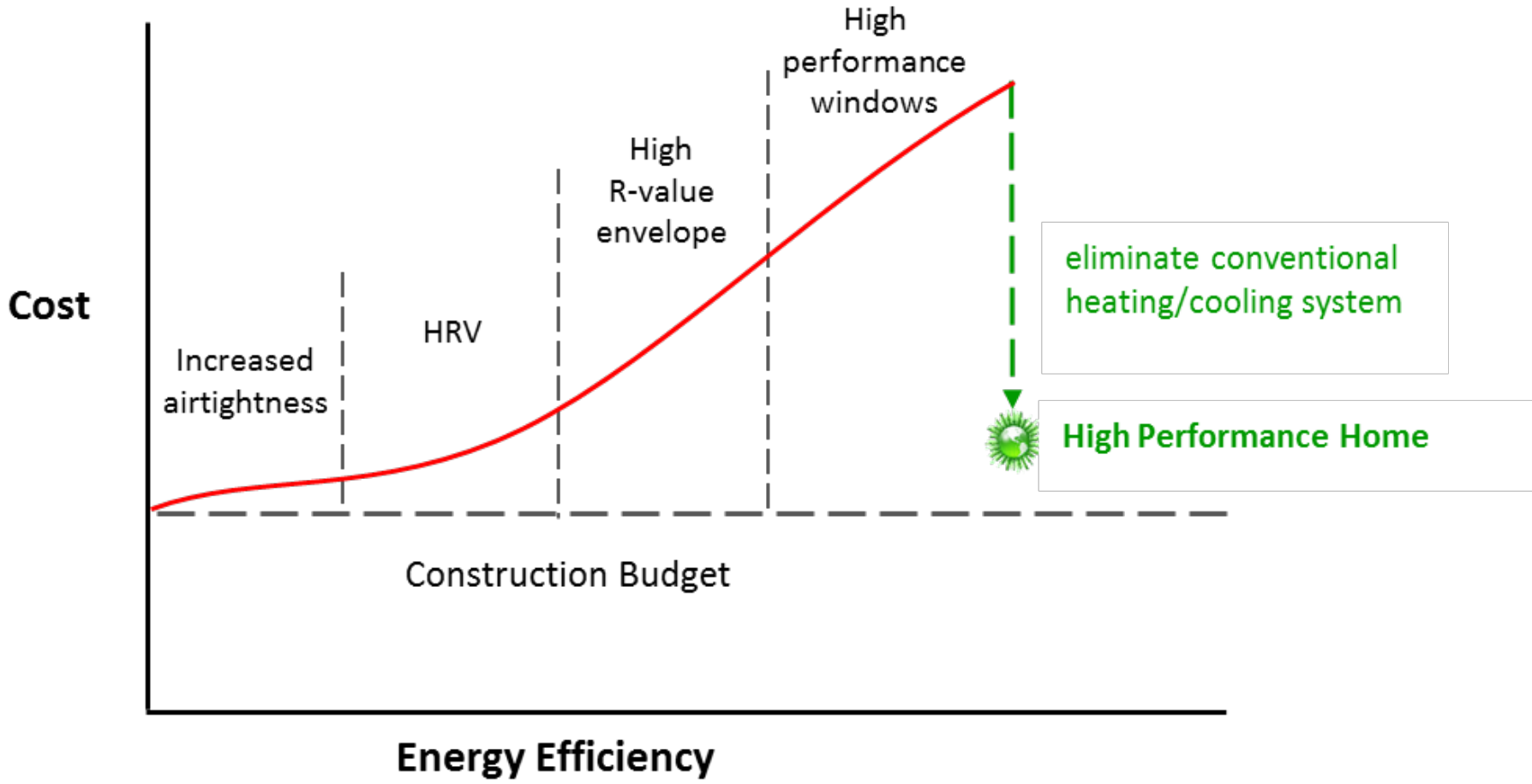
- Apply lessons learned from HPH Tier pilot phase related to envelope and mechanical specifications
- Installation of monitor devices in homes to track energy use, HVAC performance, comfort and indoor air quality
- Optimizing everything for lowest cost, and assessing total cost of ownership
- Supporting the financial sector in offering better terms
- Homeowner training and follow up support

Vermont's Comprehensive Energy Plan

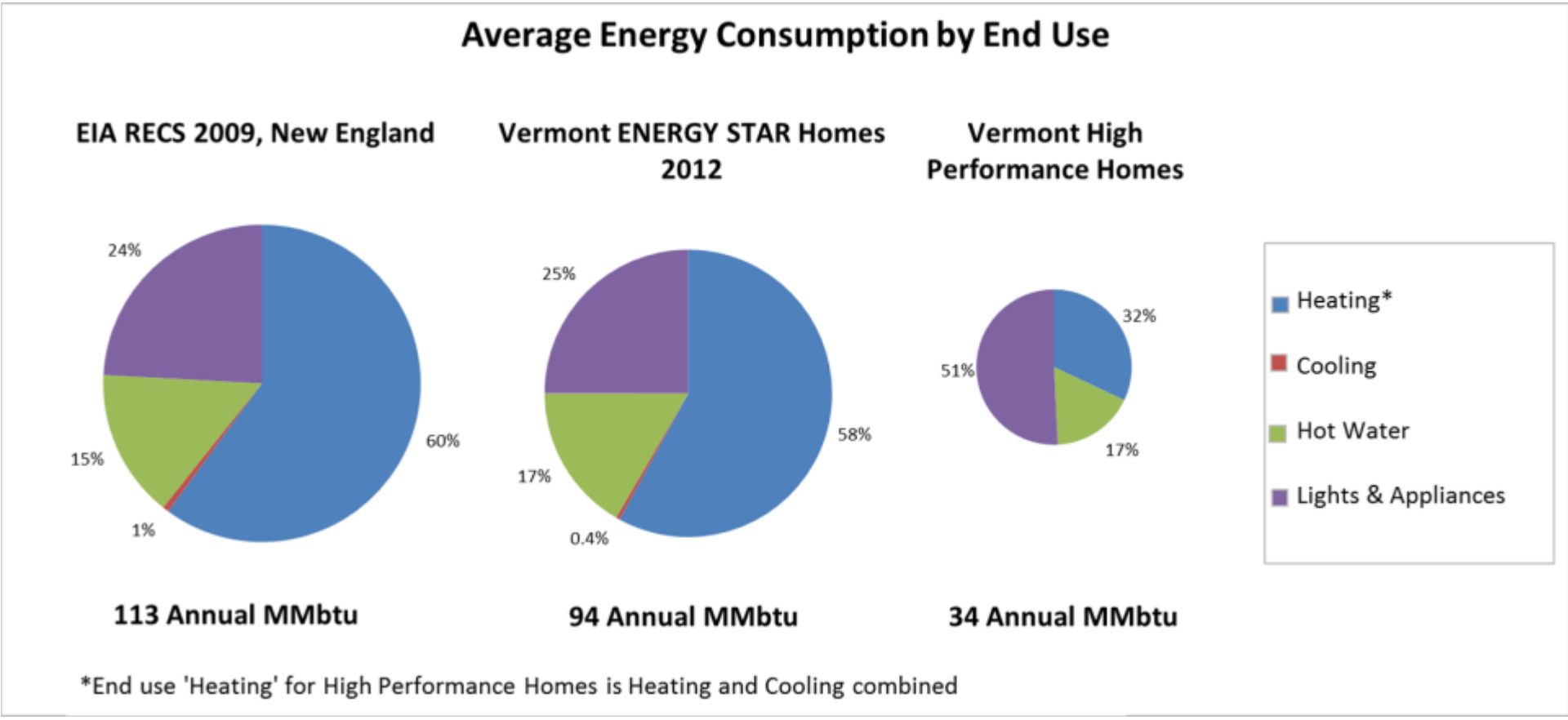
…60% of all new homes in Vermont to ENERGY STAR standards or Efficiency Vermont's Energy Code Plus and broader market penetration of net-zero energy buildings, with a goal of having 30% built to net-zero design standards by 2020 as an interim target on the way to 100% net-zero buildings by 2030.

In Vermont this translates to approximately 275 single family homes built to NZE standards per year.

Rational Behind High Performance Approach

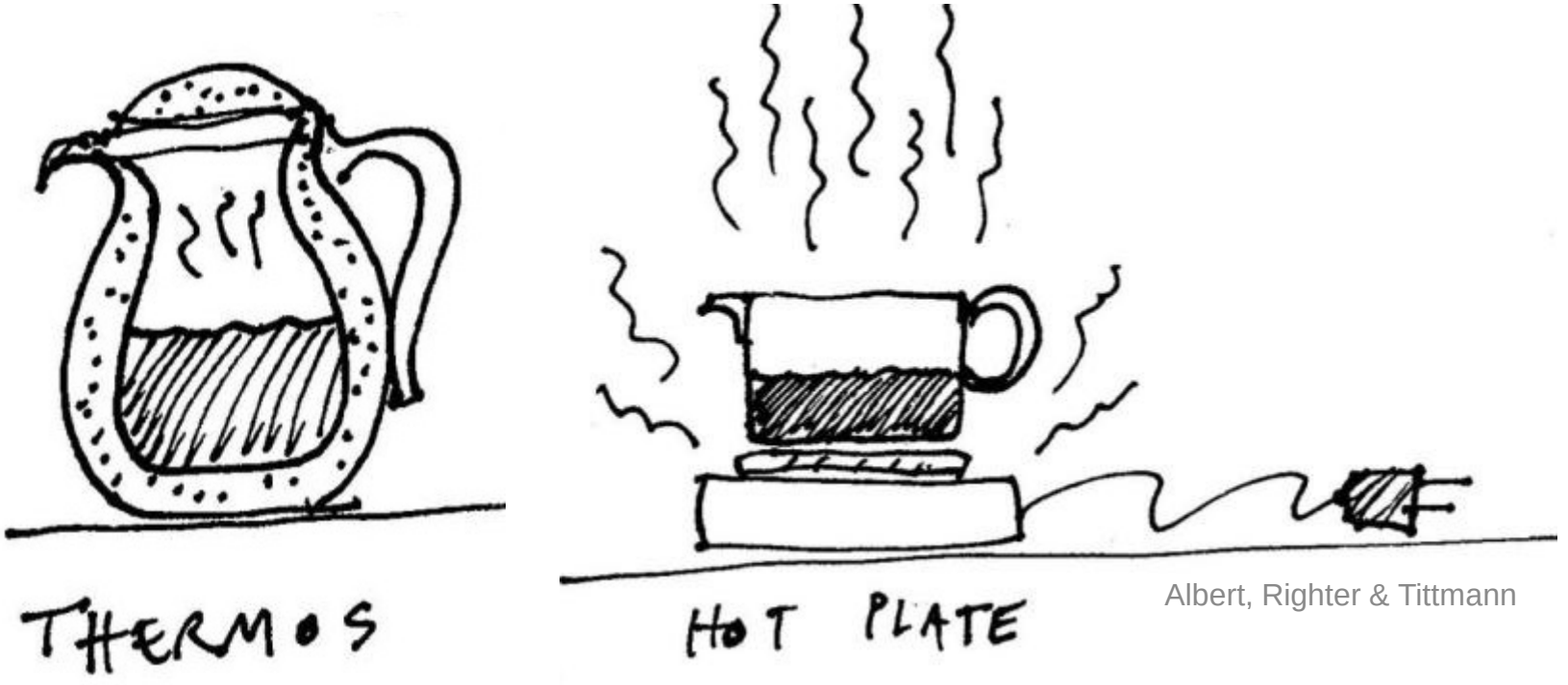


Rational Behind High Performance Approach



High Performance Concept

Maintain the temperature through conservation rather than by using energy.



Albert, Righter & Tittmann

Benefits of High Performance Specification

- Superior Indoor Air Quality
- Reduced Maintenance
- Comfortable and Quiet Home
- A Home that Holds its Value
- Eliminate Dependence on Fossil Fuel Deliveries, Section 8 energy allowance and LIHEAP
- Lower Cost per Month for Mortgage and Energy

Mobile Home Parks

Thick walls, ceilings, & floors

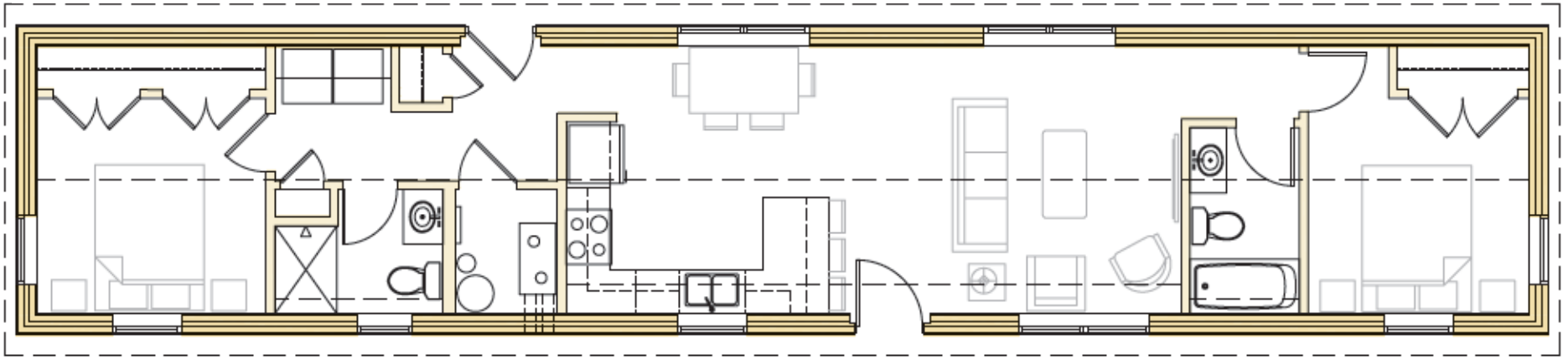
Natural sunlit spaces

Healthy materials

Fresh air ventilation

Efficient heating and cooling

Efficient hot water



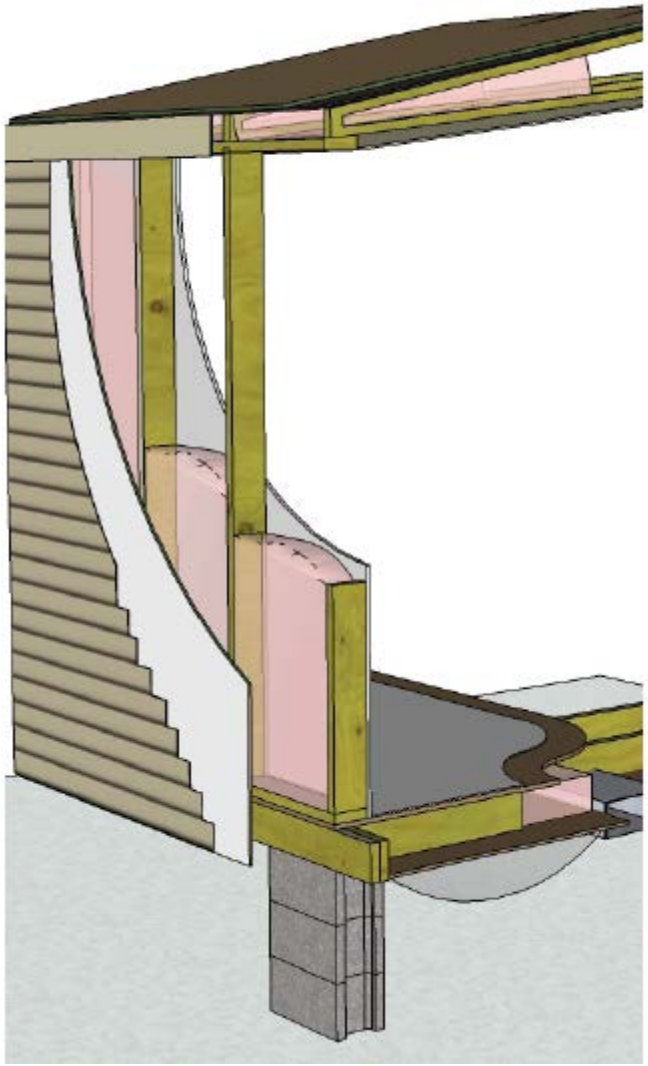
pill-maharam architects

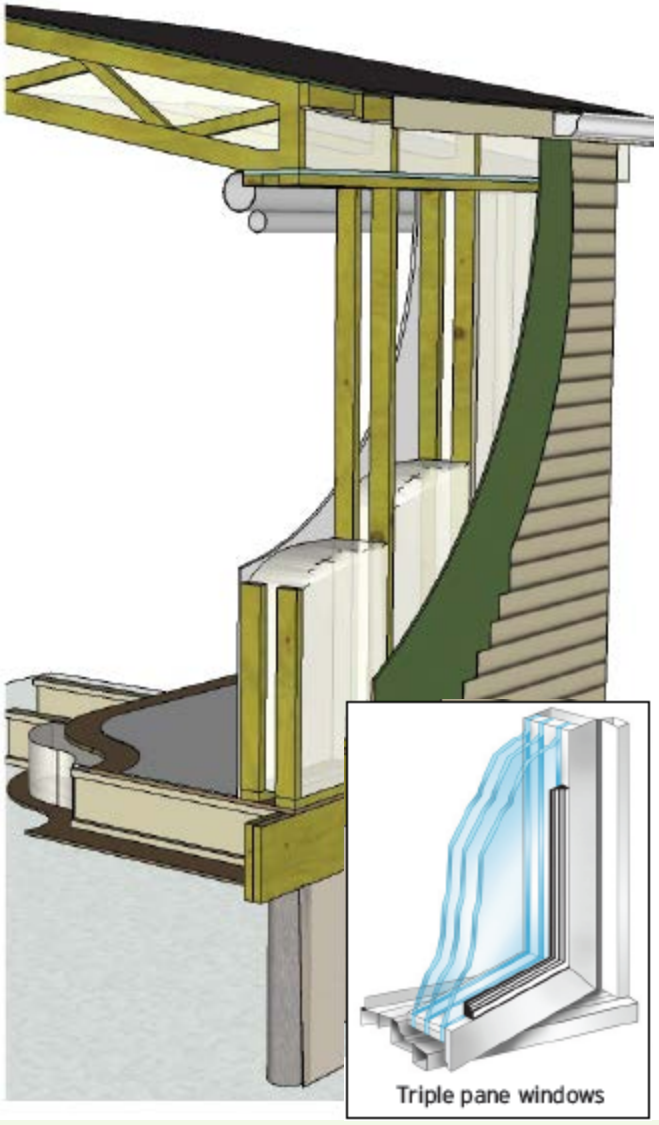
PMa

- Open floor plan
- Sound-dampened mechanical room
- Plenty of closet space
- Large kitchen

Finally, a home made for our New England weather... and built right here in Vermont.

Quality, comfort, and long-term affordability





Typical Manufactured Home

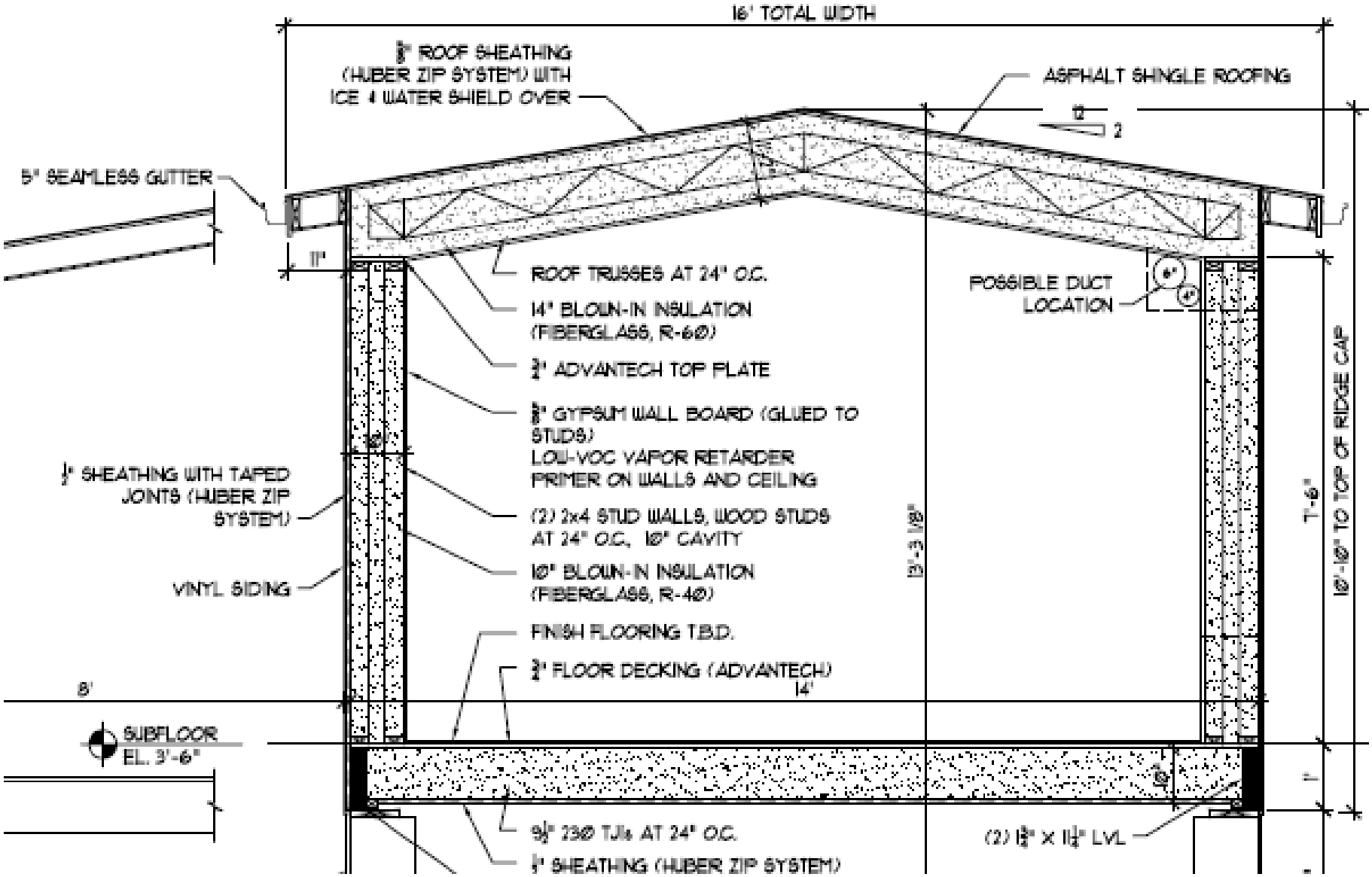
10 50-gallon barrels of oil a year

High Performance Manufactured Home

3 and 1/4 50-gallon barrels of oil a year

With solar PV

One 50-gallon barrel of oil a year


16' TOTAL WIDTH
⅜" ROOF SHEATHING (HUBER ZIP SYSTEM) WITH ICE & WATER SHIELD OVER
ASPHALT SHINGLE ROOFING
12
2
5" SEAMLESS GUTTER
11"
ROOF TRUSSES AT 24" O.C.
14" BLOWN-IN INSULATION (FIBERGLASS, R-60)
POSSIBLE DUCT LOCATION
¾" ADVANTECH TOP PLATE
⅝" GYPSUM WALL BOARD (GLUED TO STUDS)
LOW-VOC VAPOR RETARDER PRIMER ON WALLS AND CEILING
½" SHEATHING WITH TAPED JOINTS (HUBER ZIP SYSTEM)
(2) 2x4 STUD WALLS, WOOD STUDS AT 24" O.C., 10" CAVITY
10" BLOWN-IN INSULATION (FIBERGLASS, R-40)
VINYL SIDING
13'-3 1/8"
FINISH FLOORING T.B.D.
¾" FLOOR DECKING (ADVANTECH)
14'
8'
SUBFLOOR EL. 3'-6"
9½" 230 TJIs AT 24" O.C.
½" SHEATHING (HUBER ZIP SYSTEM)
(2) 1¾" X 11¼" LVL
T-6"
12'-10" TO TOP OF RIDGE CAP

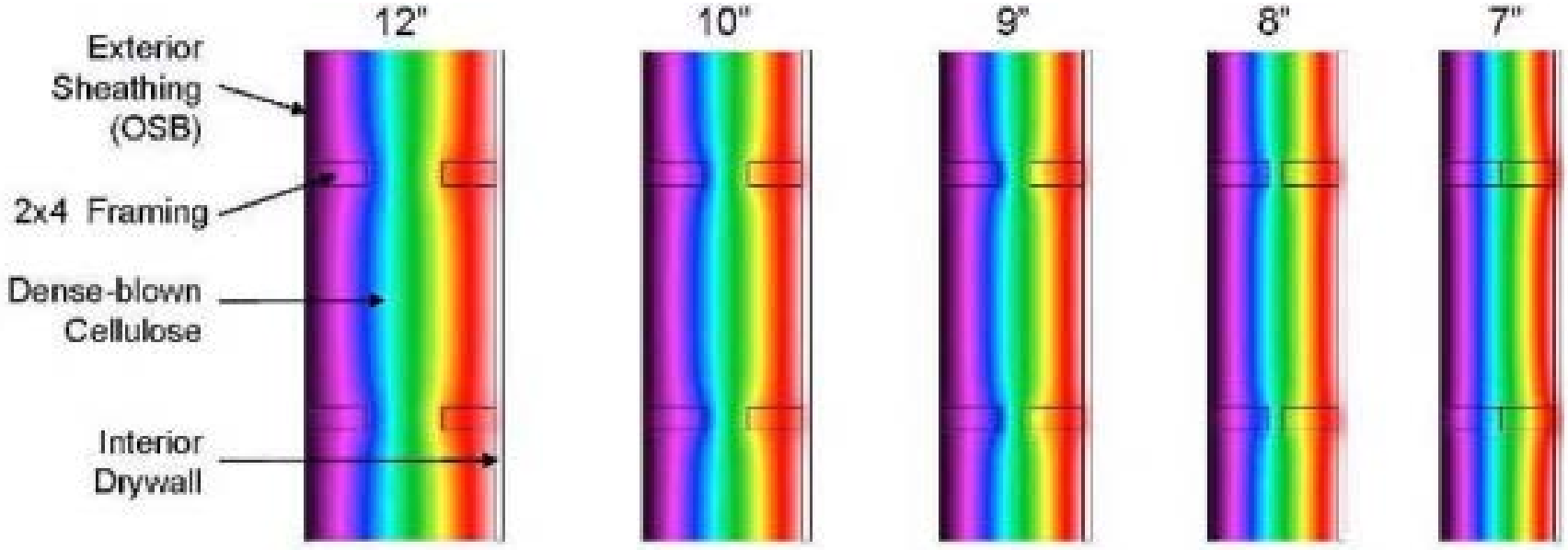
Testing Insulation Installation on Mock Walls

Verifying Quality Insulation Installation

The Start of a Modular Unit


10” Thick Walls

Staggered or Not



Effective R-values for walls from THERM analysis.

	Wall Cavity Thickness	12 in	10 in	9 in	8 in	7 in
	Gap Between Framing	5 in	3 in	2 in	1 in	-
R-Value [ft²hr°F/Btu]	In-line	42.6	35.2	31.5	27.8	23.8
	Offset	42.6	35.5	31.8	28.2	24.7


ZIPsystem
ZIPsystem

Insulated Corners – Not a Weak Spot

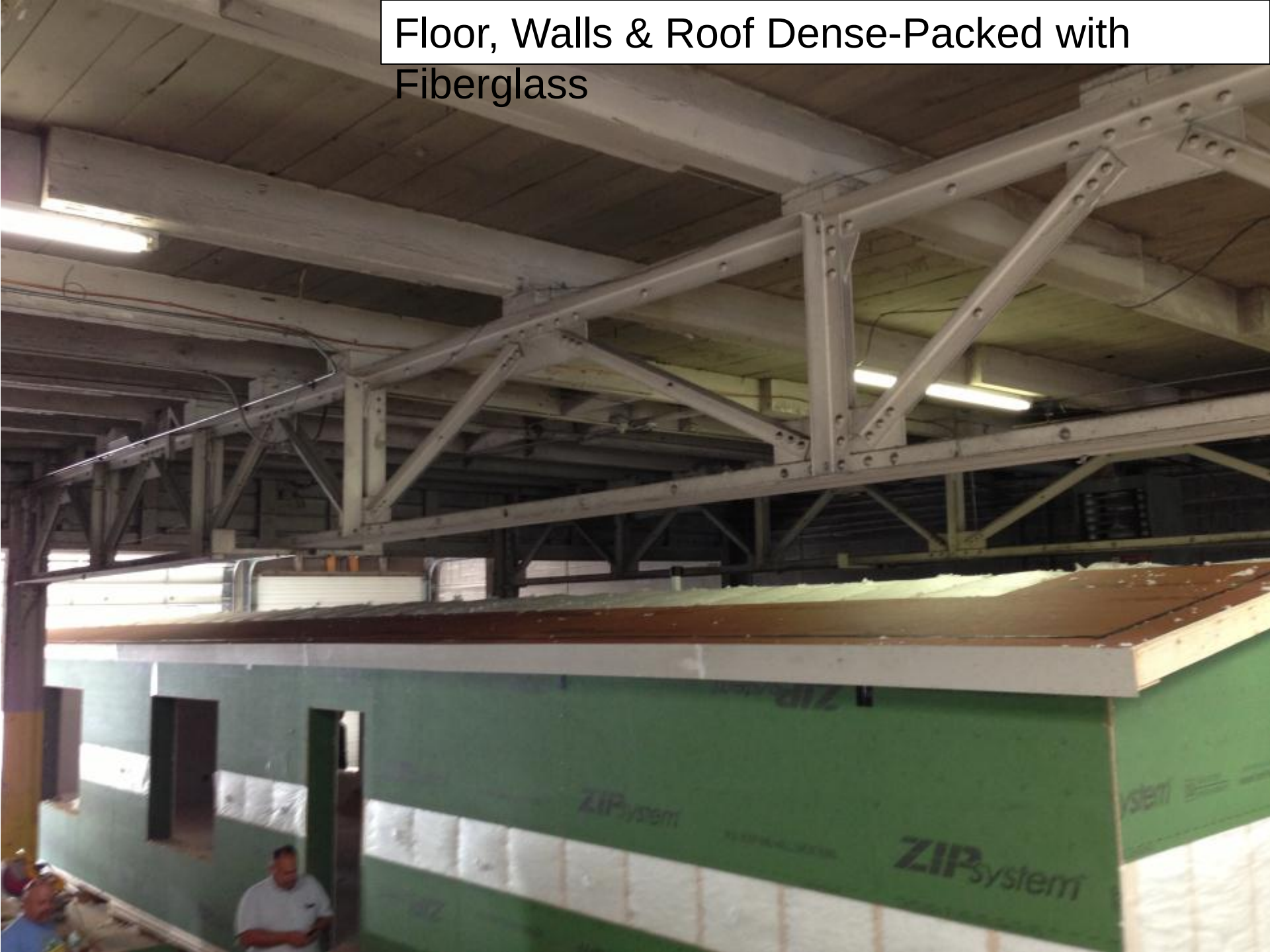
14” Truss Roof System for Heavy Loads and High Insulation Value


ZIP system
B-7500

Ceiling Sheathed Before Interior Walls Installed and Vapor Barrier Primer

Duct Chase within Envelope


Climate Pro FG: R-4.3/in – 1.8/lbs per cuft
Cellulose: R-3.6/in – 3.5-4/lbs per cuft
Climate Pro
B-7500


Floor, Walls & Roof Dense-Packed with Fiberglass
ZIPsystem
ZIPsystem


ZIP System

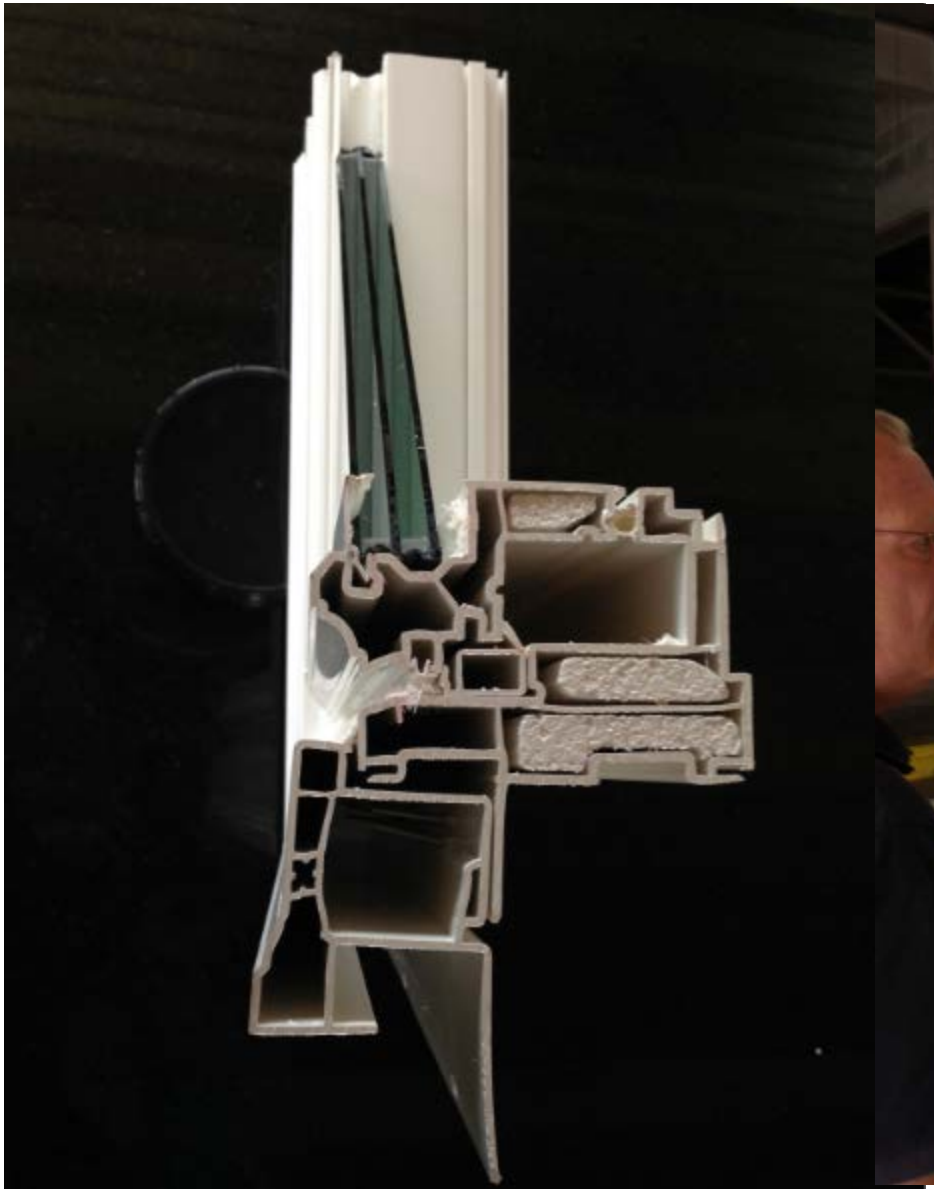
Complete Air Barrier Around House to Eliminate Leakage


ZIP System

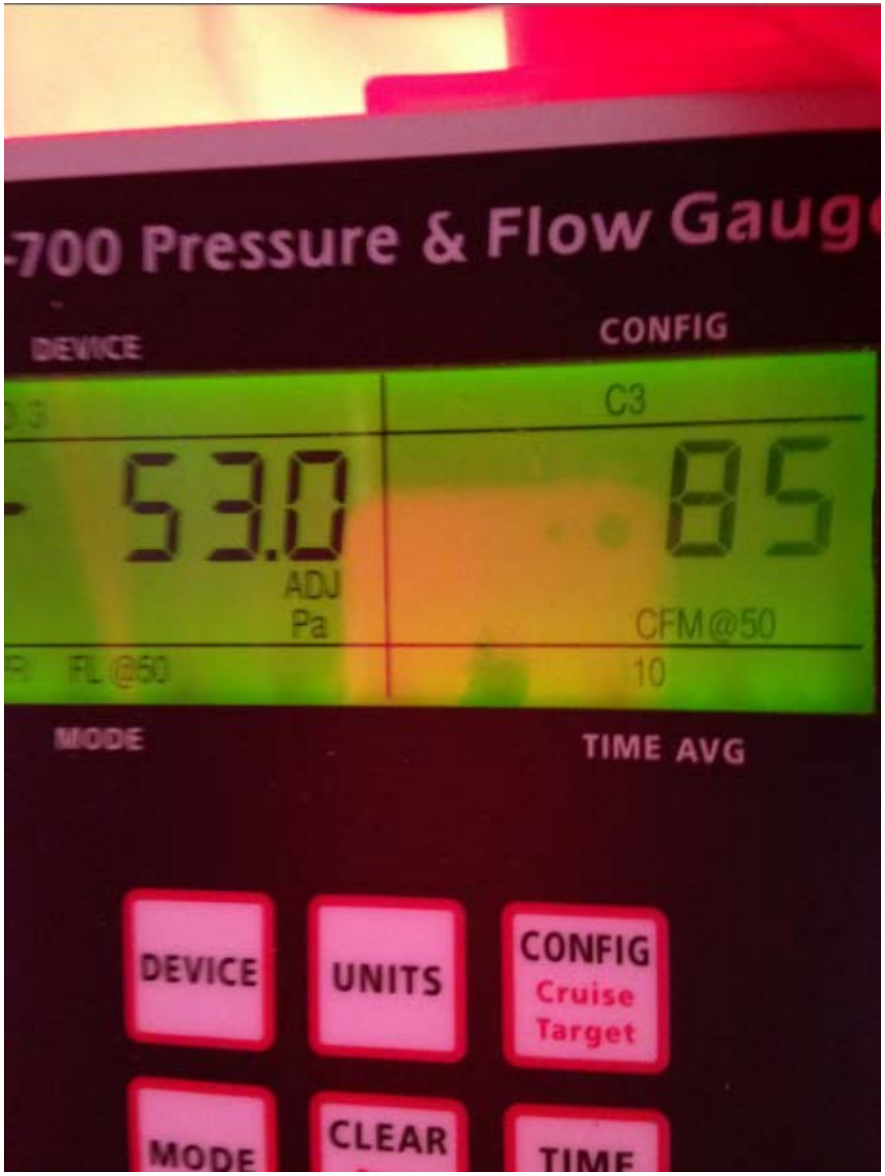
earthwise
WINDOWS & DOORS

U-0.19 SHGC-Low or High

earthwise
WINDOWS & DOORS



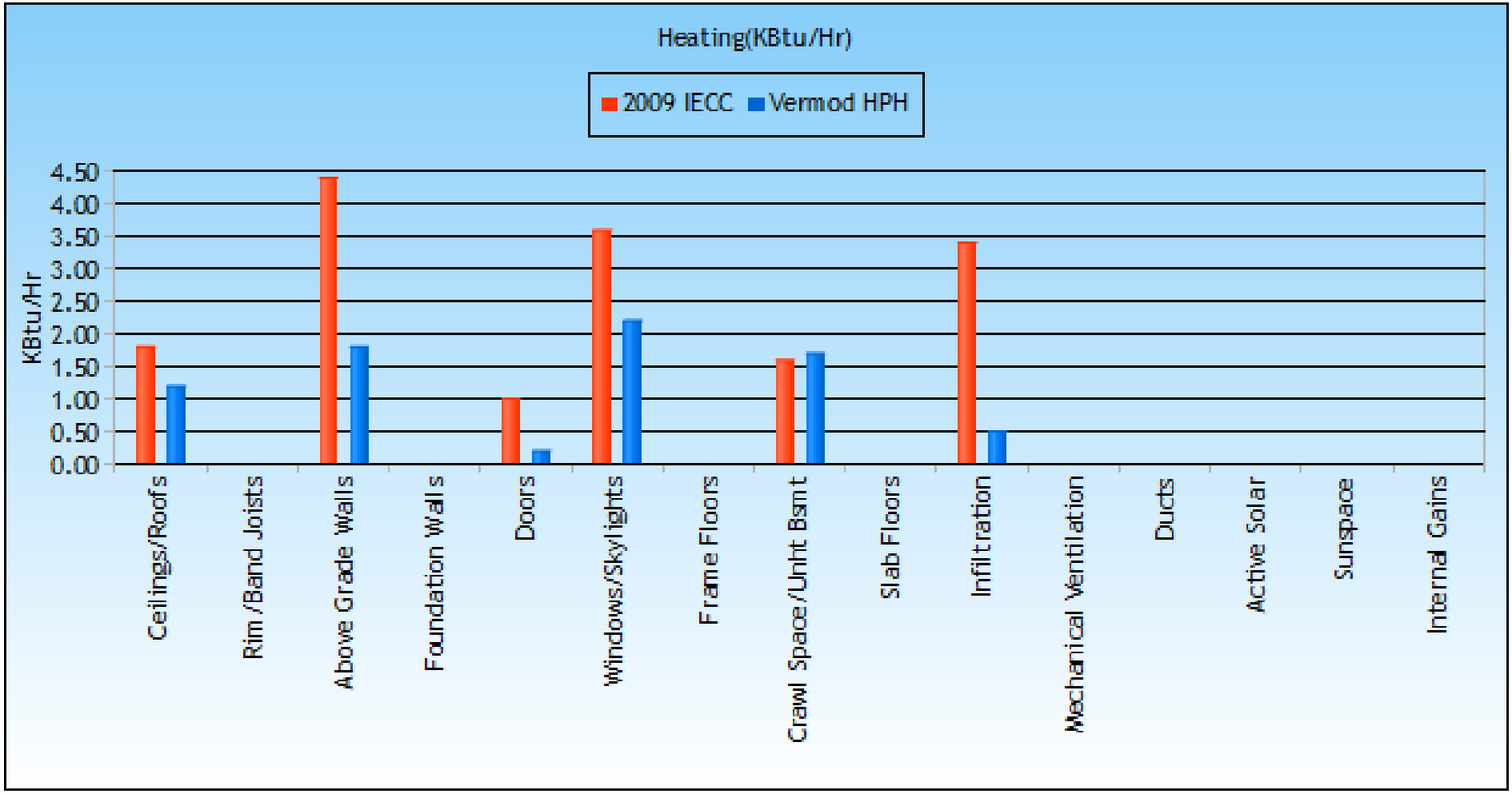
Resulting Air Tightness < 1 ACH50



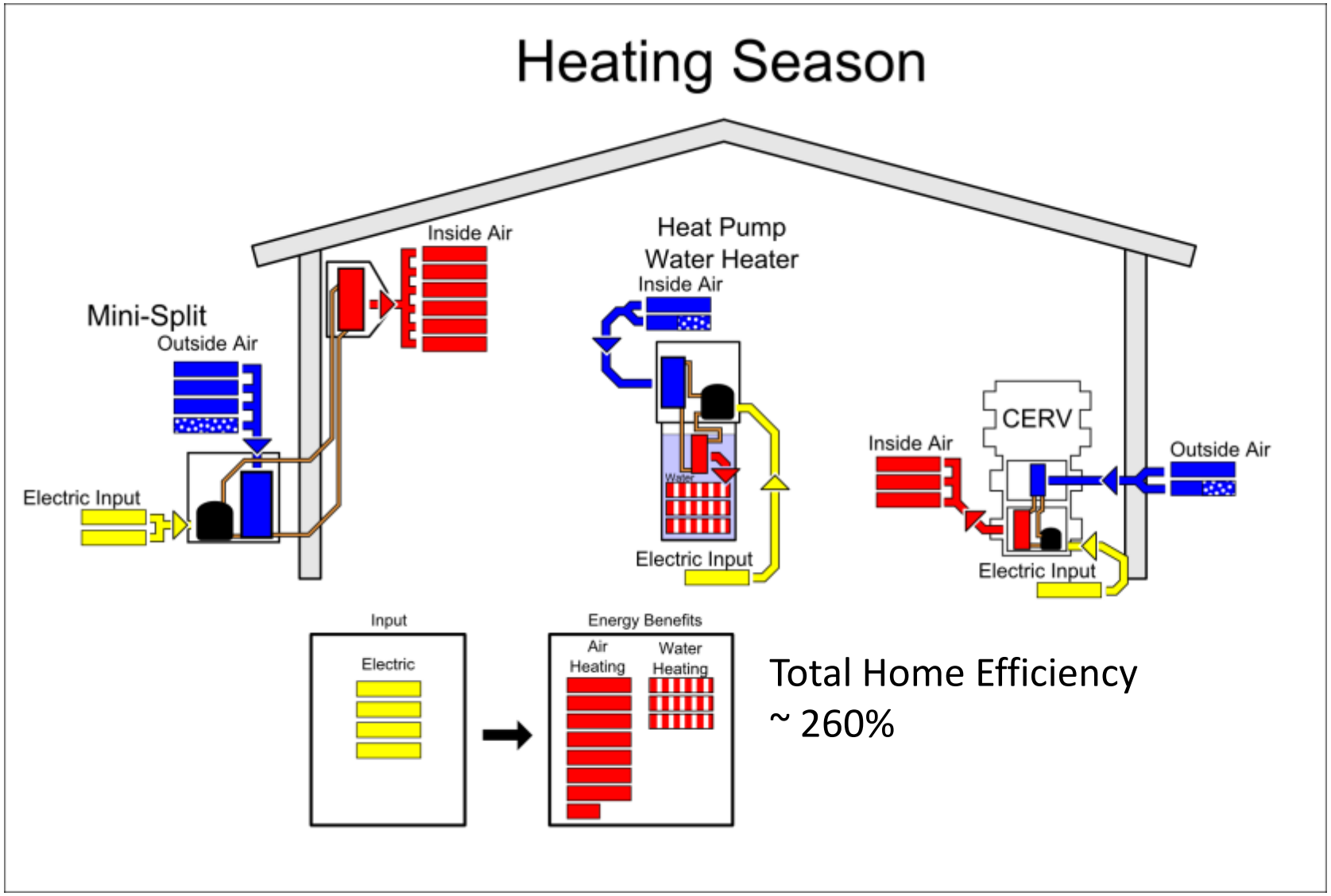

Windows & Doors Sealed and Siding Installed

Lifts for Belly Insulation and Detailing

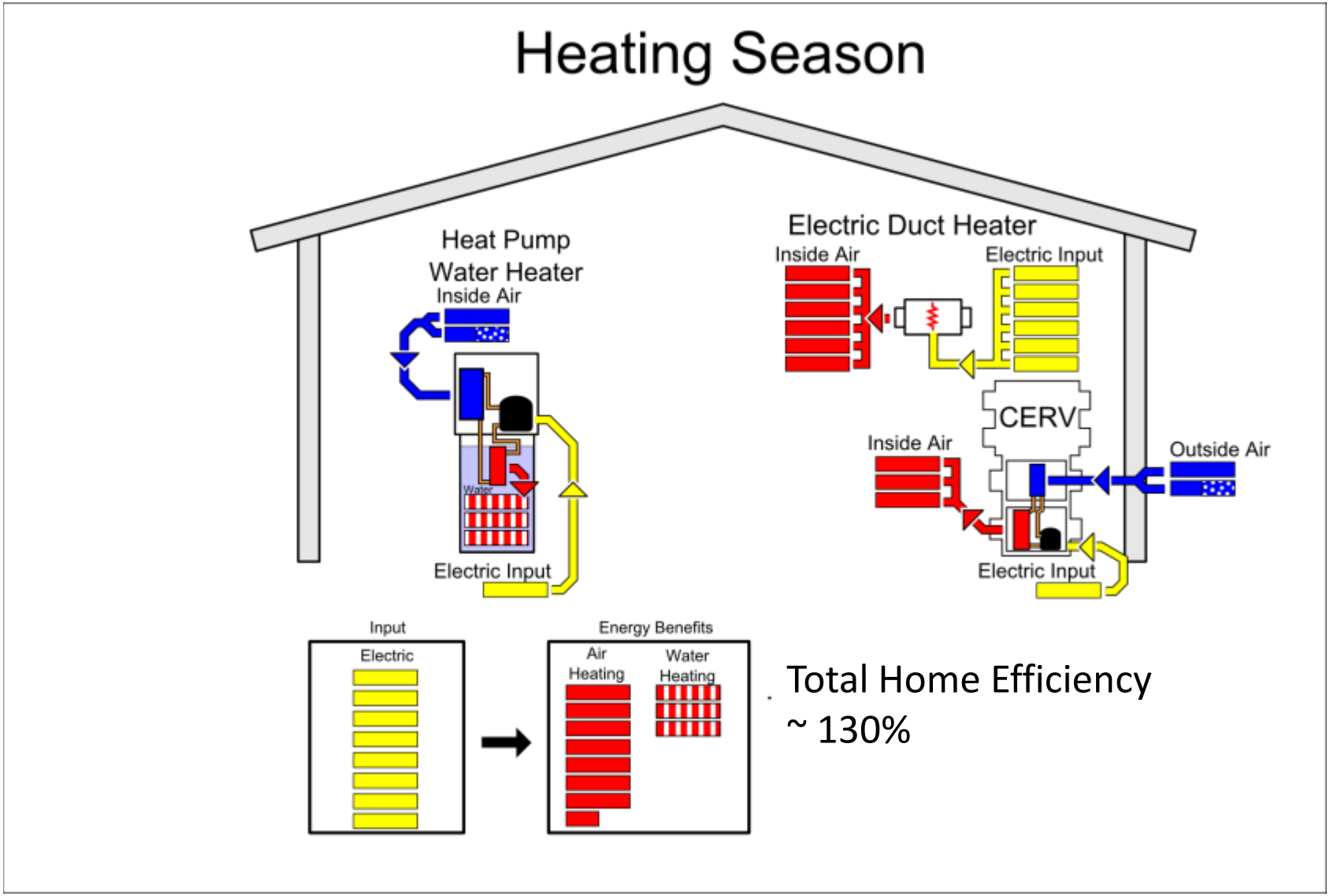
Heat Loss – 8 kBtu/hour



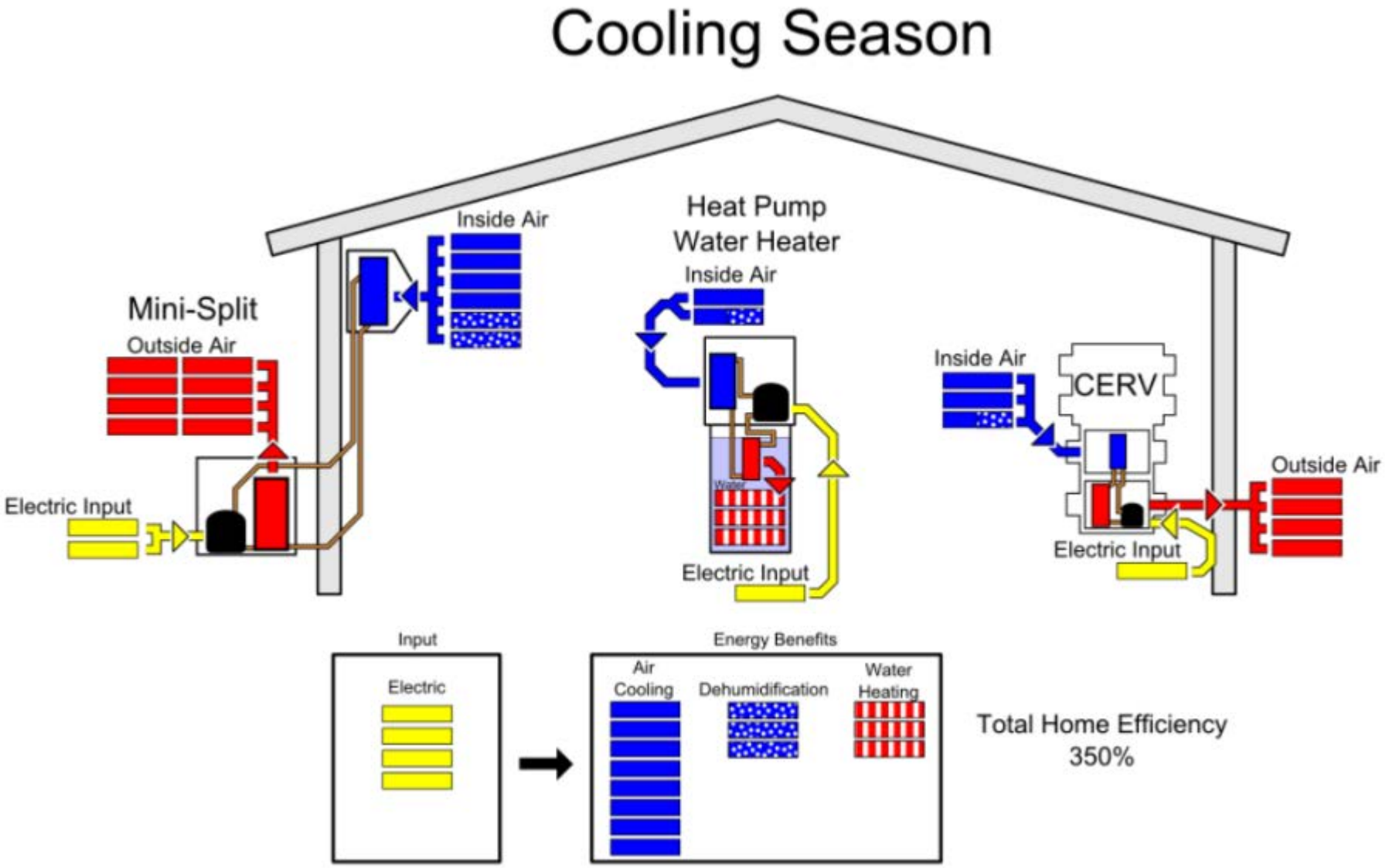
Mini-Heat & CERV & HPWH



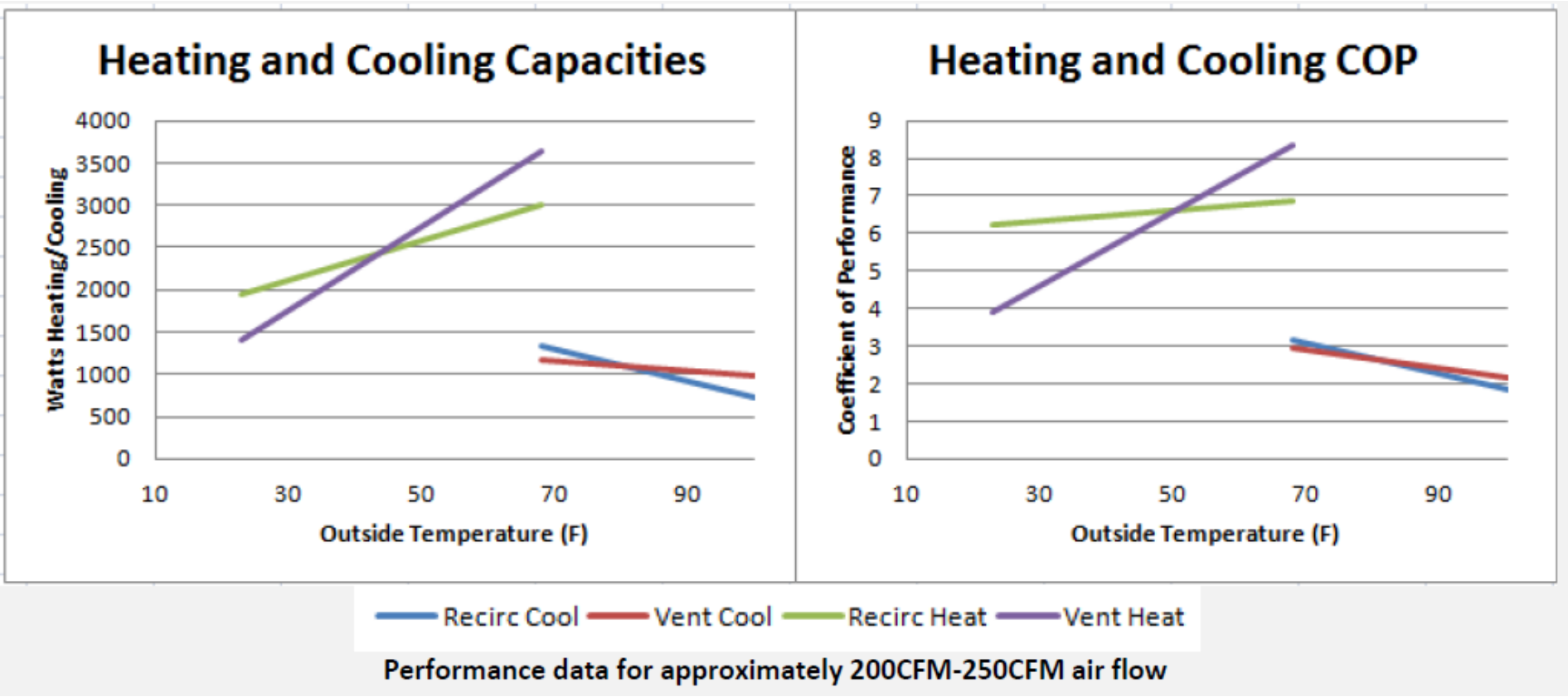
Electric Heat & CERV & HPWH



Mini-Cool & CERV & HPWH

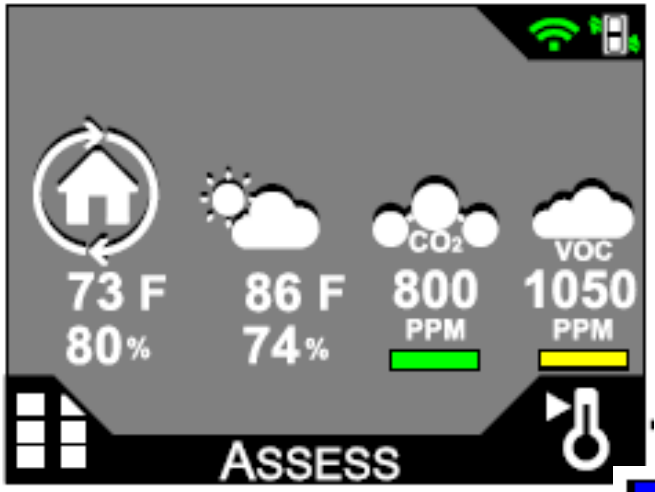


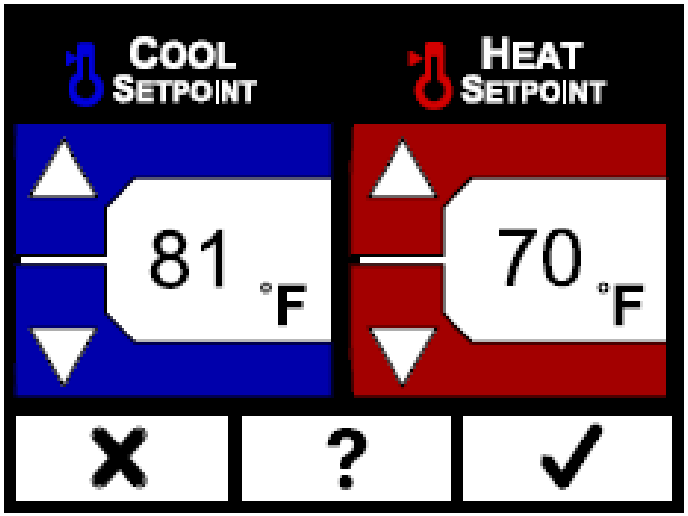
Conditioning Energy Recovery Ventilator - CERV

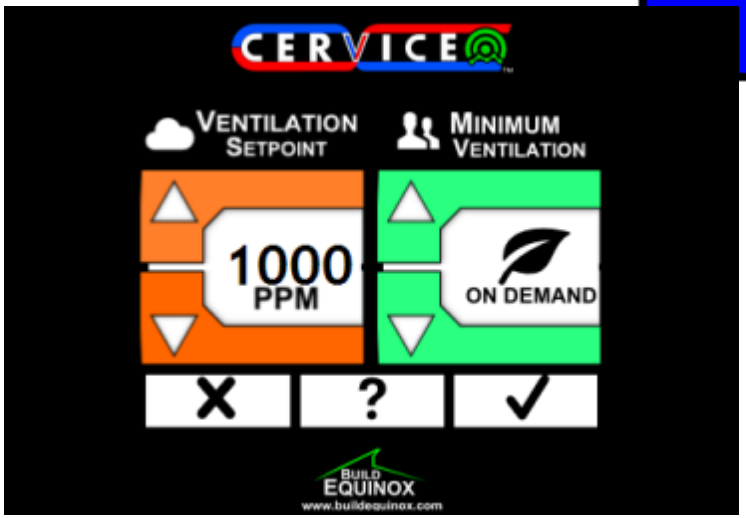


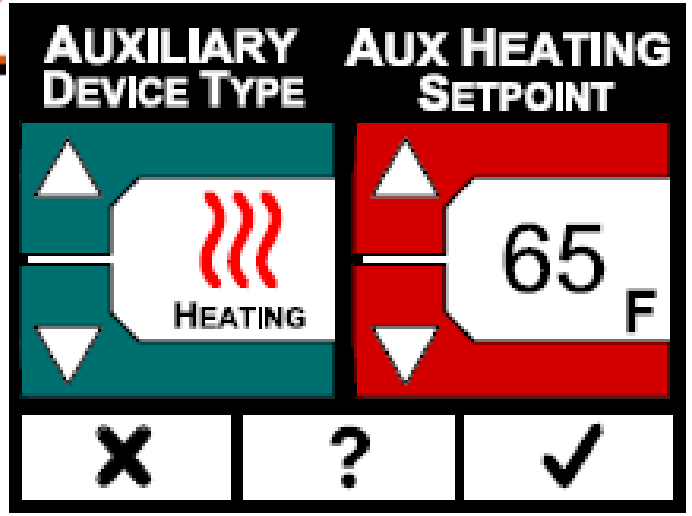
Performance data for approximately 200CFM-250CFM air flow

CERV Controller









airgenerate
Adaptive Energy Solutions

A.O. Smith
Innovation has a name.

Heat Pump Hot Water Heater

Specifications:	ATI 66
Tank Size	66 gallons
Energy Factor (Hybrid Mode)	2.25
1st Hour Rating (Hybrid Mode)	75 Gallons
Heat Pump BTU Rating	2.5 kW
Compressor Make	Panasonic
Refrigerant	R410A
Tank Capsule (Stainless Steel)	SS304
Noise	48 db

1ST HOUR RATING (GAL) BY MODE		
EFFICIENCY	HYBRID	ELECTRIC
42.1	67.5	59.1

MODEL	GALLON CAPACITY	ENERGY FACTOR BY MODE		
		EFFICIENCY	HYBRID	ELECTRIC
SHPT-50	50	2.78	2.75	0.89

Primary Heating and Cooling

- Fujitsu 9RLS2h
- Mitsubishi MSZ/MUZ FH09

MITSUBISHI FH09

Model Name	Indoor Unit		MSZ-FH09NA
	Outdoor Unit		MUZ-FH09NA
Cooling *1	Rated Capacity	Btu/h	9,000
	Capacity Range	Btu/h	1,700-12,000
	Rated Total Input	W	560
	Energy Efficiency	SEER	30.5
	Moisture Removal	Pints/h	0.6
	Sensible Heat Factor		0.920
Heating at 47° F *2	Rated Capacity	Btu/h	10,900
	Capacity Range	Btu/h	1,600 - 18,000
	Rated Total Input	W	710
	HSPF (IV)	Btu/h/W	13.5
Heating at 17° F *3	Rated Capacity	Btu/h	6,700
	Rated Total Input	W	600
	Maximum Capacity	Btu/h	12,200
Heating at 5° F	Maximum Capacity	Btu/h	10,900

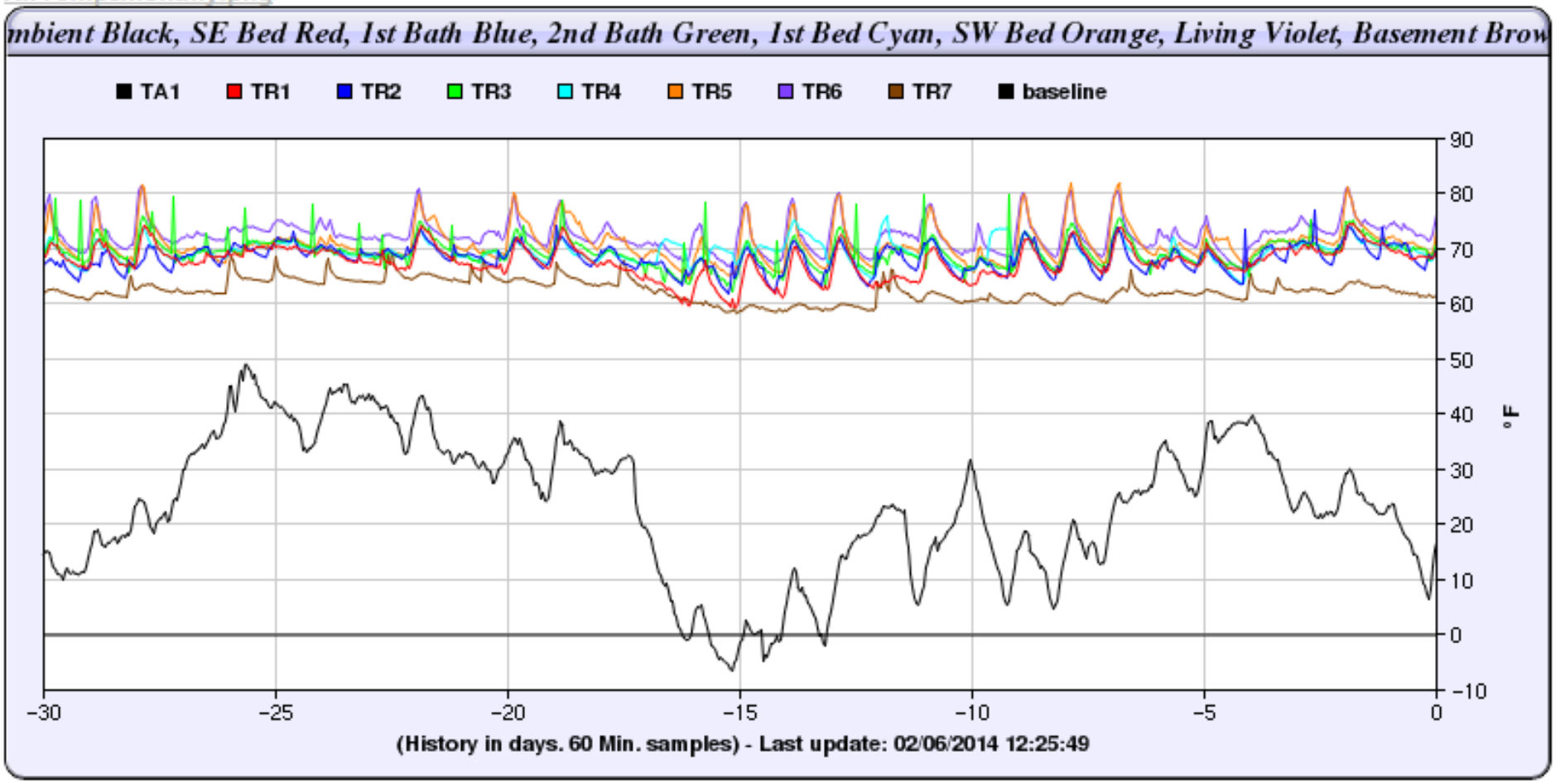
FUJITSU ASU9RLS2h

	°FDB	60		65		70	
Outdoor temperature	°FWB	TC	IP	TC	IP	TC	IP
-15	-17	11.6	2.10	11.4	2.14	11.1	2.18
-5	-7	14.7	2.12	14.3	2.16	14.0	2.20
5	3	16.1	2.13	15.7	2.17	15.4	2.21
14	12	16.8	2.06	16.4	2.10	16.0	2.14
23	19	18.3	1.99	17.9	2.03	17.5	2.07
32	28	18.8	1.93	18.4	1.97	17.9	2.00
41	37	21.3	1.85	20.8	1.89	20.3	1.93
47	43	23.1	1.91	22.6	1.95	22.0	1.99
50	47	25.5	1.94	24.9	1.98	24.3	2.02
59	50	26.5	1.95	25.8	1.99	25.2	2.03

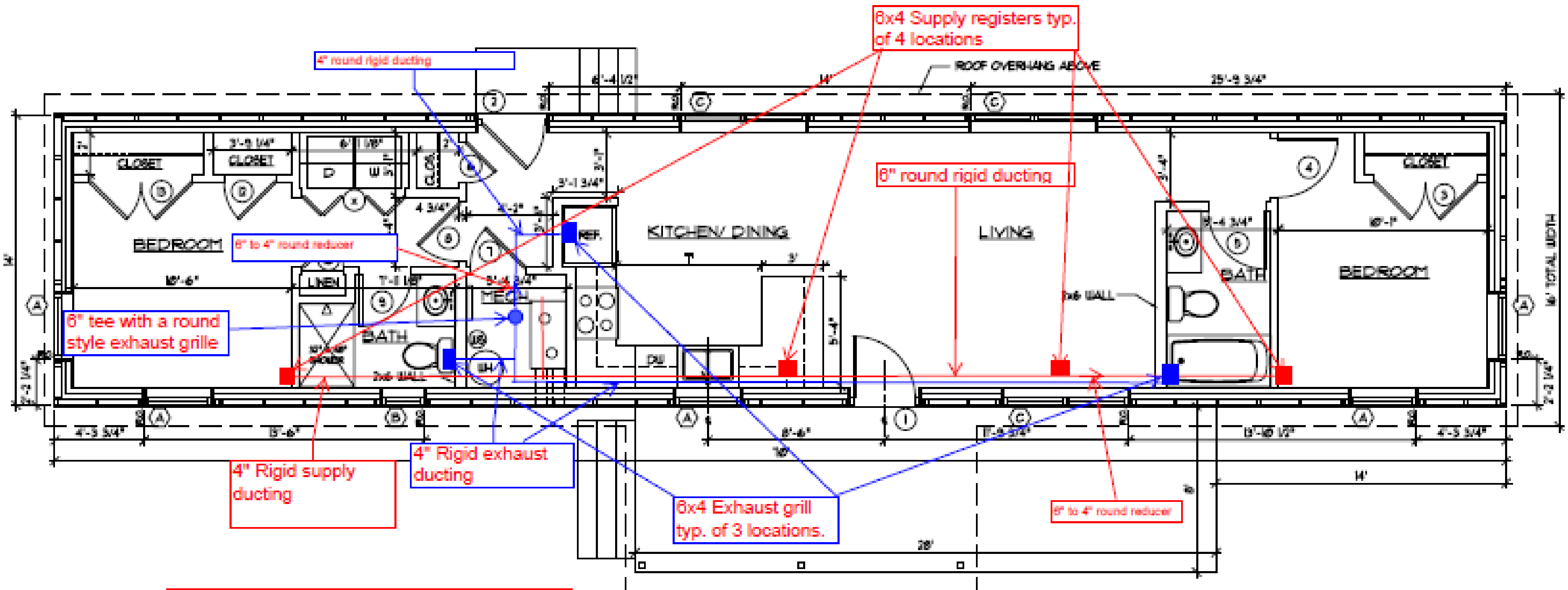
AFR : Air Flow Rate (CFM)
TC : Total Capacity (kBtu/h)
IP : Input Power (kW)

Heat Pump as Primary Heating

AirTempsmonthly.png



Duct Design



All supply ductwork or the red lines needs to be wrapped with bubble wrap type insulation.

All ductwork seams to be sealed with duct sealer or foil tape.

1.11	Hard-surface flooring in kitchens, baths, entry, laundry and utility rooms, AND piping in exterior walls insulated with pipe wrap.
4.2	Duct systems protected from construction debris AND no building cavities used as air supplies or returns.
4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home.
5.2	CO alarms installed in each sleeping zone (e.g., common hallway) according to NFPA 720.
6.1	Certified low-formaldehyde composite wood materials AND structural plywood AND OSB PS1 or PS2 compliant.
6.2	Certified low-VOC or no-VOC interior paints and finishes used.
6.3	Carpet, carpet adhesives CRI Green Label Plus AND carpet cushion CRI Green Label.
7.1	HVAC system and ductwork verified to be dry and clean AND new filter installed.

Mobile Home Replacement

Mobile Home Replacement

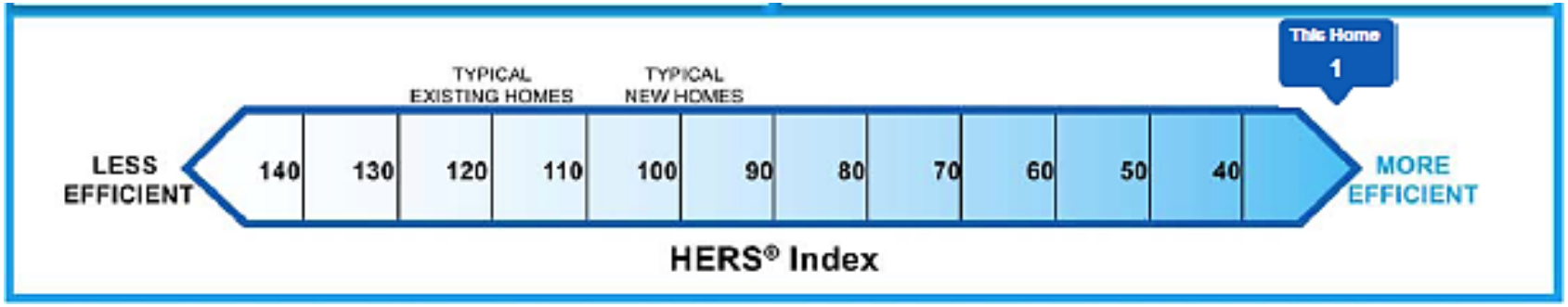
Mobile Home Replacement

Mobile Home Replacement

Mobile Home Replacement

Mobile Home Replacement

Mobile Home Replacement



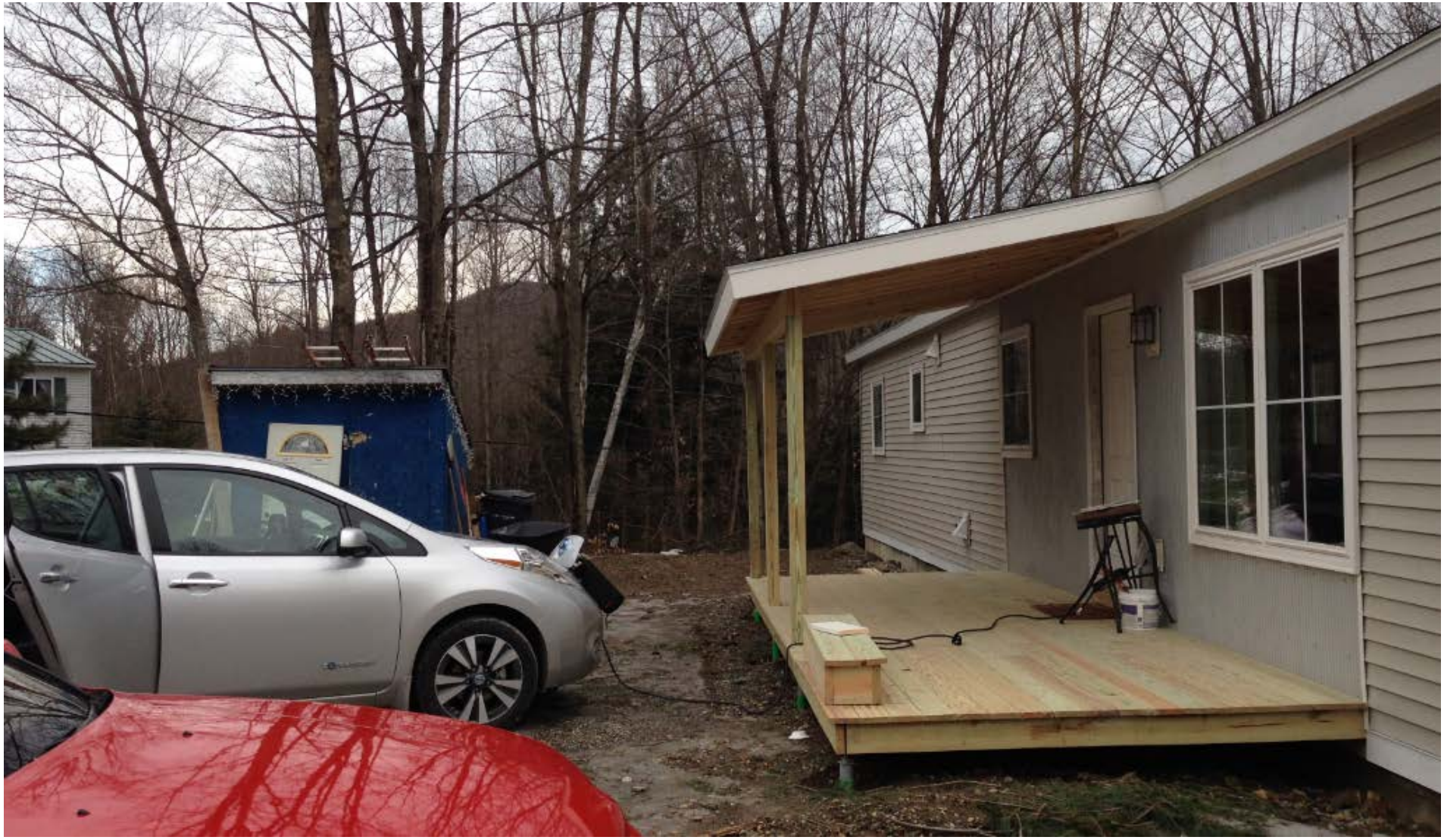
Mobile Home Replacement

Mobile Home Replacement

Mobile Home Replacement

Mobile Home Replacement

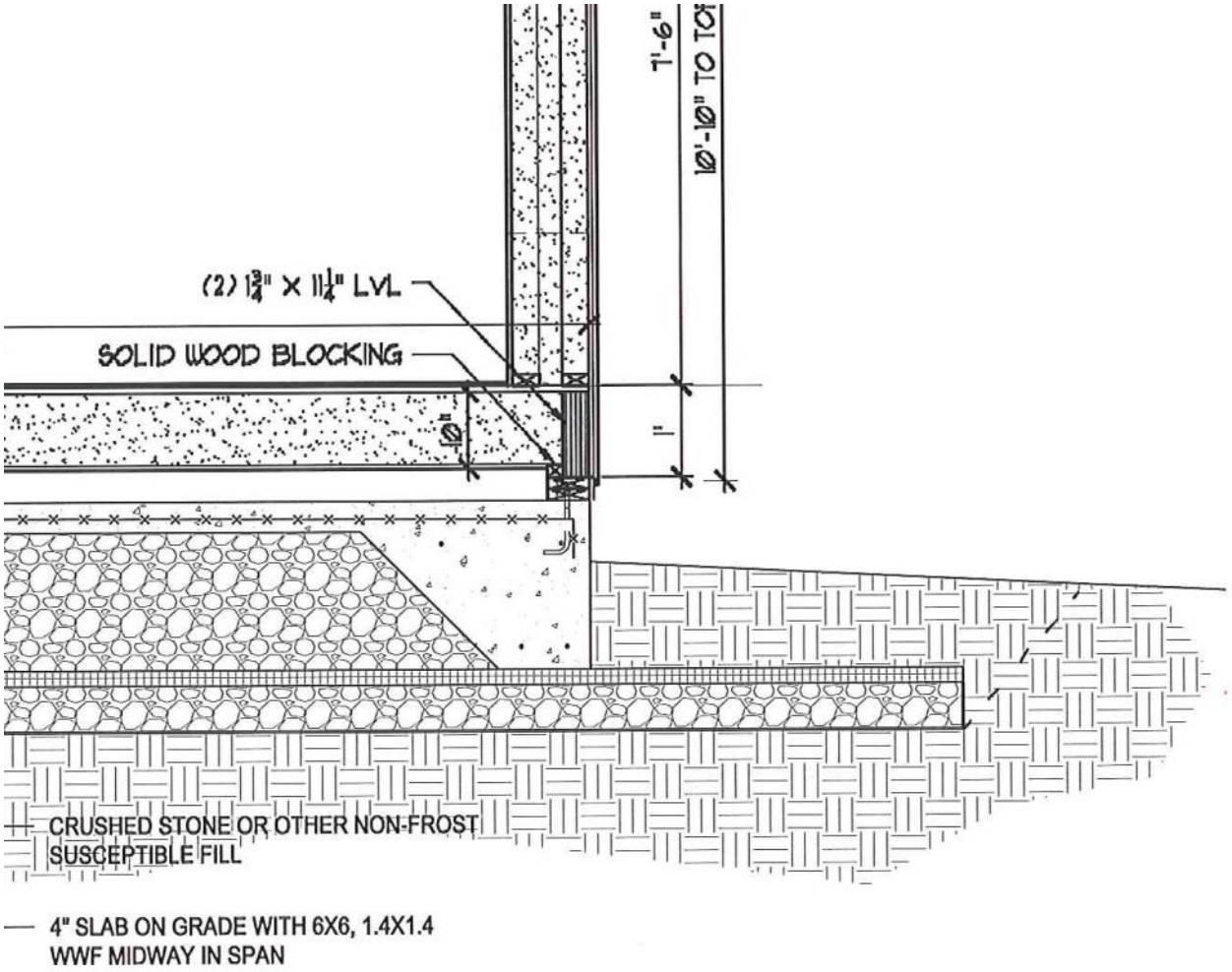
Mobile Home Replacement



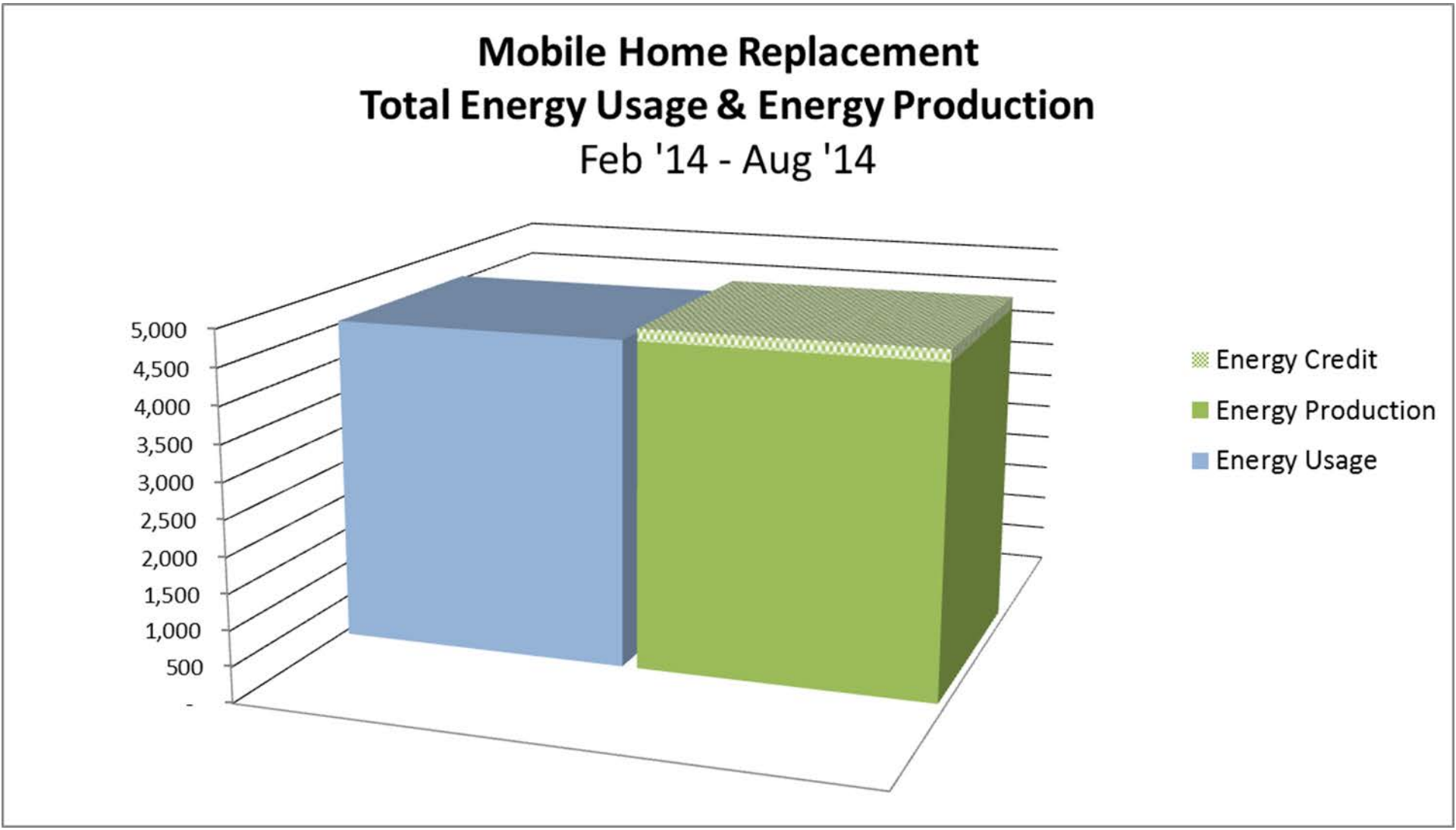
Mobile Home Replacement

Mobile Home Replacement

Mobile Home Replacement



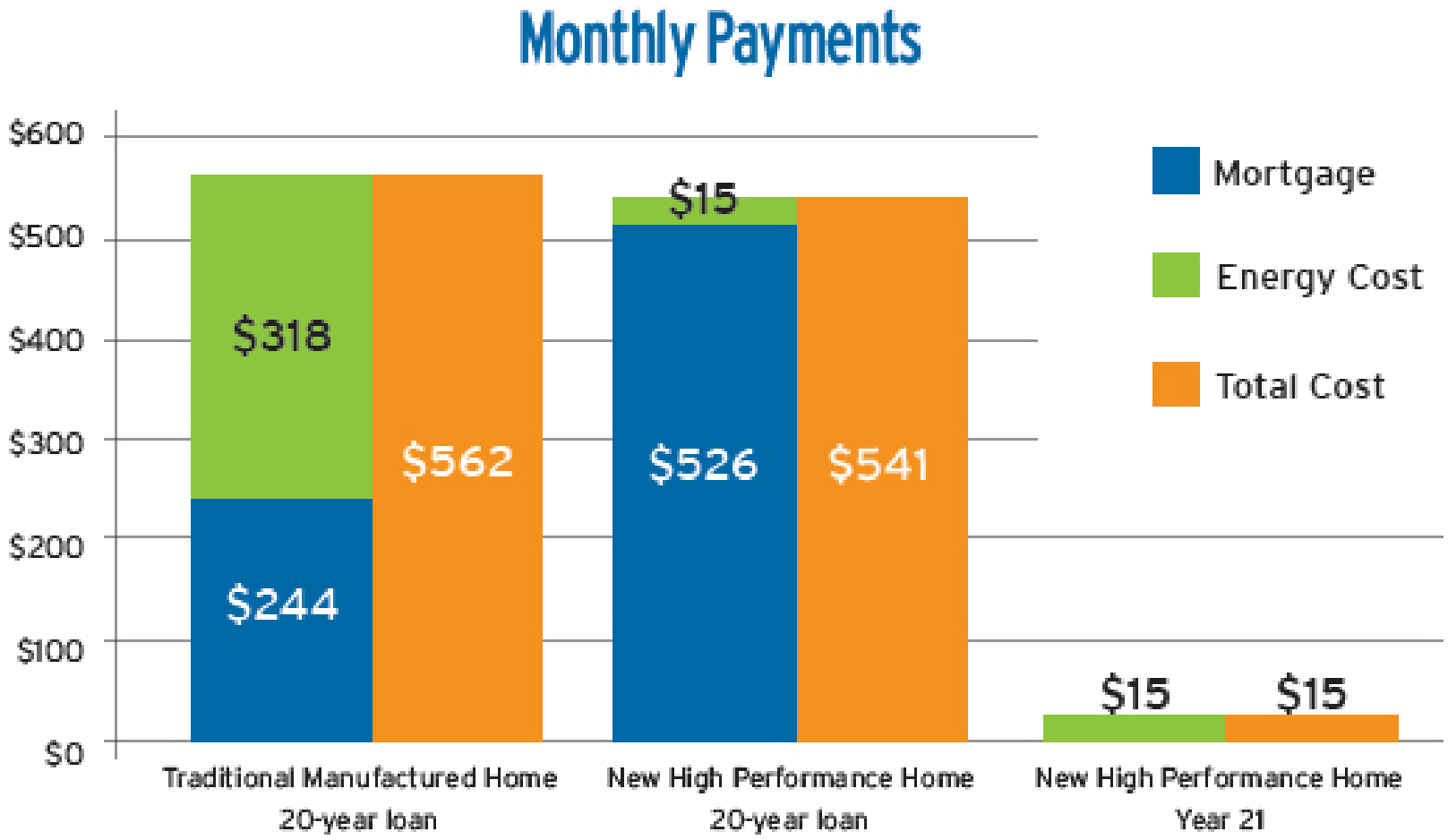
Performance

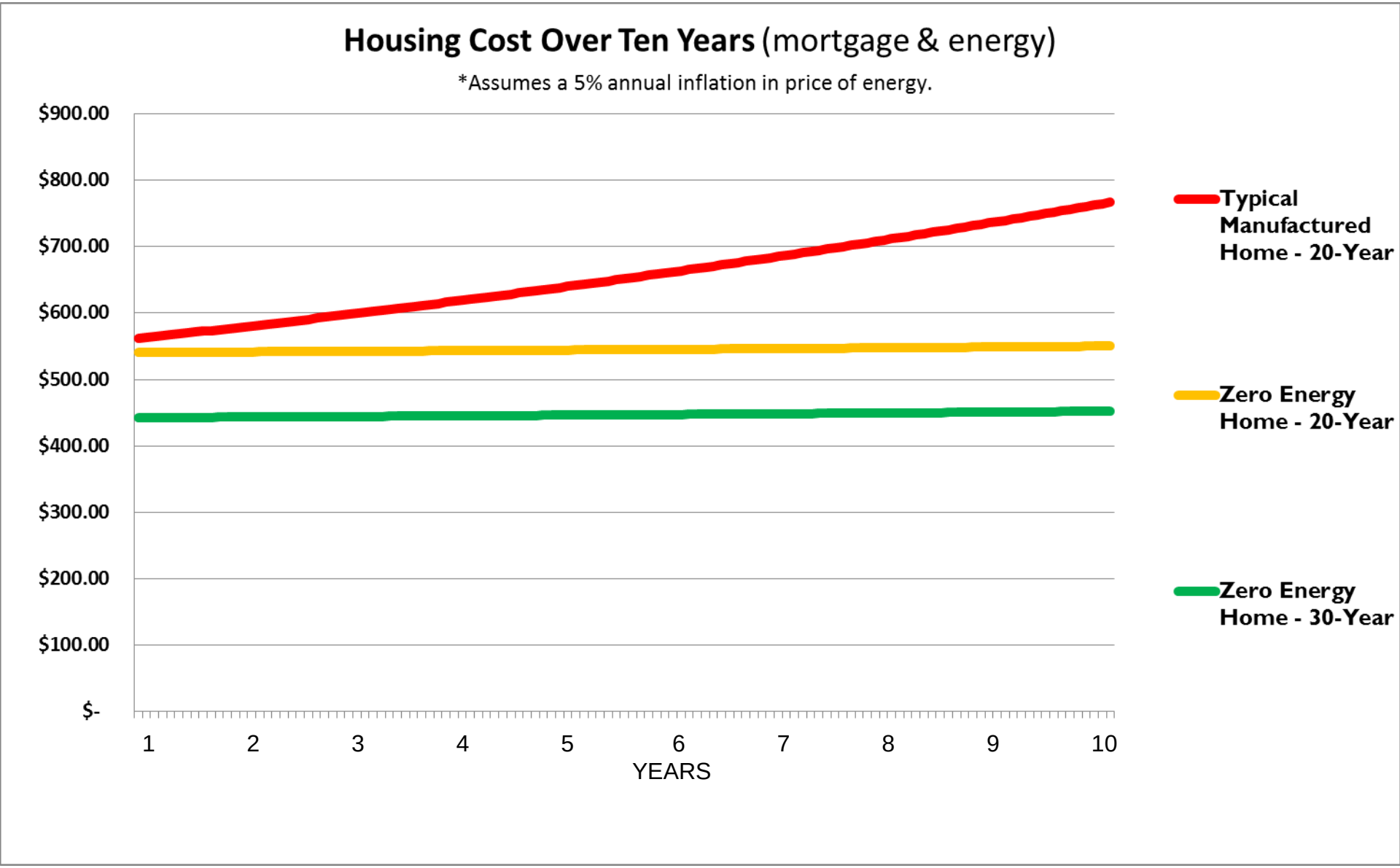


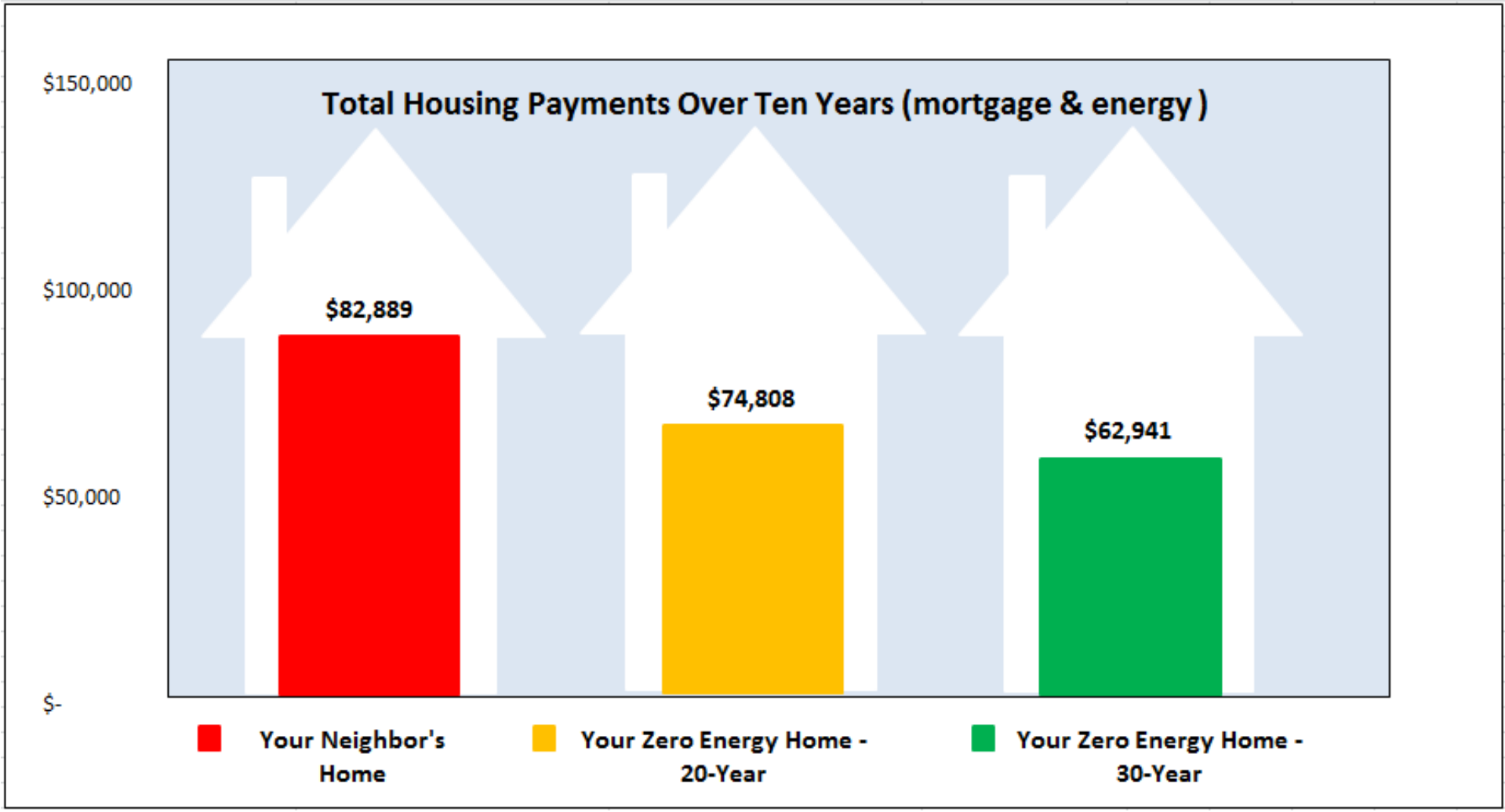
Sample Cost Comparison

	Traditional Manufactured Home	High Performance Home
Factory Home	$56,000	$105,000
Site Work	$12,000	$14,500
Delivery & Set	$2,000	$7,000
Solar Package (6kW)	$0	$14,000
VHFA Tax Credit*	($35,000)	($35,000)
Efficiency Vermont Incentive*	$0	($17,000)
Purchase Price	$35,000	$88,500
Annual Energy Cost	**$3,811**	**$180**
Down Payment	$3,500	$8,850
Interest Rate	7.00%	5.00%
Mortgage Term (years)	20	20

Cost Comparison




Housing Cost Over Ten Years (mortgage & energy)
*Assumes a 5% annual inflation in price of energy.
$900.00
$800.00
$700.00
$600.00
$500.00
$400.00
$300.00
$200.00
$100.00
$-
1
2
3
4
5
6
7
8
9
10
YEARS
Typical Manufactured Home - 20-Year
Zero Energy Home - 20-Year
Zero Energy Home - 30-Year


Total Housing Payments Over Ten Years (mortgage & energy)
$150,000
$100,000
$50,000
$-
$82,889
$74,808
$62,941
Your Neighbor's Home
Your Zero Energy Home - 20-Year
Your Zero Energy Home - 30-Year

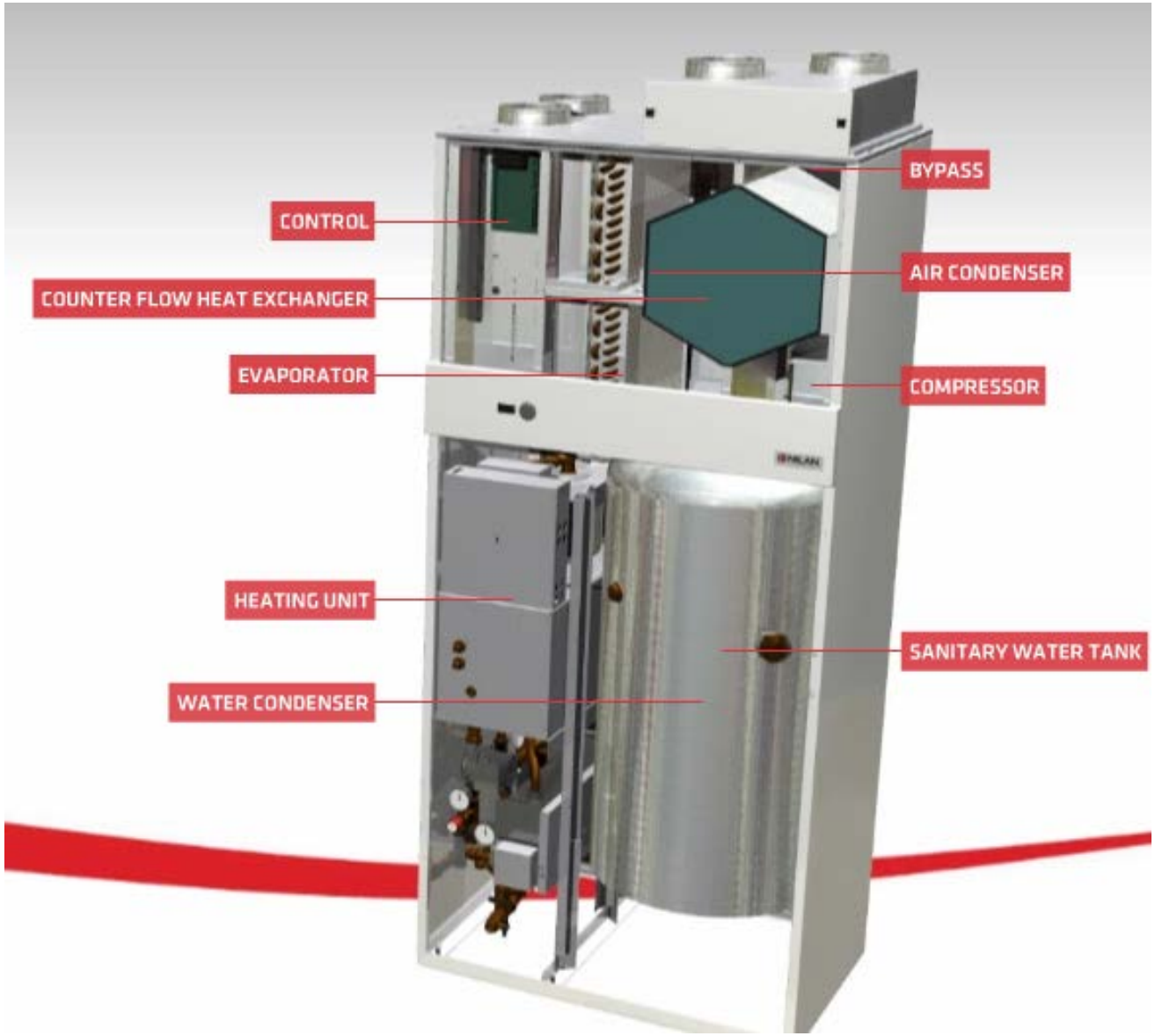
Future Plans - Financing

- Lenders will provide typical financing rates and terms to homeowners of high performance MH replacements.

- Working with appraisers to incorporate the Green & Energy Efficient Addendum and PV Value Tool and put a value on high performance features.

- Allocate more affordable housing subsidies to the rebuilding of our mobile home parks in a sustainable manner.
- Integrate on bill financing with our electric utilities.

Future Plans - HVAC



NILAN®
OUTSTANDING INDOOR CLIMATE

Future Plans - HVAC

Figur 1: CTS 602 Control Panel

DISCHARGE AIR

RETURN AIR

NILAN COMPACT P

1. Discharge air
2. Extract air
3. Supply air
4. Fresh air

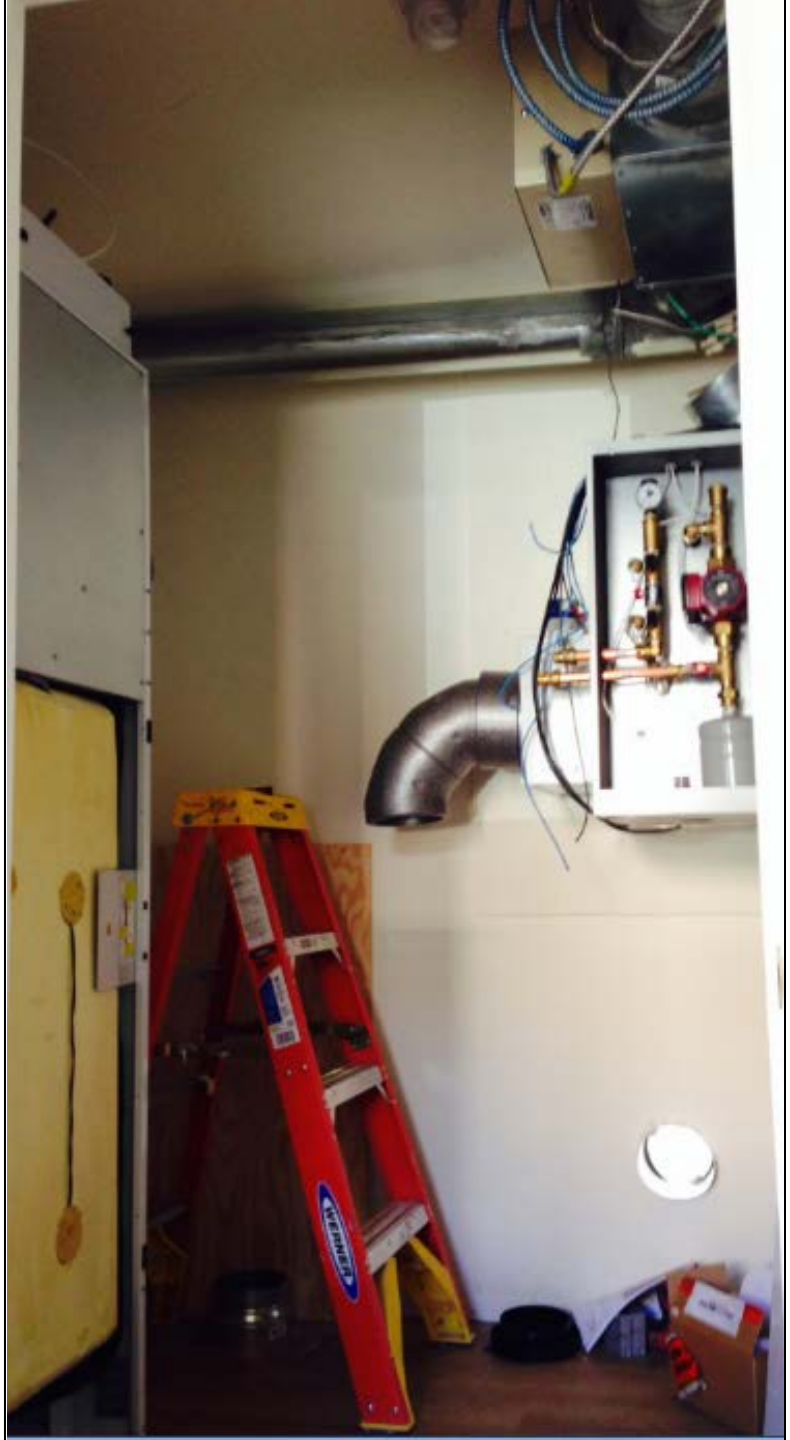
2kW DUCT HEATER

HOT WATER

300' of 1" PEX
GROUND LOOP

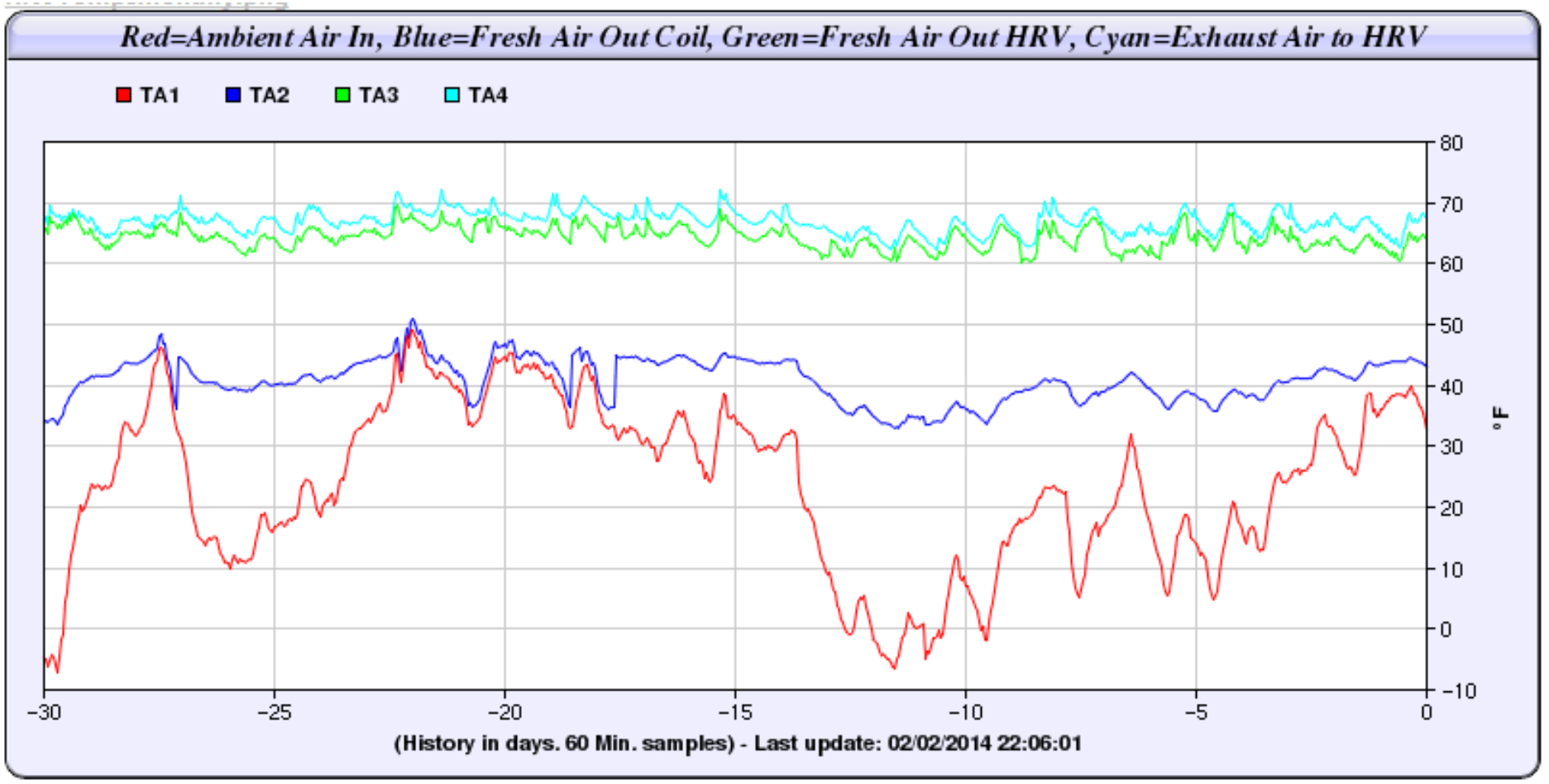
COMFOFOND SHX

FRESH AIR



Future Plans - HVAC

Future Plans - HVAC



Future Plans - HVAC

inView Passive™

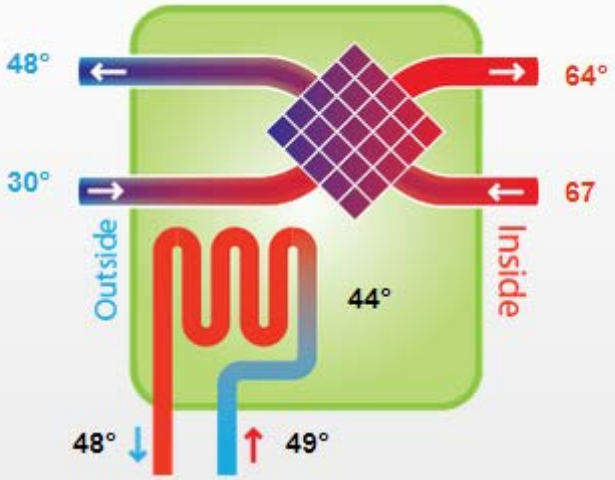
Passive House Dashboard

Welcome, Bill | Settings | Log Out

November 12, 2:54pm
High today 37°, Partly Cloudy

Tomorrow
34°, Partly Cloudy

Home | Bldg Environment | SHW Details | ERV Details



Day | Week | Month

Data	Min	Max	Avg
Temperature HRV Supply Air	59	65	63
Temperature Air out of Hx/Air into HRV	37	51	44
Temperature HRV Return Air	66	69	67
Temperature HRV Exhaust Air Out	40	51	47
Temperature SHX Glycol In	49	55	51
Temperature SHX Glycol Out	48	55	52
Temperature Fresh Air In	26	43	35
VOC Return Air	534	2078	1012
Relative Humidity Return Air	30	45	36

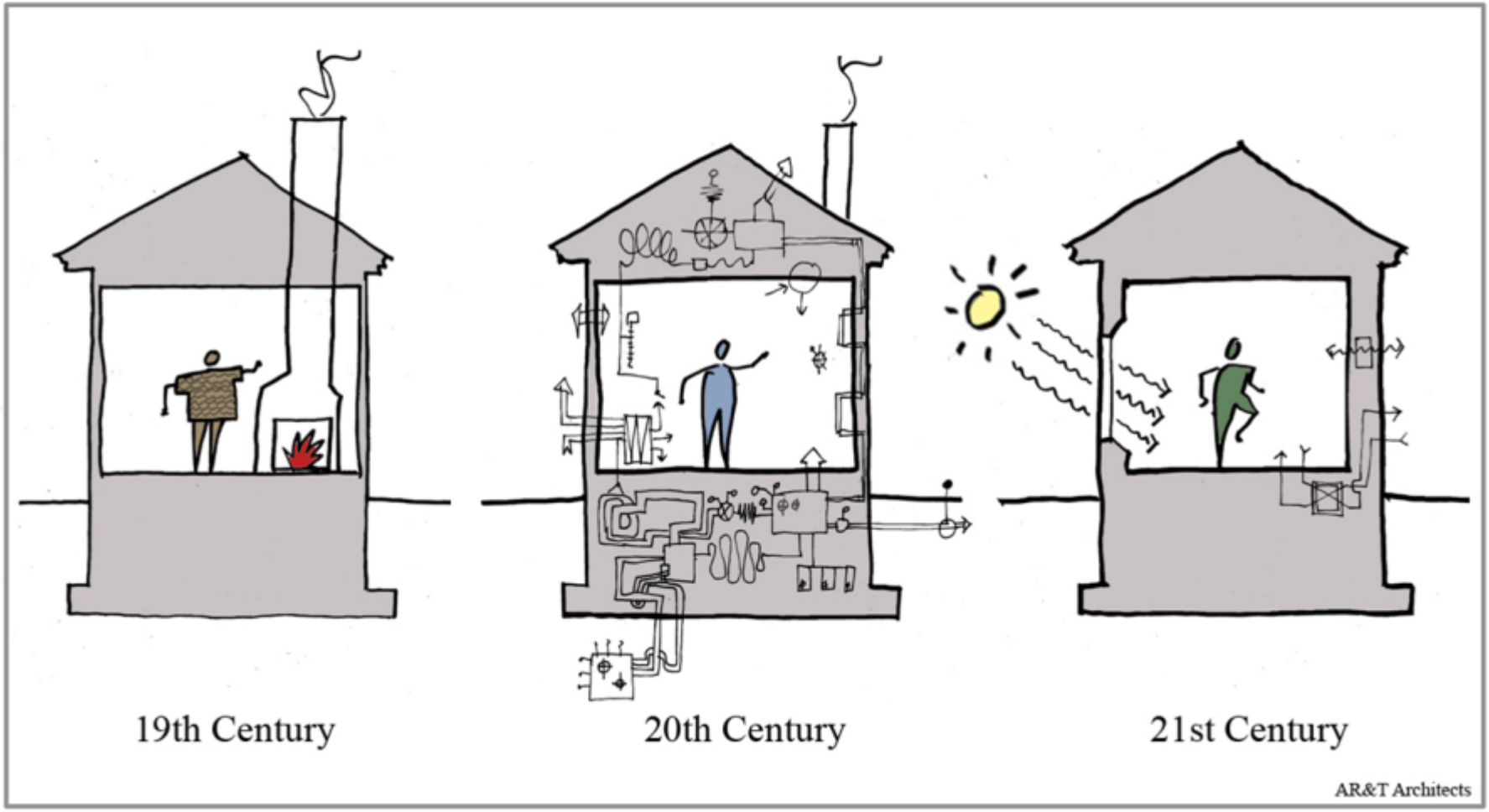
Future Plans - Design

MODERN VERSION

Efficiency Vermont
HIGH MEADOWS FUND
Vermont Housing & Conservation Board
VER MOD
pill-maharam architects
shelburne, vt
www.pillmaharam.com
PMa

High Performance Home
September 2014

Move Towards Simplicity



OPEN HOUSES

Daily at VERMOD - Wilder, VT

Data Collection

- Monitors ALL energy costs and all energy production
- Proactively alerts – safety, cost & appliance performance

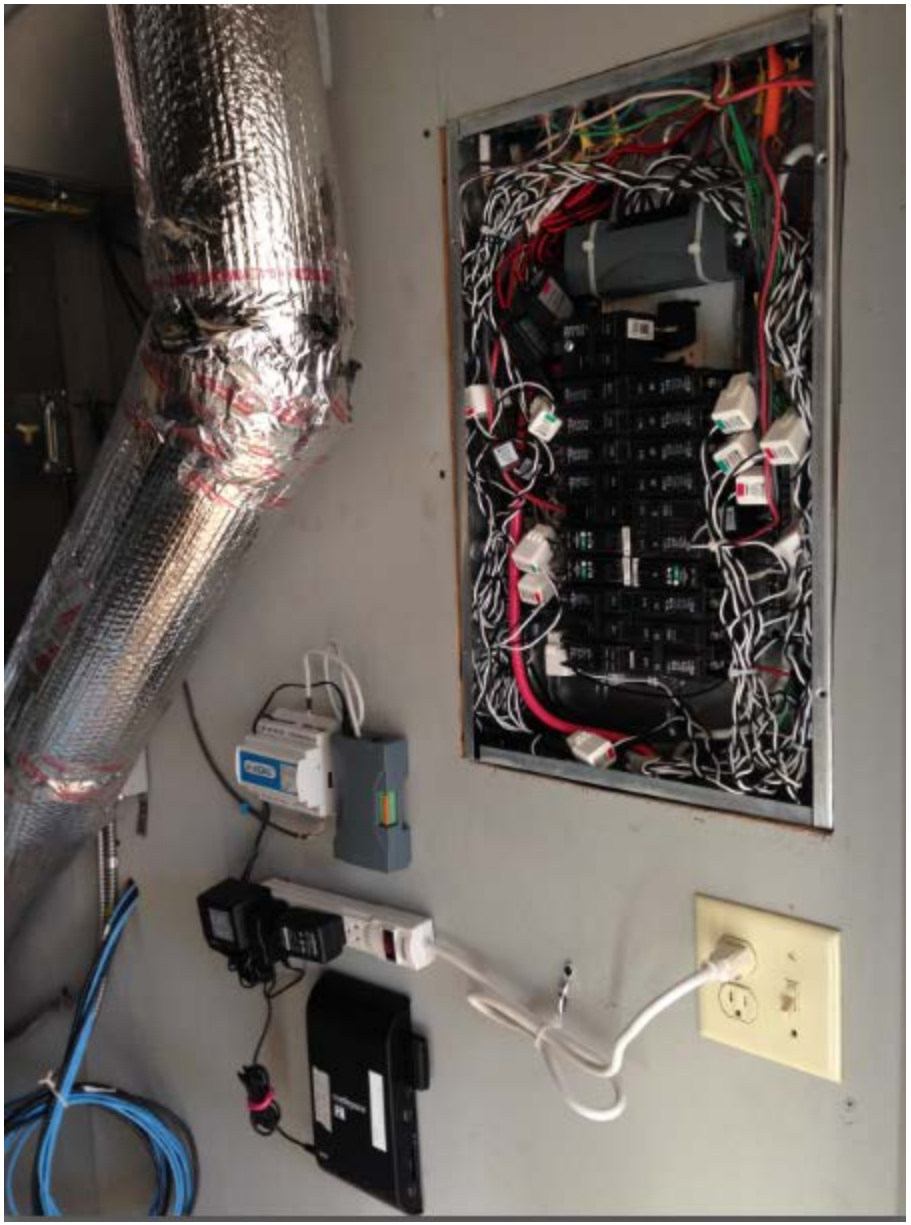
- Pinpoints major cost contributors with granular information
- Recommends targeted actions to save money
- Controls HVAC via Thermostats - the largest cost

- **Delivers Cost Savings + Peace-of-Mind**

Data Collection

- How much energy is required to heat and cool the house?
- How uniform is the temperature throughout the house?
- How much cooling/dehumidification and heating does the soil heat exchange system provide, net of the energy needed to run it?
- How much energy is saved through the HRV system and what is the recovery efficiency of the HRV?
- How much energy does the ventilation system require to run?
- How much energy does the hot water system require?
- How is the air quality of the house throughout the year (indicated by CO2 and VOC ppm)?
- What is the relative humidity level in the home?
- How much energy is each circuit using?

Data Collection



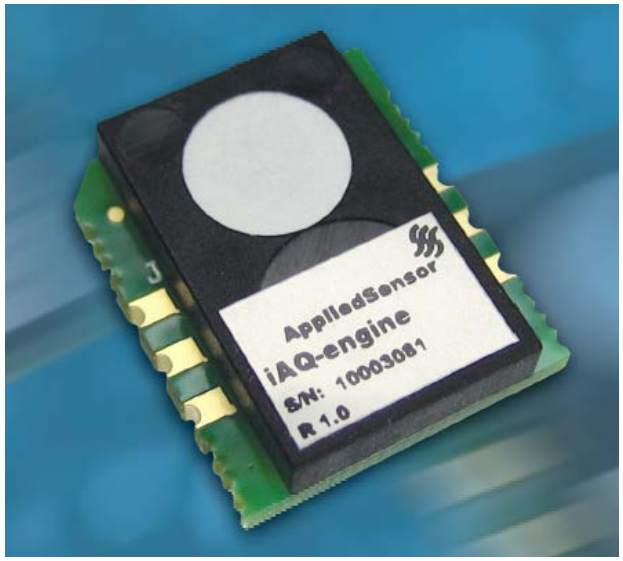
Data Collection

Equipment

One Wire Sensors

- ‘One wire’ digital sensors as opposed to analog
- High level of accuracy – Temp sensor is +/-.5C between -10C and 85C
- Thermometer resolution is +/- 1/16C
- Derives power from data line so no need for local power
- Can add sensors anywhere along the line

Equipment



IAQ Engine

- Sensor continually auto calibrates baseline to 450ppm based on cleanest air tracked.

- Senses volatile organic compounds that deteriorate air quality, especially perceived air quality.

- High correlation with CO_2 reported as CO_2 equivalents.

- Detects human VOC emissions for occupancy detection and odors - beyond CO_2.

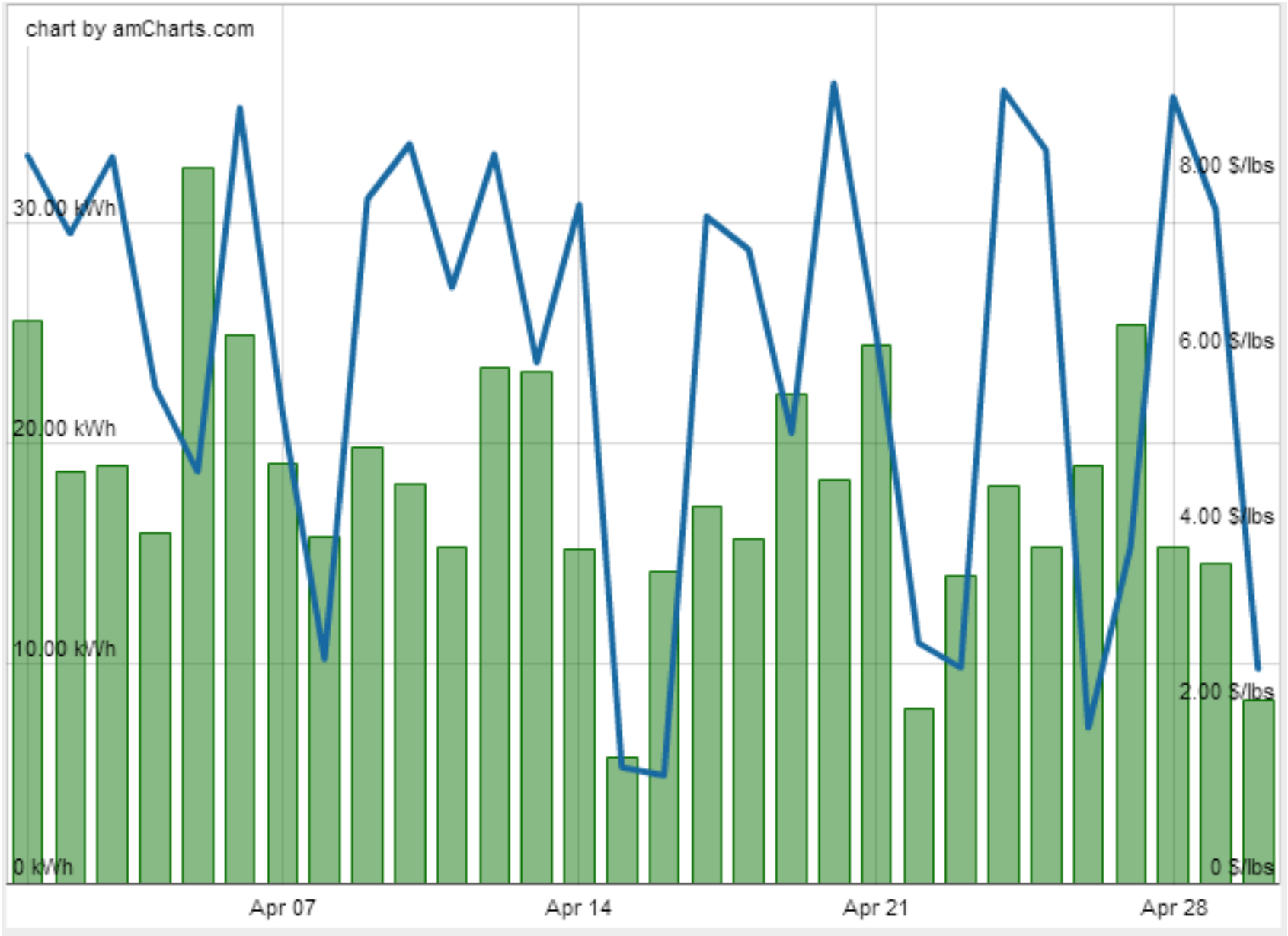
Equipment

IAQ Engine

Substances Detected

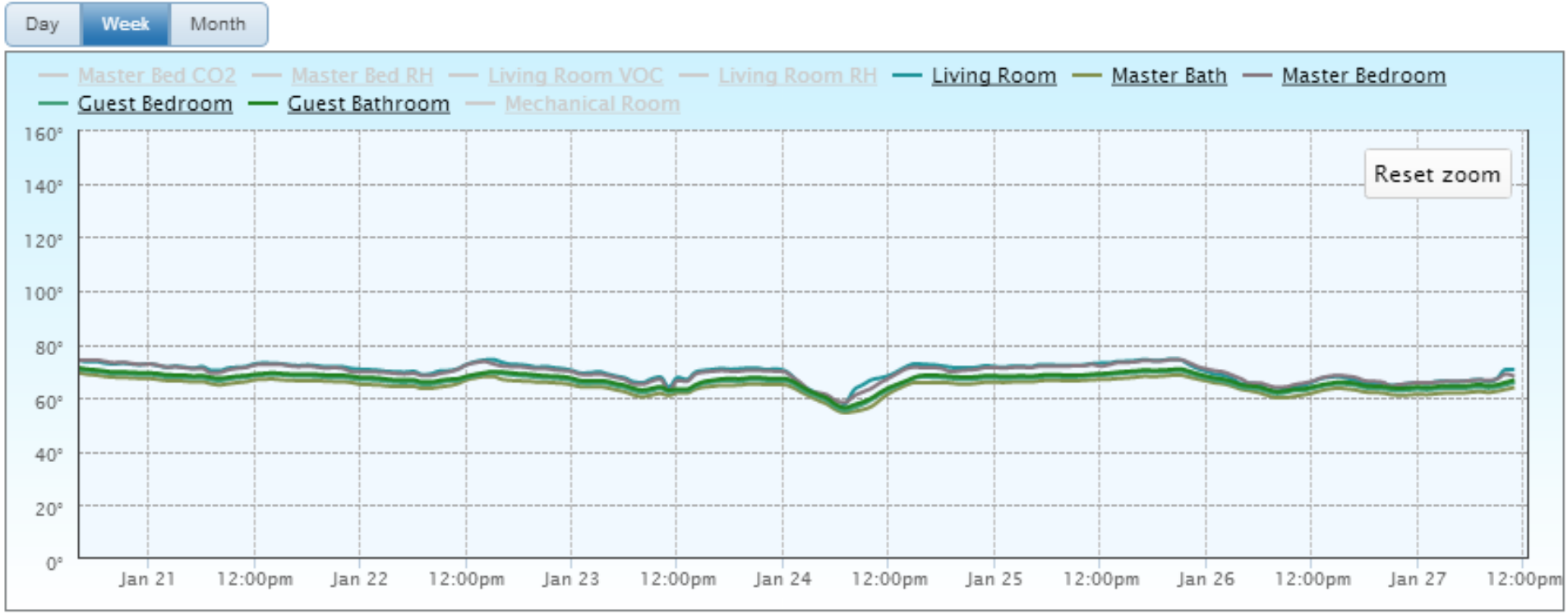
- Alcohols
- Aldehydes
- Aliphatic hydrocarbons
- Amines
- Aromatic hydrocarbons
- CO, CH4, LPG
- Ketones
- Organic acids

Data Collection

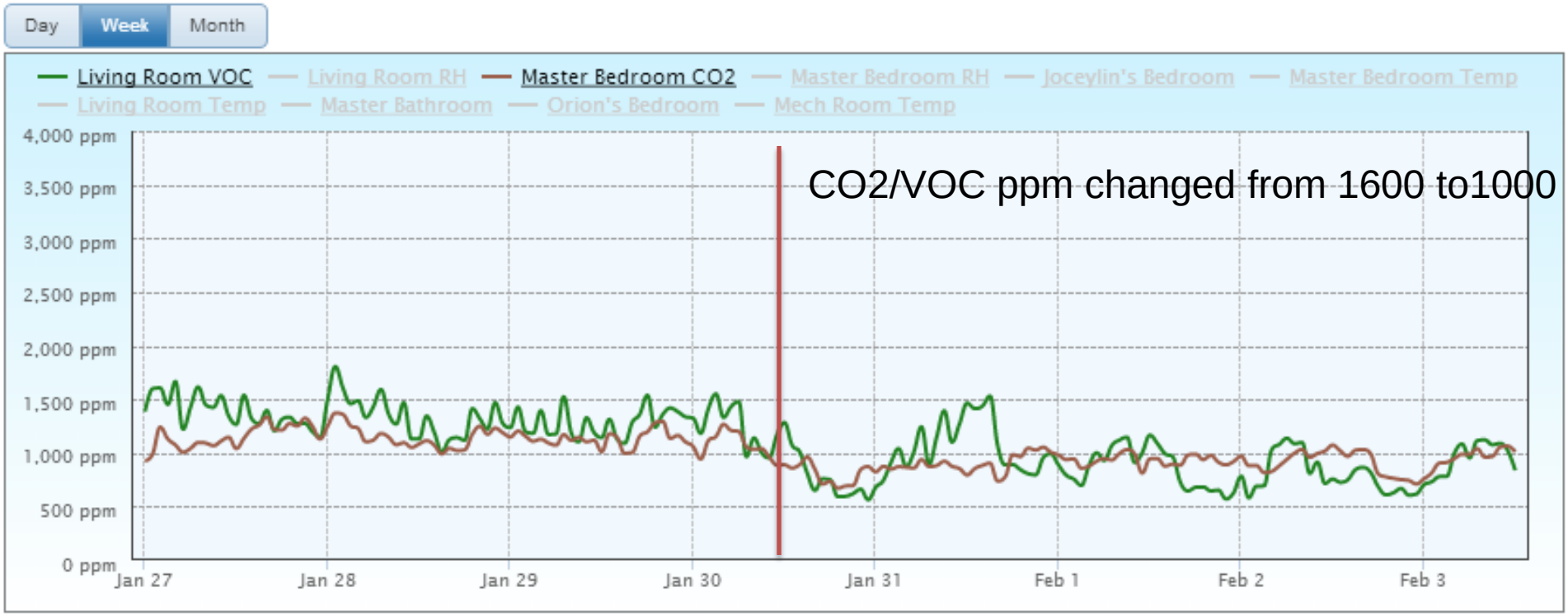


Data Collection

Performance - Comfort



Performance – Indoor Air Quality



Performance – Moisture at Exterior Sheathing