

PASSIVE HOUSE STANDARDS: A COMPARISON



DAN WHITMORE

1. THE PALATINE PASSIVE HOUSE



Architect: Tiffany Bowie, AIA, CPHC
Builder: Blue & Yellow Builders
Structural Engineer: Carissa Farkas, PE
PH Consulting: Dan Whitmore, CPHC

Images: Malboeuf Bowie Architects

2. FLORA VISTA PASSIVE HOUSE



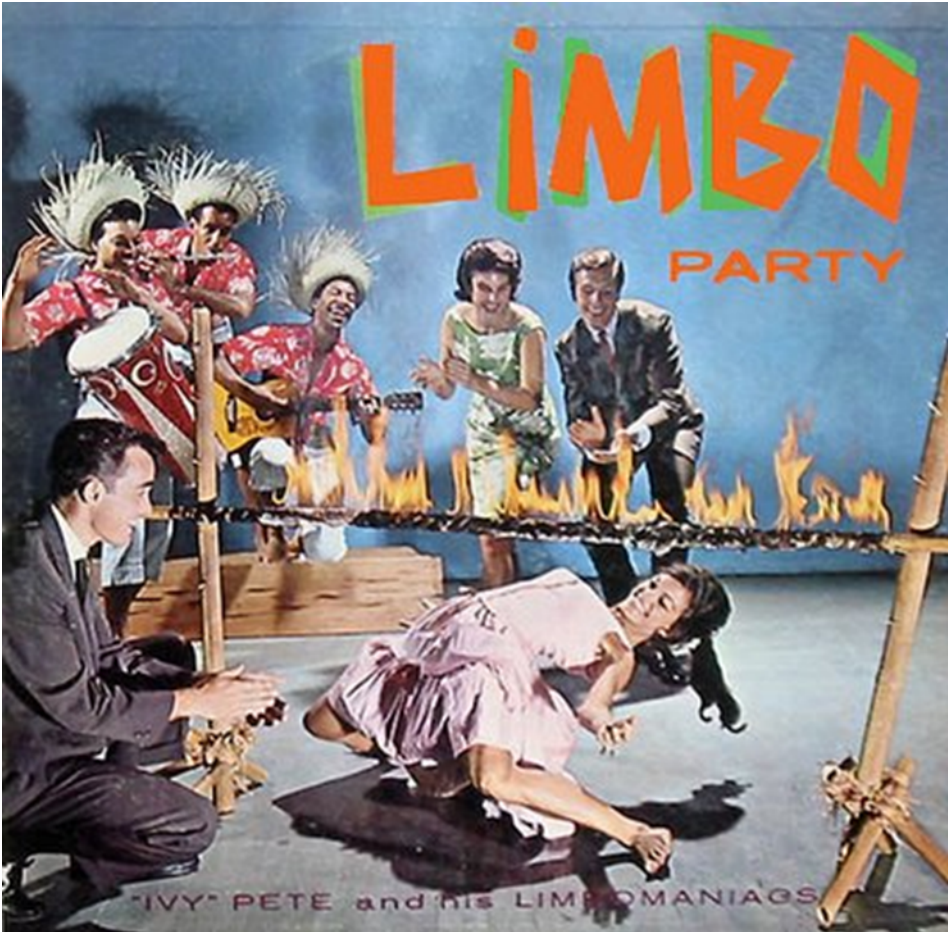
Architectural Designer: Roussa Cassel
Builder: Bicycle Homebuilding
Structural Engineer: Carissa Farkas, PE
PH Consulting: Dan Whitmore, CPHC

CASE STUDIES

	Palatine	Flora Vista
Location	Seattle, WA	Olympia, WA
Climate	4470 HDD, <200 CDD	4994 HDD, <100 CDD
Site	<ul style="list-style-type: none"> • Urban lot • E-W Orientation • Semi-dense neighborhood 	<ul style="list-style-type: none"> • Large, treed lot • E-W Orientation • On Puget Sound
Building	<ul style="list-style-type: none"> • 2-Storey, stacked • 3 Bedroom • 2700 Gross ft² • Liquifaction Soils • Crawlspace over pin-pile foundation 	<ul style="list-style-type: none"> • 2-Storey, partially stacked • 4 Bedroom • 2640 Gross ft² • Partially sub-terranean ground floor
Occupancy	???	Family of 4
Notes	Speculative-built	Adjoining MIL
Design Challenges	Large Volume w/ steep gable	Shading of adjoining structure, porches and vegetation



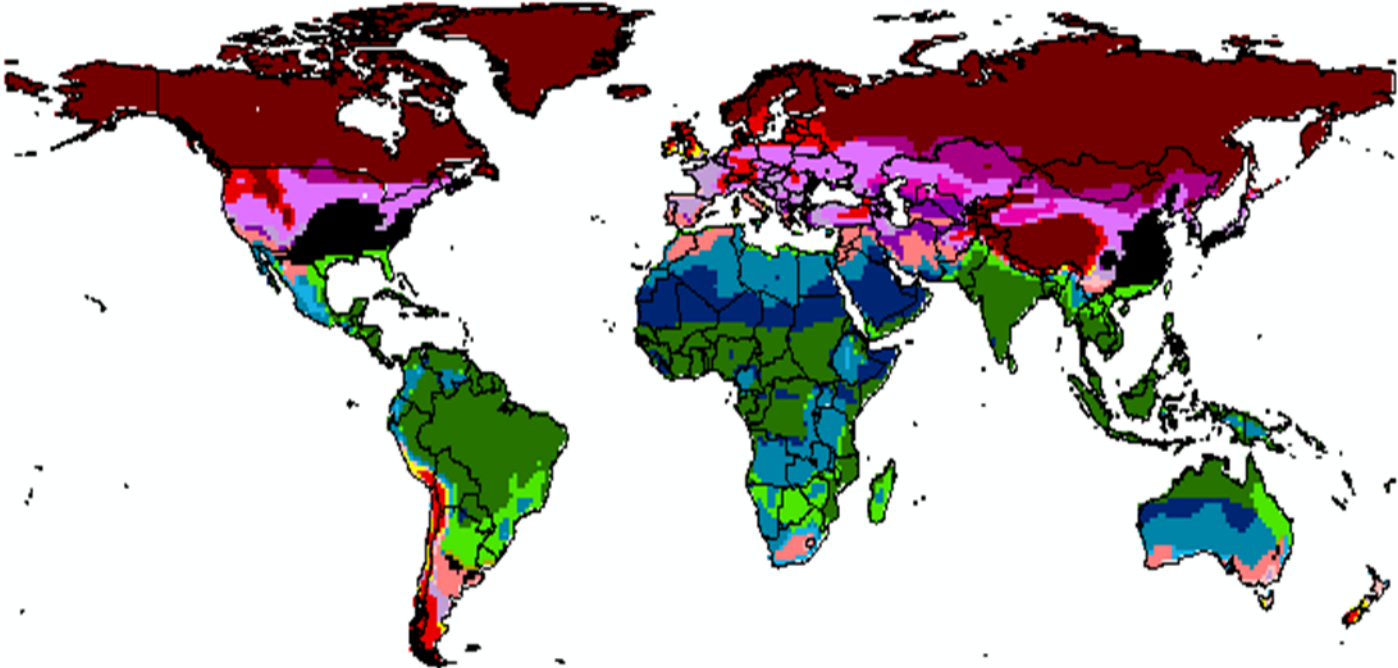
ENERGY LIMBO!



STANDARDS

Graph Courtesy of Global Buildings Performance Network

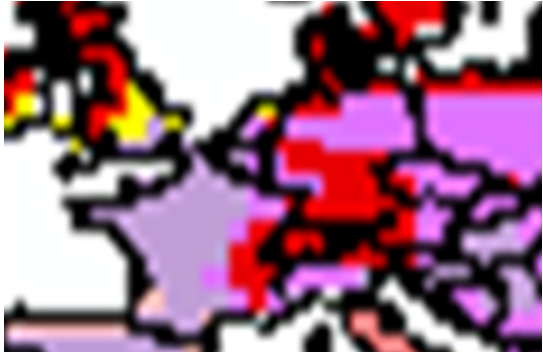
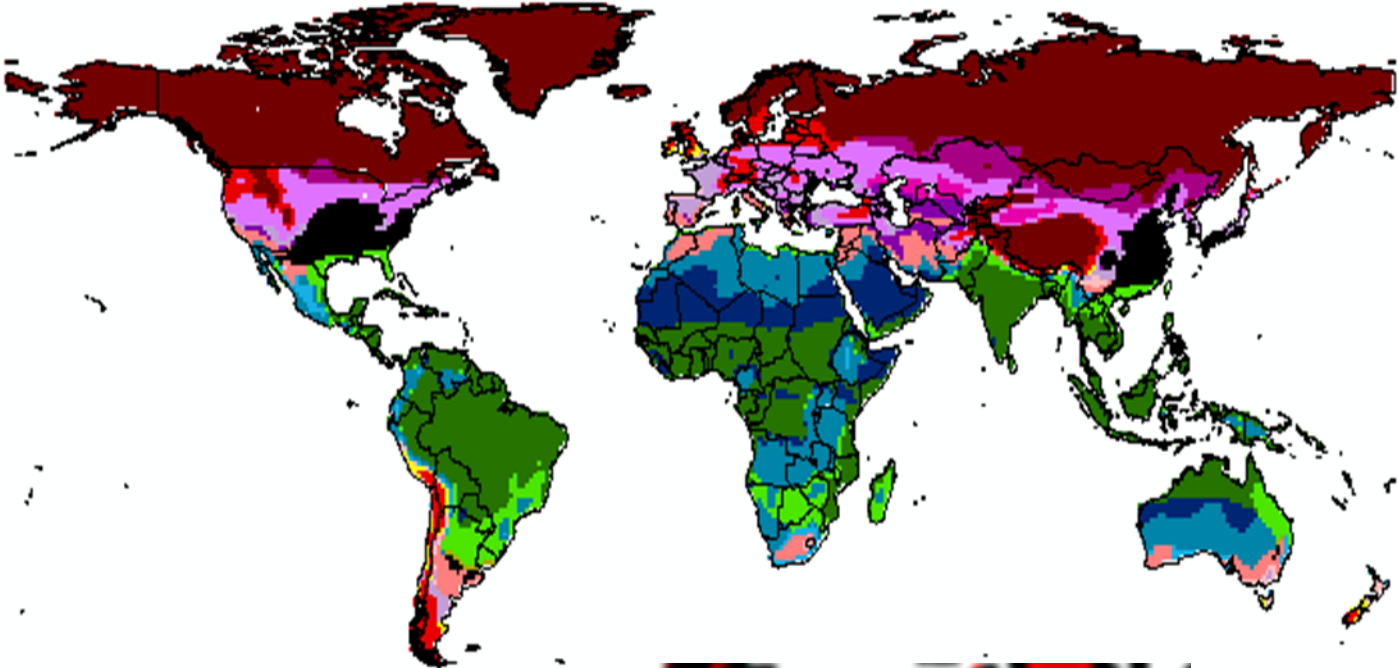
- 1. Only Heating (very HHD)
- 2. Only Heating (HHD)
- 3. Only Heating (MHD+LHD)
- 4. Heating and Cooling (very HHD+LCD)
- 5. Heating and Cooling (HHD+MCD)
- 6. Heating and Cooling (HHD+LCD)
- 7. Heating and Cooling (MHD+MCD)
- 8. Heating and Cooling (MHD+LCD)
- 9. Heating and Cooling (LHD+MCD)
- 10. Heating and Cooling (LHD+LCD)
- 11. Only Cooling (very HCD)
- 12. Only Cooling (HCD)
- 13. Only Cooling (LCD+MCD)
- 14. Cooling and Dehum (very HCD)
- 15. Cooling and Dehum (HCD)
- 16. Cooling and Dehum (LCD+MCD)
- 17. Heating, Cooling, Dehum



STANDARDS

Graph Courtesy of Global Buildings Performance Network

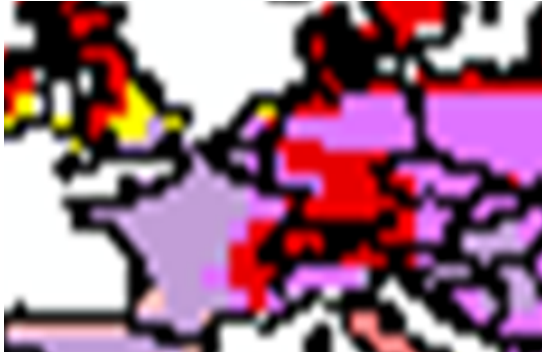
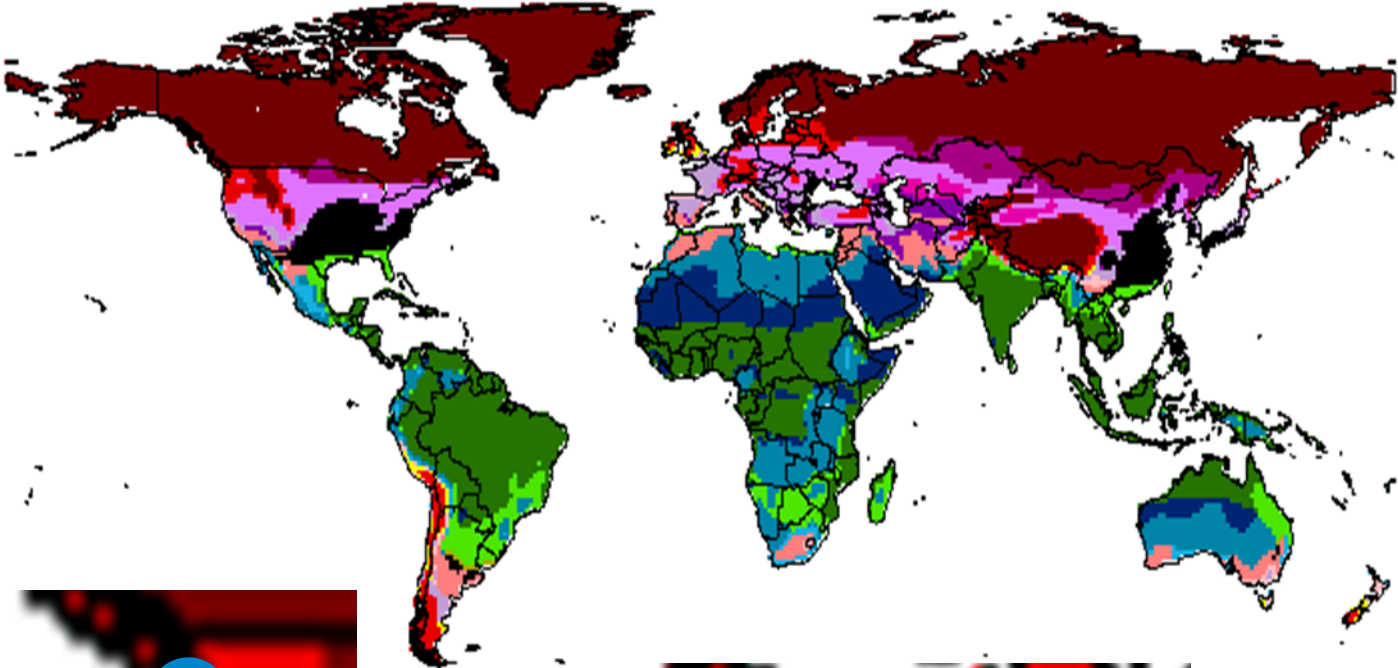
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ENERGY LIMBO

	PHI	PHIUS+
Annual Heating Demand	$\leq 4.75 \text{ kBTU/ft}^2\text{yr}$	<u>Varies by climate</u>
Annual Cooling Demand	<u>Varies by climate</u>	<u>Varies by climate</u>
Peak Heating Load	$\leq 3.17 \text{ BTU/hr.ft}^2$	<u>Varies by climate</u>
Peak Cooling Load	<u>Varies by climate</u>	<u>Varies by climate</u>
Primary Energy	$\leq 11.1 \text{ kWh/ft}^2\text{yr}$	$\leq 6,200 \times (\# \text{ of bedrooms} + 1)$
Air Tightness	$\leq 0.6 \text{ ACH50}$	$\leq 0.05 \text{ CFM/ft}^2$ Leakage Area
Reference Area	TFA	iCFA



STANDARDS ON PALATINE

LIMITS	PHI	PHIUS+ 2015
ANNUAL HEATING DEMAND	4.75	5.1 KBTU/FT ² YR
PEAK HEATING LOAD	3.17	3.4 BTU/FT ² HR
ANNUAL COOLING DEMAND	4.75	1 KBTU/FT ² YR
PEAK COOLING DEMAND	3.17	3.4 BTU/FT ² HR



Image: Dan Whitmore



ENERGY LIMBO: PALATINE

	PHI	PHIUS+	Difference
Annual Heating Demand			
Annual Cooling Demand			
Peak Heating Load			
Peak Cooling Load			
Primary Energy			
Air Tightness			
Reference Area	2489 ft ²	2587 ft ²	+4%

*previous PHI protocol



ENERGY LIMBO: PALATINE

	PHI	PHIUS+	Difference
Annual Heating Demand			
Annual Cooling Demand			
Peak Heating Load			
Peak Cooling Load			
Primary Energy			
Air Tightness	≤ 268 cfm	≤ 372 cfm	+38%
Reference Area	2489 ft ²	2587 ft ²	+4%

*previous PHI protocol



ENERGY LIMBO: PALATINE

	PHI	PHIUS+	Difference
Annual Heating Demand			
Annual Cooling Demand			
Peak Heating Load			
Peak Cooling Load			
Primary Energy	≤27,623 kWh/yr	≤24,800 kWh/yr	-13%
Air Tightness	≤ 268 cfm	≤ 372 cfm	+38%
Reference Area	2489 ft ²	2587 ft ²	+4%

*previous PHI protocol



ENERGY LIMBO: PALATINE

	PHI	PHIUS+	Difference
Annual Heating Demand			
Annual Cooling Demand			
Peak Heating Load	≤ 7,889 BTU/hr	≤ 8,795 BTU/hr	+11%
Peak Cooling Load	≤ 7,889 BTU/hr	≤ 8,795 BTU/hr	+11%
Primary Energy	≤27,623 kWh/yr	≤24,800 kWh/yr	-13%
Air Tightness	≤ 268 cfm	≤ 372 cfm	+38%
Reference Area	2489 ft ²	2587 ft ²	+4%



ENERGY LIMBO: PALATINE

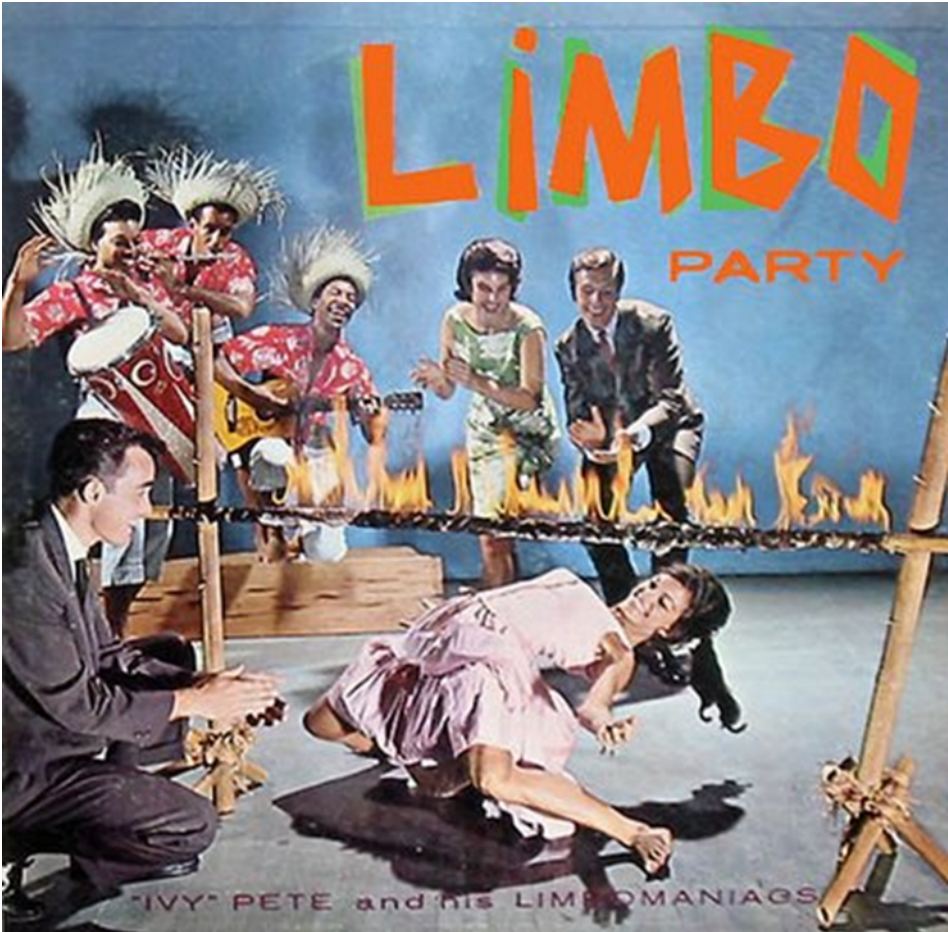
	PHI	PHIUS+	Difference
Annual Heating Demand			
Annual Cooling Demand	≤ 11,820 kBTU/yr	≤ 2,587 kBTU/yr	-78%
Peak Heating Load	≤ 7,889 BTU/hr	≤ 8,795 BTU/hr	+11%
Peak Cooling Load	≤ 7,889 BTU/hr	≤ 8,795 BTU/hr	+11%
Primary Energy	≤27,623 kWh/yr	≤24,800 kWh/yr	-13%
Air Tightness	≤ 268 cfm	≤ 372 cfm	+38%
Reference Area	2489 ft ²	2587 ft ²	+4%



ENERGY LIMBO: PALATINE

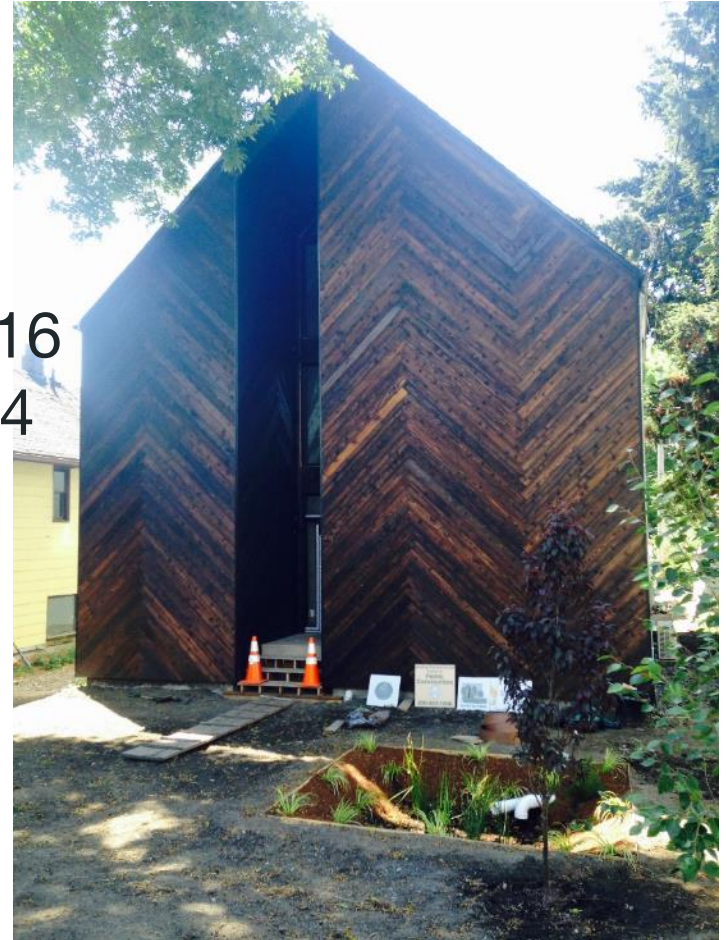
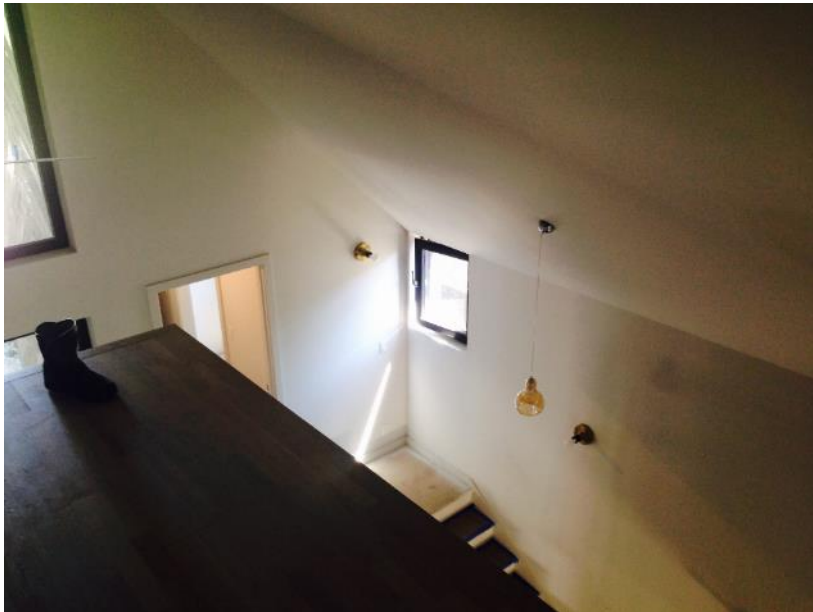
	PHI	PHIUS+	Difference
Annual Heating Demand	≤ 11,820 kBTU/yr	≤ 13,192 kBTU/yr	+12%
Annual Cooling Demand	≤ 11,820 kBTU/yr	≤ 2,587 kBTU/yr	-78%
Peak Heating Load	≤ 7,889 BTU/hr	≤ 8,795 BTU/hr	+11%
Peak Cooling Load	≤ 7,889 BTU/hr	≤ 8,795 BTU/hr	+11%
Primary Energy	≤27,623 kWh/yr	≤24,800 kWh/yr	-13%
Air Tightness	≤ 268 cfm	≤ 372 cfm	+38%
Reference Area	2489 ft ²	2587 ft ²	+4%

ENERGY LIMBO



PALATINE as BUILT

- Walls: R-46.9
- Floor: R-58.2
- Roof: R-62.6
- Windows/Doors: SHGC0.49, U-0.16
- Blower Door Test: 0.31ACH50 (164 cfm50)



Images: Dan Whitmore

PHI

	PHI Modeled	PHI Limit	Passed?
Annual Heating Demand	11,808 kBTU/yr	$\leq 11,820$ kBTU/yr	Yes!
Peak Heating Load	7,745 BTU/hr	$\leq 7,889$ BTU/hr	Yes!
Primary Energy	21,576 kWh/yr	$\leq 27,623$ kWh/yr	Yes!
Air Tightness	161 cfm	≤ 268 cfm	Yes!
Reference Area	2489 ft ²		



PHIUS+ 2015

	Modeled	Limit	Passed?
Annual Heating Demand	12,068 kBTU/yr	$\leq 13,192$ kBTU/yr	Yes!
Peak Heating Load	7,695 BTU/hr	$\leq 8,795$ BTU/hr	Yes!
Primary Energy	30,903 kWh/yr	$\leq 24,800$ kWh/yr	NO!
Air Tightness	161 cfm	≤ 372 cfm	Yes!
Reference Area	2587 ft ²		



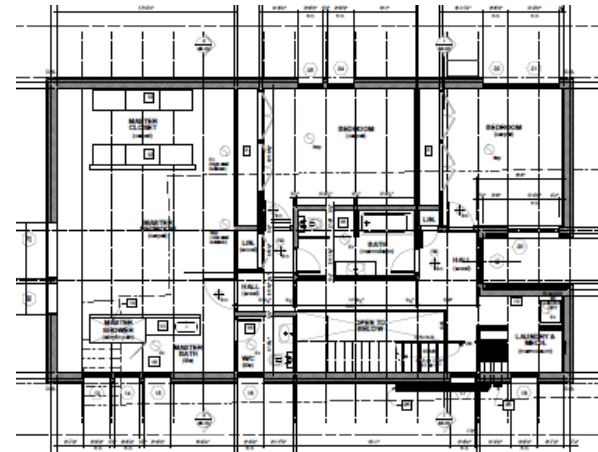
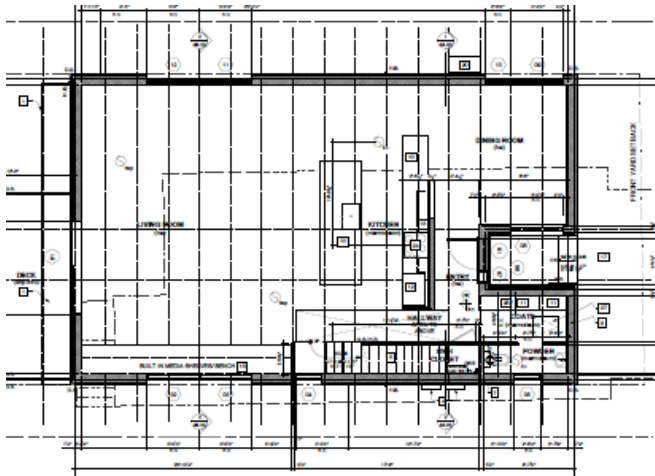
ENERGY LIMBO: PALATINE MODELED

	PHI	PHIUS+	Difference
Annual Heating Demand	≤ 11,808 kBTU/yr	≤ 12,068 kBTU/yr	+2%
Peak Heating Load	≤ 7,745 BTU/hr	≤ 7,695 BTU/hr	-1%
Primary Energy	≤21,576 kWh/yr	≤30,903 kWh/yr	+43%
Air Tightness	161 cfm	161 cfm	0%
Reference Area	2489 ft ²	2587 ft ²	+4%



CONCLUSIONS

- MINIMAL DIFFERENCE IN THIS CLIMATE FOR HEATING LIMITS
- REALITY BITES
 - PHIUS+ 2015
 1. REALISTIC DOMESTIC ELECTRICITY ASSUMPTIONS
 2. US PRIMARY ENERGY FACTOR *
 3. ENERGY PER OCCUPANT not ENERGY PER AREA
 4. LARGER BUILDING per OCC = **BIG** DRIVE FOR EFFICIENCIES



*WE CAN ARGUE ABOUT REGIONAL PE FACTORS

LIMITS

PHI

PHIUS+ 2015

ANNUAL HEATING DEMAND
PEAK HEATING LOAD

4.75
3.17

6 KBTU/FT²YR
3.5 BTU/FT²HR

ANNUAL COOLING DEMAND
PEAK COOLING DEMAND

4.75
3.17

1 KBTU/FT²YR
3.5 BTU/FT²HR

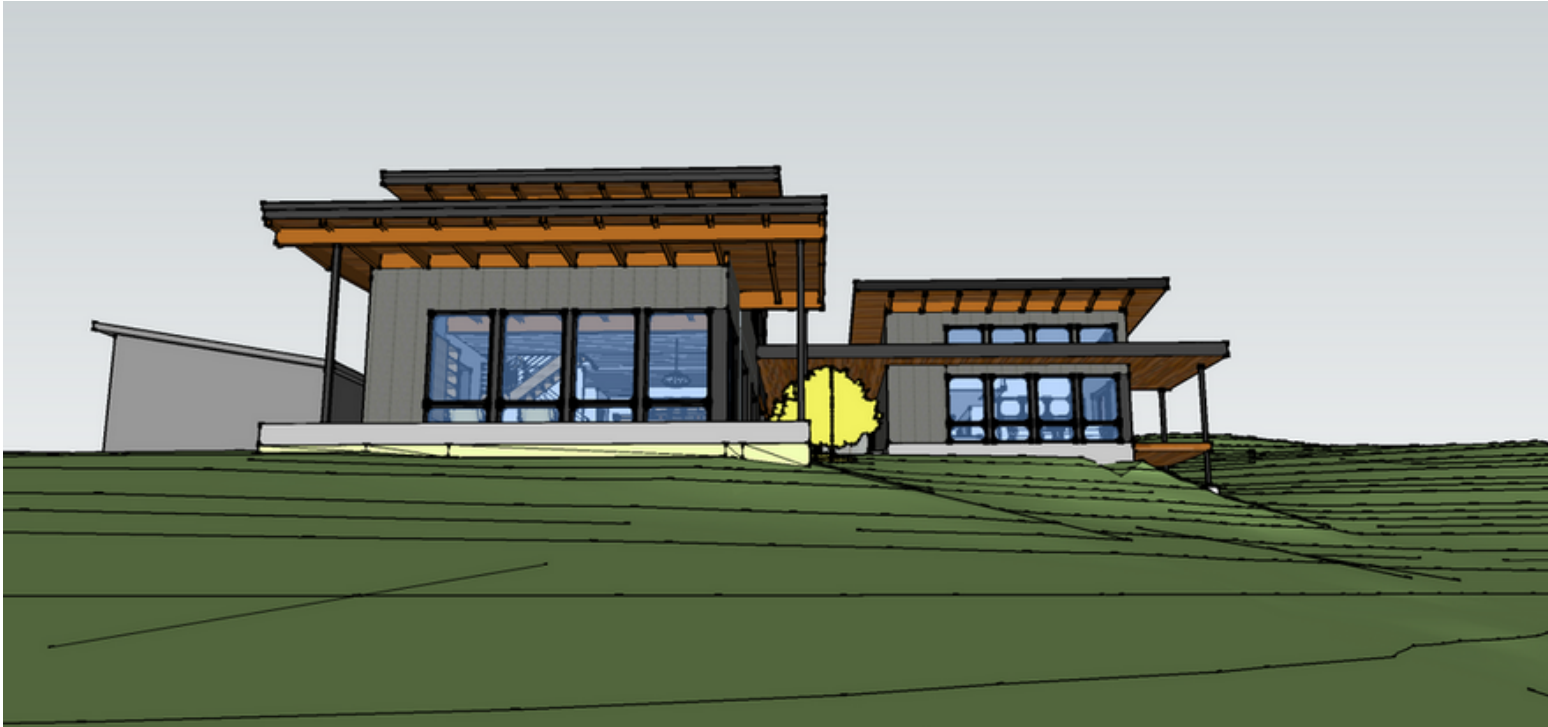


Image: Roussa Cassel



ENERGY LIMBO: FLORA VISTA LIMITS

	PHI	PHIUS+	Difference
Annual Heating Demand	$\leq 10,240$ kBTU/yr	$\leq 13,606$ kBTU/yr	+34%
Annual Cooling Demand	$\leq 10,240$ kBTU/yr	$\leq 2,281$ kBTU/yr	-78%
Peak Heating Load	$\leq 6,834$ BTU/hr	$\leq 7,984$ BTU/hr	+17%
Peak Cooling Load	$\leq 6,834$ BTU/hr	$\leq 7,984$ BTU/hr	+17%
Primary Energy	$\leq 23,930$ kWh/yr	$\leq 31,000$ kWh/yr	+30%
Air Tightness	≤ 214 cfm	≤ 352 cfm	+64%
Reference Area	2156 ft ²	2281 ft ²	+6%

PHI

	PHI Modeled	PHI Limit	Passed?
Annual Heating Demand	12,851kBTU/yr	$\leq 10,241$ kBTU/yr	No! But..
Peak Heating Load	5,868 BTU/hr	$\leq 6,835$ BTU/hr	Yes!
Primary Energy	18,326kWh/yr	$23,932 \leq$ kWh/yr	Yes!
Air Tightness	214 cfm	≤ 214 cfm	TBD
Reference Area	2156 ft ²		



PHIUS+ 2015

	Modeled	Limit	Passed?
Annual Heating Demand	12,898 kBTU/yr	$\leq 13,686$ kBTU/yr	Yes!
Peak Heating Load	6,022 BTU/hr	$\leq 8,795$ BTU/hr	Yes!
Primary Energy	26,492 kWh/yr	$\leq 31,000$ kWh/yr	Yes!
Air Tightness	352 cfm	≤ 352 cfm	TBD
Reference Area	2281 ft ²		



ENERGY LIMBO: FLORA VISTA MODELED

	PHI	PHIUS+	Difference
Annual Heating Demand	≤ 12,851 kBTU/yr	≤ 12,898 kBTU/yr	0%
Peak Heating Load	≤ 5,868 BTU/hr	≤ 6,022 BTU/hr	+3%
Primary Energy	≤18,326 kWh/yr	≤26,492 kWh/yr	+45%
Air Tightness	≤ 214 cfm	≤ 214 cfm	0%
Reference Area	2156 ft ²	2281 ft ²	+6%



FLORA VISTA



Image: Pete Chramiec





THANK YOU

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