The Growth of Passive Building in Texas

Ecotech Consulting & Passive Energy Designs

Stefan Goebel, M.Eng., CPHC
President Ecotech Consulting & VP Phius Houston

- **5 Years CPHC**
- **LEED Green Associate**
- **Building Science Principle**
- **Lecturer for Construction Technology**

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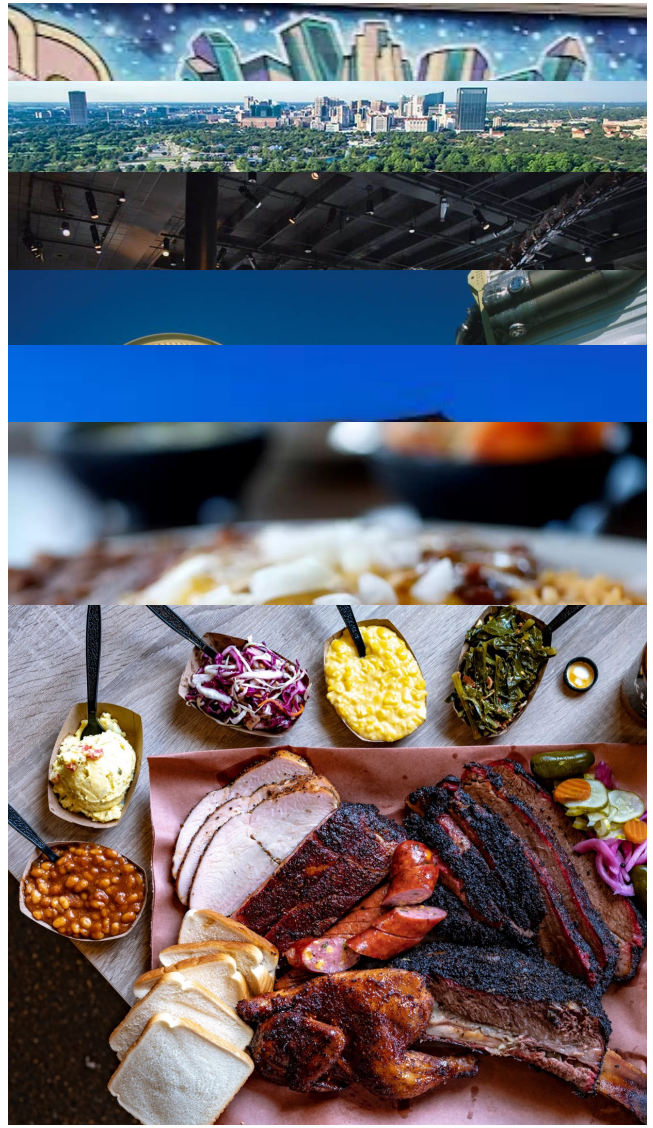
Principle at Passive Energy Designs, LLC

- **12 Years CPHC & Passive Buildings**
- **Professor of Architecture**
- **Phius Trainer & Technical Committee Member**

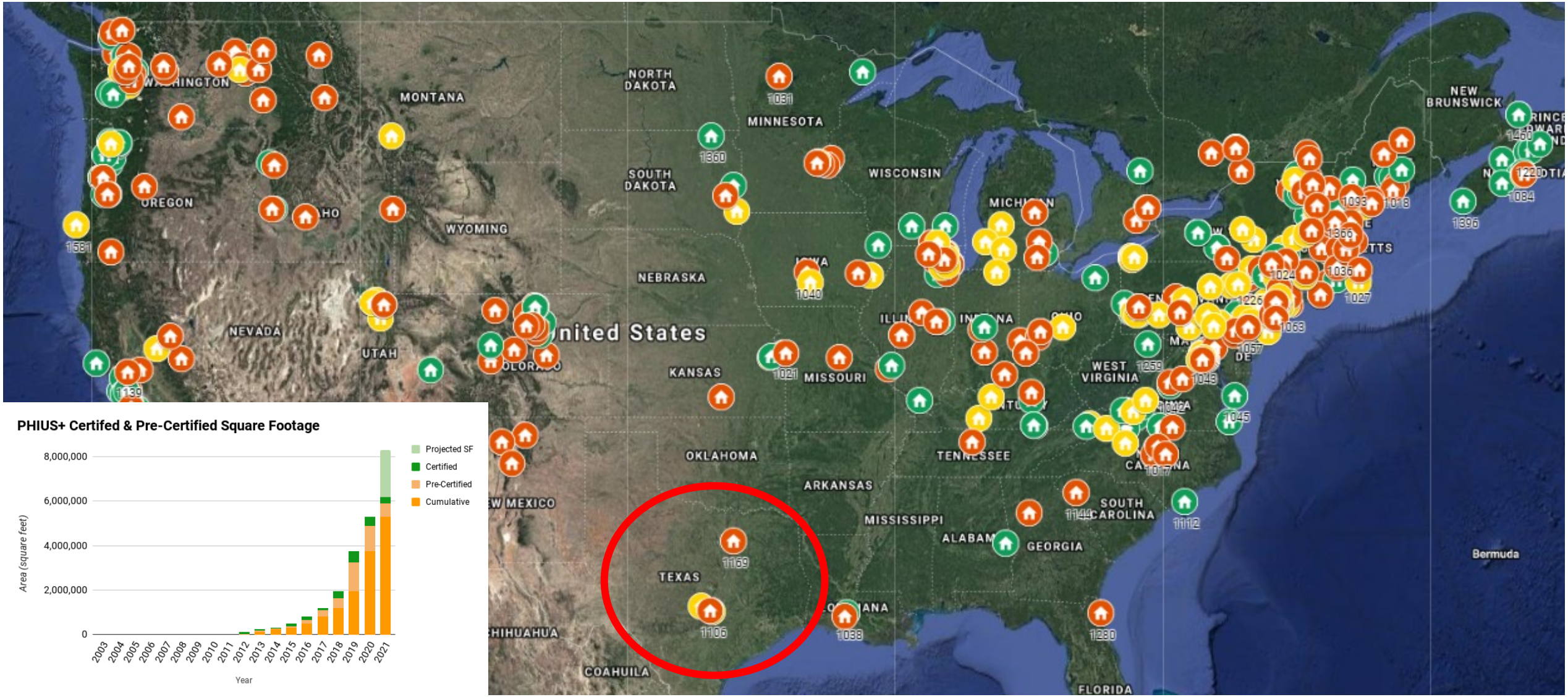
PASSIVE ENERGY DESIGNS

ECOTECH CONSULTING

PhiusCon 2023 - Houston



Certification Growth



Certification Growth

- Climate specific Phius standard launched in 2015

- Final Certified
  - Theresa Passive House; Single-Family Addition 2A, **2218 sq. ft.** (Austin)
  - Casa La Vista, Single-Family New Construction 2A **2990 sq. ft.** (Spicewood)
  - Blaise House, Single-Family Retrofit 2A, **1473 sq. ft.** (Austin)

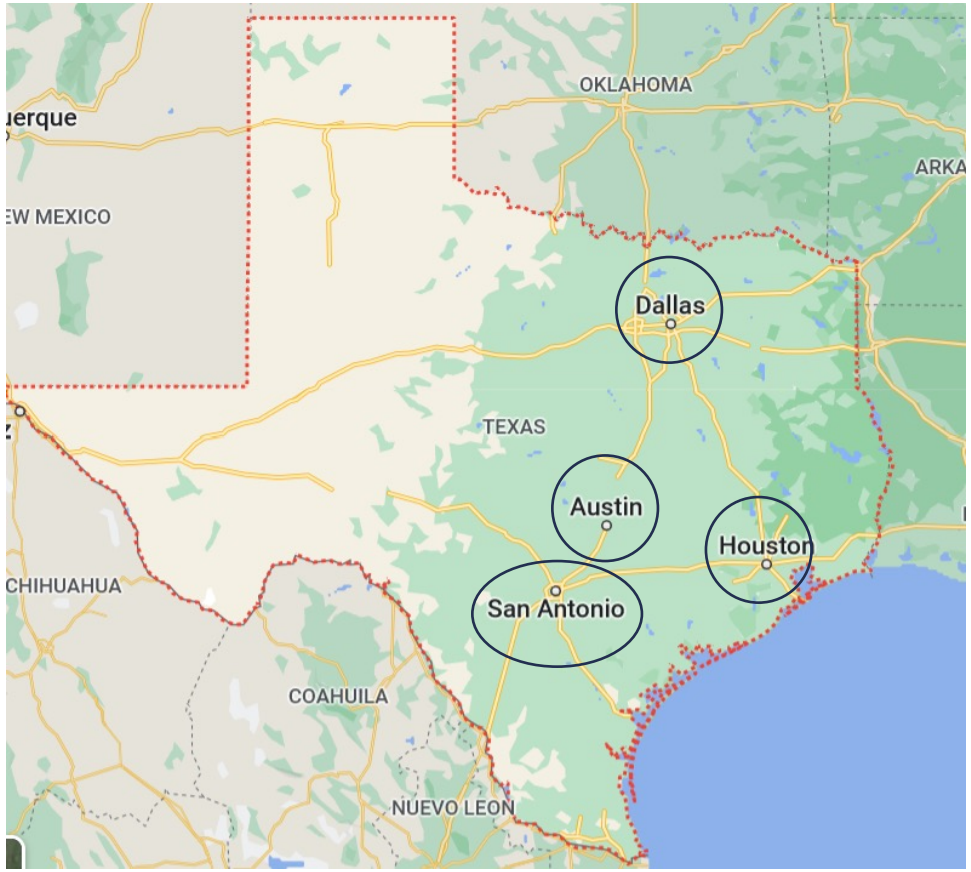
- Design Certified
  - Abbate House, Single-Family New Construction 2A, **1130 sq. ft.** (Austin)

- Registered
  - Lareina Guesthouse, Single-Family New Construction 2A, **1033 sq. ft.** (Austin)
  - 1118 W 7th, Single-Family New Construction 2A, **5000 sq. ft.** (Austin)

- Application: 3 Projects

Hot and Humid Texas

- Texas



Texas – Fact Sheet

Cities	US City Size Rank
Austin	11
Houston	4
Dallas	9
San Antonio	7
US Average	-

Hot and Humid Texas

- Houston, TX

City
HOUSTON

State
TX

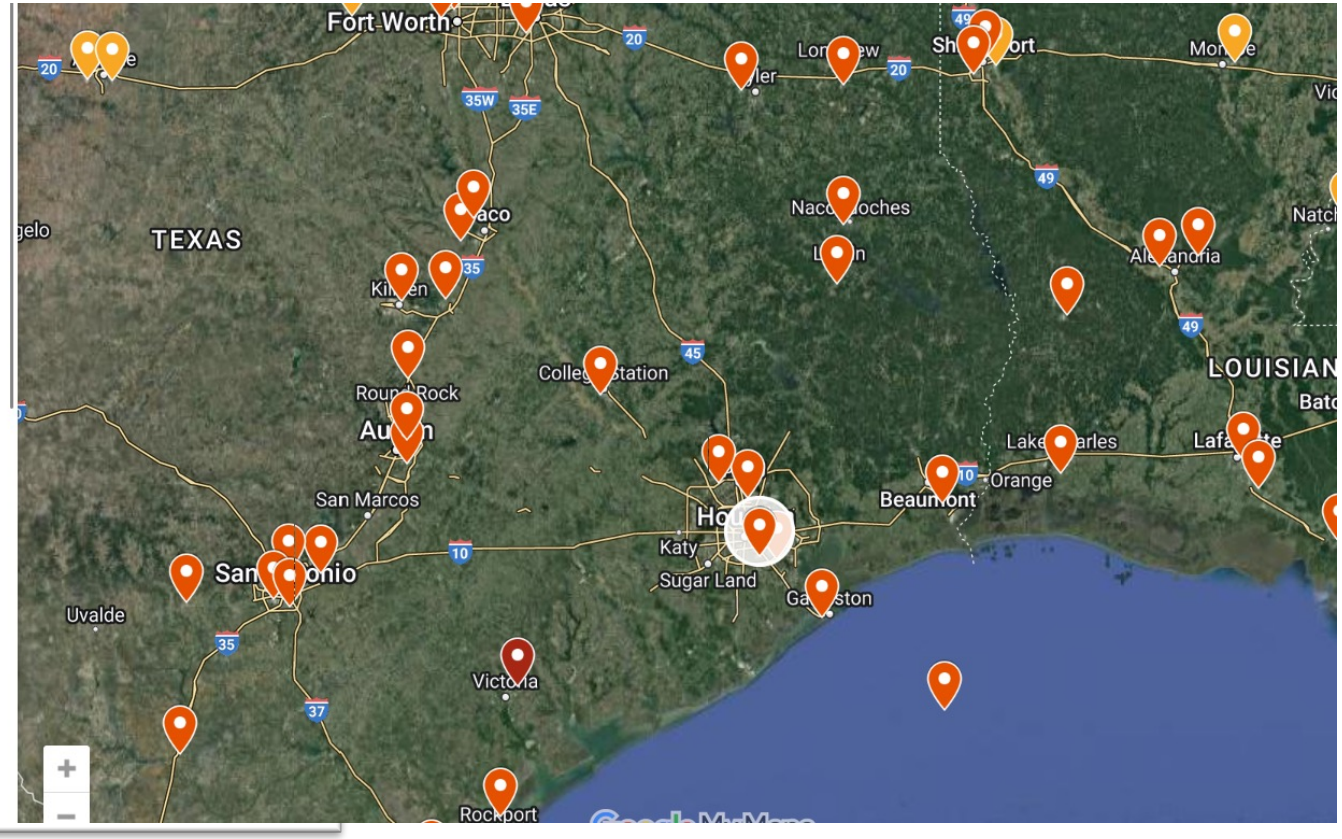
Climate Data
HOUSTON WILLIAM P HOBBY AP

Climate Zone
2A

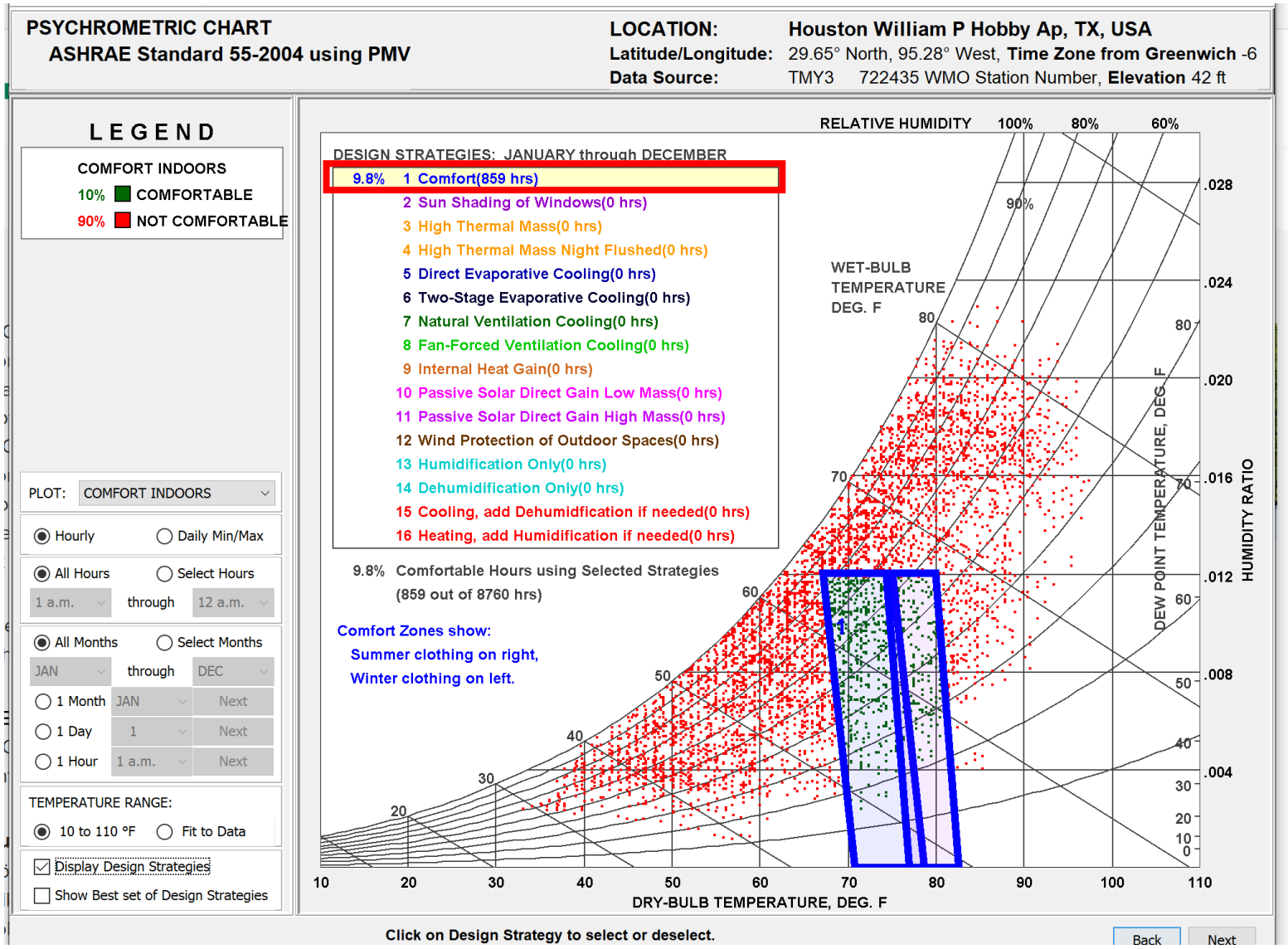
Maximum Window U-value (Btu/hr.sf.F)
0.31

Maximum SHGC
0.25

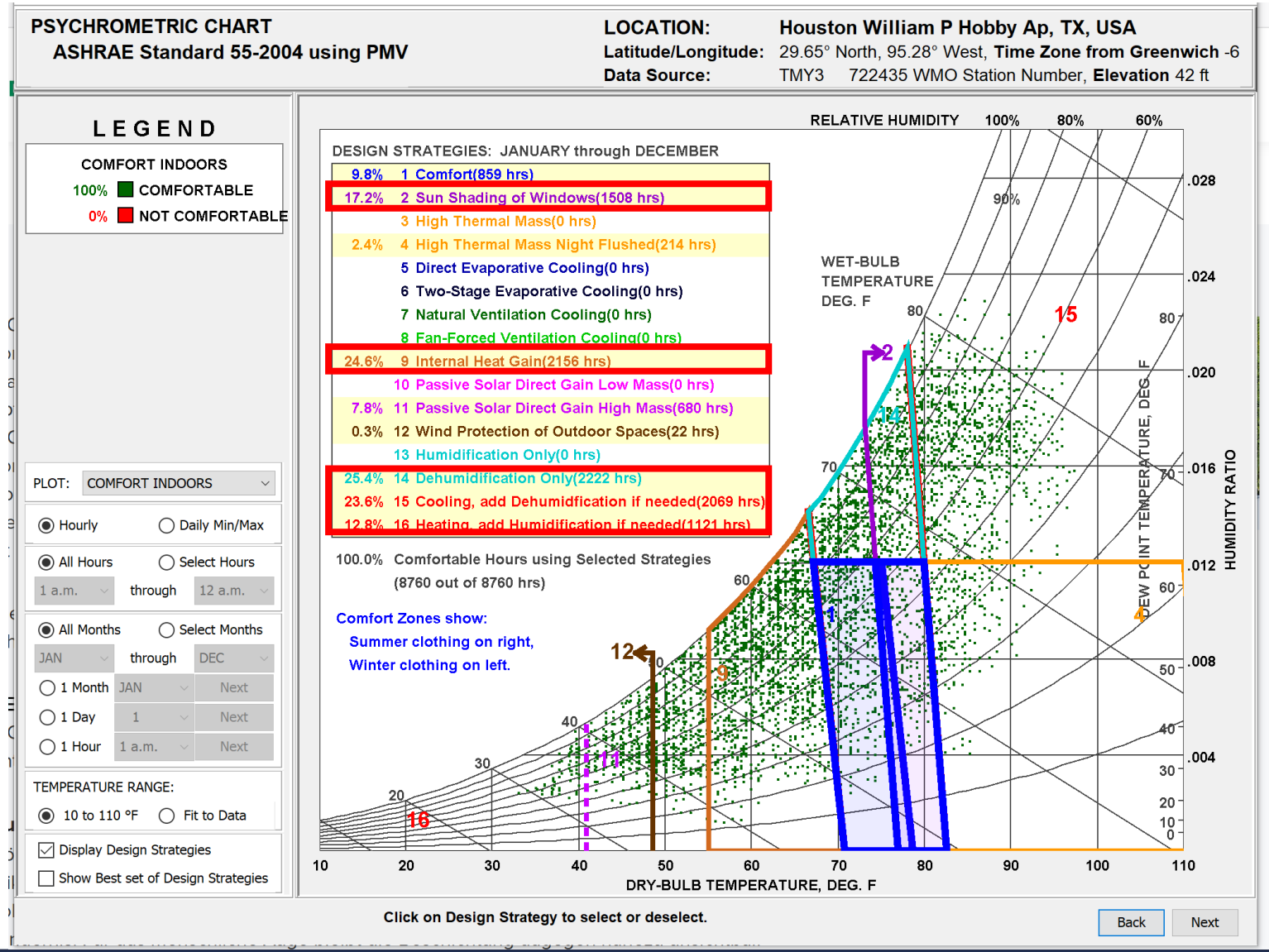
Minimum Projection Factor
0.57

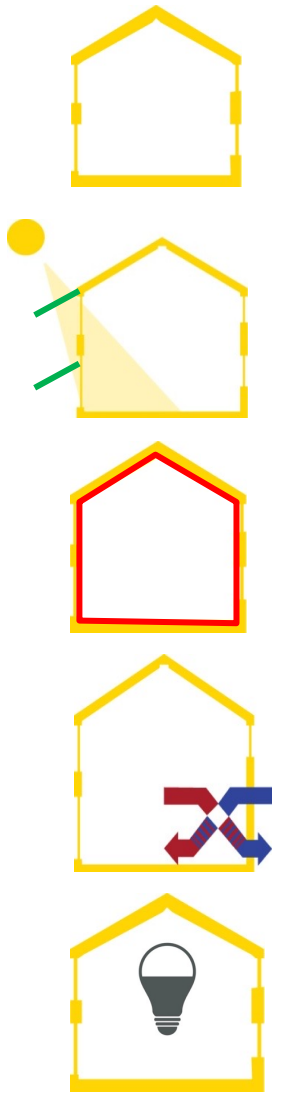


Hot and Humid Texas



Hot and Humid Texas





Phius CORE Prescriptive 2021 Snapshot

				Input or select data in teal cells		*Input or select data in teal cells*
			State	NEW YORK		TEXAS
			City	NEW YORK LAGUARDIA ARPT		HOUSTON WILLIAM P HOBBY
			ASHRAE (169-2021) Climate Zone	4A		2A
			iCFA* (ft^2)	2500		2500
			Number of Bedrooms*	4		4
			Number of Stories	2		2
				*per dwelling unit		*per dwelling unit
1	**General**					
1.1.2	iCFA divided by Number of Bedrooms	Maximum Limit		900	ft^2	900	ft^2
	(Calculated Value based on Inputs)	*OK, Meets Limit*		625	ft^2	625	ft^2
3	**Compactness**					
3.1.1	Envelope Area	Maximum		6946	ft^2	6946	ft^2
	(Maximum Envelope to Floor Area Ratio)			2.78		2.78	
4	**Solar Protection**					
4.1.1	Whole Window SHGC	Maximum		0.40		0.25	
4.4.1	Projection Factor for Fixed Overhangs	Minimum		NR		0.57	
5	**Thermal Enclosure**					
5.1.1a	Fenestration / Openings	Maximum Whole U-Value		0.20	(BTU/h.ft^2.°F)	0.31	(BTU/h.ft^2.°F)
5.1.1b	Walls & Overhang Floors - Effective R-value	Minimum Effective R-Value		36	(ft^2.°F.h/BTU)	23	(ft^2.°F.h/BTU)
5.1.1c	Roofs / Ceilings	Minimum Effective R-Value		67	(ft^2.°F.h/BTU)	53	(ft^2.°F.h/BTU)
5.1.1d	Whole Slab Foundations, Below-Grade Walls, Floors of Conditioned Basements & Crawl Spaces	Minimum Effective R-Value		17	(ft^2.°F.h/BTU)	8	(ft^2.°F.h/BTU)
5.1.1e	Ceilings of Unconditioned Basements or Crawl Spaces & Pier and Beam Floors	Minimum Effective R-Value		22	(ft^2.°F.h/BTU)	13	(ft^2.°F.h/BTU)
6	**Moisture Risk Limitation**					
6.2.1	Fenestration Condensation Resistance	Minimum		60%		65%	
7	**Mechanical Ventilation**					
7.2.1	Sensible Recovery Efficiency, Heating Mode	Minimum		76%		NR	
7.2.2	Total Recovery Efficiency, Cooling Mode	Minimum		50%		60%	
7.2.5	Total Length of Fresh Air Ducts to Outside	Maximum		28	ft	28	ft
8	**Mechanical Systems**					
	Select System Type					
8.2.1	Air Source Heat Pump	Minimum COP @ 5F		1.8		9.6	
		Minimum SEER		15.0		18.0	

Phius CORE Prescriptive **Snapshot**

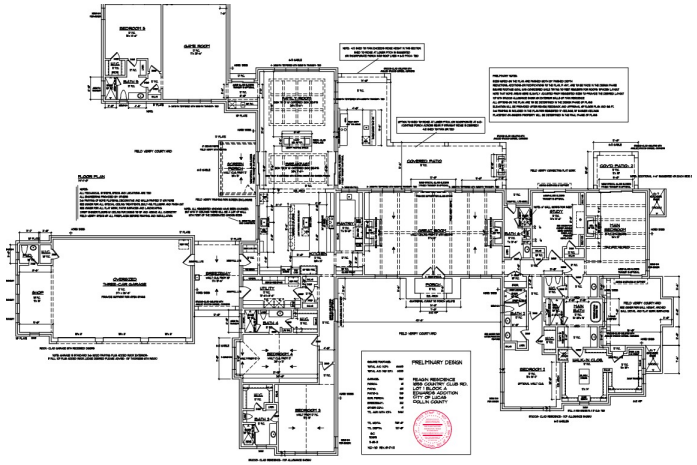
(www.phius.org)

phius

Texas Building Typologies

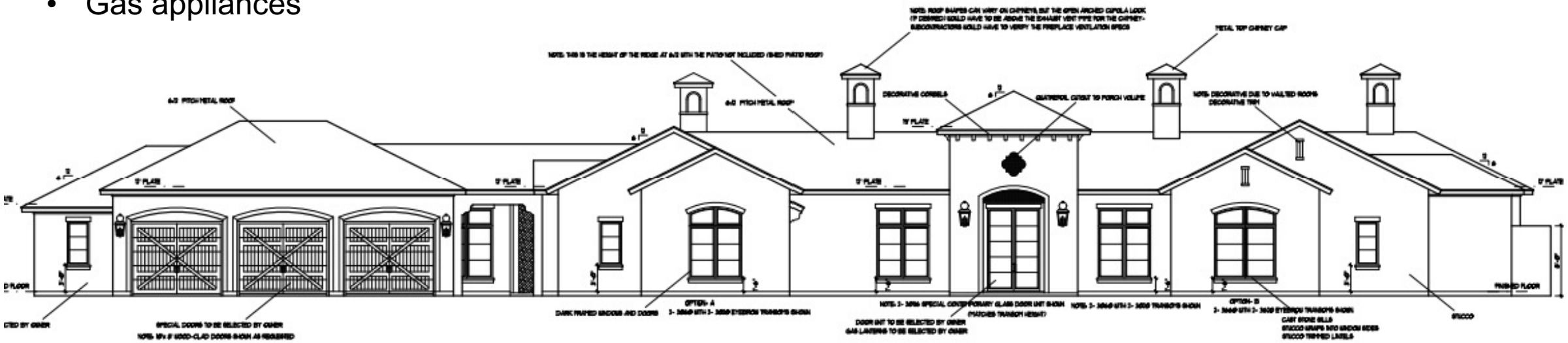
“Everything is bigger in Texas”

- Single Family 1 Story
- ~ 6000 sq ft
- 5 bed/7 bath
- 3 car garage
- Large envelope size and multiple wings
- Distributed nature of hot water use
- Combustion safety – 5 fireplaces
- Gas appliances



While not universal, the two case studies in this presentation have the following in common:

Slab on Grade
Conditioned Attic
Brick Veneer



Positive Impact Homes

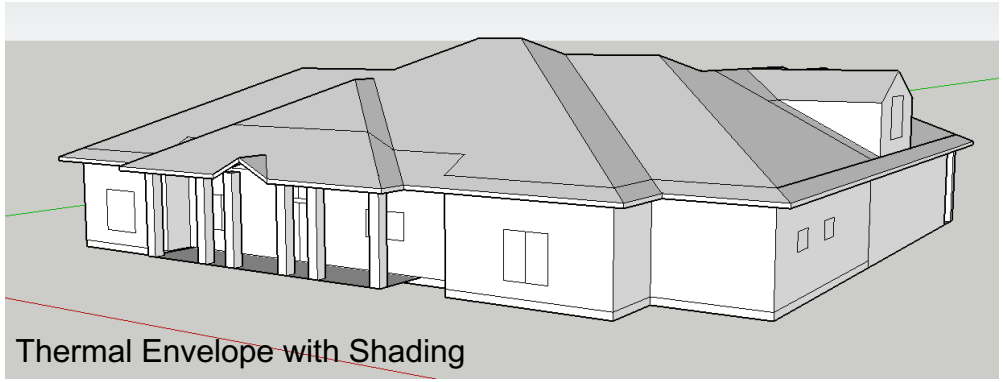
- Single Family 1 story
- Sqft: approx. 2,500
- Project Status: Construction Documents
- Positive Impact Homes

POSITIVE IMPACT HOMES
FOR VETERANS BATTLING PTSD & SPECIAL NEEDS

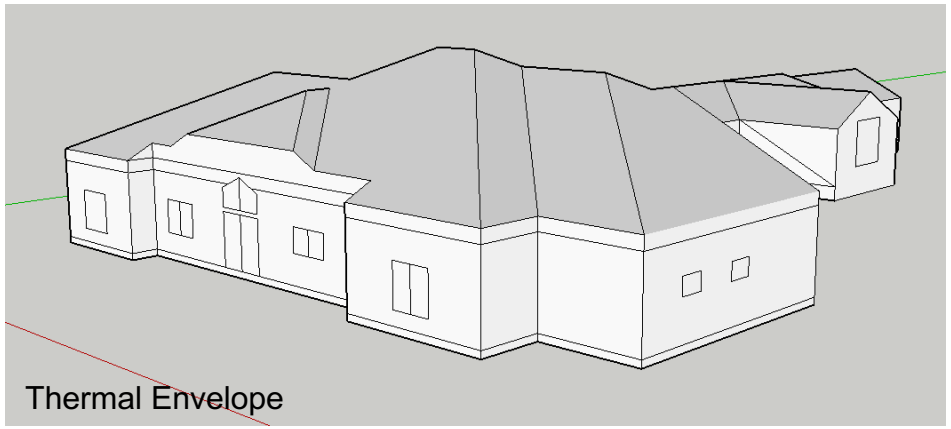
Images by Stella Maris Architecture

Positive Impact Homes

The thermal envelope area is not overly large in plan, but there is a conditioned space over the attic that greatly adds to the overall envelope to iCFA ratio.



Thermal Envelope with Shading



Thermal Envelope

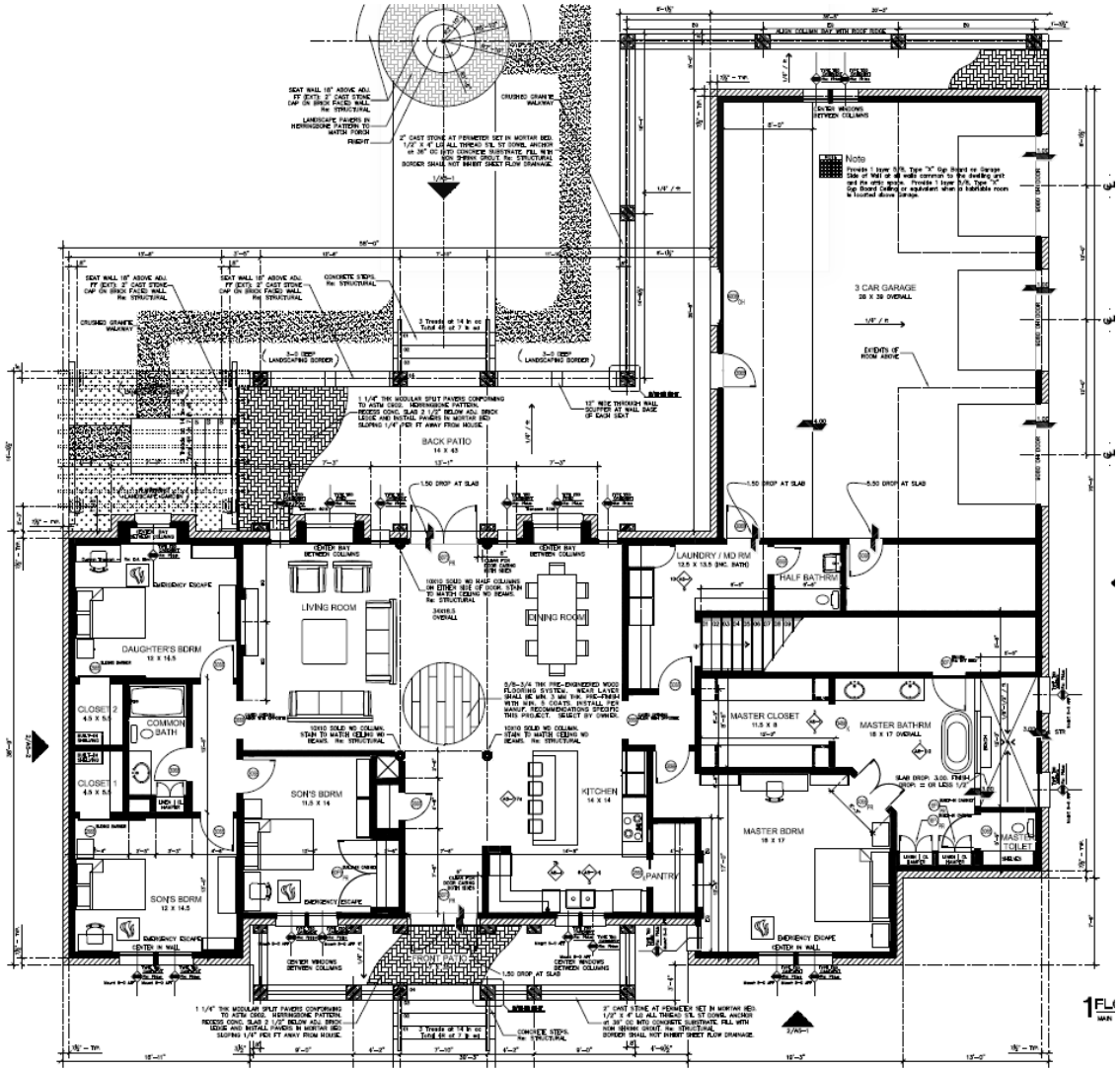
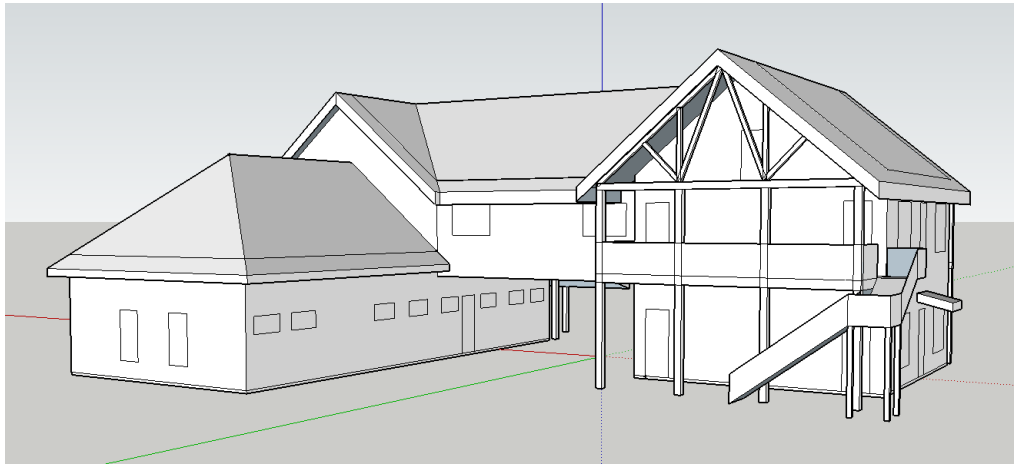


Image by Stella Maris Architecture

Palm Street Development

- Two Unit Residence
- Sqft: Unit 1 1,950; Unit 2 3,600
- Project Status: Construction Documents
- SunRoof USA PV System offering 24.96 kWp (29.6k lsb/yr CO2 reduction)
- Emphasis on carbon neutral, energy positive construction practices
- Bridge above easement that connects the two residences
- Two additional 1st floor bedrooms w/ exterior entrances



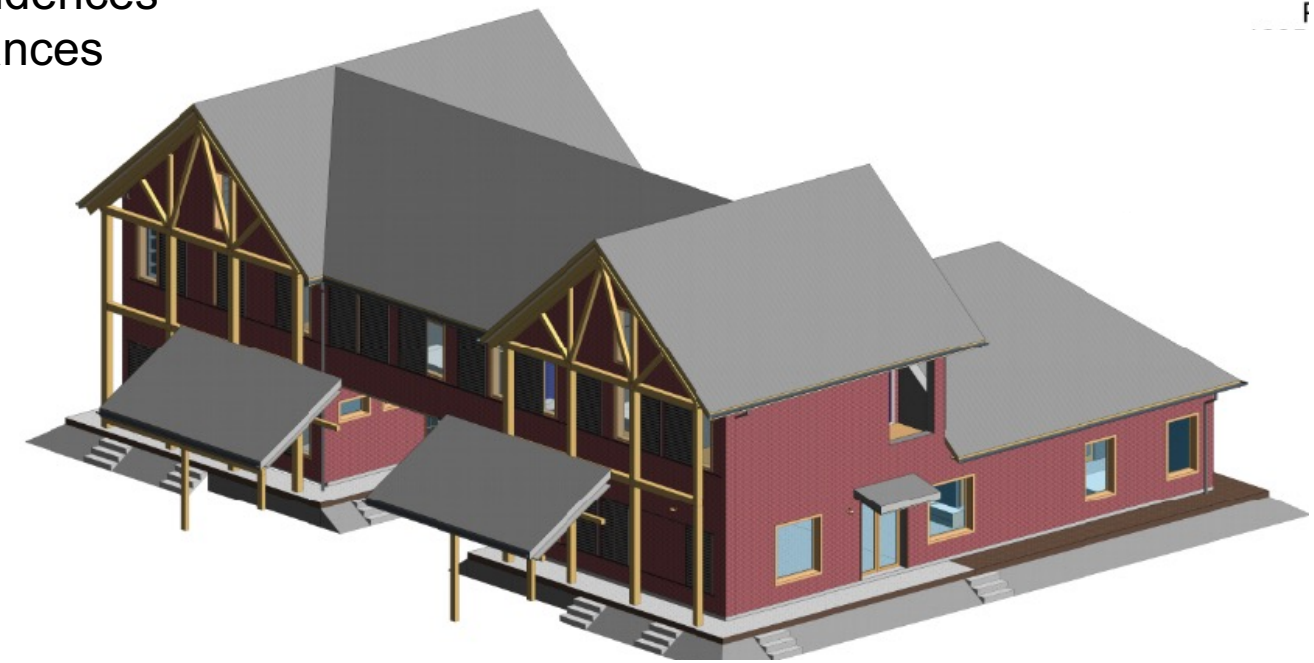
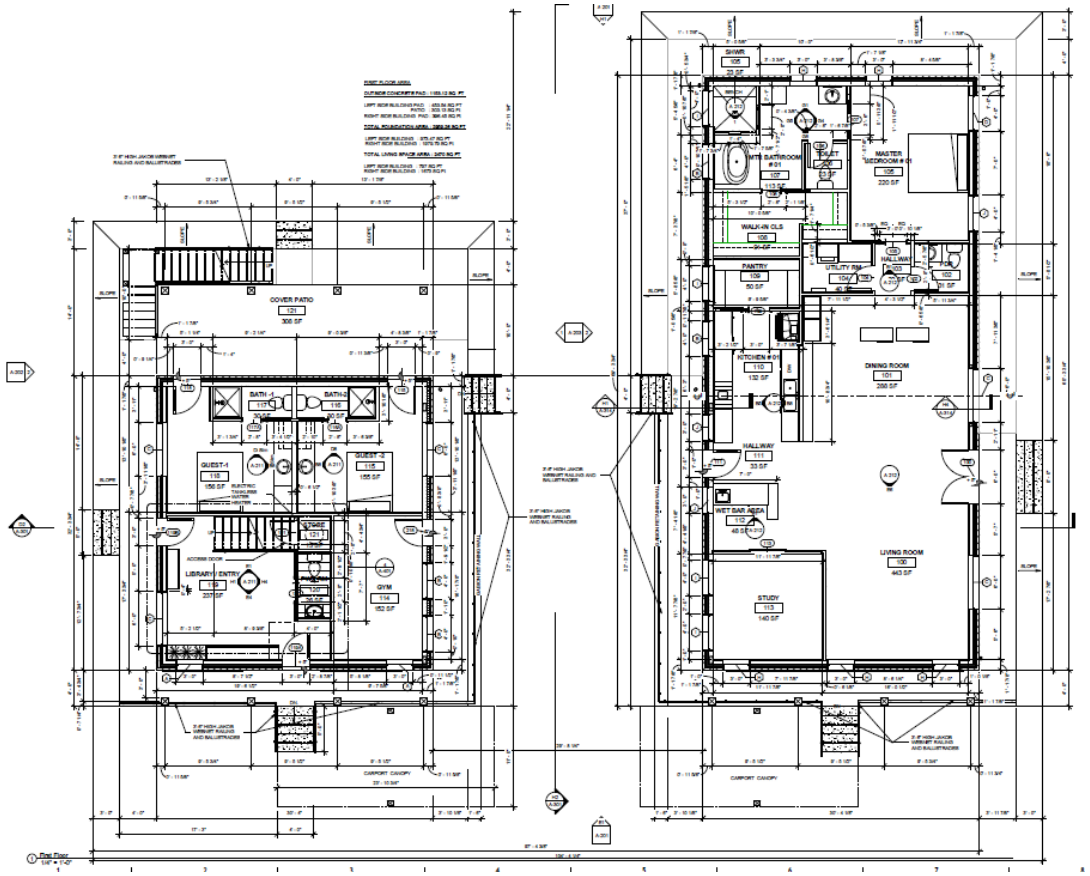


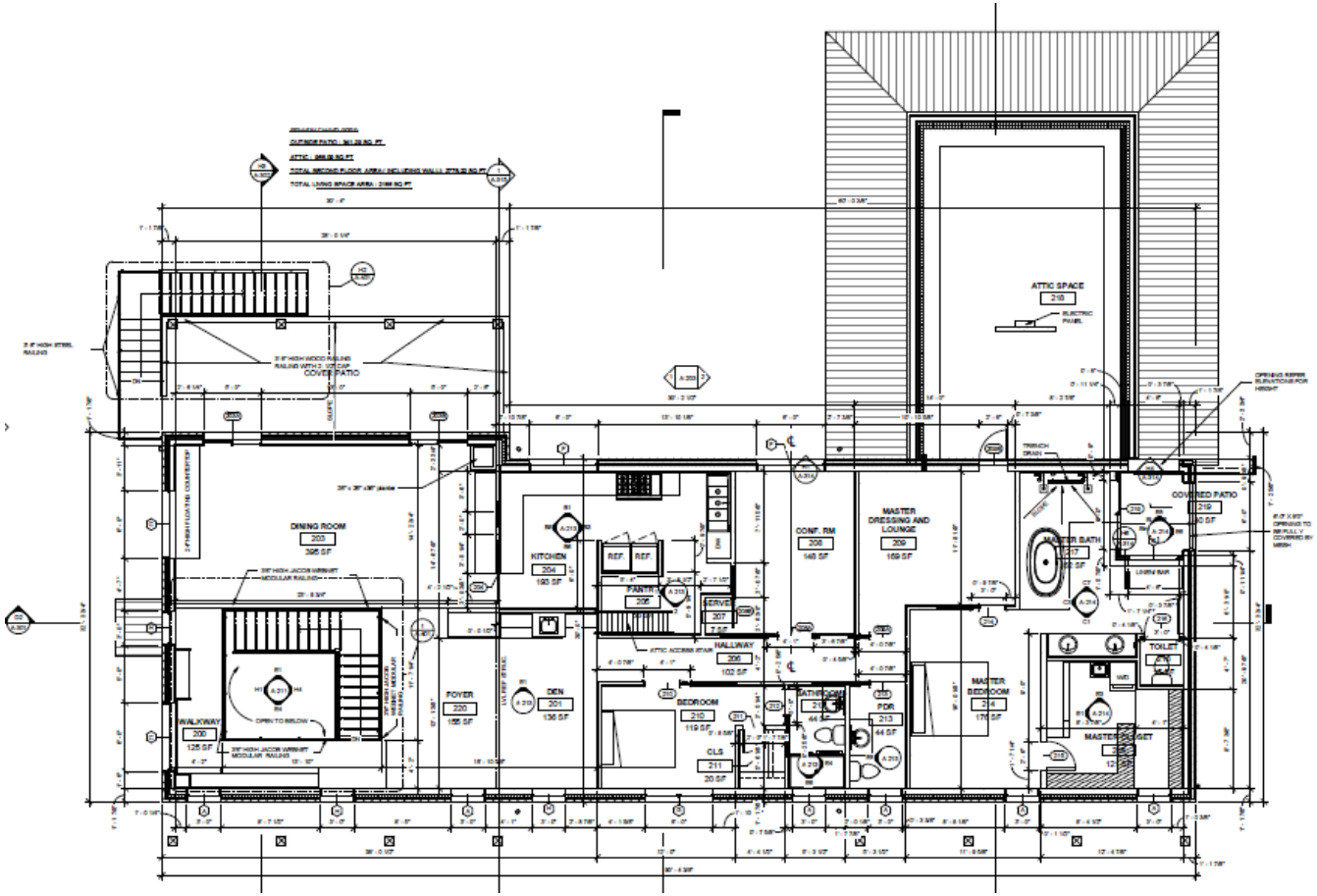
Image courtesy of Mint Homes / Raj Development Corporation

Palm Street Development

1st Floor



2nd Floor



Images courtesy of Mint Homes / Raj Development Corporation

Phius 2021 – Prescriptive

Houston

5 Thermal Enclosure				
5.1.1a	Fenestration / Openings	Maximum Whole U-Value	0.31	(BTU/h.ft^2.°F)
5.1.1b	Walls & Overhang Floors - Effective R-value	Minimum Effective R-Value	23	(ft^2.°F.h/BTU)
5.1.1c	Roofs / Ceilings	Minimum Effective R-Value	53	(ft^2.°F.h/BTU)
5.1.1d	Whole Slab Foundations, Below-Grade Walls, Floors of Conditioned Basements & Crawl Spaces	Minimum Effective R-Value	8	(ft^2.°F.h/BTU)
5.1.1e	Ceilings of Unconditioned Basements or Crawl Spaces & Pier and Beam Floors	Minimum Effective R-Value	13	(ft^2.°F.h/BTU)

Austin

5 Thermal Enclosure				
5.1.1a	Fenestration / Openings	Maximum Whole U-Value	0.26	(BTU/h.ft^2.°F)
5.1.1b	Walls & Overhang Floors - Effective R-value	Minimum Effective R-Value	25	(ft^2.°F.h/BTU)
5.1.1c	Roofs / Ceilings	Minimum Effective R-Value	55	(ft^2.°F.h/BTU)
5.1.1d	Whole Slab Foundations, Below-Grade Walls, Floors of Conditioned Basements & Crawl Spaces	Minimum Effective R-Value	9	(ft^2.°F.h/BTU)
5.1.1e	Ceilings of Unconditioned Basements or Crawl Spaces & Pier and Beam Floors	Minimum Effective R-Value	14	(ft^2.°F.h/BTU)

Dallas

5 Thermal Enclosure				
5.1.1a	Fenestration / Openings	Maximum Whole U-Value	0.24	(BTU/h.ft^2.°F)
5.1.1b	Walls & Overhang Floors - Effective R-value	Minimum Effective R-Value	26	(ft^2.°F.h/BTU)
5.1.1c	Roofs / Ceilings	Minimum Effective R-Value	56	(ft^2.°F.h/BTU)
5.1.1d	Whole Slab Foundations, Below-Grade Walls, Floors of Conditioned Basements & Crawl Spaces	Minimum Effective R-Value	9	(ft^2.°F.h/BTU)
5.1.1e	Ceilings of Unconditioned Basements or Crawl Spaces & Pier and Beam Floors	Minimum Effective R-Value	14	(ft^2.°F.h/BTU)

San Antonio

5 Thermal Enclosure				
5.1.1a	Fenestration / Openings	Maximum Whole U-Value	0.28	(BTU/h.ft^2.°F)
5.1.1b	Walls & Overhang Floors - Effective R-value	Minimum Effective R-Value	24	(ft^2.°F.h/BTU)
5.1.1c	Roofs / Ceilings	Minimum Effective R-Value	54	(ft^2.°F.h/BTU)
5.1.1d	Whole Slab Foundations, Below-Grade Walls, Floors of Conditioned Basements & Crawl Spaces	Minimum Effective R-Value	8	(ft^2.°F.h/BTU)
5.1.1e	Ceilings of Unconditioned Basements or Crawl Spaces & Pier and Beam Floors	Minimum Effective R-Value	13	(ft^2.°F.h/BTU)

Positive Impact Homes: Criteria

Phius 2021
Performance Criteria Calculator v3.2

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION
STATE/ PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HC
Envelope Area (ft²)	12,905.6
iCFA (ft²)	3,200.0
Dwelling Units (Count)	1
Total Bedrooms (Count)	4

Space Conditioning Criteria

Annual Heating Demand	2.8	kBtu/ft²yr
Annual Cooling Demand	19.3	kBtu/ft²yr
Peak Heating Load	3.2	Btu/ft²hr
Peak Cooling Load	4.2	Btu/ft²hr

Source Energy Criteria

Phius CORE	5000	kWh/person.yr
Phius ZERO	0	kWh/person.yr

PHIUS+ 2018
Space Conditioning Criteria Calculator v2

METHOD:	CALCULATOR
UNITS:	IMPERIAL (IP)
STATE / PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HOBBY

Envelope Area (ft²) / iCFA (ft²) **4.03** or enter here: 4.03

iCFA (ft²) / person **640** or enter here: 640

**Calculator method is used for official certification targets.*

Space Conditioning Criteria

Annual Heating Demand	3.4	kBTU/ft²yr
Annual Cooling Demand	24.3	kBTU/ft²yr
Peak Heating Load	3.1	BTU/ft²hr
Peak Cooling Load	5.7	BTU/ft²hr

Typed entry will override sliding scale.
The results of the CALCULATOR method take precedence over the ESTIMATOR method.

Update Reset

Positive Impact Homes: Criteria vs Results

Phius 2021
Performance Criteria Calculator v3.2

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION
STATE/ PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HC

Envelope Area (ft²)	12,905.6
iCFA (ft²)	3,200.0
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Total Bedrooms (Count)	4

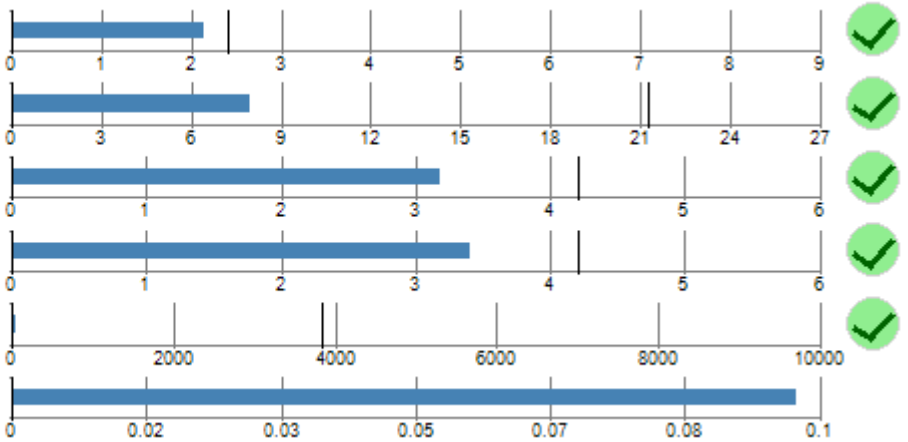
Space Conditioning Criteria

Annual Heating Demand	2.8	kBtu/ft²yr
Annual Cooling Demand	19.3	kBtu/ft²yr
Peak Heating Load	3.2	Btu/ft²hr
Peak Cooling Load	4.2	Btu/ft²hr

Source Energy Criteria

Phius CORE	5000	kWh/person.yr
Phius ZERO	0	kWh/person.yr

Heating demand:	**2.14**	kBtu/ft²yr
Cooling demand:	**7.95**	kBtu/ft²yr
Heating load:	**3.18**	Btu/hr ft²
Cooling load:	**3.4**	Btu/hr ft²
Source energy:	**51**	kWh/Person yr
Site energy:	**0.1**	kBtu/ft²yr



Palm Street: Criteria

Phius 2021
Performance Criteria Calculator v3.2

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION
STATE/ PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HC
Envelope Area (ft²)	16,032.0
iCFA (ft²)	5,254.0
Dwelling Units (Count)	2
Total Bedrooms (Count)	5

Space Conditioning Criteria

Annual Heating Demand	2.7	kBtu/ft²yr
Annual Cooling Demand	19.1	kBtu/ft²yr
Peak Heating Load	3.1	Btu/ft²hr
Peak Cooling Load	4.1	Btu/ft²hr

Source Energy Criteria

Phius CORE	5600	kWh/person.yr
Phius ZERO	0	kWh/person.yr

phius 2021
Performance Criteria Calculator v2

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION
STATE/ PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HC
Envelope Area (ft²)	16,032
iCFA (ft²)	5,254
Dwelling Units (Count)	2
Total Bedrooms (Count)	5

Space Conditioning Criteria

Annual Heating Demand	2.6	kBtu/ft²yr
Annual Cooling Demand	17.3	kBtu/ft²yr
Peak Heating Load	3.1	Btu/ft²hr
Peak Cooling Load	4.0	Btu/ft²hr

Source Energy Criteria

phius CORE	5612	kWh/person.yr
phius ZERO	0	kWh/person.yr

PHIUS+ 2018
Space Conditioning Criteria Calculator v2

METHOD:	CALCULATOR
UNITS:	IMPERIAL (IP)
STATE / PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HOBBY

Envelope Area (ft²) / iCFA (ft²) **3.05** or enter here: 3.05

iCFA (ft²) / person **751** or enter here: 751

**Calculator method is used for official certification targets.*

Space Conditioning Criteria

Annual Heating Demand	3.3	kBTU/ft²yr
Annual Cooling Demand	23.8	kBTU/ft²yr
Peak Heating Load	3.0	BTU/ft²hr
Peak Cooling Load	5.6	BTU/ft²hr

Typed entry will override sliding scale.
The results of the CALCULATOR method take precedence over the ESTIMATOR method.

Update Reset

Palm Street: Criteria vs Results

Phius 2021
Performance Criteria Calculator v3.2

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION
STATE/ PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HC

Envelope Area (ft²)	16,032.0
iCFA (ft²)	5,254.0
Dwelling Units (Count)	2
Total Bedrooms (Count)	5

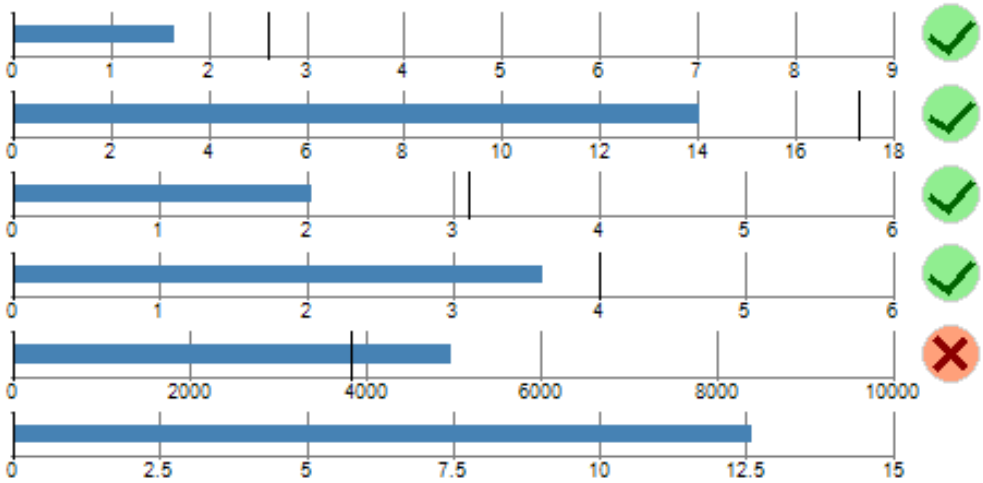
Space Conditioning Criteria

Annual Heating Demand	2.7	kBtu/ft²yr
Annual Cooling Demand	19.1	kBtu/ft²yr
Peak Heating Load	3.1	Btu/ft²hr
Peak Cooling Load	4.1	Btu/ft²hr

Source Energy Criteria

Phius CORE	5600	kWh/person.yr
Phius ZERO	0	kWh/person.yr

Heating demand:	1.65	kBtu/ft²yr
Cooling demand:	14.04	kBtu/ft²yr
Heating load:	2.04	Btu/hr ft²
Cooling load:	3.61	Btu/hr ft²
Source energy:	4,991	kWh/Person yr
Site energy:	12.6	kBtu/ft²yr

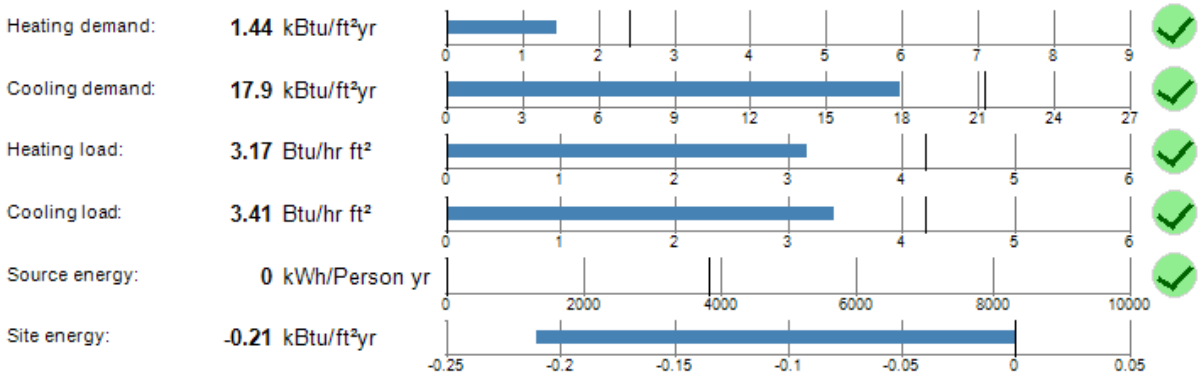


Slab Insulation

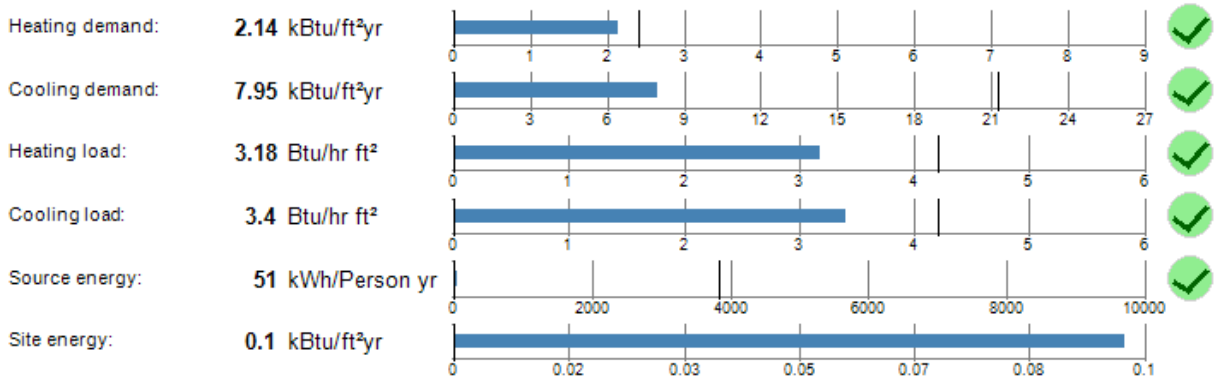
- In many cases, insulation continuous under the slab is not required or even recommended.
- There are some cases where approximately R-8 would provide meaningful results.
  See Phius Prescriptive Requirements

- Situations where this is the case:
  1. Where the building has lower internal and solar gains (benefits less from free ground contact)
  2. In climates where the ground temperature is lower
     *For example: Houston vs Dallas

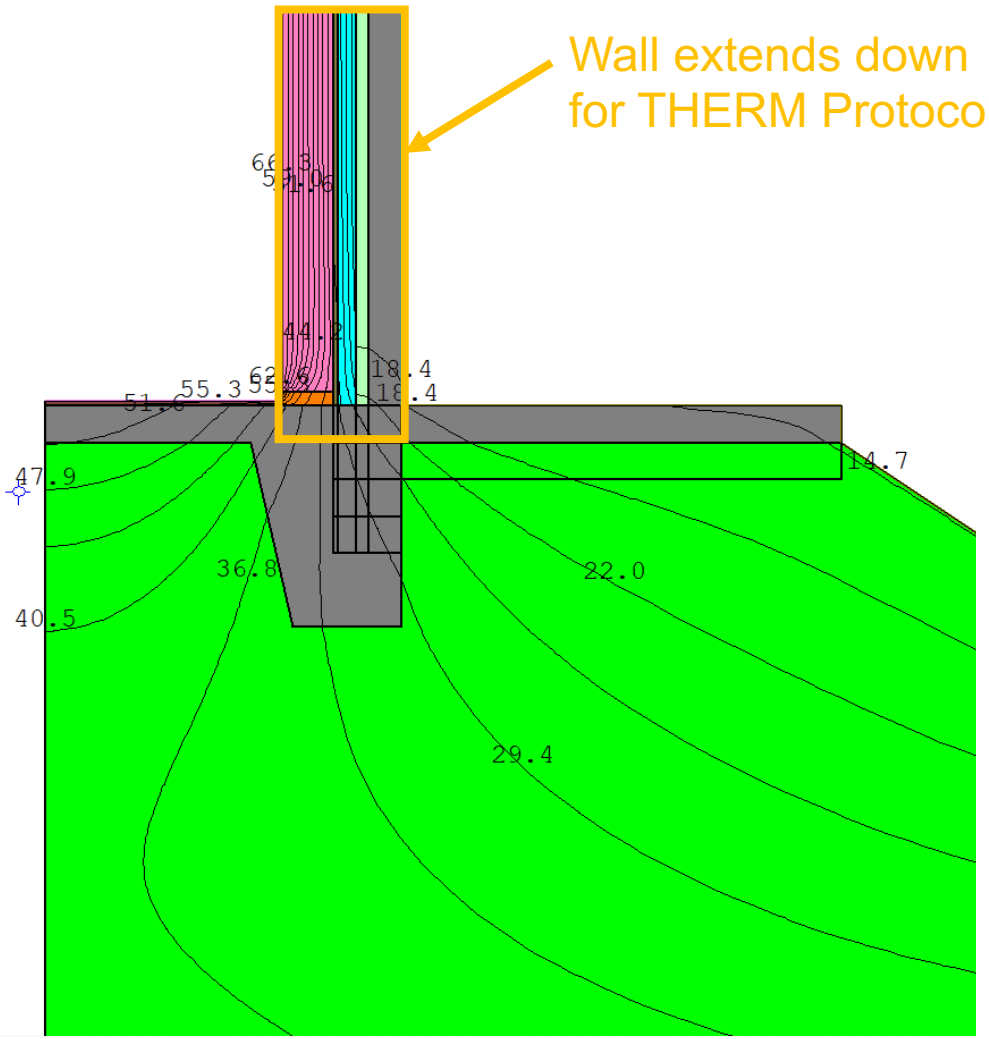
Positive Impact Homes: With R8 Slab Insulation



Positive Impact Homes: Without Slab Insulation



Slab Insulation: Perimeter



No Slab Edge Insulation

WHAT? / WHY!

- Uninsulated slabs have very little thermal resistance.
- The overlap of the wall and slab at the corner creates what is typically called double counting" of the heat loss, but in this case, it replaces concrete with additional insulation.

2D model

	U (btu/hr.sf.F)	dT (F)	L (in)	ULdT [btu/hr.ft]	error (%)
Exterior	0.016	54	468.27	33.72	3.36%
Interior	0.1029	54	73.00	33.80	3.36%

Component

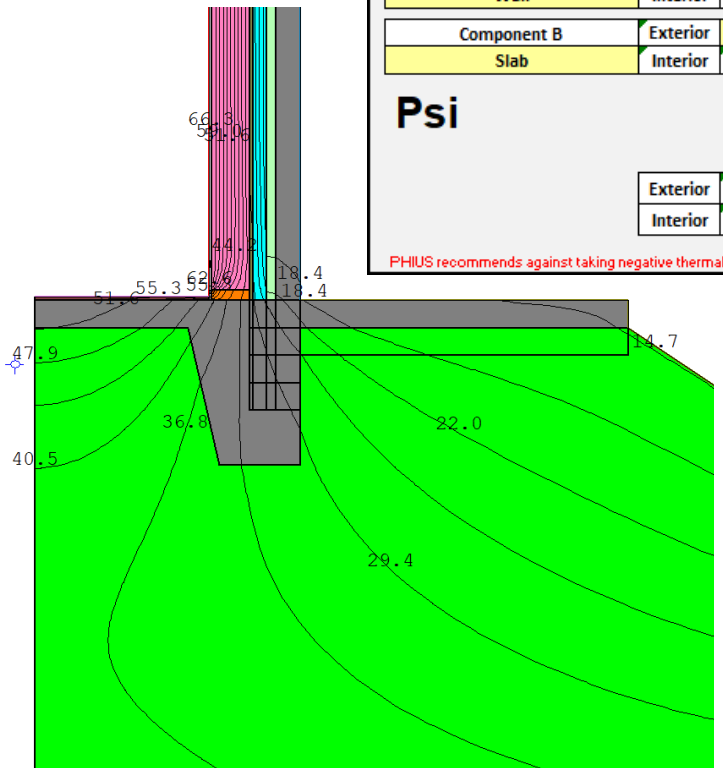
		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT [btu/hr.ft]	error (%)
Component A	Exterior	0.0282	54	52.00	6.60	0.00%
Wall	Interior	0.028	54.00	52.00	6.60	0.00%
Component B	Exterior	0.5823	27	39	51.10	1.36%
Slab	Interior	0.5823	27.00	39.00	51.10	1.36%

Psi

	PsidT (btu/hr.ft)	dT (F)	Psi (btu/hr.ft.F)	Psi for WUFI (btu/hr.ft.F)
Exterior	-23.98	54.00	-0.444	-0.443
Interior	-23.89	54.00	-0.442	

PHIUS recommends against taking negative thermal bridges in the design phase. See Thermal Bridges section in Certification Guidebook.

Slab Insulation: Perimeter



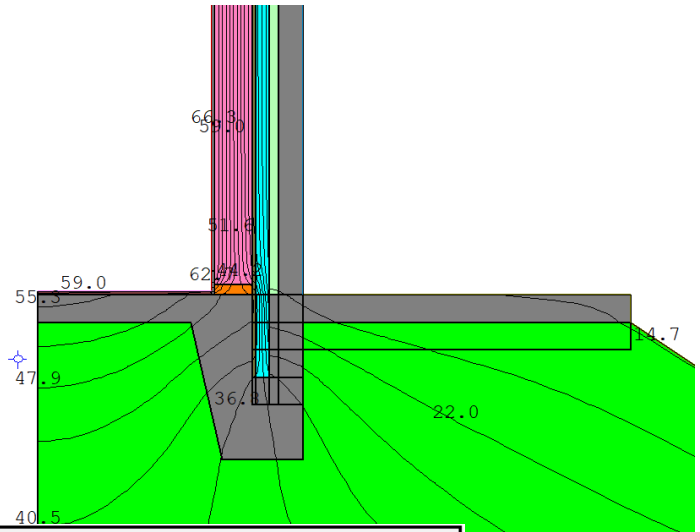
2D model		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT (btu/hr.ft)	error (%)
	Exterior	0.016	54	468.27	33.72	3.36%
	Interior	0.1029	54	73.00	33.80	3.36%

Component		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT (btu/hr.ft)	error (%)
Component A	Exterior	0.0282	54	52.00	6.60	0.00%
Wall	Interior	0.028	54.00	52.00	6.60	0.00%
Component B	Exterior	0.5823	27	39	51.10	1.36%
Slab	Interior	0.5823	27.00	39.00	51.10	1.36%

Psi		PsidT (btu/hr.ft)	dT (F)	Psi (btu/hr.ft.F)	Psi for WUFI (btu/hr.ft.F)
	Exterior	-23.98	54.00	-0.444	-0.443
	Interior	-23.89	54.00	-0.442	

PHIUS recommends against taking negative thermal bridges in the design phase. See Thermal Bridges section in Certification Guidebook.

No Slab Edge Insulation



2D model		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT (btu/hr.ft)	error (%)
	Exterior	0.0133	54	468.27	28.03	4.23%
	Interior	0.0855	54	73.00	28.09	4.23%

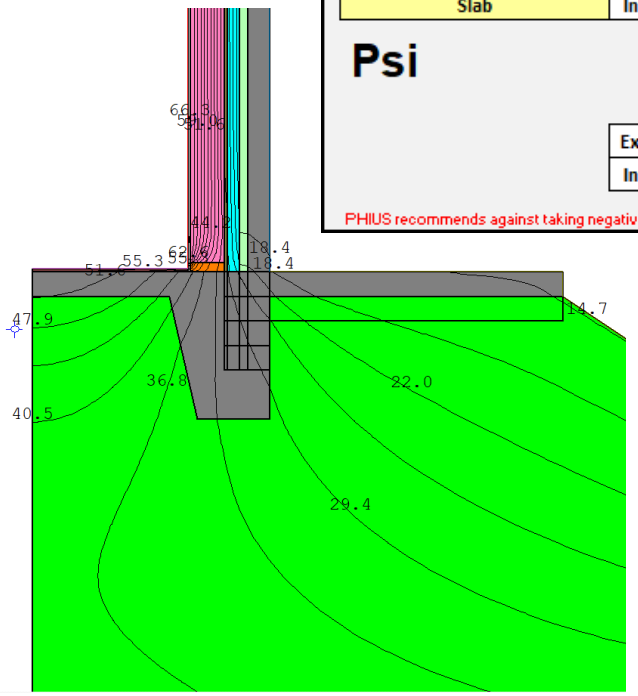
Component		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT (btu/hr.ft)	error (%)
Component A	Exterior	0.0282	54	52.00	6.60	0.00%
Wall	Interior	0.028	54.00	52.00	6.60	0.00%
Component B	Exterior	0.5823	27	39	51.10	1.36%
Slab	Interior	0.5823	27.00	39.00	51.10	1.36%

Psi		PsidT (btu/hr.ft)	dT (F)	Psi (btu/hr.ft.F)	Psi for WUFI (btu/hr.ft.F)
	Exterior	-29.67	54.00	-0.549	-0.549
	Interior	-29.61	54.00	-0.548	

PHIUS recommends against taking negative thermal bridges in the design phase. See Thermal Bridges section in Certification Guidebook.

2” CI Continued Down Past Slab Edge

Slab Insulation: Perimeter



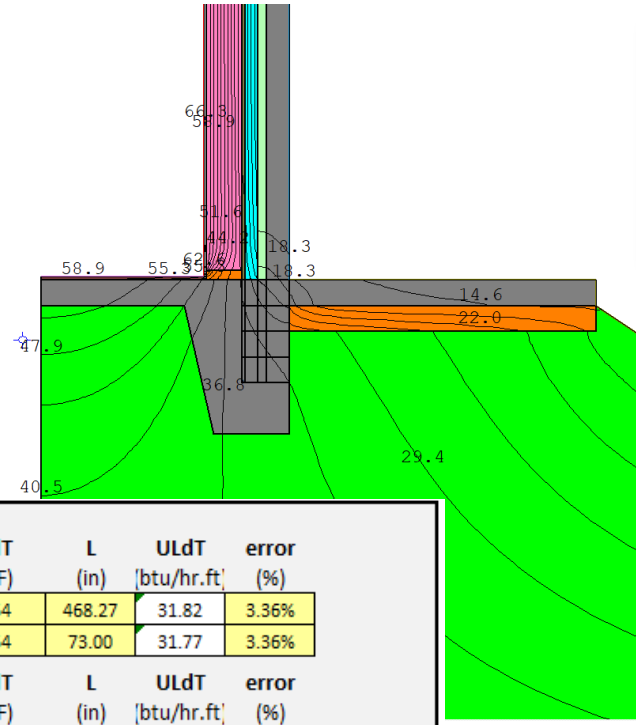
2D model		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT (btu/hr.ft)	error (%)
	Exterior	0.016	54	468.27	33.72	3.36%
	Interior	0.1029	54	73.00	33.80	3.36%

Component		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT (btu/hr.ft)	error (%)
Component A	Exterior	0.0282	54	52.00	6.60	0.00%
Wall	Interior	0.028	54.00	52.00	6.60	0.00%
Component B	Exterior	0.5823	27	39	51.10	1.36%
Slab	Interior	0.5823	27.00	39.00	51.10	1.36%

Psi		PsidT (btu/hr.ft)	dT (F)	Psi (btu/hr.ft.F)	Psi for WUFI (btu/hr.ft.F)
	Exterior	-23.98	54.00	-0.444	-0.443
	Interior	-23.89	54.00	-0.442	

PHIUS recommends against taking negative thermal bridges in the design phase. See Thermal Bridges section in Certification Guidebook.

No Slab Edge Insulation



2D model		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT (btu/hr.ft)	error (%)
	Exterior	0.0151	54	468.27	31.82	3.36%
	Interior	0.0967	54	73.00	31.77	3.36%

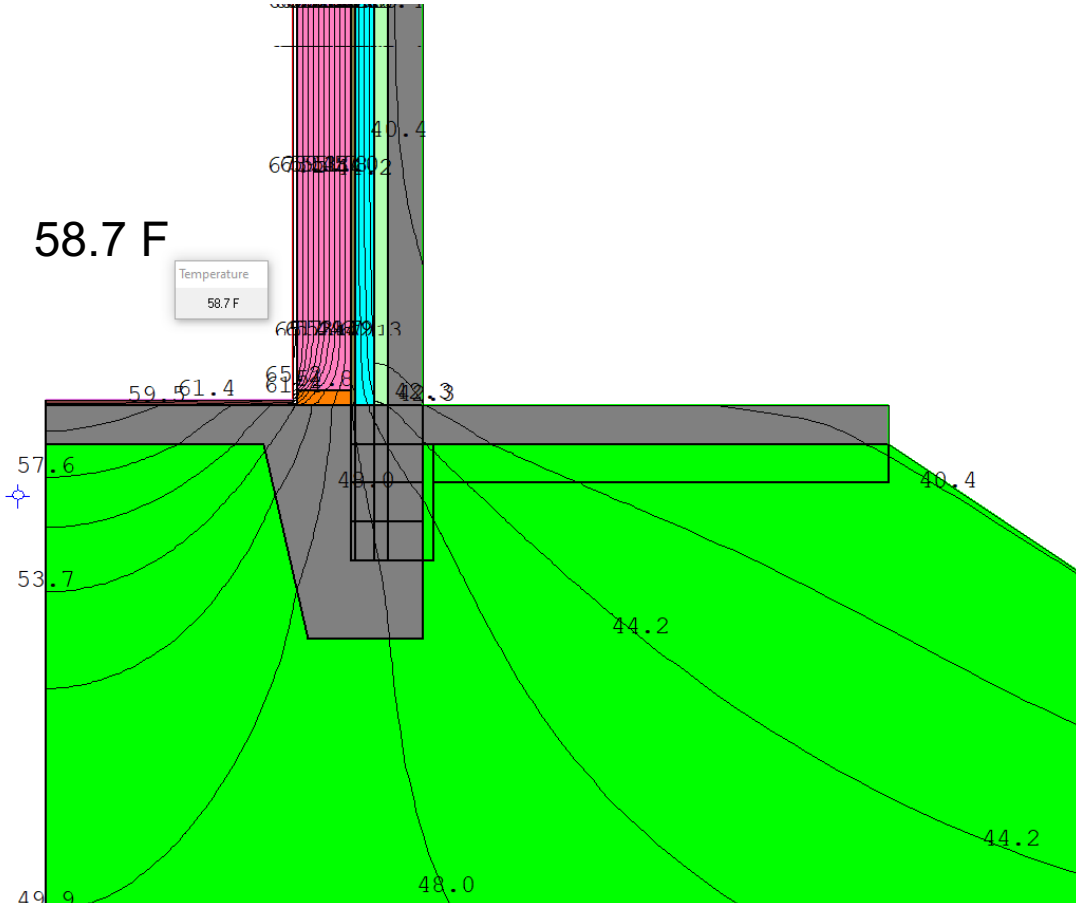
Component		U (btu/hr.sf.F)	dT (F)	L (in)	ULdT (btu/hr.ft)	error (%)
Component A	Exterior	0.0282	54	52.00	6.60	0.00%
Wall	Interior	0.028	54.00	52.00	6.60	0.00%
Component B	Exterior	0.5823	27	39	51.10	1.36%
Slab	Interior	0.5823	27.00	39.00	51.10	1.36%

Psi		PsidT (btu/hr.ft)	dT (F)	Psi (btu/hr.ft.F)	Psi for WUFI (btu/hr.ft.F)
	Exterior	-25.88	54.00	-0.479	-0.480
	Interior	-25.93	54.00	-0.480	

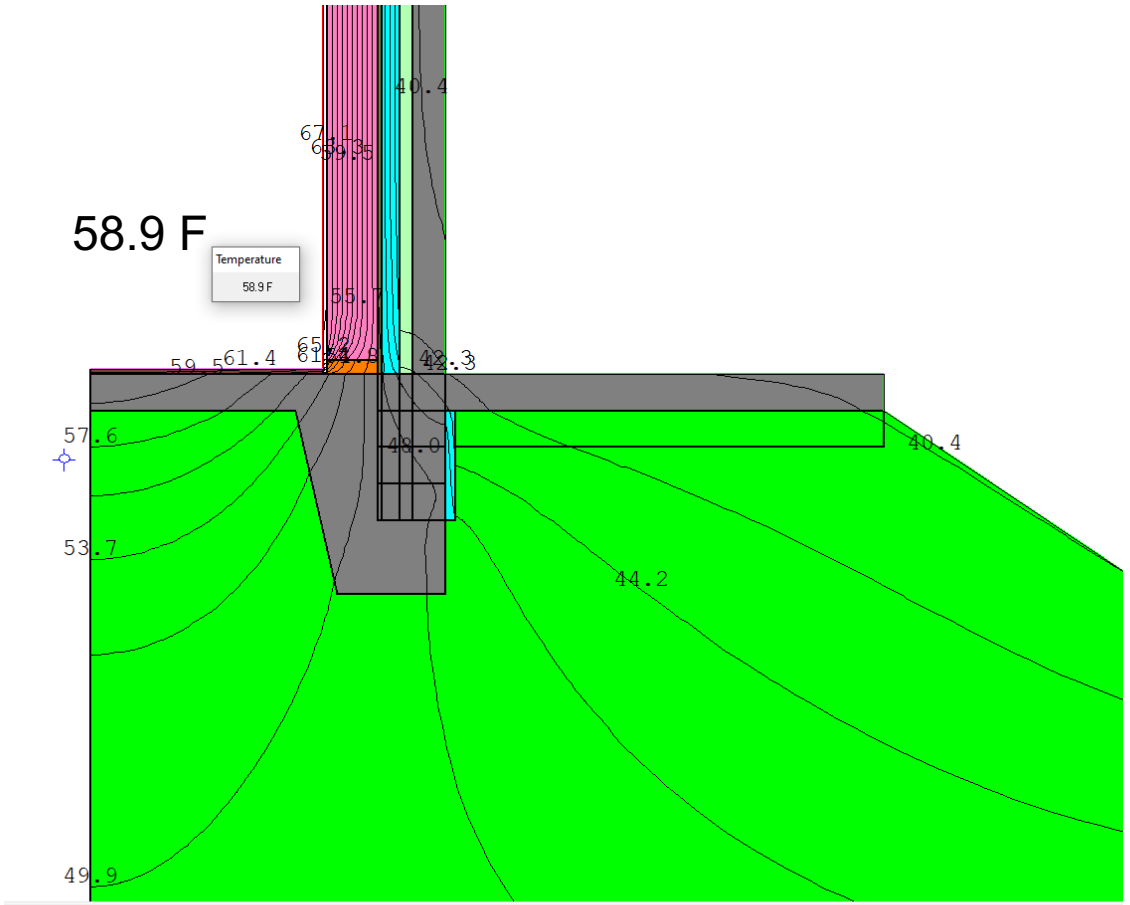
PHIUS recommends against taking negative thermal bridges in the design phase. See Thermal Bridges section in Certification Guidebook.

Glavel Slab Edge Insulation

Slab Insulation: Perimeter

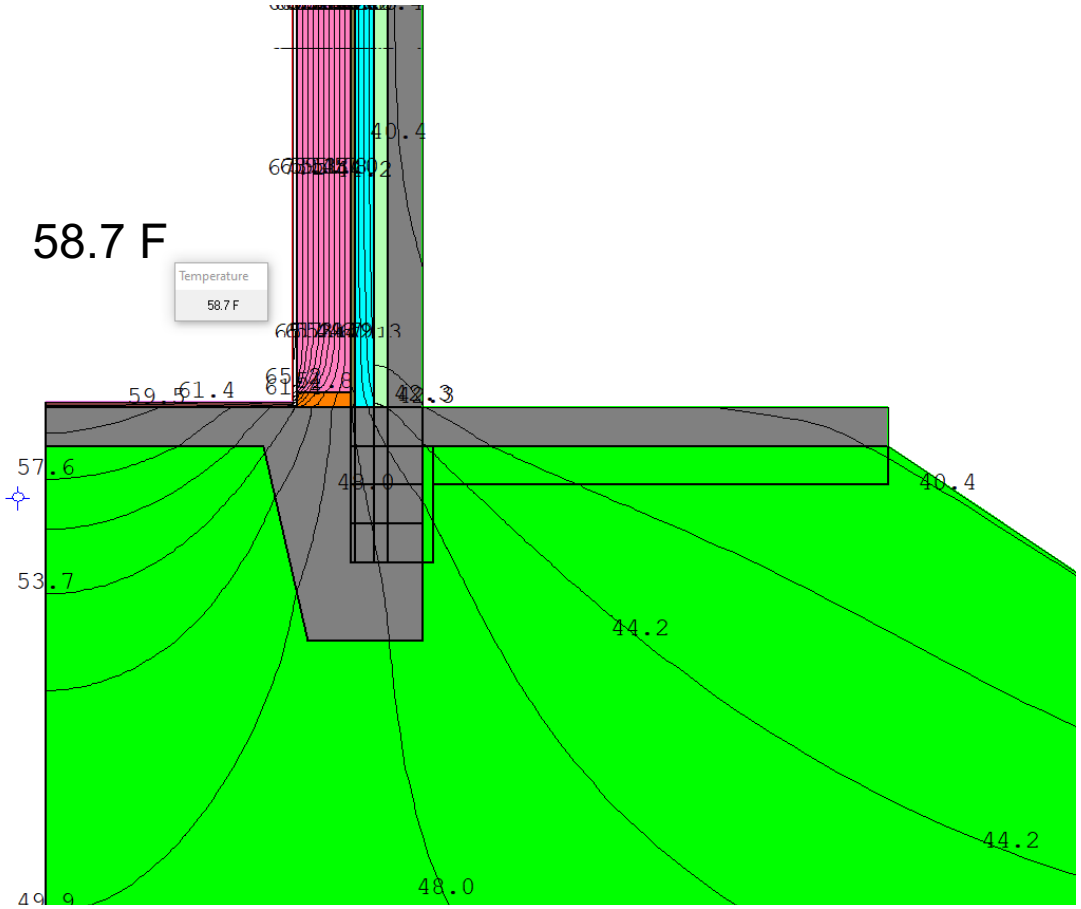


No Slab Edge Insulation

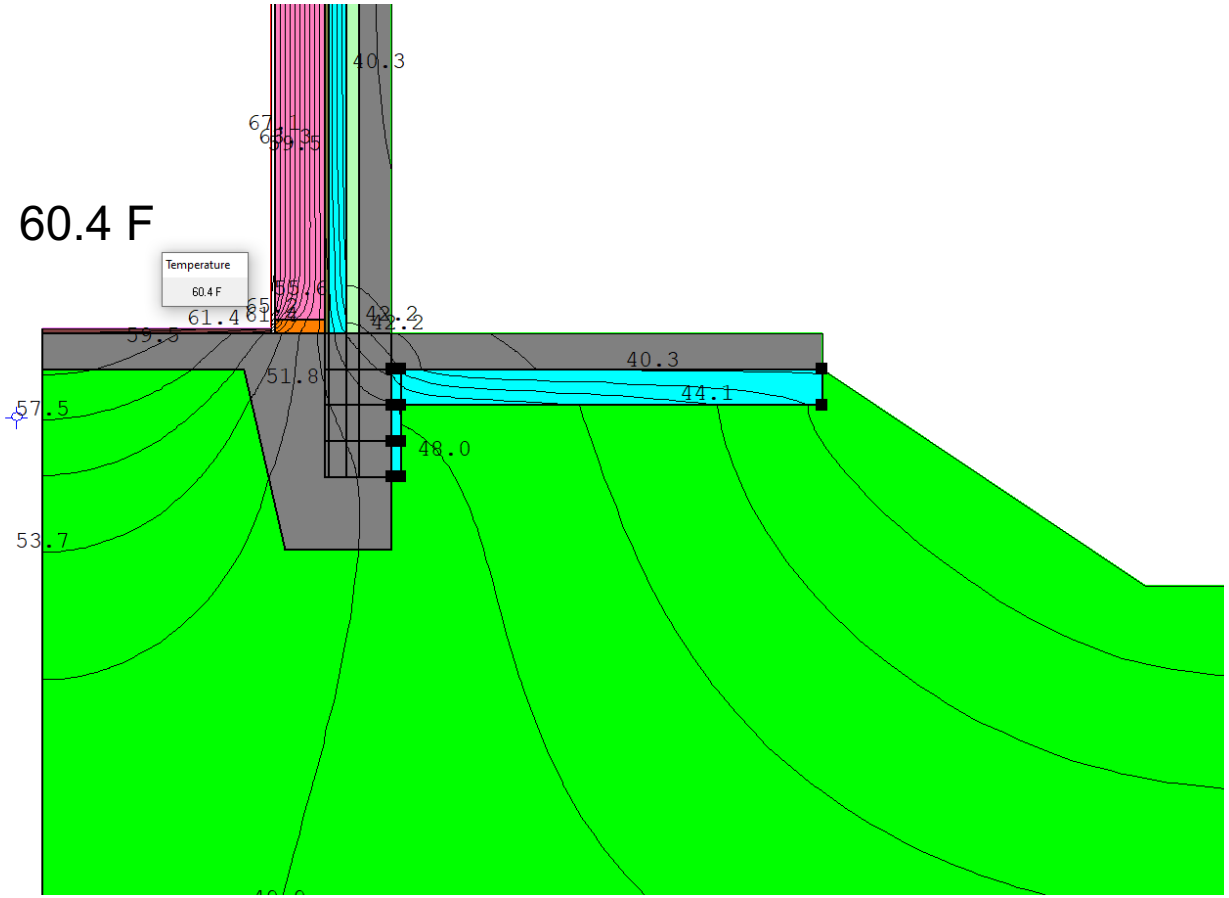


1” Slab Edge Insulation

Slab Insulation: Perimeter



No Slab Edge Insulation



4” of R4 EPS Adjacent to Slab Edge
(1” Vertical R4 EPS)

Slab Insulation: Perimeter

What about WUFI??????

The model was set to have a perimeter insulation depth of 8”, a thickness of 4”, and use R4/in material.

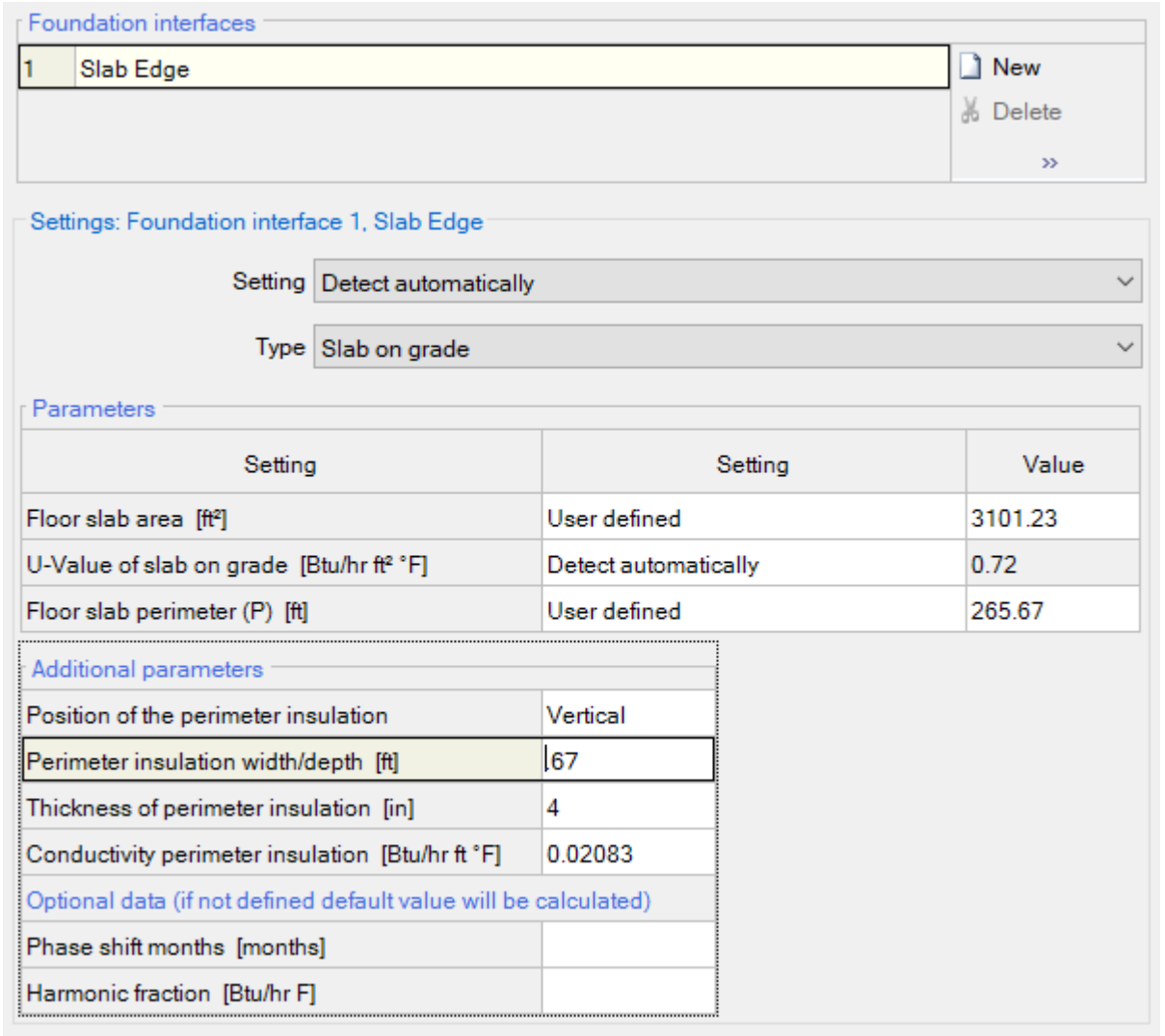
When updated to the following, the model was set to have a perimeter insulation depth of 2’-8”, a thickness of 8”, and use R4/in material the results did not substantially change.

Original:

Heating demand:	**2.14** kBtu/ft²yr
Cooling demand:	**7.95** kBtu/ft²yr
Heating load:	**3.18** Btu/hr ft²
Cooling load:	**3.4** Btu/hr ft²
Source energy:	**51** kWh/Person yr
Site energy:	**0.1** kBtu/ft²yr

2’ Perimeter @ 8” thick:

Heating demand:	**2.1** kBtu/ft²yr
Cooling demand:	**7.92** kBtu/ft²yr
Heating load:	**3.13** Btu/hr ft²
Cooling load:	**3.37** Btu/hr ft²
Source energy:	**49** kWh/Person yr
Site energy:	**0.09** kBtu/ft²yr



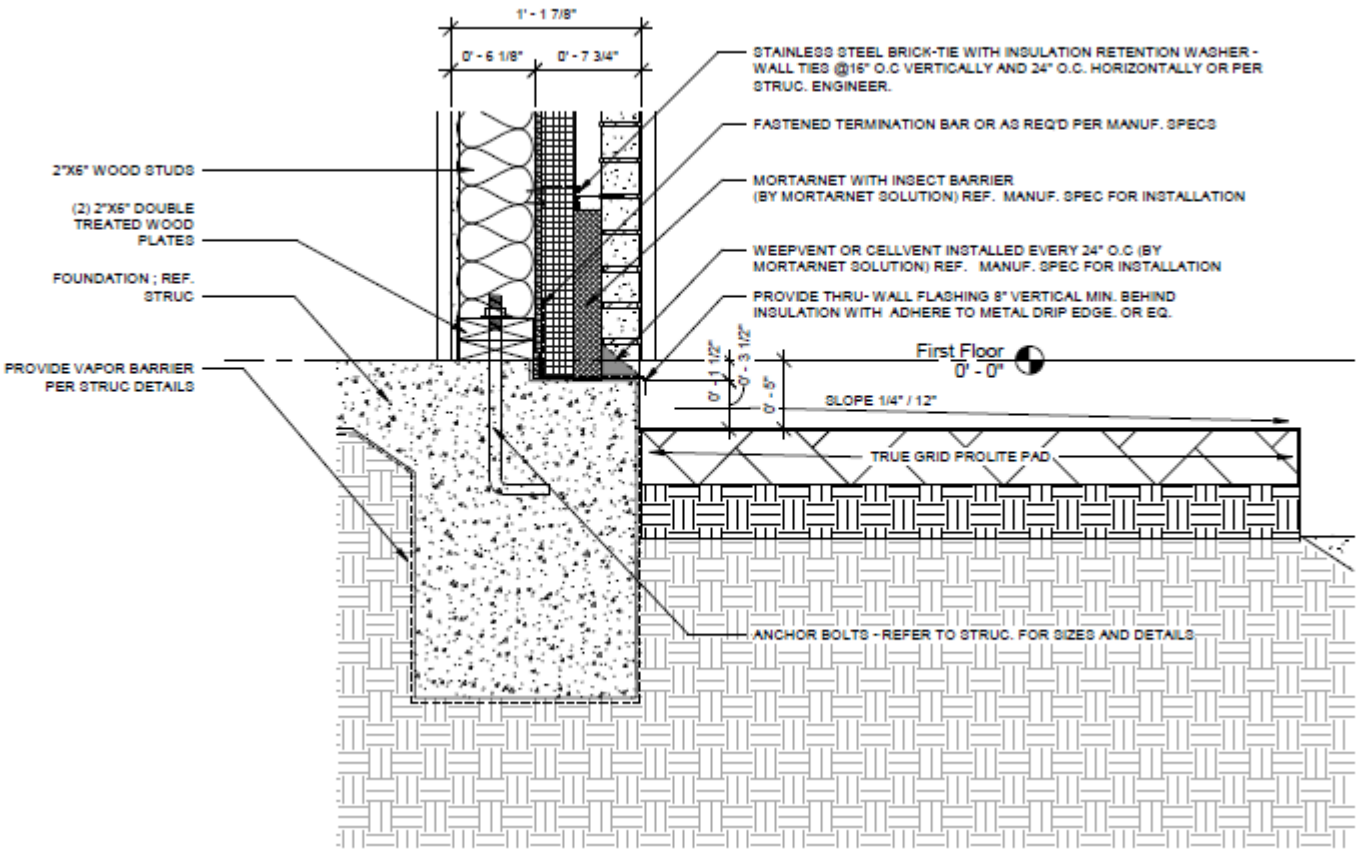
Slab Foundations

Post Tensioned Slabs

- Palm Street is using a post tensioned slab.
- This means the slab edge needs to be exposed to enable the post tensioning.
- This causes constructability issues in regards to perimeter insulation and especially in the ability to use rigid foam as formwork.

Watering the Footing/Foundation

- Building movement and foundation issues caused by soil movement
- Soil expansion and contraction due to variance in moisture levels around the foundation.



Palm Street Detail: Courtesy of Mint Homes

Exterior Wall Approaches

- Target R-Values lead to “No Exotic Materials or Techniques Required”
- “4 City” range for the Prescriptive Path is: R23 – R26
- Framing conservatively (accurately) modeled with a double top plate @ 16” o.c.

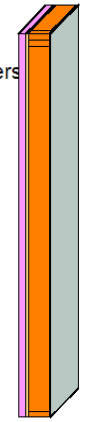
Positive Impact Homes : R30.475

Inhomogenous layers

Thermal resistance: 30.475 / 33.121 hr ft² °F/Btu (EN ISO 6946 / homogenous layers

Heat transfer coefficient (U-value): 0.032 Btu/hr ft² °F

Thickness: 8.625 in



Nr.	Material/Layer (from outside to inside)	ρ [lb/ft³]	c [Btu/lb°F]	λ [Btu/hr ft °F]	Thickness [in]	Color
1	Polyisocyanurate Board	2.03	0.35	0.0139	2	
2	OSB 3 (oriented strand board)	37.14	0.33	0.0606	0.625	
3	FiberGlass 3.6 - Fibre Glass	1.87	0.2	0.0231	5.5	
4	Gypsum Board (USA)	53.06	0.21	0.0942	0.5	

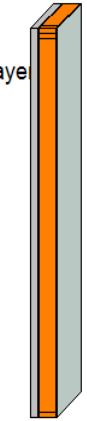
Palm Street: R 29.684

Inhomogenous layers

Thermal resistance: 29.864 / 32.935 hr ft² °F/Btu (EN ISO 6946 / homogenous laye

Heat transfer coefficient (U-value): 0.032 Btu/hr ft² °F

Thickness: 9.125 in



Nr.	Material/Layer (from outside to inside)	ρ [lb/ft³]	c [Btu/lb°F]	λ [Btu/hr ft °F]	Thickness [in]	Color
1	ROXUL FacadeRock	8.43	0.25	0.022	2.5	
2	Plywood (USA)	29.34	0.45	0.0485	0.5	
3	Roxul ComfortBatt	2.25	0.2	0.0208	5.5	
4	Gypsum Board (USA)	53.06	0.21	0.0942	0.625	

Exterior Wall Approaches

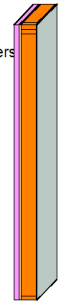
Positive Impact Homes: R30.475

Inhomogenous layers

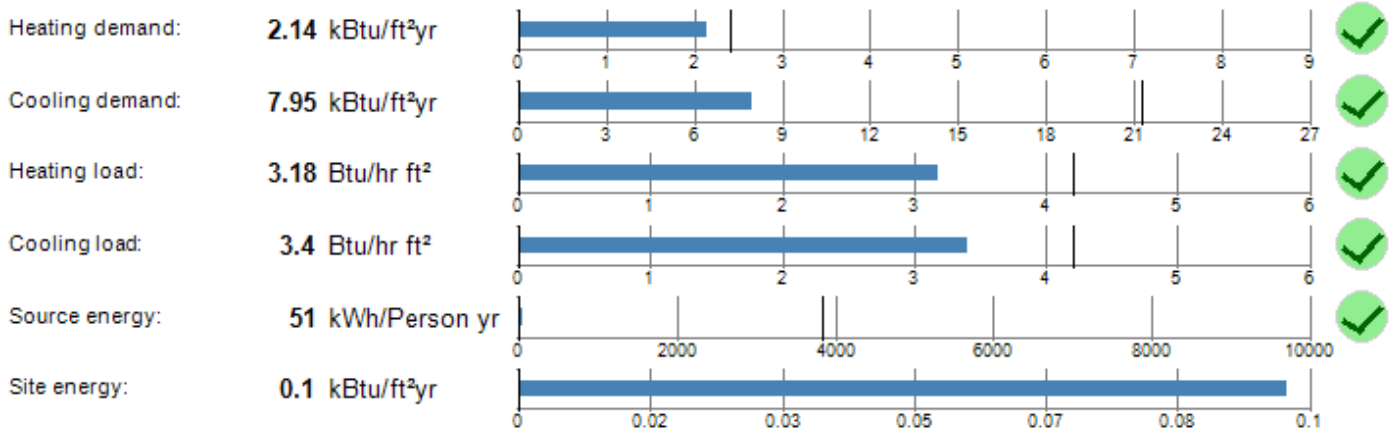
Thermal resistance: 30.475 / 33.121 hr ft² °F/Btu (EN ISO 6946 / homogenous layers

Heat transfer coefficient (U-value): 0.032 Btu/hr ft² °F

Thickness: 8.625 in



Nr.	Material/Layer (from outside to inside)	ρ [lb/ft³]	c [Btu/lb°F]	λ [Btu/hr ft °F]	Thickness [in]	Color
1	Polyisocyanurate Board	2.03	0.35	0.0139	2	
2	OSB 3 (oriented strand board)	37.14	0.33	0.0606	0.625	
3	FiberGlass 3.6 - Fibre Glass	1.87	0.2	0.0231	5.5	
4	Gypsum Board (USA)	53.06	0.21	0.0942	0.5	



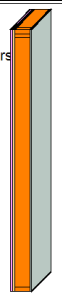
Positive Impact Homes: R 24.358

Inhomogenous layers

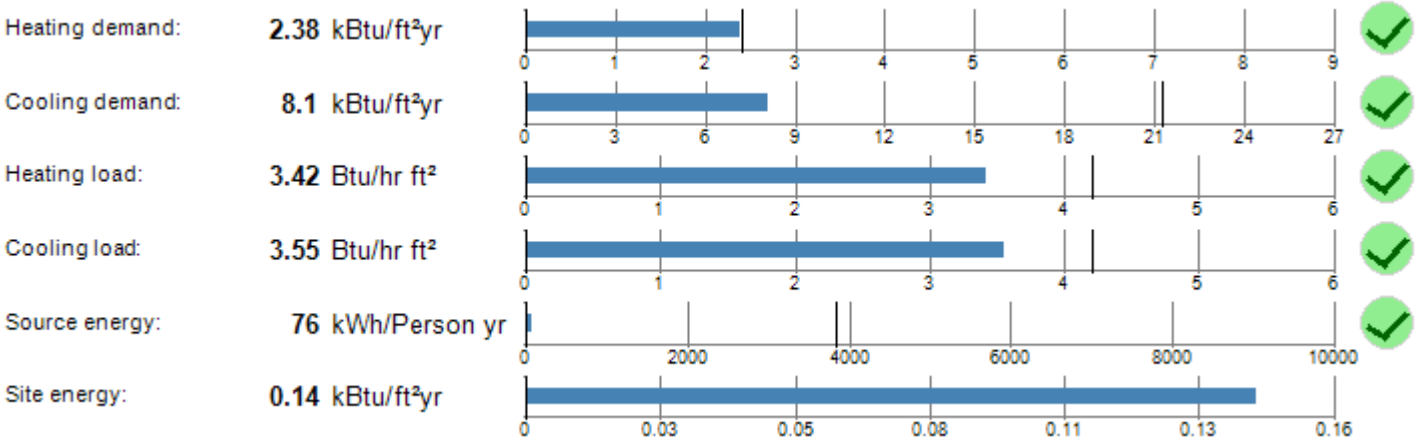
Thermal resistance: 24.358 / 27.111 hr ft² °F/Btu (EN ISO 6946 / homogenous layers

Heat transfer coefficient (U-value): 0.039 Btu/hr ft² °F

Thickness: 7.625 in



Nr.	Material/Layer (from outside to inside)	ρ [lb/ft³]	c [Btu/lb°F]	λ [Btu/hr ft °F]	Thickness [in]	Color
1	Polyisocyanurate Board	2.03	0.35	0.0139	1	
2	OSB 3 (oriented strand board)	37.14	0.33	0.0606	0.625	
3	FiberGlass 3.6 - Fibre Glass	1.87	0.2	0.0231	5.5	
4	Gypsum Board (USA)	53.06	0.21	0.0942	0.5	



Exterior Wall Approaches

Cost:

- 2x6 Framing is standard practice.
- Sheathing is standard as well
- Thin layers of CI are not standard, but fairly easy to accomplish
- 2” of foam can work well with almost all cladding materials
- Difference in cost between 2” and 1” is reasonable and can give advantages to meeting Phius Criteria (See previous slides)

Foam/No Foam

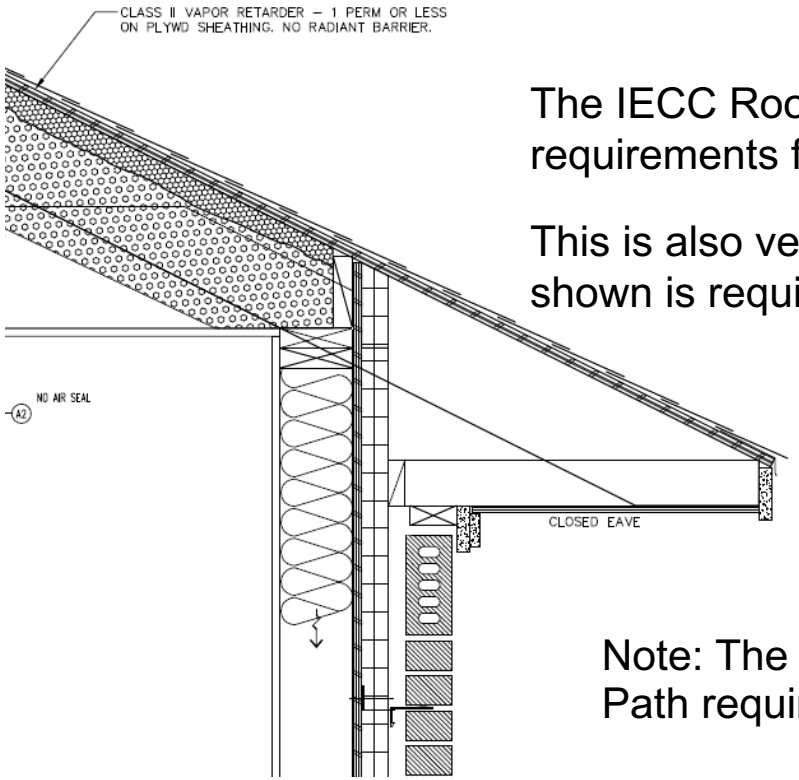
- Embodied Energy and Carbon come into play.
- Palm Street is based on a foam free assembly using rockwool
- Positive Impact Homes uses Polyisocyanurate foam
- Note: polyisocyanurate works very well in warmer climates
- Rockwool requires a thicker layer to get to equivalent R-values than some foam products.

All in one panel solutions:

- ZIP R Sheathing can be an excellent solution, the R9 panel would generally meet the requirements for Phius Certification (with 2x6 insulated framing)
- EPS “nailbase” panels are also an option and have roof applications (more on this soon)

Roof Approaches

Positive Impact Homes:
Insulation under the roof deck
Spray polyurethane foam, AeroBarrier
R40 Estimated

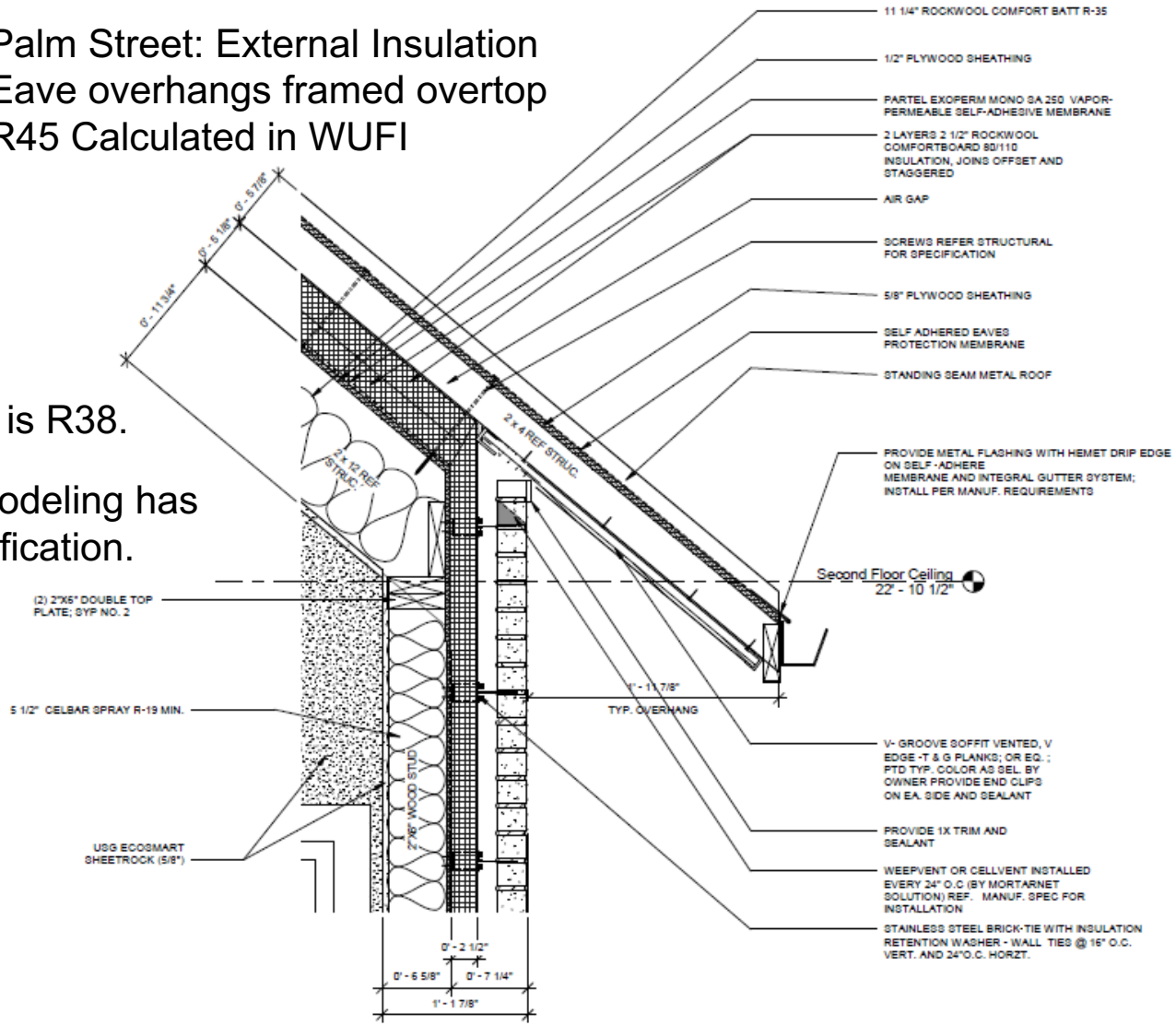


The IECC Roof Insulation requirements for Climate Zone 2 is R38.

This is also very close to what modeling has shown is required for Phius Certification.

Note: The Phius Prescriptive Path requires approx. R55

Palm Street: External Insulation
Eave overhangs framed overtop
R45 Calculated in WUFI



Windows

Performance criteria for windows in a predominately cooling climate are highly varied.
Like in colder climates, the best thing to do is to have excellent shading control for passive solar gain in the winter and complete shading in the summer.

U-values in the Prescriptive Path vary from: U 0.24 (Dallas) to U 0.31 (Houston)
The WUFI model results shown to this point vary from U 0.2 to U 0.25

Glazing specifications is still a balance as it gets cold enough to warrant some passive solar gain, but for the majority of the year strategies to limit gain is best.

- Limit West Windows
- North Windows

SHGC vs U-value vs Shading

- The better shading you have, the higher SHGC would be possible.
- SHGC is VERY Important. In testing, a SHGC reduction from .3 to .25 allowed the window to go from U .2 to U .5 and achieve the same cooling demand.
- Heating Performance suffered in the above example.

Triple Pane windows for acoustics, better performance, etc.

- Watch code requirements for SHGC (NFRC vs Center of Glass)

Phius 2018 (+V2) vs Phius 2021

Phius 2021
Performance Criteria Calculator v3.2

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION
STATE/ PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HC
Envelope Area (ft²)	16,032.0
iCFA (ft²)	5,254.0
Dwelling Units (Count)	2
Total Bedrooms (Count)	5

Space Conditioning Criteria

Annual Heating Demand	2.7	kBtu/ft²yr
Annual Cooling Demand	19.1	kBtu/ft²yr
Peak Heating Load	3.1	Btu/ft²hr
Peak Cooling Load	4.1	Btu/ft²hr

Source Energy Criteria

Phius CORE	5600	kWh/person.yr
Phius ZERO	0	kWh/person.yr

phius 2021
Performance Criteria Calculator v2

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION
STATE/ PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HC
Envelope Area (ft²)	16,032
iCFA (ft²)	5,254
Dwelling Units (Count)	2
Total Bedrooms (Count)	5

Space Conditioning Criteria

Annual Heating Demand	2.6	kBtu/ft²yr
Annual Cooling Demand	17.3	kBtu/ft²yr
Peak Heating Load	3.1	Btu/ft²hr
Peak Cooling Load	4.0	Btu/ft²hr

Source Energy Criteria

phius CORE	5612	kWh/person.yr
phius ZERO	0	kWh/person.yr

PHIUS+ 2018
Space Conditioning Criteria Calculator v2

METHOD:	CALCULATOR
UNITS:	IMPERIAL (IP)
STATE / PROVINCE	TEXAS
CITY	HOUSTON WILLIAM P HOBBY
Envelope Area (ft²) / iCFA (ft²)	3.05 (or enter here: 3.05)
iCFA (ft²) / person	751 (or enter here: 751)

**Calculator method is used for official certification targets.*

Space Conditioning Criteria

Annual Heating Demand	3.3	kBTU/ft²yr
Annual Cooling Demand	23.8	kBTU/ft²yr
Peak Heating Load	3.0	BTU/ft²hr
Peak Cooling Load	5.6	BTU/ft²hr

Typed entry will override sliding scale.
The results of the CALCULATOR method take precedence over the ESTIMATOR method.

Update Reset

Cooling has tightened significantly while heating has tightened marginally. Source Energy is just different!

Comfort in Cooling Climates

- With a high degree of certainty, I will state that Point Source Cooling is NOT EFFECTIVE
  (while point source heating often is – or can be)
- Distribution of cooling energy (and probably heating energy too) should be ducted to each room
  Central AHU not necessarily required.
  Ducted mini-splits with short runs located in conditioned attic may be sufficient pending overall design constraints.

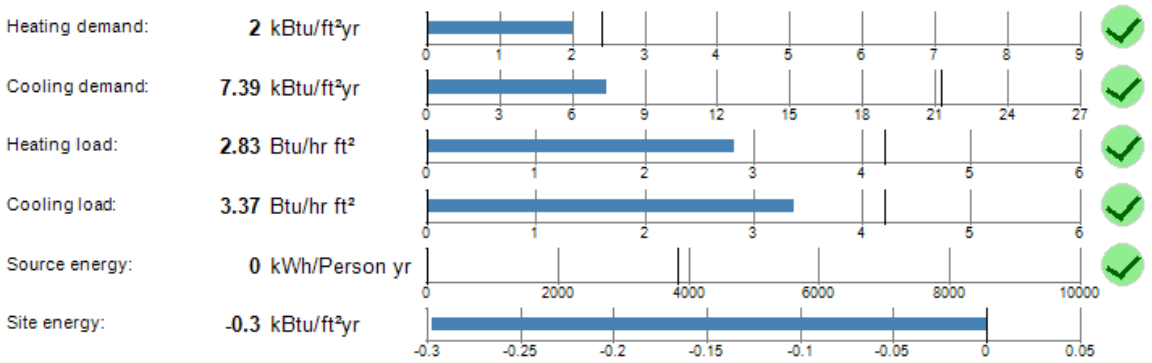
Questions - that need some more clarifying, discussion, or research:

- Impact of glass surface temperature for thermal comfort – “Mean Radiant Temperature”
- Dedicated dehumidification required?
- Effects of air leakage, stratification and air movement.
  Ceiling fans being planned for in both projects.

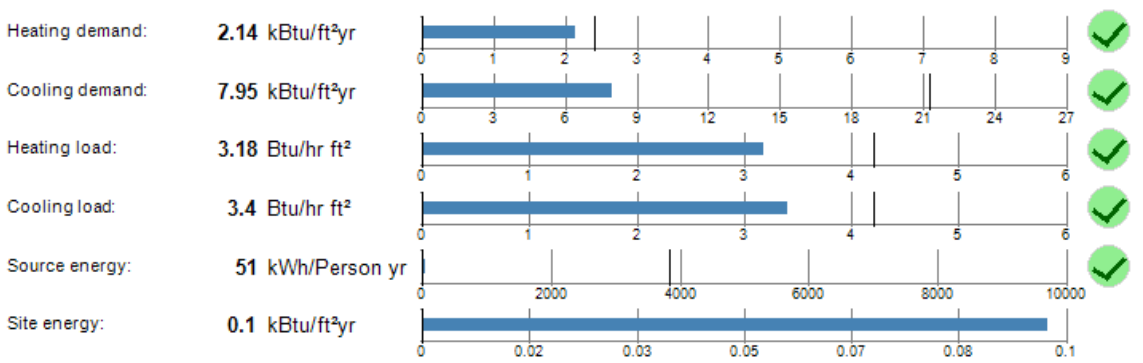
Airtightness

Baseline Target

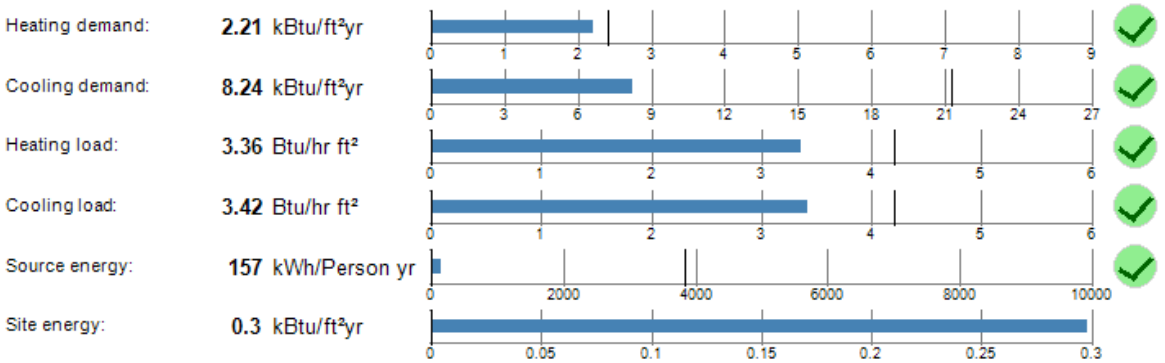
0.03 CFM50 / .48 ACH



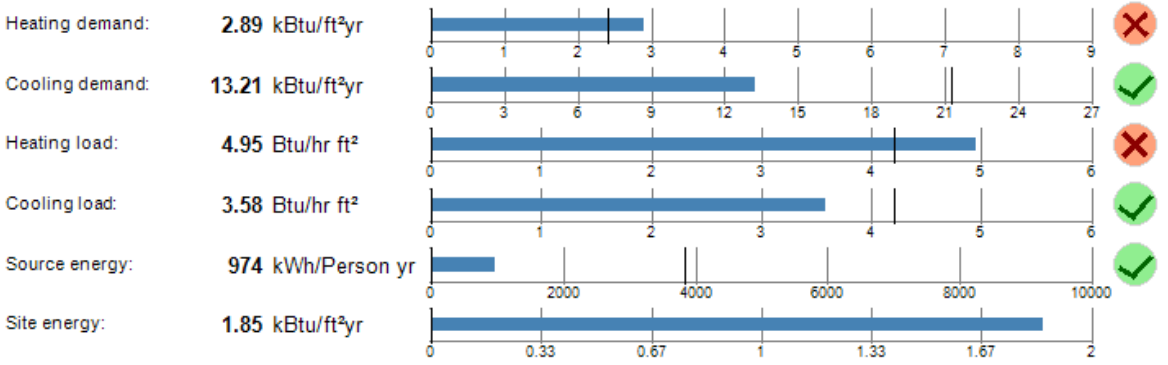
0.05 CFM50 / .81 ACH



0.06 CFM50 / .97 ACH



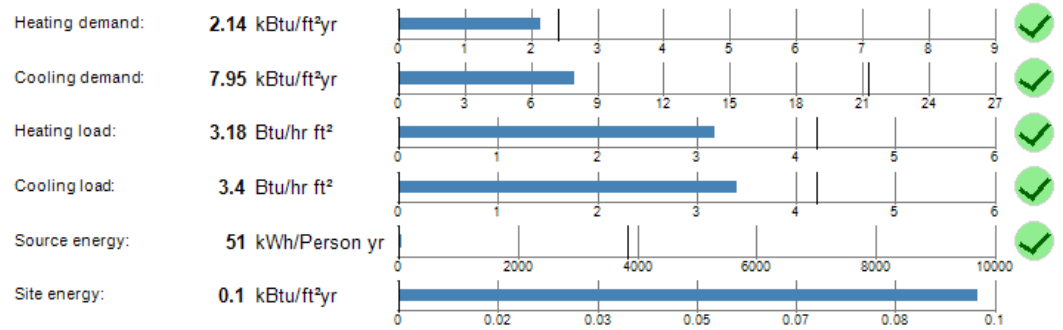
0.15 CFM50 / 2.42 ACH



Ventilation

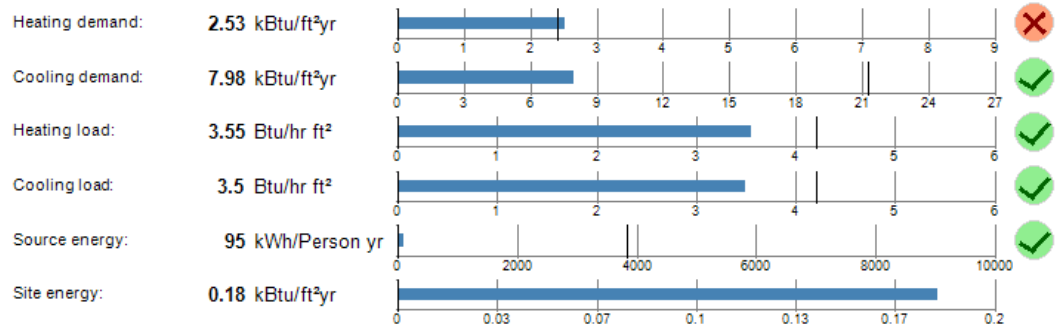
Baseline:

Sensible recovery efficiency [-]	.8
Humidity recovery efficiency [-]	.68
Electric efficiency [W/cfm]	.5



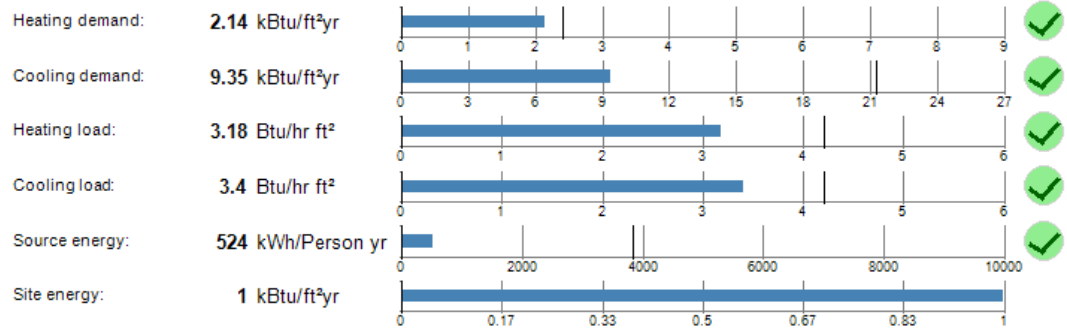
Lower Sensible Recovery:

Sensible recovery efficiency [-]	.6
Humidity recovery efficiency [-]	.68
Electric efficiency [W/cfm]	.5



Lower Humidity Recovery:

Sensible recovery efficiency [-]	.8
Humidity recovery efficiency [-]	.5
Electric efficiency [W/cfm]	.5



Zero Humidity Recovery = Cooling Demand @ 13.4 kBtu/ft²yr!

DHW

Large buildings and slab on grade construction leads to longer DHW piping runs and wait times for hot water (ZERH requirement can be challenging).

Preference to:

On-demand recirculation systems

Instantaneous water heaters for specific locations

Hot water heaters sometimes located in attics to save space on main floor

Heat Pump Water Heater inside vs Split system:

Non Split HPWH provide free cooling inside the project.

This is a big advantage compared to the split system.

The cost is substantially less as well and easier to replace.

Acoustics and cold air distribution / location of the HPWH are a concern.

System Considerations

System Requirements:

Heating, Cooling, Dehumidification

Both projects plan on using Mini-Split Heat Pump technologies as the primary heating and cooling system.

Dehumidification is being specified using a dedicated dehumidifier and duct system

Positive Impact Homes is specifying an additional air filtration system in addition to the filters on the rest of the mechanical equipment

Electrification

Both projects are pursuing full electrification, but there are some issues.

Backup Energy

A main drawback to full electrification is the requirement for backup and resiliency. This is especially a concern regarding recent events with grid outages during frosts and hurricane season.
For this reason, Positive Impact Homes has been specifying Natural Gas supply or Propane Tank for a backup generator.

System Considerations

PV Potential:

Houston: 20deg Tilt

Houston Tx
» Change Location
English Español | HELP | FEEDBACK
RESULTS

RESULTS

Print Results

14,113 kWh/Year*

m 13,653 to 14,493 kWh per year near this location.

Click HERE for more information.

Month	AC Energy (kWh)
January	901
February	956
March	1,196
April	1,303
May	1,346
June	1,337
July	1,343
August	1,311
September	1,271
October	1,239
November	992
December	917
Annual	14,112

Houston: 40deg Tilt

English Español | HELP | FEEDBACK
RESULTS

13,990 kWh/Year*

13,534 to 14,366 kWh per year near this location.

Click HERE for more information.

AC Energy (kWh)
1,024
1,041
1,204
1,224
1,191
1,146
1,178
1,211
1,260
1,324
1,121
1,063
13,987

Chicago: 40deg Tilt

Chicago IL
» Change Location
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RESOURCE DATA | SYSTEM INFO | RESULTS

RESULTS

Print Results

13,291 kWh/Year*

System output may range from 12,724 to 13,848 kWh per year near this location.

Click HERE for more information.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)
January	2.96	797
February	3.87	912
March	4.79	1,209
April	5.38	1,292
May	5.41	1,299
June	5.94	1,336
July	6.06	1,371
August	5.91	1,330
September	5.47	1,214
October	4.32	1,045
November	3.30	815
December	2.52	672
Annual	4.66	13,292

Project Teams

Where are all the Rater/Verifiers?

Grand total of:

3 Phius Raters in Texas

(1 each in Houston, Austin, Dallas)

0 Phius Verifiers in Texas

Builders?

If we remove the listings with 3+ States served, there are:

11 Phius Certified Builders in Texas

Questions?

Thank You!

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