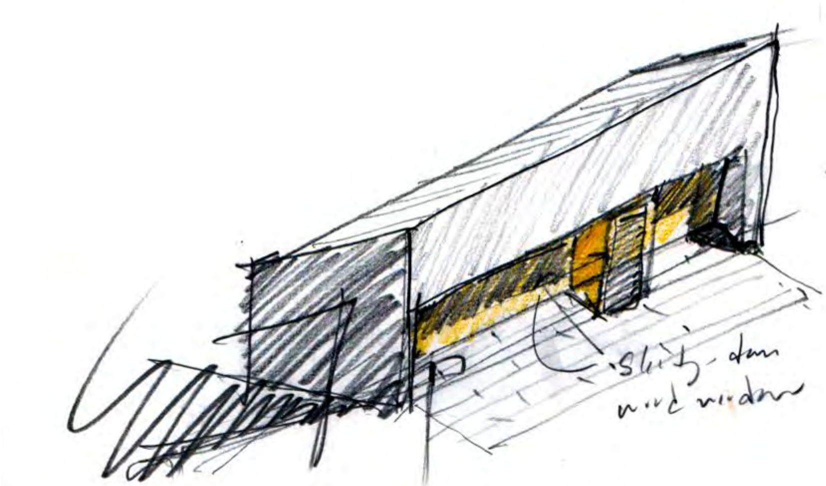
Case study of the Scranton Passive House

RPA

Richard Pedranti of Richard Pedranti Architect



Provider name and number, September 11, 2015

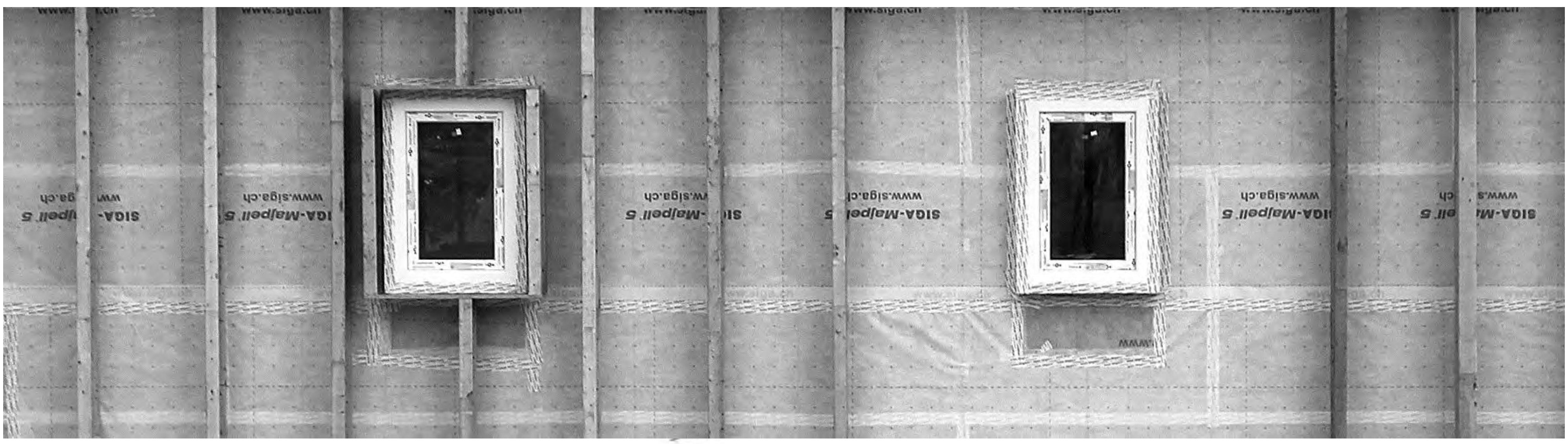
PHIUS

Presentation Outline

Case Study: Scranton Passive House

Design and construction

1. The use of Perlite under a slab foundation
2. Our experience with testing, failure, and remediation of leaky OSB
3. An affordable Passive House **IoT** monitoring system

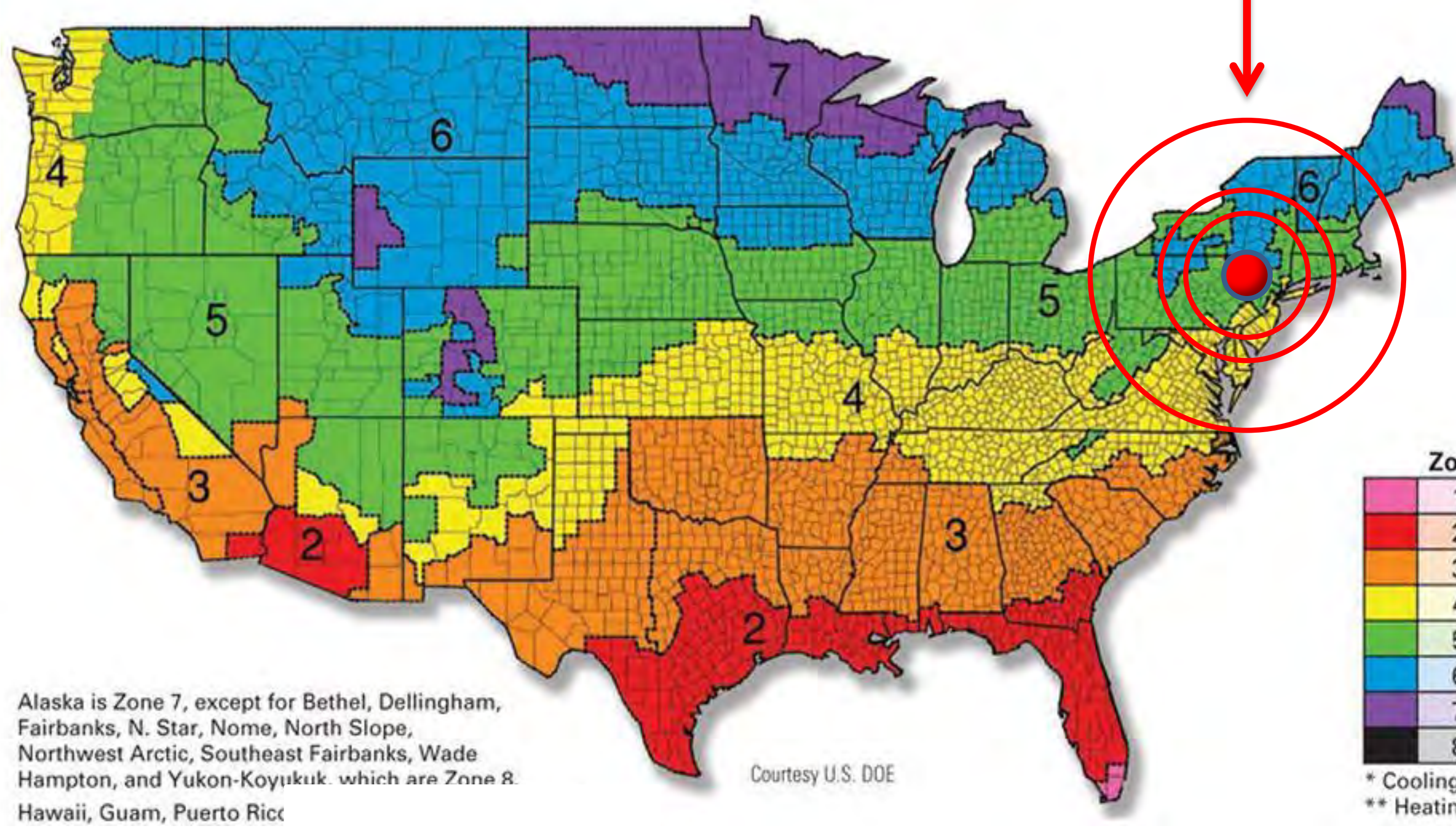


CLIMATE ZONE 5

MILFORD, PA

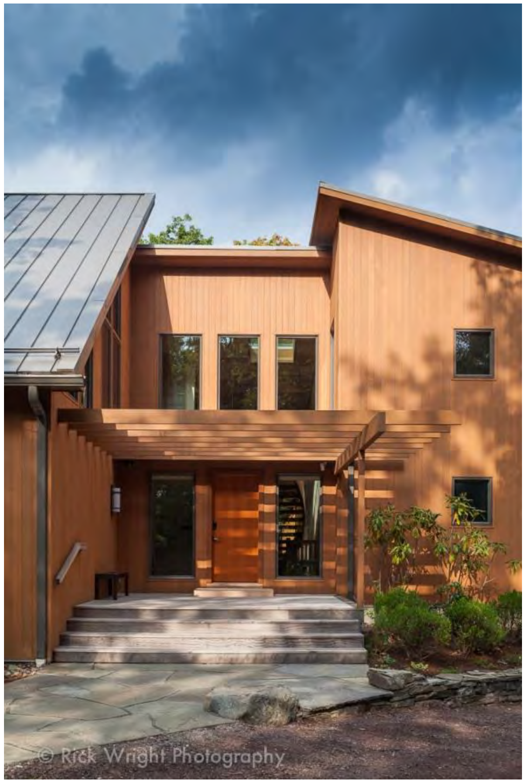
Birthplace of the American Conservation Movement

6400 HDD
600 CDD



Zone	Thermal Criteria: CDD 50° *	HDD 65° **
1	> 9000	–
2	6,300–9,000	–
3	4,500–6,300	–
4	< 4,500	< 5,400
5	–	5,400–7,200
6	–	7,200–9,000
7	–	9,000–12,600
8	–	> 12,600

* Cooling Degree Days over 50°F
** Heating Degree Days under 65°F


© Rick Wright Photography

THE SCRANTON PASSIVE HOUSE

Katie, Christie, Amanda, and Declan

Design Program

1. A simple, functional, and beautiful home for family of 4

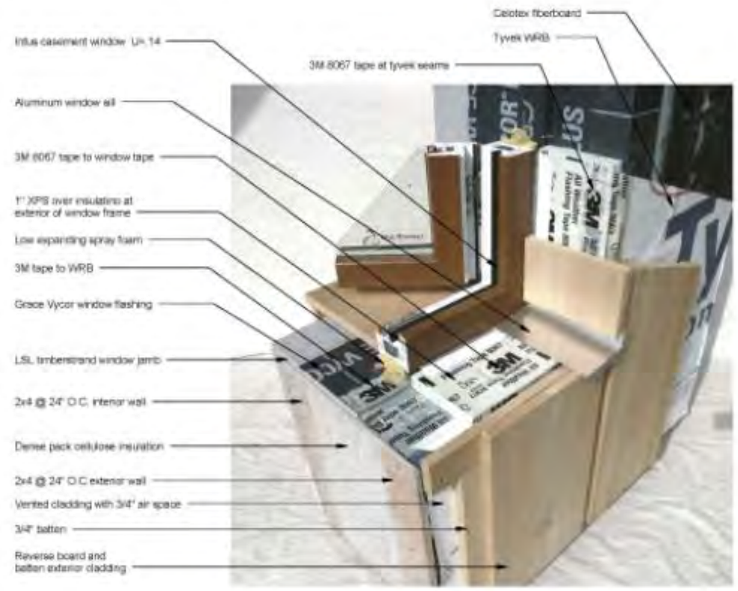
2. A sustainable and energy efficient home

3. A construction budget of $150 per square foot

View of Scranton Breaker 1836

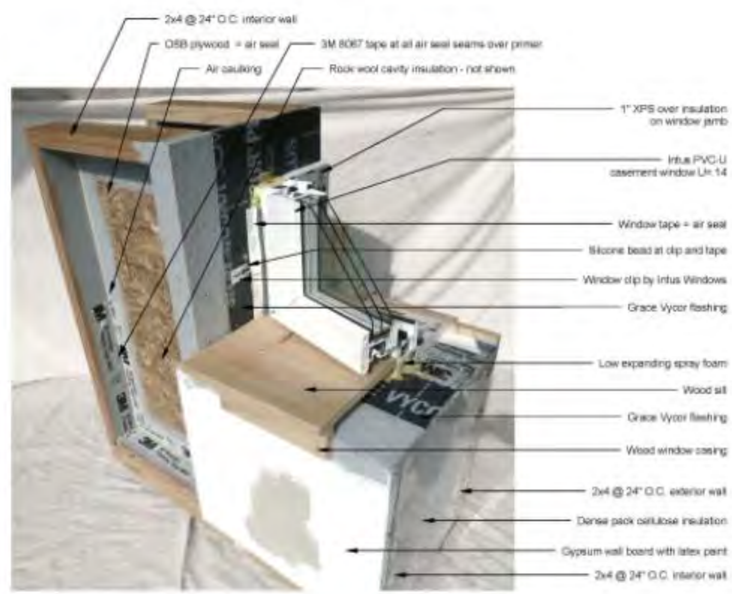
SCRANTON PASSIVE HOUSE

1/A13 Exterior view from the northeast



4/A12 Detail View of window installtion from the inside

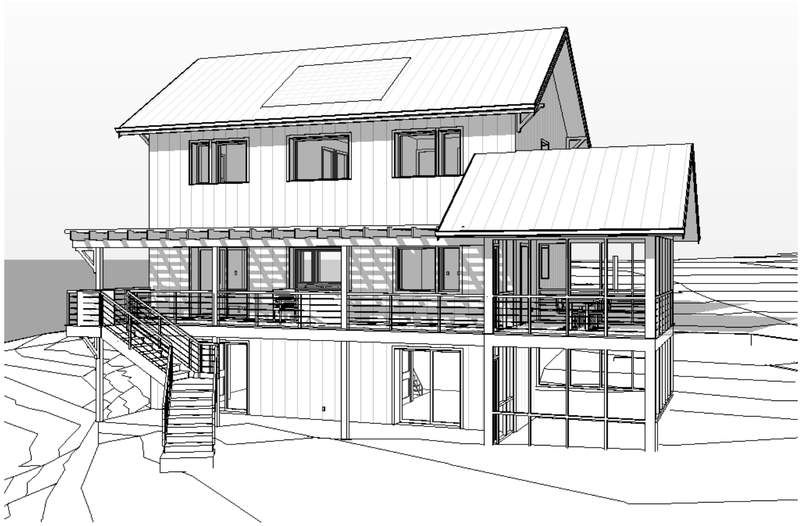
2/A13 Exterior view from the southeast

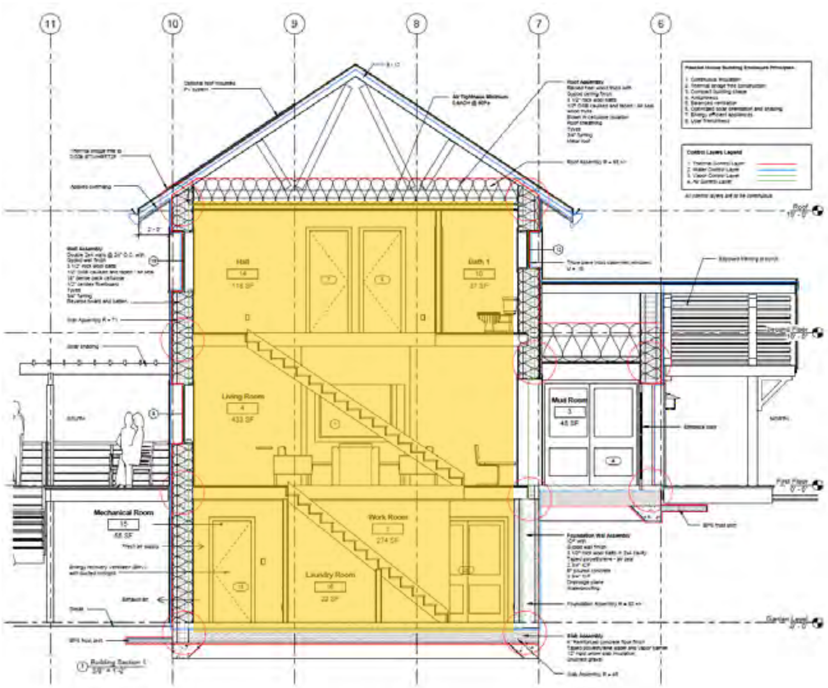


3/A12 Detail View of window installtion from the inside

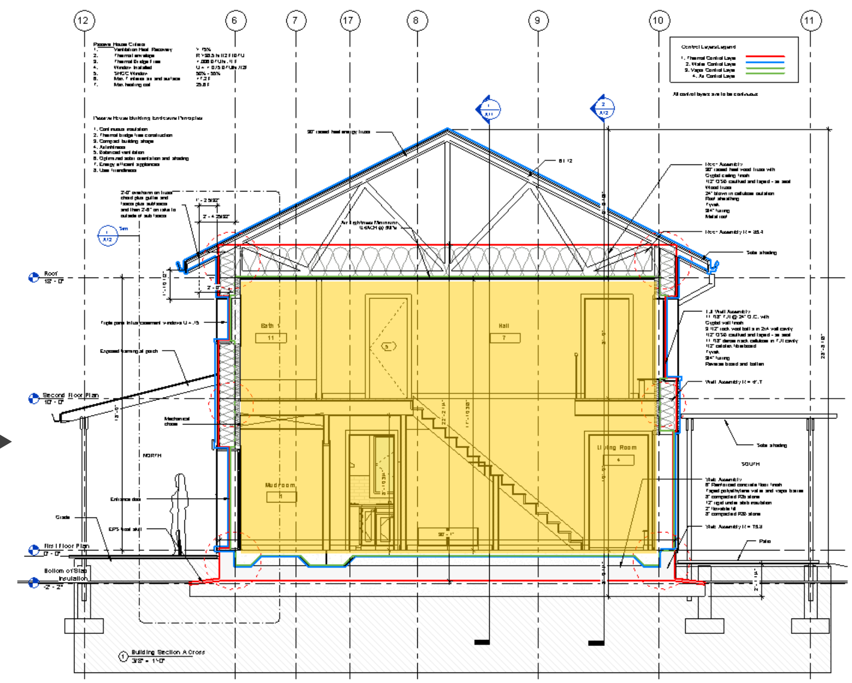
SCRANTON PASSIVE HOUSE

Design 1





Design 2



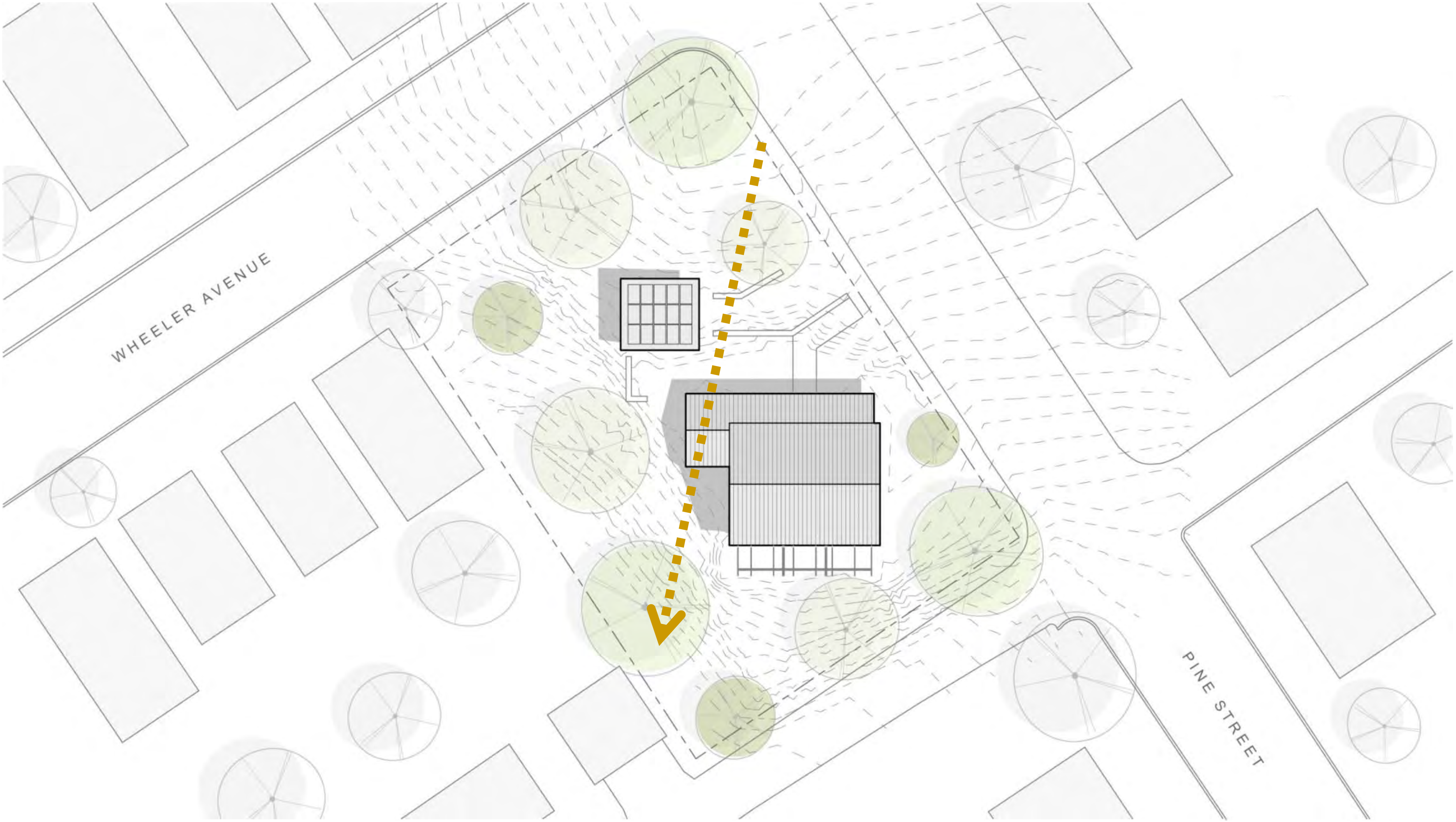
From
3 story
To
2 story

SCRANTON PASSIVE HOUSE

Southeast view of the Scranton Passive House

www.scrantonpassivehouse.com

SCRANTON PASSIVE HOUSE



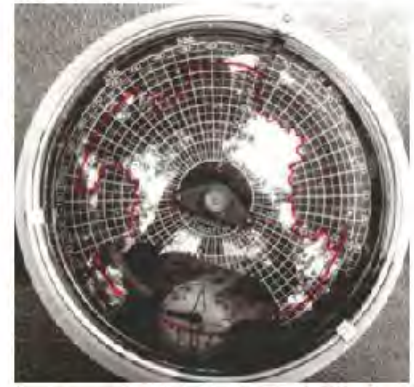
Site Plan

SCRANTON PASSIVE HOUSE

SOUTH Solar Pathfinder Photo at 11AM on March 27, 2013

	6		7		8		9		10		11		12		1		2		3		4		5		6		7		Site %
DEC					[illegible]	3	4	[illegible]	[illegible]	7	7	8	8	[illegible]	8	7	7	6	[illegible]	4	3	[illegible]							84
JAN					[illegible]	3	4	[illegible]	[illegible]	7	7	8	8	[illegible]	8	7	7	6	[illegible]	4	3	[illegible]							84
NOV				[illegible]	2	3	4	[illegible]	[illegible]	7	7	7	8	[illegible]	7	7	7	6	[illegible]	4	3	2	[illegible]						86
FEB				[illegible]	2	3	4	[illegible]	[illegible]	7	7	7	8	[illegible]	[illegible]	7	7	6	[illegible]	4	3	2	[illegible]						82.5
OCT				2	2	3	4	[illegible]	[illegible]	6	7	7	8	[illegible]	[illegible]	7	4	[illegible]	[illegible]	4	3	2	2						81.5
MAR			[illegible]	2	2	3	4	[illegible]	[illegible]	6	7	7	7	[illegible]	[illegible]	7	6	6	[illegible]	4	3	2	2	1					84.5
SEP			[illegible]	1	2	3	4	[illegible]	[illegible]	6	7	7	7	[illegible]	[illegible]	7	6	[illegible]	[illegible]	4	3	2	2	1					80.7
APR			[illegible]	1	2	3	4	5	6	6	7	7	7	7	7	7	6	6	[illegible]	4	3	2	2	1					96
AUG			[illegible]	1	2	3	4	5	6	6	7	7	7	7	7	7	6	[illegible]	[illegible]	4	3	2	2	1					93
MAY			[illegible]	1	[illegible]	3	4	5	6	6	7	7	7	7	7	7	6	[illegible]	[illegible]	4	3	2	2	1					92
JUL			[illegible]	1	[illegible]	3	4	5	6	6	7	7	7	7	7	7	6	[illegible]	[illegible]	4	3	2	2	1					92
JUN		[illegible]	[illegible]	2	2	3	4	5	6	6	6	7	7	7	7	6	6	[illegible]	[illegible]	4	3	2	2	1	1				93.5
																												Winter	84.9
																												Summer	89.2

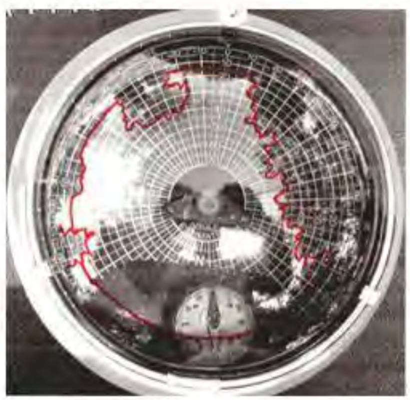
EAST Solar Pathfinder Photo at 1PM on May 20, 2013



15 degree horizon and 30% shading

	6		7		8		9		10		11		12		1		2		3		4		5		6		7		Site %
DEC					2	3	4	5	6	7	3.5	8	8	8	8	7	7	6	5	4	3	2							96.5
JAN					2	3	4	5	6	7	3.5	8	8	8	8	7	7	6	5	4	3	2							96.5
NOV				1	2	3	4	5	6	7	3.5	7	8	8	7	7	7	6	5	4	3	2	1						96.5
FEB				1	2	3	4	[illegible]	6	7	3.5	7	8	8	7	7	7	6	5	4	3	2	1						94
OCT				2	2	3	4	[illegible]	6	6	3.5	7	8	8	7	7	6	6	5	4	3	2	2						94
MAR			1	2	2	3	4	[illegible]	6	6	3.5	7	7	7	7	7	6	6	5	4	3	2	2	1					94
SEP			1	[illegible]	2	3	4	[illegible]	6	6	7	7	7	7	7	7	6	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					89.5
APR			1	[illegible]	2	3	4	5	6	[illegible]	7	7	7	7	7	7	6	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					88
AUG			1	[illegible]	2	3	4	5	6	[illegible]	7	7	7	7	7	7	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					85
MAY			1	[illegible]	[illegible]	3	4	5	6	[illegible]	7	7	7	7	7	7	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					84
JUL			1	[illegible]	[illegible]	3	4	5	6	6	7	7	7	7	7	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					84
JUN		1	[illegible]	2	2	3	4	5	6	6	6	7	7	7	7	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1				95.5
																												winter	93.5
																												summ	87.9

NORTH Solar Pathfinder Photo at 1PM on May 20, 2013



15 degree horizon and 30% shading

	6		7		8		9		10		11		12		1		2		3		4		5		6		7		Site %
DEC					2	3	4	5	6	7	7	8	8	8	8	7	7	6	5	4	3	2							100
JAN					2	3	4	5	6	7	7	8	8	8	8	7	7	6	5	4	3	2							100
NOV				1	2	3	4	5	[illegible]	7	7	7	8	8	7	7	7	6	5	4	[illegible]	2	1						95.5
FEB				1	2	3	4	5	[illegible]	7	7	7	8	8	7	7	7	6	[illegible]	[illegible]	[illegible]	[illegible]	1						90
OCT				2	2	3	4	5	[illegible]	[illegible]	7	7	8	8	7	7	6	6	[illegible]	[illegible]	[illegible]	[illegible]	2						87
MAR			1	2	2	3	4	5	[illegible]	[illegible]	7	7	7	7	7	7	6	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					86
SEP			1	[illegible]	2	3	4	5	[illegible]	[illegible]	7	7	7	7	7	7	6	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					85
APR			1	[illegible]	2	3	4	5	[illegible]	[illegible]	7	7	7	7	7	7	6	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					85
AUG			1	[illegible]	2	3	4	5	6	6	7	7	7	7	7	7	6	6	5	[illegible]	3	[illegible]	[illegible]	1					95
MAY			1	[illegible]	[illegible]	3	4	5	6	6	7	7	7	7	7	7	6	6	5	4	3	[illegible]	[illegible]	1					96
JUL			1	[illegible]	[illegible]	3	4	5	6	6	7	7	7	7	7	7	6	6	5	4	3	[illegible]	[illegible]	1					96
JUN		1	1	2	2	3	4	5	6	6	6	7	7	7	7	6	6	6	5	4	3	[illegible]	[illegible]	1	1				98
																												winter	91.1
																												summ	93

WEST Solar Pathfinder Photo at 1PM on May 20, 2013

15 degree horizon and 30% shading

Blank form: 37-43 N Latitude

	6		7		8		9		10		11		12		1		2		3		4		5		6		7		Site %
DEC					2	3	4	5	6	7	7	8	8	8	8	7	7	6	5	4	3	2							100
JAN					2	3	4	5	6	7	7	8	8	8	8	7	7	6	5	4	3	2							100
NOV				1	2	3	4	5	6	7	7	7	8	8	7	7	7	6	5	4	3	2	1						100
FEB				1	2	3	4	5	6	7	7	[illegible]	8	8	7	7	7	[illegible]	[illegible]	4	3	2	1						91
OCT				2	2	3	4	5	6	6	7	[illegible]	8	8	7	7	6	[illegible]	[illegible]	4	3	2	2						91
MAR			1	2	2	3	4	5	6	6	7	[illegible]	7	7	7	7	6	6	5	4	3	2	2	1					96.5
SEP			1	2	2	3	4	5	6	6	7	[illegible]	7	7	7	7	6	6	5	4	3	[illegible]	[illegible]	1					94.5
APR			1	2	3	3	4	5	6	6	7	[illegible]	7	7	7	7	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					85.5
AUG			1	2	2	3	4	5	6	6	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	2	1					70
MAY			1	2	2	3	4	5	6	6	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	2	1					70
JUL			1	2	2	3	4	5	6	6	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	2	1					70
JUN		1	1	2	2	3	4	5	6	6	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	2	1	1				71
																												winter	94.8
																												summ	81.1

SCRANTON PASSIVE HOUSE

Optimized building morphology

Compact building form

Mechanical core

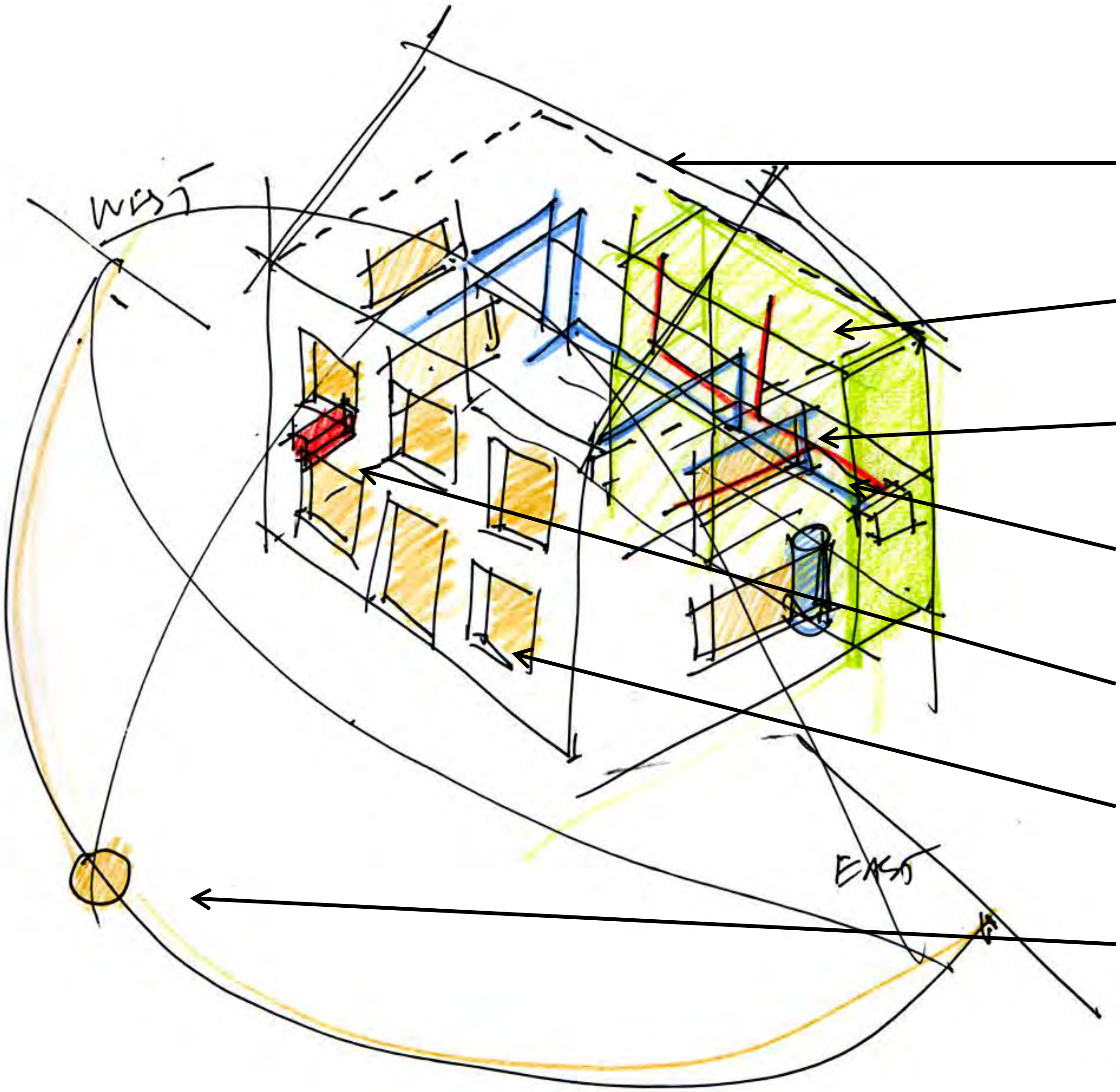
Simple ventilation layout

Efficient DHW piping

Careful placement of auxiliary heating / cooling

Careful window placement and sizes

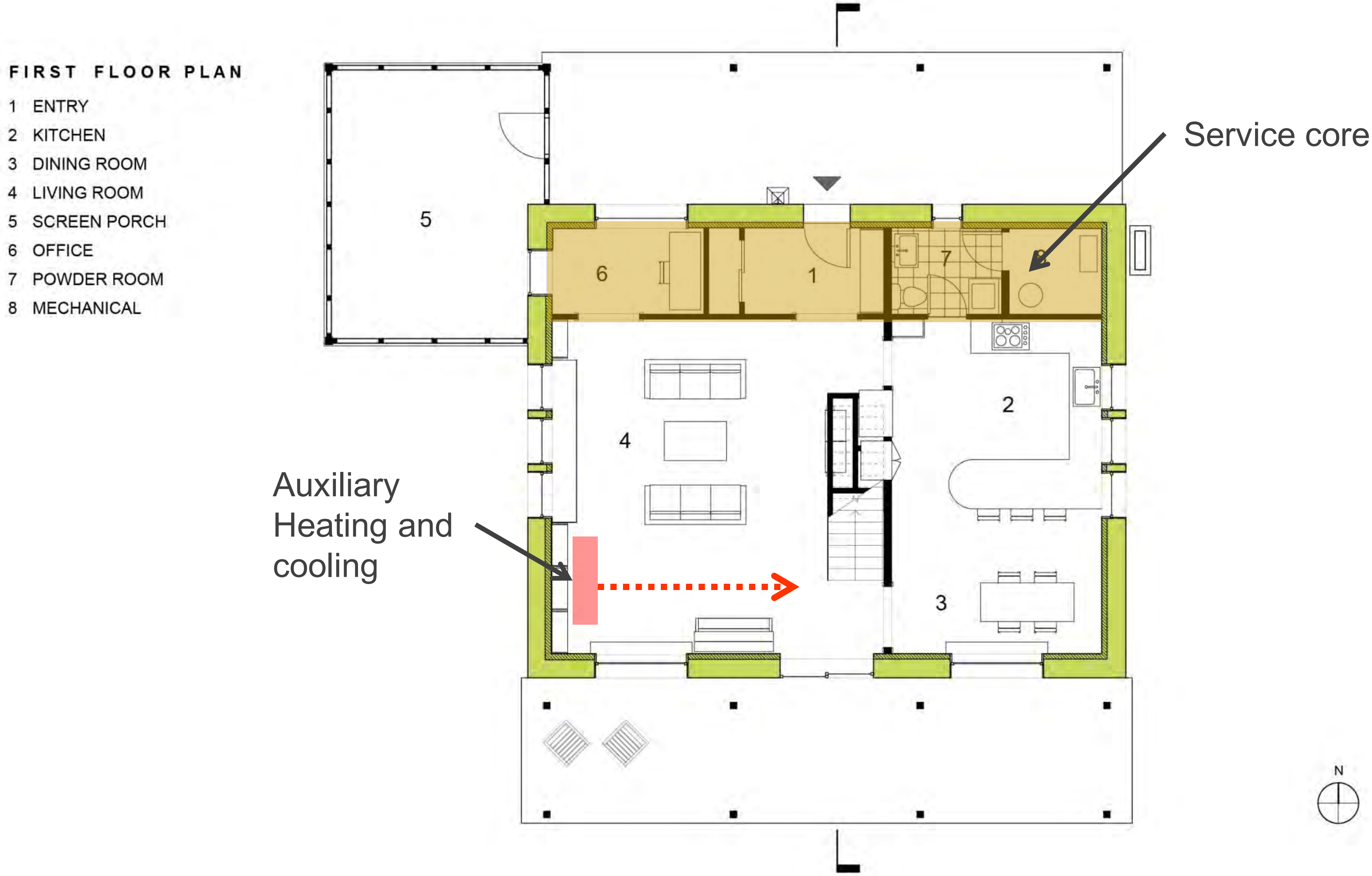
Optimized solar orientation



PHIUS

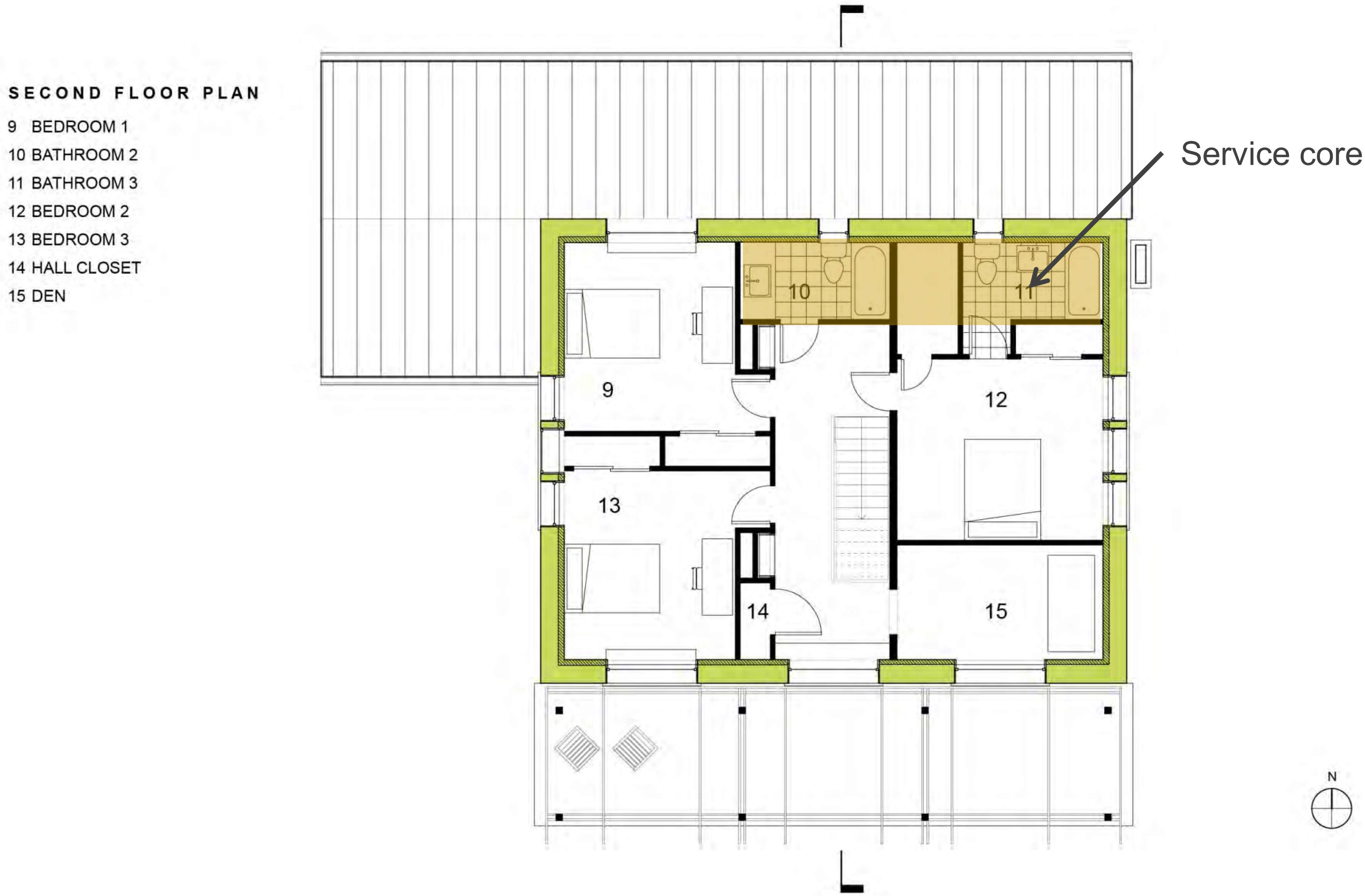
RPA

SCRANTON PASSIVE HOUSE



First Floor Plan

SCRANTON PASSIVE HOUSE

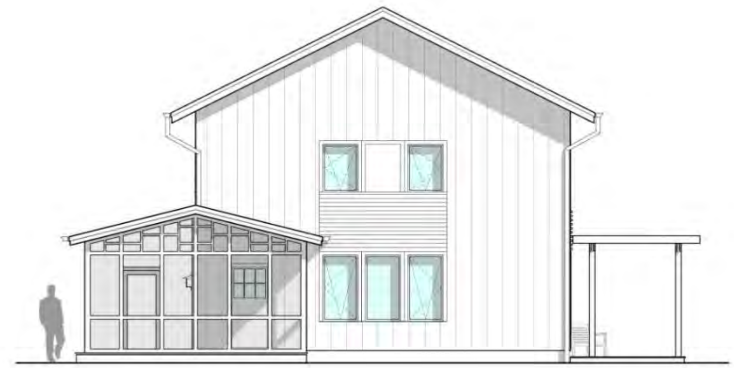


Second Floor Plan

SCRANTON PASSIVE HOUSE

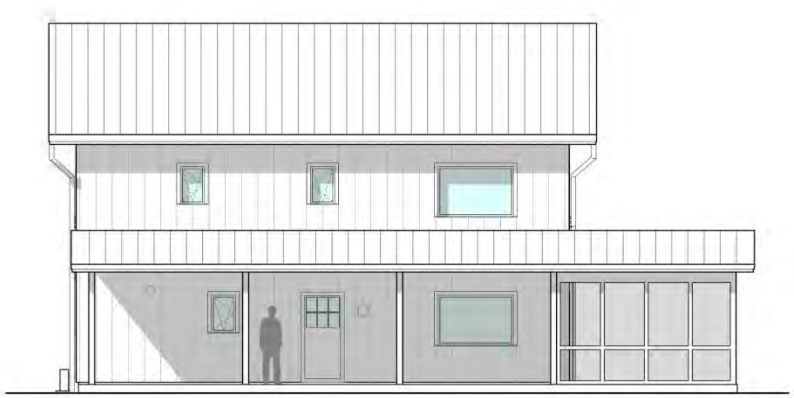
EAST ELEVATION

East Elevation



WEST ELEVATION

West Elevation



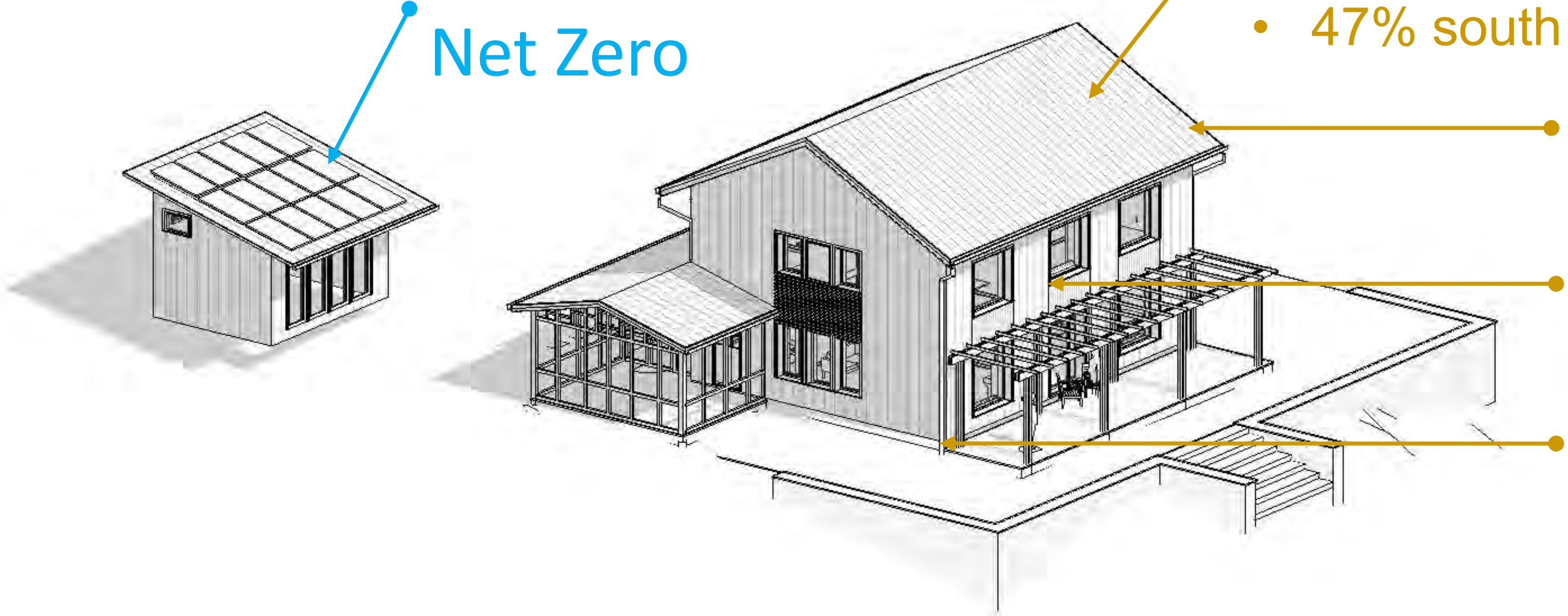
NORTH ELEVATION

North Elevation

SOUTH ELEVATION

South Elevation

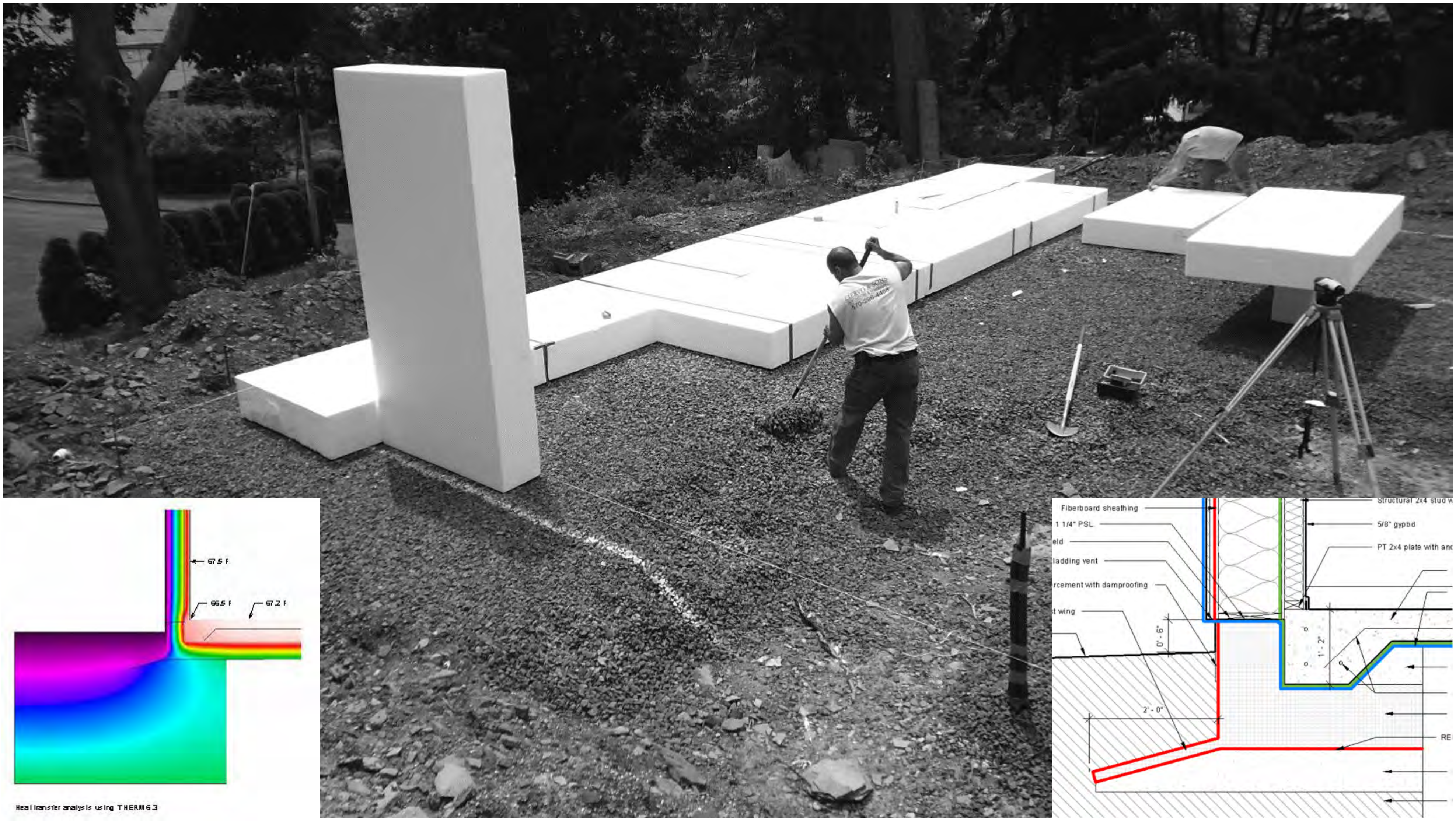
SCRANTON PASSIVE HOUSE



PASSIVE HOUSE METRICS

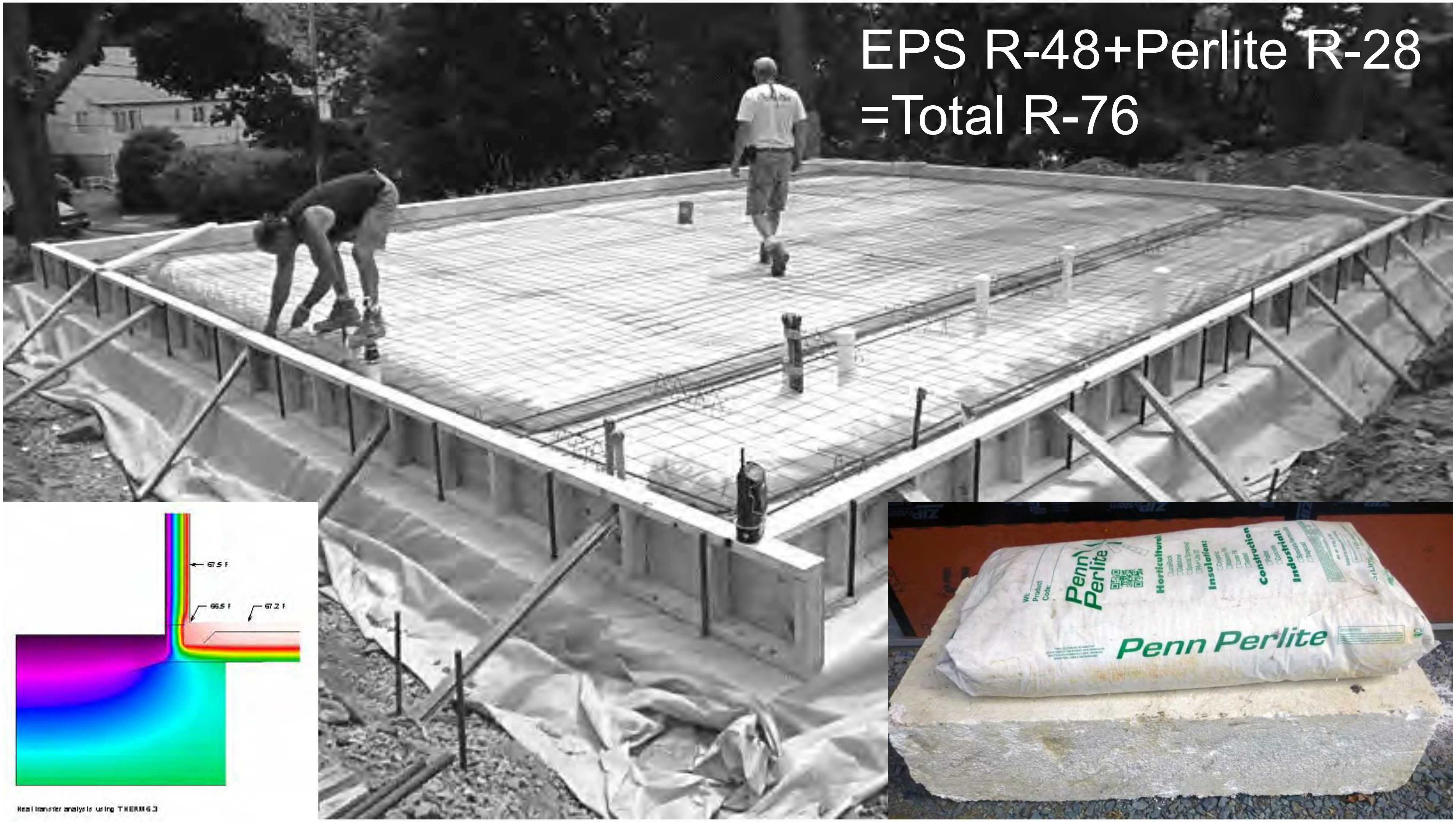
Heat Demand	4.16 kBTU/(ft2yr)
Heat Load	2.48 kBTU/(ft2hr)
Primary energy	31.4 kBTU/(ft2yr)

SCRANTON PASSIVE HOUSE



Installing 12” EPS foam over gravel setting bed

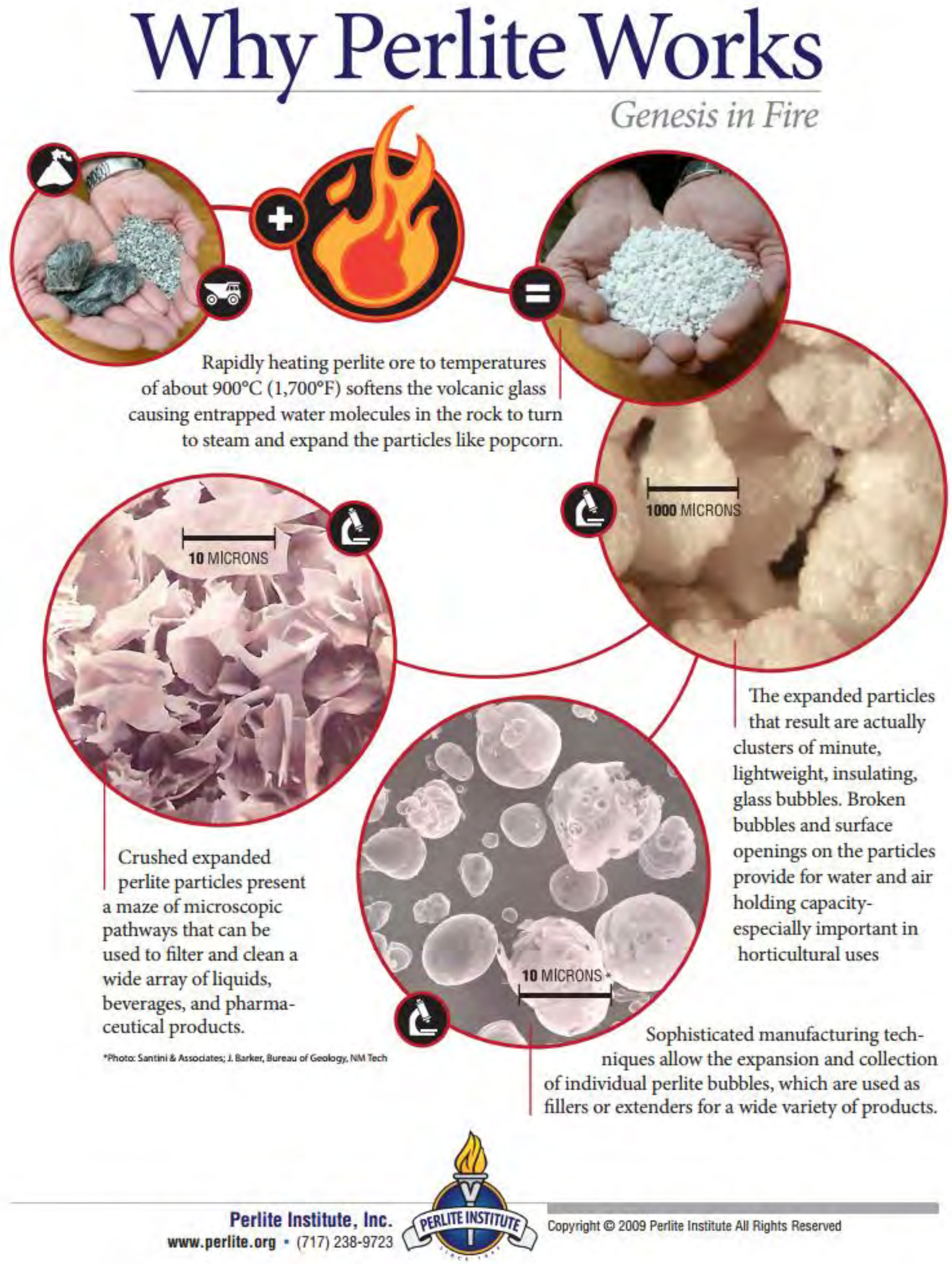
SCRANTON PASSIVE HOUSE



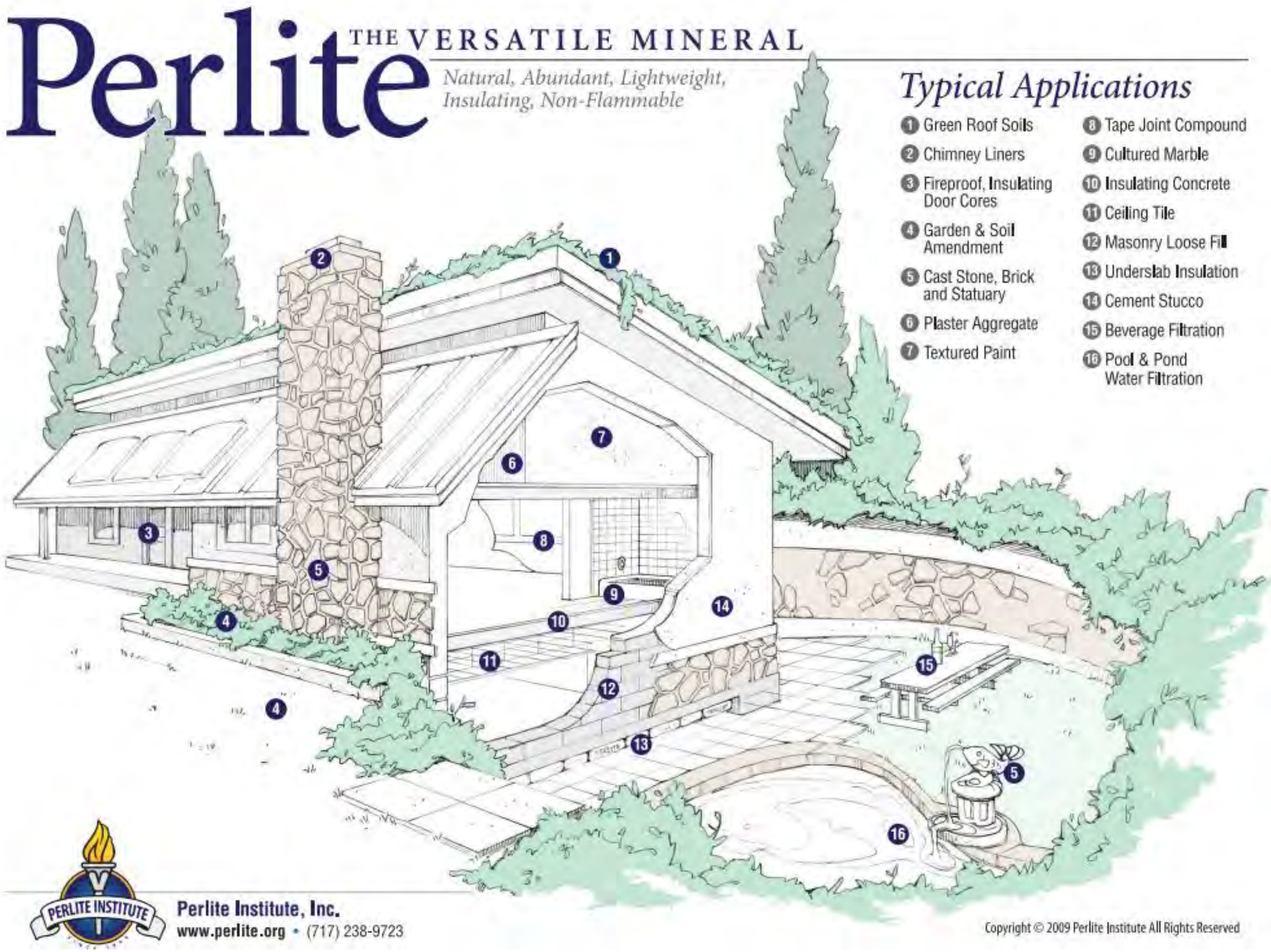
Formwork in place ready to pour concrete floor slab over 8” perlite and 12” of EPS Type 9 foam

Mining perlite rock

Forms of perlite



SCRANTON PASSIVE HOUSE



R-value = 3.7 per inch

Thermal conductivity at 75F
0.27-0.41 BTUin/hFT2F
0.04-0.06 W/mK

Physical Characteristics *of* Perlite

TYPICAL PHYSICAL PROPERTIES	
Color	White
Refractive Index	1.5
pH *(of water slurry)*	6.5 - 8.0
Free Moisture *(maximum)*	0.5%
Specific Gravity	2.2 - 2.4
Bulk Density *(loose weight)*	Expanded: 2 - 25 lb/ft³ 32-400 kg/m³ Crude Ore: 60 - 75 lbs/ft³ 960 - 1200 kg/m³
Mesh Sizes	Available as desired; 4 - 8 mesh and finer
Softening Point	1600 - 2000°F 871 - 1093°C
Fusion Point	2300 - 2450°F 1260 - 1343°C
Specific Heat	0.2 Btu/lb•F 837 J/kg•K
Thermal Conductivity at 75°F (24°C)	0.27 - 0.41 Btu•in/h•ft2•°F 0.04 - 0.06 W/m•K
Solubility	Soluble in hot concentrated alkali and HF; Moderately soluble (<10%) in 1N NaOH; Slightly soluble (<3%) in mineral acids (1N); Very slightly soluble (<1%) in water or weak acids

TYPICAL ELEMENTAL ANALYSIS	*parts per hundred*
Silicon	33.8
Aluminum	7.2
Potassium	3.5
Sodium	3.4
Iron	0.6
Calcium	0.6
Magnesium	0.2
Trace	0.2
Oxygen *(by difference)*	47.5
Net Total	97.0
Bound Water	3.0
Total	100.00

All analyses are shown in elemental form even though the actual forms present are mixed glassy silicates. Free silica may be present in small amounts, characteristic of the particular ore body. More specific information may be obtained from the ore supplier involved.

Perlite Institute, Inc.
www.perlite.org • (717) 238-9723

Underslab Insulation Using Perlite in Bags

Easy-to-install, light-weight bags are laid unopened below concrete floors

Concrete slab floors with direct thermal contact to the ground can present challenges to the maintenance of personal comfort in homes and add to heating bills. A solution to break that direct thermal contact is to use a natural insulative material such as perlite.

Top: placing unopened perlite bags on grade.
Above: perlite bags packed tightly in place.
Below: compacted gravel and hydronic heating tubing in place over perlite bag insulation; ready to pour the concrete floor.

Perlite conforming to ASTM C549, and provided in easy-to-install, light-weight bags (either plastic or paper) may be used as insulation below concrete floors as demonstrated in the accompanying photographs and schematic diagrams.

Perlite underslab insulation is a natural, inorganic product that does not rot, support combustion nor provide a habitat for rodents. Because of its neutral pH, the product does not foster corrosion in piping and electrical wiring that may be in the underfloor area.

Benefits from installation of such a system can accrue in both summer and winter. During winter, heat loss through the floor of a building can be decreased, while in summer, differences (continues)

EFFECTIVE R-VALUE OF PERLITE
THERMAL CONDUCTANCE/RESISTANCE

Section Thickness of Perlite Loose Fill Insulation		Thermal Conductance "C"		Thermal Resistance "R"	
U.S.	(SI)	U.S.	(SI)	U.S.	(SI)
1 in.	(2.5 cm)	0.32	(1.82)	3.13	(0.55)
2 in.	(5.1 cm)	0.16	(0.91)	6.25	(1.10)
3 in.	(7.6 cm)	0.11	(0.61)	9.37	(1.65)
4 in.	(10.2 cm)	0.08	(0.45)	12.50	(2.20)
5 in.	(12.7 cm)	0.06	(0.36)	15.63	(2.75)
6 in.	(15.2 cm)	0.05	(0.30)	18.75	(3.30)
7 in.	(17.7 cm)	0.045	(0.26)	21.88	(3.85)
8 in.	(20.3 cm)	0.04	(0.23)	25.00	(4.40)

* "C" values expressed in Btu/h • ft^2 • °F (W/m • K) were calculated using maximum thermal conductivity "k" factor or 0.32 Btu in/h • ft^2 • °F (0.046 W/m • K) at 75° F (24°C) mean temperature.

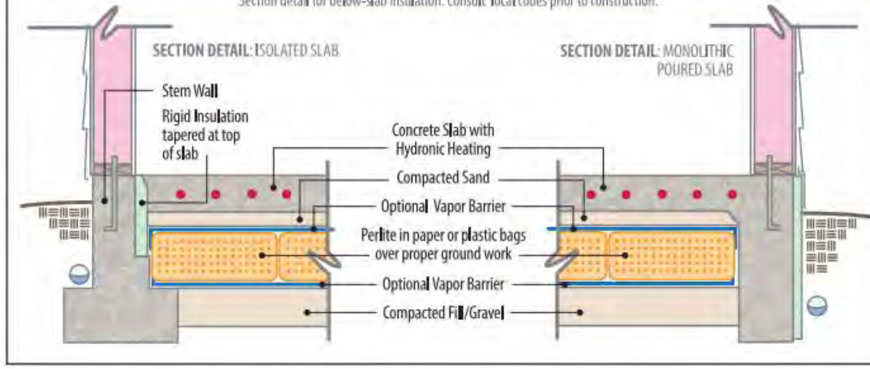
"R" values expressed in h • ft^2 • °F/Btu (K • m^2/W) were calculated using the formula R = 1/C.

Underslab Insulation Using Perlite in Bags

between floor and air temperatures are minimized and condensation on cool floors is avoided—providing a more comfortable and energy-efficient environment. This system is particularly useful when radiant under-floor heating is employed since the thermal resistance of the perlite will reduce heat loss from the heated slab to the ground below. In addition, perlite is dimensionally stable under varying temperatures and it is not combustible.

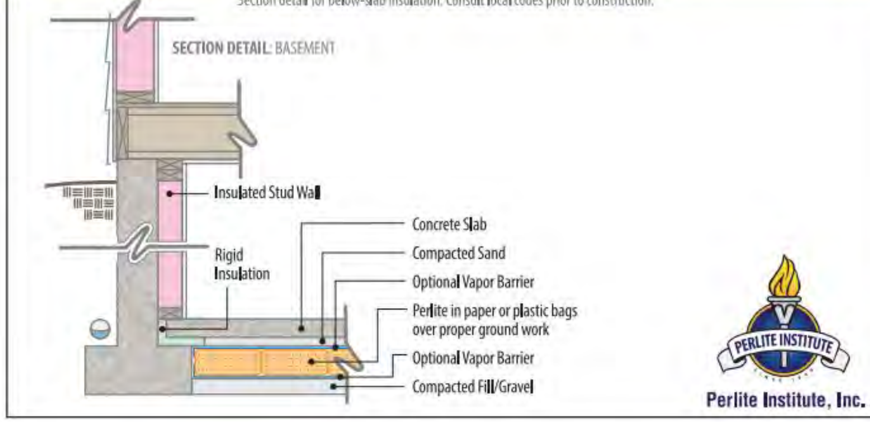
PERLITE BAGS BELOW HEATED SLAB-ON-GRADE FLOOR

Section detail for below-slab insulation. Consult local codes prior to construction.



PERLITE BAGS BELOW BASEMENT SLAB FLOOR

Section detail for below-slab insulation. Consult local codes prior to construction.



www.perlite.org • (717) 238-9723

Pennsylvania Perlite

www.pennperlite.com

Perlite Institute

www.perlite.org

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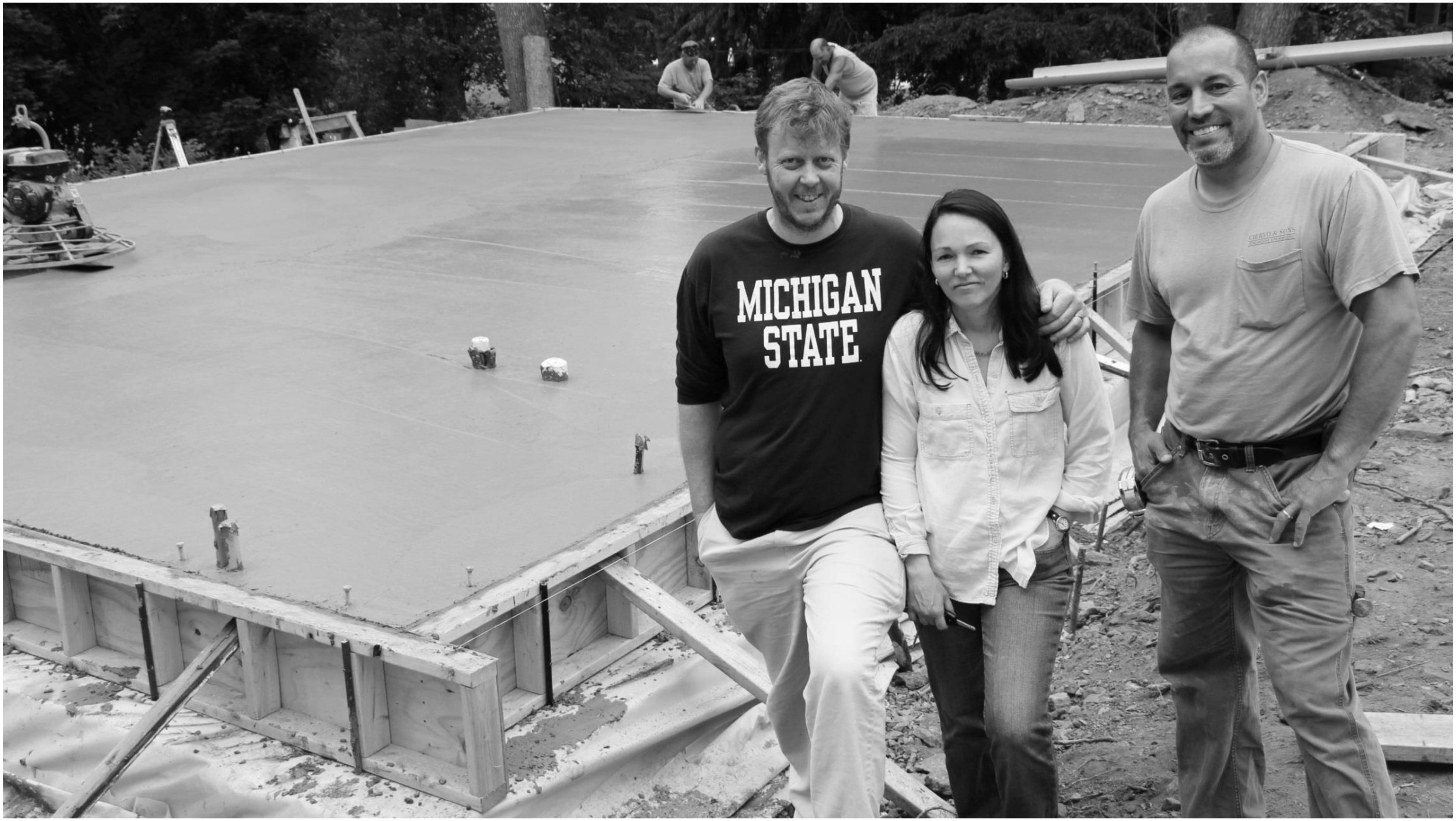
Pouring concrete floor slab over 8” perlite and 12” of EPS Type 9 foam

SCRANTON PASSIVE HOUSE



Homeowners Christie and Declan with contractor Rob Ciervo

SCRANTON PASSIVE HOUSE

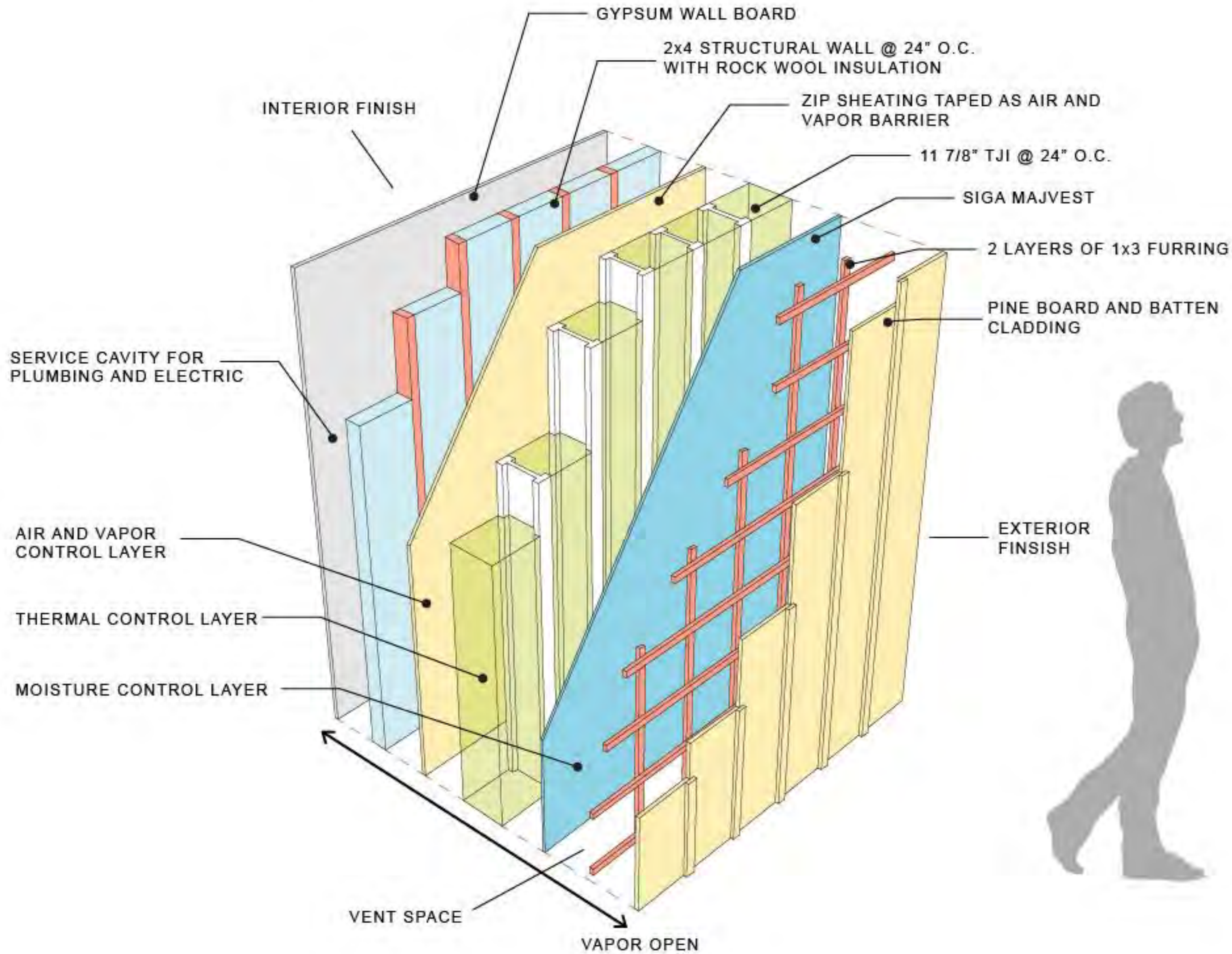
2x4 OVE structural frame

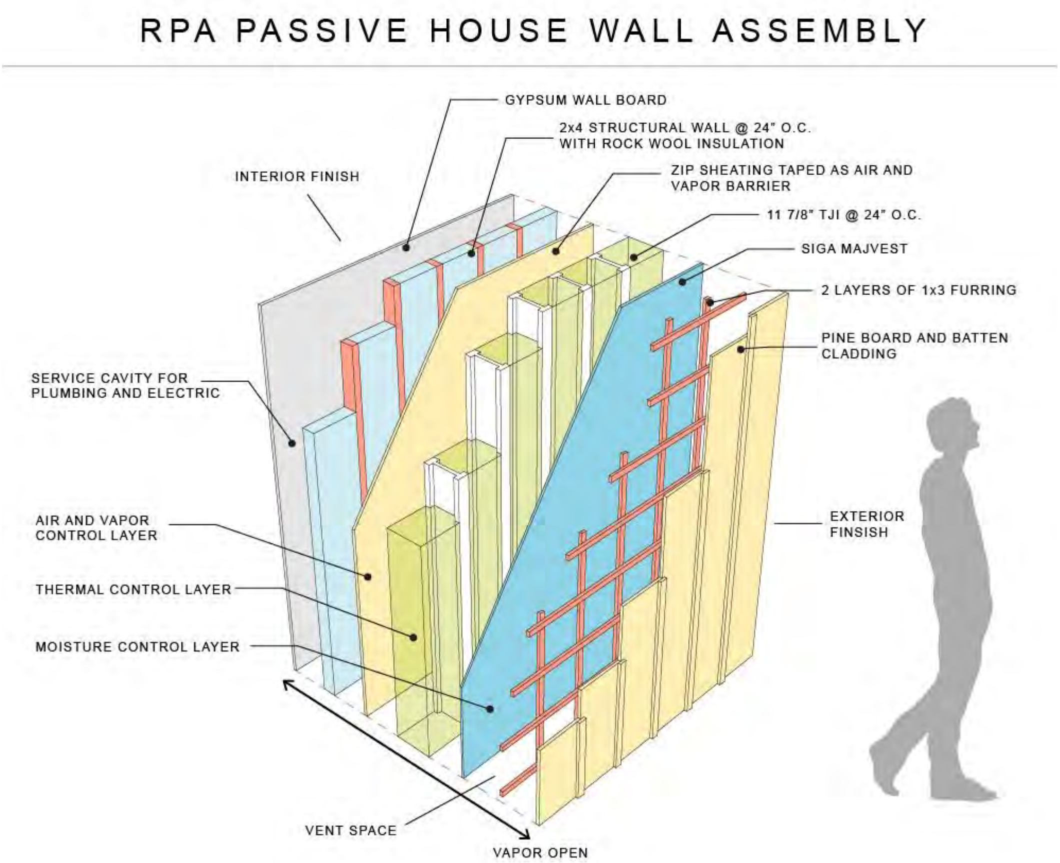
SCRANTON PASSIVE HOUSE

Happy homeowners Christie and Declan

SCRANTON PASSIVE HOUSE

RPA PASSIVE HOUSE WALL ASSEMBLY

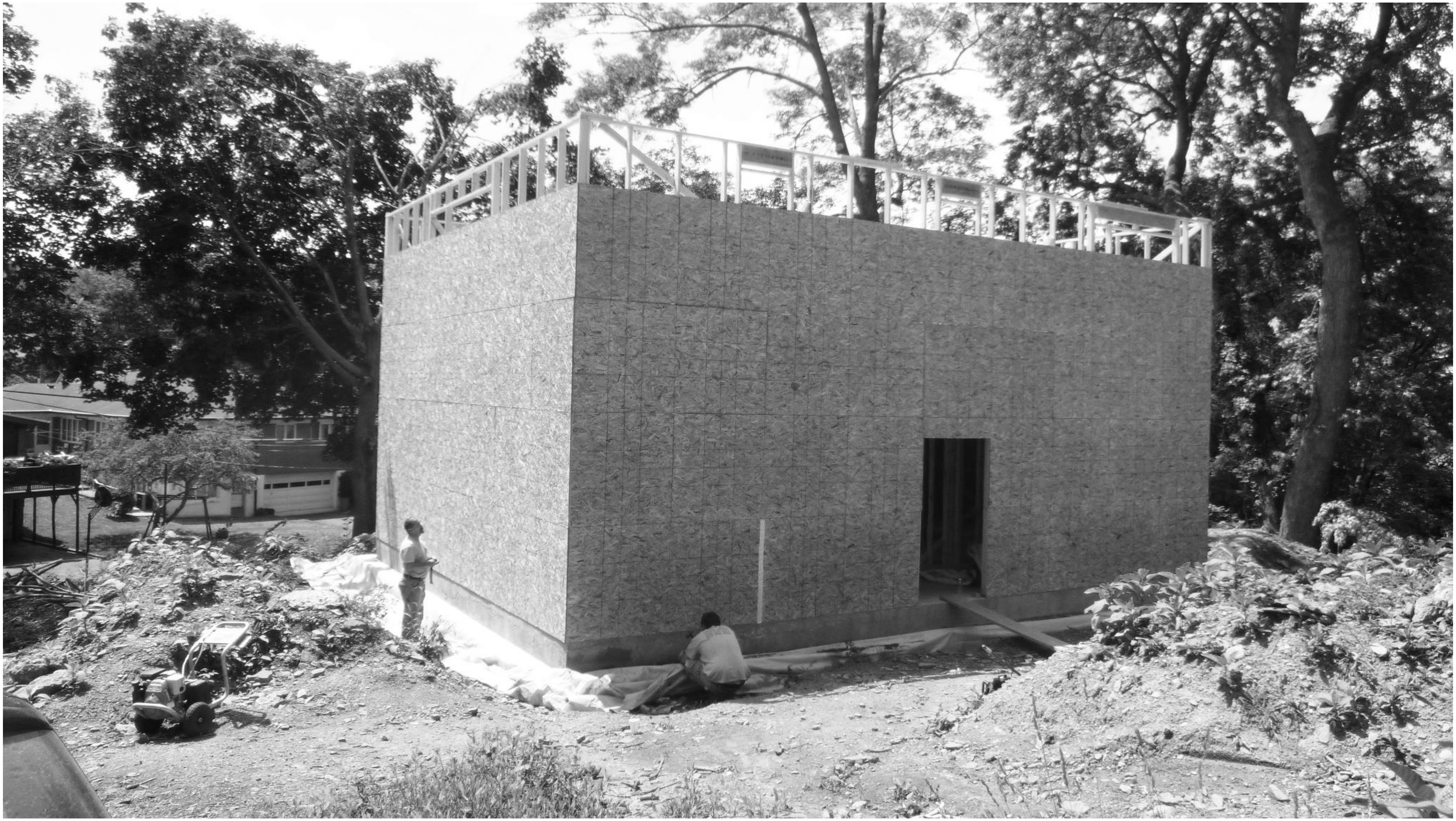




Why this wall?

- Is a proven Passive House wall assembly
- High R value
- Uses conventional methods and materials
- Has an excellent vapor profile
- All 4 control layers are continuous and clear
- Cellulose is hygroscopic
- Cellulose is cheap
- Cellulose has low embodied energy
- The primary air seal is rigid and protected
- Includes a service cavity
- Is thermal bridge free
- Allows for Duclos method testing

SCRANTON PASSIVE HOUSE



OSB sheathing over 2x4 structural frame with entry door opening

SCRANTON PASSIVE HOUSE

Setting raised heel roof trusses

SCRANTON PASSIVE HOUSE

Duclose Method

Mike Duclose
DEAP Energy Group
Newton, MA
www.deapgroup.com

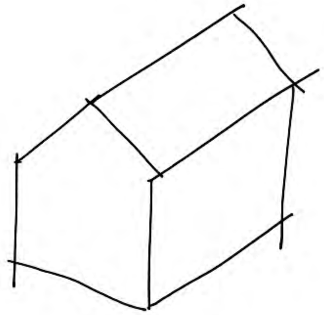
TEST 1

Initial test after slab/wall/ceiling close in

Target benchmark

< 10,000 CF	.25 ACH50
10,000 – 20,000 CF	.20 ACH50
20,000 – 30,000 CF	**.15 ACH50**
>40,000 CF	.10 ACH50

Prior to windows and door cutouts



TEST 2

Second air test after window and door installation

Target benchmark

< 10,000 CF	.45 ACH50
10,000 – 20,000 CF	.40 ACH50
20,000 – 30,000 CF	**.35 ACH50**
>40,000 CF	.30 ACH50

Prior to exterior or interior insulation

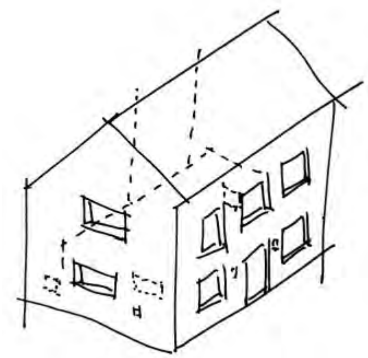
TEST 3

Third air test after MEP installation

Target benchmark

< 10,000 CF	.60 ACH50
10,000 – 20,000 CF	.55 ACH50
20,000 – 30,000 CF	**.50 ACH50**
>40,000 CF	.45 ACH50

Prior to exterior or interior insulation



SCRANTON PASSIVE HOUSE

Sheathed and ready for blower door test #1

SCRANTON PASSIVE HOUSE

Richard Pedranti, architect and Pete Vargo, PHIUS+ energy rater performing initial blower door test

SCRANTON PASSIVE HOUSE

<u>Leakage areas during blower door Test #1</u>

- Second floor top plate / ceiling
- Second floor headers
- Missed field nails
- Mechanical penetrations

1.15 ACH@50Pa

reduced to

0.93 ACH@50Pa

SCRANTON PASSIVE HOUSE

Preparing to positive test exterior after failed negative pressure test

SCRANTON PASSIVE HOUSE

Preparing positive pressure balloon test #1 on OSB panel and seam taped with SIGA wigluv

SCRANTON PASSIVE HOUSE

Ballooning of polyethylene over OSB during positive pressure test #1

SCRANTON PASSIVE HOUSE

PHIUS + rater Pete Vargo - "I was right, we have leaky OSB"

SCRANTON PASSIVE HOUSE

Owner, Declan Mulhall and PHIUS + rater, Pete Vargo during balloon test #2 over OSB panel only

SCRANTON PASSIVE HOUSE

Balloon test #2 over OSB panel only

Air leakage Solutions

Concerns

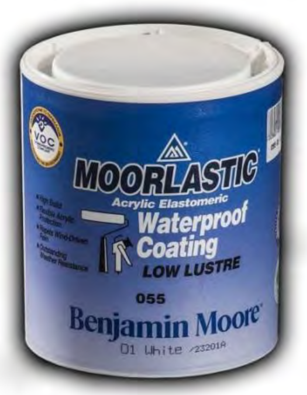
- Needs to be 100% effective
- Cost effective
- Has a warranty
- Labor friendly
- Compatible with SIGA wigluv

Liquid applied

- Prosoco R-Guard Cat 5
- Dow Corning Defendair 200
- BASF Enershield
- Elastormeric paint

Membranes

- Pro Clima DA menbrane
- SIGA Majpell 5



SCRANTON PASSIVE HOUSE

Installing SIGA Majpell 5 on exterior

SCRANTON PASSIVE HOUSE

Richard Pedranti, architect and Pete Vargo, PHIUS+ energy rater performing initial blower door test

SCRANTON PASSIVE HOUSE

Second blower door test with first window installed

WEYERHAUSER

MADE IN USA

APA

RATED SHEATHING

24/16

SIZED FOR SPACING
EXPOSURE 1
THICKNESS 0.418

537 (Elkin,NC)

PS2-10

HUD-UM-40C
7/16 CATEGORY

SCRANTON PASSIVE HOUSE

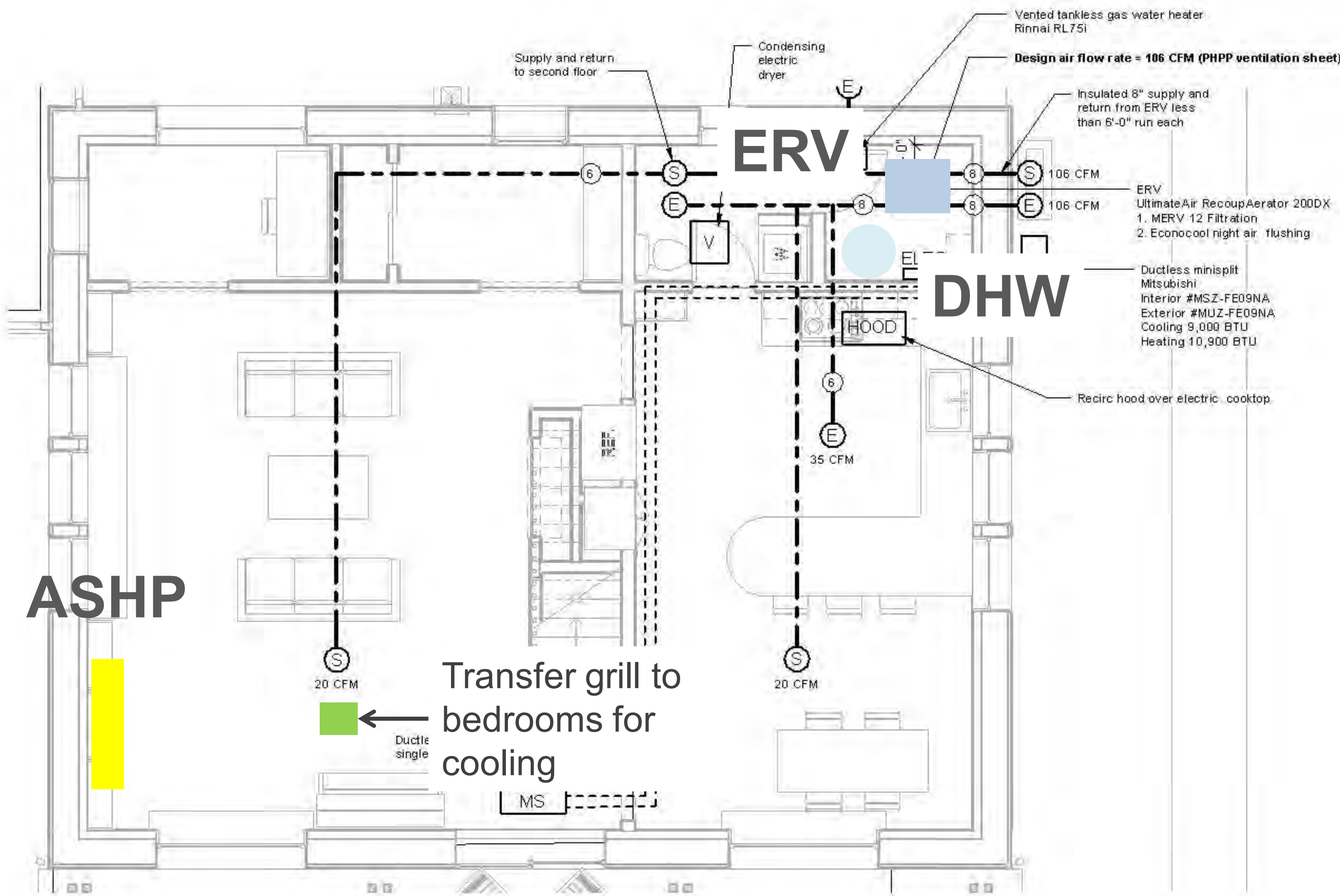
Taping window interior

Preparing window exterior

South windows

Completed window installation

SCRANTON PASSIVE HOUSE



PHIUS

RPA

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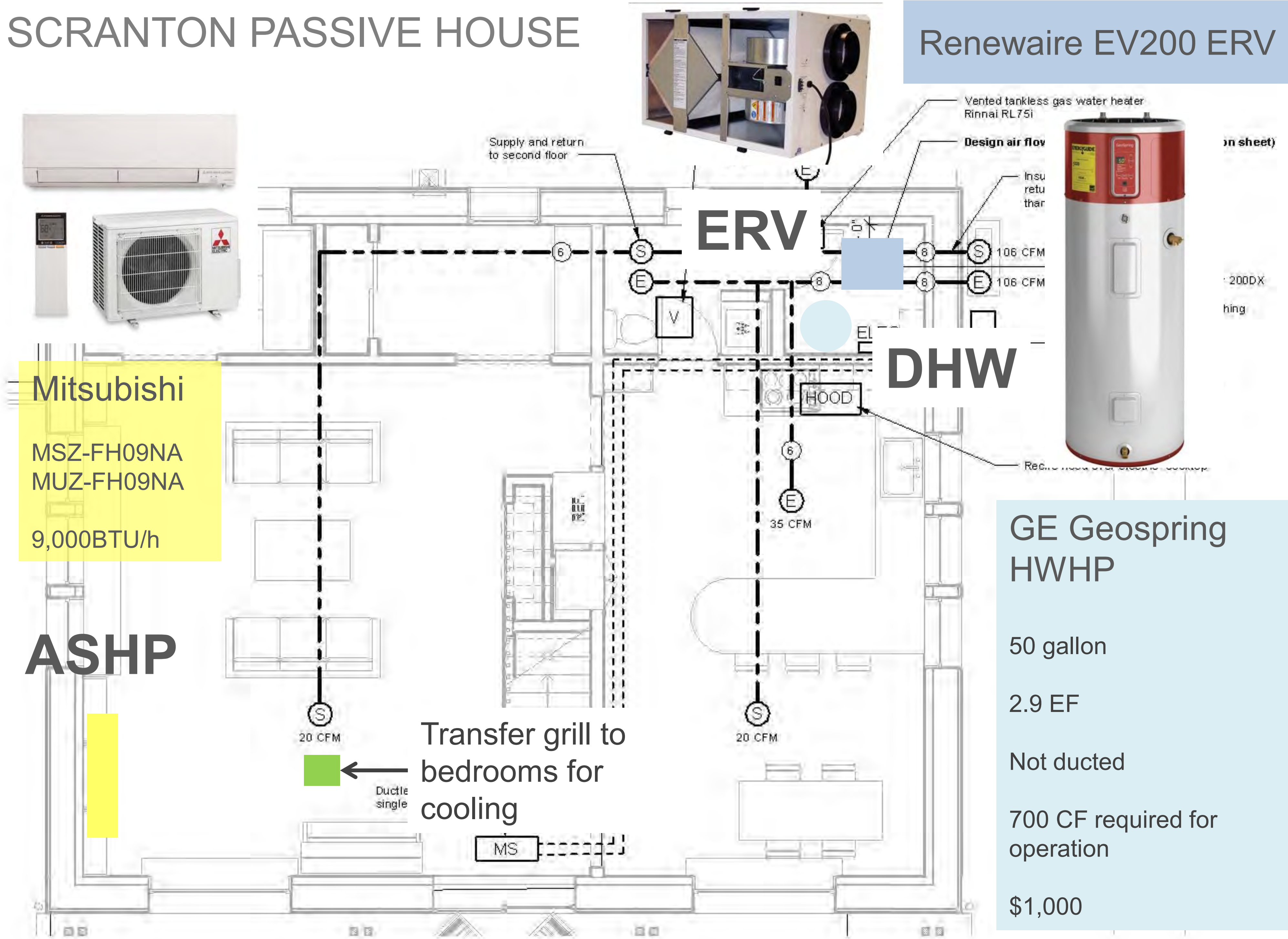
Renewaire EV200 ERV



Mitsubishi

MSZ-FH09NA
MUZ-FH09NA

9,000BTU/h

ASHP

Transfer grill to bedrooms for cooling

GE Geospring HWHP

50 gallon

2.9 EF

Not ducted

700 CF required for operation

$1,000

SCRANTON PASSIVE HOUSE

Renewaire EV200 ERV

ERV single speed fan and Mitsubishi heat exchange core

HVI Certified

Static plate heat and humidity transfer

Can be mounted in any orientation

Merv 8 filter

At 157 watts produces 181CFM and 78%

Intermittent operation

Measured 0.93 W/CFM

Cost $1,450 (unit, filters, and controls)

Honeywell EARD motorized damper

<u>Intermittent ventilation</u>

Required = 94 CFM

Measured = 160 CFM

94/160 = 58%

Runtime = 60% or 40min/hr

SCRANTON PASSIVE HOUSE

SCRANTON PASSIVE HOUSE

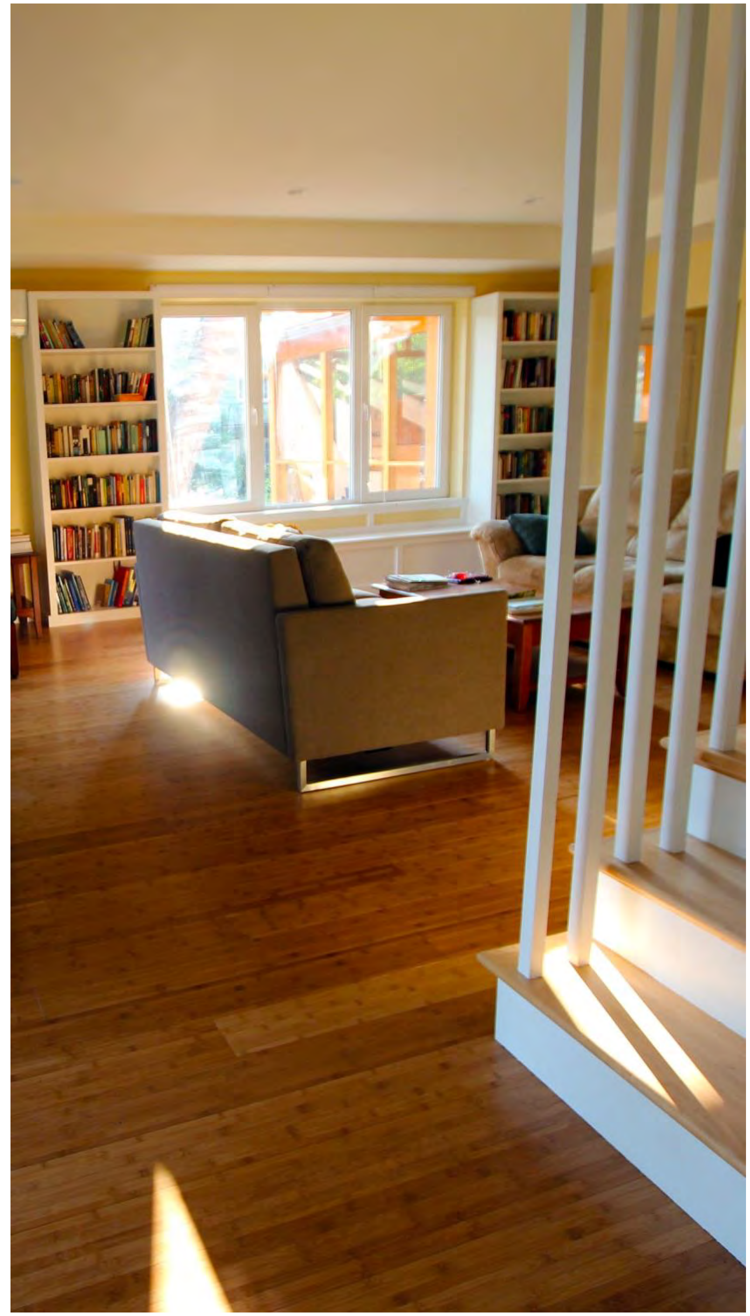
SCRANTON PASSIVE HOUSE

SCRANTON PASSIVE HOUSE

PHIUS

RPA

SCRANTON PASSIVE HOUSE



SCRANTON PASSIVE HOUSE

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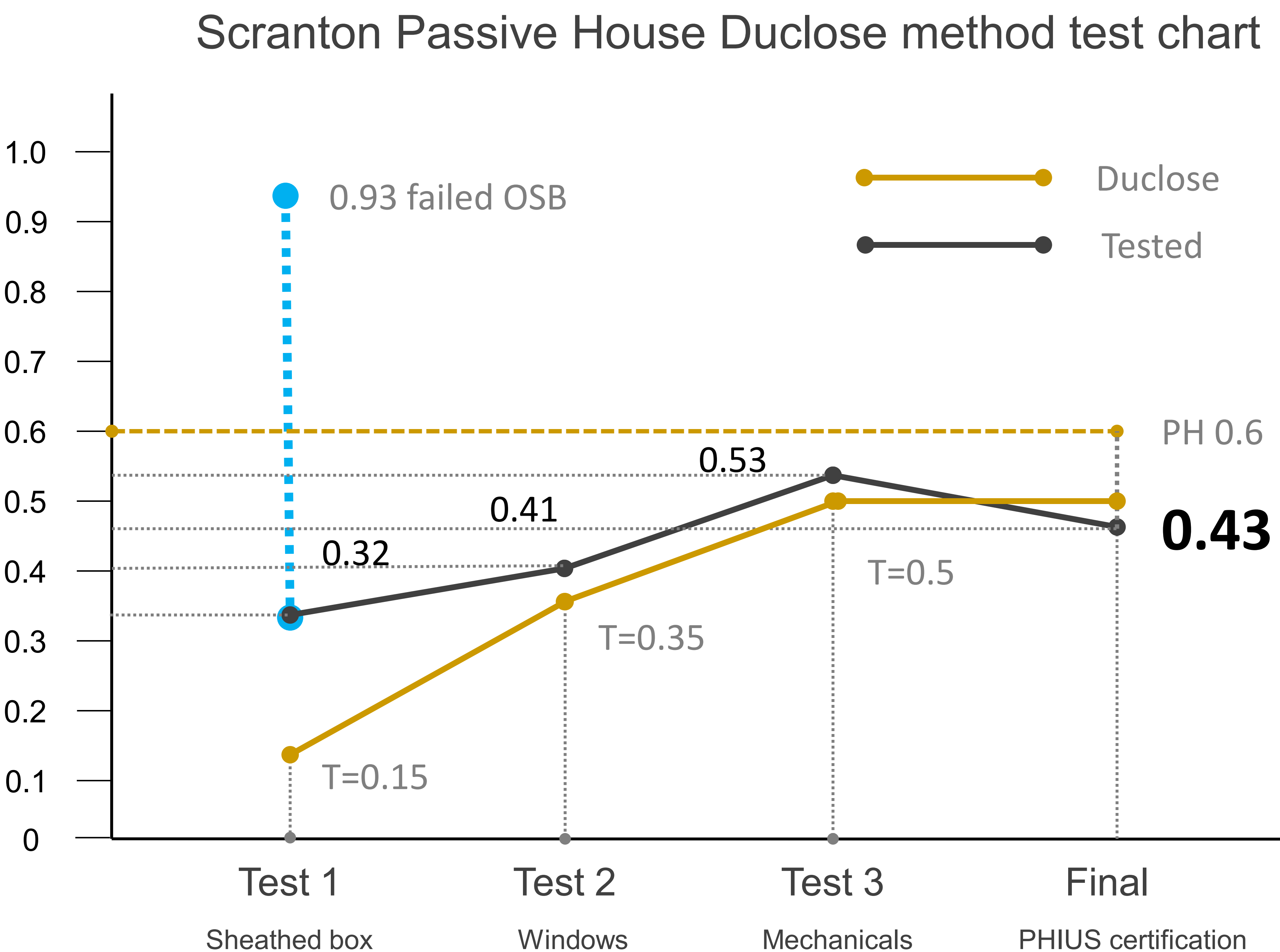


Lessons learned

1. Based on our experience, OSB is nor a reliable air control layer. We are specifying **ZIP sheathing** as the air control layer on all ongoing and future projects.

2. The **Duclose method** is a very effective approach to assuring high levels of air tightness. It's also effective in teaching about air tight concepts to builders and stakeholders.

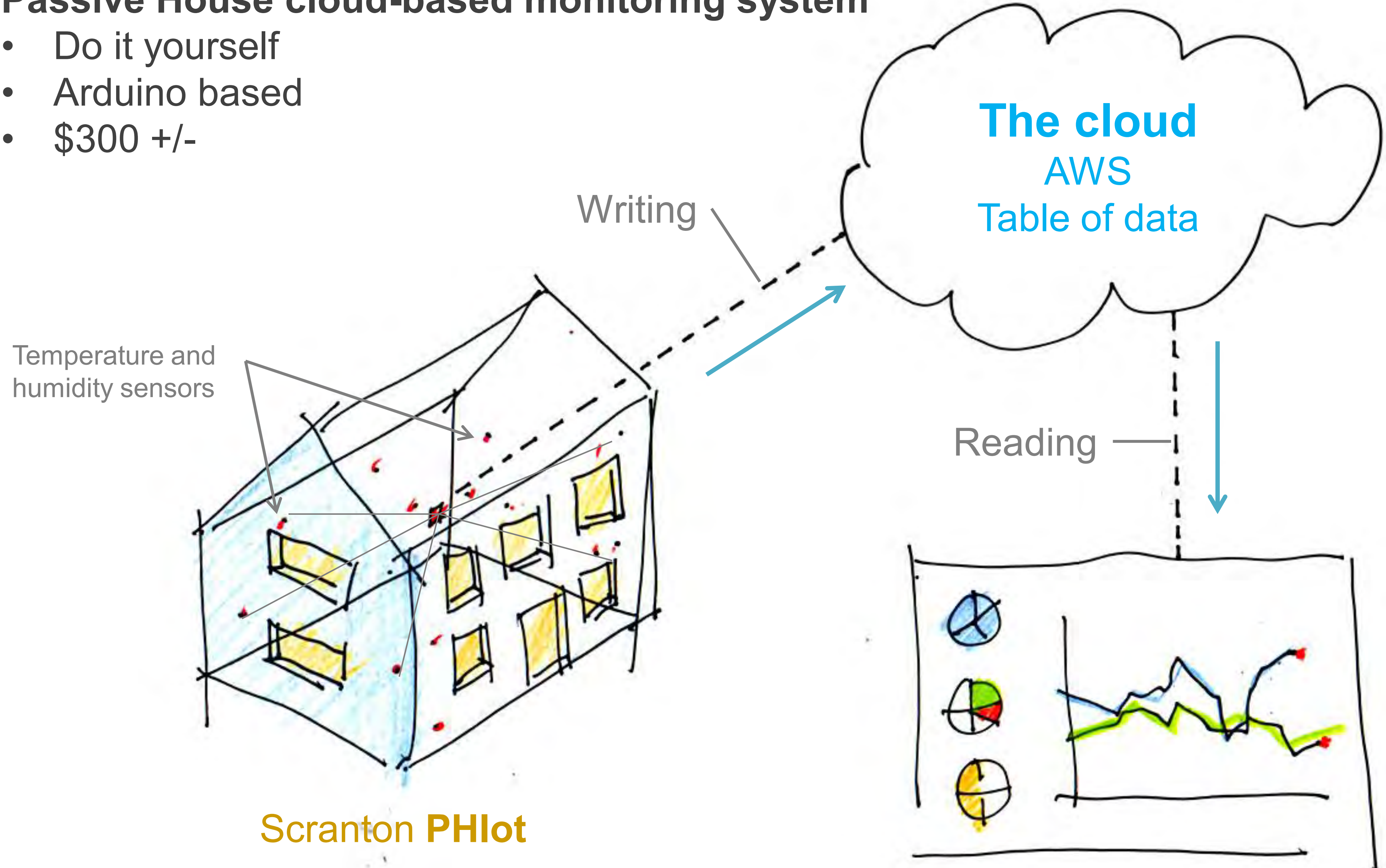
3. **Perlite** is a cost effective and easy to use sub slab insulation.

4. With carefully optimized design, it is possible to build an **affordable Passive House** in our region.

SCRANTON PASSIVE HOUSE

Passive House cloud-based monitoring system

- Do it yourself
- Arduino based
- $300 +/-

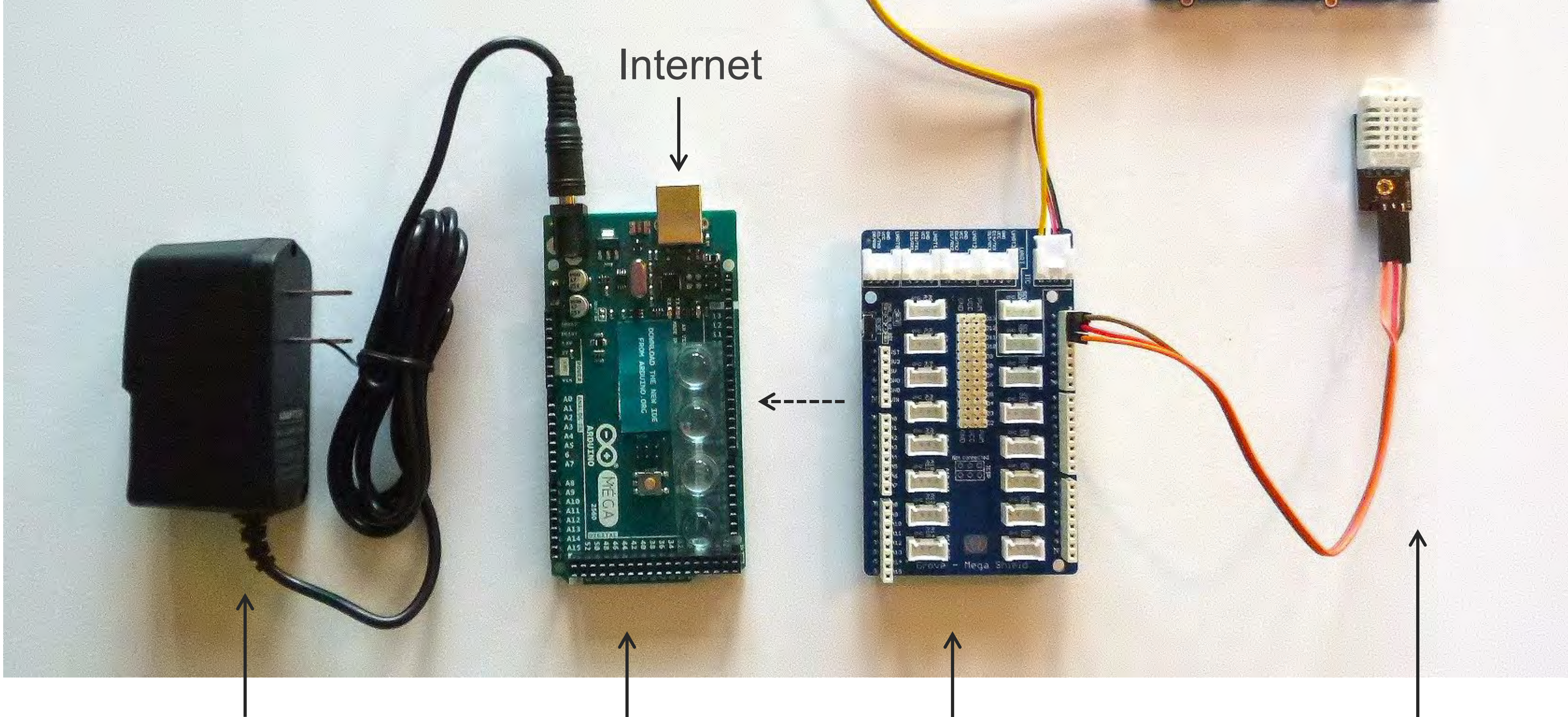


PHIot – Passive house Internet of Things

www.scrantonpassivehousedata.com

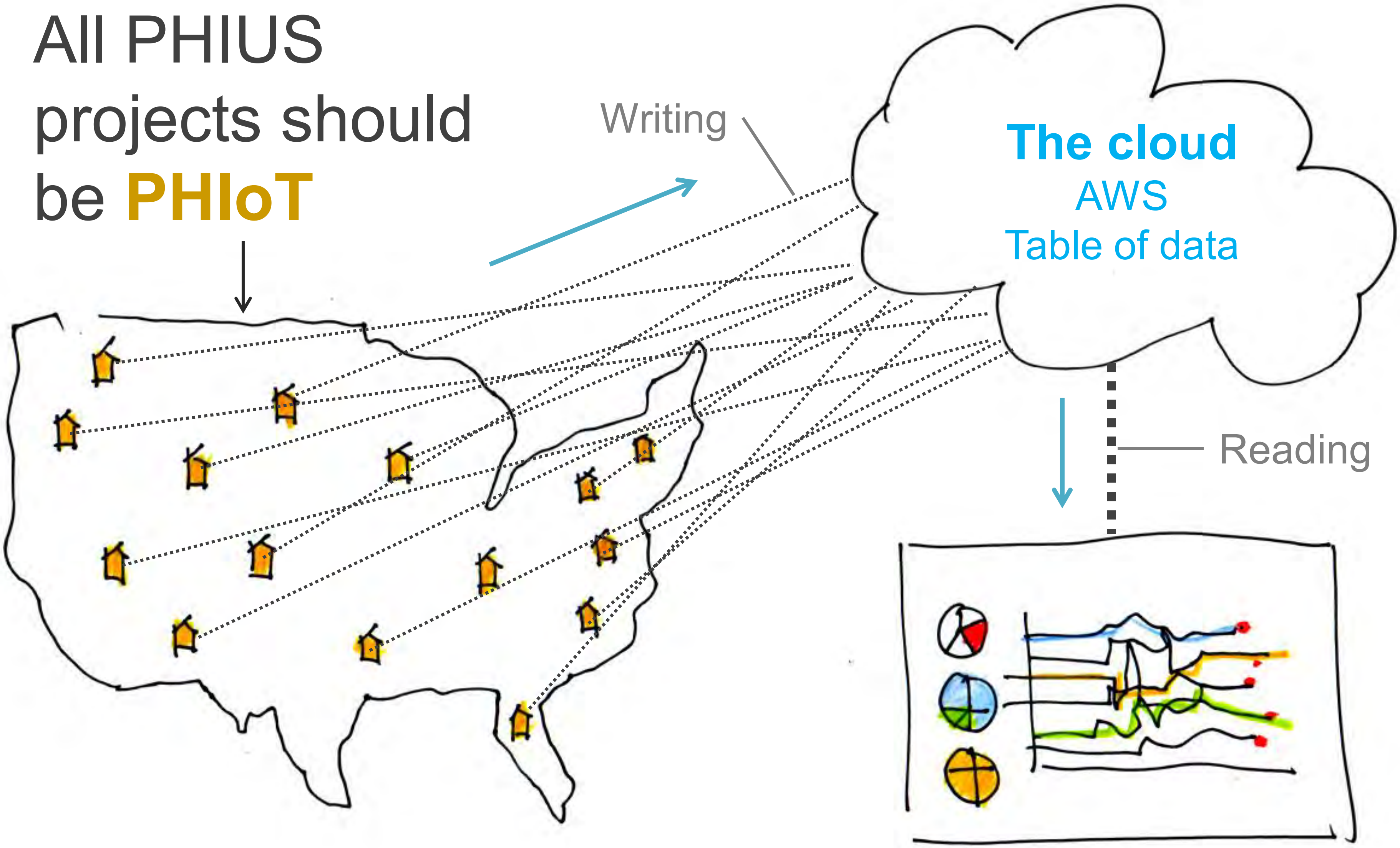
Passive House cloud-based monitoring system

- Do it yourself
- Arduino based
- $300 +/-



Passive House cloud-based monitoring system

All PHIUS projects should be PHIoT



PHIUS PHIot's

PHIoT dashboard

WYLIE WOODS PASSIVE HOUSE

South view of the Wylie Woods Passive House

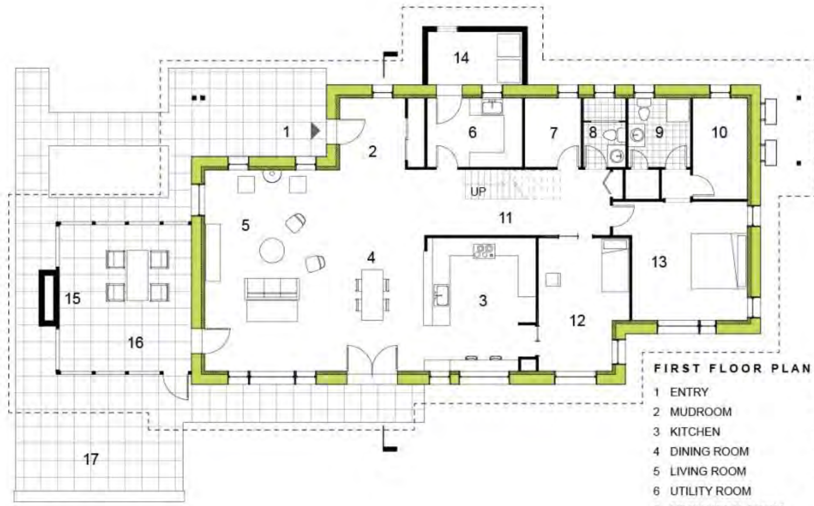
WYLIE WOODS PASSIVE HOUSE

South west view of the Wylie Woods Passive House

KEFFER PASSIVE HOUSE

South view of the Keffer Passive House

KEFFER PASSIVE HOUSE



FIRST FLOOR PLAN

1 ENTRY
2 MUDROOM
3 KITCHEN
4 DINING ROOM
5 LIVING ROOM
6 UTILITY ROOM
7 MECHANICAL ROOM
8 BATHROOM
9 MASTER BATHROOM
10 MASTER CLOSET
11 HALL
12 BEDROOM
13 MASTER BEDROOM
14 LAUNDRY ROOM
15 FIRE PLACE
16 SCREEN PORCH
17 BLUESTONE PAVING

WEST ELEVATION

SOUTH ELEVATION

EAST ELEVATION

NORTH ELEVATION

KEFFER PASSIVE HOUSE

Gravel setting bed

12” of EPS under slab foam

Pouring slab over perlite and EPS foam

Completed slab with plumbing in place

KEFFER PASSIVE HOUSE

First floor 2x4 framing at 24” O.C.

First floor framing at entry

Northwest view of ZIP sheathing over 2x4 frame

Southeast view of ZIP sheathing over 2x4 frame

KEFFER PASSIVE HOUSE

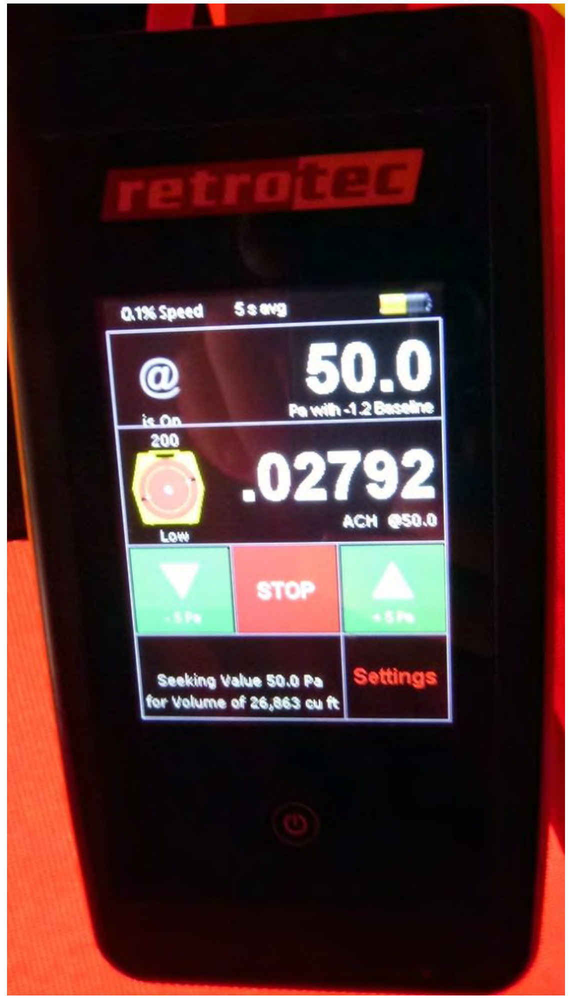
KEFFER PASSIVE HOUSE

Air tightness improvements

- ZIP sheathing
- Rolling the ZIP tape
- Redundant air tight detailing at the intersections
- Better quality construction

KEFFER PASSIVE HOUSE

KEFFER PASSIVE HOUSE



KEFFER PASSIVE HOUSE

Bill Case and his crew, Pat, Bill, Drew, and Chris

SCRANTON PASSIVE HOUSE


Thank you
BIL-JAX

RICHARD PEDRANTI ARCHITECT

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