17 Mile Haus

Operational + Embodied Carbon
A PHribbon Case Study

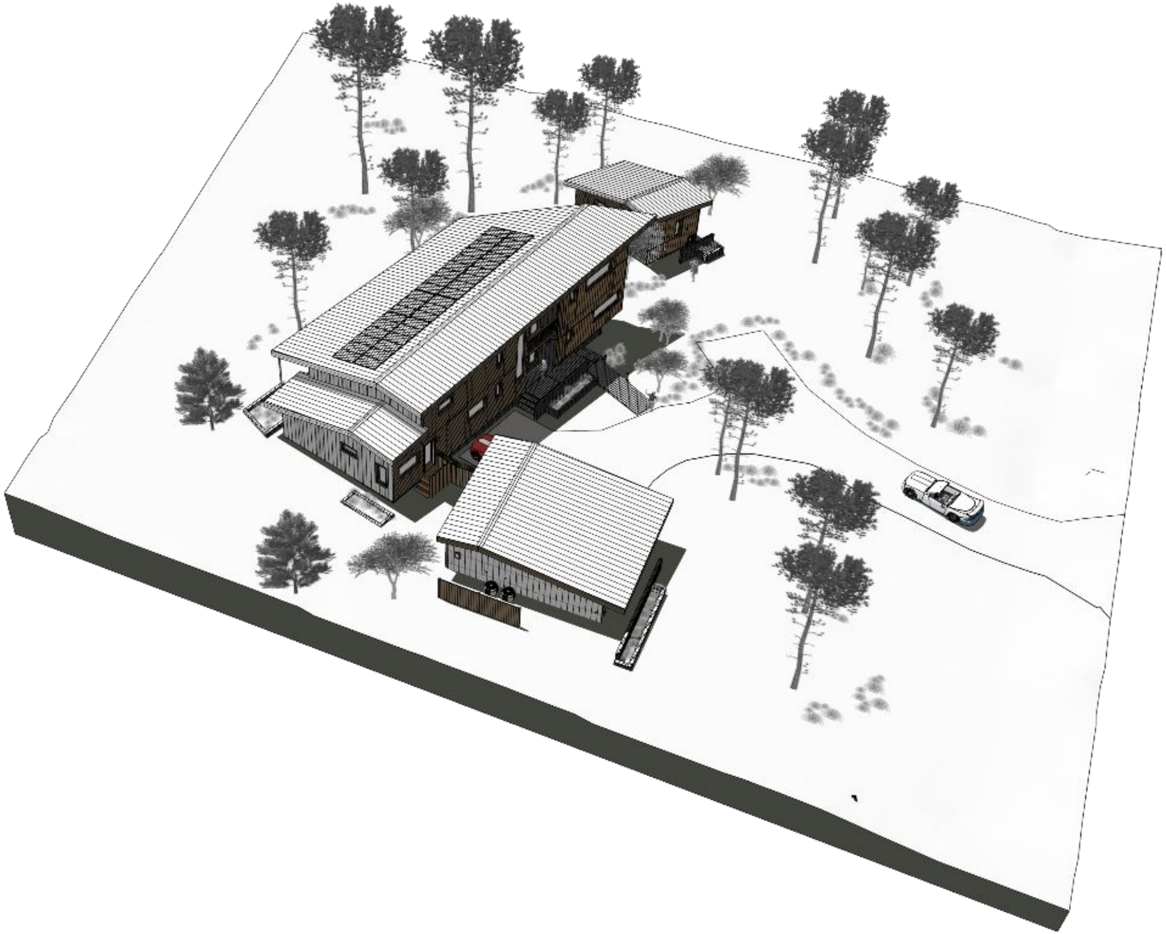
Bronwyn Barry, RA, CPHD

Introductions

Exploring Passive House since 2007

PH Architect
PH Window designer
PH Policy wonk

Co-Founder:
Passive House California
Passive House Network



Agenda

[May 18th, 2023]

PHribbon Case Study

1. **17 Mile Haus Overview**
2. **PHribbon Results**
3. **Lessons Learned**

Overview

[A lovely site]

passive house

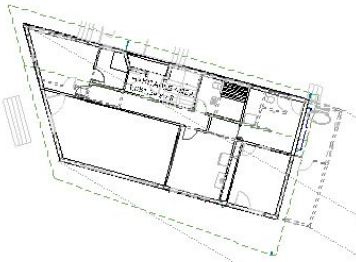
Making progress

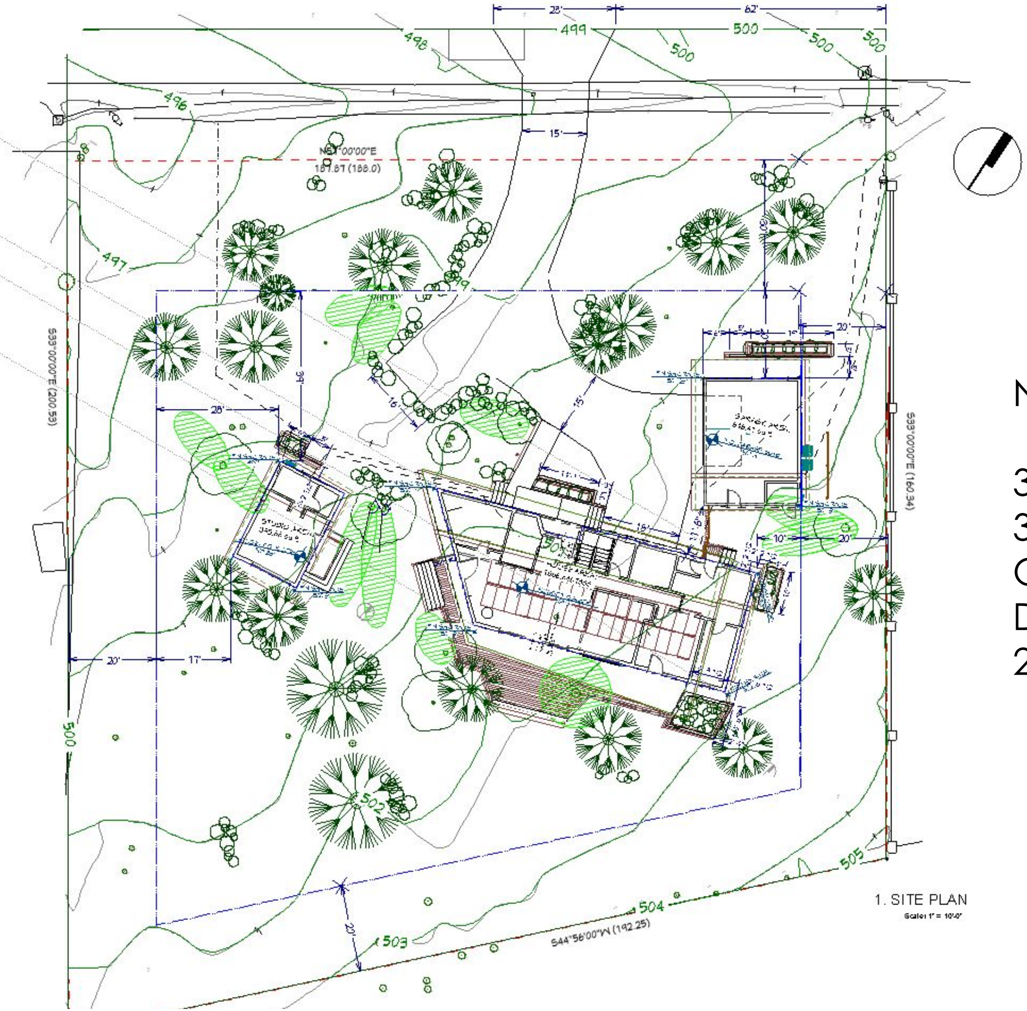
passive house

Location, location, location

passive house

Plans





1. SITE PLAN

FLOOR AREA CALCS:

PRIMARY RESIDENCE:	
1ST FLR	1,887 SF
2ND FLR	1,051 SF
	2,938 SF
STUDIO:	396 SF
GARAGE:	646 SF
TOTAL :	**3,980 SF**

Not so big:

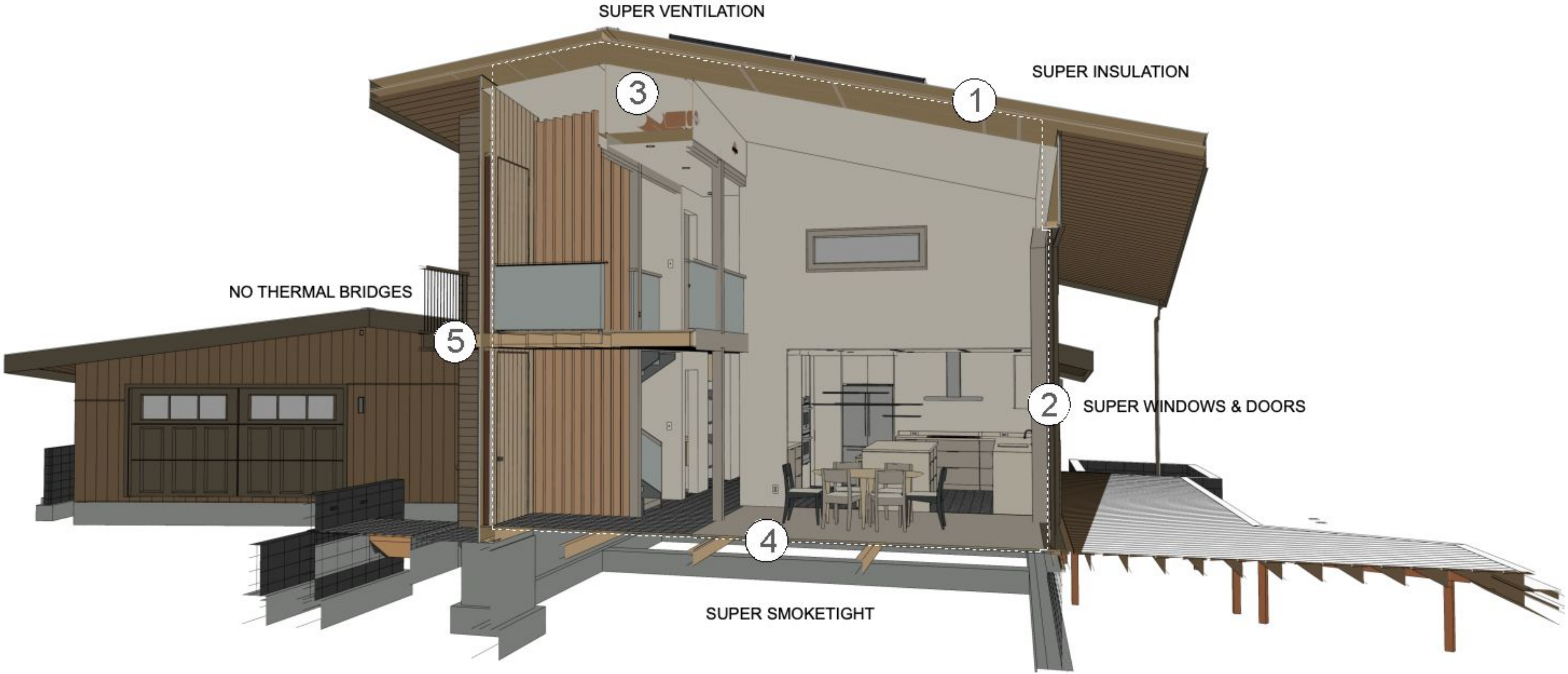
3 bedrooms
3.5 bathrooms
Office
Detached studio
2-car garage

A nod to Monterey Modernism

Considered resilience

- ❑ Shading
- ❑ On site water retention
- ❑ Solar + storage + EVs
- ❑ Zero fossil fuel
- ❑ Fire hardened

All the PH Essentials



Seeking Certification

Passive House Verification

Building:	Asnis Residence
Street:	
Postcode/City:	CA
Province/Country:	California / US-United States of America
Building type:	Single Family Dwelling Unit
Climate data set:	ud---01-Monterey, CA
Climate zone:	5: Warm — Altitude of location: 20 ft
Home owner / Client:	Asnis
Street:	
Postcode/City:	
Province/Country:	

Architecture:	Passive House BB	Mechanical engineer:	
Street:		Street:	
Postcode/City:	CA 94110 San Francisco	Postcode/City:	
Province/Country:	California	Province/Country:	
Energy consultancy:	Hyperlocal Workshop	Certification:	Steve Mann
Street:		Street:	
Postcode/City:	80541 Masonville	Postcode/City:	
Province/Country:	Colorado / US-United States of America	Province/Country:	

Year of construction:	2021	Interior temperature winter [°F]:	68.0	Interior temp. summer [°F]:	77.0
No. of dwelling units:	1	Internal heat gains (IHG) heating case [BTU/(hr.ft²)]:	0.74	IHG cooling case [BTU/(hr.ft²)]:	0.74
No. of occupants:	2.0	Specific capacity [BTU/F per ft² TFA]:	10.6	Mechanical cooling:	x

Specific building characteristics with reference to the treated floor area — PHPP has not been completed; it is not valid as verification (see 'Check' worksheet)

				Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area ft²	2196				
Space heating	Heating demand kBTU/(ft²yr)	0.66	≤	4.75	-	yes
	Heating load BTU/(hr.ft²)	1.71	≤	-	3.17	
Space cooling	Cooling & dehum. demand kBTU/(ft²yr)	4.34	≤	4.75	4.75	yes
	Cooling load BTU/(hr.ft²)	2.75	≤	-	3.25	
	Frequency of overheating (> 77 °F) %	-	≤	-		-
	Frequency of excessively high humidity (> 0.012 lb/lb) %	0.0	≤	3.17		yes
Airtightness	Pressurization test result n_{50} 1/hr	0.6	≤	0.19		yes
Non-renewable Primary Energy (PE)	PE demand kBTU/(ft²yr)	27.39	≤	-		-
Primary Energy Renewable (PER)	PER demand kBTU/(ft²yr)	12.02	≤	19	19	yes
	Generation of renewable energy (in relation to pro-jected building footprint area) kBTU/(ft²yr)	6.04	≥	-	-	

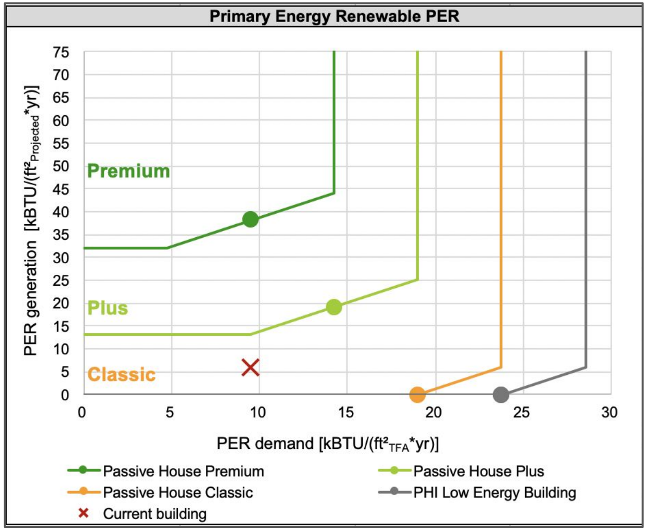
[2] Empty field: Data missing; '-': No requirement

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

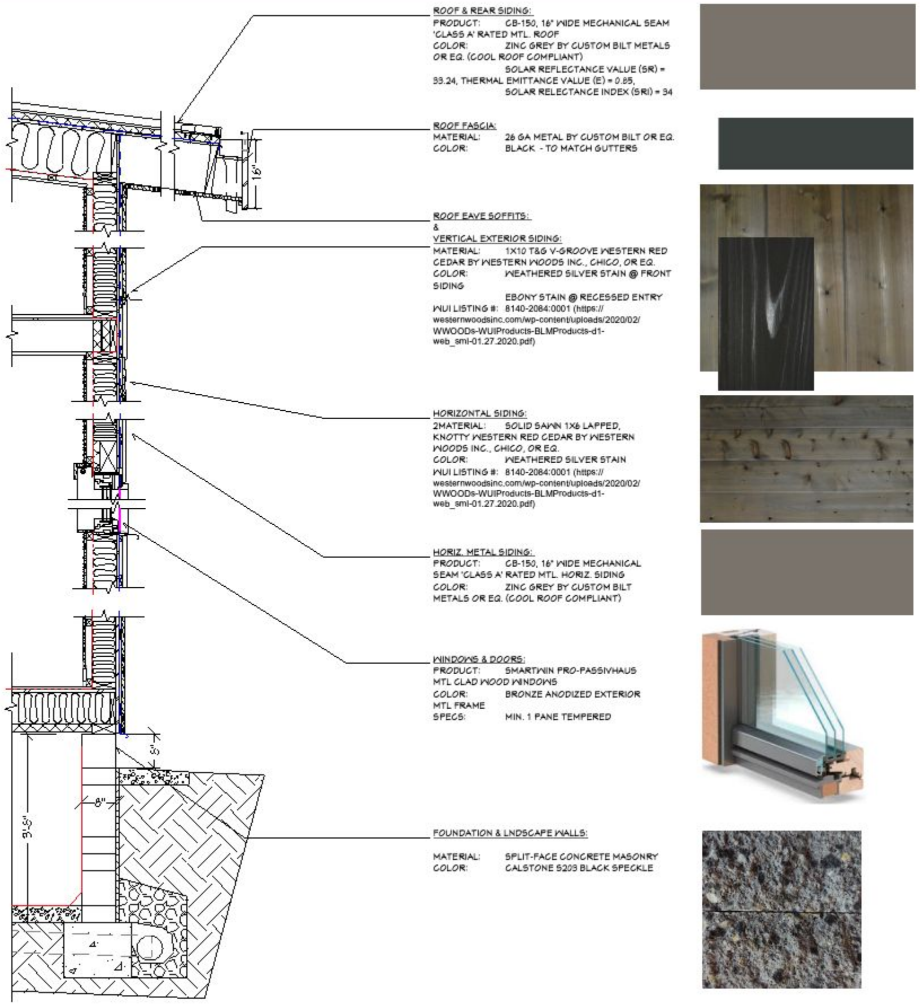
Passive House Classic? **yes**

Task: First name: Surname: Signature:

Issued on: City:



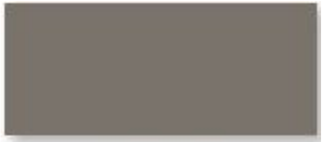
A Fire-Resistant Palette



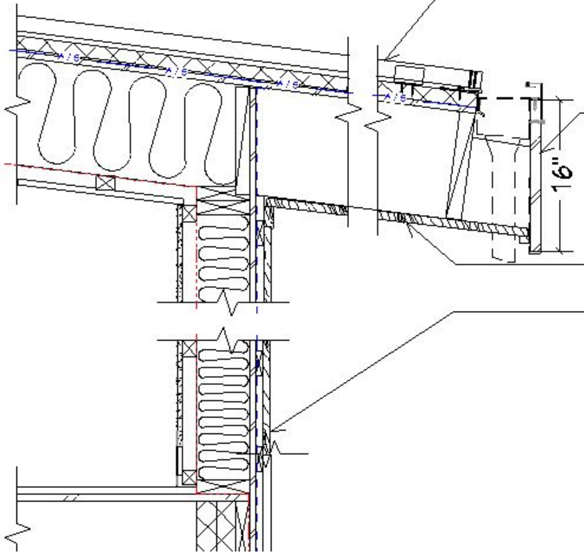
In a Wildfire Urban Interface (WUI) Zone

[Required to be WUI-compliant by code]

Roof



Zinc Gray
SR-33.24 E-.85 SRI- 34



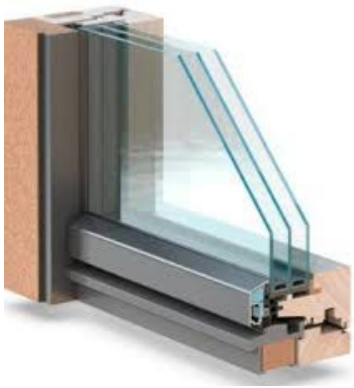
ROOF & REAR SIDING:
PRODUCT: CB-150, 16" WIDE MECHANICAL SEAM 'CLASS A' RATED MTL. ROOF
COLOR: ZINC GREY BY CUSTOM BILT METALS OR EQ. (COOL ROOF COMPLIANT)
SOLAR REFLECTANCE VALUE (SR) = 33.24, THERMAL EMITTANCE VALUE (E) = 0.85,
SOLAR RELECTANCE INDEX (SRI) = 34

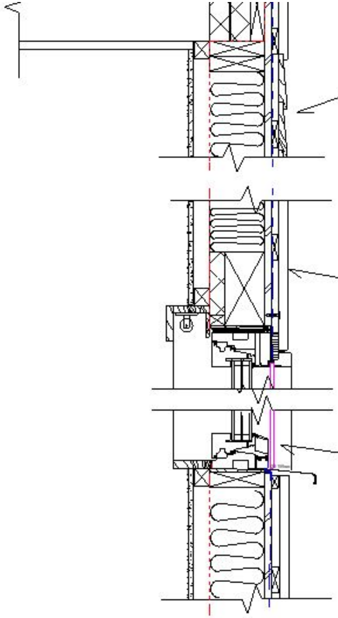
ROOF FASCIA:
MATERIAL: 26 GA METAL BY CUSTOM BILT OR EQ.
COLOR: BLACK - TO MATCH GUTTERS

ROOF EAVES:
&
VERTICAL EXTERIOR SIDING:
MATERIAL: 1X10 T&G V-GROOVE WESTERN RED CEDAR BY WESTERN WOODS INC., CHICO, OR EQ.
COLOR: WEATHERED SILVER STAIN @ FRONT SIDING
EBONY STAIN @ RECESSED ENTRY
WUI LISTING #: 8140-2084:0001 (https://westernwoodsinc.com/wp-content/uploads/2020/02/WWOODs-WUIProducts-BLMProducts-d1-web_sml-01.27.2020.pdf)

- ❑ Internal utility chase
- ❑ Intello air barrier
- ❑ 2x Rafters w/ Dense-pack Cellulose
- ❑ Plywood
- ❑ Mento Membrane
- ❑ Rockwool
- ❑ Furring strips
- ❑ Standing Seam Metal Roofing

Walls





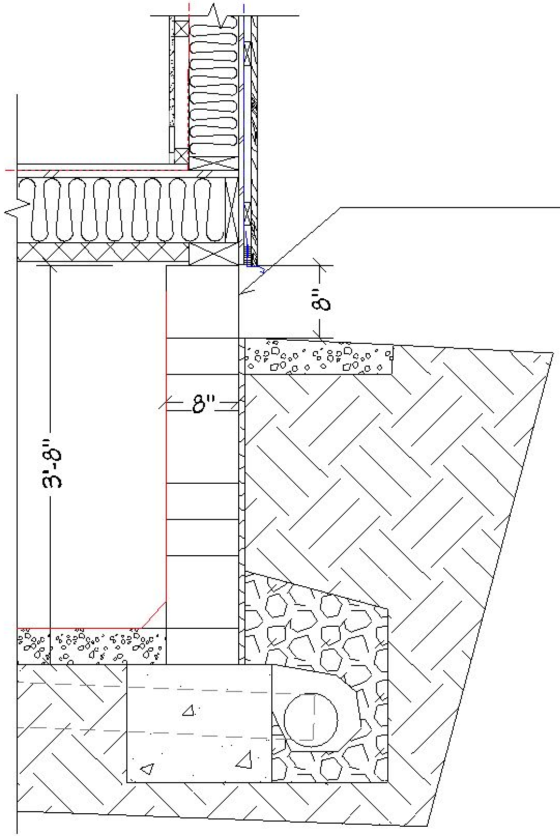
HORIZONTAL SIDING:
2MATERIAL: SOLID SAWN 1X6 LAPPED, KNOTTY WESTERN RED CEDAR BY WESTERN WOODS INC., CHICO, OR EQ.
COLOR: WEATHERED SILVER STAIN
WUI LISTING #: 8140-2084:0001 (https://westernwoodsinc.com/wp-content/uploads/2020/02/WWOODs-WUIProducts-BLMProducts-d1-web_sml-01.27.2020.pdf)

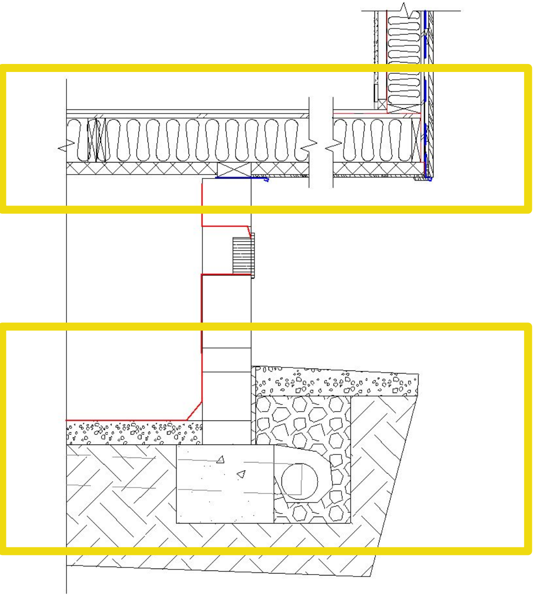
VERT. METAL SIDING:
PRODUCT: CB-150, 16" WIDE MECHANICAL SEAM 'CLASS A' RATED MTL. HORIZ. SIDING
COLOR: ZINC GREY BY CUSTOM BILT METALS OR EQ. (COOL ROOF COMPLIANT)

WINDOWS & DOORS:
PRODUCT: SMARTWIN PRO-PASSIVHAUS MTL CLAD WOOD WINDOWS
COLOR: BRONZE ANODIZED EXTERIOR MTL FRAME
SPECS: MIN. 1 PANE TEMPERED

- ❑ Internal utility chase
- ❑ Intello air barrier
- ❑ 2x6 Wood framing w/ Dense-pack Cellulose
- ❑ Plywood
- ❑ Adhero Membrane
- ❑ Rainscreen
- ❑ Siding

Floor & Foundation





FLOOR:

- ❏ Finish floor (wood)
- ❏ Subfloor Ply
- ❏ 2x Floor Joists w/ Dense-pack Cellulose
- ❏ Rockwool @ cantilever

FOUNDATION:

- ❏ Concrete footings
- ❏ Split-face masonry block stem walls
- ❏ Compacted gravel unvented crawlspace

Dream Team

1

2




3

RASMUSSEN
LAND SURVEYING

4

LANDSET
ENGINEERS, INC.

5

Arnold Engineering Associates, Inc.

6

7

8

9

1. Prime Contractor: Rob Nicely, Matt Hanes, Eddy Ortiz, Jeff Carmel Building & Design
2. Interiors: Machell Sturbrick, Carmel Building & Design
3. Surveyor: Rasmussen Land Surveying Inc.
4. Geotechnical Engineer: Brian Papurello, Landset Engineers, Inc.
5. Civil & Structural Engineer: Arnold Engineering
6. T-24 & PH Certification & PHribbon: Steve Mann, Home Energy Services
7. CPHC & HVAC Consultant: Andrew Michler, Hyperlocal Workshop
8. Thermal Bridging Consultant: Vlad Pezel, Emod Studio
9. Architect: Bronwyn Barry, Passive House BB

PHribbon

[the results]

PHribbon

Consultant:
Street:
Postcode/City:
Province/Country:

Client:
Street:
Postcode/City:
Province/Country:

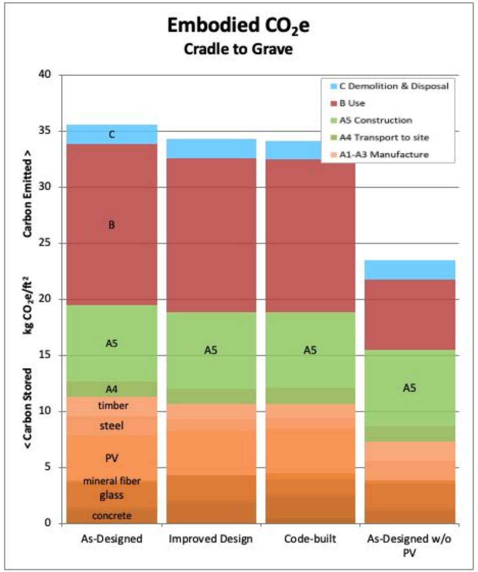
Building:
Street:
Postcode/City:
Province/Country:
Building type:

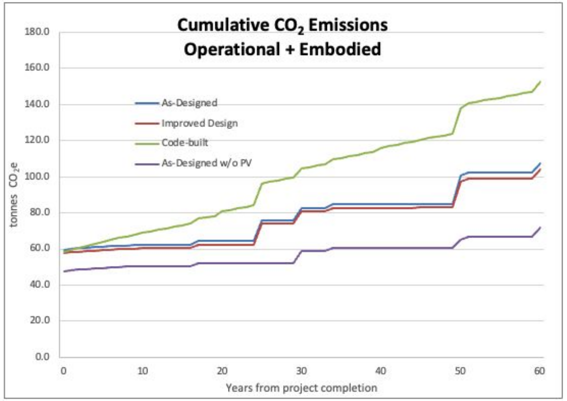
The Passive House Network

PHN Embodied Carbon Assessment

Year of construction:	**2022**
No. of dwelling units:	**1**
TFA:	**2400**
Building Life, yrs	**60**

For this Certificate Building life must be 60 yrs





if Operational varies then adjust these cells

Operational CO_2	Scen 1	Scen 2	Scen 3	Scen 4
Heating Demandl kBTU/(ft²yr)	0.9	0.9	1.2	0.9
Final Energy kBTU/(ft²yr) (excl PV)	8.1	8.1	10.0	8.1
metric tonnes CO_2e (incl PV if any)	3.1	3.1	52.4	3.1
US tons CO_2e (incl PV if any)	3.5	3.5	57.8	3.5
kgCO2e/ft² (incl PV if any)	1.1	1.1	17.8	1.1

Embodied CO_2	Scen 1	Scen 2	Scen 3	Scen 4
metric tonnes CO_2e	104.4	100.7	100.3	68.8
US tons CO_2e	115.1	111.0	110.5	75.9
kgCO2e/ft²	35.5	34.3	34.1	23.4

RIBA (UK) Embodied CO_2 targets 2030

New Build Offices	70 $kgCO_2e/ft^2$
New Build Schools	50 $kgCO_2e/ft^2$
domestic/residential	58 $kgCO_2e/ft^2$

Compared 17 Mile Haus:

1. As-designed (Permit)
2. Improved via PHribbon (As built)
3. Mixed Fuel Code built (kinda)
4. As-designed without PV

EC3 Materials Selections + Heat Map

	Quantity					Material				Transport Distance				Selections													Results, tonnes CO_2e		C2-C4		D	
Matched Material	Area, ft²	Thick in	Qty	Units	lbs/unit	% FSC/ PEFC certified	Life, yrs	End of Life Category	Category	Ship miles(1)	Rail miles(2)	Truck miles(3)	OPTIONAL Results Category	Reuse at end of life*	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Mfr Locn, Notes	A1-A3 Manufac	A1-A3 Storage	A4 Transp to site	A5 Construc	B1, B2, B3	B4, B5	C1 Demolition	C2 Transport	Recycle	Combust	Landfill	reuse	Total A-C
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	2791.46 ft2	0.50	98.86	ft3	30.8537	0%	life	timber	national	0	1340	100			✓		✓	✓	Dillard	0.44	0.00	0.08		0.00	0.00			0.00	0.01	0.21		0.7
Blown - Ecocel Cellulose Fiber Insulation	2791.46 ft2	5.50	1087.51	ft3	2.31006		life	timber	national	0	1340	100			✓	✓		✓	Cork	0.36	0.00	0.06		0.00	0.00			0.00	0.01	0.17		0.6
Wood Framing - Softwood Lumber	2791.46 ft2	5.50	191.91	ft3	28.4671		life	timber	national	0	1340	100			✓		✓	✓	Dillard	0.24	0.00	0.14		0.00	0.00			0.00	0.02	0.38		0.8
Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas			2791.46	ft2	1.8806		life	gypsum	national	0	1340	100			✓	✓	✓	✓	Las Vegas Board	0.51	0.00	0.13		0.00	0.00			0.00	0.00	0.05		0.7
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	279.15 ft2	0.50	9.89	ft3	30.8537	0%	life	timber	national	0	1340	100			✓		✓	✓	Dillard	0.04	0.00	0.01		0.00	0.00			0.00	0.00	0.02		0.1
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1313.45 ft2	0.50	46.52	ft3	30.8537	0%	life	timber	national	0	1340	100			✓		✓	✓	Dillard	0.21	0.00	0.04		0.00	0.00			0.00	0.01	0.10		0.4
Steel, Cold Formed - Average of Finished Flat Products (Steel)			1478.02	lbs			life	steel	national	0	1340	100			✓		✓	✓	Unspecified JSW Steel Limite	1.85	0.00	0.04		0.00	0.00			0.05	0.00	0.01		1.9
									national	0	1340	100																				0.0
Board - Rockwool COMFORTBOARD 80	1959.07 ft2	1.50	214.93	ft3	8.01158	0%	life	mineral fiber	national	0	1340	100			✓		✓	✓	Milton	0.69	0.00	0.04		0.00	0.00			0.00	0.00	0.02		0.7
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1959.07 ft2	0.50	81.63	ft3	30.8537	0%	life	timber	national	0	1340	100			✓		✓	✓	Dillard	0.36	0.00	0.06		0.00	0.00			0.00	0.01	0.18		0.6
Blown - Ecocel Cellulose Fiber Insulation	1959.07 ft2	9.50	1364.82	ft3	2.31006		life	timber	national	0	1340	100			✓	✓		✓	Cork	0.45	0.00	0.08		0.00	0.00			0.00	0.01	0.22		0.8
Wood Framing - Softwood Lumber	1959.07 ft2	9.50	186.11	ft3	28.4671		list	timber	national	0	1340	100			✓		✓	✓	Dillard	0.24	0.00	0.13		0.00	0.00			0.00	0.02	0.37		0.8
Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas			1959.07	ft2	1.8806		life	gypsum	national	0	1340	100			✓	✓	✓	✓	Las Vegas Board	0.35	0.00	0.09		0.00	0.00			0.00	0.00	0.04		0.5
Steel, Cold Formed - Average of Finished Flat Products (Steel)			1959.07	lbs			50	steel	national	0	1340	100			✓	✓		✓	Unspecified JSW Steel Limite	2.45	0.00	0.05		0.00	2.58			0.06	0.00	0.01		5.2
									national	0	1340	100																				0.0
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1848.13 ft2	0.75	101.38	ft3	30.8537	0%	life	timber	national	0	1340	100			✓		✓	✓	Dillard	0.45	0.00	0.08		0.00	0.00			0.00	0.01	0.22		0.8
Blown - Ecocel Cellulose Fiber Insulation	1848.13 ft2	7.50	1016.47	ft3	2.31006	0%	life	timber	national	0	1340	100			✓	✓		✓	Cork	0.33	0.00	0.06		0.00	0.00			0.00	0.01	0.16		0.6
Wood Framing - Softwood Lumber (give dims)	1848.13 ft2	7.50	108.29	ft3	28.4671	0%	life	timber	national	0	1340	100			✓		✓	✓	Dillard	0.14	0.00	0.08		0.00	0.00			0.00	0.01	0.21		0.4
Board - Rockwool COMFORTBOARD 80	1848.13 ft2	1.50	231.02	ft3	8.01158	0%	life	timber	national	0	1340	100			✓		✓	✓	Milton	0.74	0.00	0.05		0.00	0.00			0.00	0.01	0.13		0.9
Wood - hardwood flooring, generic value	2938.00 ft2	0.75	161.17	ft3	46.82	0%	50	timber	national	0	1340	100			✓		✓	✓		1.05	0.00	0.19		0.00	1.80			0.00	0.03	0.53		3.6
									national	0	1340	100																				0.0
Concrete - Aggregate Industries USA 2500 Footer, 2500 PSI Footer Mix, Texas			667.00	ft3	149.827		life	Concrete	national	0	1340	100					✓		Texas	5.65	0.00	2.53		0.00	0.00			0.36	0.00	0.28		8.8
Wood Framing - North American Softwood Lumber - kiln dried, planed			31.18	ft3	28.4671	0%	30	timber	national	0	1340	100			✓	✓	✓	✓		0.06	0.00	0.02		0.00	0.15			0.00	0.00	0.06		0.3
Openings - Cardinal Insulating glass - triple pane			727.07	ft2	4.8951		30	glass	national	0	1340	100			✓	✓		✓	Unspecified Cardinal Glass Ir	6.34	0.00	0.09		0.00	6.47			0.00	0.00	0.03		12.9
MEV and duct system, plastic - per cu ft/min (based on 35 cu ft/min, 59m3/hr), ave of 8, France			98.43	cu ft/min	0.28797		17	composite	national	0	1340	100			✓	✓	✓	✓		0.10	0.00	0.00		0.00	0.30			0.00	0.00	0.00		0.4
Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C			5.00	kBTU/hr	48.6496		17	steel	national	0	1340	100			✓	✓	✓	✓		0.41	0.00	0.01		0.43	2.58			0.01	0.00	0.00		3.4
Refrigerant Leakage R410a (HFC)			2.00	lbs			15						Refrigerant Leakage		✓	✓	✓	✓						0.59								
Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C			5.00	kBTU/hr	48.6496		17	steel	national	0	1340	100			✓	✓	✓	✓		0.41	0.00	0.01		0.43	2.58			0.01	0.00	0.00		3.4
Refrigerant Leakage R410a (HFC)			2.00	lbs			15						Refrigerant Leakage		✓	✓	✓	✓						0.59								
PV, polycrystalline			638.63	ft2	1.57935		25	PV	national	0	1340	100			✓	✓	✓			11.51	0.00	0.03		0.00	23.09			0.00	0.00	0.01		34.6
PV, polycrystalline			13.50	kWh	0.0186		15	composite	national	0	1340	100			✓	✓	✓			0.24	0.00	0.00		0.00	0.73			0.00	0.00	0.00		1.0
									national	0	1340	100																				0.0
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1478.02 ft2	0.51	53.58	ft3	30.8537	0%	life	timber	national	0	1340	100							Dillard	0.24	0.00	0.04		0.00	0.00			0.00	0.01	0.12		0.4
Board - GUTEX Wood Fiber Insulating Boards			445.95	ft3	10.8065	0%	life	timber	national	0	1340	100				✓			Waldshut-Tiengen	1.35	0.00	0.12		0.00	0.00			0.00	0.02	0.34		1.8
Wood Framing - Softwood Lumber (give dims)			985.76	ft3	28.4671	100%	life	timber	national	0	1340	100				✓			Dillard	1.25	0.00	0.71		0.00	0.00			0.00	0.13	1.95		4.0
Concrete - Aggregate Industries USA 2000 AE, 2000 Slag 50%, Texas			667.00	ft3	149.827		life	Concrete	national	0	1340	100			✓	✓		✓	Texas	3.17	0.00	2.53		0.00	0.00			0.36	0.00	0.28		6.3
									national	0	1340	100																				0.0
Blown - CertainTeed Blowing Wool Fiberglass Insulation- InsulSafe® S			3468.80	ft3	0.31433		life	mineral fiber	national	0	1340	100					✓		Athens	1.11	0.00	0.03		0.00	0.00			0.00	0.00	0.01		1.1
Siding - HardiePlank®			2791.46	ft2	2.13009		life	concrete	national	0	1340	100				✓			James Hardien USA sites	1.90	0.00	0.15		0.00	0.00			0.02	0.00	0.02		2.1
Steep Slope Roofing - Duration® Series Shingles			1959.07	ft2	4.32162		20	composite	national	0	1340	100					✓		Medina Roofing Plant	0.96	0.00	0.21		0.00	3.15			0.00	0.00	0.40		4.7
Openings - Cardinal Insulating glass - double pane			727.07	ft2	3.19513		30	glass	national	0	1340	100					✓		Unspecified Cardinal Glass Ir	3.67	0.00	0.06		0.00	3.75			0.00	0.00	0.02		7.5
									national	0	1340	100																				0.0
									national	0	1340	100																				0.0
									national	0	1340	100																				0.0
									national	0	1340	100																				0.0
									national	0	1340	100																				0.0

EC3 Materials Selections + Heat Map

Table1			Quantity						Material			Transport Distance					Selections						
Assembly/ substage	Your Description	Matched Material	Area, ft²		Thick in	Qty	Units	lbs/unit	% FSC/ PEFC certified	Life, yrs	End of Life Category	Category	Ship miles(1)	Rail miles(2)	Truck miles(3)	OPTIONAL Results Category		Reuse at end of life*	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Mfr Locn, Notes
1.Walls	Sheathing	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	2791.46	ft2	0.50	98.86	ft3	30.85366	0%	life	timber	national	0	1340	100				✓		✓	✓	Dillard
1.Walls	Cellulose	Blown - Ecocel Cellulose Fiber Insulation	2791.46	ft2	5.50	1087.51	ft3	2.310063		life	timber	national	0	1340	100				✓	✓		✓	Cork
1.Walls	Framing	Wood Framing - Softwood Lumber	2791.46	ft2	5.50	191.91	ft3	28.46712		life	timber	national	0	1340	100				✓		✓	✓	Dillard
1.Walls	Drywall	Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas				2791.46	ft2	1.880602		life	gypsum	national	0	1340	100				✓	✓	✓	✓	Las Vegas Board
	Furring	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	279.15	ft2	0.50	9.89	ft3	30.85366	0%	life	timber	national	0	1340	100				✓		✓	✓	Dillard
	N&W Siding	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1313.45	ft2	0.50	46.52	ft3	30.85366	0%	life	timber	national	0	1340	100				✓		✓	✓	Dillard
	E&S Siding	Steel, Cold Formed - Average of Finished Flat Products (Steel)				1478.02	lbs			life	steel	national	0	1340	100				✓		✓	✓	Unspecified JSW Steel Limited
												national	0	1340	100								
2.Roof	Insulation	Board - Rockwool COMFORTBOARD 80	1959.07	ft2	1.50	214.93	ft3	8.011579	0%	life	mineral fiber	national	0	1340	100				✓		✓	✓	Milton
2.Roof	Plywood	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1959.07	ft2	0.50	81.63	ft3	30.85366	0%	life	timber	national	0	1340	100				✓		✓	✓	Dillard
2.Roof	Cellulose	Blown - Ecocel Cellulose Fiber Insulation	1959.07	ft2	9.50	1364.82	ft3	2.310063		life	timber	national	0	1340	100				✓	✓		✓	Cork
2.Roof	Framing	Wood Framing - Softwood Lumber	1959.07	ft2	9.50	186.11	ft3	28.46712		list	timber	national	0	1340	100				✓		✓	✓	Dillard
2.Roof	Drywall	Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas				1959.07	ft2	1.880602		life	gypsum	national	0	1340	100				✓	✓	✓	✓	Las Vegas Board
	Roofing	Steel, Cold Formed - Average of Finished Flat Products (Steel)				1959.07	lbs			50	steel	national	0	1340	100				✓	✓		✓	Unspecified JSW Steel Limited
												national	0	1340	100								
3.Floor	Subfloor	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1848.13	ft2	0.75	101.38	ft3	30.85366	0%	life	timber	national	0	1340	100				✓		✓	✓	Dillard
3.Floor	Cellulose	Blown - Ecocel Cellulose Fiber Insulation	1848.13	ft2	7.50	1016.47	ft3	2.310063	0%	life	timber	national	0	1340	100				✓	✓		✓	Cork
3.Floor	Framing	Wood Framing - Softwood Lumber (give dims)	1848.13	ft2	7.50	108.29	ft3	28.46712	0%	life	timber	national	0	1340	100				✓		✓	✓	Dillard
3.Floor	Insulation	Board - Rockwool COMFORTBOARD 80	1848.13	ft2	1.50	231.02	ft3	8.011579	0%	life	timber	national	0	1340	100				✓		✓	✓	Milton
	Finish Floor (T24)	Wood - hardwood flooring, generic value	2938.00	ft2	0.75	161.17	ft3	46.82	0%	50	timber	national	0	1340	100				✓		✓	✓	
												national	0	1340	100								
Other	Foundation	Concrete - Aggregate Industries USA 2500 Footer, 2500 PSI Footer Mix, Texas				667.00	ft3	149.8269		life	Concrete	national	0	1340	100						✓		Texas
	Woindow Frames	Wood Framing - North American Softwood Lumber - kiln dried, planed				31.18	ft3	28.46712	0%	30	timber	national	0	1340	100				✓	✓	✓	✓	
	Glazing	Openings - Cardinal Insulating glass - triple pane				727.07	ft2	4.8951		30	glass	national	0	1340	100				✓	✓		✓	Unspecified Cardinal Glass Ind
	HRV	MEV and duct system, plastic - per cu ft/min (based on 35 cu ft/min, 59m3/hr), ave of 8, France				98.43	cu ft/min	0.287968		17	composite	national	0	1340	100				✓	✓	✓	✓	
	DHW Heat Pump	Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C heati				5.00	kBTU/hr	48.64962		17	steel	national	0	1340	100				✓	✓	✓	✓	
	DHW Heat Pump Refrigerant	Refrigerant Leakage R410a (HFC)				2.00	lbs			15						Refrigerant Leakage			✓	✓	✓	✓	
	Heating/Cooling Heat Pump	Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C heati				5.00	kBTU/hr	48.64962		17	steel	national	0	1340	100				✓	✓	✓	✓	
	Heating/Cooling Heat Pump Refrigerant	Refrigerant Leakage R410a (HFC)				2.00	lbs			15						Refrigerant Leakage			✓	✓	✓	✓	
	Solar PV	PV, polycrystalline				638.63	ft2	1.579352		25	PV	national	0	1340	100				✓	✓	✓		
	Batteries	PV, polycrystalline				13.50	kWh	0.0186		15	composite	national	0	1340	100				✓	✓	✓		
												national	0	1340	100								
Better	Metal Siding -> Wood	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1478.02	ft2	0.51	53.58	ft3	30.85366	0%	life	timber	national	0	1340	100								Dillard
	Mineral Wool -> Gutex	Board - GUTEX Wood Fiber Insulating Boards				445.95	ft3	10.80648	0%	life	timber	national	0	1340	100					✓			Waldshut-Tiengen
	100% FSC Lumber	Wood Framing - Softwood Lumber (give dims)				985.76	ft3	28.46712	100%	life	timber	national	0	1340	100					✓			Dillard
	50% Slag Concrete	Concrete - Aggregate Industries USA 2000 AE, 2000 Slag 50%, Texas				667.00	ft3	149.8269		life	Concrete	national	0	1340	100				✓	✓		✓	Texas
												national	0	1340	100								
Code-built	Celulose -> Fiberglass	Blown - CertainTeed Blowing Wool Fiberglass Insulation- InsulSafe® S				3468.80	ft3	0.31433		life	mineral fiber	national	0	1340	100						✓		Athens
	All Siding -> Hardiplank	Siding - HardiePlank®				2791.46	ft2	2.130085		life	concrete	national	0	1340	100					✓			James Hardien USA sites
	Metal Roof -> Asphalt Shingles	Steep Slope Roofing - Duration® Series Shingles				1959.07	ft2	4.321615		20	composite	national	0	1340	100						✓		Medina Roofing Plant
	3-pane Glass -> 2-pane Glass	Openings - Cardinal Insulating glass - double pane				727.07	ft2	3.195128		30	glass	national	0	1340	100						✓		Unspecified Cardinal Glass Ind
												national	0	1340	100								
												national	0	1340	100								
												national	0	1340	100								
												national	0	1340	100								
												national	0	1340	100								

EC3 Materials Selections + Heat Map

	Quantity			Material					Transport Distance			
Matched Material	Area, ft²	Thick in	Qty	Units	lbs/unit	% FSC/ PEFC certified	Life, yrs	End of Life Category	Category	Ship miles(1)	Rail miles(2)	Truck miles(3)
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	2791.46 ft2	0.50	98.86	ft3	30.8537	0%	life	timber	national	0	1340	100
Blown - Ecocel Cellulose Fiber Insulation	2791.46 ft2	5.50	1087.51	ft3	2.31006		life	timber	national	0	1340	100
Wood Framing - Softwood Lumber	2791.46 ft2	5.50	191.91	ft3	28.4671		life	timber	national	0	1340	100
Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas			2791.46	ft2	1.8806		life	gypsum	national	0	1340	100
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	279.15 ft2	0.50	9.89	ft3	30.8537	0%	life	timber	national	0	1340	100
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1313.45 ft2	0.50	46.52	ft3	30.8537	0%	life	timber	national	0	1340	100
Steel, Cold Formed - Average of Finished Flat Products (Steel)			1478.02	lbs			life	steel	national	0	1340	100
									national	0	1340	100
Board - Rockwool COMFORTBOARD 80	1959.07 ft2	1.50	214.93	ft3	8.01158	0%	life	mineral fiber	national	0	1340	100
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1959.07 ft2	0.50	81.63	ft3	30.8537	0%	life	timber	national	0	1340	100
Blown - Ecocel Cellulose Fiber Insulation	1959.07 ft2	9.50	1364.82	ft3	2.31006		life	timber	national	0	1340	100
Wood Framing - Softwood Lumber	1959.07 ft2	9.50	186.11	ft3	28.4671		list	timber	national	0	1340	100
Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas			1959.07	ft2	1.8806		life	gypsum	national	0	1340	100
Steel, Cold Formed - Average of Finished Flat Products (Steel)			1959.07	lbs			50	steel	national	0	1340	100
									national	0	1340	100
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1848.13 ft2	0.75	101.38	ft3	30.8537	0%	life	timber	national	0	1340	100
Blown - Ecocel Cellulose Fiber Insulation	1848.13 ft2	7.50	1016.47	ft3	2.31006	0%	life	timber	national	0	1340	100
Wood Framing - Softwood Lumber (give dims)	1848.13 ft2	7.50	108.29	ft3	28.4671	0%	life	timber	national	0	1340	100
Board - Rockwool COMFORTBOARD 80	1848.13 ft2	1.50	231.02	ft3	8.01158	0%	life	timber	national	0	1340	100
Wood - hardwood flooring, generic value	2938.00 ft2	0.75	161.17	ft3	46.82	0%	50	timber	national	0	1340	100
									national	0	1340	100
Concrete - Aggregate Industries USA 2500 Footer, 2500 PSI Footer Mix, Texas			667.00	ft3	149.827		life	Concrete	national	0	1340	100
Wood Framing - North American Softwood Lumber - kiln dried, planed			31.18	ft3	28.4671	0%	30	timber	national	0	1340	100
Openings - Cardinal Insulating glass - triple pane			727.07	ft2	4.8951		30	glass	national	0	1340	100
MEV and duct system, plastic - per cu ft/min (based on 35 cu ft/min, 59m3/hr), ave of 8, France			98.43	cu ft/min	0.28797		17	composite	national	0	1340	100
Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C			5.00	kBTU/hr	48.6496		17	steel	national	0	1340	100
Refrigerant Leakage R410a (HFC)			2.00	lbs			15					
Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C			5.00	kBTU/hr	48.6496		17	steel	national	0	1340	100
Refrigerant Leakage R410a (HFC)			2.00	lbs			15					
PV, polycrystalline			638.63	ft2	1.57935		25	PV	national	0	1340	100
PV, polycrystalline			13.50	kWh	0.0186		15	composite	national	0	1340	100
									national	0	1340	100
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	1478.02 ft2	0.51	53.58	ft3	30.8537	0%	life	timber	national	0	1340	100
Board - GUTEX Wood Fiber Insulating Boards			445.95	ft3	10.8065	0%	life	timber	national	0	1340	100
Wood Framing - Softwood Lumber (give dims)			985.76	ft3	28.4671	100%	life	timber	national	0	1340	100
Concrete - Aggregate Industries USA 2000 AE, 2000 Slag 50%, Texas			667.00	ft3	149.827		life	Concrete	national	0	1340	100
									national	0	1340	100
Blown - CertainTeed Blowing Wool Fiberglass Insulation- InsulSafe® S			3468.80	ft3	0.31433		life	mineral fiber	national	0	1340	100
Siding - HardiePlank®			2791.46	ft2	2.13009		life	concrete	national	0	1340	100
Steep Slope Roofing - Duration® Series Shingles			1959.07	ft2	4.32162		20	composite	national	0	1340	100
Openings - Cardinal Insulating glass - double pane			727.07	ft2	3.19513		30	glass	national	0	1340	100
									national	0	1340	100
									national	0	1340	100
									national	0	1340	100
									national	0	1340	100
									national	0	1340	100

	Selections							Results, tonnes CO_2e								C2-C4			D	
Matched Material	OPTIONAL Results Category	Reuse at end of life*	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Mfr Locn, Notes	A1-A3 Manufac	A1-A3 Storage	A4 Transp to site	A5 Construc	B1, B2, B3	B4, B5	C1 Demolition	C2 Transport	Recycle	Combust	Landfill	reuse	Total A-C
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood			✓		✓	✓	Dillard	0.44	0.00	0.08		0.00	0.00			0.00	0.01	0.21		0.7
Blown - Ecocel Cellulose Fiber Insulation			✓	✓		✓	Cork	0.36	0.00	0.06		0.00	0.00			0.00	0.01	0.17		0.6
Wood Framing - Softwood Lumber			✓		✓	✓	Dillard	0.24	0.00	0.14		0.00	0.00			0.00	0.02	0.38		0.8
Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas			✓	✓	✓	✓	Las Vegas Board	0.51	0.00	0.13		0.00	0.00			0.00	0.00	0.05		0.7
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood			✓		✓	✓	Dillard	0.04	0.00	0.01		0.00	0.00			0.00	0.00	0.02		0.1
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood			✓		✓	✓	Dillard	0.21	0.00	0.04		0.00	0.00			0.00	0.01	0.10		0.4
Steel, Cold Formed - Average of Finished Flat Products (Steel)			✓		✓	✓	Unspecified JSW Steel Limit	1.85	0.00	0.04		0.00	0.00			0.05	0.00	0.01		1.9
																				0.0
Board - Rockwool COMFORTBOARD 80			✓		✓	✓	Milton	0.69	0.00	0.04		0.00	0.00			0.00	0.00	0.02		0.7
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood			✓		✓	✓	Dillard	0.36	0.00	0.06		0.00	0.00			0.00	0.01	0.18		0.6
Blown - Ecocel Cellulose Fiber Insulation			✓	✓		✓	Cork	0.45	0.00	0.08		0.00	0.00			0.00	0.01	0.22		0.8
Wood Framing - Softwood Lumber			✓		✓	✓	Dillard	0.24	0.00	0.13		0.00	0.00			0.00	0.02	0.37		0.8
Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas			✓	✓	✓	✓	Las Vegas Board	0.35	0.00	0.09		0.00	0.00			0.00	0.00	0.04		0.5
Steel, Cold Formed - Average of Finished Flat Products (Steel)			✓	✓		✓	Unspecified JSW Steel Limit	2.45	0.00	0.05		0.00	2.58			0.06	0.00	0.01		5.2
																				0.0
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood			✓		✓	✓	Dillard	0.45	0.00	0.08		0.00	0.00			0.00	0.01	0.22		0.8
Blown - Ecocel Cellulose Fiber Insulation			✓	✓		✓	Cork	0.33	0.00	0.06		0.00	0.00			0.00	0.01	0.16		0.6
Wood Framing - Softwood Lumber (give dims)			✓		✓	✓	Dillard	0.14	0.00	0.08		0.00	0.00			0.00	0.01	0.21		0.4
Board - Rockwool COMFORTBOARD 80			✓		✓	✓	Milton	0.74	0.00	0.05		0.00	0.00			0.00	0.01	0.13		0.9
Wood - hardwood flooring, generic value			✓		✓	✓		1.05	0.00	0.19		0.00	1.80			0.00	0.03	0.53		3.6
																				0.0
Concrete - Aggregate Industries USA 2500 Footer, 2500 PSI Footer Mix, Texas					✓		Texas	5.65	0.00	2.53		0.00	0.00			0.36	0.00	0.28		8.8
Wood Framing - North American Softwood Lumber - kiln dried, planed			✓	✓	✓	✓		0.06	0.00	0.02		0.00	0.15			0.00	0.00	0.06		0.3
Openings - Cardinal Insulating glass - triple pane			✓	✓	✓	✓	Unspecified Cardinal Glass I	6.34	0.00	0.09		0.00	6.47			0.00	0.00	0.03		12.9
MEV and duct system, plastic - per cu ft/min (based on 35 cu ft/min, 59m3/hr), ave of 8, France			✓	✓	✓	✓		0.10	0.00	0.00		0.00	0.30			0.00	0.00	0.00		0.4
Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C			✓	✓	✓	✓		0.41	0.00	0.01		0.43	2.58			0.01	0.00	0.00		3.4
Refrigerant Leakage R410a (HFC)	Refrigerant Leakage		✓	✓	✓	✓						0.59								
Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C			✓	✓	✓	✓		0.41	0.00	0.01		0.43	2.58			0.01	0.00	0.00		3.4
Refrigerant Leakage R410a (HFC)	Refrigerant Leakage		✓	✓	✓	✓						0.59								
PV, polycrystalline			✓	✓	✓			11.51	0.00	0.03		0.00	23.09			0.00	0.00	0.01		34.6
PV, polycrystalline			✓	✓	✓			0.24	0.00	0.00		0.00	0.73			0.00	0.00	0.00		1.0
																				0.0
Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood							Dillard	0.24	0.00	0.04		0.00	0.00			0.00	0.01	0.12		0.4
Board - GUTEX Wood Fiber Insulating Boards				✓			Waldshut-Tiengen	1.35	0.00	0.12		0.00	0.00			0.00	0.02	0.34		1.8
Wood Framing - Softwood Lumber (give dims)				✓			Dillard	1.25	0.00	0.71		0.00	0.00			0.00	0.13	1.95		4.0
Concrete - Aggregate Industries USA 2000 AE, 2000 Slag 50%, Texas			✓	✓		✓	Texas	3.17	0.00	2.53		0.00	0.00			0.36	0.00	0.28		6.3
																				0.0
Blown - CertainTeed Blowing Wool Fiberglass Insulation- InsulSafe® S					✓		Athens	1.11	0.00	0.03		0.00	0.00			0.00	0.00	0.01		1.1
Siding - HardiePlank®				✓			James Hardien USA sites	1.90	0.00	0.15		0.00	0.00			0.02	0.00	0.02		2.1
Steep Slope Roofing - Duration® Series Shingles					✓		Medina Roofing Plant	0.96	0.00	0.21		0.00	3.15			0.00	0.00	0.40		4.7
Openings - Cardinal Insulating glass - double pane					✓		Unspecified Cardinal Glass I	3.67	0.00	0.06		0.00	3.75			0.00	0.00	0.02		7.5
																				0.0
																				0.0
																				0.0
																				0.0
																				0.0

EC3 Materials Selections + Heat Map

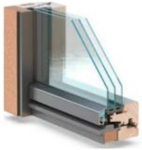
passive house

Table1

Assembly/ substage	Your Description	Matched Material	A1-A3 Manufac	A1-A3 Storage	A4 Transp to site	A5 Construc	B1, B2, B3	B4, B5	C1 Demolition	C2 Transport	C2-C4 Recycle	C2-C4 Combust	C2-C4 Landfill	D reuse	Total A-C
			Results, tonnes CO_2e												
1.Walls	Sheathing	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	0.44	0.00	0.08		0.00	0.00			0.00	0.01	0.21		0.7
1.Walls	Cellulose	Blown - Ecocel Cellulose Fiber Insulation	0.36	0.00	0.06		0.00	0.00			0.00	0.01	0.17		0.6
1.Walls	Framing	Wood Framing - Softwood Lumber	0.24	0.00	0.14		0.00	0.00			0.00	0.02	0.38		0.8
1.Walls	Drywall	Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas	0.51	0.00	0.13		0.00	0.00			0.00	0.00	0.05		0.7
	Furring	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	0.04	0.00	0.01		0.00	0.00			0.00	0.00	0.02		0.1
	N&W Siding	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	0.21	0.00	0.04		0.00	0.00			0.00	0.01	0.10		0.4
	E&S Siding	Steel, Cold Formed - Average of Finished Flat Products (Steel)	1.85	0.00	0.04		0.00	0.00			0.05	0.00	0.01		1.9
															0.0
2.Roof	Insulation	Board - Rockwool COMFORTBOARD 80	0.69	0.00	0.04		0.00	0.00			0.00	0.00	0.02		0.7
2.Roof	Plywood	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	0.36	0.00	0.06		0.00	0.00			0.00	0.01	0.18		0.6
2.Roof	Cellulose	Blown - Ecocel Cellulose Fiber Insulation	0.45	0.00	0.08		0.00	0.00			0.00	0.01	0.22		0.8
2.Roof	Framing	Wood Framing - Softwood Lumber	0.24	0.00	0.13		0.00	0.00			0.00	0.02	0.37		0.8
2.Roof	Drywall	Gypsum Sheathing Board - CertainTee Type C 1/2", Las Vegas	0.35	0.00	0.09		0.00	0.00			0.00	0.00	0.04		0.5
	Roofing	Steel, Cold Formed - Average of Finished Flat Products (Steel)	2.45	0.00	0.05		0.00	2.58			0.06	0.00	0.01		5.2
															0.0
3.Floor	Subfloor	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	0.45	0.00	0.08		0.00	0.00			0.00	0.01	0.22		0.8
3.Floor	Cellulose	Blown - Ecocel Cellulose Fiber Insulation	0.33	0.00	0.06		0.00	0.00			0.00	0.01	0.16		0.6
3.Floor	Framing	Wood Framing - Softwood Lumber (give dims)	0.14	0.00	0.08		0.00	0.00			0.00	0.01	0.21		0.4
3.Floor	Insulation	Board - Rockwool COMFORTBOARD 80	0.74	0.00	0.05		0.00	0.00			0.00	0.01	0.13		0.9
	Finish Floor (T24)	Wood - hardwood flooring, generic value	1.05	0.00	0.19		0.00	1.80			0.00	0.03	0.53		3.6
															0.0
Other	Foundation	Concrete - Aggregate Industries USA 2500 Footer, 2500 PSI Footer Mix, Texas	5.65	0.00	2.53		0.00	0.00			0.36	0.00	0.28		8.8
	Woindow Frames	Wood Framing - North American Softwood Lumber - kiln dried, planed	0.06	0.00	0.02		0.00	0.15			0.00	0.00	0.06		0.3
	Glazing	Openings - Cardinal Insulating glass - triple pane	6.34	0.00	0.09		0.00	6.47			0.00	0.00	0.03		12.9
	HRV	MEV and duct system, plastic - per cu ft/min (based on 35 cu ft/min, 59m3/hr), ave of 8, France	0.10	0.00	0.00		0.00	0.30			0.00	0.00	0.00		0.4
	DHW Heat Pump	Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C heati	0.41	0.00	0.01		0.43	2.58			0.01	0.00	0.00		3.4
	DHW Heat Pump Refrigerant	Refrigerant Leakage R410a (HFC)					0.59								
	Heating/Cooling Heat Pump	Heat Pump (ASHP), Air to Water - per kBTU/hr (based on 20 kBTU/hr, 5.8kW) SPF 3.6 ave air 7C heati	0.41	0.00	0.01		0.43	2.58			0.01	0.00	0.00		3.4
	Heating/Cooling Heat Pump Refrigerant	Refrigerant Leakage R410a (HFC)					0.59								
	Solar PV	PV, polycrystalline	11.51	0.00	0.03		0.00	23.09			0.00	0.00	0.01		34.6
	Batteries	PV, polycrystalline	0.24	0.00	0.00		0.00	0.73			0.00	0.00	0.00		1.0
															0.0
Better	Metal Siding -> Wood	Plywood and OSB Sheathing Panels - Roseburg Softwood Plywood	0.24	0.00	0.04		0.00	0.00			0.00	0.01	0.12		0.4
	Mineral Wool -> Gutex	Board - GUTEX Wood Fiber Insulating Boards	1.35	0.00	0.12		0.00	0.00			0.00	0.02	0.34		1.8
	100% FSC Lumber	Wood Framing - Softwood Lumber (give dims)	1.25	0.00	0.71		0.00	0.00			0.00	0.13	1.95		4.0
	50% Slag Concrete	Concrete - Aggregate Industries USA 2000 AE, 2000 Slag 50%, Texas	3.17	0.00	2.53		0.00	0.00			0.36	0.00	0.28		6.3
															0.0
Code-built	Celulose -> Fiberglass	Blown - CertainTeed Blowing Wool Fiberglass Insulation- InsulSafe® S	1.11	0.00	0.03		0.00	0.00			0.00	0.00	0.01		1.1
	All Siding -> Hardiplank	Siding - HardiePlank®	1.90	0.00	0.15		0.00	0.00			0.02	0.00	0.02		2.1
	Metal Roof -> Asphalt Shingles	Steep Slope Roofing - Duration® Series Shingles	0.96	0.00	0.21		0.00	3.15			0.00	0.00	0.40		4.7
	3-pane Glass -> 2-pane Glass	Openings - Cardinal Insulating glass - double pane	3.67	0.00	0.06		0.00	3.75			0.00	0.00	0.02		7.5
															0.0
															0.0
															0.0
															0.0
															0.0

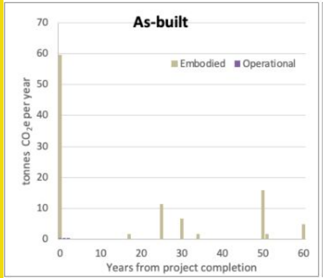


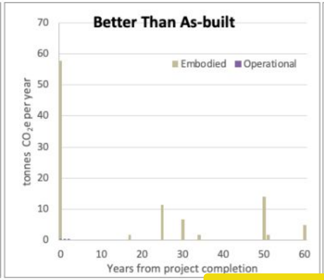


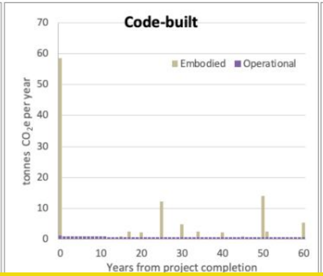



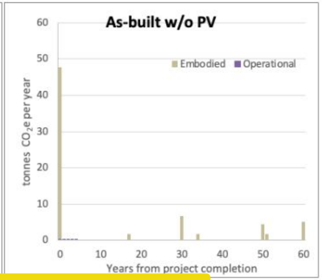

Operational use from PHPP

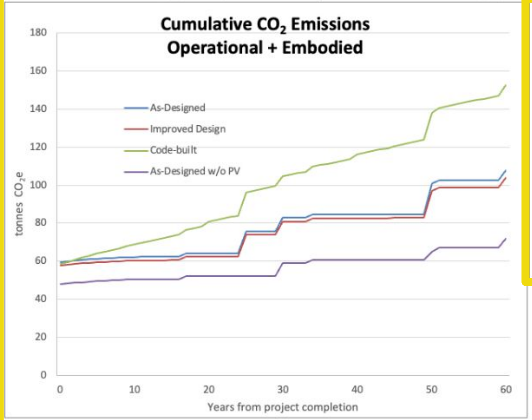
Heating	kBTU/(ft²yr)	MMBTU/yr
Electricity (HP compact unit)		0.00
Electricity (heat pump)	0.43	1.03
District heating: 1-None		0.00
Wood and other biomass		0.00
Natural gas / RE gas		0.00
Heating oil / RE methanol		0.00
Solar thermal system		0.00
Electricity (direct)		0.00
		0.00
Aux. electricity (heating, wintertime ventilation)	0.12	0.29
		0.00
Cooling and dehumidification		0.00
Electricity cooling (heat pump)	1.69	4.06
Auxiliary electricity cooling, ventilation summer	0.31	0.76
Electricity dehumidification (heat pump)		0.00
Auxiliary electricity (dehumidification)		0.00
		0.00
DHW generation		0.00
Electricity (HP compact unit)		0.00
Electricity (heat pump)	1.86	4.46
District heating: 1-None		0.00
Wood and other biomass		0.00
Natural gas / RE gas		0.00
Heating oil / Methanol		0.00
Solar thermal system		0.00
Electricity (direct)		0.00
		0.00
Aux. electricity (DHW + solar DHW)	0.21	0.52
		0.00
Electricity (household or non-residential lighting, etc.)	3.50	8.39
Auxiliary electricity (other)		0.00
		0.00
Gas / RE gas dry/cook	0.00	0.00
PV electricity		-11.51
Solar thermal system		0.00
		0.00
Total for Operational Demand	8.13	

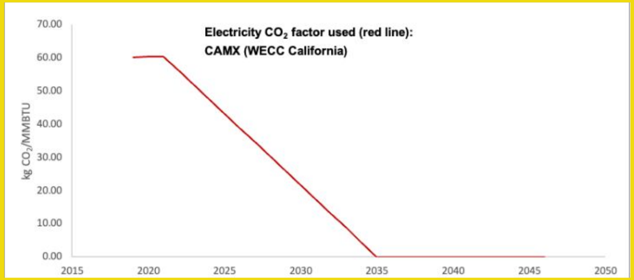












Total cumulative emissions

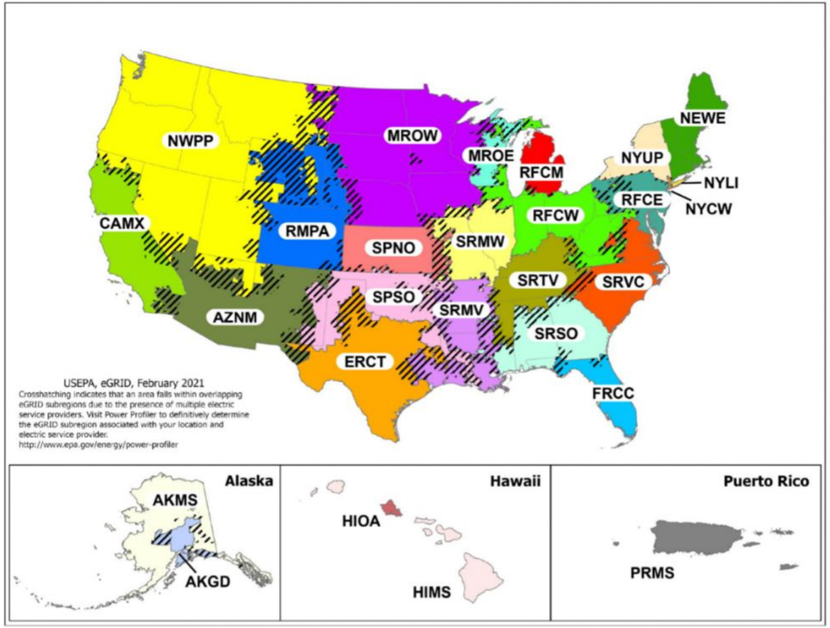
	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Building Life (yrs)	tonnes	$kgCO_2/ft^2$	tonnes	$kgCO_2/ft^2$	tonnes	$kgCO_2/ft^2$	tonnes	$kgCO_2/ft^2$
60	108	45	104	43	152	63	72	30

End of life, tonnes

Scenario1	5.0248
Scenario2	4.92947
Scenario3	4.75672
Scenario4	5.0147

Materials with a life of "life" are assumed to last the life of the building

Localized EPA Grid factors



Electricity CO_2 Factors by eGrid

State	CO2e lb/MWh 2019	CO2e kg/MMBTU 2019	CO2 lb/MWh 2021	CH4 lb/MWh 2021	N2O lb/MWh 2021	kgCO2e/MMBTU 2021
US Average	884.23	117.5	884.2	0.075	0.011	118.2
AKGD (ASCC Alaska Grid)	1114.4	148.1	1114.4	0.098	0.013	149.0
AKMS (ASCC Miscellaneous)	549.31	73.0	549.3	0.026	0.004	73.3
AZNM (WECC Southwest)	952.32	126.6	952.3	0.068	0.01	127.2
CAMX (WECC California)	453.21	60.2	453.2	0.033	0.004	60.5
ERCT (ERCOT All)	868.64	115.5	868.6	0.057	0.008	116.0
FRCC (FRCC All)	861.03	114.5	861	0.055	0.007	114.9
HIMS (HICC Miscellaneous)	1185.6	157.6	1185.6	0.143	0.022	159.0
HIOA (HICC Oahu)	1694.5	225.3	1694.5	0.185	0.028	227.0
MROE (MRO East)	1502.6	199.7	1502.6	0.147	0.022	201.1
MROW (MRO West)	1098.4	146.0	1098.4	0.119	0.017	147.1
NEWE (NPCC New England)	488.89	65.0	488.9	0.077	0.01	65.6
NWPP (WECC Northwest)	715.24	95.1	715.2	0.068	0.01	95.7
NYCW (NPCC NYC/Westchester)	553.8	73.6	553.8	0.021	0.002	73.8
NYLI (NPCC Long Island)	1209	160.7	1209	0.157	0.02	162.0
NYUP (NPCC Upstate NY)	232.31	30.9	232.3	0.017	0.002	31.0
PRMS (Puerto Rico Miscellaneous)	1537.3	204.4	1537.3	0.084	0.013	205.2
RFCE (RFC East)	695.03	92.4	695	0.053	0.007	92.8
RFCM (RFC Michigan)	1189.3	158.1	1189.3	0.114	0.016	159.1
RFCW (RFC West)	1067.7	141.9	1067.7	0.099	0.014	142.8
RMPA (WECC Rockies)	1242.6	165.2	1242.6	0.117	0.017	166.2
SPNO (SPP North)	1070	142.2	1070	0.112	0.016	143.2
SPSO (SPP South)	1002	133.2	1002	0.07	0.01	133.8
SRMV (SERC Mississippi Valley)	806.76	107.2	806.8	0.043	0.006	107.6
SRMW (SERC Midwest)	1584.4	210.6	1584.4	0.169	0.025	212.2
SRSO (SERC South)	969.17	128.8	969.2	0.071	0.01	129.5
SRTV (SERC Tennessee Valley)	949.7	126.2	949.7	0.087	0.013	127.1
SRVC (SERC Virginia/Carolina)	675.42	89.8	675.4	0.058	0.008	90.3
		100yr GWP	1	25	298	
		0.1329 conversion factor				

factors from table 6 in EPA factors 2021

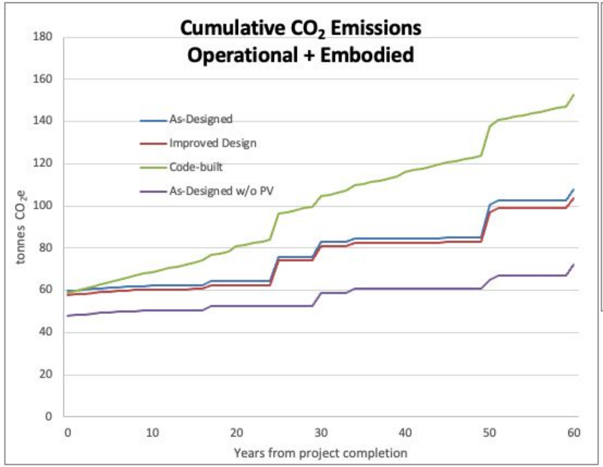
using "Total Output Emission Factors"

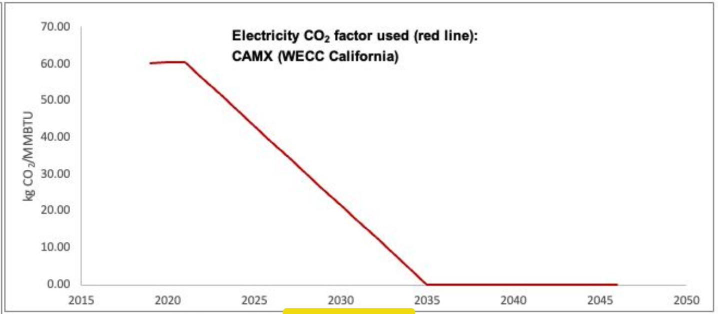
Electricity CO_2 Factors over time

Years from data start	Year	CO2e kg/MMBTU	
	2019	60.247	from th
	2020	60.381	
	2021	60.514	from th
1	2022	56.192	
2	2023	51.869	
3	2024	47.547	
4	2025	43.224	
5	2026	38.902	
6	2027	34.580	
7	2028	30.257	
8	2029	25.935	
9	2030	21.612	
10	2031	17.290	
11	2032	12.967	
12	2033	8.645	
13	2034	4.322	
14	2035	0.000	zero fc
15	2036	0.000	
16	2037	0.000	
17	2038	0.000	
18	2039	0.000	
19	2040	0.000	
20	2041	0.000	
21	2042	0.000	
22	2043	0.000	
23	2044	0.000	
24	2045	0.000	
25	2046	0.000	
26	2047	0.000	
27	2048	0.000	
28	2049	0.000	
29	2050	0.000	

2035 Year of Net zero
14 Year of Net zero

Rates of Grid Decarbonization





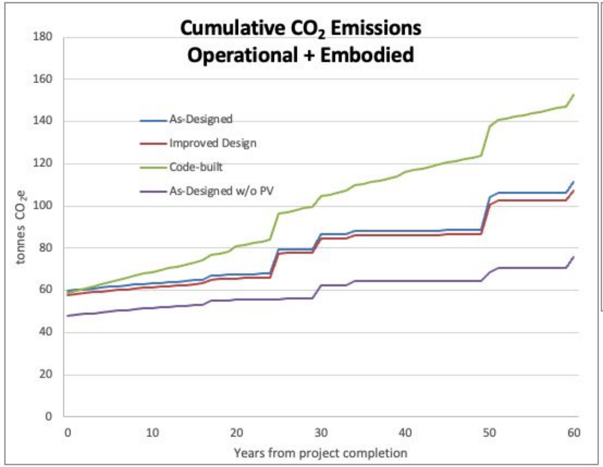
2035 Clean Grid

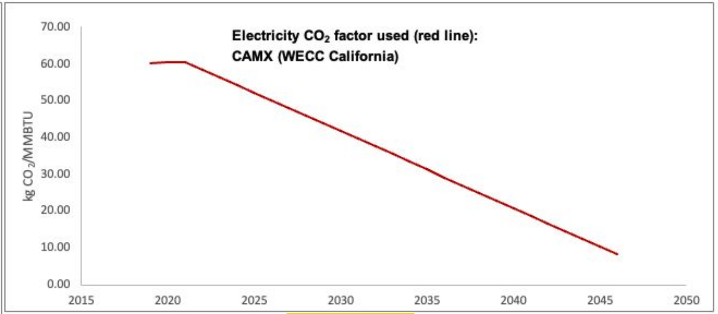
Total cumulative emissions

Building Life (yrs)	Scenario 1 tonnes	Scenario 1 $kgCO_2/ft$	Scenario 2 tonnes	Scenario 2 $kgCO_2/ft$	Scenario 3 tonnes	Scenario 3 $kgCO_2/ft$	Scenario 4 tonnes	Scenario 4 $kgCO_2/ft^2$
60	108	45	104	43	152	63	72	30

End of life, tonnes

Scenario1	5.0248
Scenario2	4.92947
Scenario3	4.75672
Scenario4	5.0147





2050 Clean Grid

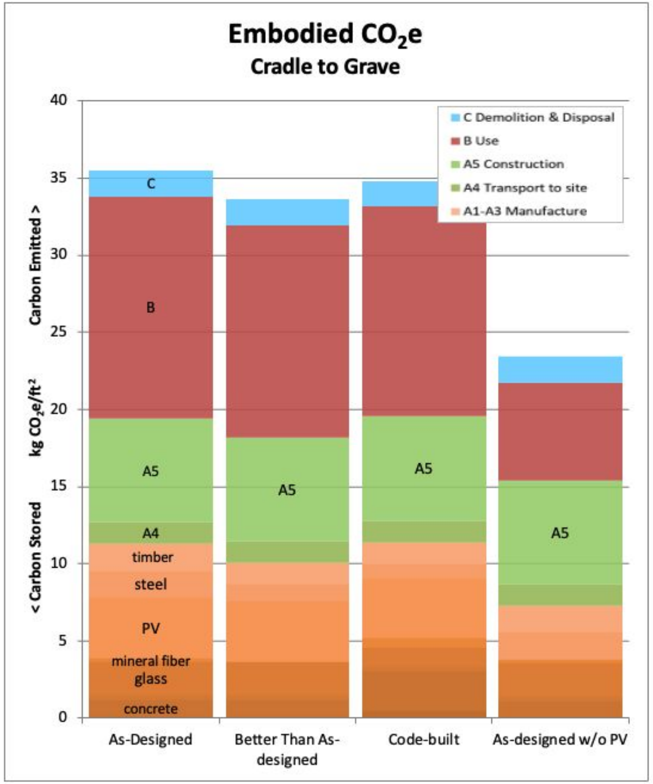
Total cumulative emissions

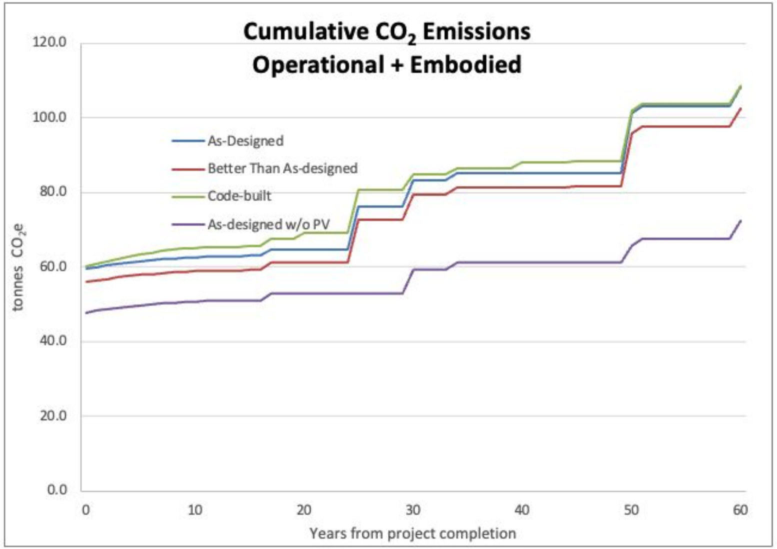
Building Life (yrs)	Scenario 1 tonnes	Scenario 1 $kgCO_2/ft$	Scenario 2 tonnes	Scenario 2 $kgCO_2/ft$	Scenario 3 tonnes	Scenario 3 $kgCO_2/ft$	Scenario 4 tonnes	Scenario 4 $kgCO_2/ft^2$
60	111	46	107	45	152	63	76	32

End of life, tonnes

Scenario1	5.0248
Scenario2	4.92947
Scenario3	4.75672
Scenario4	5.0147

What if all scenarios are 100% Electric?





Operational CO_2	if Operational varies then adjust these cells			
	Scen 1	Scen 2	Scen 3	Scen 4
Heating Demandl kBTU/(ft²yr)	0.9	0.9	0.9	0.9
Final Energy kBTU/(ft²yr) (excl PV)	8.1	8.1	8.1	8.1
metric tonnes CO_2e (incl PV if any)	3.6	3.6	6.1	3.6
US tons CO_2e (incl PV if any)	4.0	4.0	6.7	4.0
kgCO2e/ft² (incl PV if any)	1.2	1.2	2.1	1.2

Embodied CO_2	Scen 1	Scen 2	Scen 3	Scen 4
metric tonnes CO_2e	104.4	99.0	102.4	68.8
US tons CO_2e	115.1	109.1	112.8	75.9
kgCO2e/ft²	35.5	33.7	34.8	23.4

Looks close

BUT….

[We didn't edit operational use for code option]

Unexplored Variables

passive house

Table 3. Miles and Transport emissions

	ship	rail	truck	
local			100	
national		1340	100	
North America		1340	100	kgCO2e/ton-mile from table 8 in
world	7000	1340	100	link to EPA pdf
kgCO2 per ton-mile	0.036	0.022	0.211	

Table 5. Vehicle Miles Travelled and effect on CO_2 emissions
(FYI only, not part of these Whole Life Carbon transport emission calcs)

	Miles	MPG	kgCO2/ gallon	kg CO_2	
gasoline	2,000	25	8.78	702	
diesel	1,000	37	10.21	276	
		Mile/MMBTu	kg CO2/ MMBTu		
EV	1,000	500	83.6	167	
			Total	1146	kg CO_2

On the Total CO2 sheet select your electricity network in cell E48.
Then the "kg CO2/MMBTu" becomes the "Total CO2" sheet W69 for 2022.

Transport emissions:
[Look at ship vs truck!]

Cost and longevity:

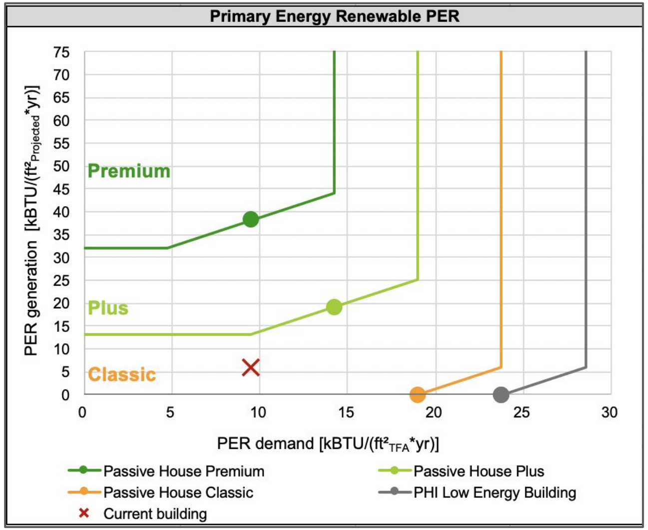
Table 2a.		Description	Project Value, $	Floor Area, ft^2
	Scenario 1	As-Designed	2,000,000	2938.0
	Scenario 2	Better Than As-designed	2,000,000	2938.0
	Scenario 3	Code-built	2,000,000	2938.0
	Scenario 4	As-designed w/o PV	2,000,000	2938.0

Life of building 60 yrs

Lessons Learned

[Summary]

Novice User Experience



if Operational varies then adjust these cells

Operational CO_2	Scen 1	Scen 2	Scen 3	Scen 4
Heating Demandl kBTU/(ft²yr)	0.9	0.9	0.9	0.9
Final Energy kBTU/(ft²yr) (excl PV)	8.1	8.1	8.1	8.1
metric tonnes CO_2e (incl PV if any)	3.1	3.1	52.4	3.1
US tons CO_2e (incl PV if any)	3.5	3.5	57.8	3.5
kgCO2e/ft² (incl PV if any)	1.1	1.1	17.8	1.1

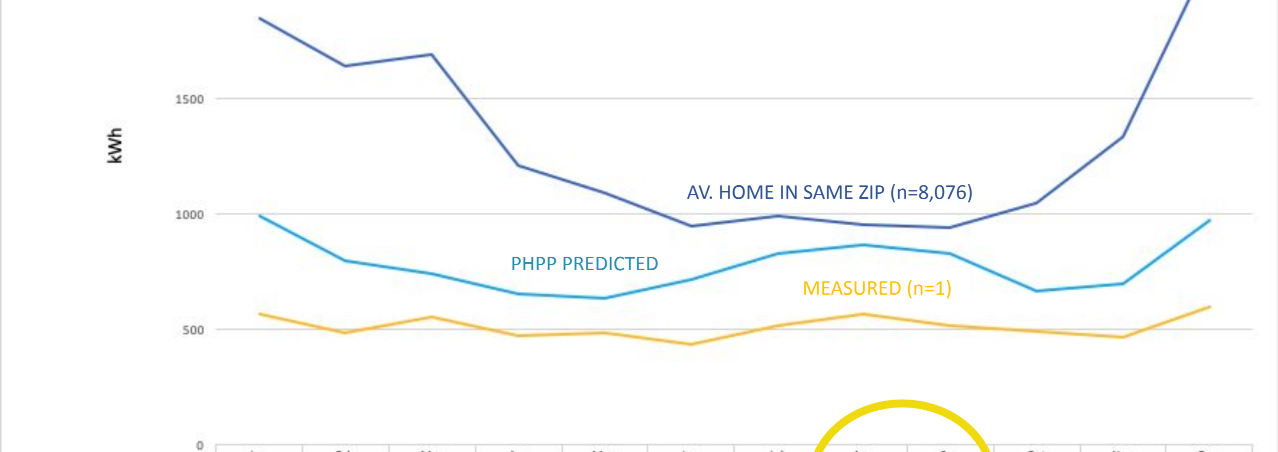
Embodied CO_2	Scen 1	Scen 2	Scen 3	Scen 4
metric tonnes CO_2e	104.4	100.7	100.3	68.8
US tons CO_2e	115.1	111.0	110.5	75.9
kgCO2e/ft²	35.5	34.3	34.1	23.4

RIBA (UK) Embodied CO_2 targets 2030	
New Build Offices	70 kgCO_2e/ft²
New Build Schools	50 kgCO_2e/ft²
domestic/residential	58 kgCO_2e/ft²

- ❑ Useful for guiding material choices [approximations used while EPD database expands]
- ❑ PV was our highest embodied carbon product. [Revised goal of PH Plus to PH Classic Certification]
- ❑ Hard to compare true 'code' equiv.
- ❑ Full capacity of PHribbon still TBD [I'm a beginner user]
- ❑ No local benchmarks for comparison [yet!]

passive house

PHPP works very well in California

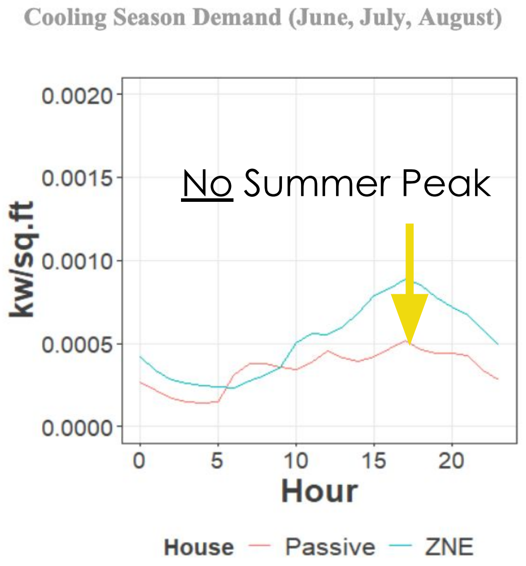


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Av. Comparable in Same Zip	1844	1641	1689	1206	1086	948	987	953	941	1046	1332	2116
Total Predicted (house only)	990	796	738	651	631	715	829	866	825	666	694	970
Total Measured (house only)	563	480	550	471	483	431	516	562	516	489	467	597

Sunnyvale all-electric 1,542 sf home

Uses **~half the energy** of similar homes In CA's highest CO_2 months of Aug + Sept

PHPP delivers SUPERPOWERS for our Grid



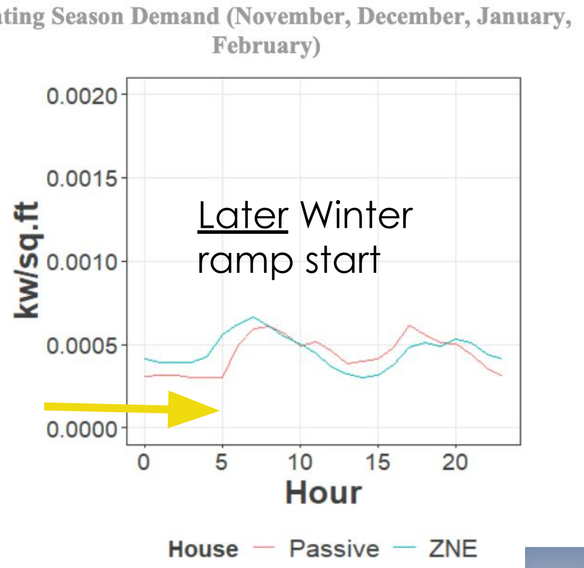


Figure 2. Passive House and ZNE Seasonal Load Comparisons

Hourly monitoring data:

- 5 ZNE homes vs.
- 2 Passive House homes

Source: https://aceee2022.conferencespot.org/event-data/pdf/catalyst_activity_32610/catalyst_activity_paper_20220810191639356_eee5e703_cea0_4aa3_8454_3e92c950ae91

Still all about BALANCE

LIFE-CYCLE ENERGY ANALYSIS: COMPARISON OF LOW-ENERGY HOUSE, PASSIVE HOUSE, SELF-SUFFICIENT HOUSE

Dr. Wolfgang Feist, Passive House Institut, 1997

1 Abstract

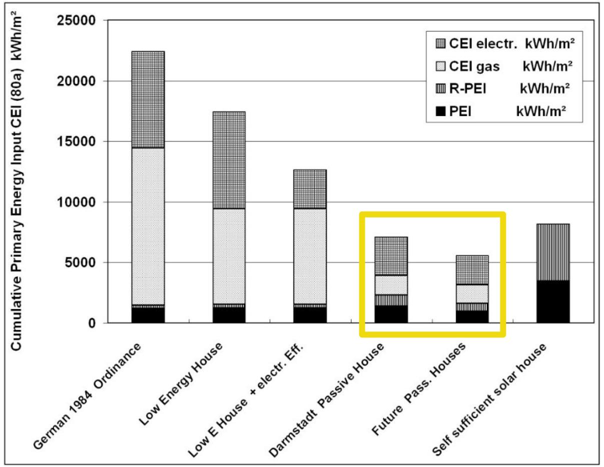


Fig. 1: Cumulative primary energy input compared

Abstract: The cumulative primary energy input (CEI) over a service life of 80 years has been compared for six construction standards (Fig. 1). For poorly insulated buildings (complying to the 1984 German Thermal Insulation Ordinance), the primary energy input for building production (PEI) only amounts to some 5% of the consumption of natural gas and primary energy for household electricity. With the low energy house (LEH standard), the volumes of electricity and natural gas consumption over the service life are brought to similar levels, amounting each to 45% of the total, so that further progress can above all be achieved by the efficient use of electricity (Low E House + electr. Eff.). Improving to the passive house standard, very good thermal protection reduces the heat requirement to such a low level that a separate heating system is not necessary any longer. The PEI of future passive houses can be even lower than that of conventional new-build houses. Projects with cost-effective passive

1

Wolfgang Feist @WolfgangFeist · Apr 23

Interesting.

By the way: Motivation for Passive House:
- we need to reduce total lifecycle carbon
- we could do that by stopping ALL new construction right now (oh, they dont like that... 😉)
- OR: By planning new construction to be highly energy efficient

Wolfgang Feist
@WolfgangFeist

2 add. remarks:
1)If we hadn't investigated the impact on whole lifecycle energy balance (&CO2),we wouldn't even have come up with the passive house solution
2)There's no major measure you can take on a building to get more net-CO2-savings in the lifecycle than insulation(>50:1)

12:45 PM · Apr 23, 2023 · **199** Views

Design [GRID] Connected Buildings!

[EMBODIED CARBON IS THE NEW BALANCE]

Bronwyn Barry, RA, CPHD

THANK YOU