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## Who We Are: C&H Architects



c&h architects: design for the next hundred years.

designing buildings that are loved in the region where we live, for mission-driven clients with residential and institutional projects.

## Tom Hartman - Principal



## Bruce Coldham – Principal Emeritus



## Andrew Webster – Designer / Project Manager



## **Who Are You?**

## **Deep Energy Retrofits**

Farmhouse



Coldham&Hartman Architects  
www.coldhamandhartman.com 133 Pine Street Amherst, MA 01002 T 413.548.3616 F 413.548.6832  
Inspired by Marc Rosenbaum, Energysmiths



Extended  
Family



Inspired by Marc Rosenbaum, Energysmiths

Coldham & Hartman Architects

www.coldhamandhartman.com 150 Pine Street, Amherst, MA 01002 T 413.549.3816 F 413.549.6902

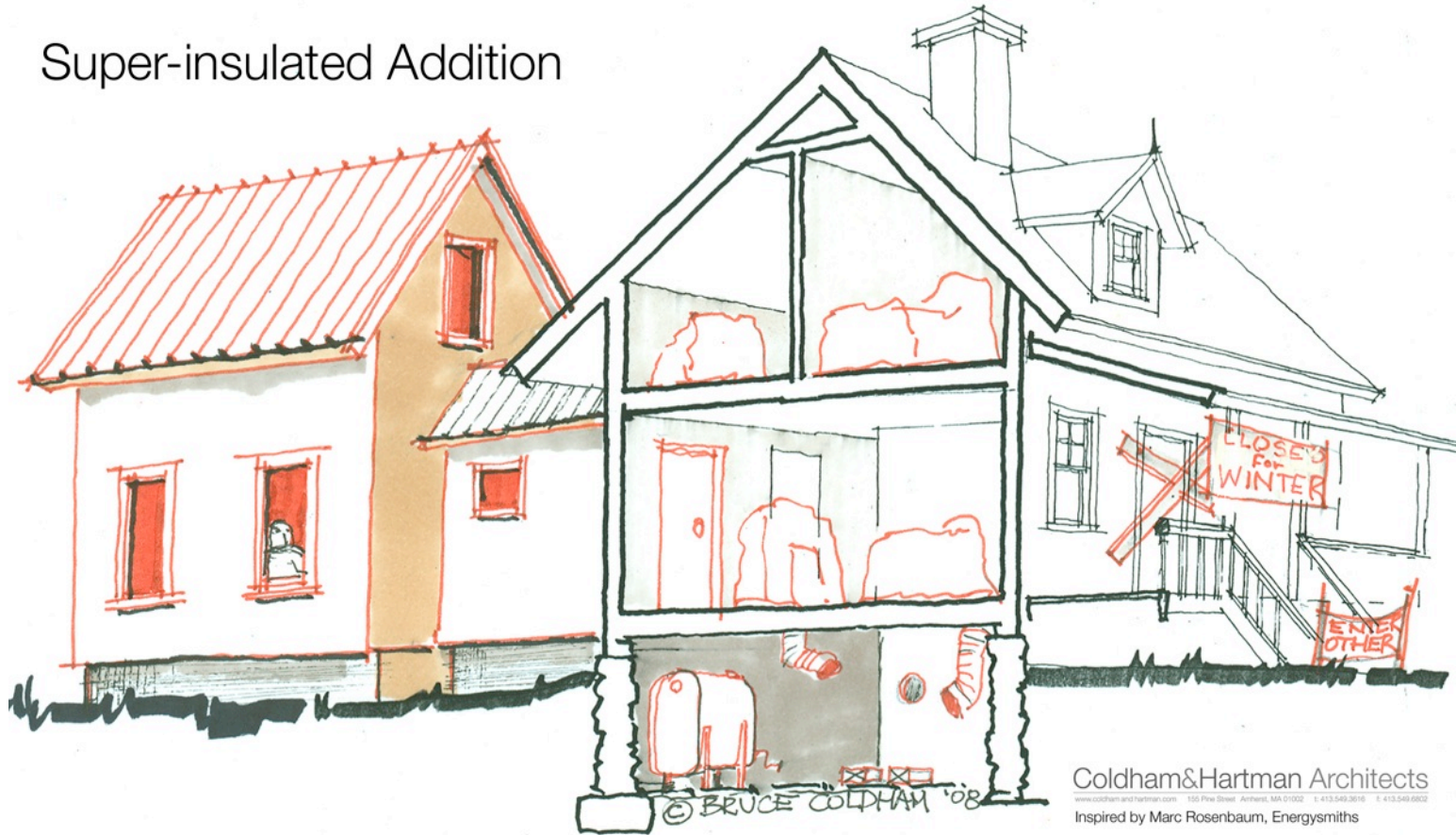
Cocoon



Pull back

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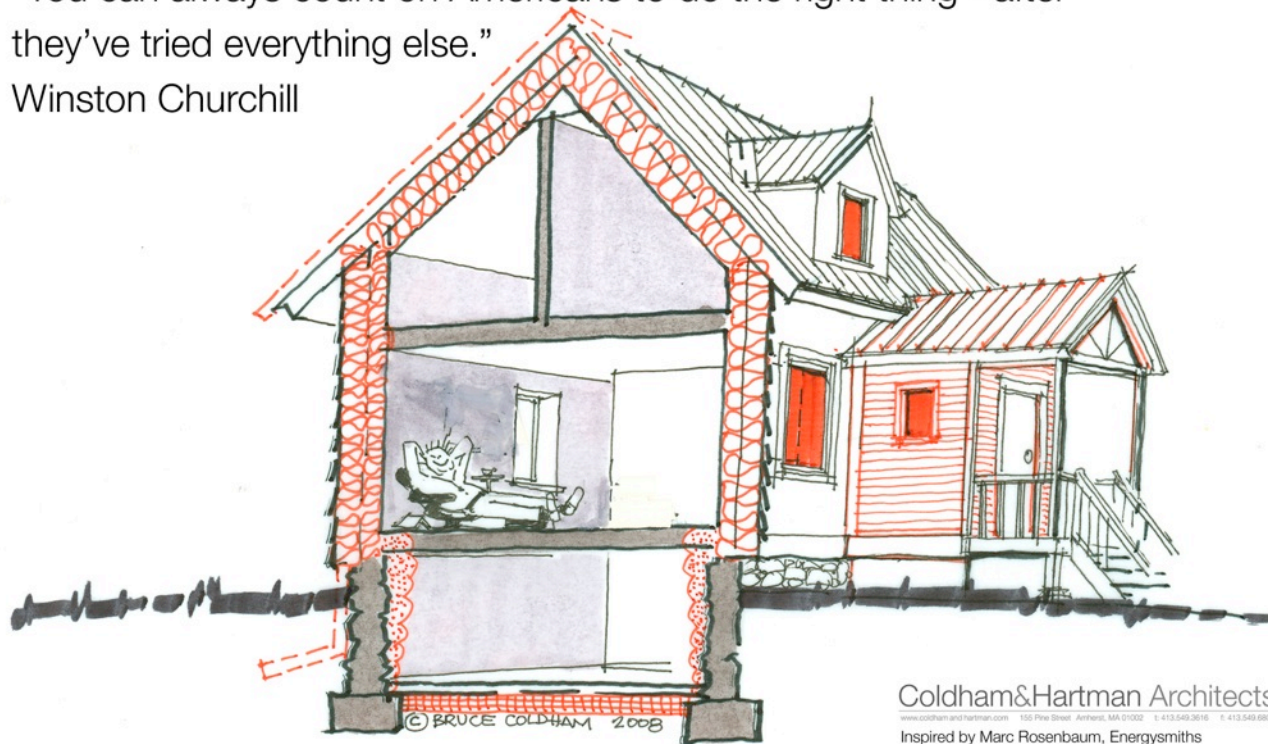
Super-insulated Addition



## Deep Energy Retrofit, aka Fix It

“You can always count on Americans to do the right thing - after they’ve tried everything else.”

Winston Churchill



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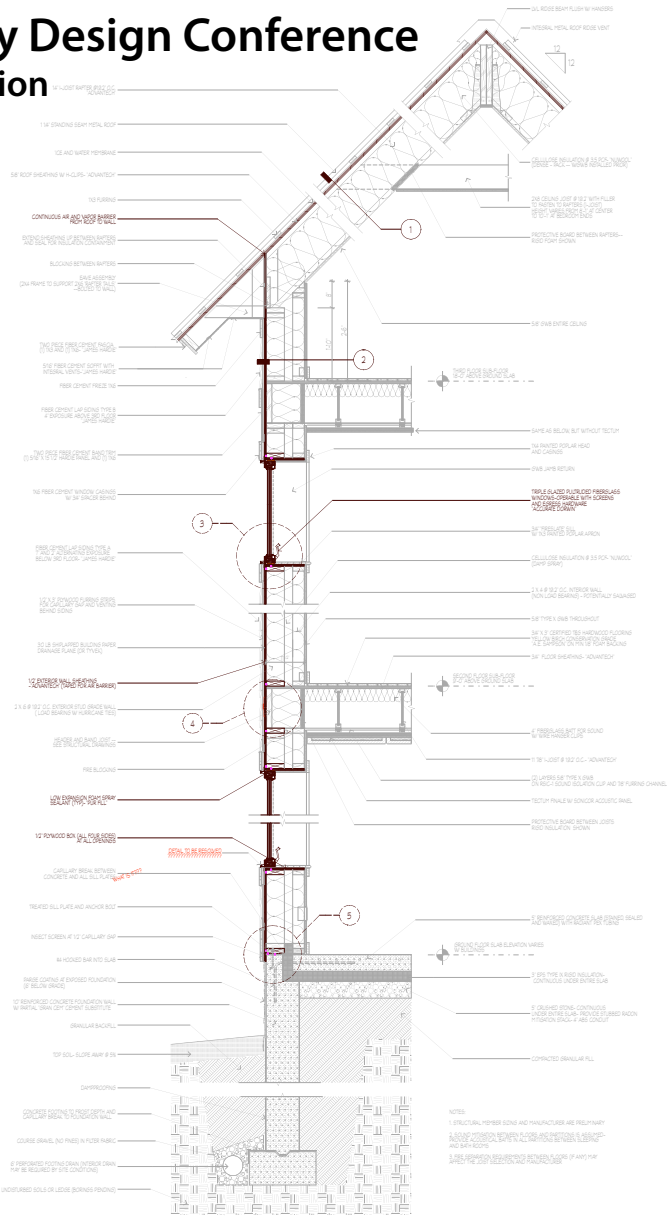
## First Forays – 2008 – Cottage Street - Gut



Ross came to us with this

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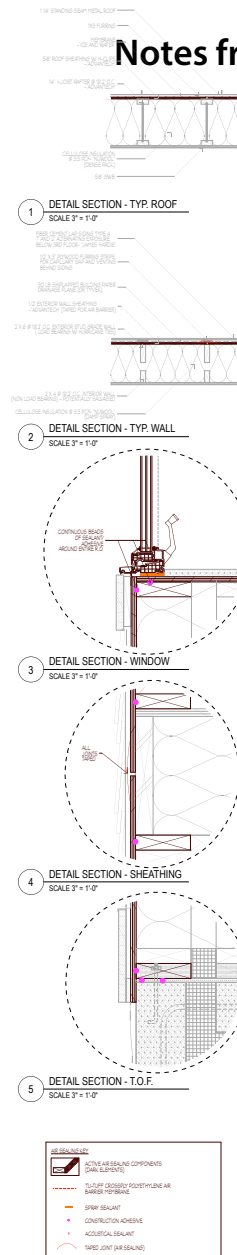
# Energy Design Conference Revolution



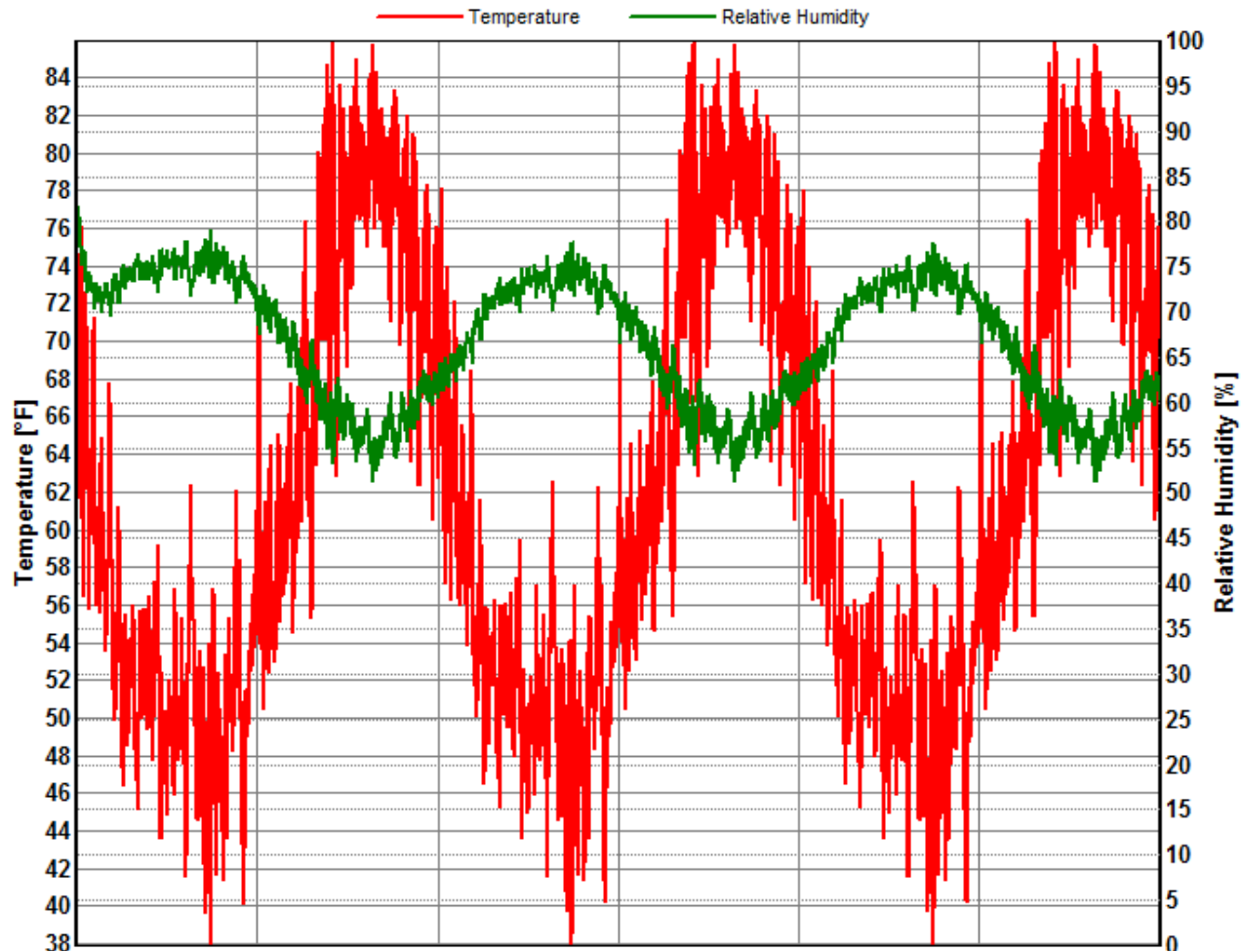
## Notes from the Frontlines of the Deep Energy

# 2004 – 12" Double Stud with DPC (typ.)

# At CoA (new construction) – first exterior air barrier (at sheathing) achieves exceptional air tightness.



## Concern – by WUFI



And even that gave us  
concern

# Cottage Street – Hemming and Hawing with Numbers

Heat Loss Component Budget			
Ross Residence- Proposed			
R VALUES		Design Temperature Diff.	69
2x4 Wall, 3" Ext. Foam	30	Flat Ceiling R Value	1
Wall Type 2	1	Joist Bays	14
Floor over air	1	Skylight R Value	1
Window R Value	5	1/2 Glass Door R Value	4
Sloped Ceiling R Value	42	Full Glass Door R Value	3
Slab edge	1	Basement Wall R Value	14
ELEMENT	AREA	AU	
2x4 Wall - 3" Ext. Foam	2,680	88.60	
Basement Wall	267	72.75	Basement perimeter
Slab edge	x	104.25	Slab edge perimeter
7" Wall	0	0.00	
Floor over air	0	0.00	
Joist Bays	112	7.78	
Window	330	66.00	
Sloped Ceiling	1,775	42.47	
Flat Ceiling	0	0.00	
Skylight	0	0.00	
1/2 Glass Door	42	10.50	
Full Glass Door	21	7.00	
Ventilation (@75% eff.)		18.90	Ventilation system capacity
Composter exhaust		0.00	ventilation rate
INFILTRATION Volume (cu.ft)	ACH (Nat)	Equiv. AU	
32000	0.20	115.20	
AU Conduction Only		399.35	
AU Total (Btu/deg/hr)		533.45	
Design Heat Loss, BTU/Hr	36,808		(capacity of heater required)
Design Heat Loss, Kw	10.78		
Floor area,sf (finished, incl. attic)	2700		
	13.6		Design heat loss per unit area

**4" Wall Cavity with Exterior Rigid Foam**

Cavity depth (inches)	4	
Continuous insulation depth (inches)	3	
Stud Cavity Depth (inches)	4	
Stud/XPS Thermal Resistance (R/inch)	5.69	22.75
Stud % of wall surface area	0.24	
Cavity/XPS Thermal Resistance (R/inch)	8.19	32.75
Cavity insulation thermal resistance (R/inch)	3.5	1cynene
Continuous insulation thermal resistance (R/inch)	6.25	Polyiso Board
System R Value	<b>29.62</b>	

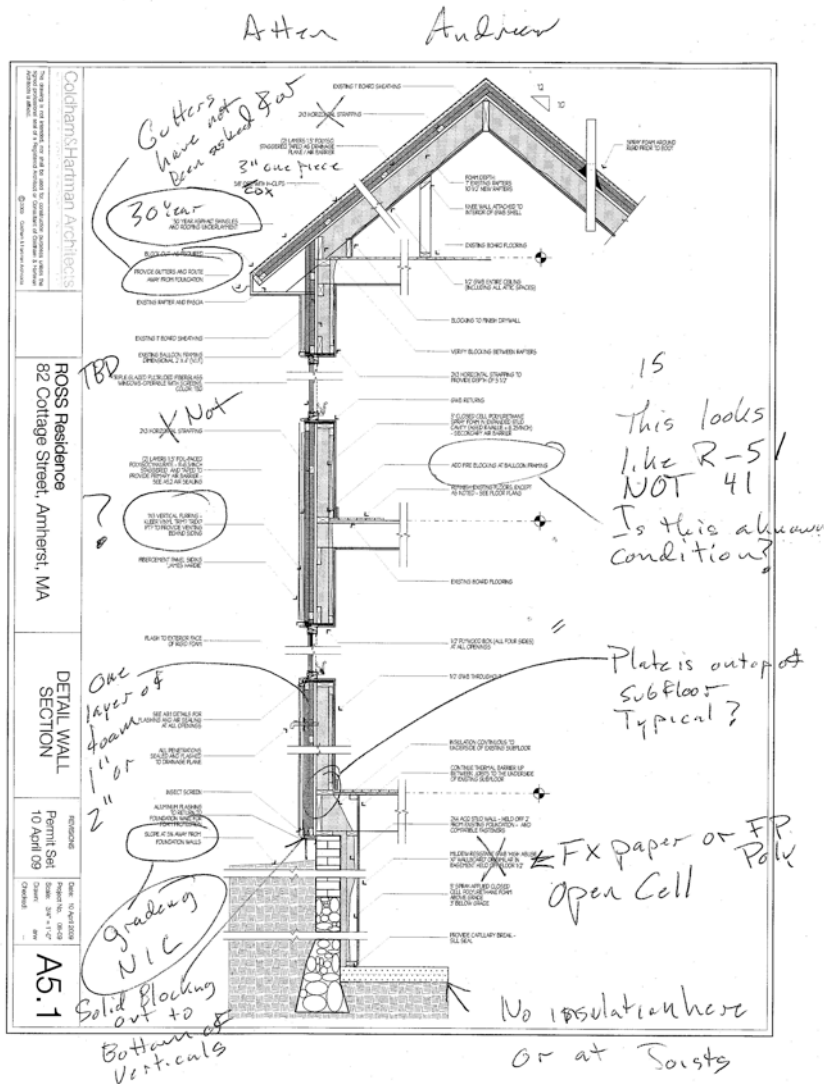
**2 x 4 wood stud @16" frame with 2 x 3 horiz. strapping @16"**

Stud Depth (inches)	4	
Strapping Depth (inches)	1.5	
Zone A – percentage of wall area	75.00%	all insulation
Zone B – percentage of wall area	15.00%	all wood
Zone C – percentage of wall area	5.00%	insulation plus strapping
Zone D – percentage of wall area	5.00%	insulation plus stud
Insulation Depth (inches)	5.5	
Wood Framing Thermal Resistance (R/inch)	1.00	
Insulation Thermal Resistance (R/inch)	6.25	
System R Value	22.72	34.375

**Add 1.5" Polyiso Board to the exterior - no Thermal Bridge**

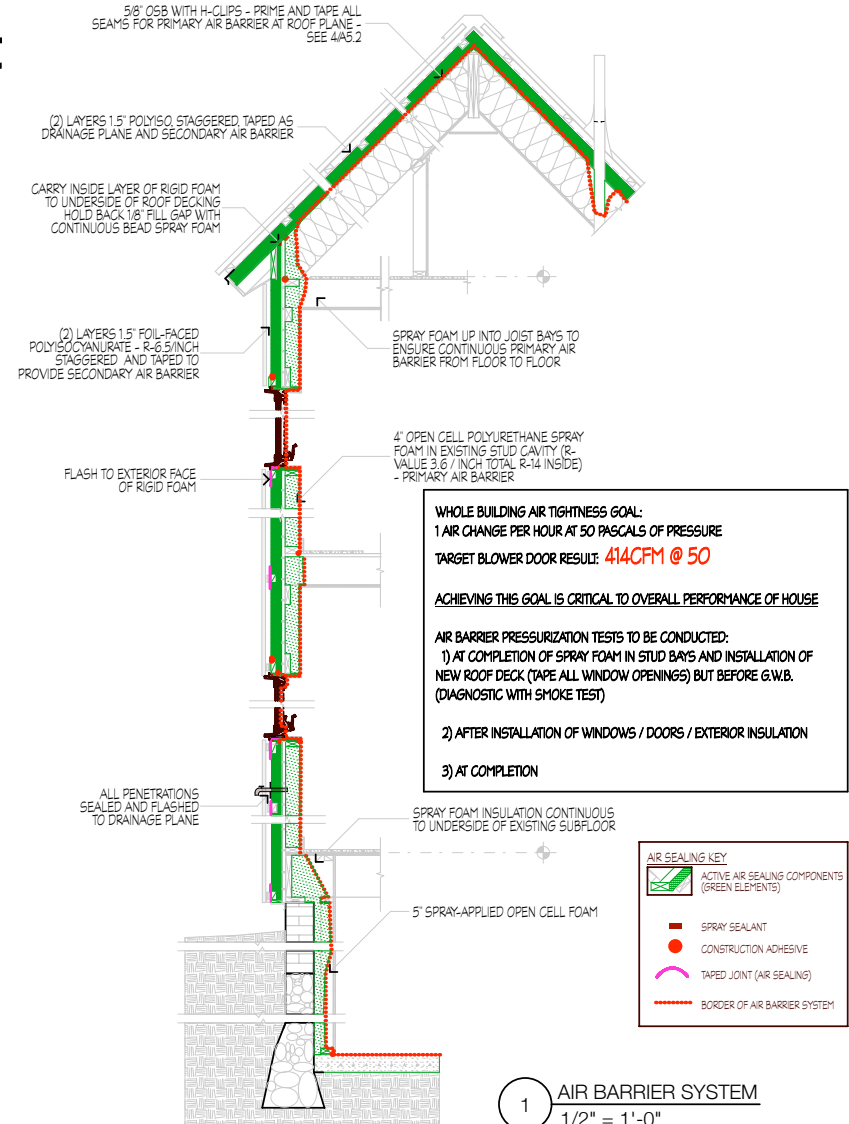
System R Value	9.375
Cumulative R-Value	<b>32.10</b>





Struggle with GC matches our learning curve.

# Spray foam in, rigid foam out



Air barrier drawing, shown in red  
Thermal in green. Fancy!

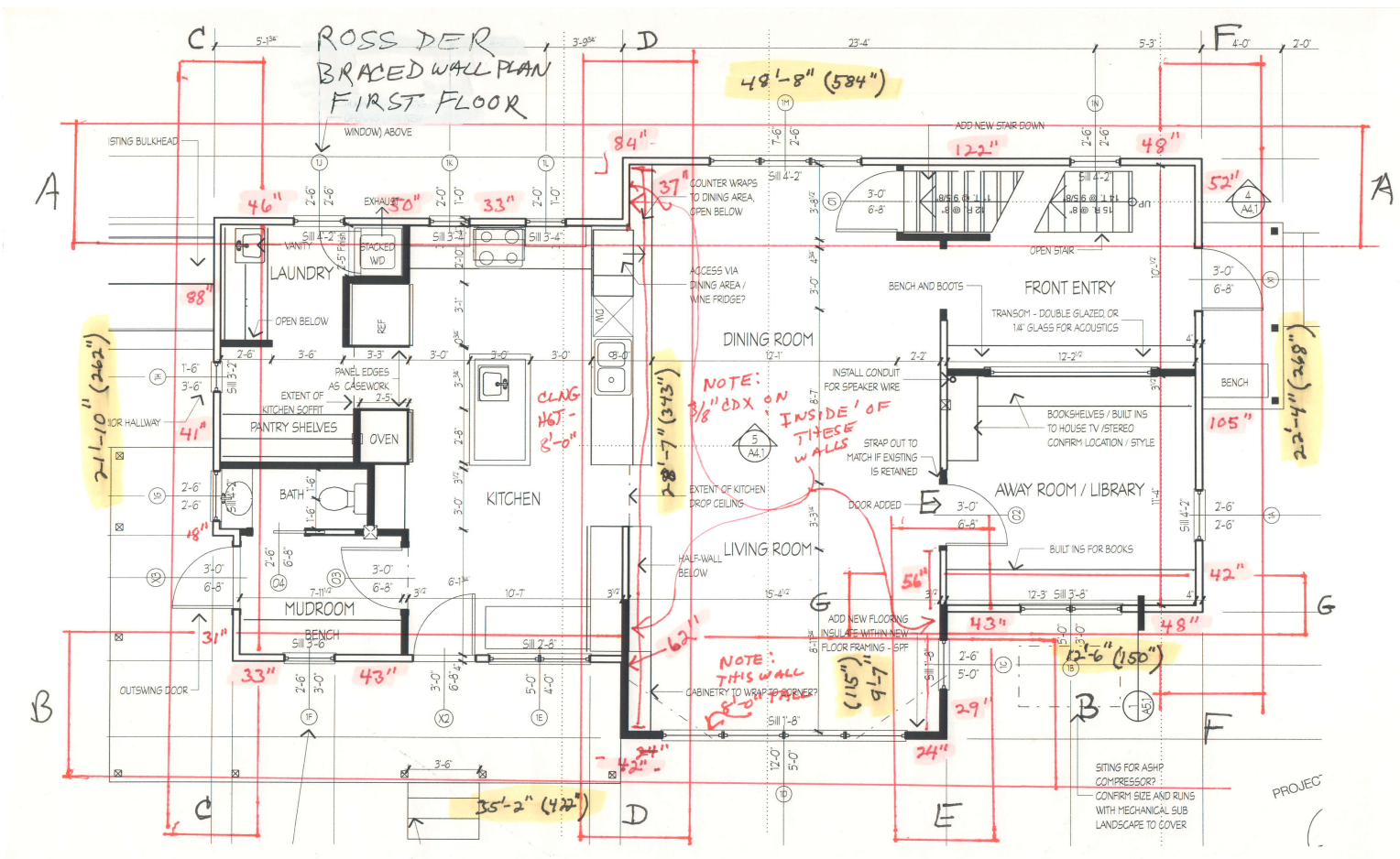
Move insulation out



which leads to Weird

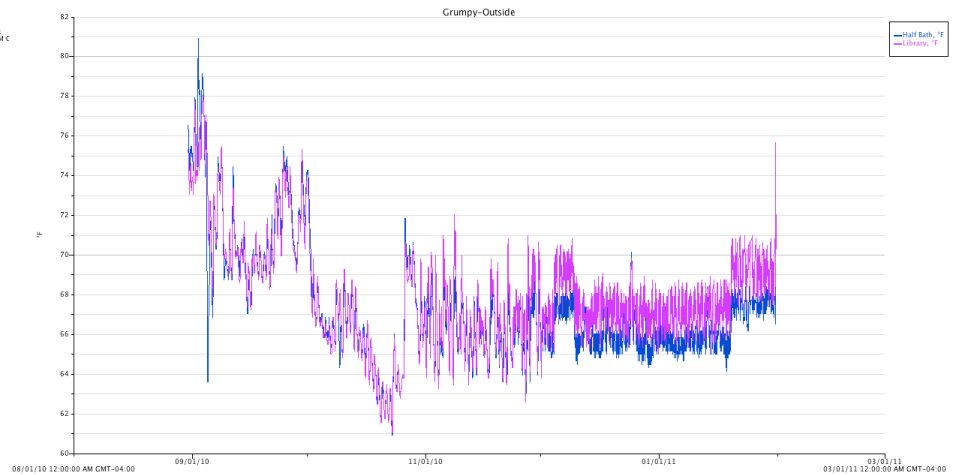
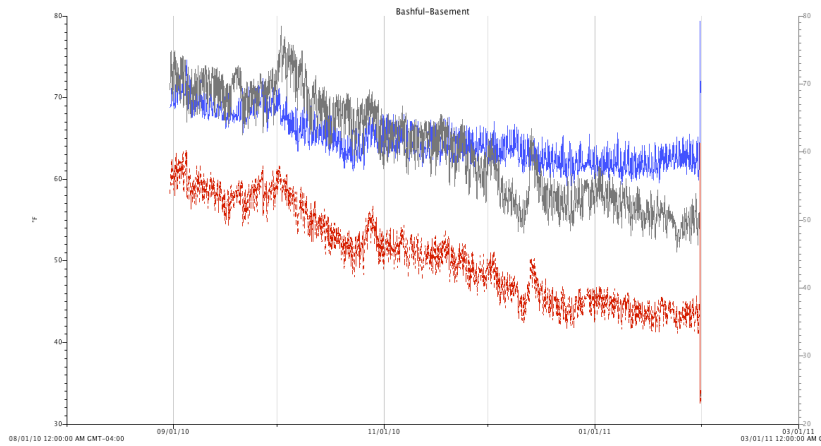
Drainage plane goes where?

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Shear means plywood – should've moved aB

# Air Sealing, Excellent Performance, Maxi-splits



## A New Business Model



Generates interest on many levels

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Rigid over AB, then drainage and strapping





# Energy Design Conference Revolution

# Notes from the Frontlines of the Deep Energy

Wick-NatGrid-DERapp.xls

Home Layout Tables Charts Formulas Data Review

G32 fx

**8) Summary of Project and Finances** Customer Name: Michele and David Wilc 59 Massasoit St - Northampton MA First Application Date: 08/16/19 Second Application Date: 10/15/19

**A) Summary of Measures and Incentives** Kent Hicks Construction Comprehensive DER Incentive Level: 2

Component	Indicator	Existing Conditions	Proposed Value	Description of Type and Model	Units Proposed	Total Measure Cost	Allowable Cost	Incentive %	Estimated Incentive
Attic or Roof	R Value	25	60	4" battman insulation over existing ceiling, pre- and post-Anchor-Straps, rafters sealed and blown	2,054	\$45,620	\$27,150	100%	\$27,150
Above Grade Walls	R Value	11	35	4" ext. polystyrene over 1/2" gypsum board on 2x4 studs, 1/2" poly of wall or 6 mils in wall cavity. Drapage cover used for less	3,276	\$83,470	\$18,510	100%	\$18,510
Foundation A.G.	R Value	3	33	8" rigid foam board on exterior of foundation and crawlspace	407	\$19,968	\$4,538	100%	\$4,538
Foundation B.G.	R Value	3	33	See above	1,456	\$6,863	\$1,513	100%	\$1,513
Slab Floor	R Value	1	10	2" rigid foam board on under of four sides of a new slab. Insulation increases on one face	1,502	\$10,480	\$6,090	100%	\$6,090
Basement Ceiling	R Value	0	0		0	\$0	\$0	100%	\$0
Floor over Garage or Overhang	R Value	0	0		0	\$0	\$0	100%	\$0
Rapid Windows/Doors	R Value	2	5	Series 80 series, 2x4 Krypton plus film, basement and - (2) insulated, Thermally B/B doors, full edge	453	\$36,430	\$30,580	100%	\$30,580
Other Window & Door	R Value	1	32	Form-board inserts in 2 front windows, 8" glass fiber insulation, Acrylic, 8pt. Note	48	\$500	\$500	100%	\$500
Air Sealing	CFM50	6,155	615	Blow-In EPS under slab to DCSPP at wall. AGRM. Insulation applied. GFCI used exterior light fixture.	0	\$0	\$0	0%	\$0
Mechanical Ventilation	EF %	0	50-70%	Meritor 160 T 75% sensible recovery efficiency = additional unit provided for new addition. Installation per Manufacturer's instructions.	1	\$4,100	\$4,100	100%	\$4,100
Heating equipment	A/FUE	88	9	Mitsubishi PMSH/F280R10, Variable Refrigerant Rate (VRF), 4800 BTU/h, Annual COP: 3.29, SEER: 8.7, reset as above per AHRI certified R410A/32	1	\$30,540	\$30,540	50% w/ 5th cap	\$4,000
Cooling equipment	SEER / EER	0	16.8 / 7	See note per AHRI certified R410A/32	1	\$0	\$0	50% w/ 5th cap	\$0
Other w/ Prior Approval		88	3	See note per AHRI certified R410A/32	1	\$4,200	\$2,450	TBD	\$1,000
<b>TOTALS Enclosure and Heating Ventilation and HVAC</b>						\$21,991	\$125,931		\$87,941
Solar hot water system	Qty. panels								
Water Heating	En Factor (EF)			GE HPWH - included in Other, above				uses by case for level 2 projects only	
Wind turbine system	KW						N/A	N/A	N/A
Other Incl. Appliances						\$13,000	N/A	N/A	N/A
Lighting				All electrical loads - no broken down estimate yet		\$13,470	N/A	CFL or better. NGM to provide \$200 worth LED or CFLs	
<b>Grand Totals Deep Energy Retrofit</b>						\$251,991	\$125,931	N/A	\$87,941

**B. Summary of Project Costs**

Project Category	Pre Application Estimated Costs	Current Application Costs
Renovation Associated with DER	\$40,000	\$186,460
Addition, Remodeling, other Renovation/Remediation	\$40,000	\$86,000
Total non-Energy Related	\$100,000	\$194,460
DER Enclosure and HVAC w/o Renovation	\$133,531	\$133,531
DER Retrofit excluding Enclosure and HVAC	\$10,000	\$10,000
Total Energy Related	\$143,531	\$143,531
<b>Total Project Costs</b>	<b>\$243,531</b>	<b>\$337,991</b>

**C. Financing Confirmation**

This Section of the worksheet is intended to verify that all the funding and incentives are sufficient to cover the entire project. This is a vital component of project viability. Sufficient Funds is a MUST

(f) Costs, Incentives and Finances	Current Application	Incentive Level	Max Incentives for Project
(a) Total Project Costs	\$337,991	Level 1 >	\$42,000
(b) Total Incentives minus Level 2 set aside	\$48,700	Level 2 25% additional	\$16,000
(c) Costs Less Incentives = a minus b	\$289,291	- Combined >	\$52,000
(d) Total Customer and Other Funding and Financing (from Word Part A Sect 1B(ii))	\$300,000	Level 2 incentive set aside >	\$3,300
<b>Balance of Funds or (Shortfall) = D minus C</b>	<b>\$16,709</b>	G320 Notes - Funding and Financing needs or exceeds supply. Detailed costs	

**D) Worksheet for Proposed Payment Plan**

Group (1, 2, or 3)	Total Group 1	Total Group 2	Total Group 3	Work Start - Days After Agreement	Days to Complete	Days after Agreement to Complete
1	\$27,150	\$0	\$0	16	16	30
2	\$0	\$18,510	\$0	30	25	65
3	\$4,538	\$0	\$0	7	16	21
4	\$1,513	\$0	\$0	7	16	21
5	\$6,090	\$0	\$0	16	7	21
6	\$0	\$0	\$0			
7	\$0	\$30,580	\$0	66	15	70
8	\$0	\$500	\$0	66	15	70
9	\$0	\$0	\$0	30	16	46
10	\$0	\$4,100	\$0	135	12	148
11	\$0	\$4,000	\$0	132	16	148
12	\$0	\$0	\$0	132	16	148
13	\$0	\$0	\$0	140	15	150
14	\$0	\$0	\$0			
Group Split 5	\$30,251	\$49,590	\$9,100			
Payment #	1	2	3			
<b>Adjusted for Max</b>	<b>\$19,517</b>	<b>\$24,658</b>	<b>\$4,525</b>	Supplemental note or comment		
<b>Total of Payment Groups</b>	<b>\$48,700</b>	< Excludes Level 2 set aside for final compliance				

Heat Fuel: Electricity Building Type: Victorian

Construction Period: 1850 - 1899 Total Incent/Enc BF

DER Enclosure \$ \$207,251 \$6.0

Conditioned Sq. Ft.

Planned Conditioned Sq. Ft. Existing Enc'd S.I.Q.F.T.

2747 2032 \$75.4

DER Surface Area 1.5SF 8694 \$23.8

Occupants: 4 # Apts 1

Site Mble Pre Plan Source kWh/Sq Ft

131 88

NOTICE: This application and proposed payment plan is not a commitment to provide incentives. Incentives are NOT part of an "official" offer until project agreement is signed

### BUILDING LEAKAGE TEST

# Third party verification

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Date of Test: 2011-07-06	Technician: HW
Test File: 2011-07-06 Wick Final Blower Door Test	
Customer: National Grid DER Wick 59 Massasoit Street Northampton, MA 01060 Phone	Building Address: 59 Massasoit Street Northampton, MA 01060

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**Test Results**

1. Airflow at 50 Pascals: (50 Pa = 0.2 w.c.)	435 CFM ( +/- 0.5 %) 0.75 ACH 0.16 CFM per ft2 floor area
2. Leakage Areas:	43.0 in2 ( +/- 3.3 %) Canadian EqLA @ 10 Pa 22.3 in2 ( +/- 5.2 %) LBL ELA @ 4 Pa
3. Minneapolis Leakage Ratio:	0.06 CFM50 per ft2 surface area
4. Building Leakage Curve:	Flow Coefficient (C) = 30.8 ( +/- 8.1 %) Exponent (n) = 0.677 ( +/- 0.021 ) Correlation Coefficient = 0.99903
5. Test Settings:	Test Standard: = CGSB Test Mode: = Depressurization Equipment = Model 3 Minneapolis Blower Door

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#### Infiltration Estimates

1. Estimated Average Annual Infiltration Rate:	42.9 CFM 0.07 ACH 8.6 CFM per person (using bedrooms + 1)
2. Estimated Design Infiltration Rate:	Winter: 48.3 CFM 0.08 ACH  Summer: 20.3 CFM 0.04 ACH
3. Recommended Whole Building Mechanical Ventilation Rate: (based on ASHRAE 62.2)	65.0 CFM

---

#### Cost Estimates

1. Estimated Cost of Air Leakage for Heating:
2. Estimated Cost of Air Leakage for Cooling:

## Massasoit – 5kW and GSHP

Actual     Estimated

**nationalgrid**

PO Box 960  
Northborough MA 01532

KEEP THIS PORTION FOR YOUR RECORDS.

RETURN THIS PORTION WITH YOUR PAYMENT.

ACCOUNT NUMBER	PLEASE PAY BY	AMOUNT DUE
[REDACTED]	No Payment Due	\$ 0.00



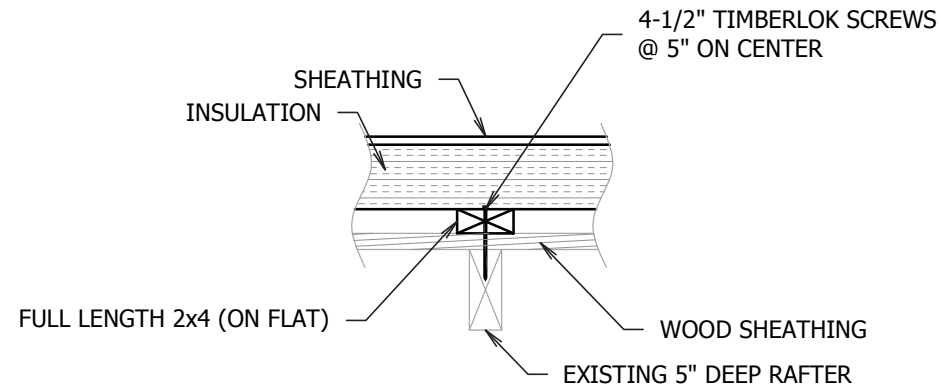
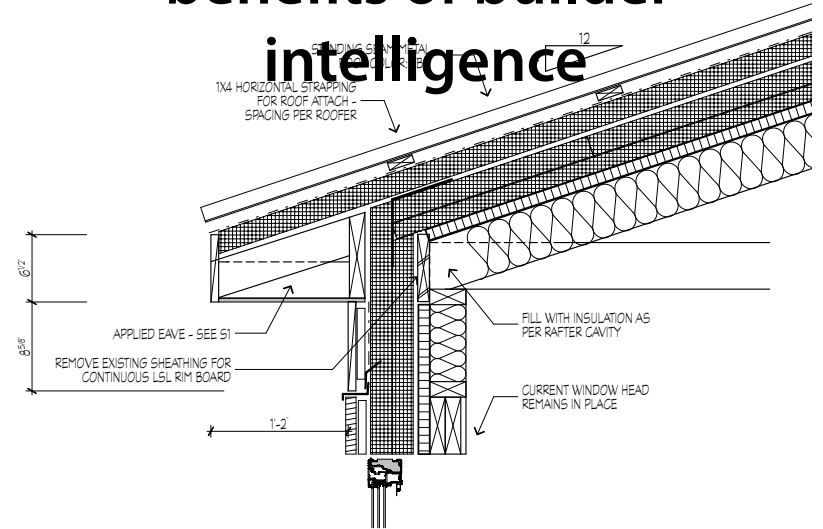




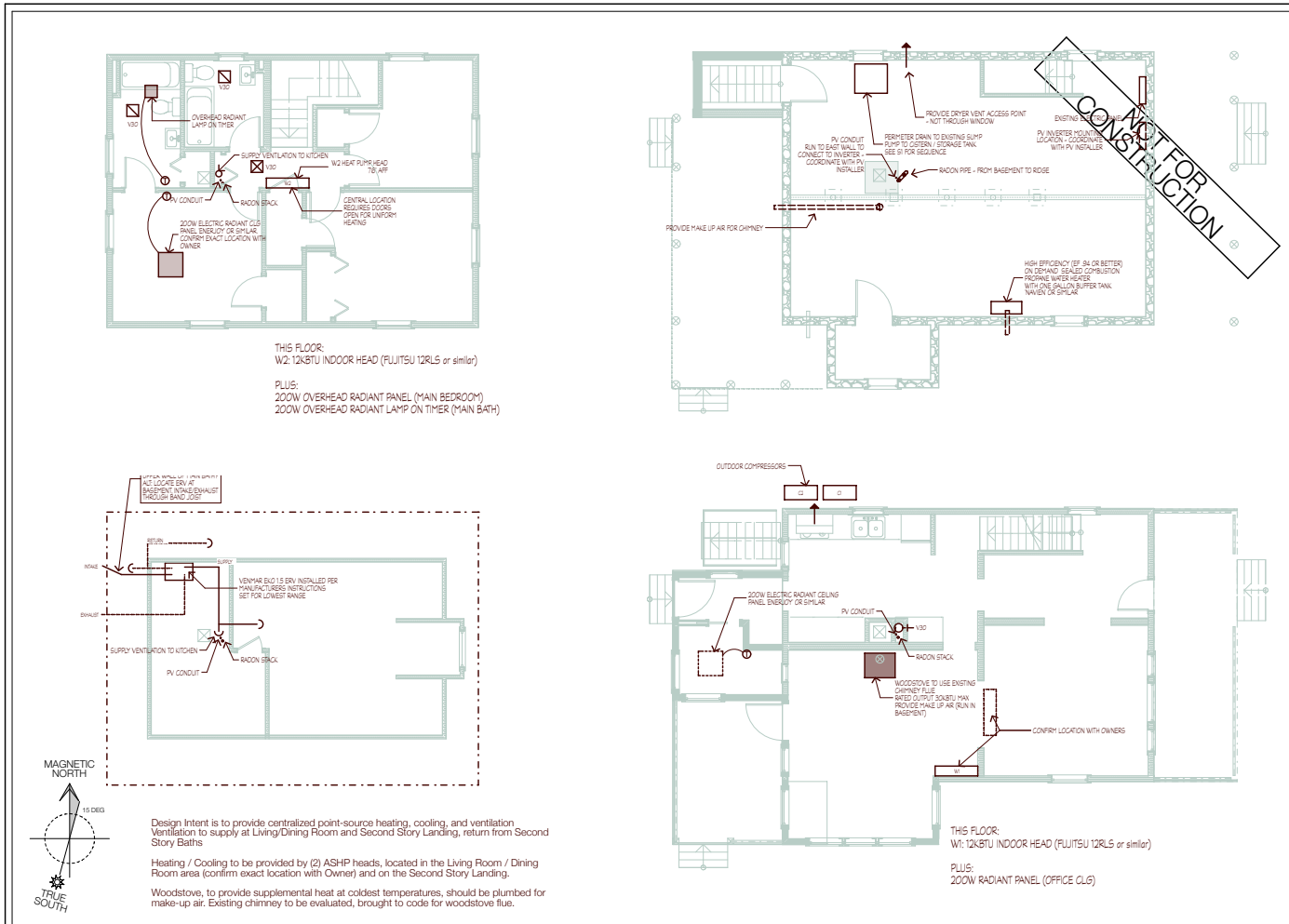


Holden Builders' innovation with the applied eave

# Ward Street – Applied eave construction and the benefits of builder intelligence



# Ward Street – supply at the center







## Hampden Street – a new air barrier?









T

4"



## Stockbridge



Incentives bring interest

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## Powdermill Village – the affordable solution



How we can use this more broadly?

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## Powdermill Village - challenges



Struggles are new

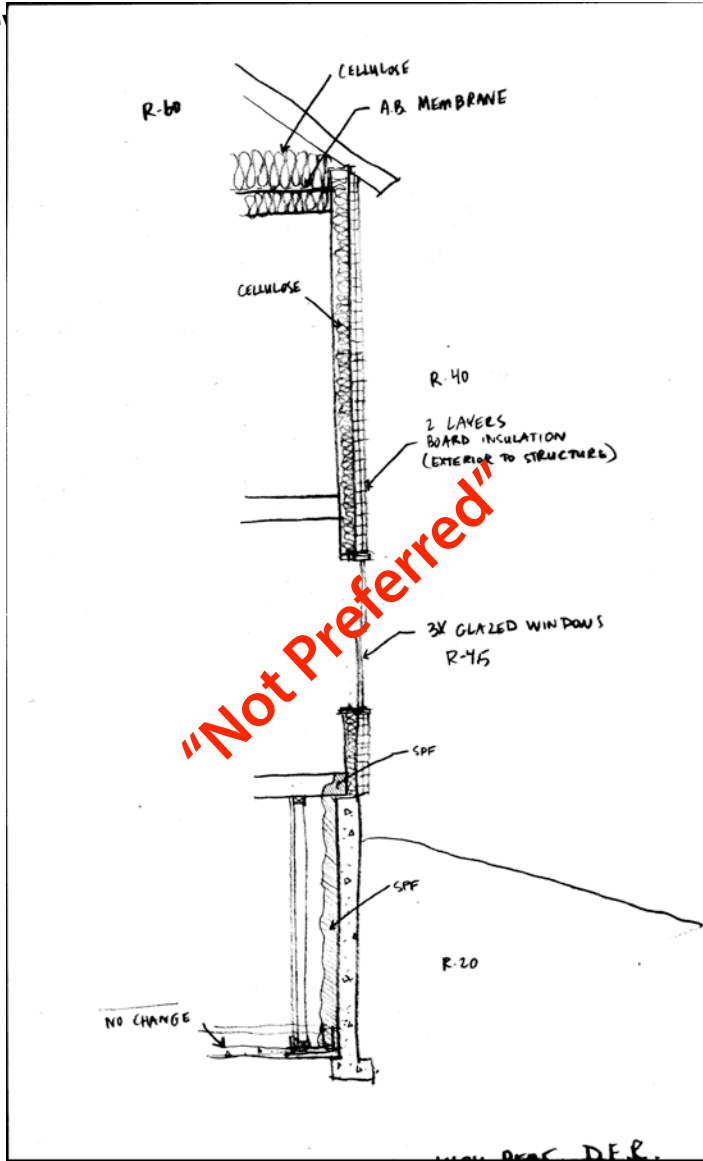
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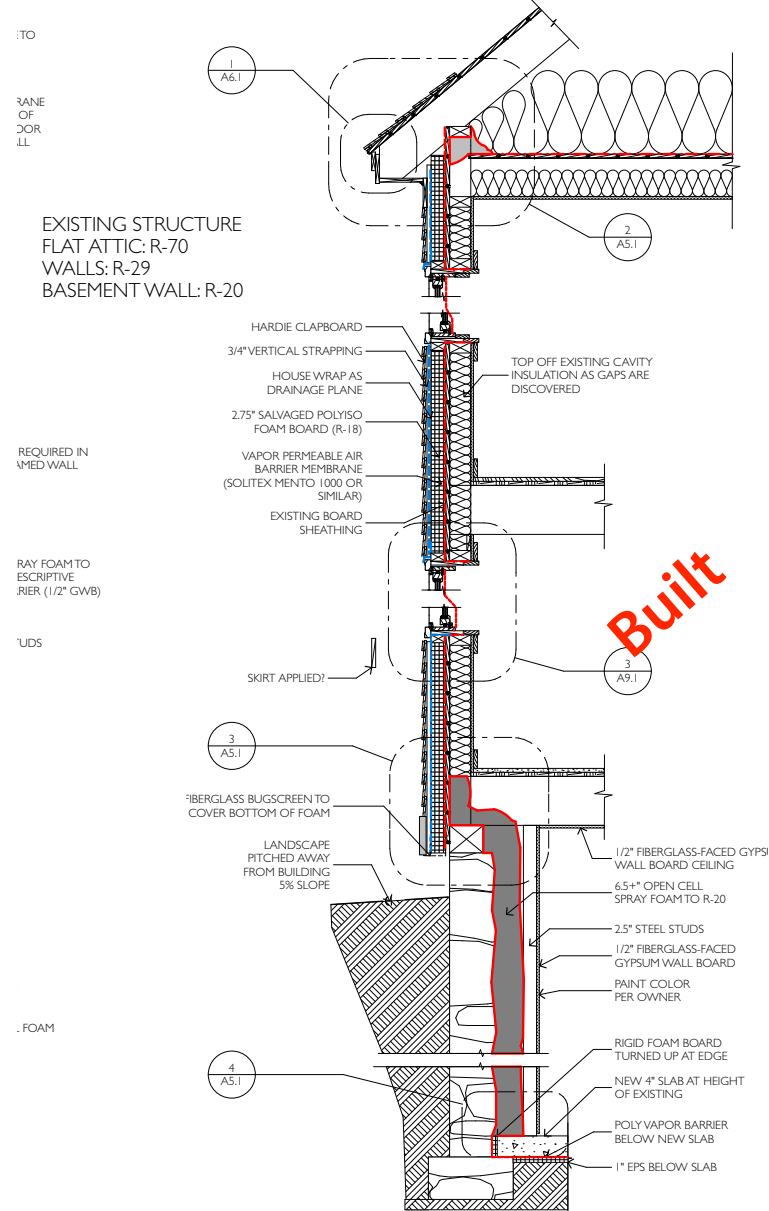
**Right house, right place**

# Energy Design Conference

Re



# Notes from the Frontlines of the Deep Energy



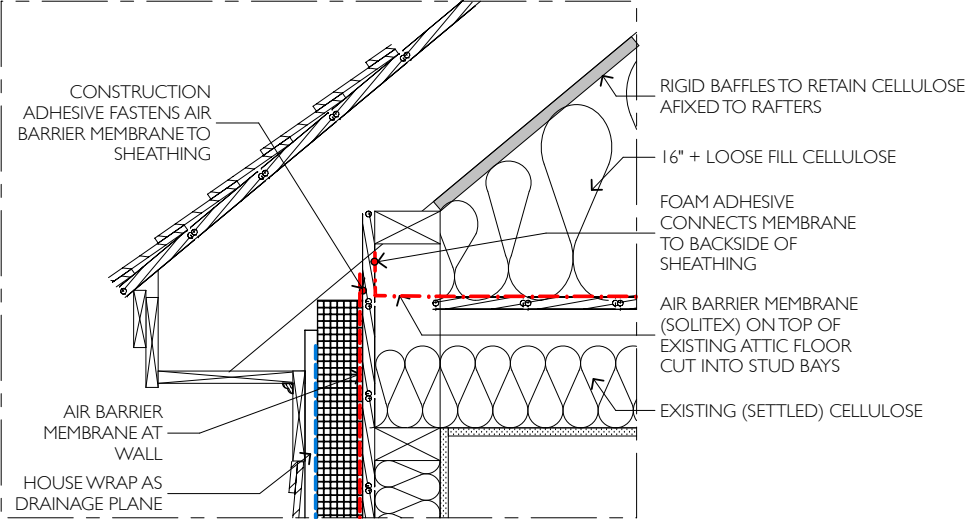
No DER as described – but when we got down to it..

1 DETAIL WALL SECTION - EXISTING  
SCALE: 3/4" = 1'-0"

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File: 13-26 Turners Four Square Print Date: 5/14/15

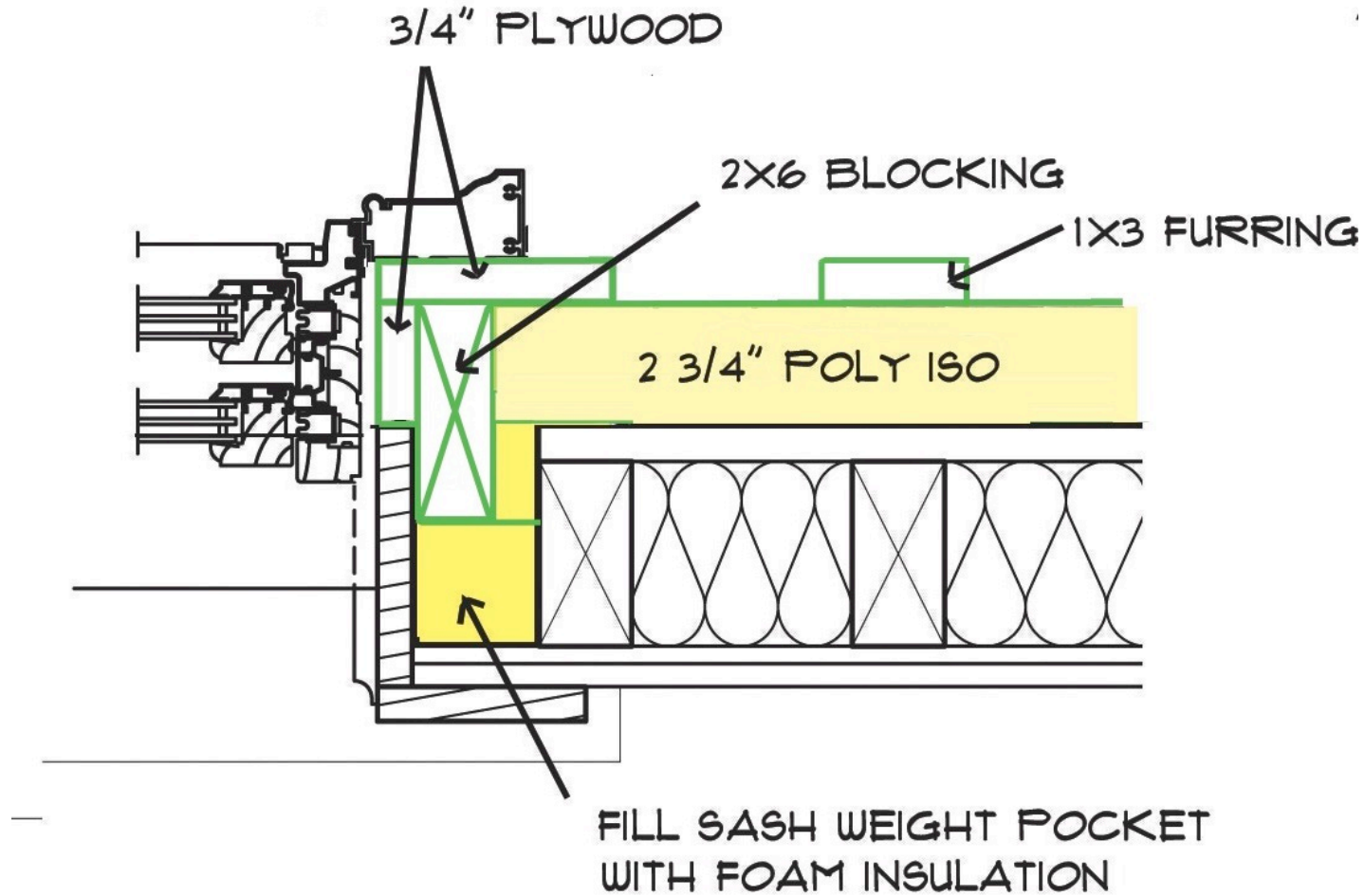
<p>c&amp;h architects coldham and hartran.com amherst, ma</p>	<h2>Keep the attic outside</h2>  <p>The diagram illustrates a cross-section of an attic assembly. On the left, a roof slope is shown with rafters and sheathing. A dashed line indicates the air barrier membrane is fastened to the sheathing with construction adhesive. Below the roof, a vertical wall section is shown with a drainage plane (housewrap) and an air barrier membrane. The attic floor consists of existing settled cellulose insulation, a new air barrier membrane (SOLITEX) cut into stud bays, and a layer of foam adhesive connecting the membrane to the backside of the sheathing. Above this, 16" or more of loose fill cellulose insulation is shown, held in place by rigid baffles attached to the rafters.</p>
<p>ATTIC FLOOR AB</p>	
<p>Date: 14 May 2015 Project: Turners Four Dwg Ref: Scale: 1/4" = 1'-0"</p>	
<p>SK- DET</p>	



See the pattern again

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## Montague Road – retaining the trim









**By now, there's a product to want**

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## Beston Street – SIP roof overlay





Ventilation still a big concern – in the form of humidity. For a piano.



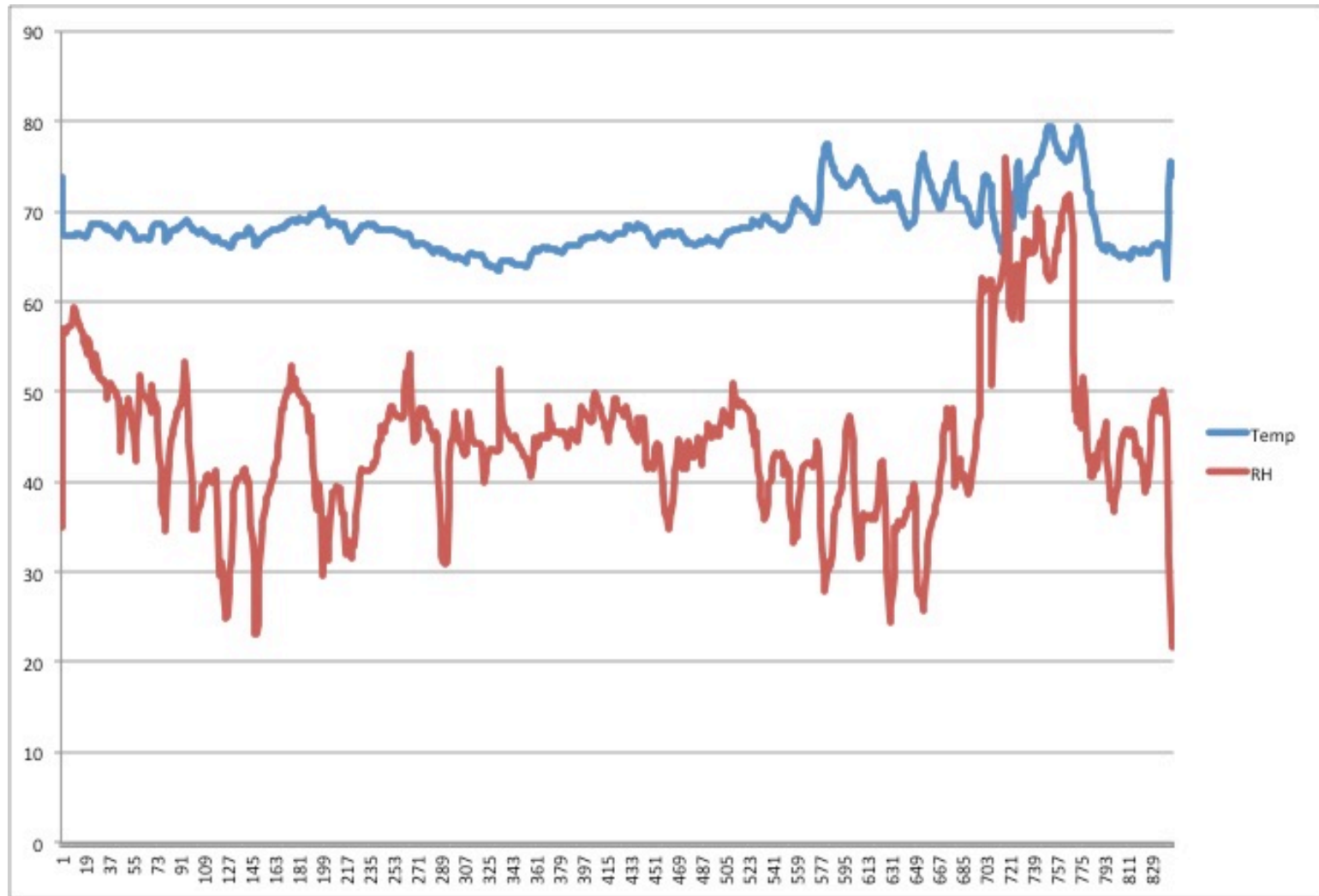
## Beston Street – ASHP and behavior



ASHP is training

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## **What did we learn?**



## Aspirations?



**Thank you.**

**Questions?**

**[andrew@coldhamandhartman.com](mailto:andrew@coldhamandhartman.com)**

**[candharchitects.com](http://candharchitects.com)**