Net Zero Ready MT Passive House

Comparison of a
Montana 2009 IECC House with
a Montana Passive House

Objective

To determine if

a super insulated *Passive House*

is a cost-effective approach

for bridging the affordability gap

using alternative energy applications

Method

- Two houses:
  a **MT 2009 IECC** house (designed) and
  a PHI **Passive House** (designed and built)
- Same site, floor plan and square footage
- Analyze both using the same energy modeling tool (PHPP)
- Compare energy use, affordability, solar applications and Net Zero potential

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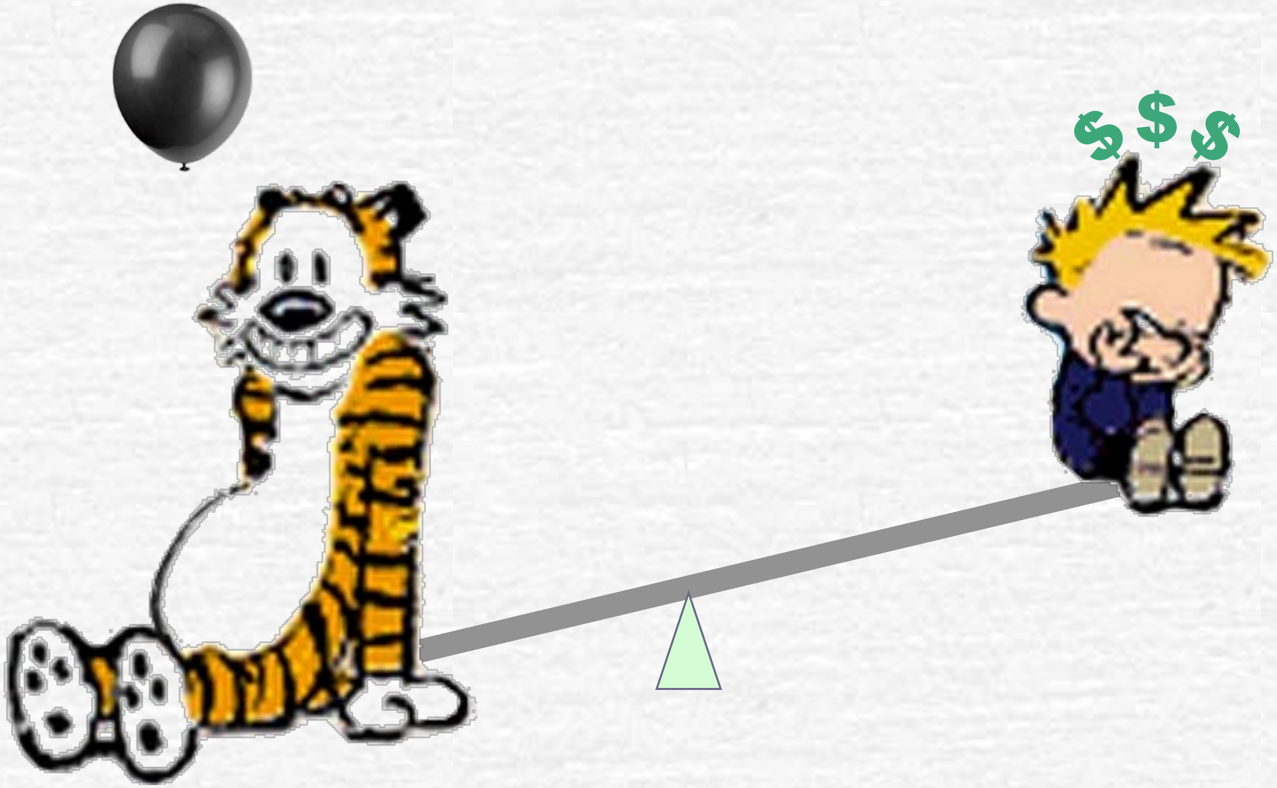
The Issue

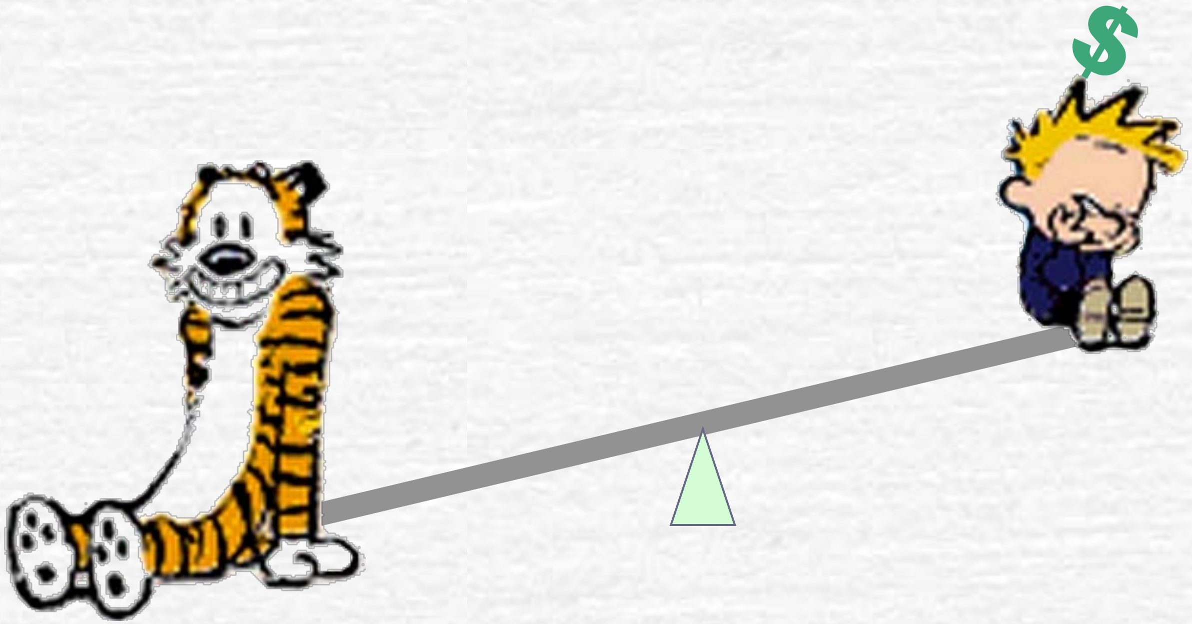


Consumption Appetite

Costly Alternative Energy Resources

Reduce CO_2 Emissions

Reduce AE Costs



Reduce Consumption

Alternative Energy Production

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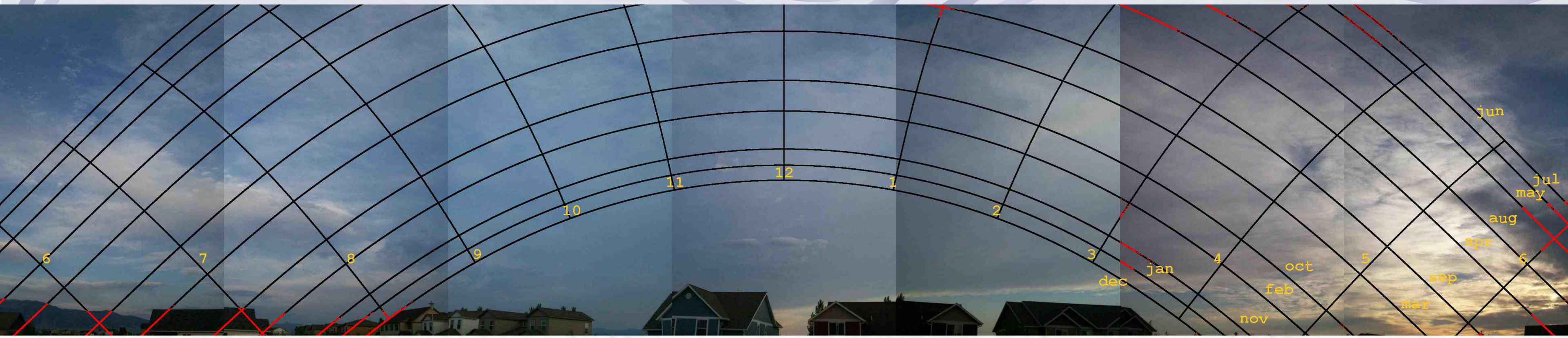
Site Orientation

S 27🎹51’49” W

Lot Cost $15,000

PH Sun Path



Passive House Planning

CALCULATING SHADING FACTORS

Climate:	BOZEMAN GALLATIN FIELD MT*
Building:	Habitat PLAN 15.2
Latitude:	45.8 °

Orientation	Glazing Area ft²	Reduction Factor r_S
North	10.5	54%
East	17.1	27%
South	152.3	74%
West	5.0	35%
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 Horizontal	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 Overhang	Additional Shading Reduction Factor	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor	Overhang Shading Reduction Factor	Total Shading Reduction Factor
			Degrees	Degrees		in	in	ft²	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	r_R	r_O	r_S
N1 W5	1	N1W5	28	90	North	21.6	35.2	5.3	20.89583	71	10	4 5/7	31	18 3/4		78%	82%	79%	51%
N2 W5	1	N2W5	28	90	North	21.6	35.2	5.3	10.125	71	10	4 5/7	28 1/5	17 4/5		88%	82%	80%	58%
E1 W6	1	E1W6	118	90	East	15.6	33.2	3.6	20.89583	16.33	10	4 5/7	31 1/2	115 1/2		35%	75%	94%	25%
E1 W7a	1	E1W7a	118	90	East	21.6	33.2	5.0	20.89583	16.33	10	4 5/7	31 1/2	88 1/2		35%	79%	92%	25%
E1 W7b	1	E1W7b	118	90	East	21.6	33.2	5.0	20.89583	16.33	10	4 5/7	31 1/2	237 1/2		35%	79%	97%	27%
E2 W6	1	E2W6	118	90	East	15.6	33.2	3.6	10.95833	16.33	10	4 5/7	31 1/2	17 1/4		57%	75%	79%	33%
S1 W1a	2	S1W1a pic	208	90	South	54.1	65.3	49.1	19.89583	110	10	4 5/7	31	16		93%	92%	88%	75%
S1 W1b	2	S1W1b t/t	208	90	South	18.1	61.2	15.3	19.89583	110	10	4 5/7	31	16		93%	82%	88%	67%
S1 W2	1	S1W2 t/t	208	90	South	24.6	61.2	10.4	19.89583	110	10	4 5/7	31	16		93%	85%	88%	69%
S2 W3a	2	S2W3a pic	208	90	South	54.1	60.8	45.7	10.75	110	10	4 5/7	28 1/5	13		97%	92%	88%	78%
S2 W3b	2	S2W3b t/t	208	90	South	18.1	56.7	14.2	10.75	110	10	4 5/7	28 1/5	13		97%	82%	88%	70%
S2 4a	1	S2W4a pic	208	90	South	47.1	39.3	12.9	10.75	110	10	4 5/7	28 1/5	13		97%	91%	85%	74%
S2 4b	1	S2W4b t/t	208	90	South	19.1	35.2	4.7	10.75	110	10	4 5/7	28 1/5	13		97%	83%	84%	67%
W1 W8	1	W1W8 t/t	298	90	West	21.6	33.2	5.0	1.791667	6	10	4 5/7	82	22 1/4		77%	78%	57%	35%

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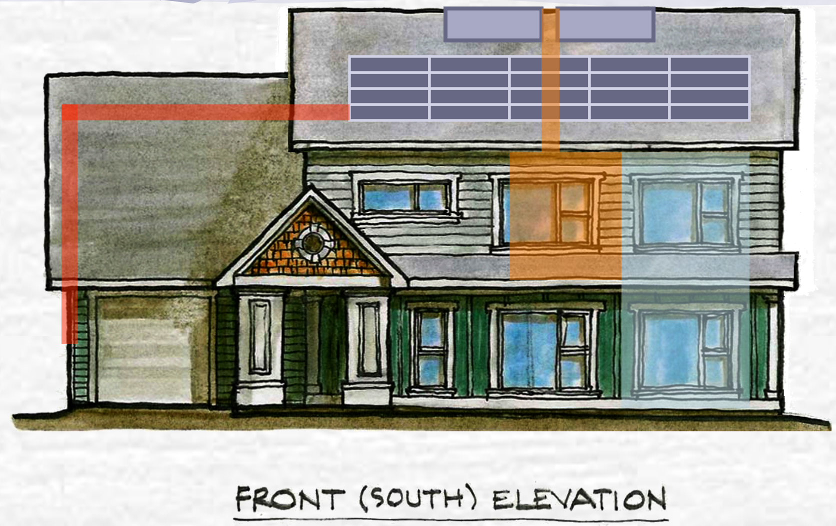
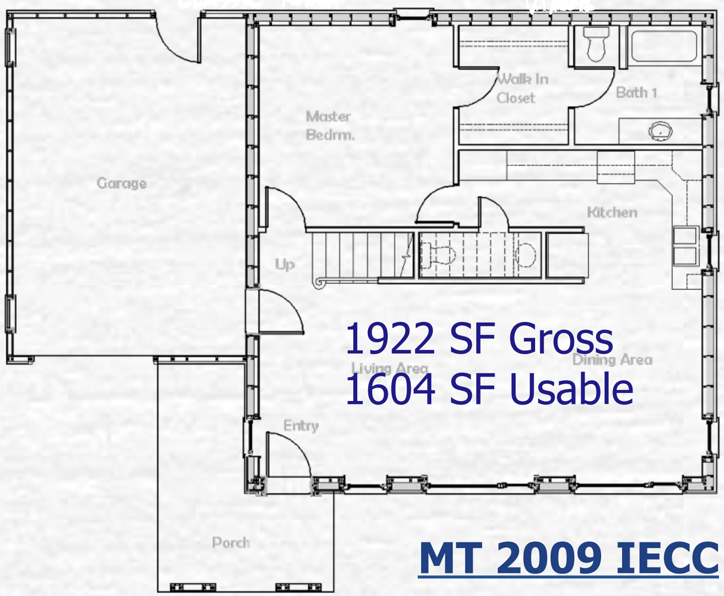
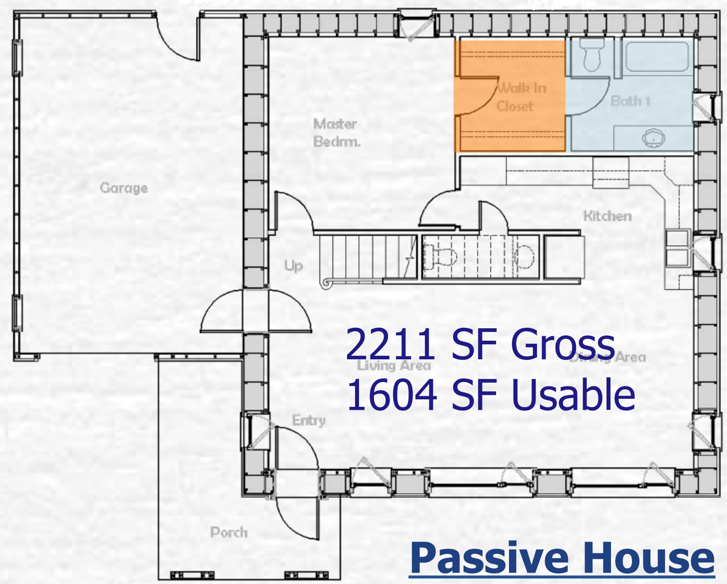
Plan Comparison





1922 SF Gross
1604 SF Usable

MT 2009 IECC



2211 SF Gross
1604 SF Usable

Passive House

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Thermal Envelopes Compared

COMPONENT	MT 2009 IECC	North West Energy Star	Passive House
Slab	**R-10**	**R-10**	**~R-50**
Wall	**R-20**	**R-23**	**~R-70**
Ceiling	**R-49**	**R-49**	**~R-103**
Windows	**U <or= 0.33**	**U <or= 0.30**	**U <or= 0.11**
Air Tightness	**<or= 4 ACH 50**	**<or= 2.5**	**<or= 0.6 ACH 50**

Construction Foundation

Construction Framing

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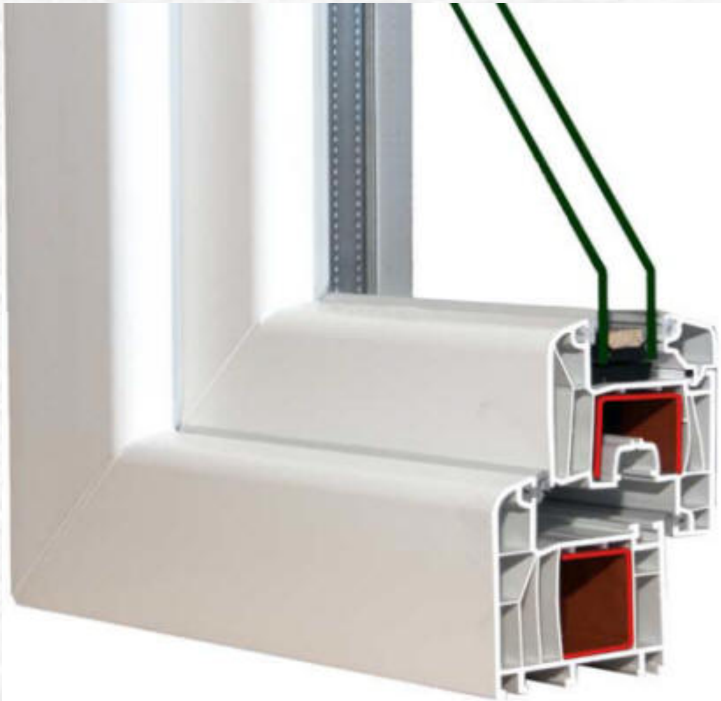
Windows Compared

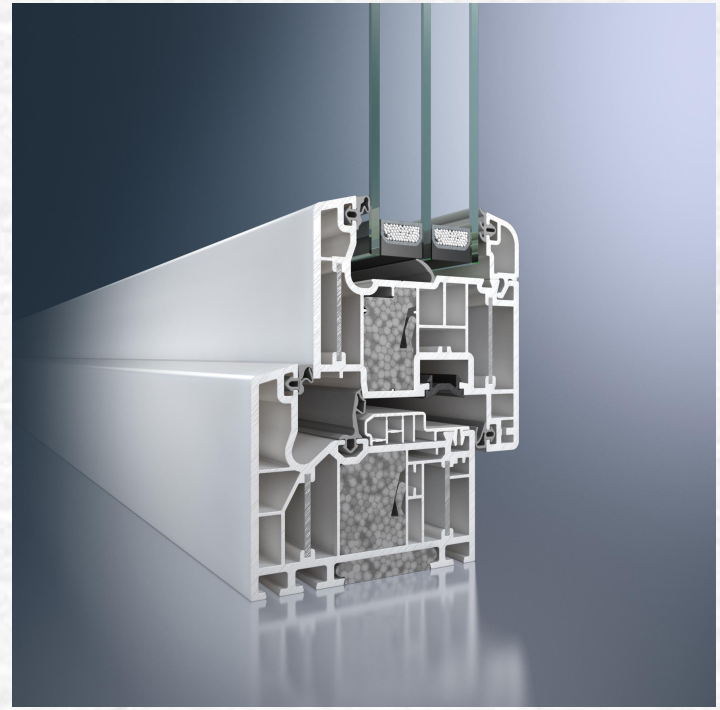


Vinyl window multi-chamber frame with steel support. Alum. Spacer, double glazed, low E

SHGC	0.3
Ucog (BTU/hr.ft.2F)	0.33
Rcog (hr.ft.2F/BTU)	3.0

MT 2009 IECC

$7,500



UPVC multi-chamber frame with warm edge spacer, triple glazed, triple seal, argon filled.

SHGC	0.6
Ucog (BTU/hr.ft.2F)	0.11
Rcog (hr.ft.2F/BTU)	9.46

Passive House

High Performance Windows $16,000

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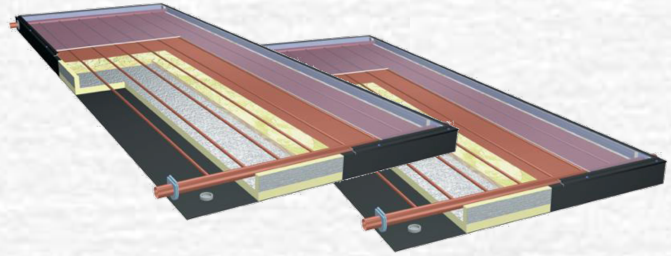
Mechanical Systems Compared

Tankless Hot
Water Heater
$2,400

40,000 Btu
Condensing
Boiler $5,100



Solar Thermal
Collectors
$6,650

Indoor Unit: MSZ-FE12NA

12,000 Btu
Mini Split System
$4,165

Wireless Remote
Controller

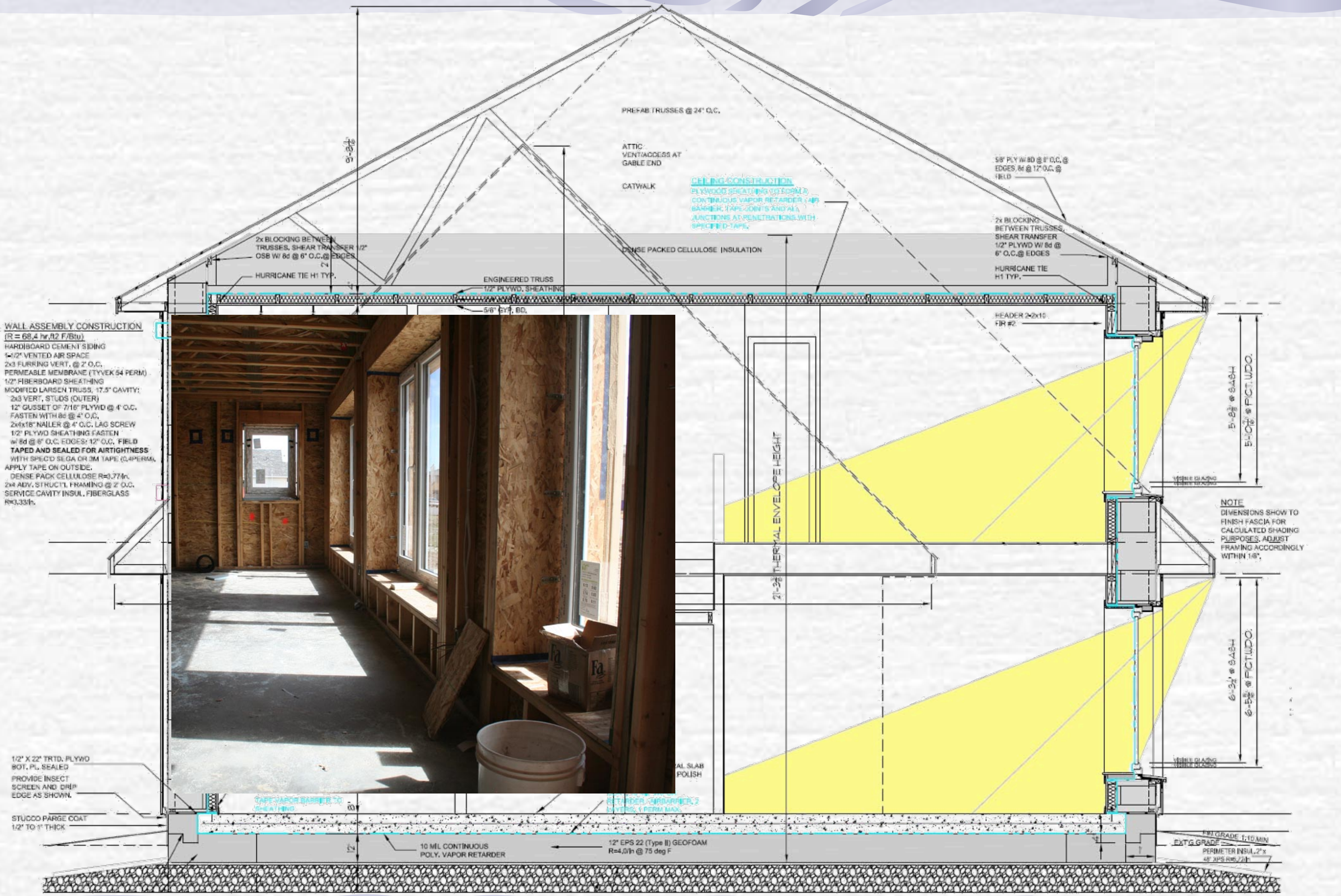
Outdoor Unit: MUZ-FE12NA

Backup Heat:
Electric Cove
$1,200

MT 2009 IECC
$7,500

Passive House
$13,405

Passive Solar Gain



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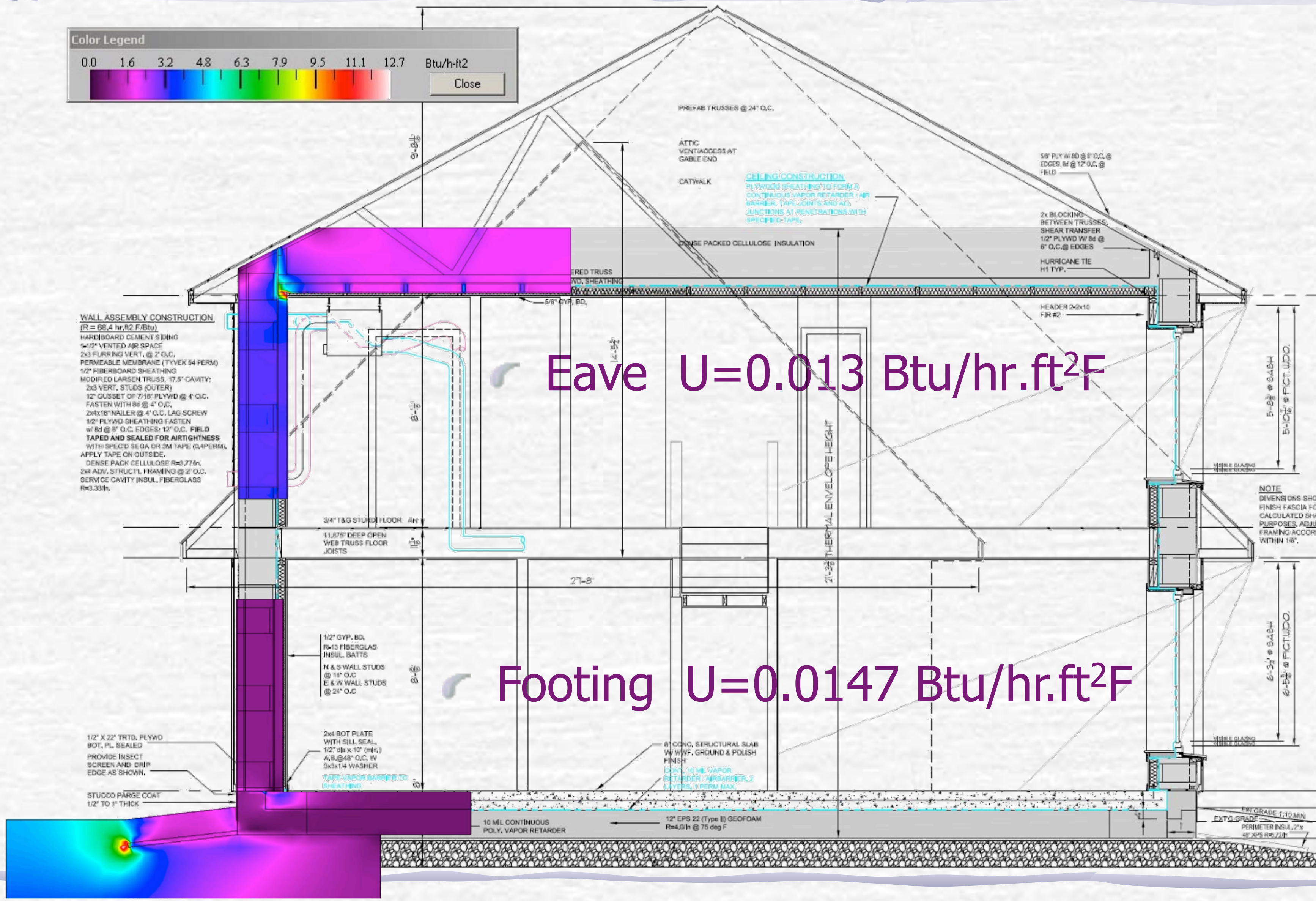
Thermal Continuity



Eave U=0.013 Btu/hr.ft^{2}F

Footing U=0.0147 Btu/hr.ft^{2}F

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PH Project Construction

Solar Thermal

HRV

Montana's First *Passive House*

Net Zero Ready Passive House

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Carbon Equivalents

in black balloon represents 2 oz. Of CO_2 equivalent greenhouse gas emissions

520

50,000

50,000

50,000

18,815 lbs.

50,000

10,000

8,000

8,517 lbs.

754 Therms + 4,330 kWh/yr

Heating, Cooling, DHW, Auxiliary & Household Electricity

MT 2009 IECC

Natural Gas Heat

Average

MT Home

94.7 Dkt/yr

9,139 kWh/yr

5,600 kWh/yr

Heating, Cooling, DHW, Auxiliary & Household Electricity

Passive House

All Electric

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Passive House Cost

Economics of PH Related Upgrades

Added value: Interest is tax-deductible!

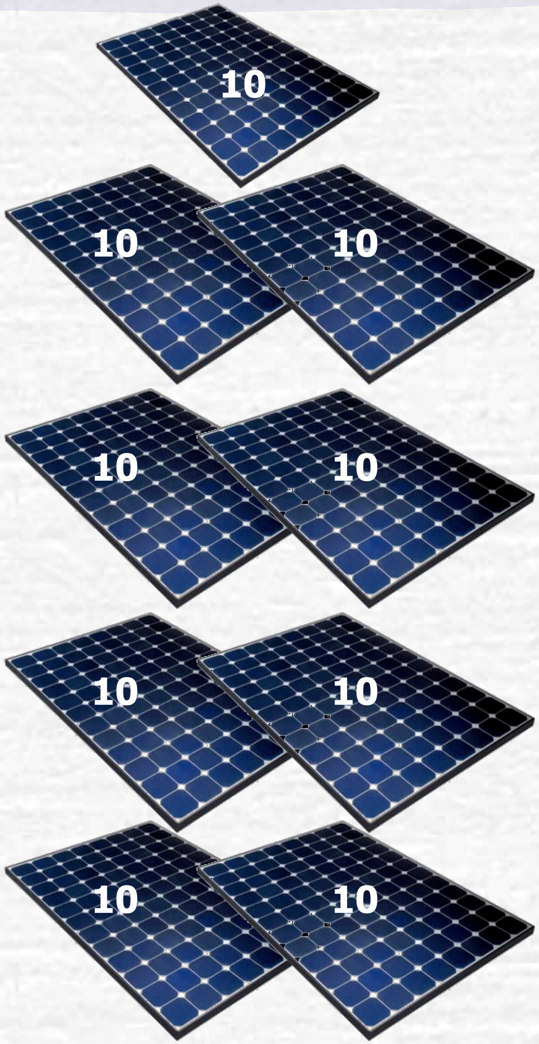
Estimated Additional Cost of PH features			
		Cost	
Framing upgrade		6,500	
Window Package upgrade		8,500	
Insulation Package upgrade		6,500	
Mechanical Systems difference		6,000	
Air Tightness		2,000	
Miscellaneous		1,000	
Capitalized cost of PH Improvements		30,500	
Est. Cost of Utilities Before Improvements		91	per mo.
Est. Cost of Utilities After PH Improvements		51	per mo.
Estimated premium for PH upgrades		40	per month

MT 2009 IECC house
754 Therms; 4,330 kWh/yr
82c per therm cost
11c per kWh cost

Passive House
5,600 kWh/yr
11c per kWh cost

Rate	0.0036	4.375%				
per	360	30	yrs			
Nper	12	12	payments per year			
Pv	30,500	Capitalized cost				
Fv	0					
Payment			Monthly	($151.73)	($1,821)	P&I per year
					($1,342)	Annual cost for PH upgrades

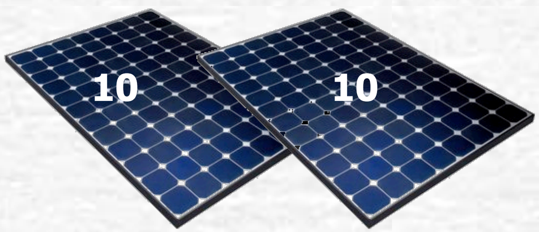
Offsets for Net Zero



MT 2009 IECC

 $ 30,000 Cost
-$ 6,000 NW Energy Grant
-$ 7,200 30% Fed.Tax Credit
-$ 1,000 State Tax Credit (2p)

$ 15,800



Passive House

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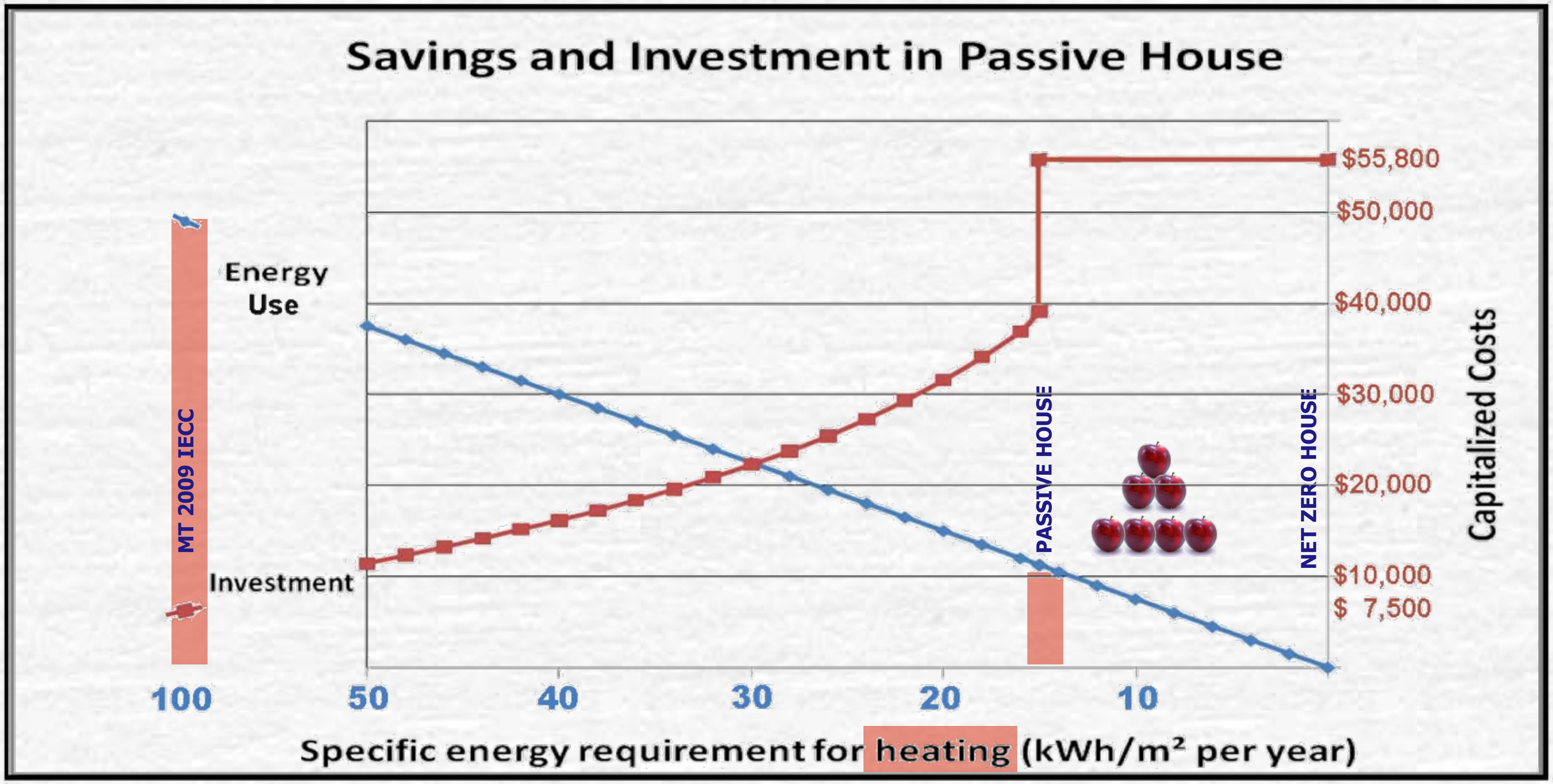
Cost Trade Off



Passive house, with increasing efficiency the consumption decreases but the costs for construction goes up.

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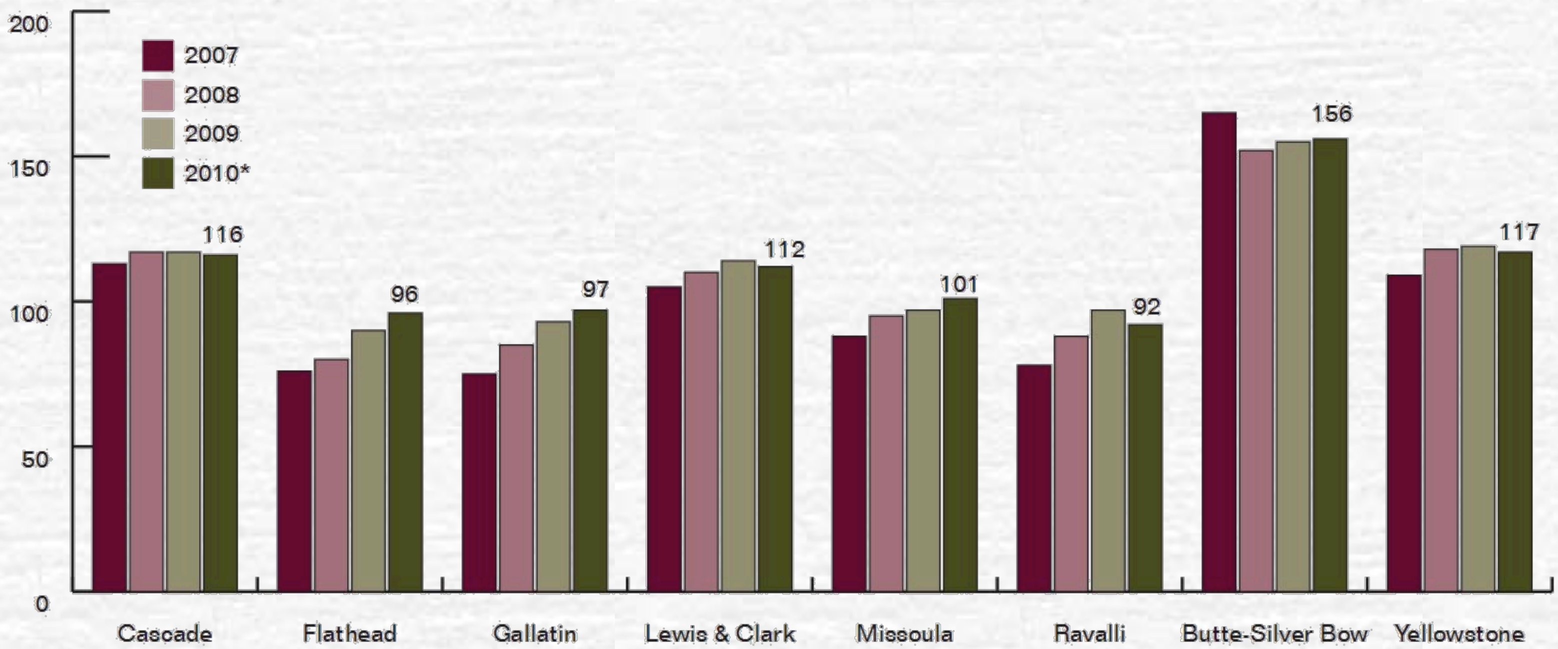
Affordability Analysis

Definition of 'Affordability Index'
A measure of a population's ability to afford to purchase … a house, indexed to the population's income. The value of 100 represents someone earning a population's median income;

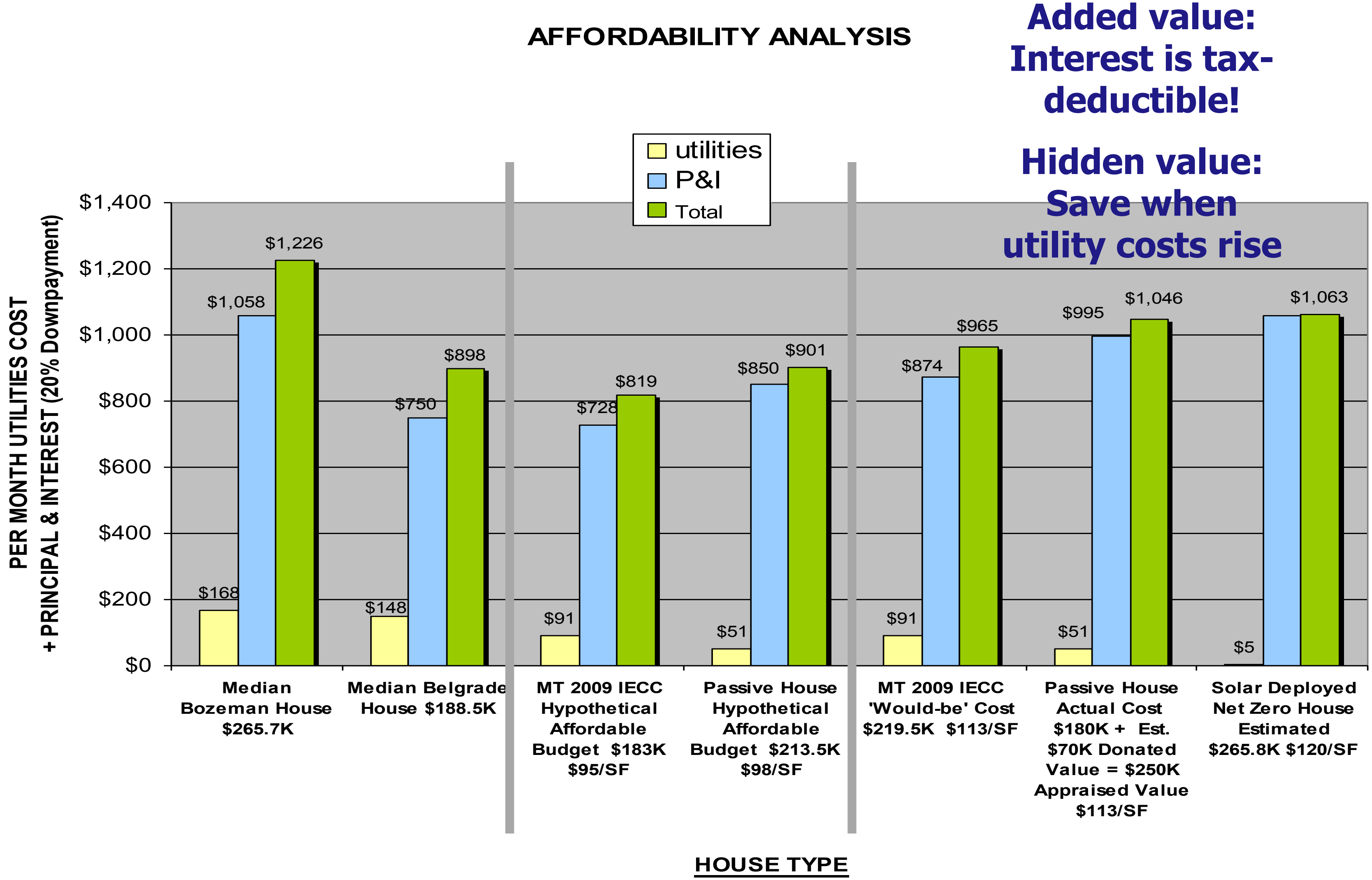
values above 100 indicate a house is more affordable and values below 100 indicating that an item is less affordable.

Figure E2
Housing Affordability Index in Montana's Major Real Estate Markets, 2007 - 2010



* Preliminary estimates using 2009 income data.
Source: Bureau of Business and Economic Research, University of Montana

Affordability Analysis



Added value: Interest is tax-deductible!

Hidden value: Save when utility costs rise

Outlook

Reduced Consumption

Leveraged by design efficiencies

Optimized Alternative Energy Production

Review

1. What is the best way to reduce CO_2 emissions?
   a. increase alternative energy production
   b. reduce consumption
   c. design for energy efficiency
   d. all of the above

2. Where can gains in efficiency best be leveraged?
   a. increased insulation and air tightness
   b. solar readiness for active and passive applications
   c. windows and mechanical equipment selection
   d. all of the above

3. Which factors affect long-term home affordability?
   a. median price for land and homes
   b. homeowner's annual income and expenses
   c. alternative energy grants and tax credits
   d. a and c
   e. a, b and c

David Magistrelli, Executive Director

Lou Moro, ReStore Manager

Dave Horvath Construction Manager

Volunteers

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Thank You!

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