Passive House Learning Curve:

Learned and Applied Over 10 Years of Passive House and High-Performance Building

Presenters

Stephen DeMetrick

- Principle: DeMetrick Housewrights
- Certified Passive House Builder

DEMETRICK HOUSEWRIGHTS
EST | 1995

Jon Erickson

- Certified Passive House Builder Trainer
- Certified Passive House Consultant
- Certified Passive House Verifier
- RESNET HERS Rater
- ACCA Certified Residential HVAC Design

CLEAResult®

phius

Charlestown, Rhode Island

1,797 sqft.

Energy Modeling

Annual Heating Consumption

Charlestown, RI – *1,797 sqft.*

RI SBC Minimum		***77,000,000 Btu/yr***
As-Built	—	***5,200,000 Btu/yr***
		71,800,000 Btu/yr

94% reduction

Annual Heating Consumption

Charlestown, RI – *1,797 sqft.*

71,800,000 Btu/yr

94% reduction

785 gallons propane

$2,675 @ $3.40/gal

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000

Slab	*R10U, 2'*
Walls	*R21*
Windows	*U.35, SHGC.30*
Ceiling	*R38*
Airtightness	*5.00 ACH_{50}*

Ductwork	*8% (outside)*
Hot water	*95% instant*
Heating	*96% furnace*
Ventilation	*Bath fan*
Appliances	*Energy Star*

***TOTAL** Consumption (Btu/yr)*
103,900,000

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
43,900	***55,800,000***	***59,300,000***

Slab	*R10U, 2'*
Walls	*R21*
Windows	*U.35, SHGC.30*
Ceiling	*R38*
Airtightness	*5.00 ACH_{50}*

→ ***R20U all, R15P***

Ductwork	*8% (outside)*
Hot water	*95% instant*
Heating	*96% furnace*
Ventilation	*Bath fan*
Appliances	*Energy Star*

TOTAL *Consumption (Btu/yr)*
103,900,000
86,900,000

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
40,100	***46,100,000***	***49,100,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*		
Ceiling	*R38*		
Airtightness	*5.00 ACH_{50}*		

Ductwork	*8% (outside)*
Hot water	*95% instant*
Heating	*96% furnace*
Ventilation	*Bath fan*
Appliances	*Energy Star*

***TOTAL** Consumption (Btu/yr)*
103,900,000
76,800,000

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
36,800	***33,300,000***	***35,600,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*	→	***U.17, SHGC.54***
Ceiling	*R38*		
Airtightness	*5.00 ACH_{50}*		

Ductwork	*8% (outside)*
Hot water	*95% instant*
Heating	*96% furnace*
Ventilation	*Bath fan*
Appliances	*Energy Star*

TOTAL *Consumption (Btu/yr)*
103,900,000
65,300,000

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
35,500	***29,400,000***	***31,500,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*	→	***U.17, SHGC.54***
Ceiling	*R38*	→	***R93***
Airtightness	*5.00 ACH_{50}*		

Ductwork	*8% (outside)*
Hot water	*95% instant*
Heating	*96% furnace*
Ventilation	*Bath fan*
Appliances	*Energy Star*

TOTAL *Consumption (Btu/yr)*
103,900,000
61,300,000

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
24,300	***22,200,000***	***23,800,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*	→	***U.17, SHGC.54***
Ceiling	*R38*	→	***R93***
Airtightness	*5.00 ACH_{50}*	→	***0.30 ACH_{50}***

Ductwork	*8% (outside)*
Hot water	*95% instant*
Heating	*96% furnace*
Ventilation	*Bath fan*
Appliances	*Energy Star*

***TOTAL** Consumption (Btu/yr)*
103,900,000
53,400,000

Methodology - airtightness

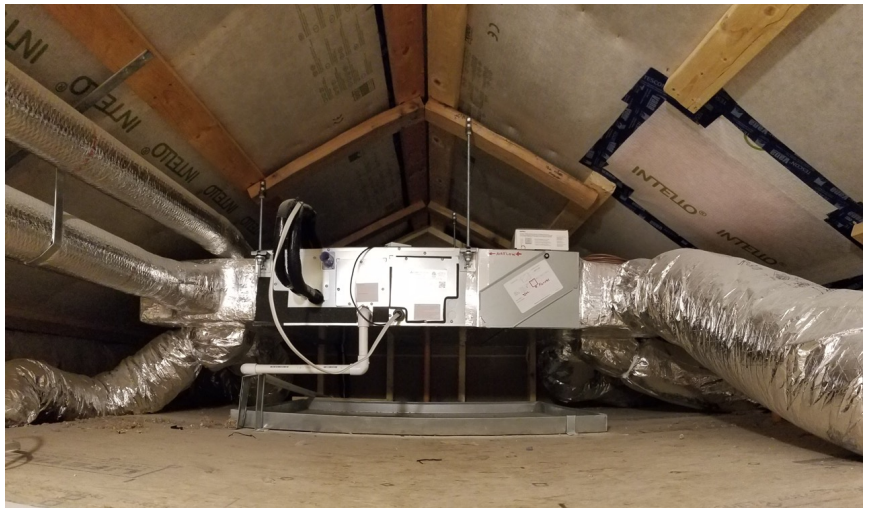
What is the primary function of the air barrier?

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
12,500	***17,800,000***	***18,900,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*	→	***U.17, SHGC.54***
Ceiling	*R38*	→	***R93***
Airtightness	*5.00 ACH_{50}*	→	***0.30 ACH_{50}***

Ductwork	*8% (outside)*	→	***inside***
Hot water	*95% instant*		
Heating	*96% furnace*		
Ventilation	*Bath fan*		
Appliances	*Energy Star*		



***TOTAL** Consumption (Btu/yr)*
103,900,000
47,800,000

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
12,500	***19,500,000***	***20,600,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*	→	***U.17, SHGC.54***
Ceiling	*R38*	→	***R93***
Airtightness	*5.00 ACH_{50}*	→	***0.30 ACH_{50}***

Ductwork	*8% (outside)*	→	***inside***
Hot water	*95% instant*	→	***HPHW + distrib***
Heating	*96% furnace*		
Ventilation	*Bath fan*		
Appliances	*Energy Star*		

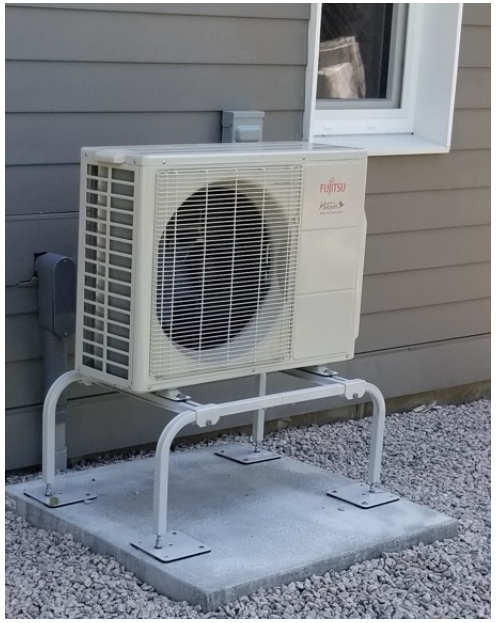
TOTAL *Consumption (Btu/yr)*
103,900,000
41,300,000

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
12,500	***19,500,000***	***6,700,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*	→	***U.17, SHGC.54***
Ceiling	*R38*	→	***R93***
Airtightness	*5.00 ACH_{50}*	→	***0.30 ACH_{50}***

Ductwork	*8% (outside)*	→	***inside***
Hot water	*95% instant*	→	***HPHW + distrib***
Heating	*96% furnace*	→	***ASHP***
Ventilation	*Bath fan*		
Appliances	*Energy Star*		



TOTAL *Consumption (Btu/yr)*
103,900,000
26,300,000

Equipment Efficiencies

RI SBC Minimum	
Annual Load	***Annual Consumption***
72.7 ***MMBtu/yr***	***77.0*** ***MMBtu/yr***

As-Built	
Annual Load	***Annual Consumption***
15.4 ***MMBtu/yr***	***5.2*** ***MMBtu/yr***

96% *AFUE gas furnace*

AHRI Efficiency Ratings	
SEER (SEER2) / HSPF (HSPF2) / EER (EER2)	
COP at 47° F / 17° F	4.44 / 3.3

COP = ratio of useful heating or cooling provided to energy required

HEATING *(1,797 sqft)*

Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
10,000	***15,400,000***	***5,200,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*	→	***U.17, SHGC.54***
Ceiling	*R38*	→	***R93***
Airtightness	*5.00 ACH_{50}*	→	***0.30 ACH_{50}***

Ductwork	*8% (outside)*	→	***inside***
Hot water	*95% instant*	→	***HPHW + distrib***
Heating	*96% furnace*	→	***ASHP***
Ventilation	*Bath fan*	→	***ERV***
Appliances	*Energy Star*		

TOTAL *Consumption (Btu/yr)*
103,900,000
25,100,000

HEATING *(1,797 sqft)*

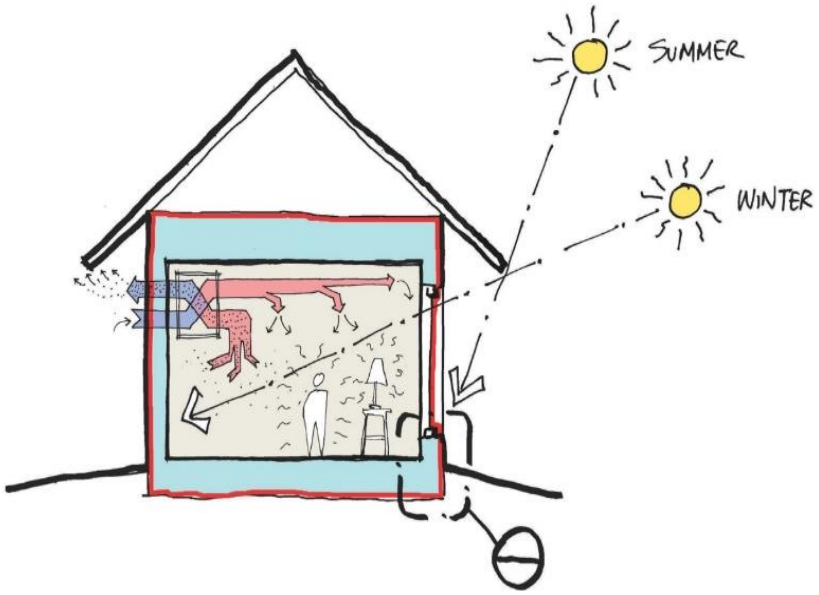
Design Load (kBtu/hr)	*Annual Load (Btu/yr)*	*Annual Consumption (Btu/yr)*
50,300	72,700,000	77,000,000
10,000	***15,400,000***	***5,200,000***

Slab	*R10U, 2'*	→	***R20U all, R15P***
Walls	*R21*	→	***R43 dbl stud***
Windows	*U.35, SHGC.30*	→	***U.17, SHGC.54***
Ceiling	*R38*	→	***R93***
Airtightness	*5.00 ACH_{50}*	→	***0.30 ACH_{50}***

Ductwork	*8% (outside)*	→	***inside***
Hot water	*95% instant*	→	***HPHW + distrib***
Heating	*96% furnace*	→	***ASHP***
Ventilation	*Bath fan*	→	***ERV***
Appliances	*Energy Star*	→	***HP dryer***

TOTAL *Consumption (Btu/yr)*
103,900,000
24,100,000

In the beginning…

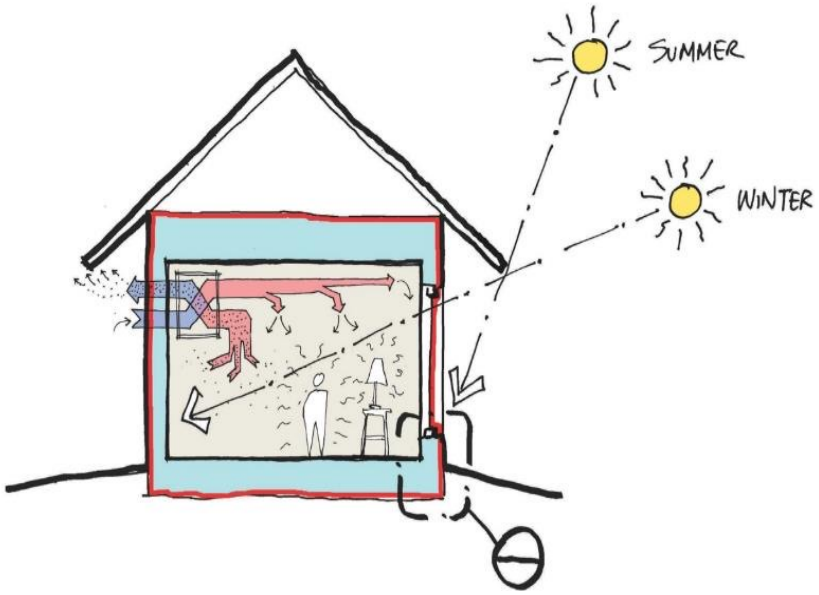


Courtesy JB Clancy, Albert, Righter & Tittmann Architects

What was our focus 10 years ago?

- Air sealing – this seemed an impossible metric!
- thermal bridging – I think the early WUFI models generated more questions than answers!
- How do we install these European windows?
- is 12” of foam under the slab going to be enough?
- What about the subcontractors? Will the cable guy blow up my blower door number?

Today with a renewed and refined perspective:



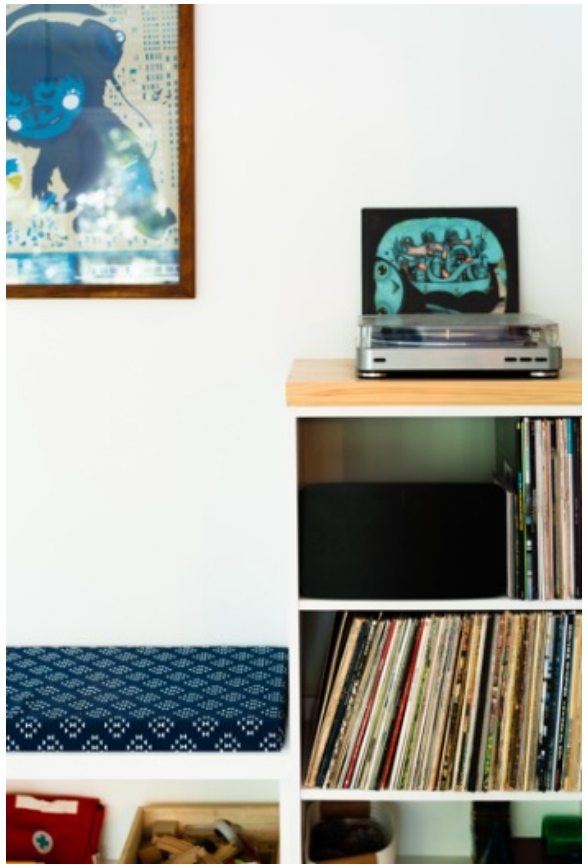
Courtesy JB Clancy, Albert, Righter & Tittmann Architects

What is our focus now?

- Health - Ventilation for Indoor air quality and health
- Comfort - Engineering our HVAC with a focus on humidity before temperature
- Durability - Detailing our assemblies for long term durability and low maintenance – vapor open assemblies
- Sustainability - healthy low carbon materials
- Practicality – we need to simplify this work to pave the way for the next generation to make a larger impact, it will be well received if it makes sense

Where do these ideas come together?

1. **Design**
   90% of the work needs to be planned for here



2. **Build**
   This should be the easy part, but there are too many humans involved

Deep thoughts on the Design Side

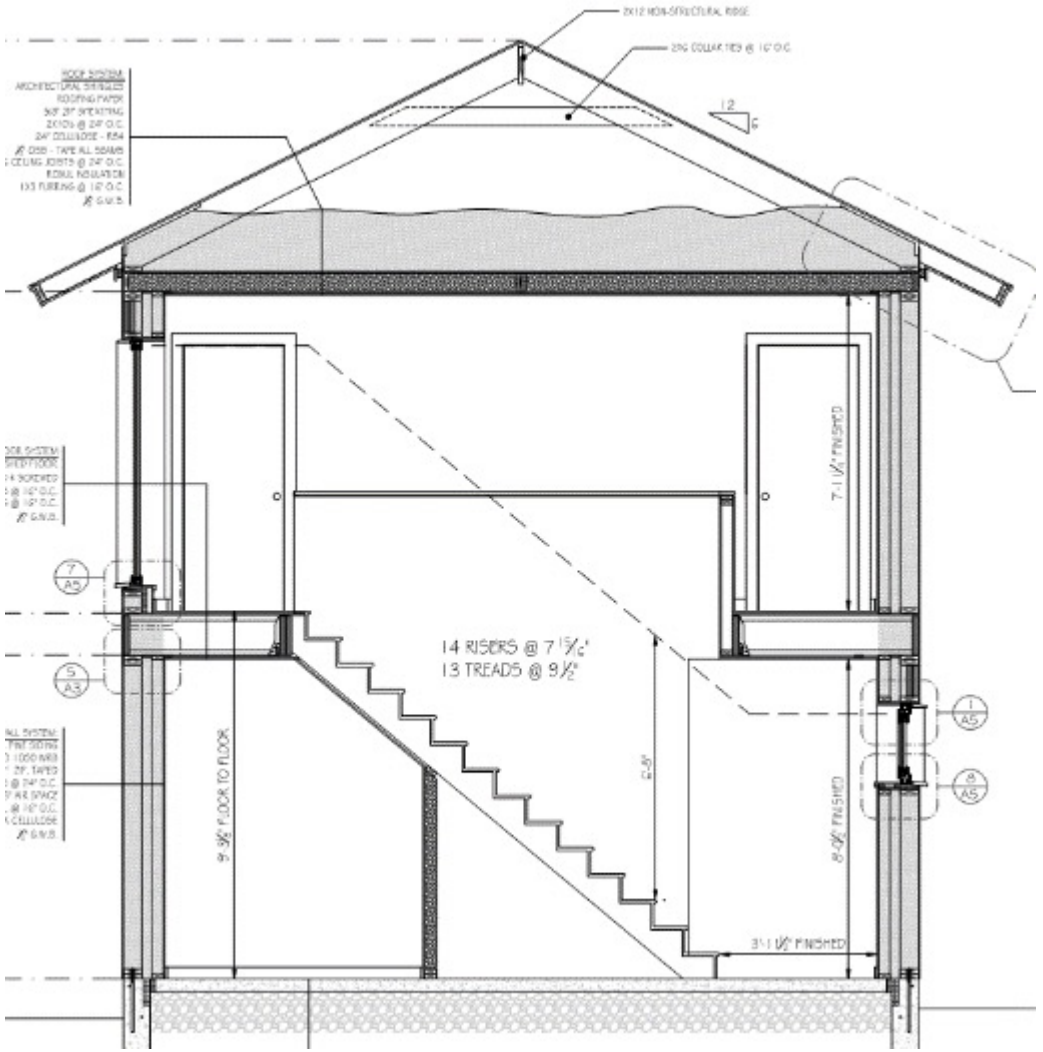
- Simple shapes, follow the dimensions of existing building products

- Select materials that are familiar to the trades and less difficult to install, healthy to work with and live with

- HVAC – keep it simple and…
  - *Design the HVAC into the space*
  - *Engineer the HVAC - this is critical*

- Provide critical detail drawings
  - *Don't leave crucial decisions to be made in the field*

- Problem solve with design choices
  - *Layout locate the water heater, kitchens and bathrooms to shorten hot water piping runs*
  - *Choose an air barrier system and building shapes that don't rely on spray foam*



The key to health and comfort

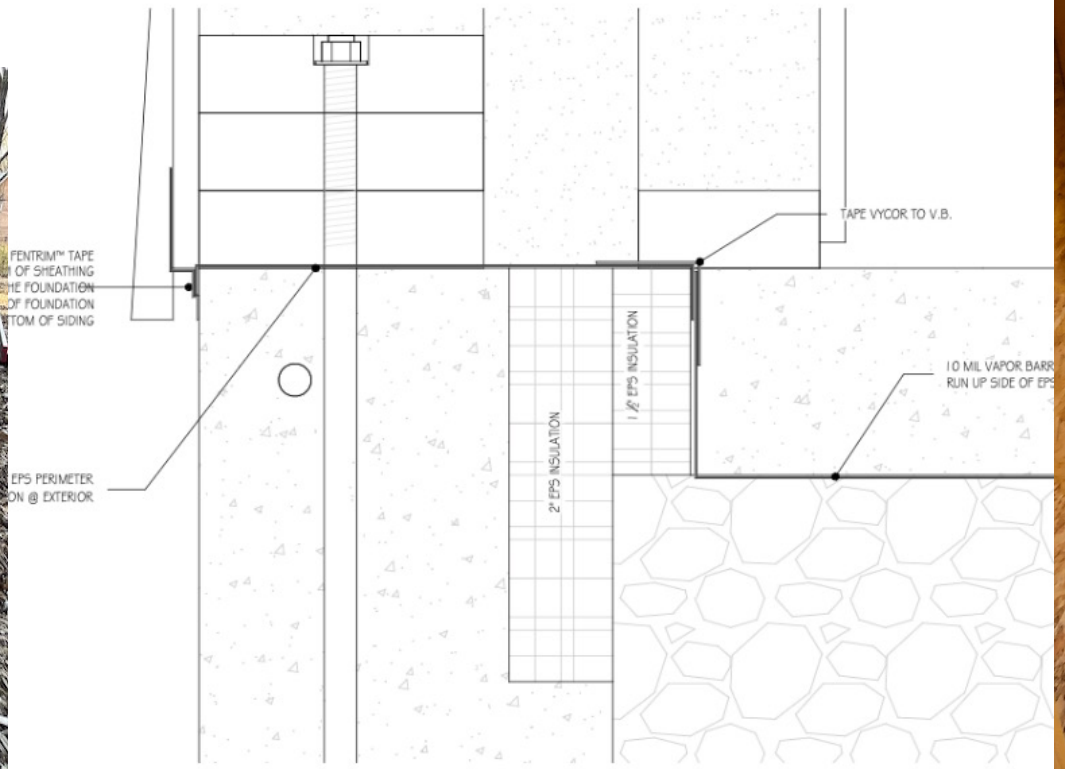
Air Tight with Balanced Ventilation

The sheathing is our primary air barrier

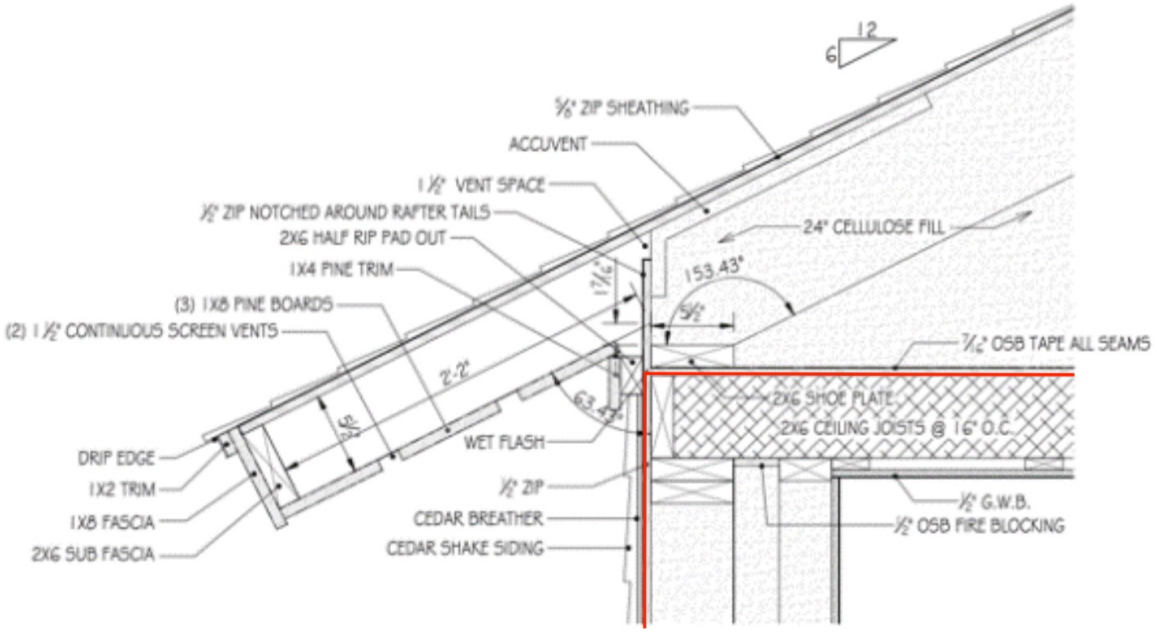
Why – this is the easiest and most cost effective system

This is why we use the sheathing:

Air seal at the sill

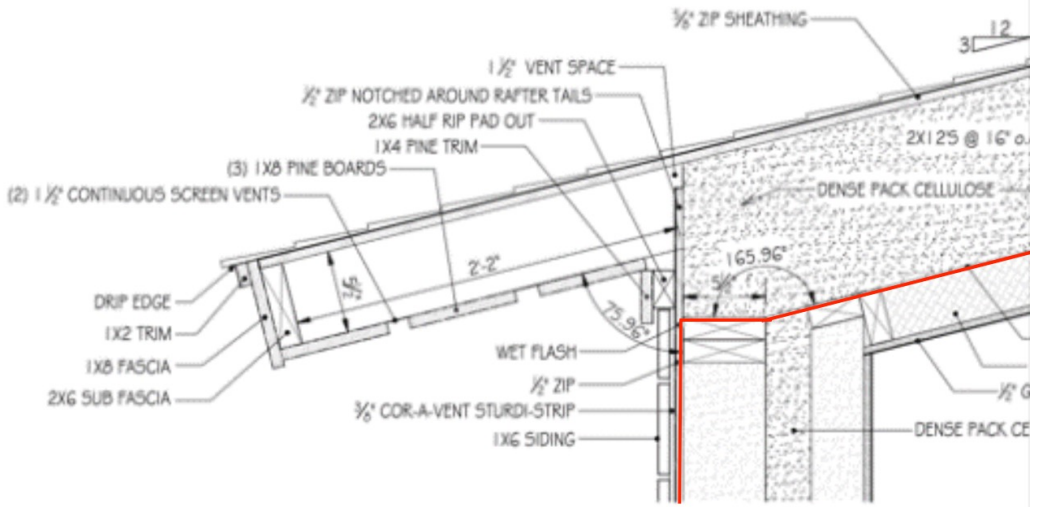


Connect the walls to the ceiling air barrier



UPPER SOFFIT 6/12

3: A4 SCALE : 1-1/2" = 1'-0"



LOWER SOFFIT 3/12

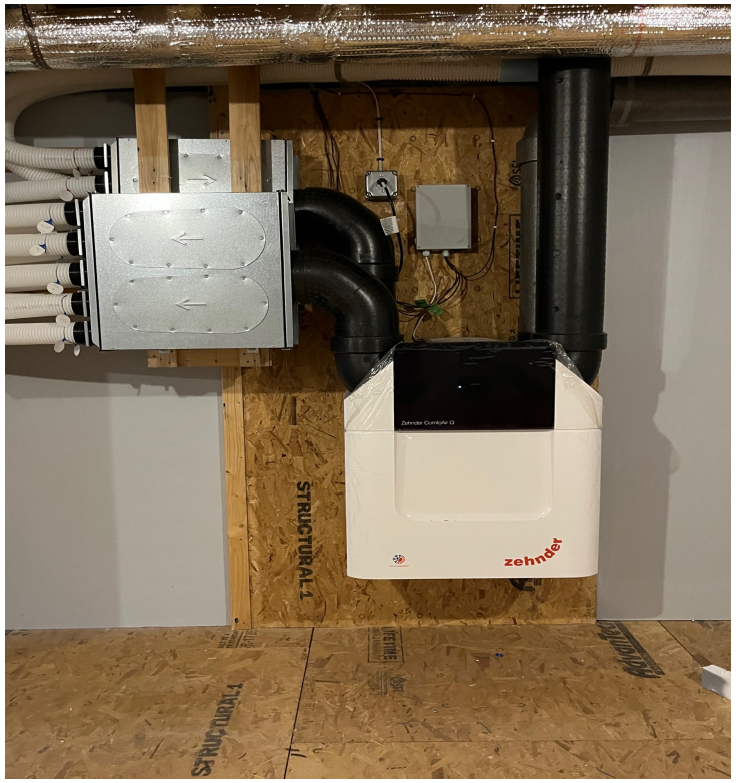
4: A4 SCALE : 1-1/2" = 1'-0"

This is what it looks like:

Airtight sheathing blower door numbers

And balanced ventilation

What are we bringing into our homes without good ventilation?



Comfort in action

This alone is proof that the envelope works!

These

1st floor bedroom

Kitchen window

2nd floor hall

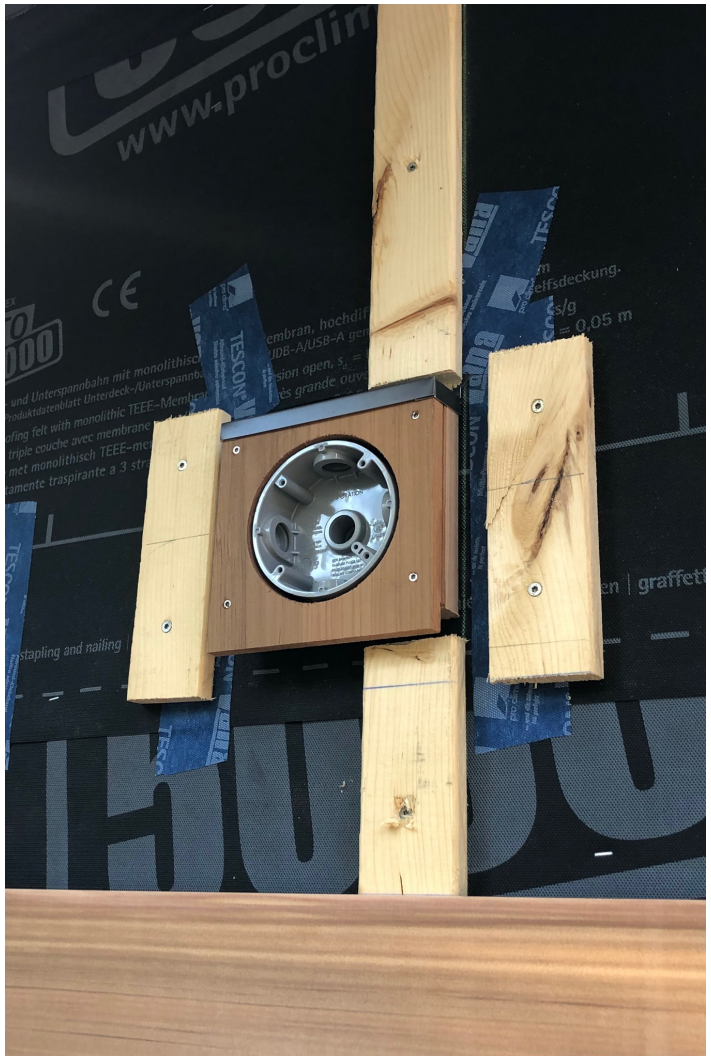
Comfort in action

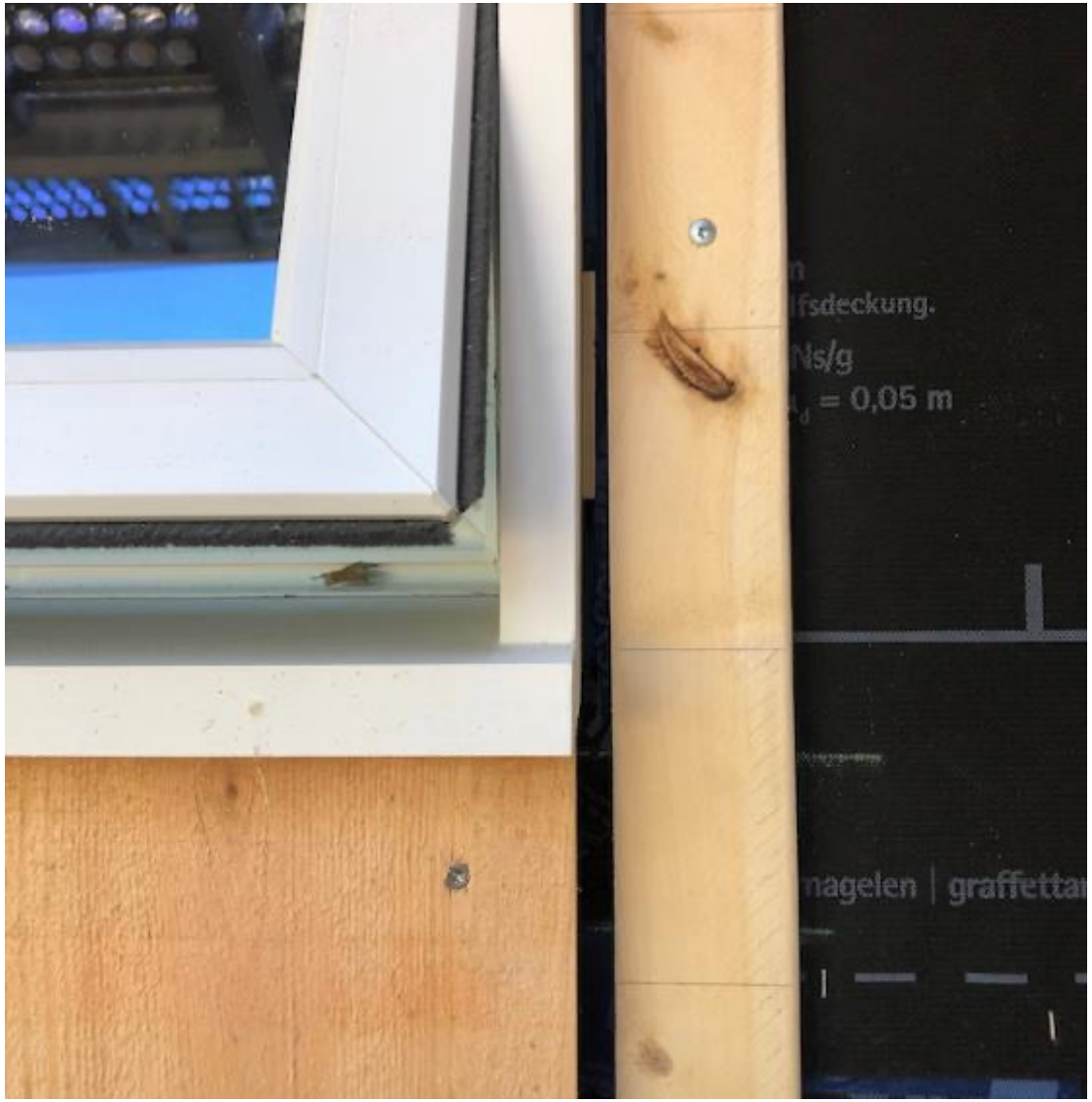
- 15 degrees outside
- 68 degrees inside

Durability

The money is in the WRB and Siding

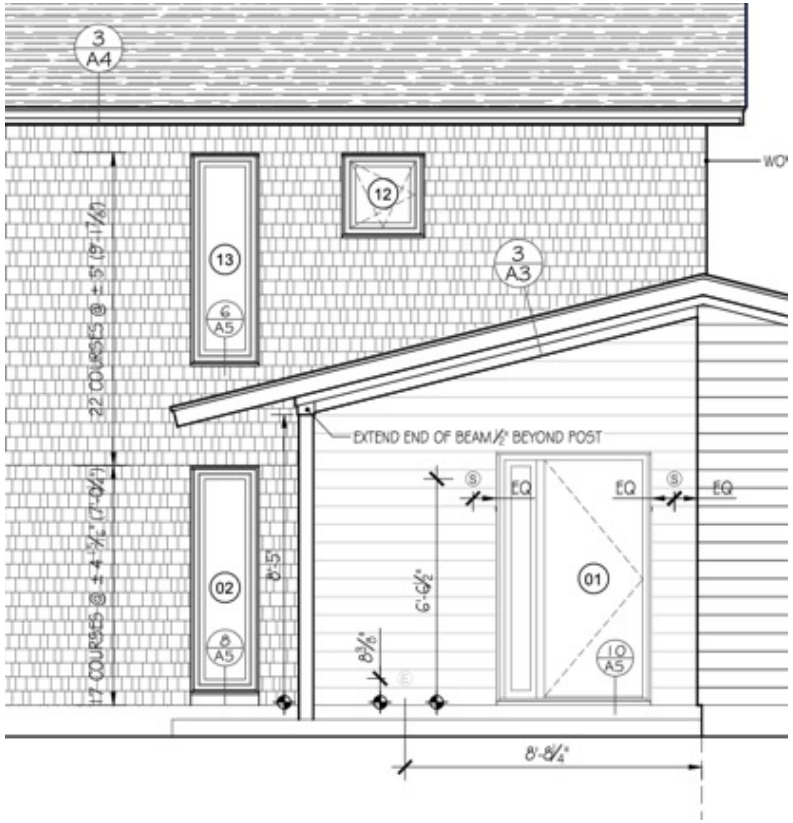
All siding is spaced off the WRB with provision for drainage




fsdeckung.
Ns/g
= 0,05 m
nagelen | graffetta

Details – Exterior elevations and layout is done in autocad

This reduces labor costs and unintended waste of our building materials



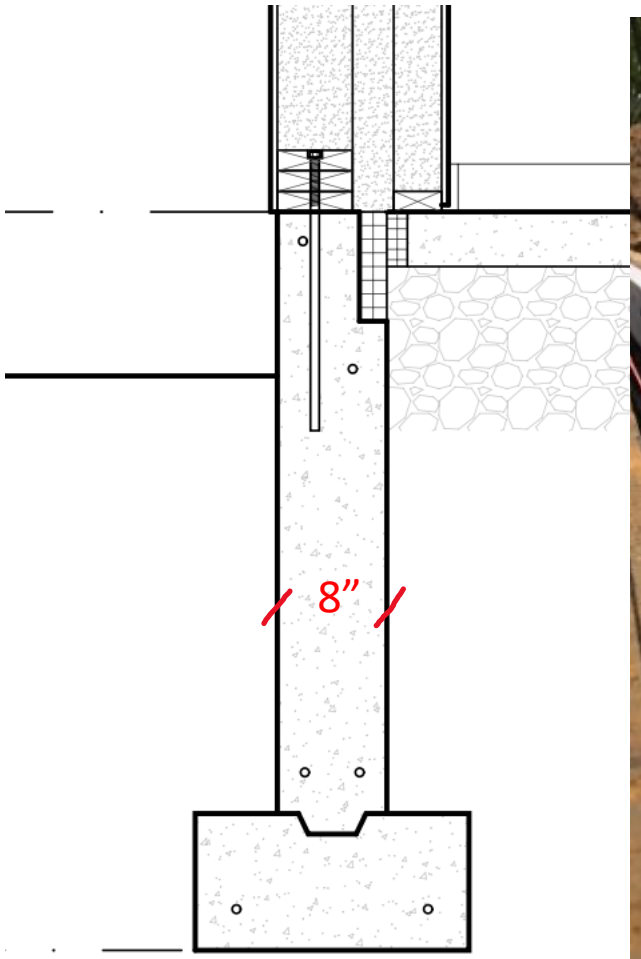
Detailing penetrations

This is extremely important stuff for long term durability

Sustainability

Its all about simple choices

1. EPS can be cast in place in the foundation for thermal break and reduce some concrete
2. Why pour a foundation thicker than it needs to be?



Further reduce concrete in our buildings - Remove the slab

Foundation insulation – Glavel if we can get it in time, or recycled EPS

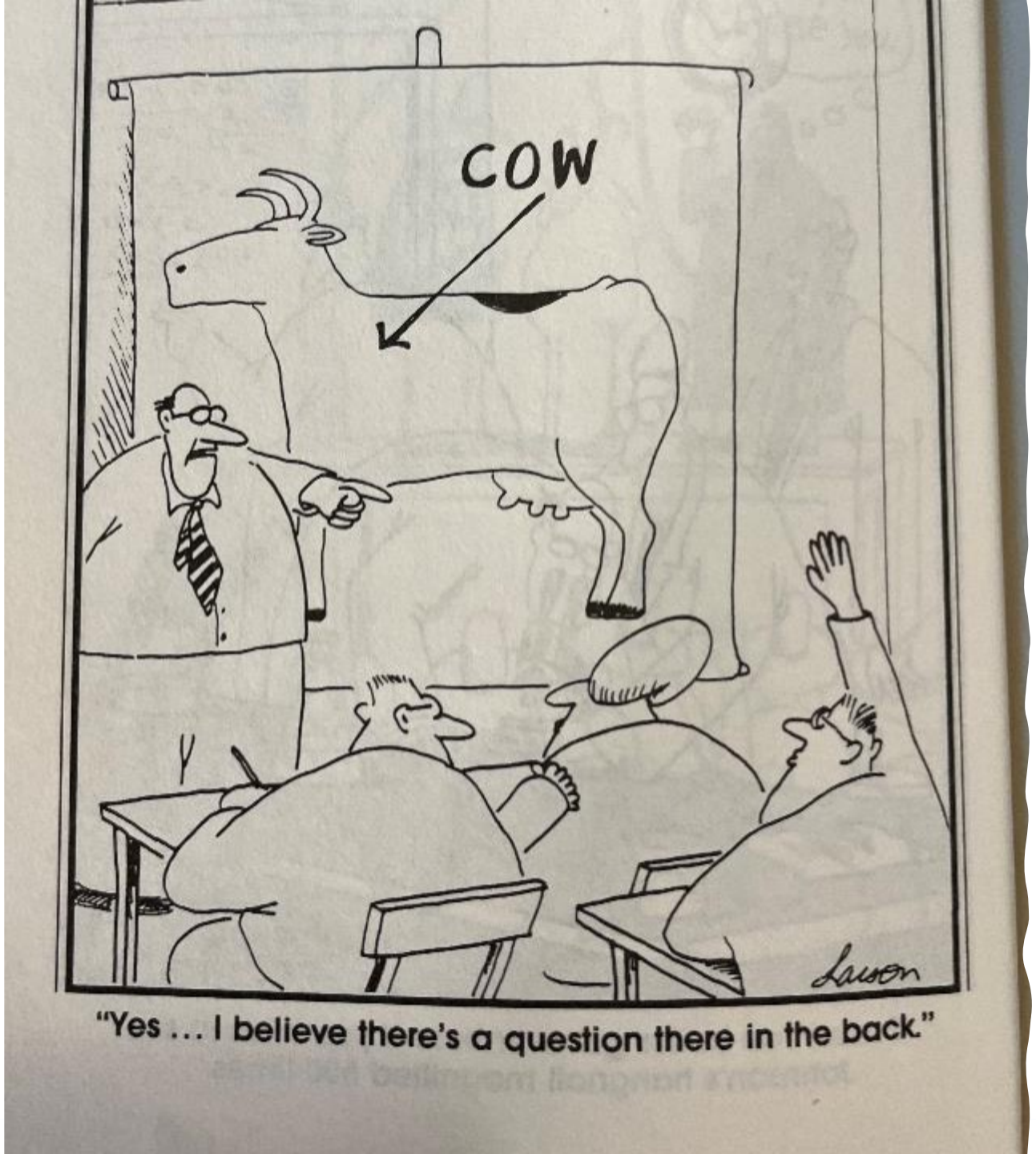
Glavel or EPS or Recycled EPS or just stick with Glavel

Cellulose is our go to in walls as ceilings until wood fiber is available

Working with the materials we know

- Building dimensions are based on the sheetgoods we work with
- All exterior trim and siding was designed and layed out based on off the shelf dimensions – we didn't rip any materials to width
- All wood exteriors are carpenter friendly
- All waste is biodegrageable
- The materials are healthy to work with

Minimal waste starts with good design and good planning



"Yes ... I believe there's a question there in the back."

Questions?