8th Annual PH Conference, Oct 2013

SQUIRREL HILL PASSIVE HOUSE IN PITTSBURGH, PA

Alan Dunn RA, Erik Fritzberg RA & CPHC of Dunn &Associates
Lucyna de Barbaro, Ayres Freitas, owners

Pittsburgh in few pictures

Our drivers

- Living within city limits and with close access to university /work, amenities, events, culture – with a strong desire to reduce driving
- Living close to a big park (to “regenerate”) and in a neighborhood with trees, flowers, etc.
- Living more densely in those great neighborhoods as that permits more people to benefit and also drive less
- Pushing the envelope of sustainability – both in terms of energy use in the building and also in terms of embodied energy of the materials and their global warming potential

Coveted Squirrel Hill Neighborhood




Squirrel Hill Blooms

Squirrel Hill shops and amenities ~1.5 mile away

2885-2887 Fernwald
Walkability Index: 43

Universities: ~3.5 miles away
Downtown: 5.5 miles

Lot sizes: 35 x 100 ft
Southern slope ~10°

Distances/driving (20 lb of CO_2 from each gallon of gas) are also a big part of sustainability

Misery brought about by global warming

Can buildings "make a dent" in a quest to stabilize the climate?

Possible roadmap for residential sector to do its part towards 80% ghg reduction goal

(From presentation at 2009 PH Conference)

Assuming **500%** increase in "carbon-free" energy by 2050:			
If *all* existing homes retrofitted to pre-PV HERS index of…	85	75	65
New homes need to average pre-PV HERS index of…	21	51	81

Assumptions:
- Current average HERS of 120;
- 20% increase in dwelling units by 2050;
- 5% of pre-2009 dwelling units replaced by 2050;
- Homes will be operated to levels predicted by HERS

Retrofitting ALL houses to index 85 is pretty hard! The more reason to start well with new homes… Index of 21 is ~a very tight Passive House!

HERS = Home Energy Rating System
pre-PV = not counting Photo-Voltaic Solar

LEED NC (New Construction) Study

March 2008 Report prepared for Green Building Council

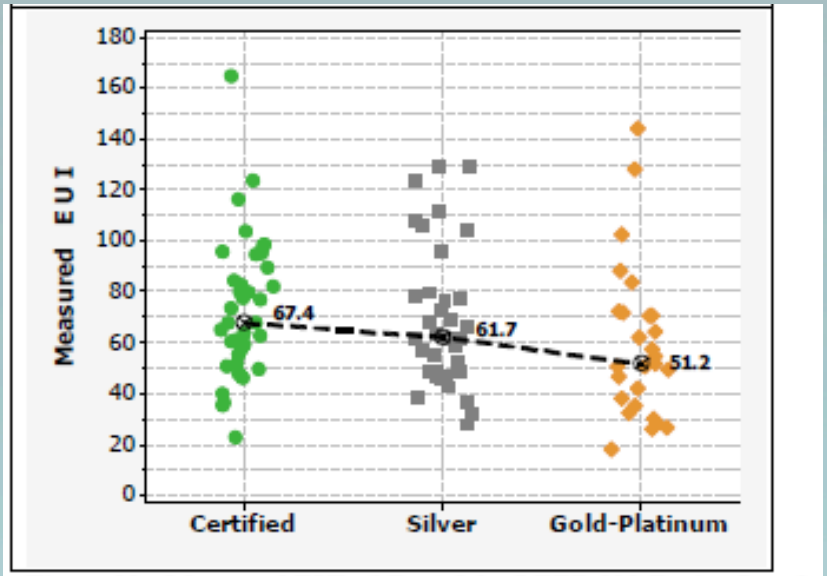


Figure 11: Measured EUIs (kBtu/sf) by LEED-NC Rating Level

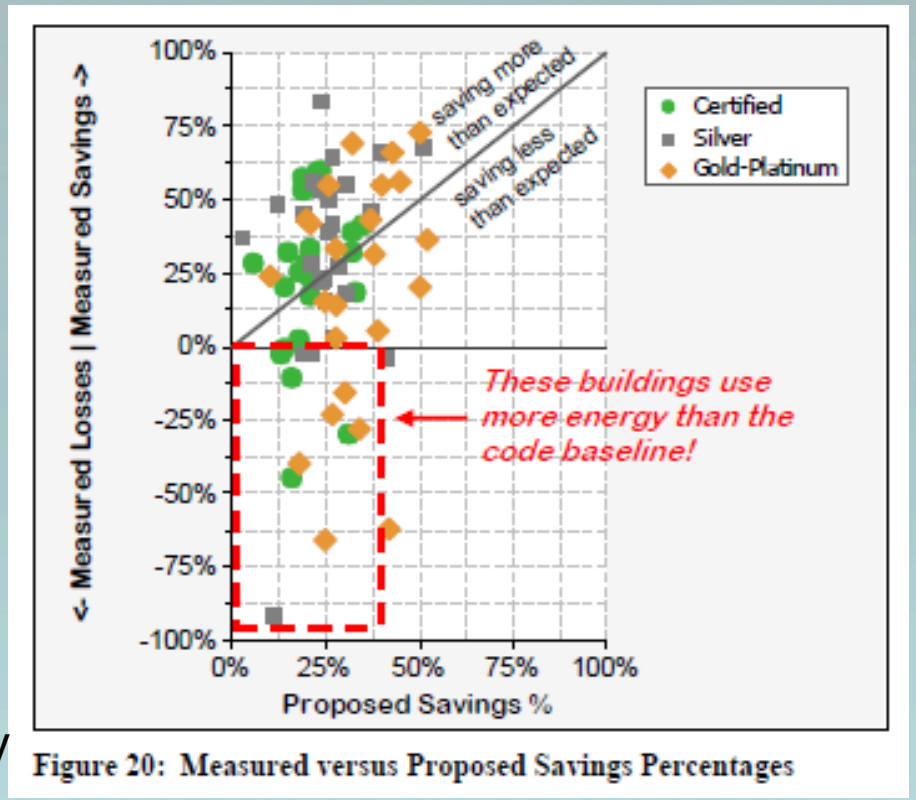
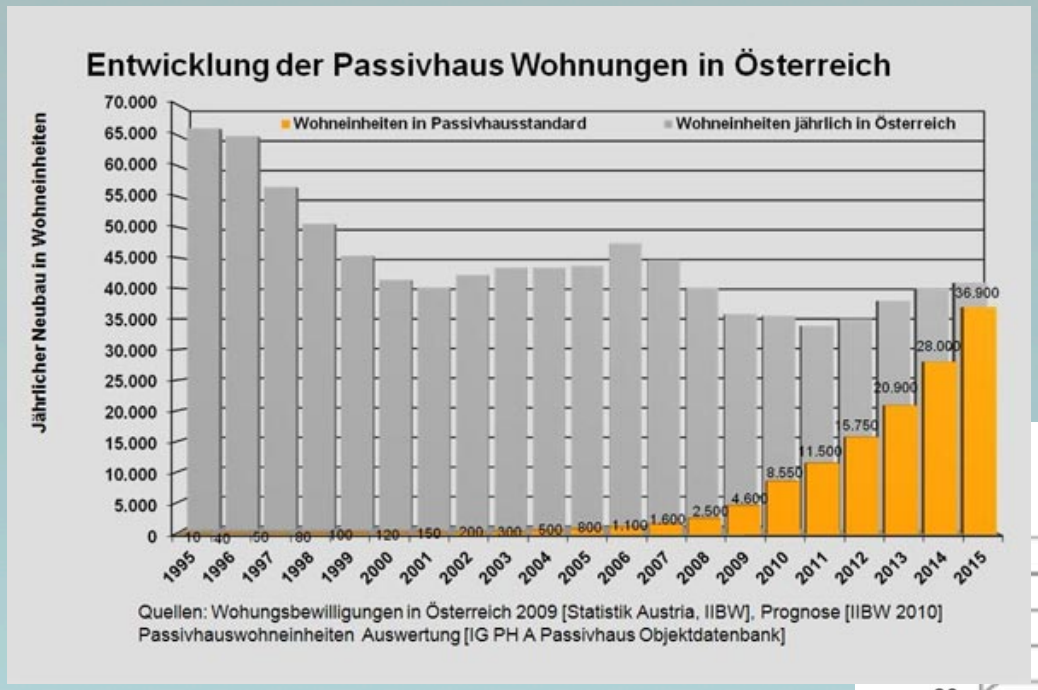


Figure 20: Measured versus Proposed Savings Percentages

Inconsistent results between proposed and measured energy saving of LEED buildings →

Even LEED-Gold on average save only 44% of national average energy use. EUI = Energy Use Intensity; average=91 kBtu/sf/y; Gold median: 51 kBtu/sf/y.

Inspiration from Passive House standard adoption in Europe

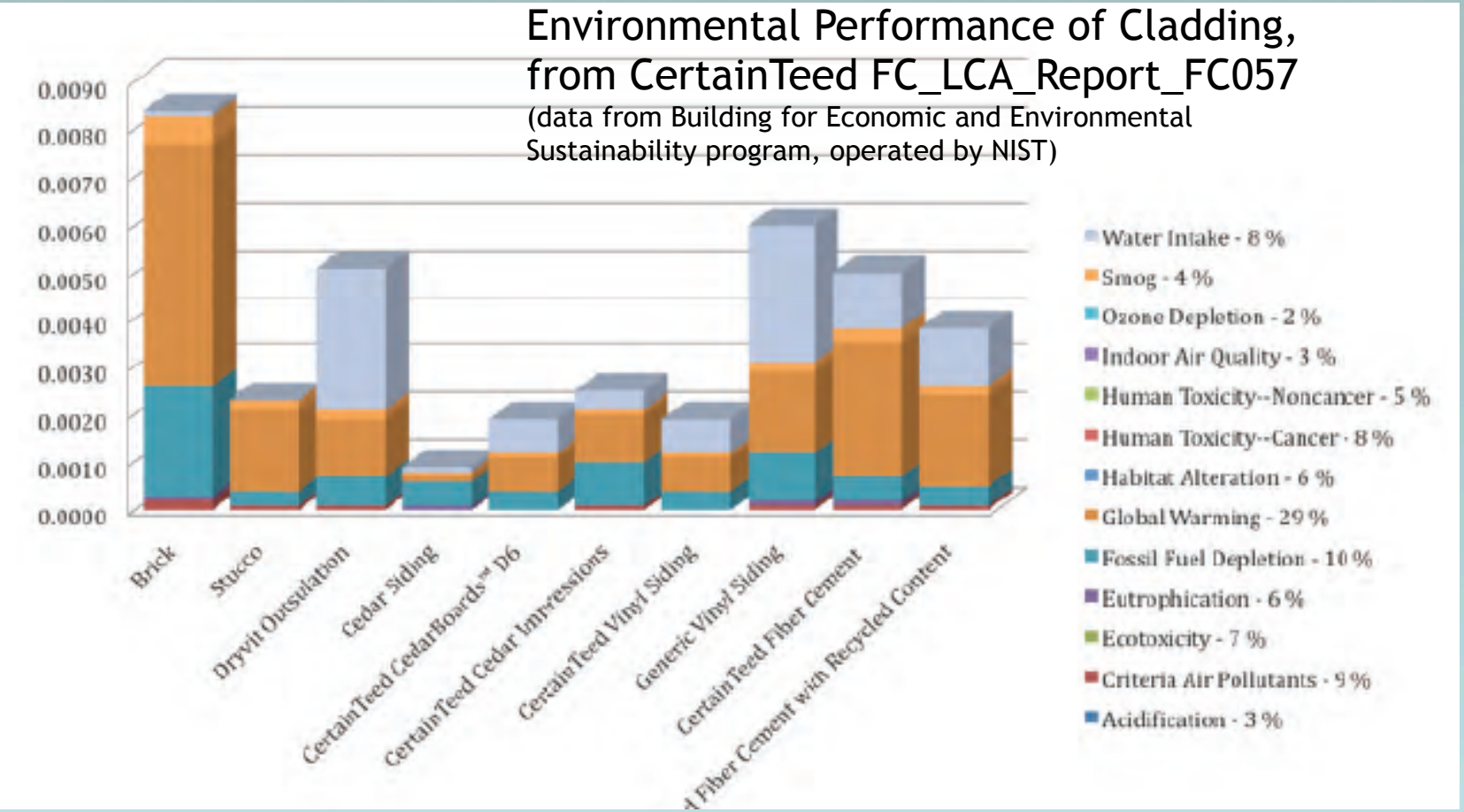


Annual New Construction #s in Austria

PHIUS
Passive House Institute US

Squirrel Hill Passive House Duplex

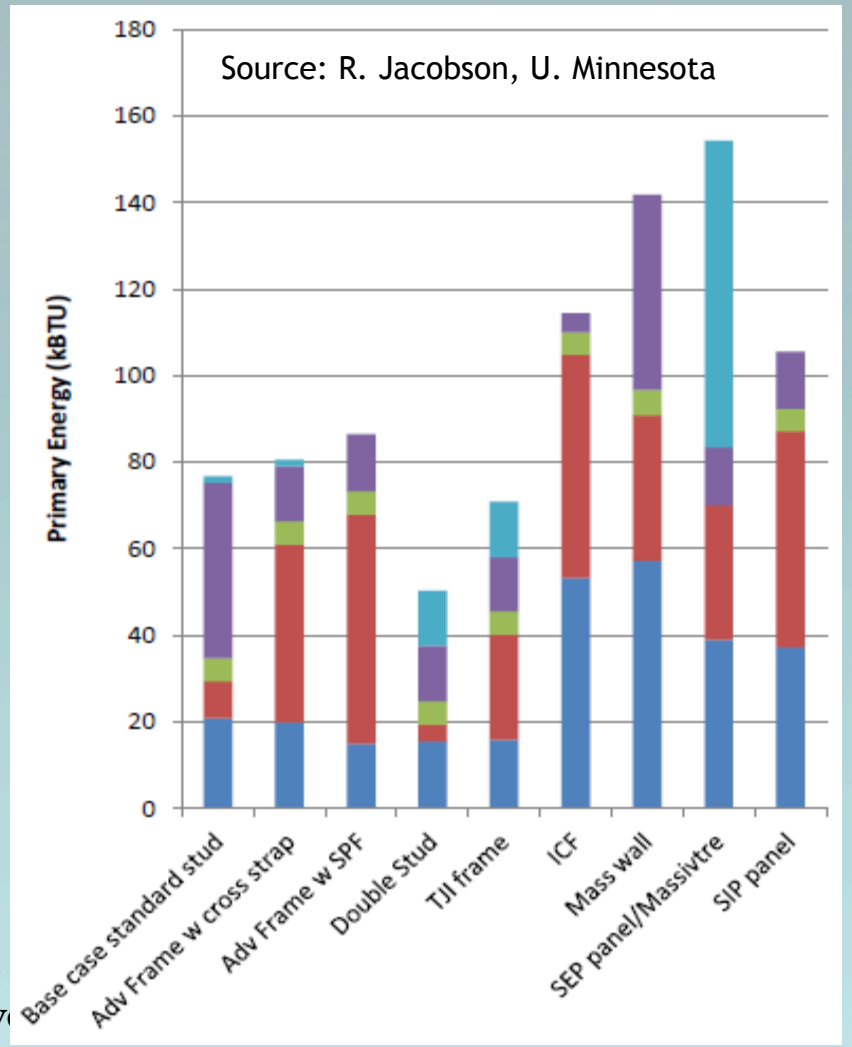
Materials differ w/respect to energy use and global warming contribution – we want to select them based on durability, cost and low impact.



Squirrel Hill Passive House Duplex

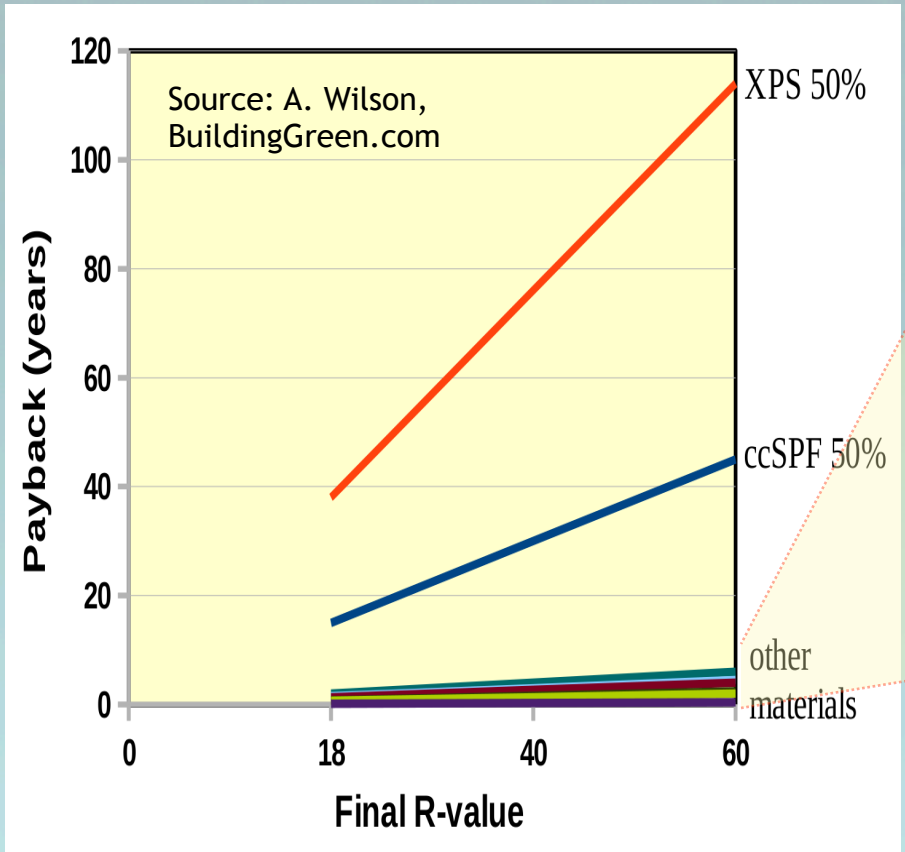
Analysis of whole wall assemblies

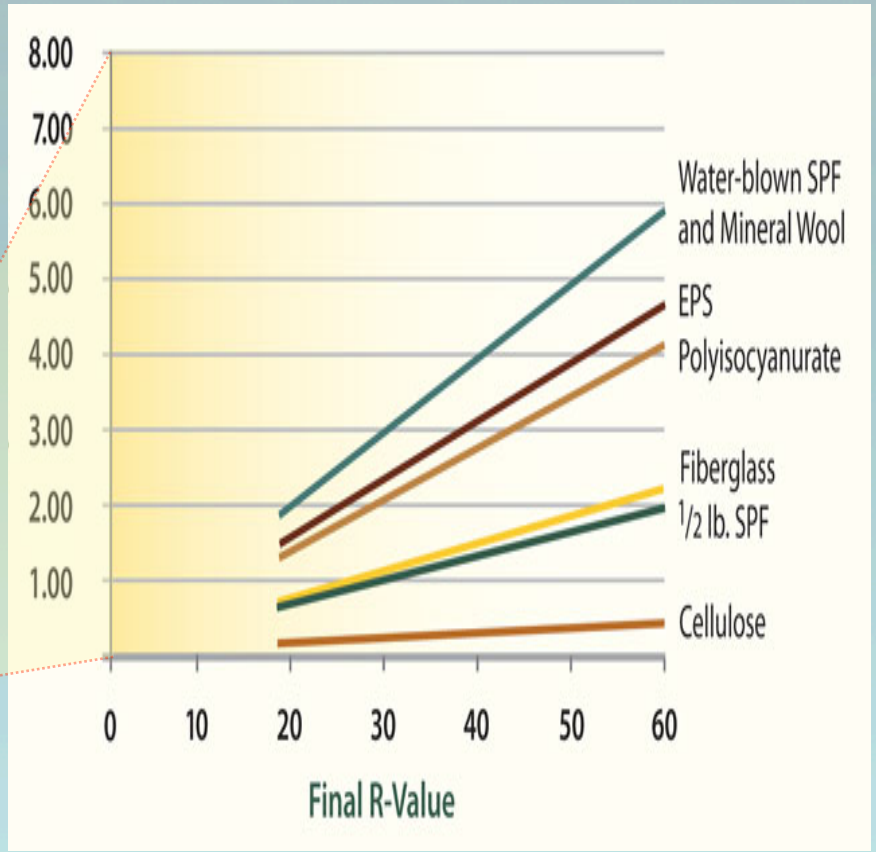
- Substantial differences between materials in terms of *primary energy* and *greenhouse gases* emitted
- This translates to differences in wall structures



Insulation materials: trade-off between reduced operating energy and emissions and materials' production, installation and off-gassing

- Time until R-5 of extra insulation saves the amount of greenhouse emissions from the material itself:





Squirrel Hill Passive House Duplex

Hempcrete – new construction material that we wished we could use

- Combination of hemp shiv and lime
- High R-value
- Hygroscopic
- Hard, durable, thermal mass
- Molds and fungus don't like it
- Non-flammable without chemicals
- "Healing of cracks"
- Cradle to cradle
- Carbon footprint: negative!
- Simplicity, beauty
- Appears too costly…

Nauhaus Project, NC

Fernwald Rd lots

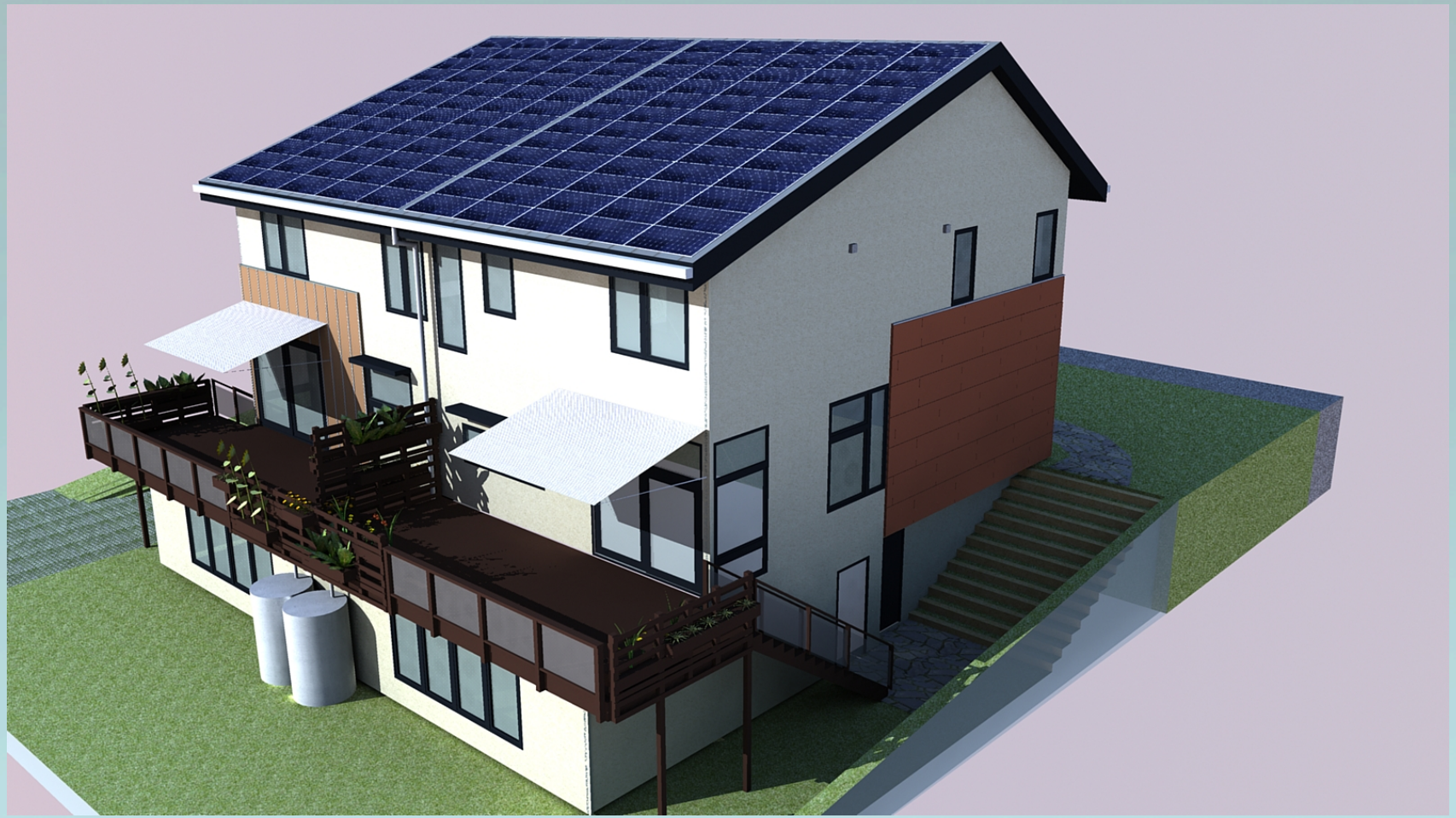
Duplex housing on street


Surrounding housing context on street

Squirrel Hill Passive House Duplex

Squirrel Hill Passive House Duplex

Squirrel Hill Passive House Duplex



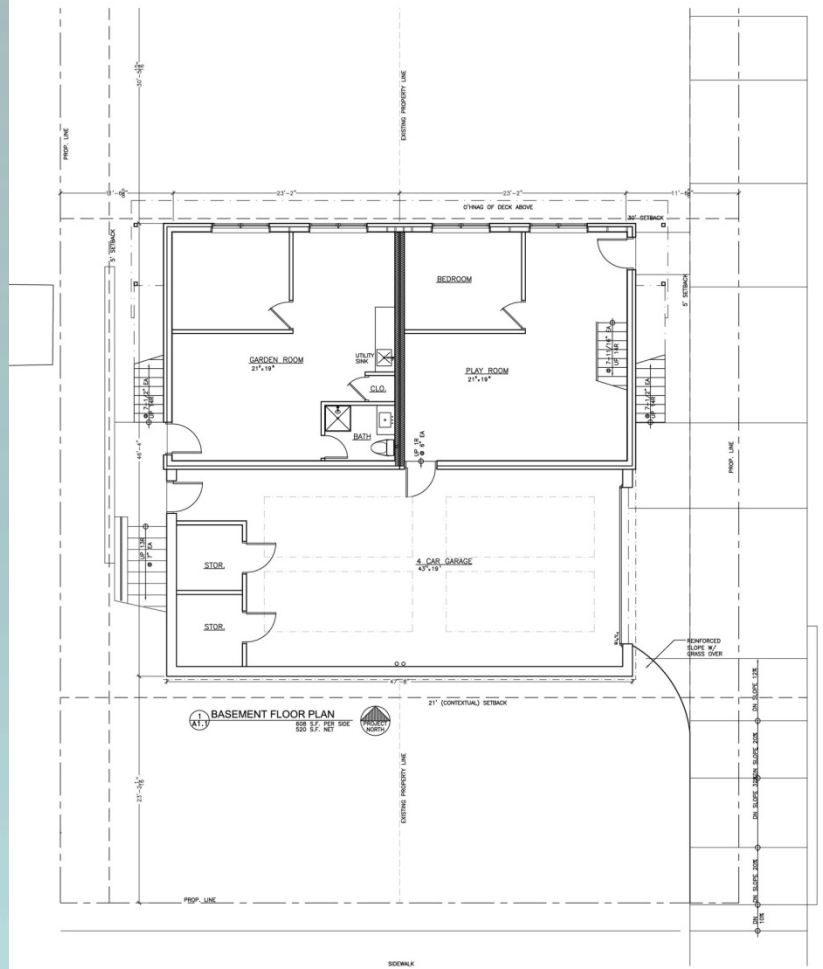
Squirrel Hill Passive House Duplex

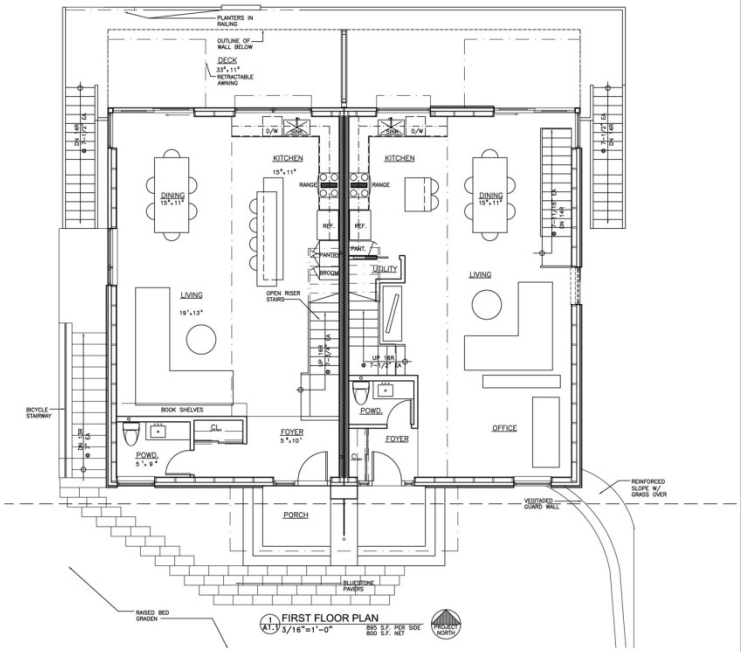
Squirrel Hill Passive House Duplex

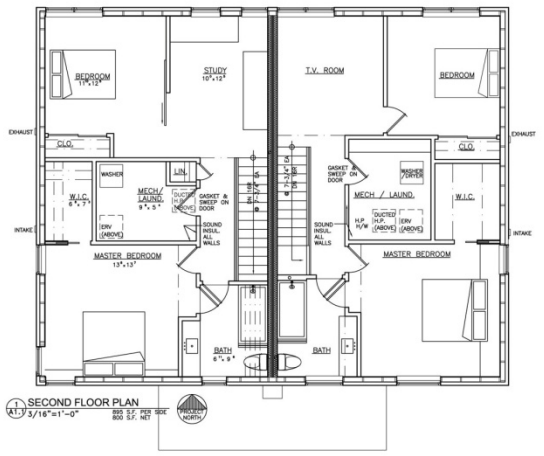
- The owners are seeking a second family to join the project / agree on pre-sale
- Permeable driveway
- 1000 gal rain water cisterns
- PV solar panels on southern roof face

Dunn and Associates Inc

PH consultant: John Semmelhack of Think Little







- 840 sf. per side per floor & 529 sf. at basement level

DUNN
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PITTSBURGH, PA 15217
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REGISTRATION:

PROPOSED

SQUIRREL HILL DUPLEX

2885-2887
FERNWALD ROAD
PITTSBURGH, PA 15217

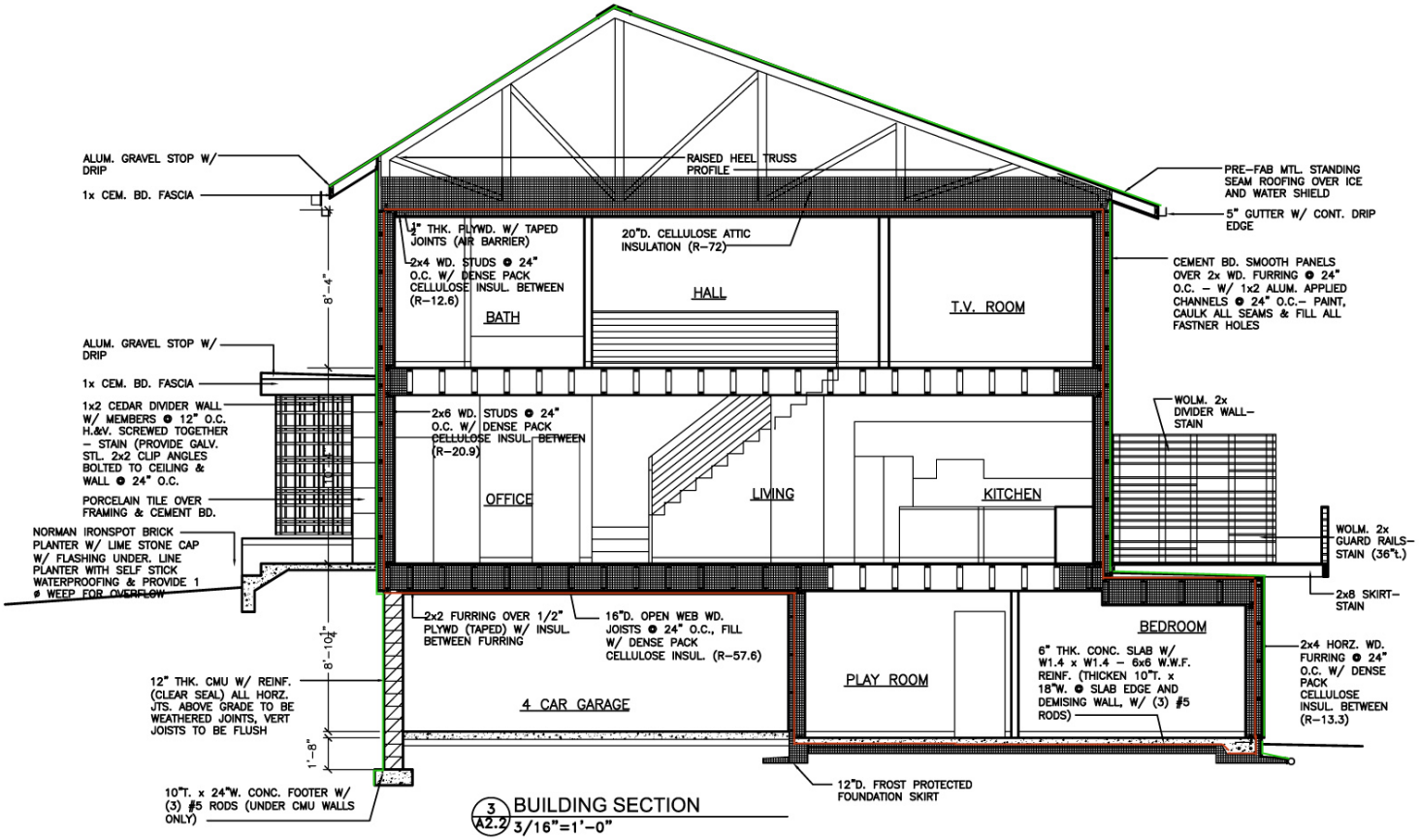
REVISIONS:

PROJECT NUMBER
DATE JUNE 21, 2013
DRAWN BY
FILE

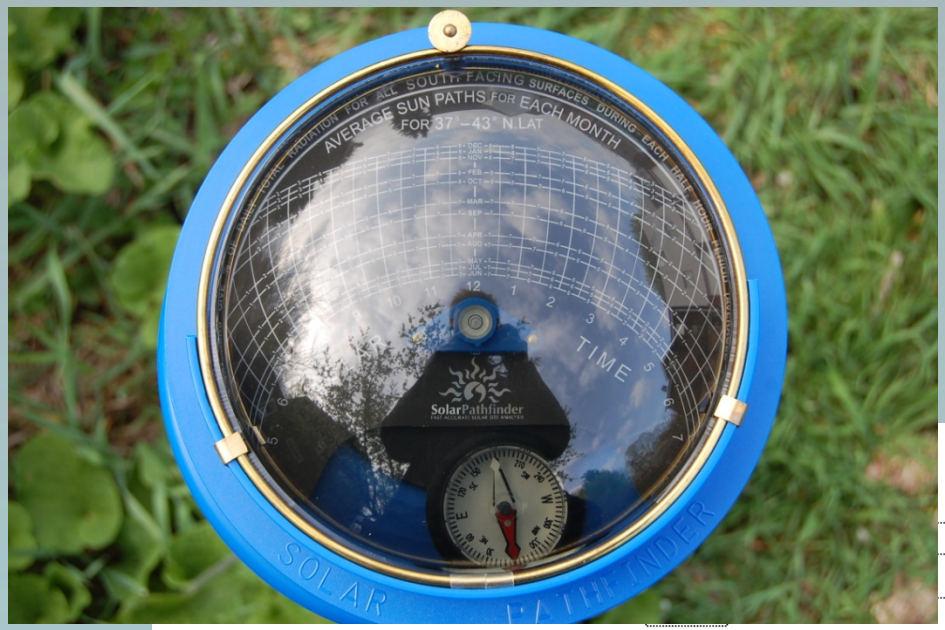
DRAWING TITLE:
FLOOR PLANS

DRAWING NUMBER:
A1.1
SHEET OF

Squirrel Hill Passive House Duplex



Squirrel Hill Passive House Duplex



Potential solar gain of 67% for the whole year

Passive House Planning

CALCULATING SHADING FACTORS

Orientation	Glazing Area ft^2	Reduction Factor r_s
North	85.9	60%
East	93.1	41%
South	261.0	83%
West	33.7	61%
Horizontal	0.0	100%

Inch/Foot Conversion Tool	
(in)	(ft)
1	0.0833333
(ft)	(in)

Description	Qty	Window Unit Label	Deviation from North	Angle of Inclination from the Horizont	Orientation	Glazing Width	Glazing Height	Glazing Area	Height of the Shading Object	Horizontal Distance	Window Jamb Reveal Depth	Distance from Glazing Edge to Reveal	Overhang Depth	Distance from Upper Glazing Edge to	Additional Shading Reduction Factor	Horizontal Shading Reduction Factor
			Degrees	Degrees		in	in	ft^2	ft	ft	in	in	in	in	%	%
						w_G	h_G	A_G	h_{Hori}	d_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{other}	r_H
wdw 1	1	unit 1 front dr sl	347	90	North	22.0	13.0	2.0								100%
wdw 1	1	unit 1 front dr sl	347	90	North	22.0	78.0	11.9	18	83	0	4	78	0	100%	84%
wdw 1	1	unit 1 front dr tr	347	90	North	32.0	13.0	2.9	18	83	0	4	78	0	100%	84%
wdw 2	1	unit 2 front dr sl1	347	90	North	6.0	78.0	3.2	18	83	0	4	78	0	100%	84%
wdw 2	1	unit 2 front dr tr	347	90	North	32.0	13.0	2.9	18	83	0	4	78	0	100%	84%
wdw 2	1	unit 2 front dr sl2	347	90	North	12.0	83.0	6.9	18	83	0	4	78	0	100%	84%
wdw 3	1	wdw 3	347	90	North	44.2	14.2	4.3	18	83	0	4	48	132	100%	84%
wdw 4	1	wdw 4	347	90	North	28.0	46.0	8.9	18	83	0	4	48	0	100%	84%
wdw 5	1	wdw 5	347	90	North	20.2	38.2	5.3	18	83	0	4	48	12	100%	84%
wdw 6	1	wdw 6	347	90	North	40.2	14.2	3.9	18	83	0	4	48	36	100%	84%
wdw 7	1	wdw 7	347	90	North	46.2	44.2	14.2	18	83	0	4	48	0	100%	84%
wdw 8	1	wdw 8 lower	347	90	North	38.2	44.2	11.7	18	83	0	4	48	104	100%	84%
wdw 9	1	wdw 9	257	90	West	32.2	44.2	9.9	21	26	0	4	14	120	100%	53%
wdw 10	1	wdw 10 lower	257	90	West	38.2	44.2	11.7	21	26	0	4	14	204	100%	53%
wdw 11	1	wdw 11 upper	257	90	West	46.0	19.0	6.1	21	26	0	4	14	125	100%	53%
wdw 11	1	wdw 11 lower	77	90	East	46.0	72.0	23.0	20	17	0	4	14	218	100%	42%
wdw 12	1	wdw 12	77	90	East	26.2	44.2	8.0	20	17	0	4	14	61	100%	42%
wdw 13	1	wdw 13	77	90	East	26.2	44.2	8.0	20	17	0	4	14	120	100%	42%
wdw 14	1	wdw 14 upper	77	90	East	40.0	19.0	5.3	20	17	0	4	14	175	100%	42%
wdw 14	1	wdw 14 lower	77	90	East	38.2	44.2	11.7	20	17	0	4	14	204	100%	42%

Windows Selection…

- Current plan: Klearwall EcoClad, PH certified
- U value, total window 0.1
- Glazing area as a % of Gross floor area = average 10.2% (south side: 22.1%)
- SHGC 0.39 on the south/east side to reduce overheating in shoulder seasons
- SHGC 0.49 on the north/west side
- Warranty: 15 years
- Wood type: pine
- Note: limitation on window size in height to 4’6” for tilt/turn

Summary of R-values for various assemblies of Squirrel Hill PH Duplex

Passive House Planning

R - LIST

Compilation of the building elements calculated in the R-Values worksheet and other construction types from databases.

Type	Total Thickness	R-Value
Assembly Description	in	(hr.ft^2.F/BTU)
basement slab	12.0	26.2
1st and 2nd floor walls	15.1	44.8
Insulated ceiling below attic	24.5	83.4
basement walls	14.0	9.7
Basement wall @ garage	12.4	35.9
Insulated floor over garage	17.9	52.5
door	1.0	6.2
Recommended 1-hr party wall	9.8	27.6
Alt wall #1	12.3	36.8
Alt wall #2	10.5	33.9
2x6 wall + 2x4 horizontal strapping	10.7	33.5
Alt wall #4	10.7	36.6
	0.0	

Investigations and challenges with Wall Design

- Wood framing and cellulose preferred due to lowest environmental impact
- 2x6 w/cellulose, plywood, 2x4 horizontal strapping w/cellulose better than double wall or 2x10 wall
- Traditional stucco will not work well with wood wall; specialized "Sto Quick Silver Next Drain Screen Cement Board Stucco"
- Brick veneer for this house would be equivalent to burning 2550 gallons of gasoline, rejected
- We learned that Hardi supports fiber cement panel installation over rain screen only if aluminum reveal is used, rejected
- Using other manufacturers/thicker panels can double the cladding LCA impact, not desirable
- "StoTherm Next with StoGuard Moisture Protection" EIFS.. ? Not insured in PA…

Wall Design Options We Are Considering:

Hardi-panel Wall #1 "horizontal strapping"	Stucco wall #1 "horizontal strapping"
drywall	drywall
2x6 w/ cellulose	2x6 w/ cellulose
plywood sheathing w/ taped seams	plywood sheathing
2x4 (horizontal) w/ cellulose	2x4 (horizontal) w/ cellulose
fiberboard sheathing	Dens-Glass sheathing (or similar)
housewrap	Sto-Emerald Coat
3/4" vertical furring strips	Sto Drain Screen
cement-board panels	Sto-cement board
	Sto-synthetic stucco
Total $17.72 /sf	Total $20.85 /sf

Wall can dry-out to both sides and thermal bridges from wood are minimized

Hempcrete wall	EIFS wall
interior plaster	drywall
12-14" hempcrete wall around 2x6 framing	2x6 w/ cellulose
exterior stucco	plywood sheathing
	Sto-Gold Coat
	3-4" EPS
	Sto-synthetic stucco
Total $28 ($20)/sf brand (off-brand)	Total $14.62/sf

Verification:

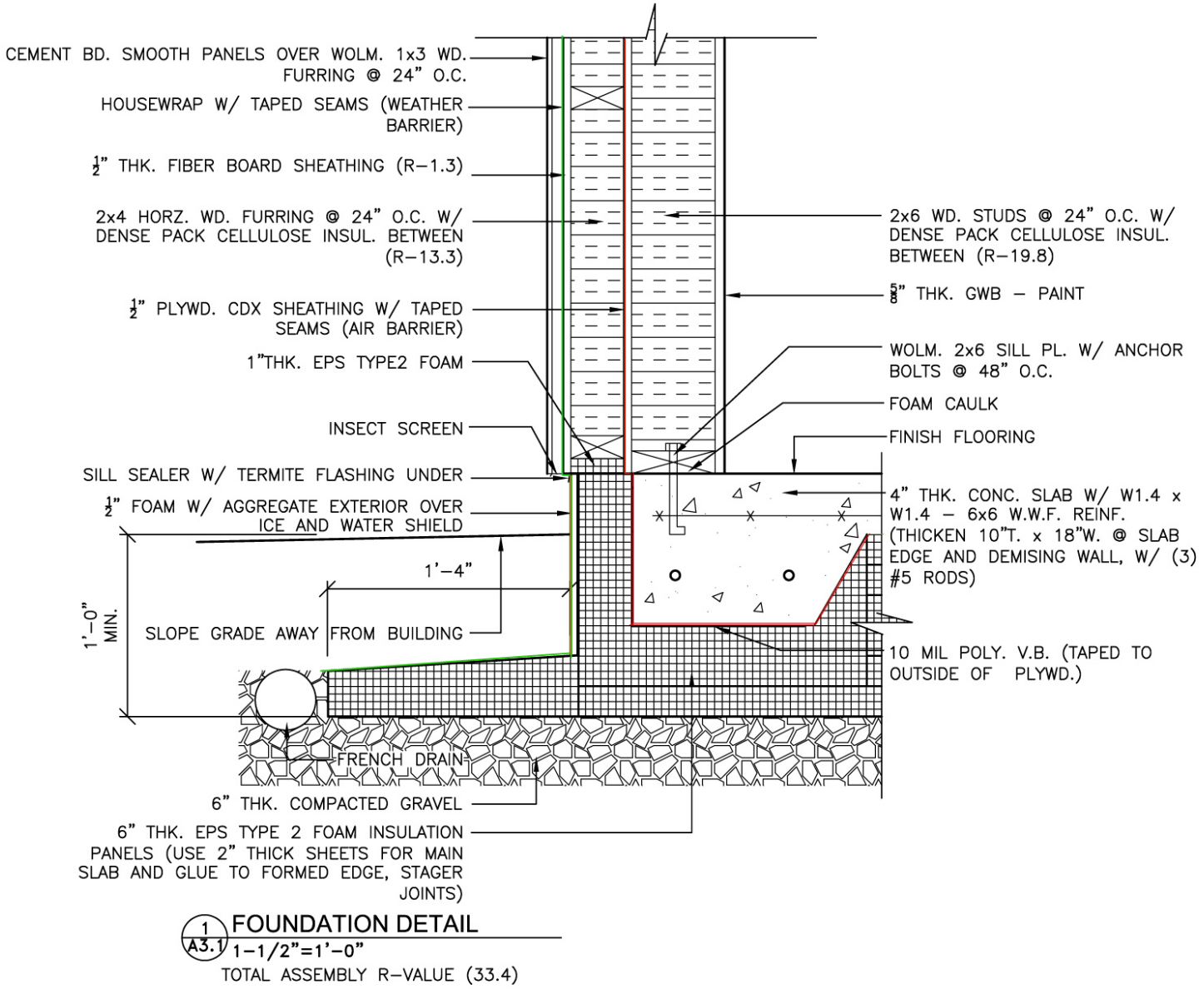
Energy Demands with Reference to the Treated Floor Area						
Treated Floor Area:	4221	ft²				
	Applied:	Monthly Method			PH Certificate:	Fulfilled?
Specific Space Heat Demand:	4.06	kBTU/(ft²yr)		4.75	kBTU/(ft²yr)	Yes
Pressurization Test Result:	0.60	ACH_{60}		0.6	ACH_{50}	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	32.6	kBTU/(ft²yr)		38.0	kBTU/(ft²yr)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	15.9	kBTU/(ft²yr)				
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kBTU/(ft²yr)				
Heating Load:	3.51	BTU/(ft²hr)				
Frequency of Overheating:		%	over	77.0	°F	
Specific Useful Cooling Energy Demand:	0.52	kBTU/(ft²yr)		4.75	kBTU/(ft²yr)	Yes
Cooling Load:	1.83	BTU/(ft²hr)				

We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The calculations with PHPP are attached to this application.

issued on:

signed:

Squirrel Hill Passive House Duplex



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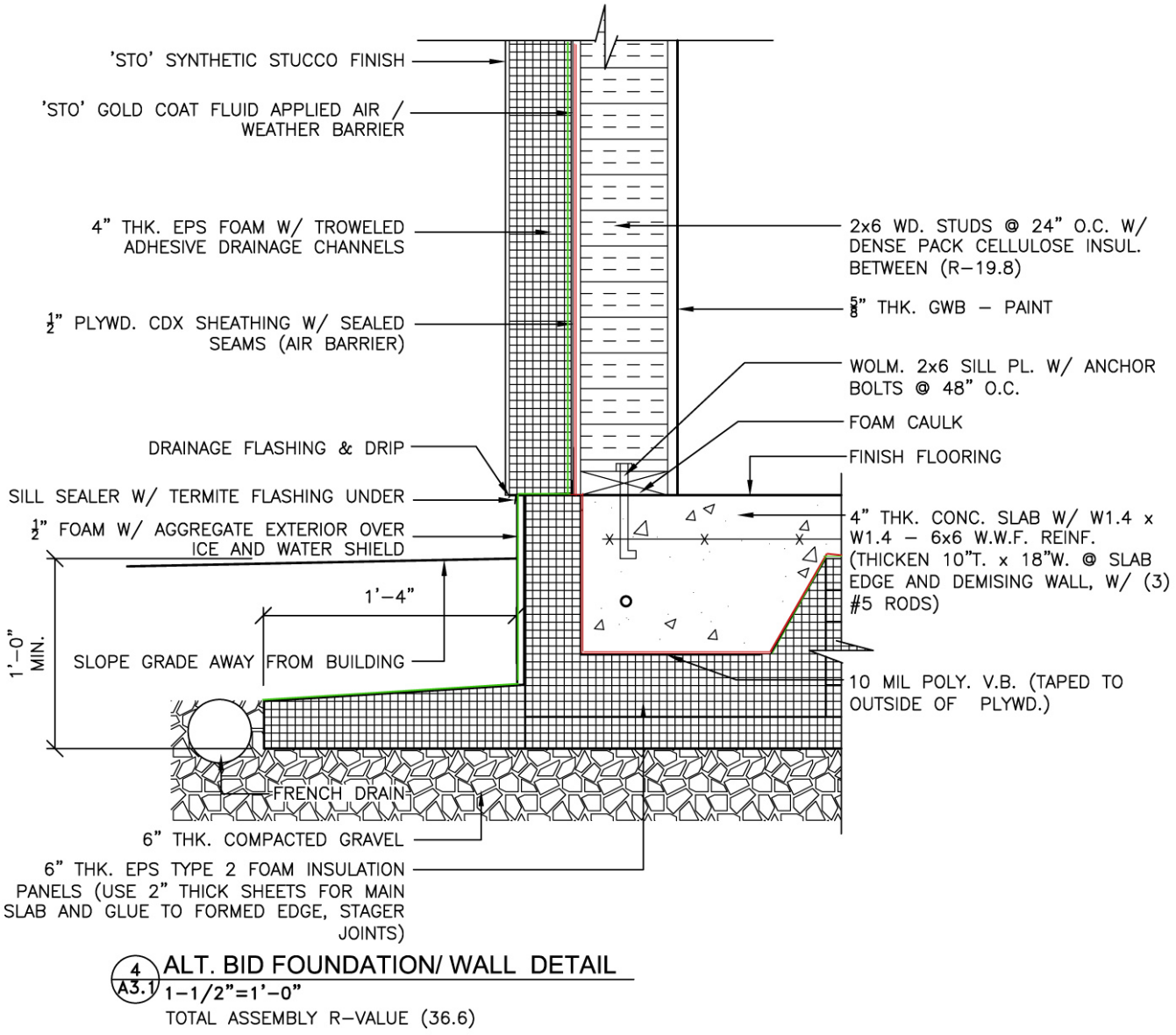
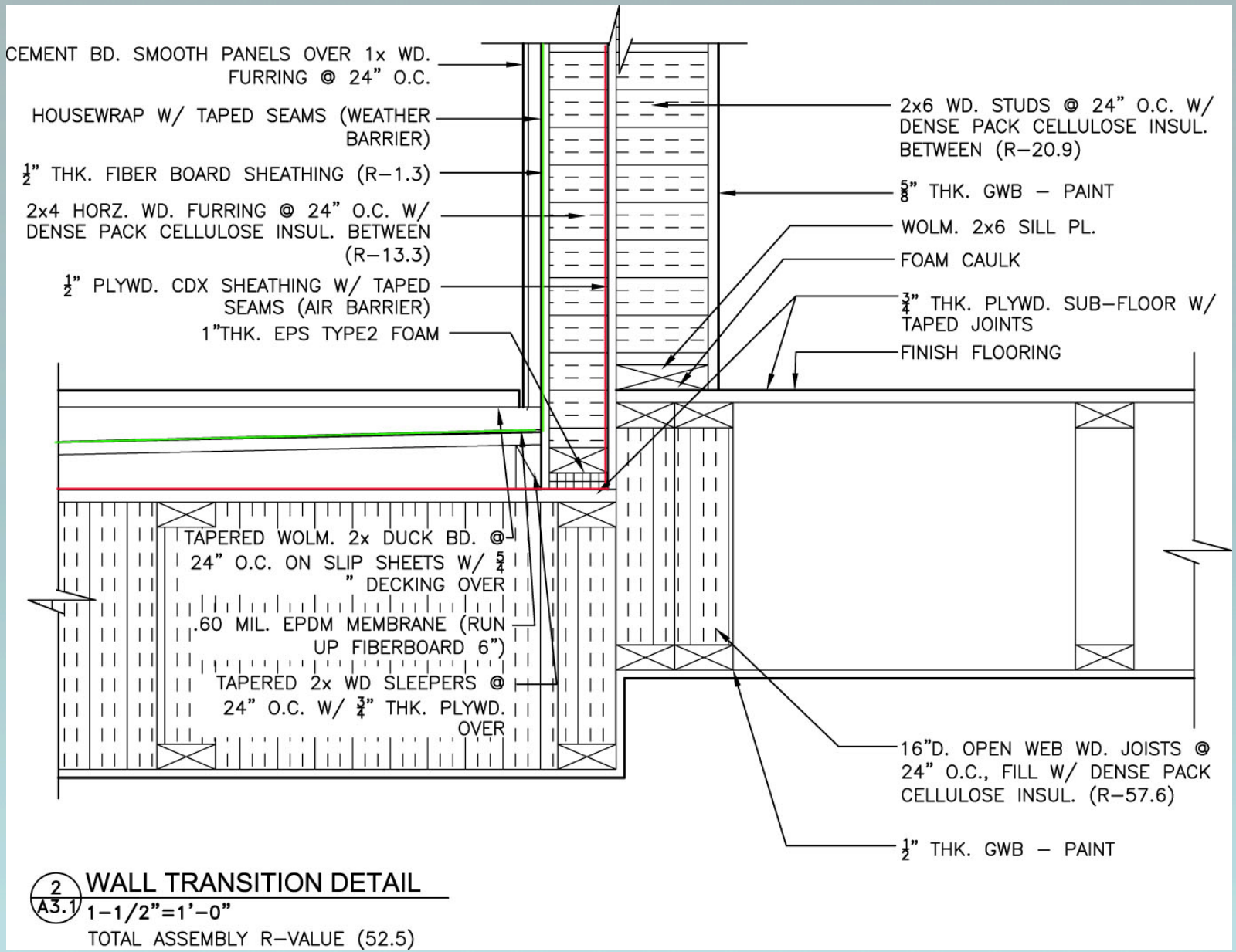


4 / A3.1 ALT. BID FOUNDATION/ WALL DETAIL

1-1/2"=1'-0"

TOTAL ASSEMBLY R-VALUE (36.6)

Squirrel Hill Passive House Duplex



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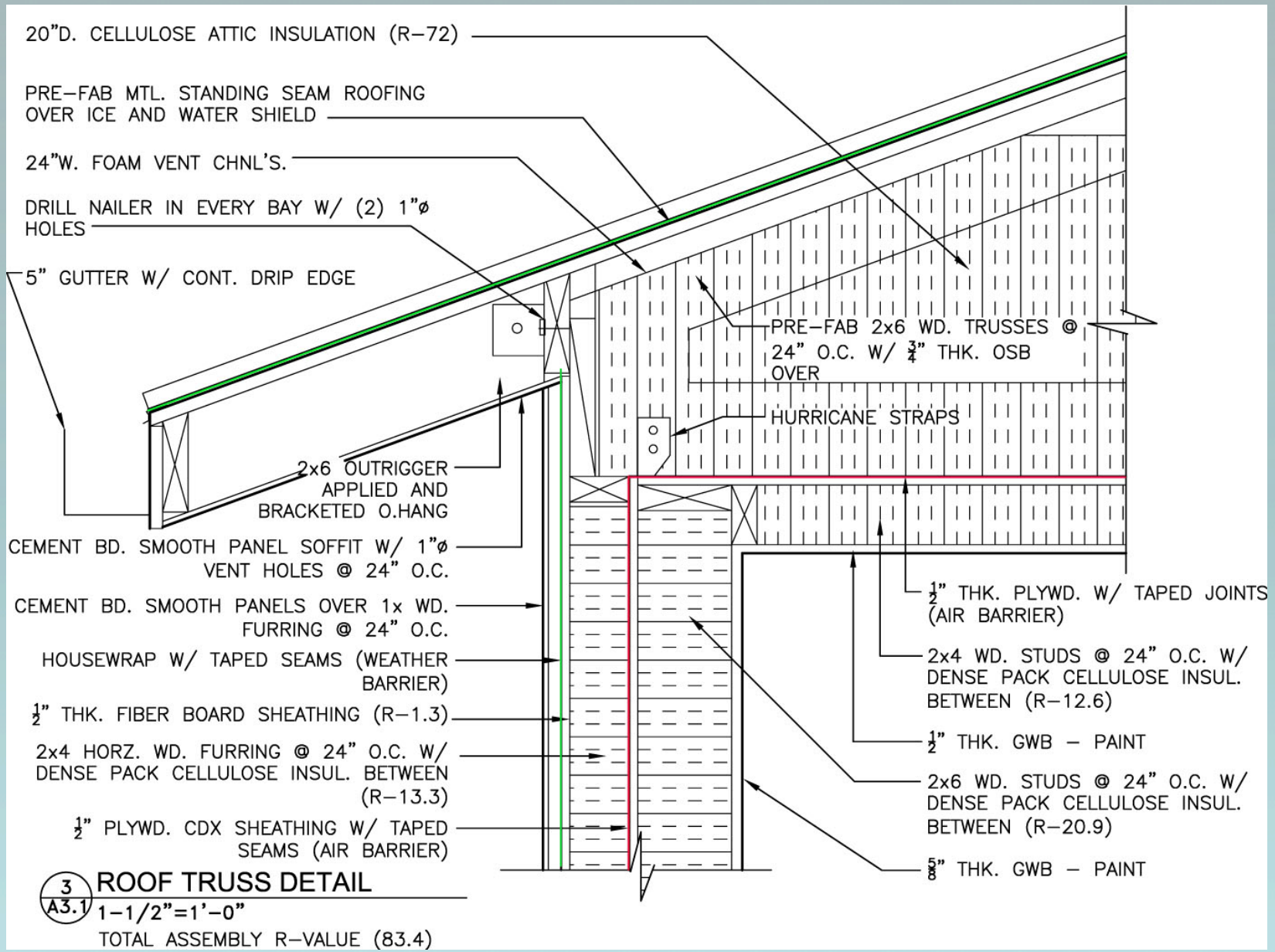
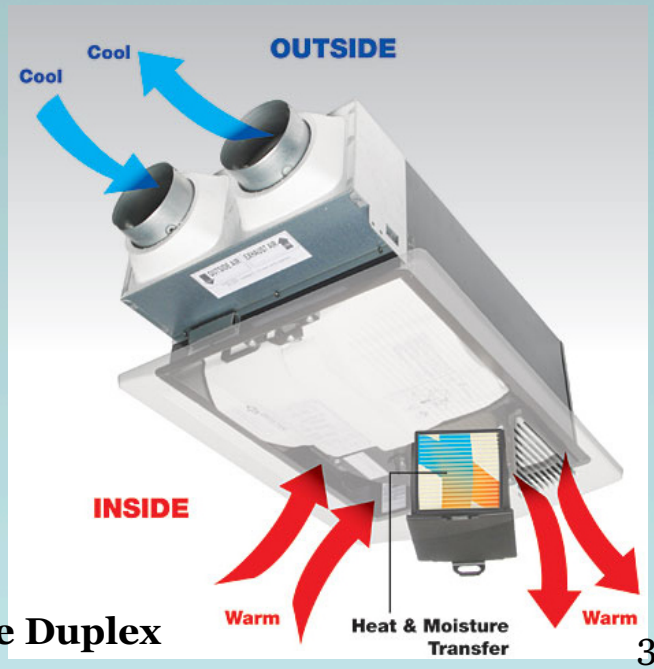
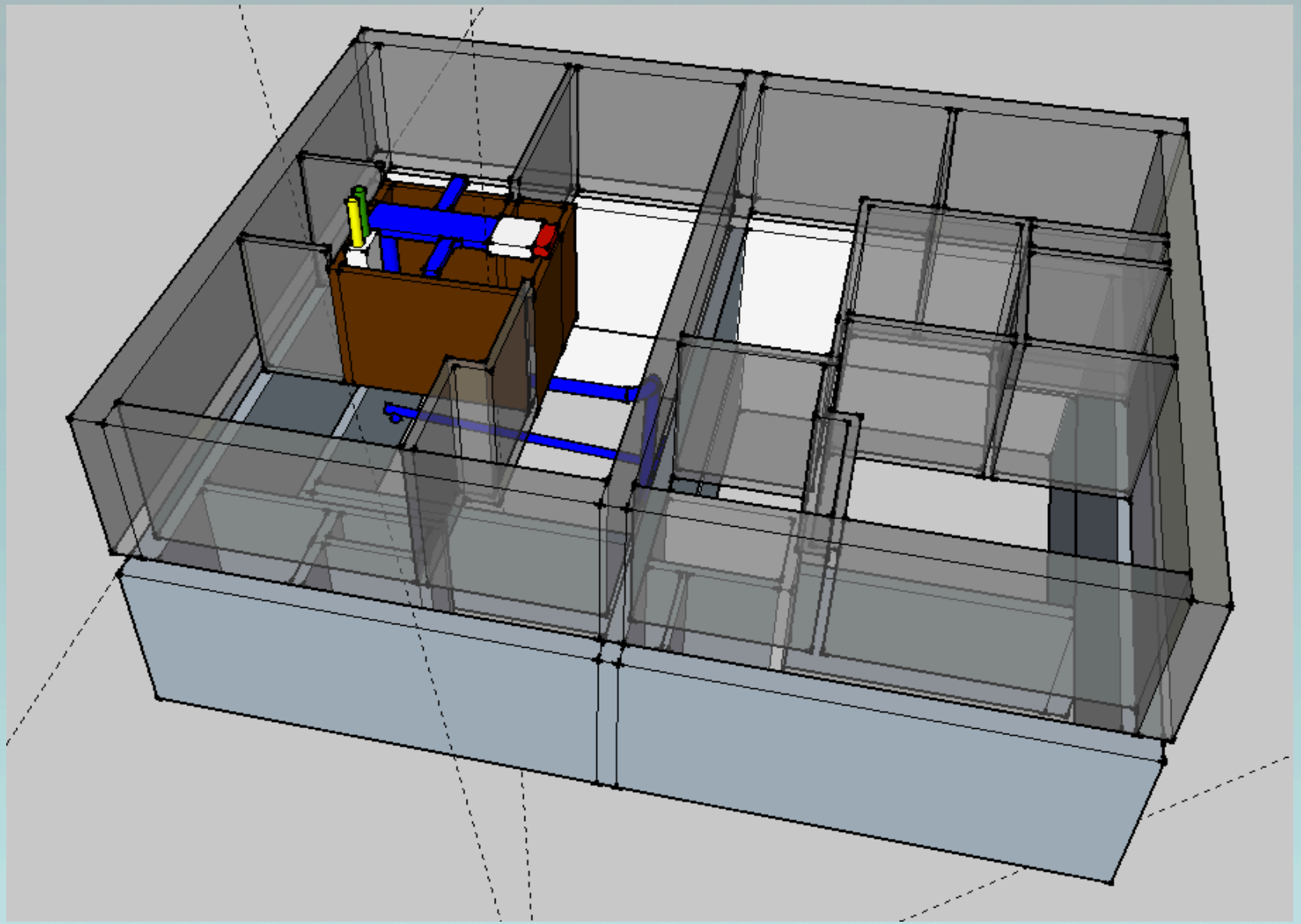


Squirrel Hill Passive House Duplex

Mechanical Systems

- Fujitsu 12kBtu/hr ducted heat pump for both heating and cooling
- Zehnder Comfo 200 ERV for continuous ventilation with energy recovery
- Each system will have its own set of ducts to allow proper balancing of each function





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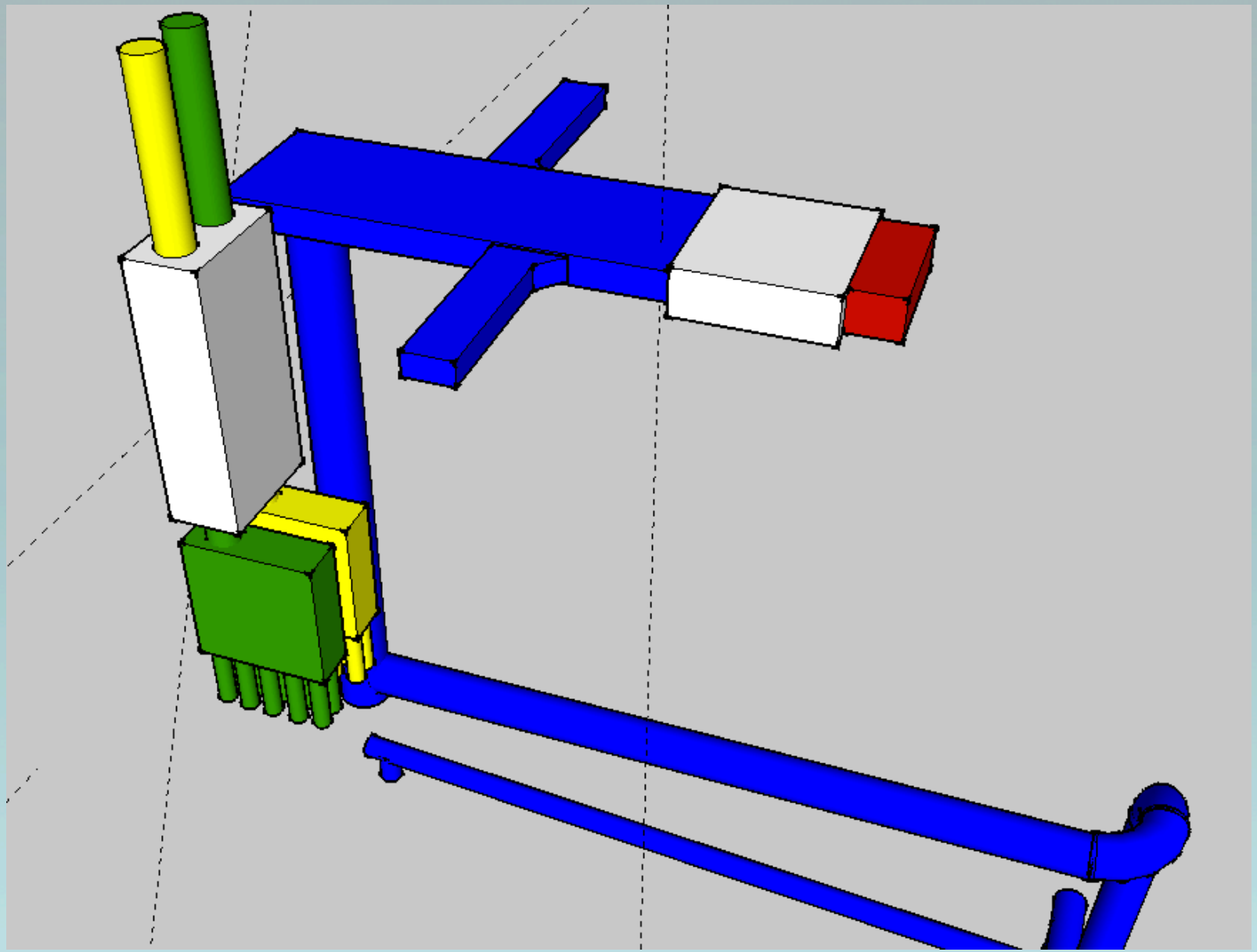

Squirrel Hill Passive House Duplex

Current Status

- Pittsburgh's housing market still very affordable: the median listing price: $129,000
- This neighborhood /zip area: $310,000
- This street: ~$220,000
- Current estimated cost of construction for each unit: $358,000; total cost ~$500k.
- When starting, we expected the cost of new construction to be more affordable than PH retrofit; may not be true in Pittsburgh…
- Cost substantially exceeds the real estate appraisal for this house; challenging esp. due to duplex design and the need to find buyer for the second half.

Despite challenges, we are still committed to PH standard

References

- http://sites.google.com/site/phconferenceoct172009/home
- http://www.mnshi.umn.edu/
- http://www.thenauhaus.com/
- http://www.igpassivhaus.at/
- https://wiki.umn.edu/pub/PA5721_Building_Policy/WebHome/LEEDENERGYSTAR_STUDY.pdf
- http://dsexteriors.com/certainteed-life-cycle-assessment-report/