Passive House
and California Code

EEBA High Performance Home Summit

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www.essentialhabitat.com

ESSENTIAL HABITAT ARCHITECTURE

What is Passive House?

- **Rigorous Building Design & Performance Standard**
- **Formalized by European Scientists ~1990**
- **Based on Super-Insulated, Passive Solar & "Low-Energy" Buildings**
- **"Quality" = How <u>LITTLE</u> Energy is Required for Comfort & Convenience**
- **Superior Comfort, Indoor Air Quality & Durability**
- **30,000+ Worldwide: Residential, Commercial, Institutional Buildings**

World's 1st Passive House
Kranichstein Passive House
Darmstadt, Germany (1990)

1st Passive House in US
Smith House
Urbana, Illinois (2003)

1st Passive House in CA
Tahan Residence
Berkeley, California (2007)

1st Certified Passive House in CA
1st Certified PH Retrofit in US
O'Neill Residence
Sonoma, California (2010)

How Does Passive House Work?

- Optimized Solar Gains
- Draft-Free Shell
- Heat Recovery Ventilation (typical)
- Continuous Insulation
- High Performance Windows & Doors
- Efficient Equipment, Appliances & Lighting

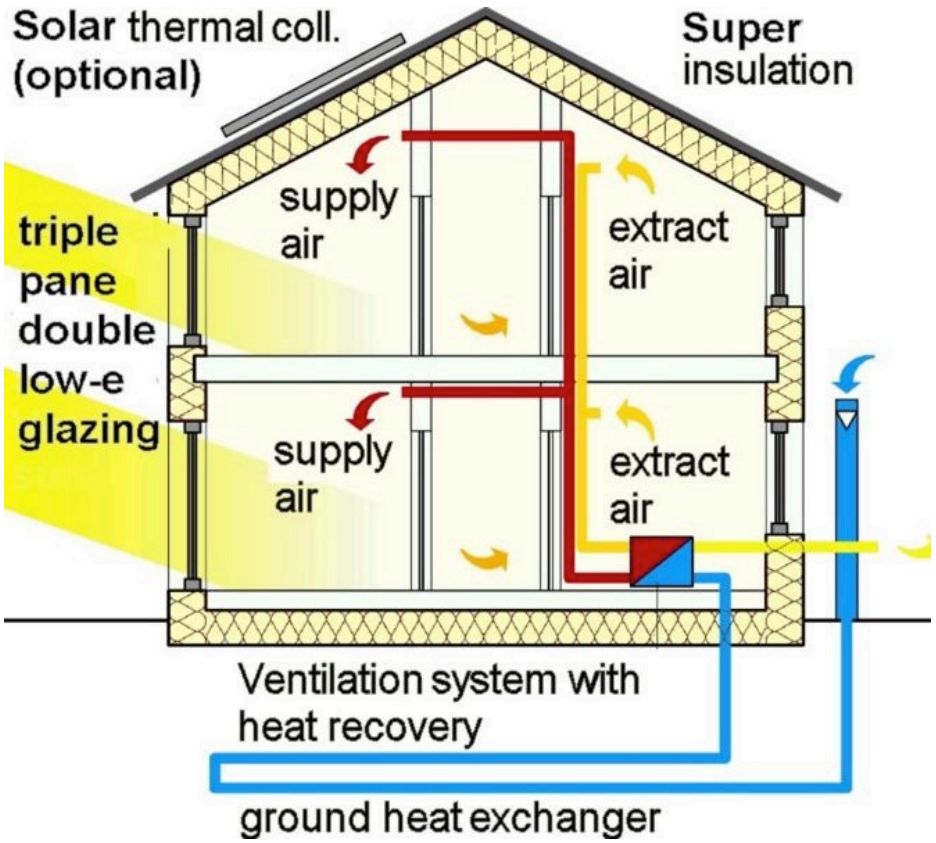


Image: Passivhaus Institut (PHI)

Goal: Wider Adoption in CA

Study: CA Code → Passive House

2013 California Code vs. Passive House

1. Analysis of California Code-Minimum Construction in Passive House Planning Package (PHPP 8.4) by Climate Zone.
2. Step by Step Analysis of Cost Effective Upgrades to Reach Passive House Performance.

T24 Prototype Single-Story Home

Conditioned Floor Area: 2100 ft^2
Ceiling Height: 9 ft
Conditioned Volume: 18,900 ft^3
Slab Area: 2100 ft^2
Slab Perimeter: 162 ft
Ceiling Area: 2100 ft^2

Figure A-1: One Story Prototype Front View

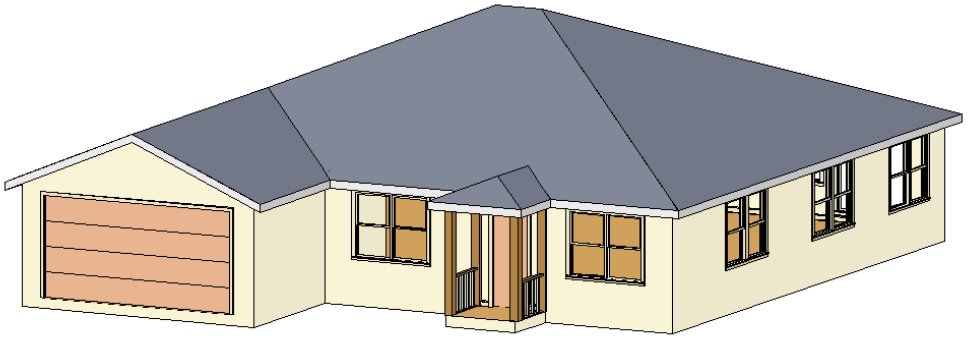


Figure A-2: One Story Prototype Back View

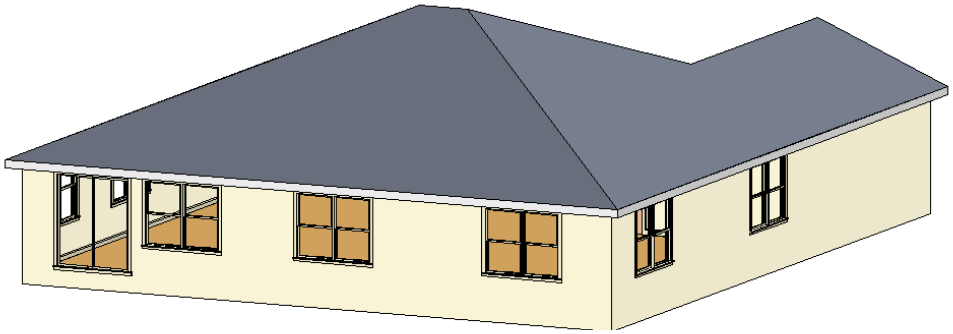
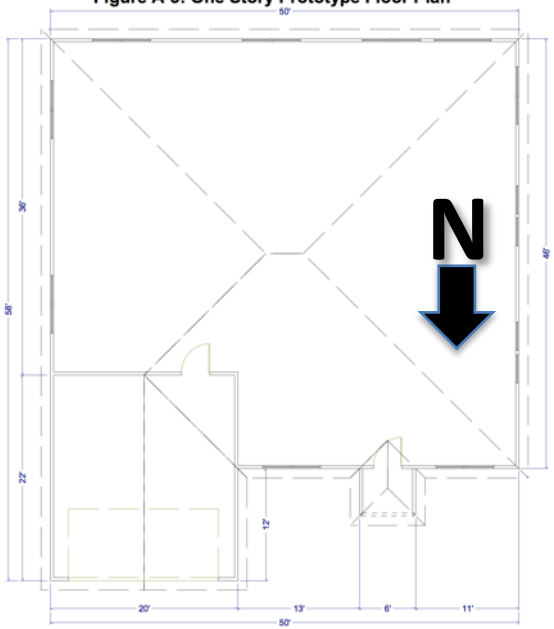
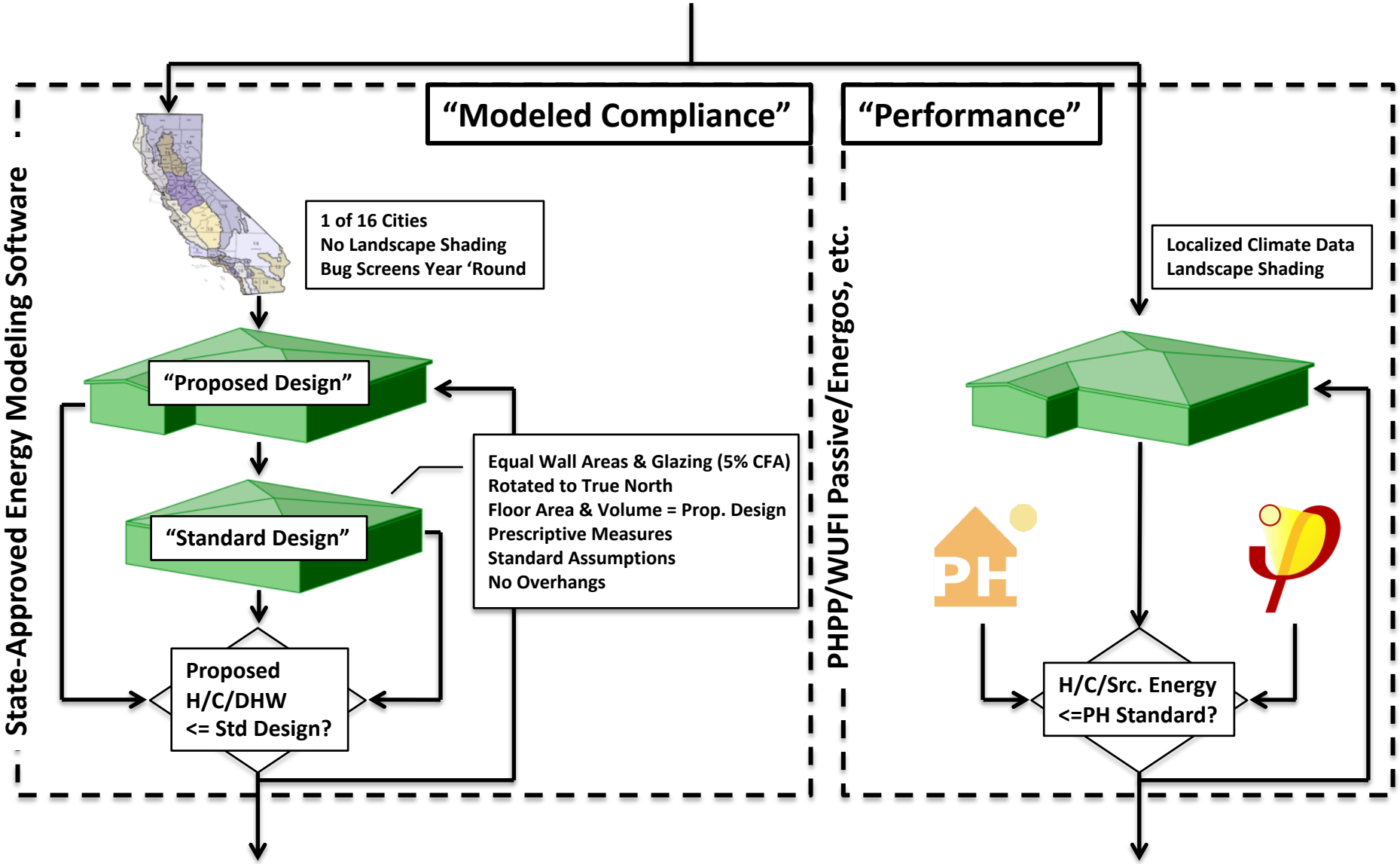


Figure A-3: One Story Prototype Floor Plan



Source: 2013 Residential Alternative Calculation Method Reference Manual CEC-400-2013-003-SD-REV
2013 Residential ACM Reference Manual CEC-400-2013-003-CMF

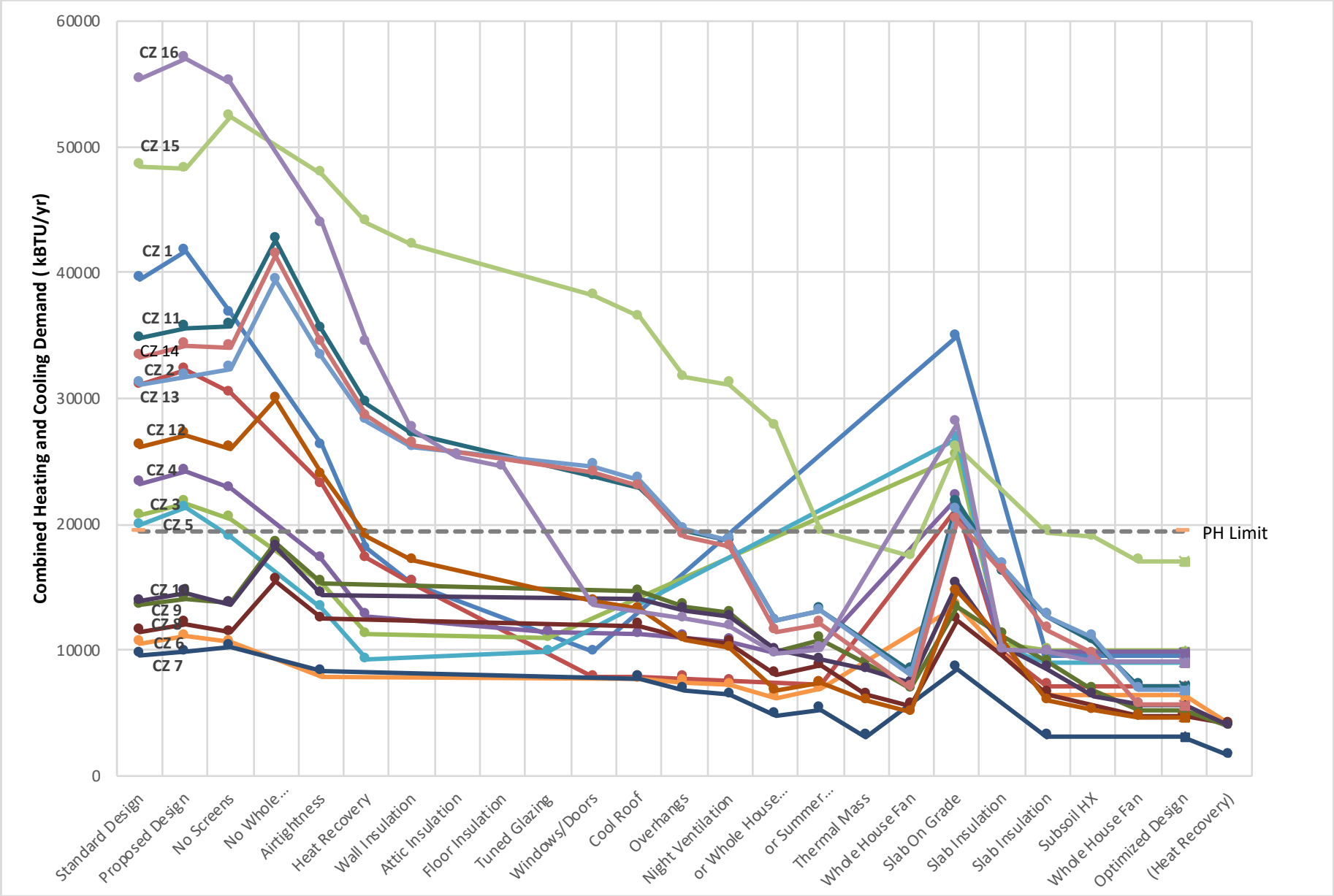
Title 24 vs. PH Energy Modeling



2013 T24 Requirements/Assumptions

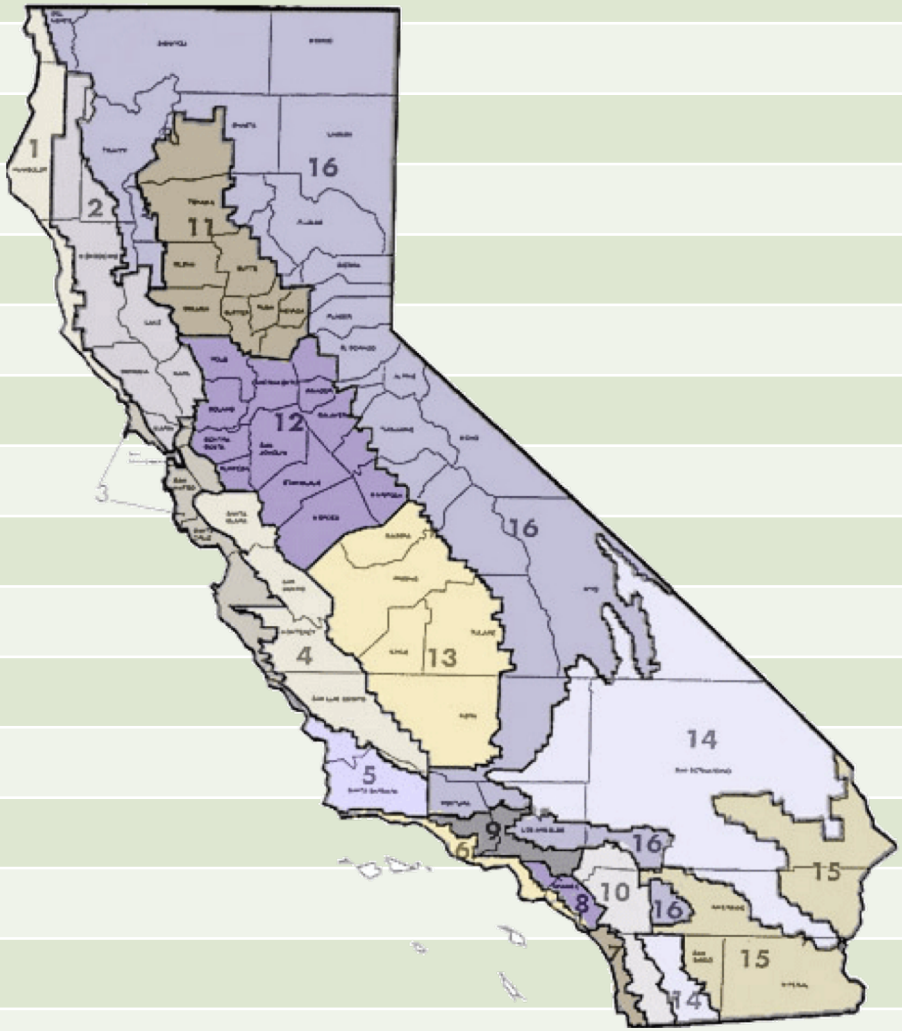
Location	Roof	Walls	Raised Floor	Slab	Windows	Air-Tightness
01 Arcata	R38	$R15_{cavity}$+R4	R19	NR	U 0.32 0.50 SHGC	NR (5 ACH_{50})
02 Santa Rosa	R30				0.25 SHGC	
03 Oakland					0.50 SHGC	
04 San Jose					0.25 SHGC	
05 Santa Maria					0.50 SHGC	
06 Torrance					0.25 SHGC	
07 San Diego						
08 Fullerton						
09 Burbank						
10 Riverside	R38					
11 Red Bluff						
12 Sacramento						
13 Fresno						
14 Palmdale						
15 Palm Springs						
16 Blue Canyon				R7 (Edge)		

Results: CA Code → Passive House



Heating & Cooling Savings vs. 2013 T24

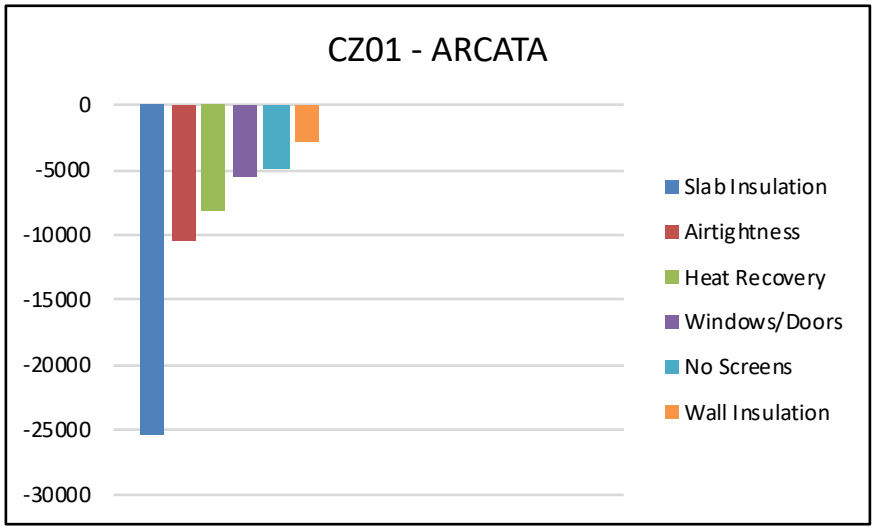
Location	# Passive Houses = 1 Code House, ( ) = w/ Optional Heat Recovery
01 Arcata	
02 Santa Rosa	
03 Oakland	
04 San Jose	
05 Santa Maria	
06 Torrance	( )
07 San Diego	( )
08 Fullerton	( )
09 Burbank	( )
10 Riverside	( )
11 Red Bluff	
12 Sacramento	
13 Fresno	
14 Palmdale	
15 Palm Springs	
16 Blue Canyon	

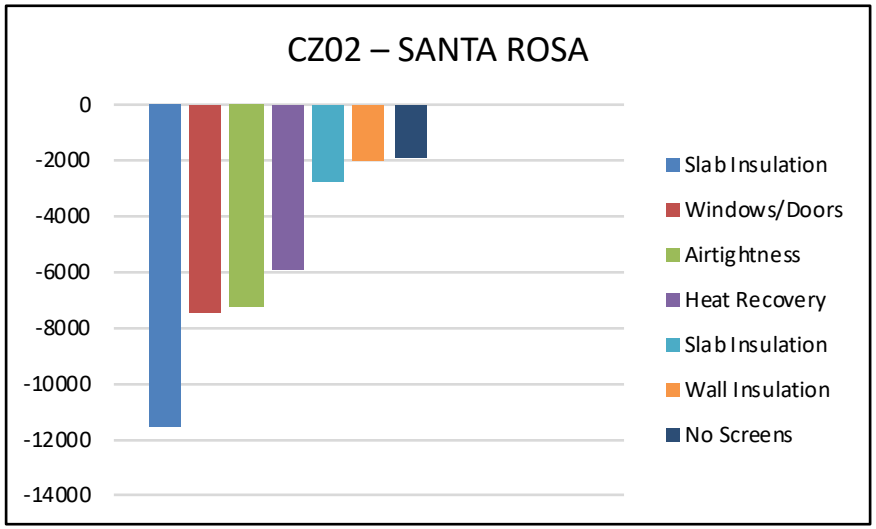


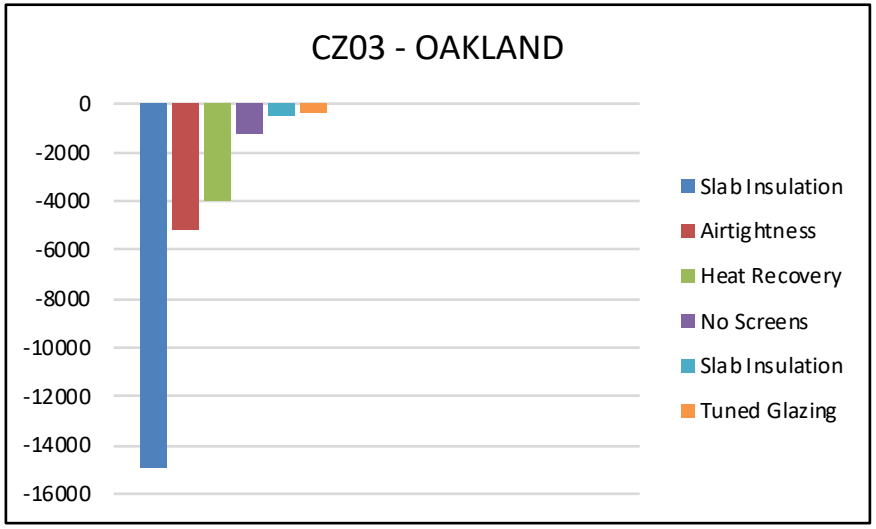
Optimized Building Shell

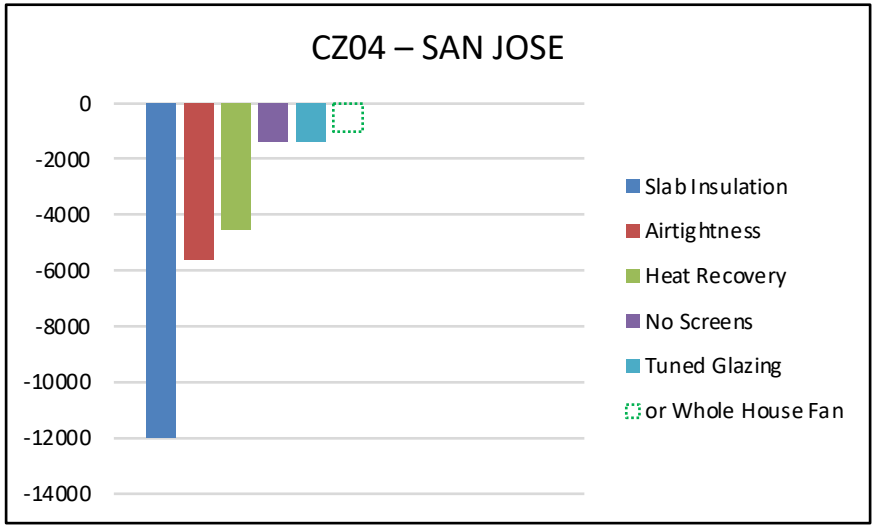
Location	Roof	Walls	Raised Floor	Slab	Windows	Air-Tightness
01 Arcata	Code	$R21_{cavity}$+R4	Code	R14	U 0.14 0.35 SHGC	0.6 ACH_{50}
02 Santa Rosa						
03 Oakland		Code		R13	Code 0.50 South	
04 San Jose						
05 Santa Maria				R12		
06 Torrance				R10	Code	
07 San Diego				R18		
08 Fullerton				R19		
09 Burbank						
10 Riverside						
11 Red Bluff		$R21_{cavity}$+R4		R14	U 0.14 0.35 SHGC	
12 Sacramento				R19		
13 Fresno				R13		
14 Palmdale				R12		
15 Palm Springs				R16		
16 Blue Canyon	R62	$R21_{cavity}$+R20	$R19_{cavity}$+R4	R18		

Most Effective Upgrades by Location









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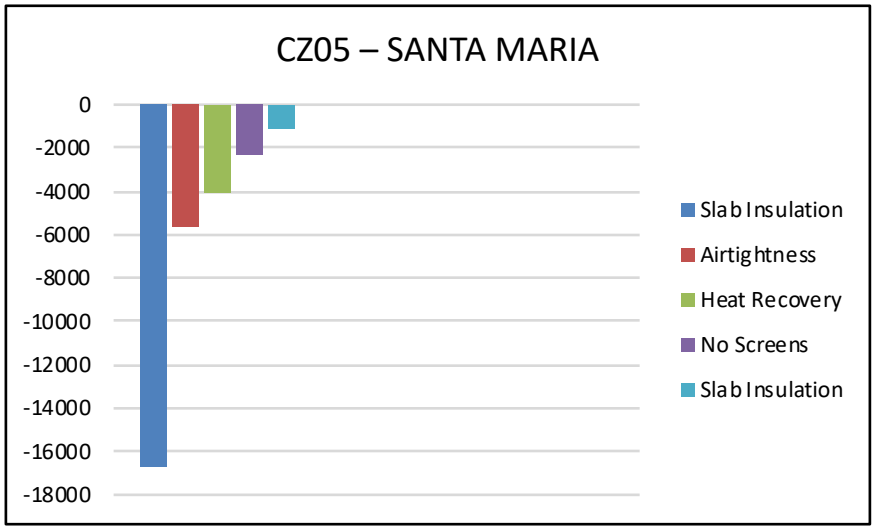

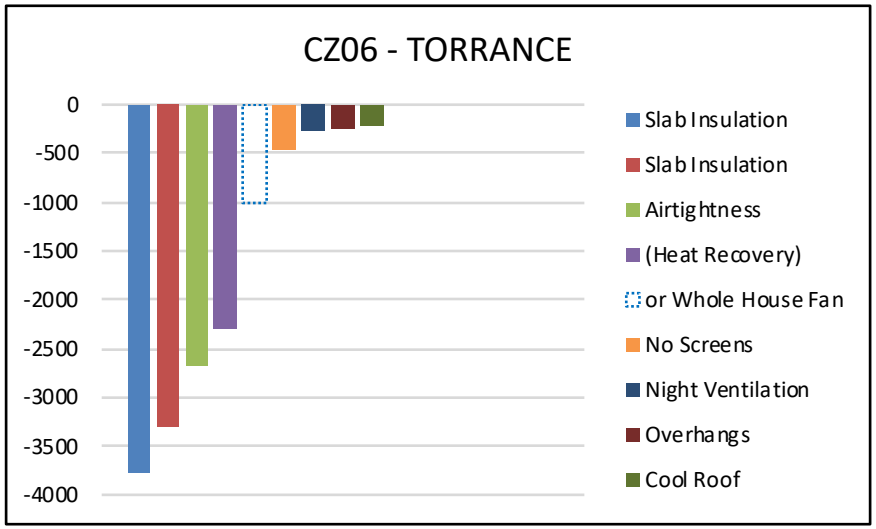

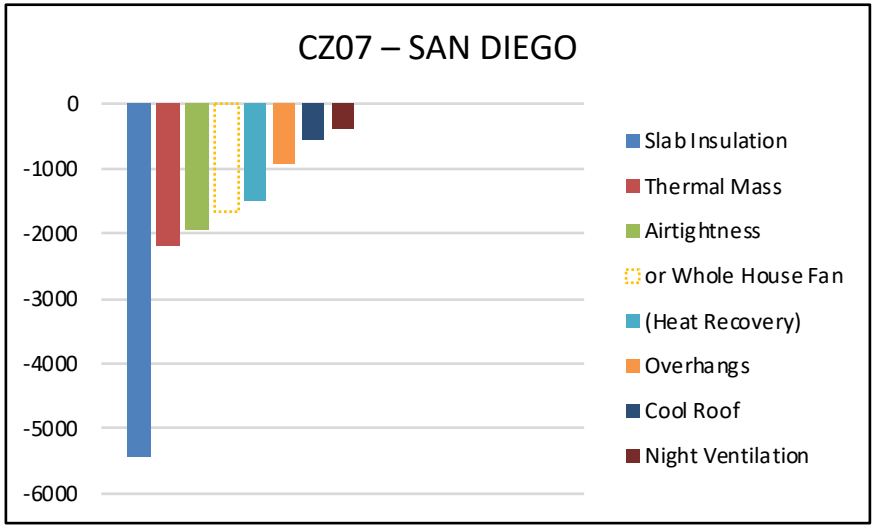

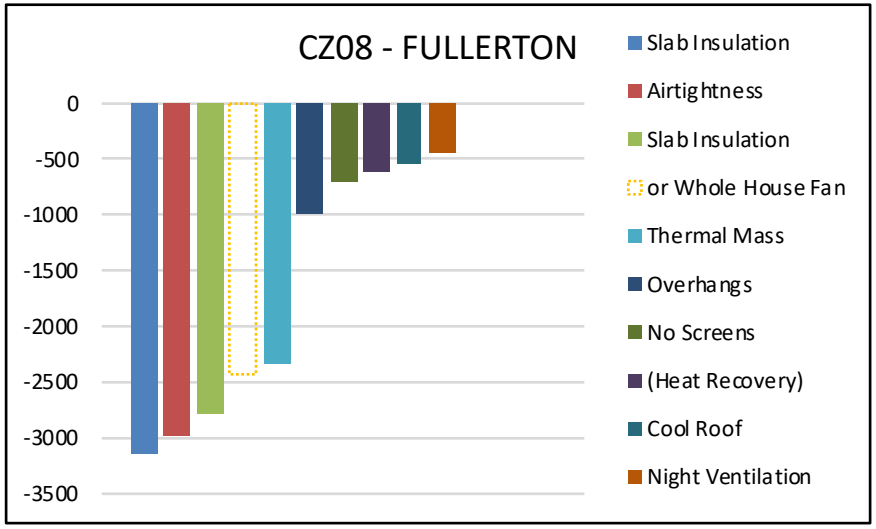

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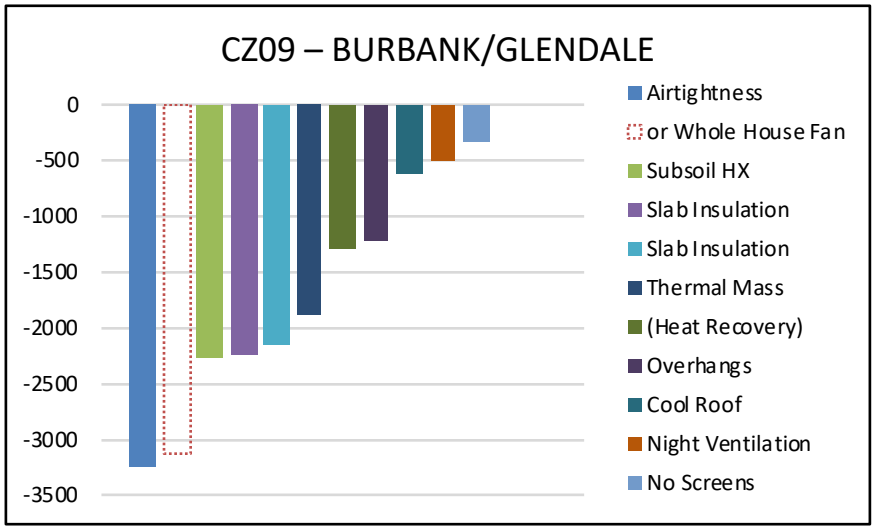

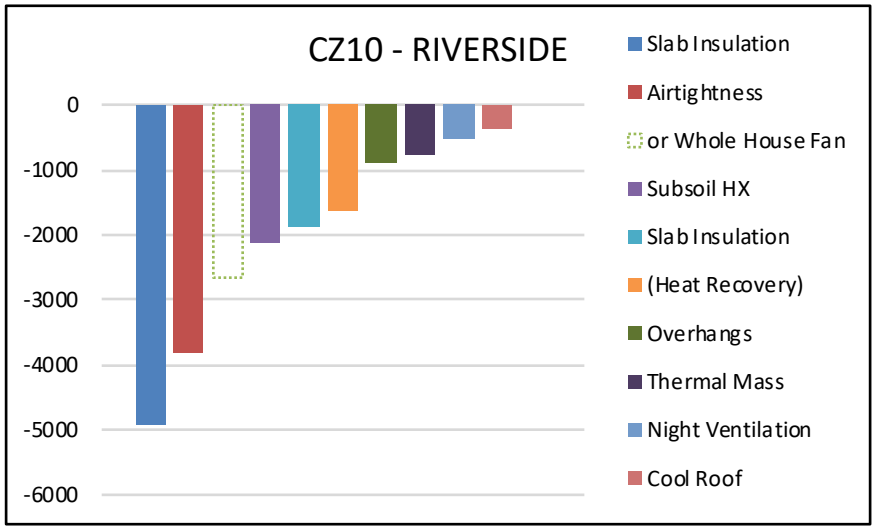

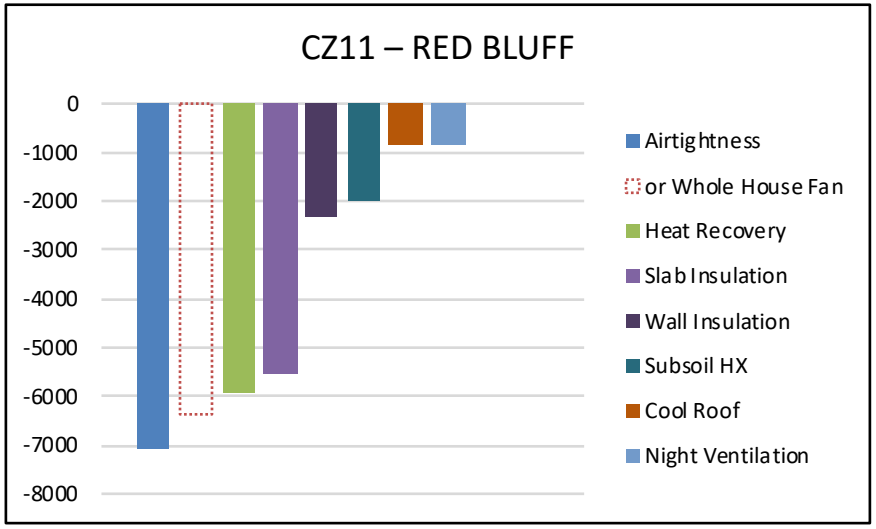

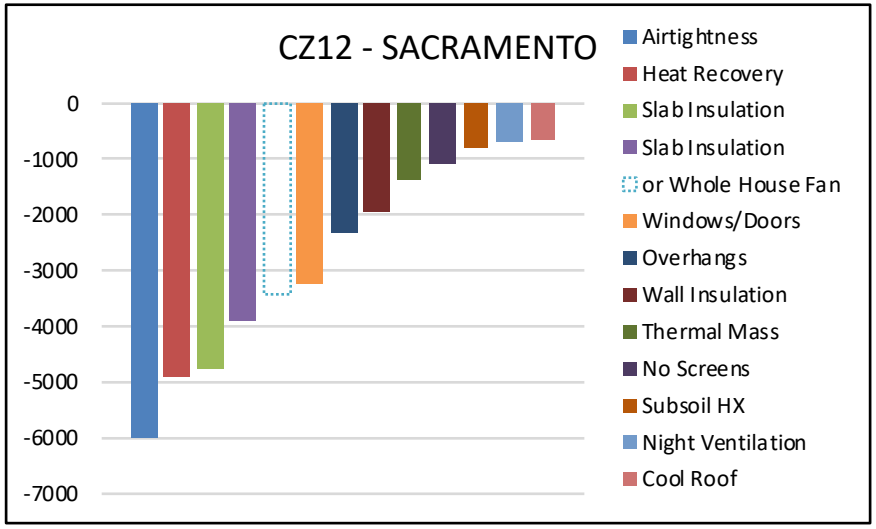

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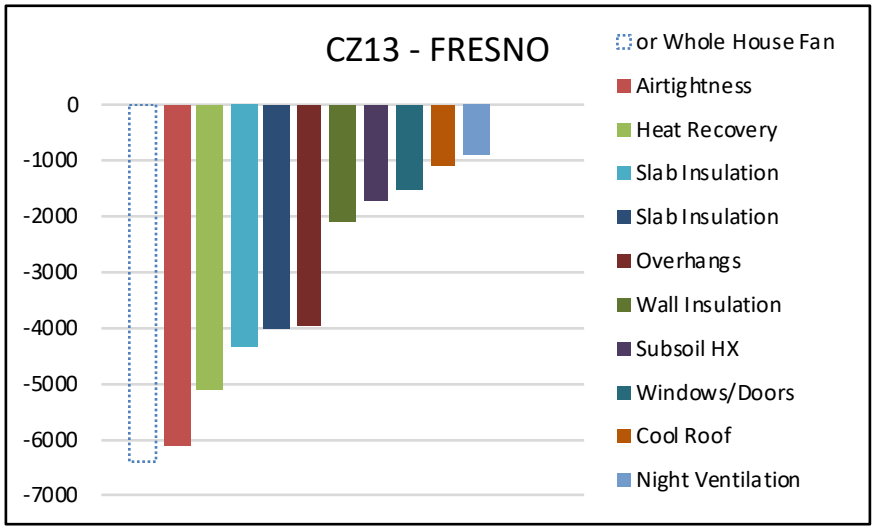
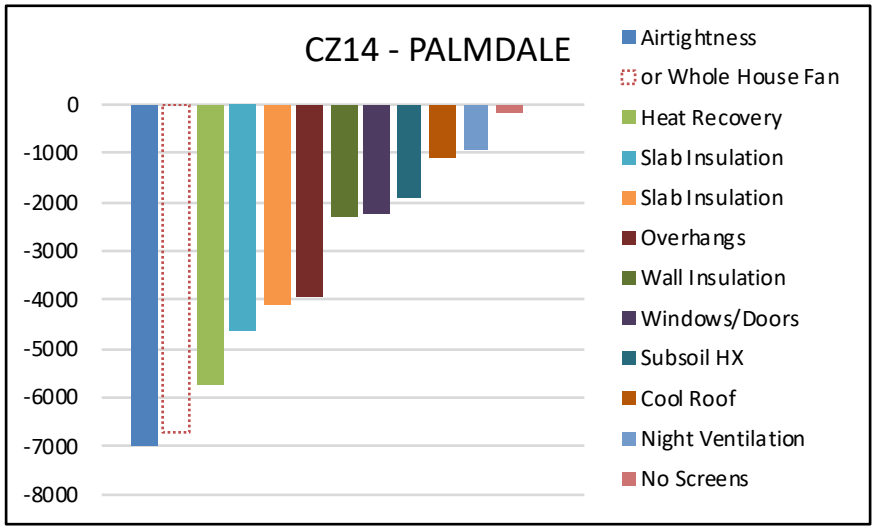
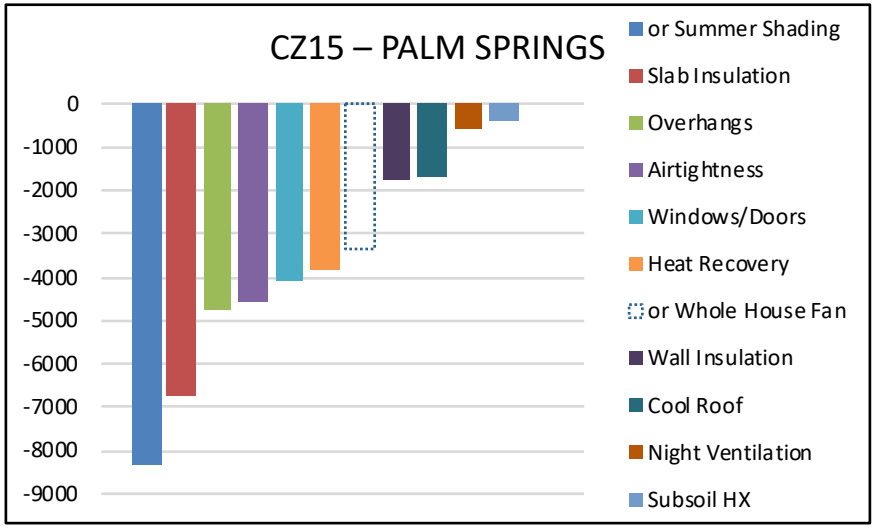
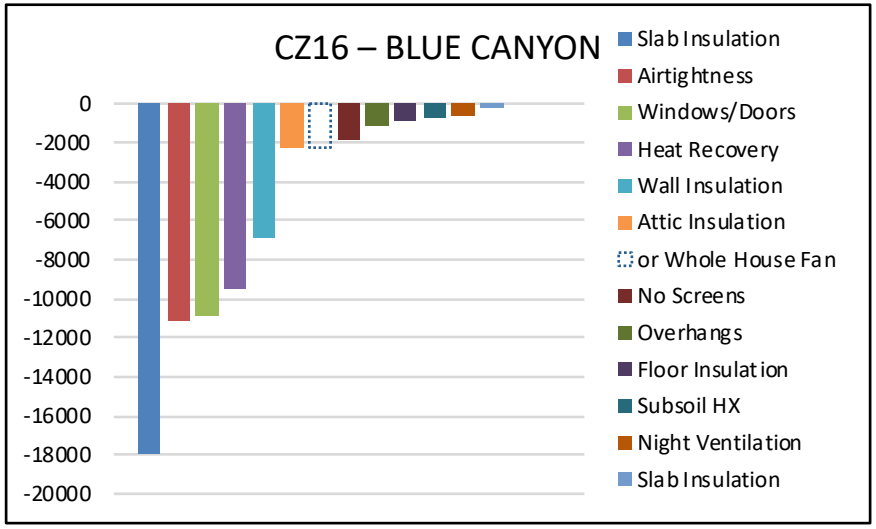
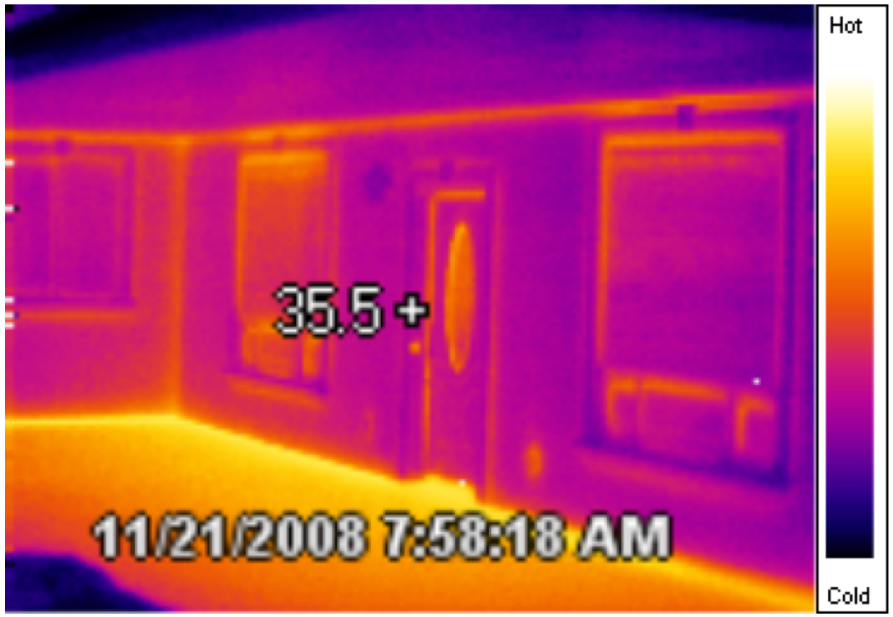


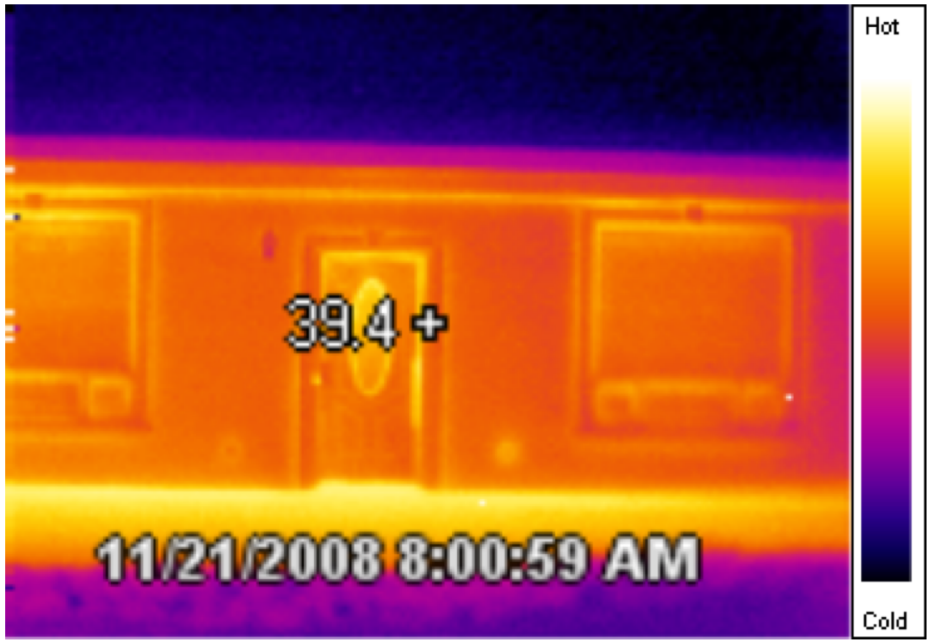






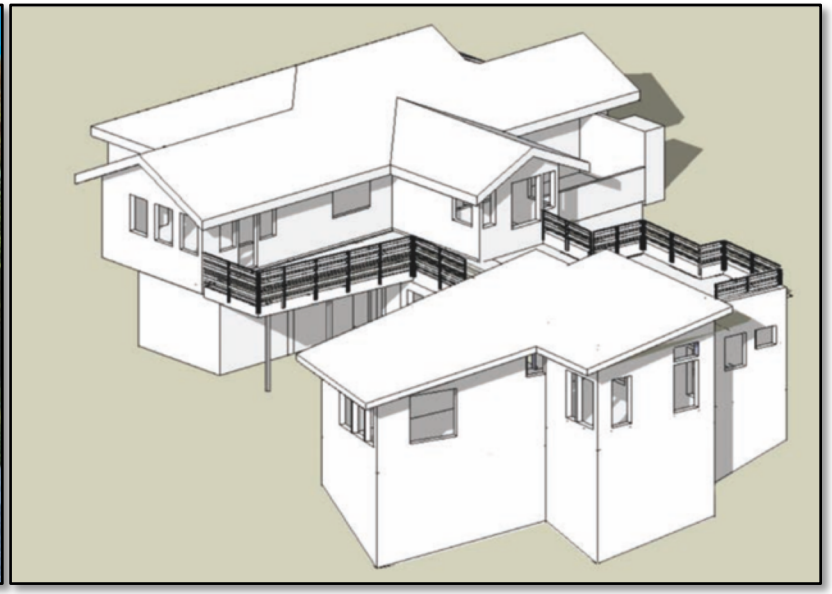
Study Assumption: No Thermal Bridges!



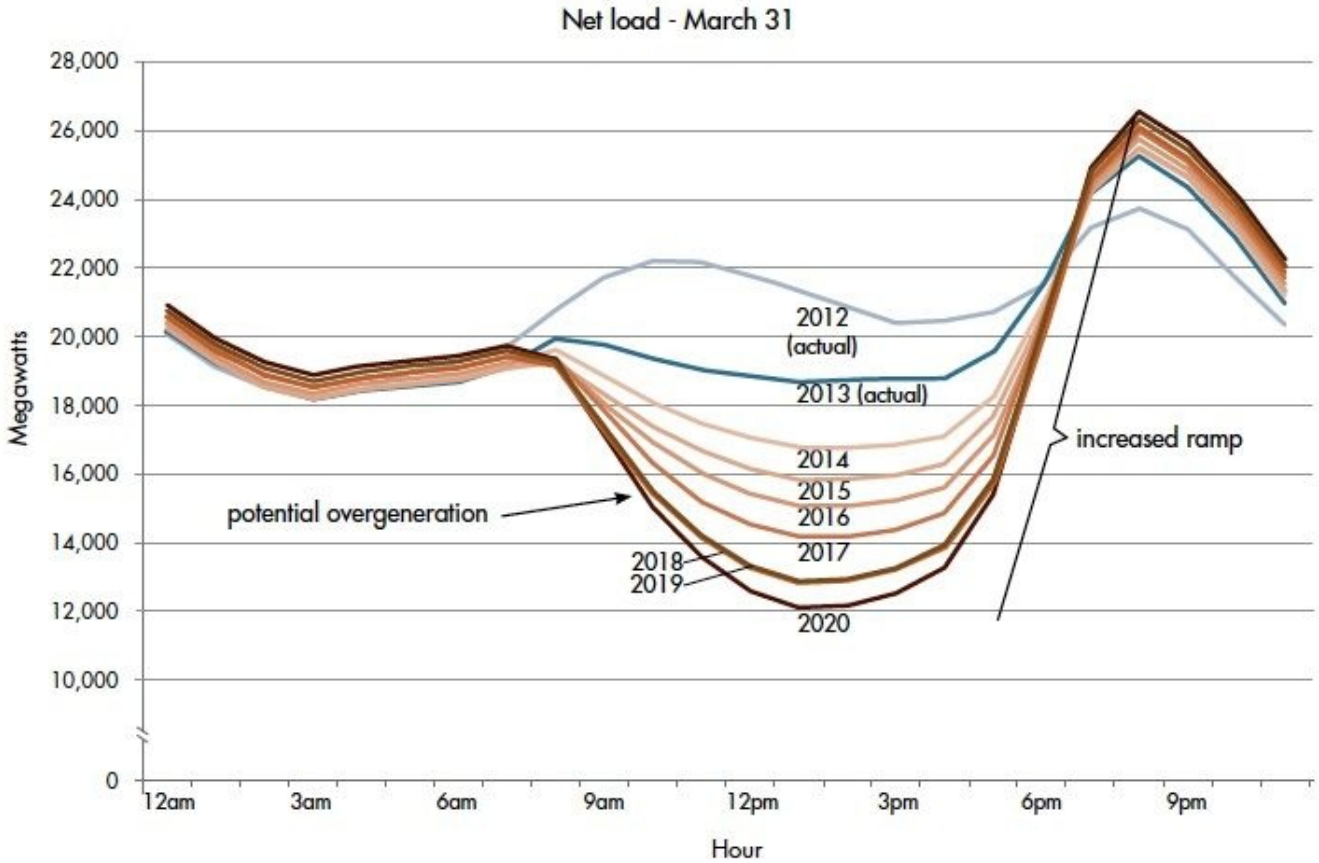


Images: Gavin Healy, Balance Point Home Performance

SoCal Passive Houses



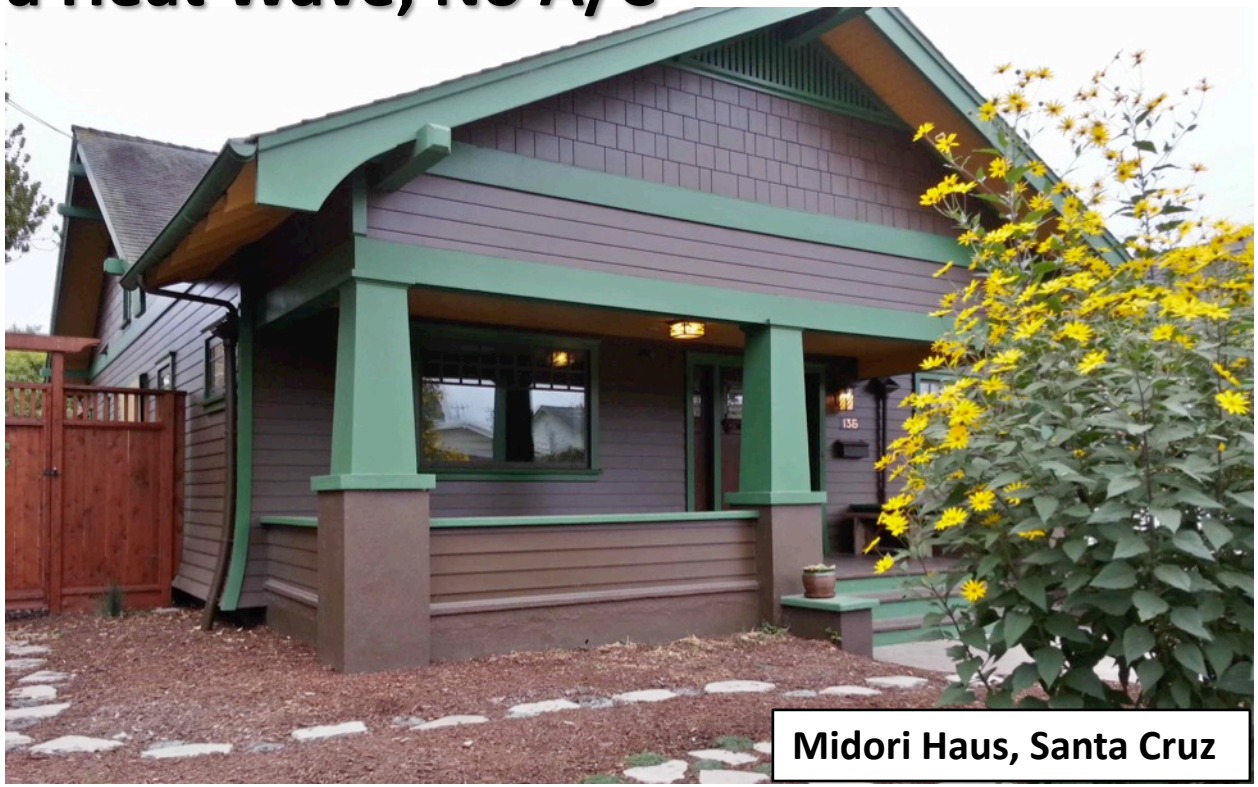
Passive House to "Tame the Duck"



- California Independent System Operator (CAISO)

Proof in Practice:

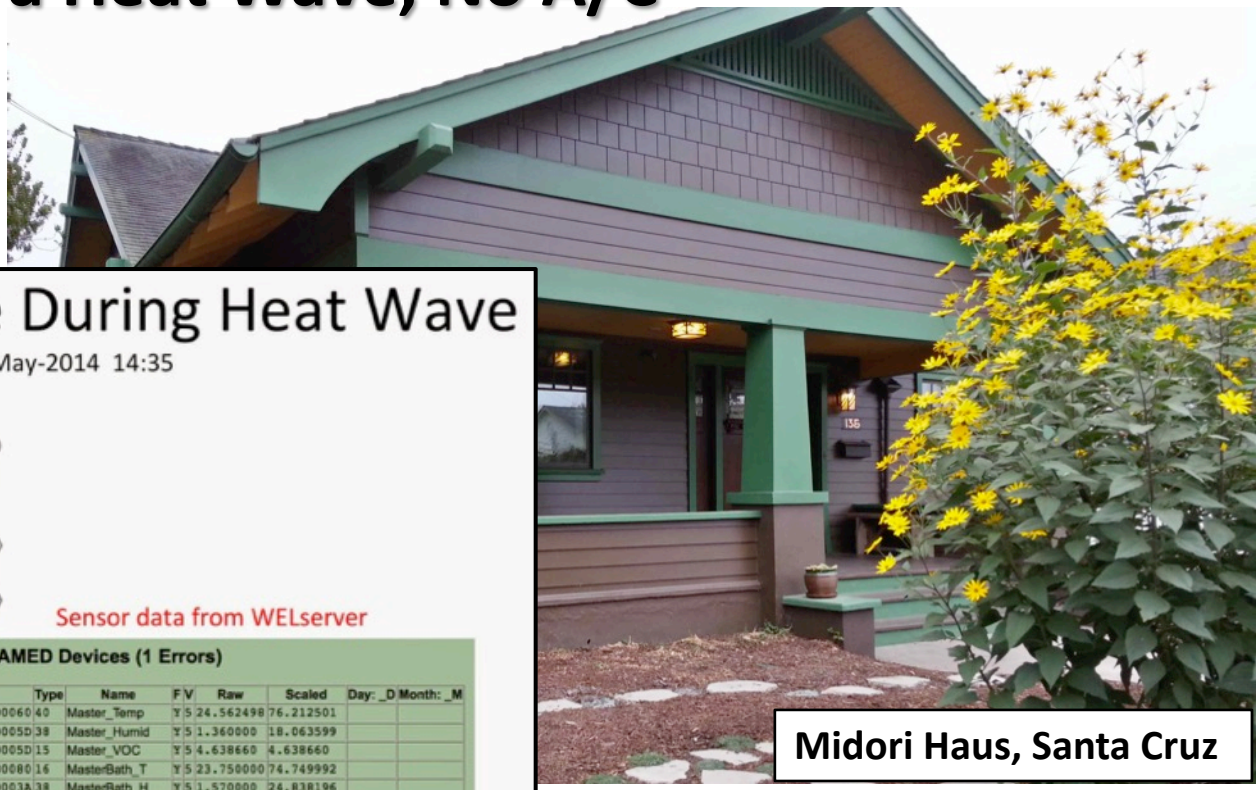
Passive House in a Heat Wave, No A/C



Midori Haus, Santa Cruz

Proof in Practice:

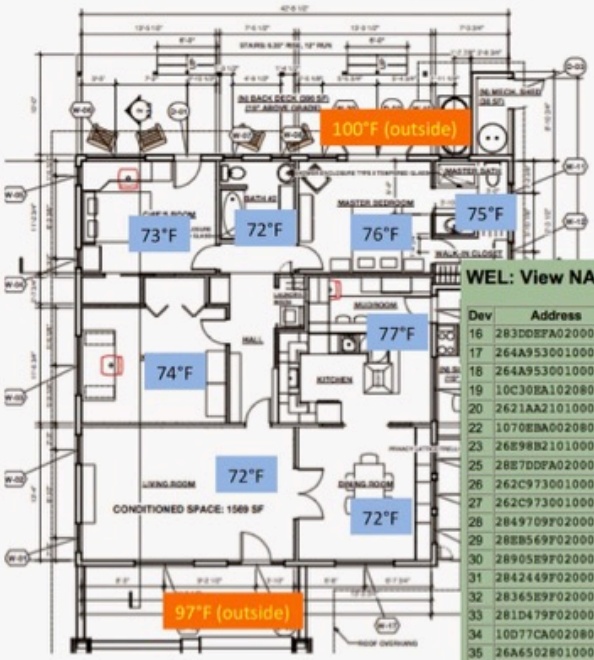
Passive House in a Heat Wave, No A/C



Midori Haus, Santa Cruz

Comfortable Inside During Heat Wave

example at 14-May-2014 14:35



Sensor data from WELserver

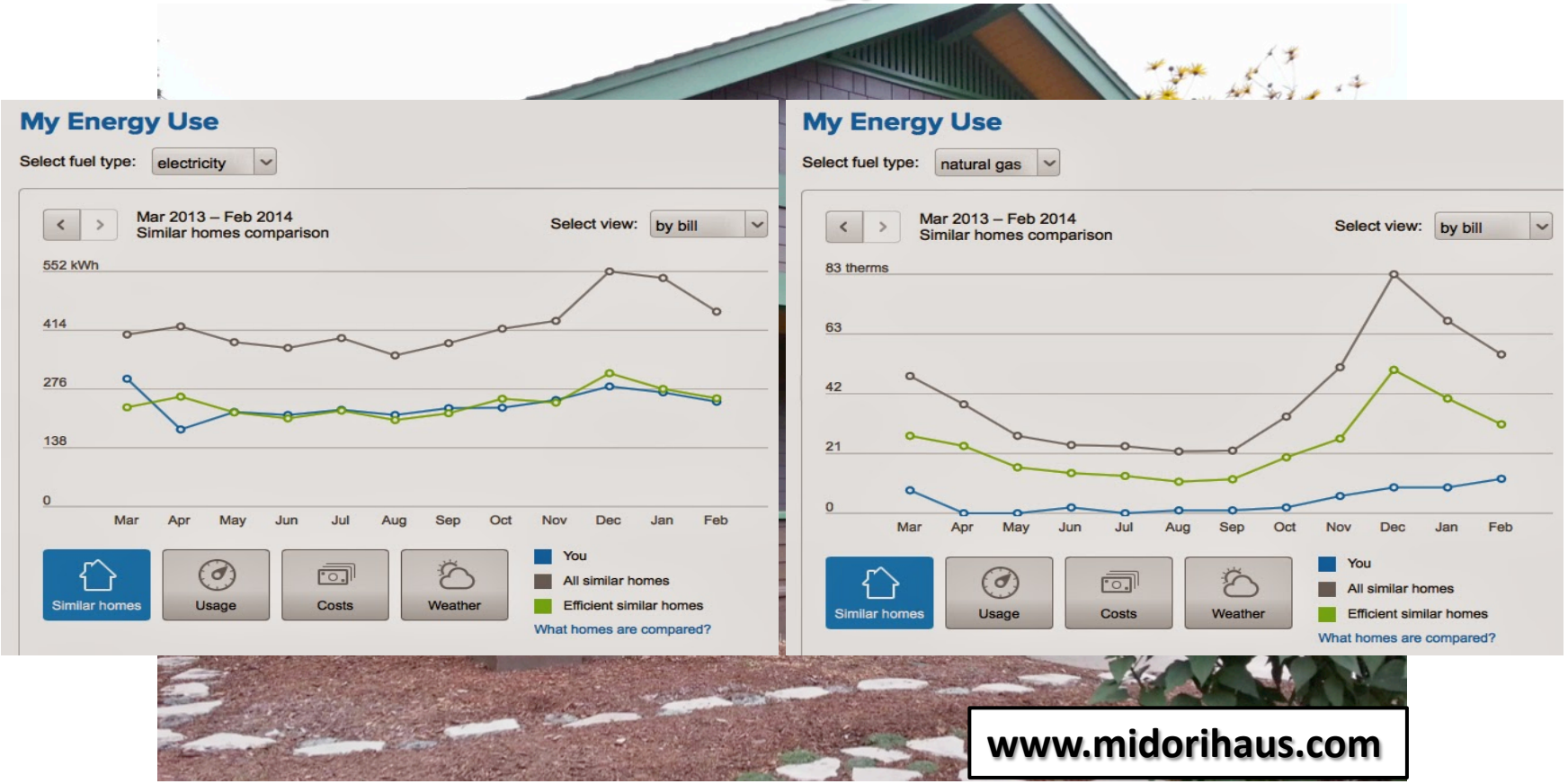
WEL: View NAMED Devices (1 Errors)

Dev	Address	Type	Name	F	V	Raw	Scaled	Day: _D	Month: _M
16	283DDEFA02000060	40	Master_Temp	Y	5	24.562498	76.212501		
17	264A95300100005D	38	Master_Humid	Y	5	1.360000	18.063599		
18	264A95300100005D	15	Master_VOC	Y	5	4.638660	4.638660		
19	10C30EA102080080	16	MasterBath_T	Y	5	23.750000	74.749992		
20	2621AA210100003A	38	MasterBath_H	Y	5	1.570000	24.838196		
22	1070EBA002080059	16	SDeck_Temp	Y	5	38.249996	100.849998		
23	26E98B2101000031	38	SDeck_Humid	Y	0	0.940000	4.514400		
25	28E7DDFA02000025	40	Mudroom_T	Y	5	24.937498	76.887489		
26	262C9730010000AF	38	Mudroom_H	Y	5	1.640000	27.096397		
27	262C9730010000AF	15	Mudroom_VOC	Y	5	8.544900	8.544900		
28	28497D9F020000A4	40	MechRoom_Temp	Y	5	40.749996	105.349998		
29	28EB569F020000F2	40	Hallway_Bath_T	Y	5	22.499998	72.499992		
30	28905E9F020000AC	40	Dining_Room_T	Y	5	22.499998	72.499992		
31	2842449F020000C7	40	Front_Porch_T	Y	5	35.874996	96.574989		
32	28365E9F02000042	40	Chie's_Room_T	Y	5	22.749998	72.949989		
33	281D479F02000083	40	Living_Room_T	Y	5	22.374998	72.275001		
34	10D77CA002080066	16	Kurt's_Room_T	Y	5	23.062498	73.512489		
35	26A6502801000DD	38	Kurt's_Room_H	Y	5	1.490000	22.257393		

1-Wire Status = Devices Found

Proof in Practice:

Passive House Seasonal Energy Use.

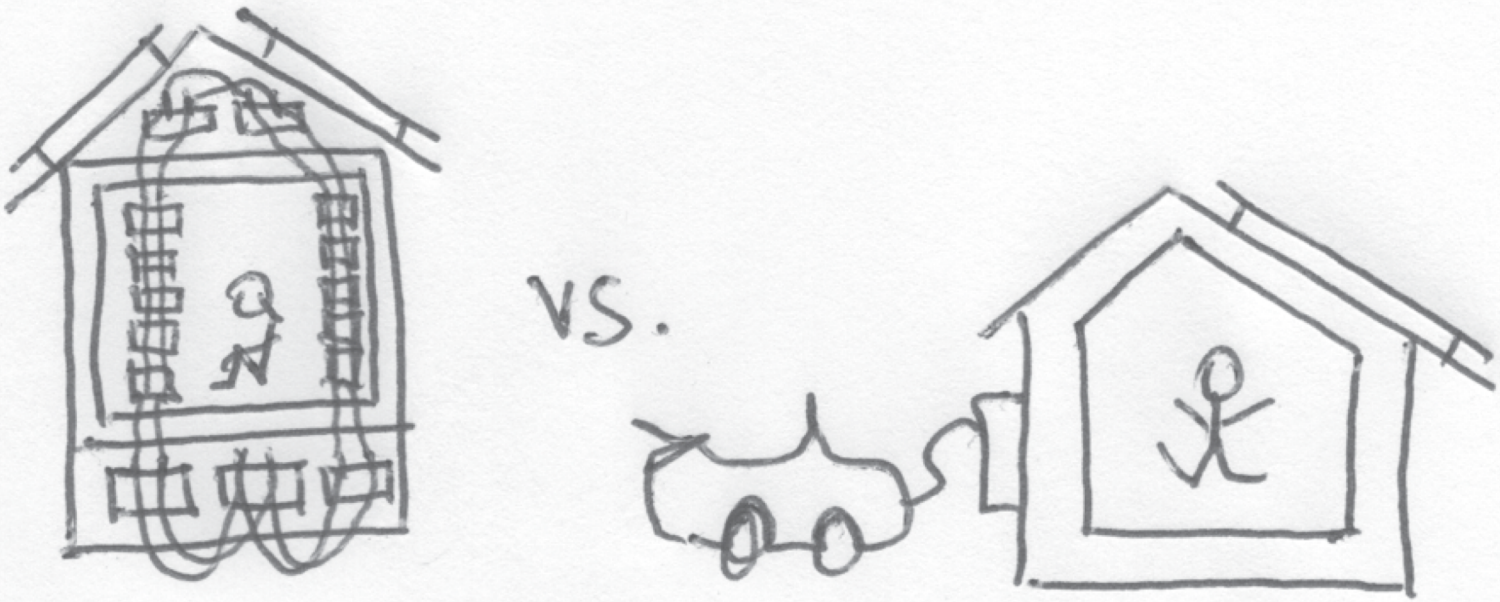


www.midorihaus.com

2869 kWh Elec. + 50 Therms (1,465 kWh) Nat. Gas = 4,334 kWh (before PV!)

Before: 21,928 kWh/yr (80% Reduction), Similar CA Home: 19,596 kWh/yr

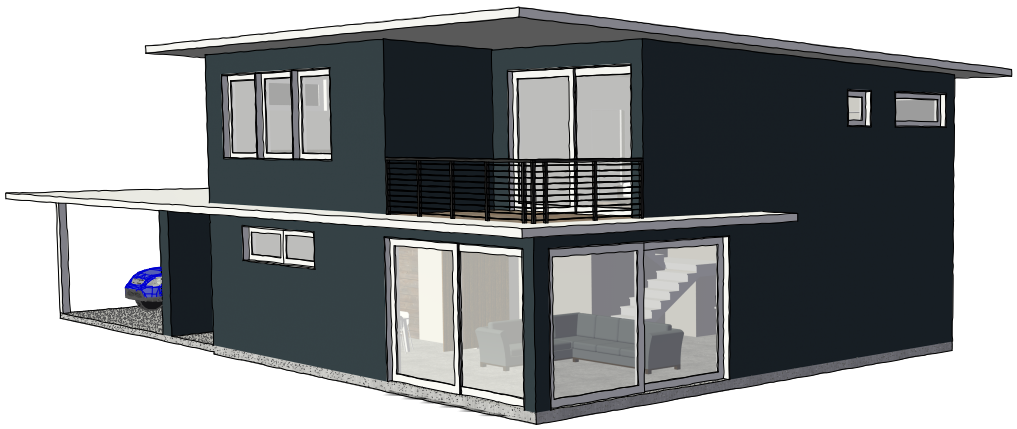
House of Batteries or House as Battery?



Passive House = Thermal Battery

Steps Toward Wider Adoption

"Pocket Production" Passive Houses

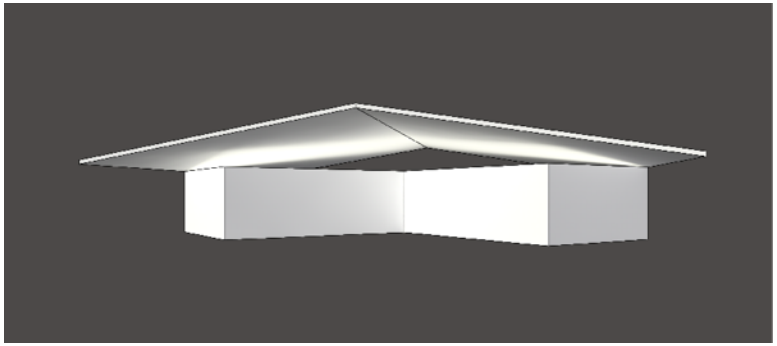


"The Healdsburg"

2790 SF (4 BR, 3-1/2 BA)

"The Mendocino"

2270 SF (4 BR, 3-1/2 BA)



"The Mojave"

German Performance, California Cool

Cali PASSIV

Thank You! Questions?

Graham Irwin, AIA

Principal, Essential Habitat Architecture

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