Building Envelopes for Net Zero Buildings

Lessons Learned Over 20 Years

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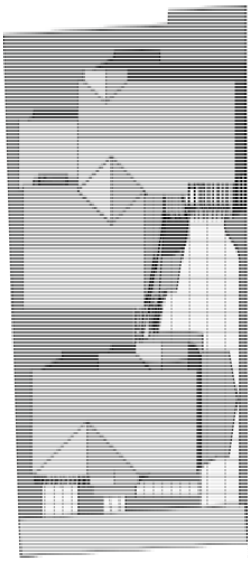

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Emeryville Resourceful Building Project

Exterior Wall Assembly					
Standard	**$ / Sq. Ft.**	**Alternate 1 (Selected)**	**$ / Sq. Ft.**	**Alternate 2**	$ / Sq. Ft.
2 x 6 @ 16" OC	$3.30	**Certified 2 x 6 @ 24" OC**	**$2.75**	Engineered 2 x 6 @ 24" OC	$3.70
R-19 Fiberglass Batts	$0.40	**R-20 Cellulose**	**$0.55**	R-20 Cellulose	$0.55
1/2" OSB	$1.10	**5/8" OSB**	**$1.20**	5/8" OSB	$1.20
MDF Siding	$4.50	**Cement Fiber Cladding**	**$5.00**	Cement Fiber Cladding	$5.00
Standard Exterior Paint	$0.55	**Recycled Exterior Paint**	**$0.65**	Recycled Exterior Paint	$0.65
15# Building Paper	$0.15	**15# Building Paper**	**$0.15**	15# Building Paper	$0.15
1/2" Gypsum board	$1.15	**5/8" Gypsum Board**	**$1.25**	5/8" Gypsum Board	$1.25
Standard Interior Paint	$0.55	**Lowo VOC Interior Paint**	**$0.75**	Low VOC Interior Paint	$0.75
Standard Caulking	$0.05	**Low VOC Caulking**	**$0.08**	Low VOC Caulking	$0.08
$ / Sq. Ft. of Wall	**$11.75**		**$12.38**		**$13.33**
Total Sq. Ft. Wall	6,365		6,365		6,365
Total Project Cost	**$74,789**		**$78,799**		**$84,845**

Compare Building Assemblies

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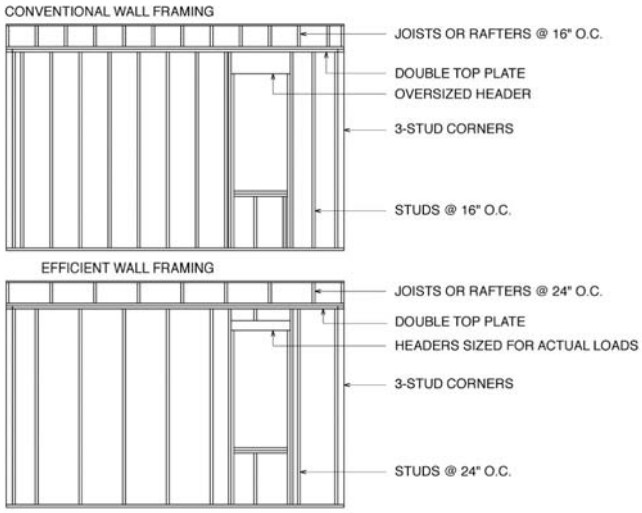

Resource Efficient Wall Framing		
	Standard Framing	**Optimized Framing**
Lumber Used **Wood Savings**	2 x 6 @ 16" OC 14,600 BF	2 x 6 @ 24" OC 11,800 BF 2800 BF (19%)
Installed Cost **Cost Savings**	$9,052	$7,316 $1,736 (19%)
Cost Certified Wood **Cost Savings**	$9,459	$7,645 $1,814 (19%)

Reduce Material Used

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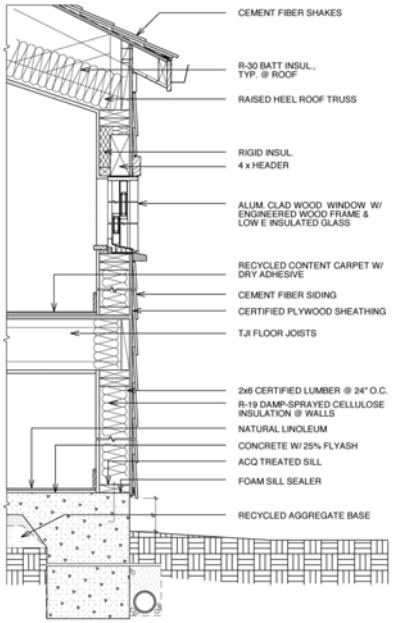

Results:

- Reduced operating energy by 33%
- Reduced operating emissions by 23%
- Reduced fuel for materials production by 50%
- Reduced wood used for framing by 19%
- Cost no more than conventional housing
- Used standard materials and methods to achieve

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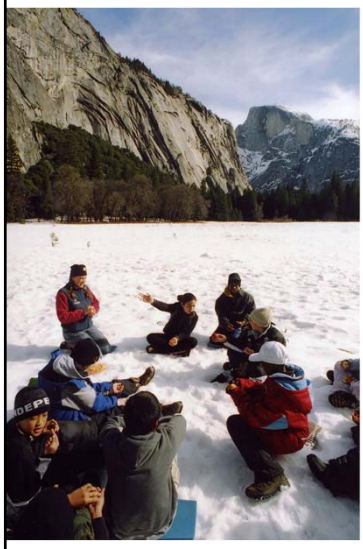

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National Environmental Science Center, Yosemite National Park

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Constructability & Remoteness

Foam:
- High global warming potential
- Toxic flame retardants

Mineral Wool:
- No flame retardants
- Less common in small buildings

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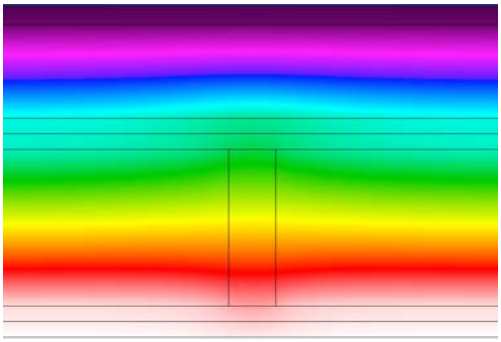
Alternatives to Rigid Foam Insulation

EXTERIOR

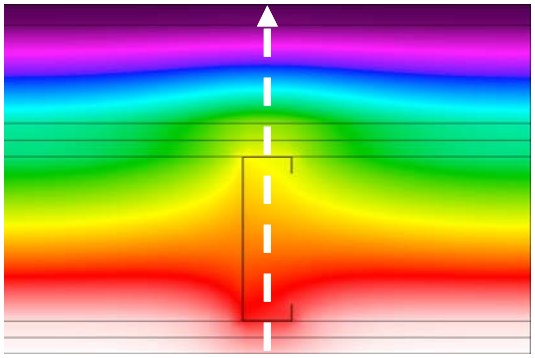


INTERIOR

U-VALUE: 0.0306
Equivalent R-Value: R-32-33
Thickness: 11 1/8”

Wood Framed Wall Assembly

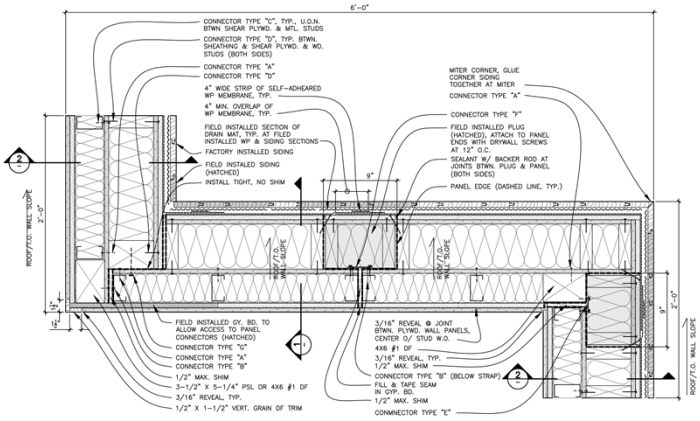
EXTERIOR

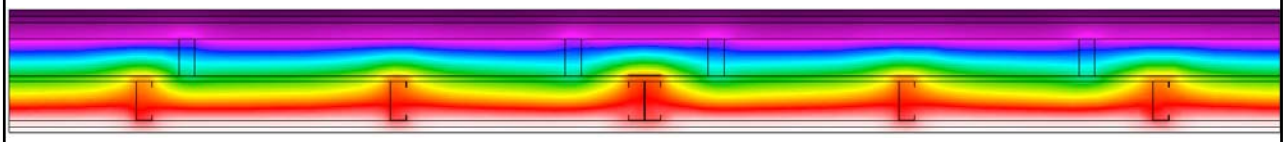


INTERIOR

U-Value: 0.0370 BTU/H ft2 F
Equivalent R-Value: R-27
Total Thickness: 11 1/8”

Steel Framed Wall Assembly





Resulting “Steel” Assembly

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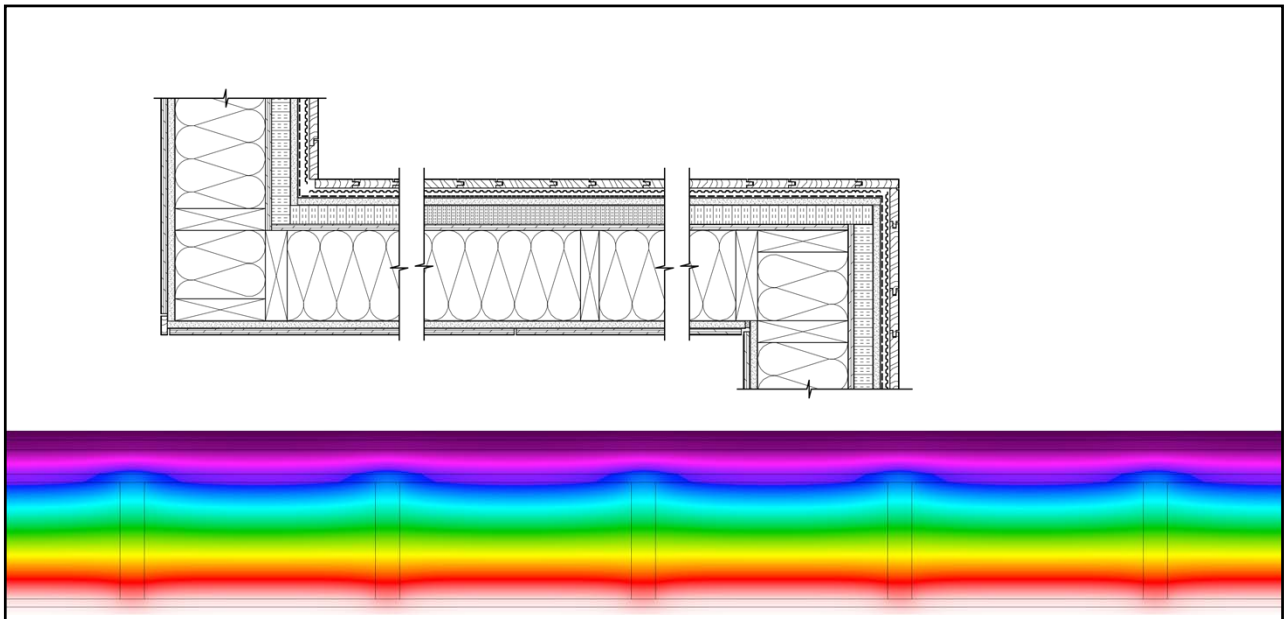

Resulting Wood Assembly

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Jackson Sustainable Winery Building, UC Davis

Project Objectives

- Net exporter of energy and water to support adjacent building
- Operate Building Passively
- 55 – 80 deg F interior temp
- “Best Value” Design-build

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NOTES:
VIEW OF JSWB FROM SOUTHEAST WITH BWF IN BACKGROUND

DESIGN INNOVATIONS [DI]
1. INCREASED SOUTH ROOF AREA
2. SHADED, SCREENED PORCHES AT EAST & WEST ENDS
3. 3KW PHOTOVAOLTAIC SYSTEM
4. HIGH PERFORMANCE "THERMACORE" SECTIONAL DOOR

BY:
CHARLES PANKOW BUILDERS
SIEGEL & STRAIN ARCHITECTS
CUNNINGHAM ENGINEERING
GUTTMANN & BLAEVOET
COLLINS ELECTRICAL
AIRCO MECHANICAL
INGRAHAM DEJESSE ASSOC.

PROJECT: 9519700
UC DAVIS – JSWB
VIEW FROM SOUTHEAST

DATE: 01/23/12
SCALE:

Jess Jackson Winery Building

	U-value	SC
Average Glass	0.45	0.5
Superglass	0.25	0.27
Lesson Opal White	0.275	0.66
Serious Glass 1	0.08	0.36
Serious Glass 2 (1") : SG 7 65/49-150	0.15	0.61
Serious Glass 3 (1"): SG 5 56/25-100	0.19	0.31

Scheme D - Flat Roof

		Wall R-Value	Roof R-Value	Infiltration Rate	Glass Type	Thermal Mass/Night Flushing	Ventilation Rates	Min Temp	Max Temp	Hours space above 80 °F
A	Simulation 30 - 6' glass on N & S - Serious Glass 2 - 16" hemcrete thermal mass	40	65	0.167	Serious Glass 2	Yes	no ventilation	45.19	81.98	30
B	Simulation 29 - 6' glass on N & S - Serious Glass 2 - 8" hemcrete thermal mass	20	65	0.167	Serious Glass 2	Yes	no ventilation	45.01	82.51	42
C	Simulation 28 - 6' glass on N & S - Serious Glass 2 - 8" hemcrete thermal mass	20	50	0.167	Serious Glass 2	Yes	no ventilation	44.85	82.81	48
D	Simulation 33 - 6' glass on N & S - Serious Glass 2 - 6" NWC thermal mass *updated glazing & shading	26.5	65	0.167	Serious Glass 3	Yes	no ventilation	45.28	77.43	0
E	Simulation 32 - 6' glass on N & S - Serious Glass 2 - 6" NWC thermal mass *no vertical fins	26.5	65	0.167	Serious Glass 2	Yes	no ventilation	46.6	79.02	0
F	Simulation 31 - 6' glass on N & S - Serious Glass 2 - 6" NWC thermal mass *updated glazing & shading	26.5	65	0.167	Serious Glass 2	Yes	no ventilation	46.6	78.97	0
G	Simulation 27a - 6' glass on N & S - Serious Glass 2 - 8" NWC thermal mass	16	80	0.167	Serious Glass 2	Yes	no ventilation	46.01	79.31	0
H	Simulation 27b - 6' glass on N & S - Serious Glass 2 - 8" NWC thermal mass	16	80	0.4	Serious Glass 2	Yes	no ventilation	43.07	83.13	48
I	Simulation 23a - 6' glass on N & S - Serious Glass 2 - 8" NWC thermal mass	40	48	0.167	Serious Glass 2	Yes	no ventilation	45.94	80.02	2
J	Simulation 23b - 6' glass on N & S - Serious Glass 2 - 8" NWC thermal mass	40	48	0.4	Serious Glass 2	Yes	no ventilation	43.09	82.85	43
K	Simulation 24a - 6' glass on N & S - Serious Glass 2 - 8" NWC thermal mass	19	48	0.167	Serious Glass 2	Yes	no ventilation	45.61	80.64	7
L	Simulation 24b - 6' glass on N & S - Serious Glass 2 - 8" NWC thermal mass	19	48	0.4	Serious Glass 2	Yes	no ventilation	42.91	83.27	49
M	Simulation 21a - 6' glass on N & S - Serious Glass 2 - 2" LWC thermal mass	40	48	0.167	Serious Glass 2	Yes	no ventilation	45.25	80.72	16
N	Simulation 21b - 6' glass on N & S - Serious Glass 2 - 2" LWC thermal mass	40	48	0.4	Serious Glass 2	Yes	no ventilation	41.94	84.72	107
O	Simulation 18a - 12' glass on N & S - Serious Glass 1 - 2" LWC thermal mass	70	80	0.167	Serious Glass 1	Yes	no ventilation	45.84	79.90	0
P	Simulation 18b - 12' glass on N & S - Serious Glass 1 - 2" LWC thermal mass	70	80	0.4	Serious Glass 1	Yes	no ventilation	42.25	84.22	88
Q	Simulation 20a - 12' glass on N & S - Serious Glass 2 - 2" LWC thermal mass	40	48	0.167	Serious Glass 2	Yes	no ventilation	45.44	83.00	47
R	Simulation 20b - 12' glass on N & S - Serious Glass 2 - 2" LWC thermal mass	40	48	0.4	Serious Glass 2	Yes	no ventilation	41.95	86.36	192
S	Simulation 25a - 6' glass on N& S - Serious Glass 2 - *No thermal mass*	40	48	0.167	Serious Glass 2	Yes	no ventilation	43.93	83.00	40
T	Simulation 25b - 6' glass on N& S - Serious Glass 2 - *No thermal mass*	40	48	0.4	Serious Glass 2	Yes	no ventilation	40.77	87.68	269
U	Simulation 26a - 6' glass on N& S - Serious Glass 2 - *No thermal mass*	19	48	0.167	Serious Glass 2	Yes	no ventilation	43.93	84.48	100
V	Simulation 26b - 6' glass on N& S - Serious Glass 2 - *No thermal mass*	19	48	0.4	Serious Glass 2	Yes	no ventilation	40.31	89.14	359
W	Simulation 19 - glass on N & S - Serious Glass 2	70	80	0.167	Serious Glass 2	Yes	no ventilation	45.84	79.82	0
X	Simulation 11a - no glass	70	80	0.167	No Glass	Yes	no ventilation	44.66	75.11	0
Y	Simulation 11 - -no glass	40	48	0.167	No Glass	Yes	no ventilation	44.03	76.27	0
Z	Simulation 2 - no glass	40	48	0.167	No Glass	No	no ventilation			27
AA	Simulation 15 - glass on all sides - Serious Glass 1	70	80	0.167	Serious Glass 1	Yes	no ventilation			46
BB	Simulation 13 - glass on all sides - Superglass	70	80	0.167	Superglass	Yes	no ventilation			60
CC	Simulation 14 - glass on all sides - Serious Glass 1	40	48	0.167	Serious Glass 1	Yes	no ventilation			66
DD	Simulation 17 - glass on all sides - Serious Glass 2	70	80	0.167	Serious Glass 2	Yes	no ventilation			218
EE	Simulation 12 - glass on all sides - Average Glass	40	48	0.167	Average Glass	Yes	no ventilation			260
FF	Simulation 2 - glass as SS designed	40	48	0.167	Average Glass	No	no ventilation			790

Single variable iteration

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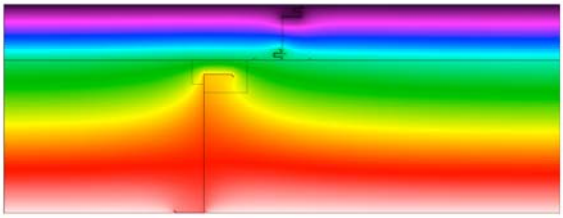

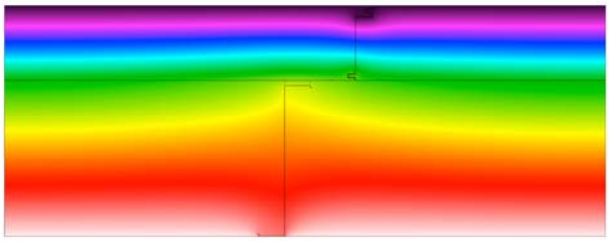

Exterior Wall
4 inch insulated wall panel over
Snap-R 1 inch EPS spacer over
10 inch girt (11in batt insulation)
= R-55.7

Roof
6 inch insulated roof panel over
12 inch metal girt with
batt insulation
= R-70

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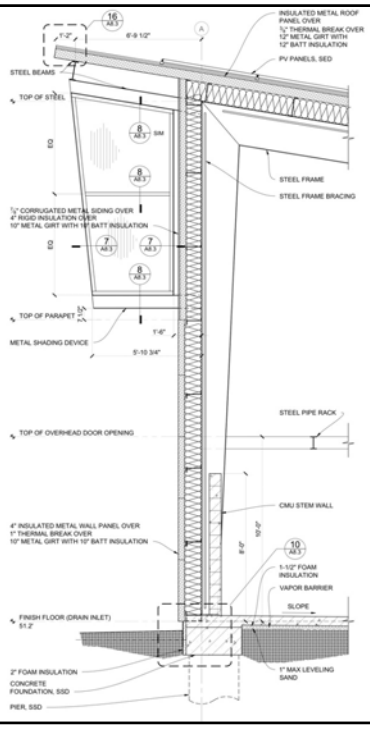

Optimize Design
reduce loads
insulate well
provide daylight
reduce infiltration
address thermal breaks
passive cooling

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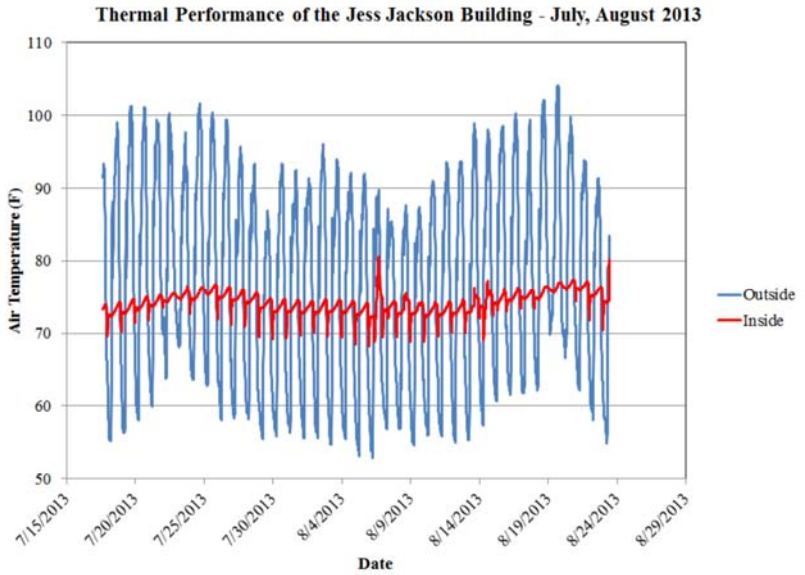
Temperature Results



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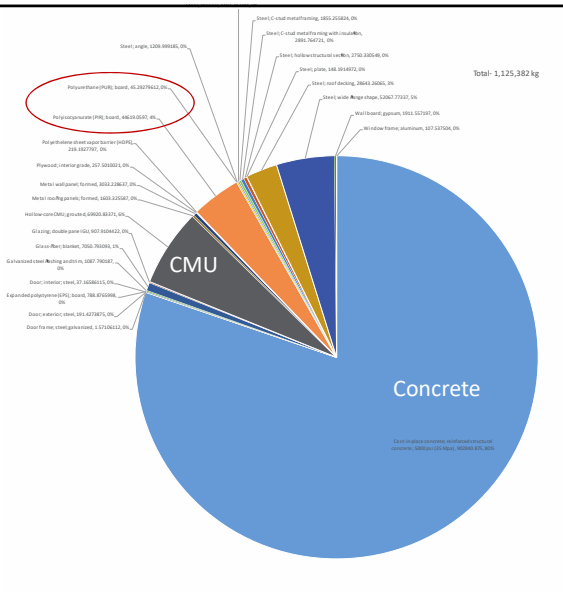
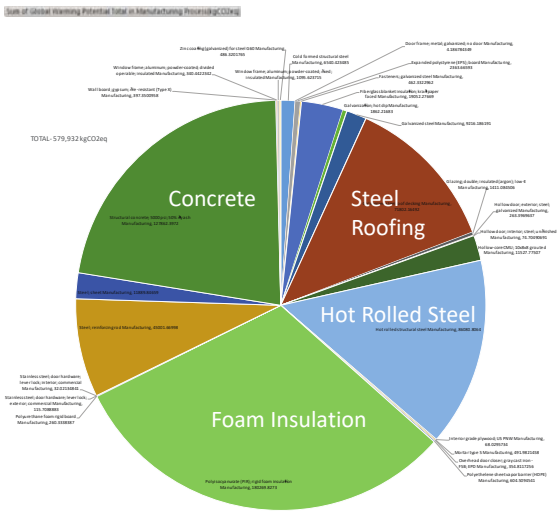


Mass of Materials



Embodied Carbon of Materials

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Tally: Embodied Carbon Calculations

Faculty/Staff Housing
UC Davis

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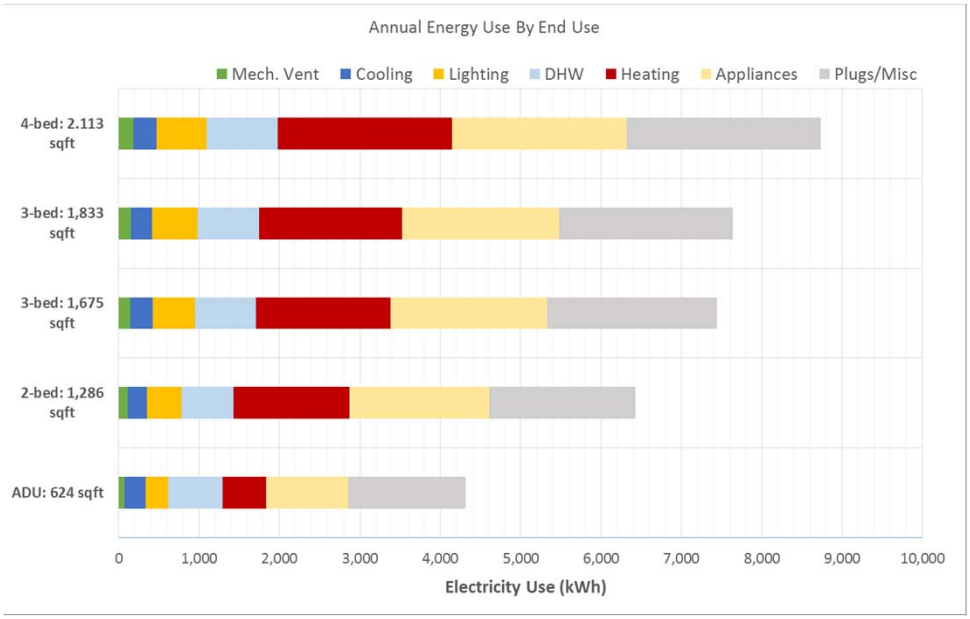

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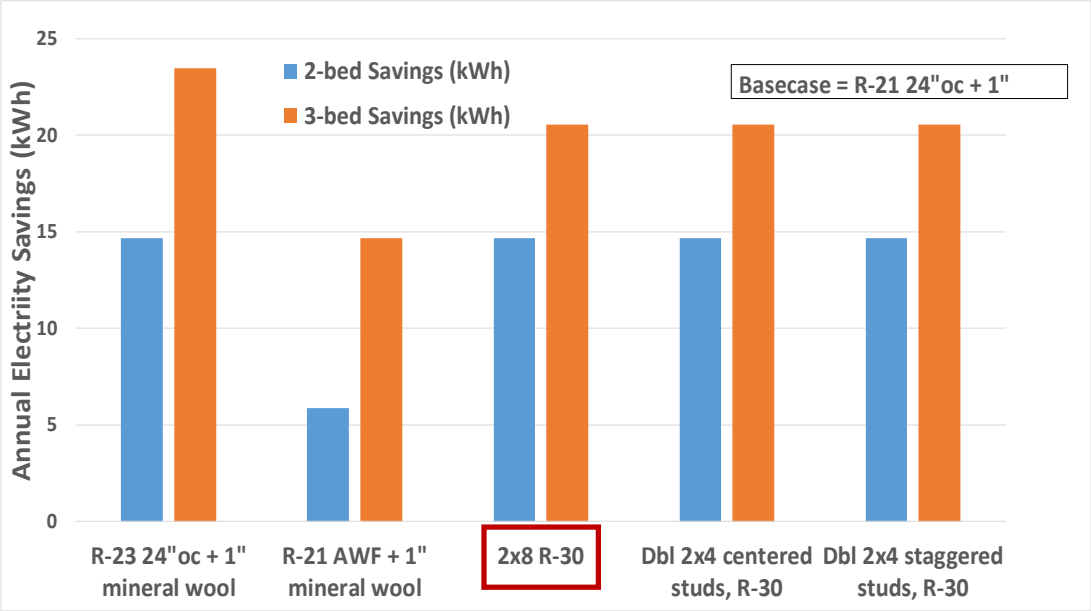
ANNUAL ENERGY USE FOR BASE CASE



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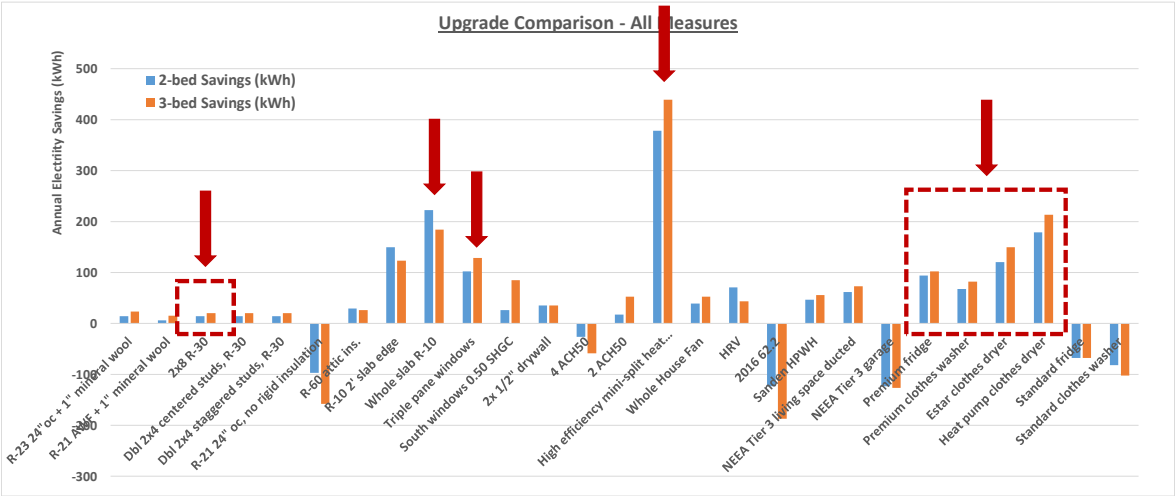
WALL ASSEMBLY COMPARISON



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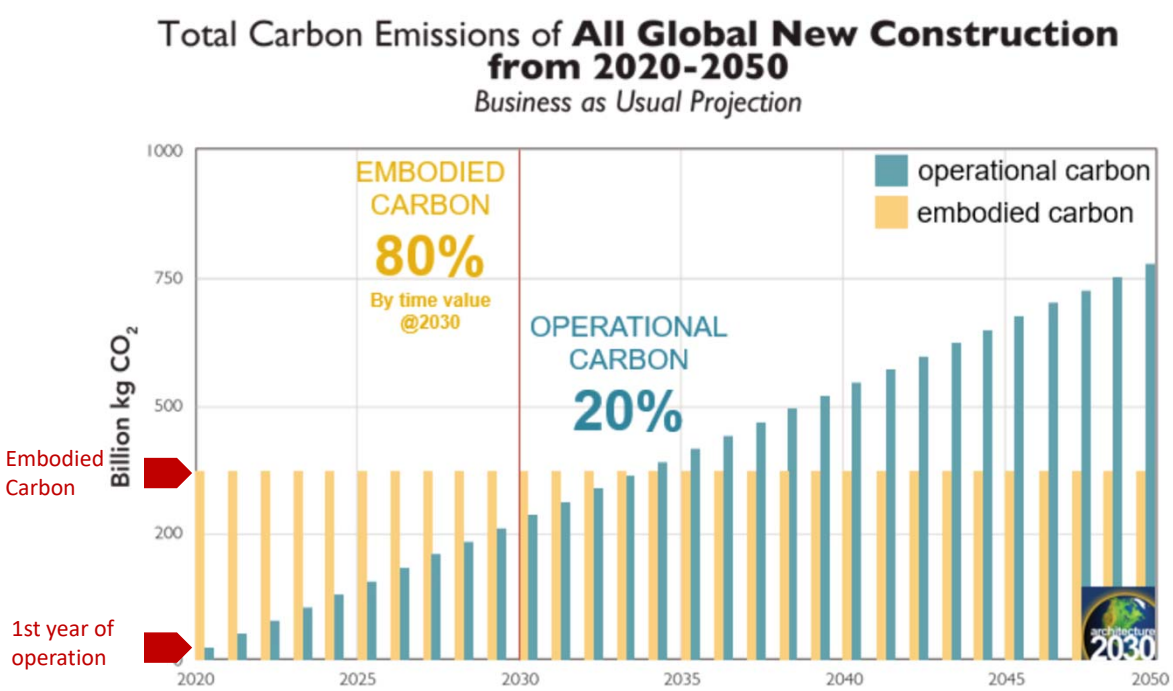
Summary of Energy Upgrades