Integrating Passive House Standards with CALGreen forMultifamily Buildings — Across California's Climate Zones

Sponsored by:

PHCA PASSIVE HOUSE CALIFORNIA

3C-REN TRI-COUNTY REGIONAL ENERGY NETWORK
SAN LUIS OBISPO • SANTA BARBARA • VENTURA

PASSIVE HOUSE CALIFORNIA

PassiveHouseCal.org

The Passive House Network

International PASSIVE HOUSE Association iPHA

Passive House Institute

Thank You

TRI-COUNTY REGIONAL ENERGY NETWORK

SAN LUIS OBISPO • SANTA BARBARA • VENTURA

Thank You

Gold Sponsor

SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead®

· Silver Sponsors ·

SMALL PLANET SUPPLY
Building the World of High Performance

MINOTAIR
All-in-one HVAC/D units

ROCKWOOL

Supporters


475
HIGH PERFORMANCE
BUILDING SUPPLY
FOURSEVENFIVE.COM


MITSUBISHI
ELECTRIC
Cooling and Heating Solutions


FGA
FERGUS·GARBER·ARCHITECTS


Construction Progress
CPHBA
for Home, Building, and Automation
Expert
Partner
warema


PETE MOFFAT
CONSTRUCTION


THE HEINRICH TEAM
HOME | FAMILY | COMMUNITY


EARTH BOUND
HOMES


Rheem


PROSOCO


HAYWARD
SO YOU CAN BUILD


GOODSPACE
HIGH PERFORMANCE BUILDERS

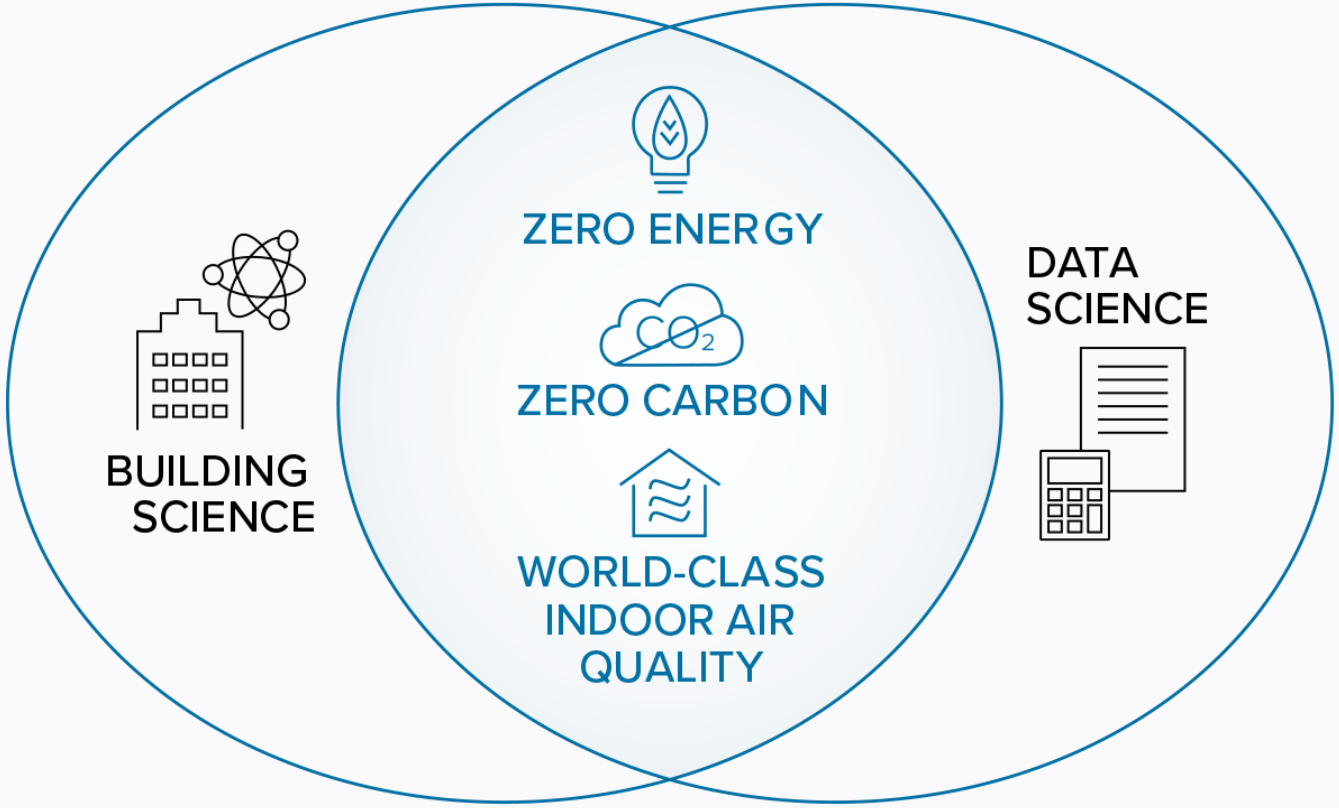

STIEBEL ELTRON
Simply the Best

AUROS GROUP

BUILDING PERFORMANCE. CONNECTED.

An Affordable Path to Zero Anything…

… requires both building science and data science



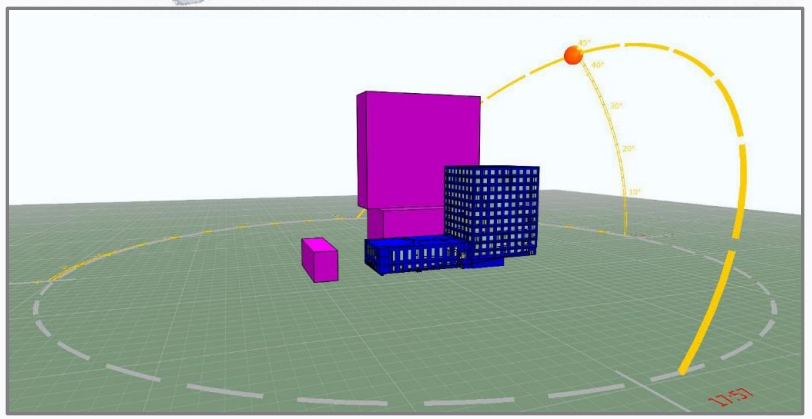
Metrics, Not Narratives

What will owners measure in operations? What defines success?

Change the Process

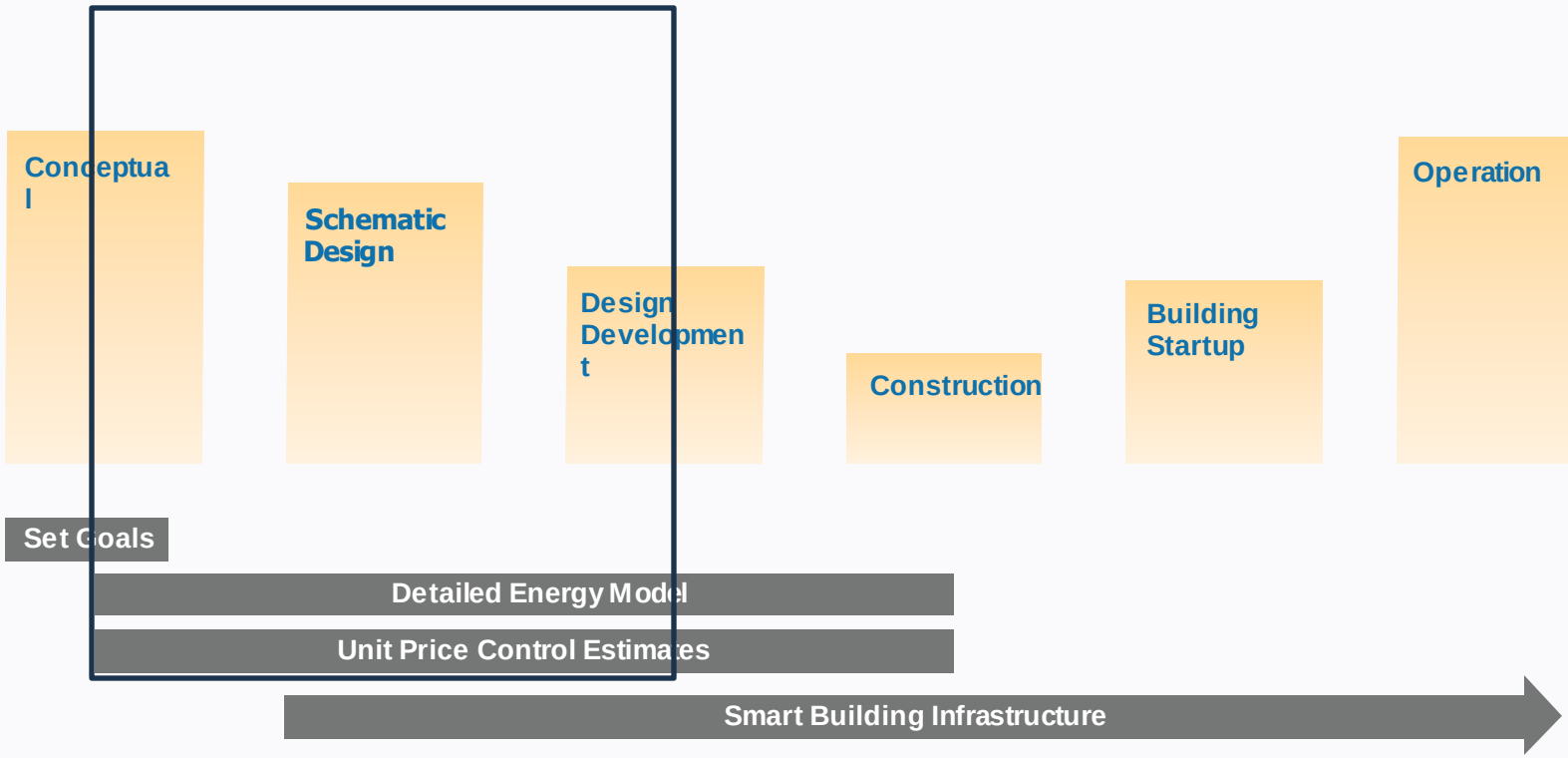
- Set metrics-based goals
- Align team to goals
- Open-source simulation to spin scenarios until we reach the highest performance at the lowest cost.

SUSTAINABILITY CERTIFICATION PROGRAM GOALS `	Evidence-based goals *[Select your programs]*
ENERGY	
Site Energy Use Intensity (EUI)	14 kBtu/sf/yr
Gas v. Electrification Balance	
Renewables	Offset annual energy consumption to Zero Energy
Building Envelope Infiltration	0.05 cfm/gross sf shell @50Pa
INDOOR AIR QUALITY	
Particulate Matter 2.5 (PM2.5)	< 12 µg/m3
Total Volatile Organic Compound (TVOC)	< 0.4 mg/m3 (< 400 µg/m3)
Carbon Dioxide (CO2)	< 600 ppm
Temperature	Monitored
Humidity	Monitored
Carbon Monoxide (CO)	< 9 ppm
Ozone (O3)	< 51 ppb
Particulate Matter 10 (PM10)	< 50 µg/m3
Radon	< 0.148 Bq/L [4 pCi/L] in the lowest occupied level
Ventilation Rate:	PH Compliance



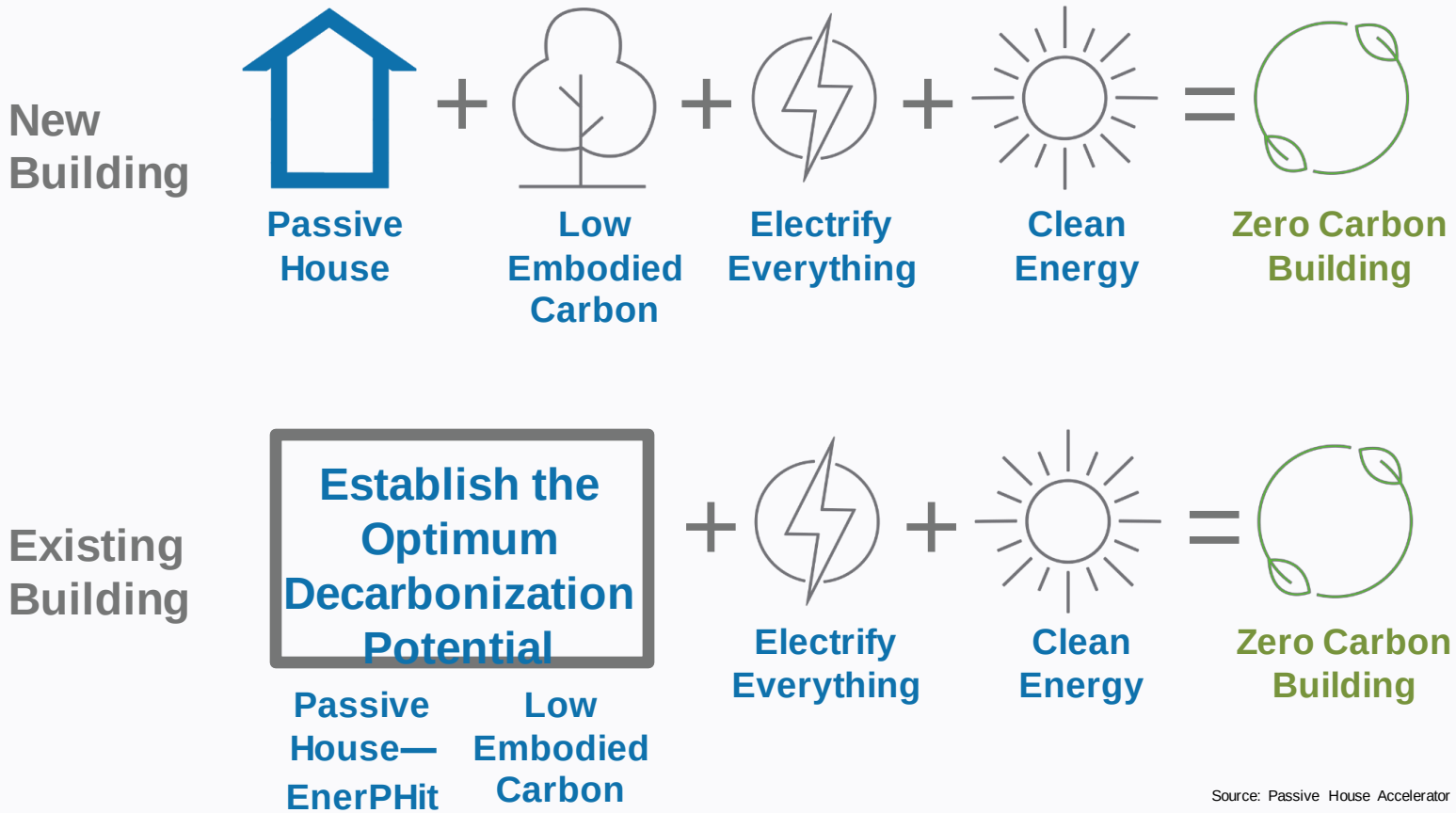
Zero Energy/Zero Carbon

Low/No cost solutions come during SD/DD using simulation



Natural Order of Decarbonization…

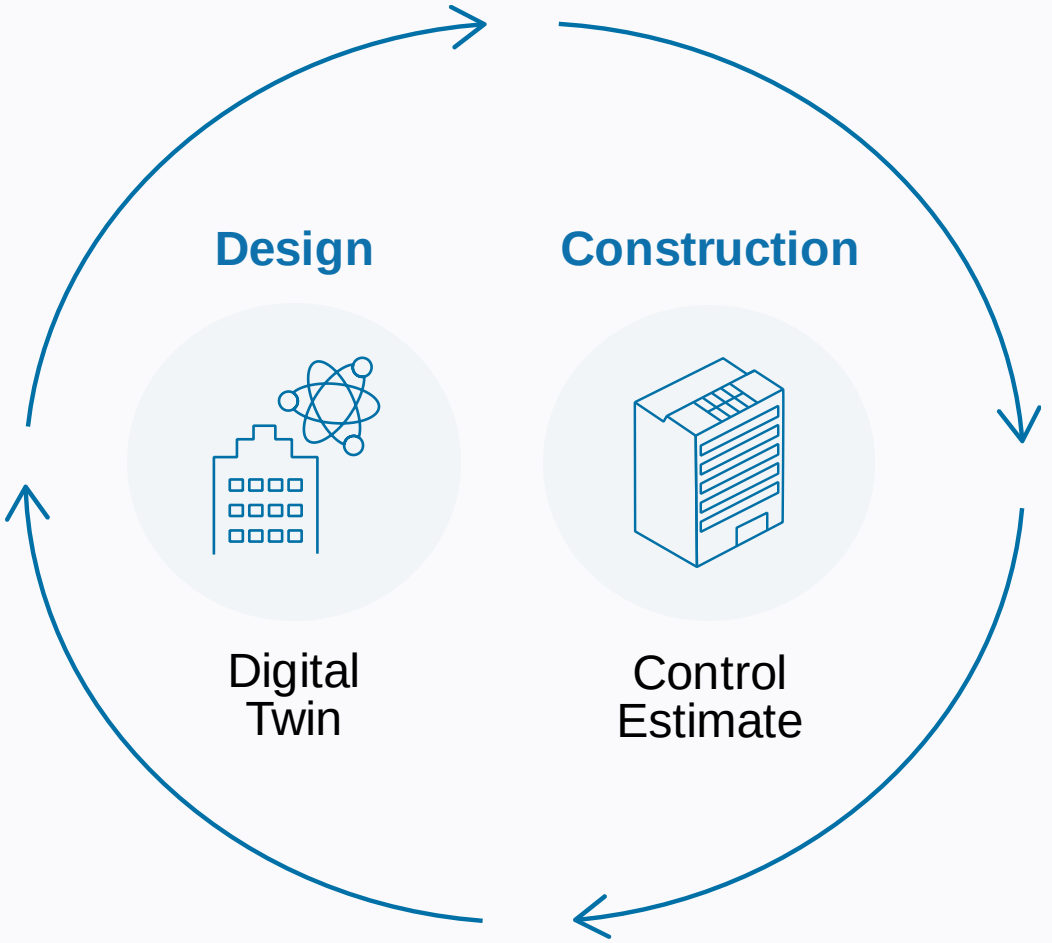
… must begin with efficiency



Source: Passive House Accelerator

Technology reduces risk

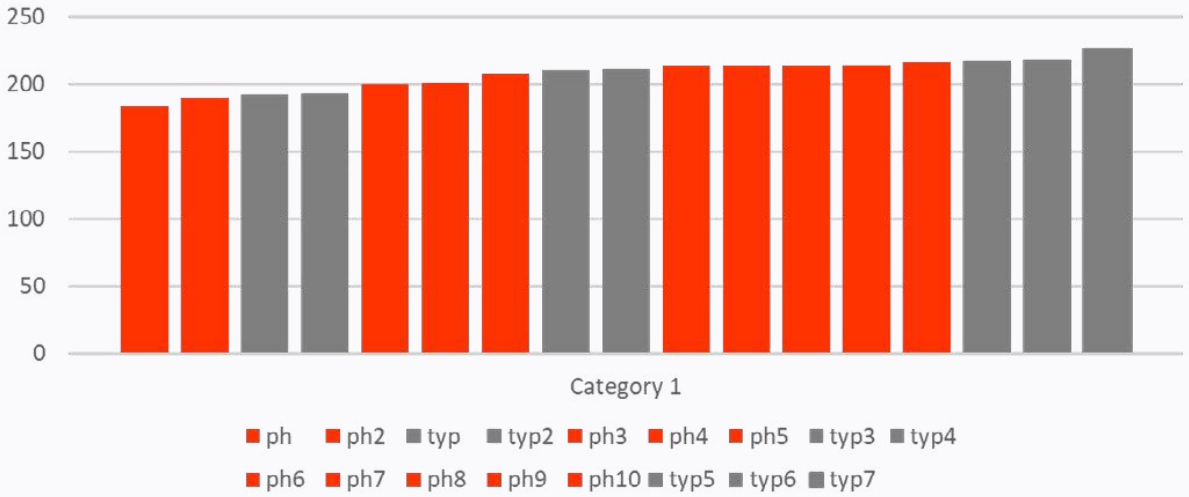
Continuous modeling meets continuous estimating



Not a Typical "Cost-Plus" Paradigm

PHFA Multifamily Housing Around Philadelphia Region

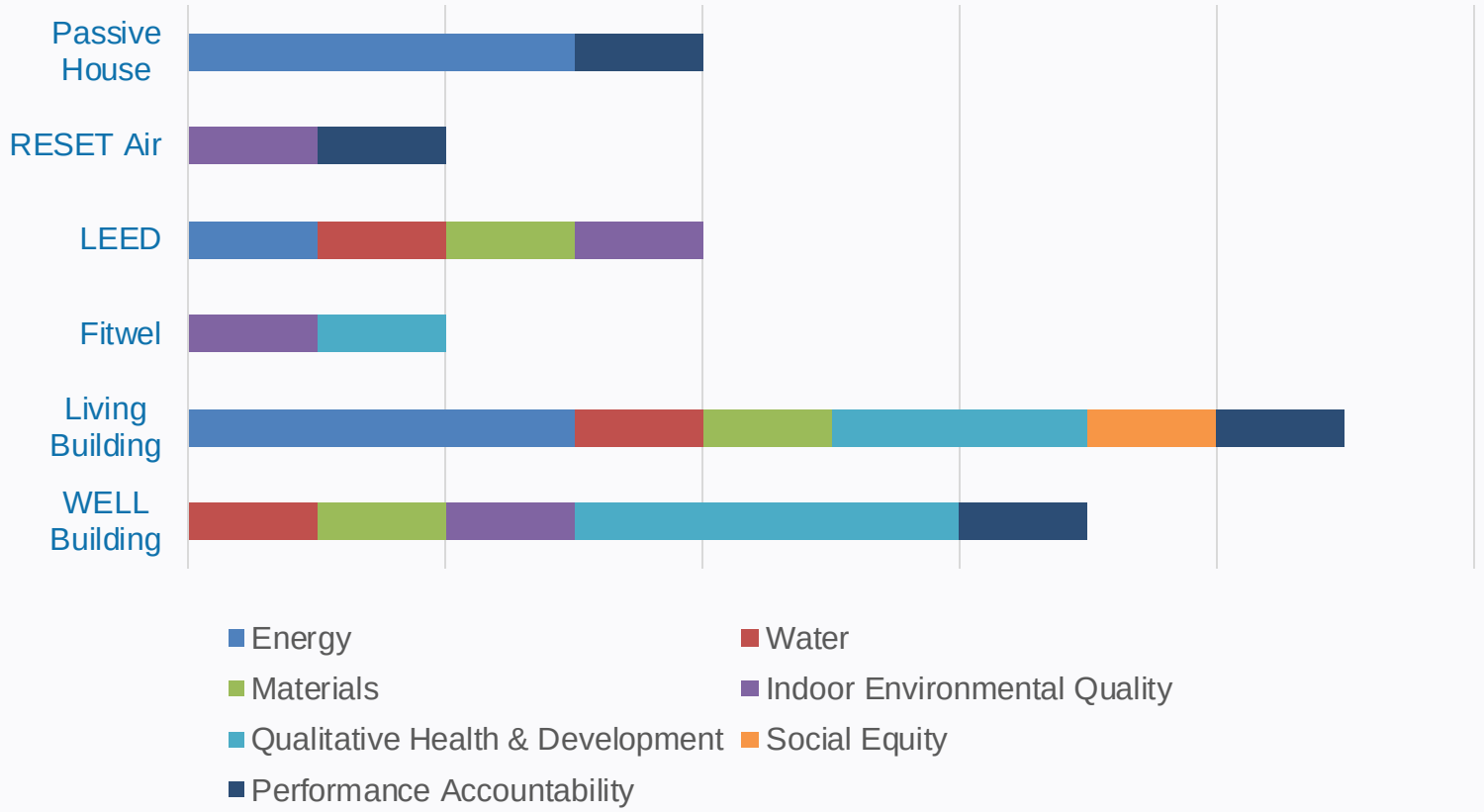
17 Buildings



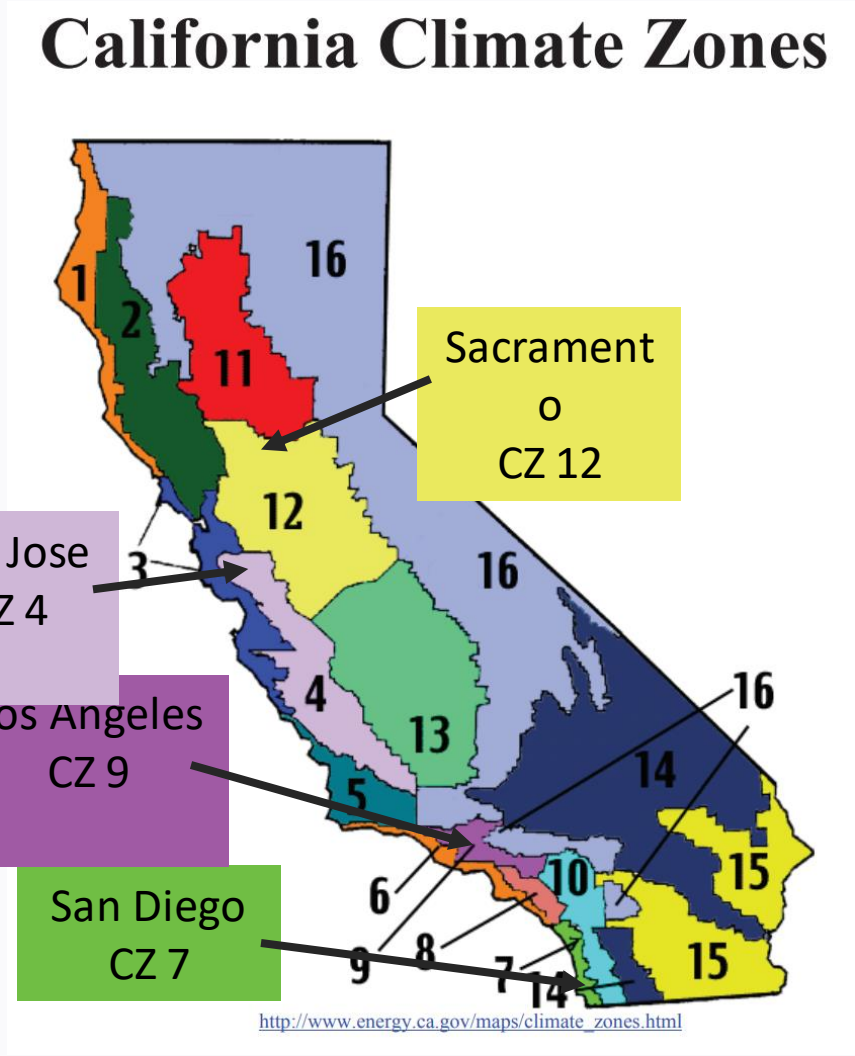
$206/sf vs. **$208/sf** averange

Source: Onion Flats

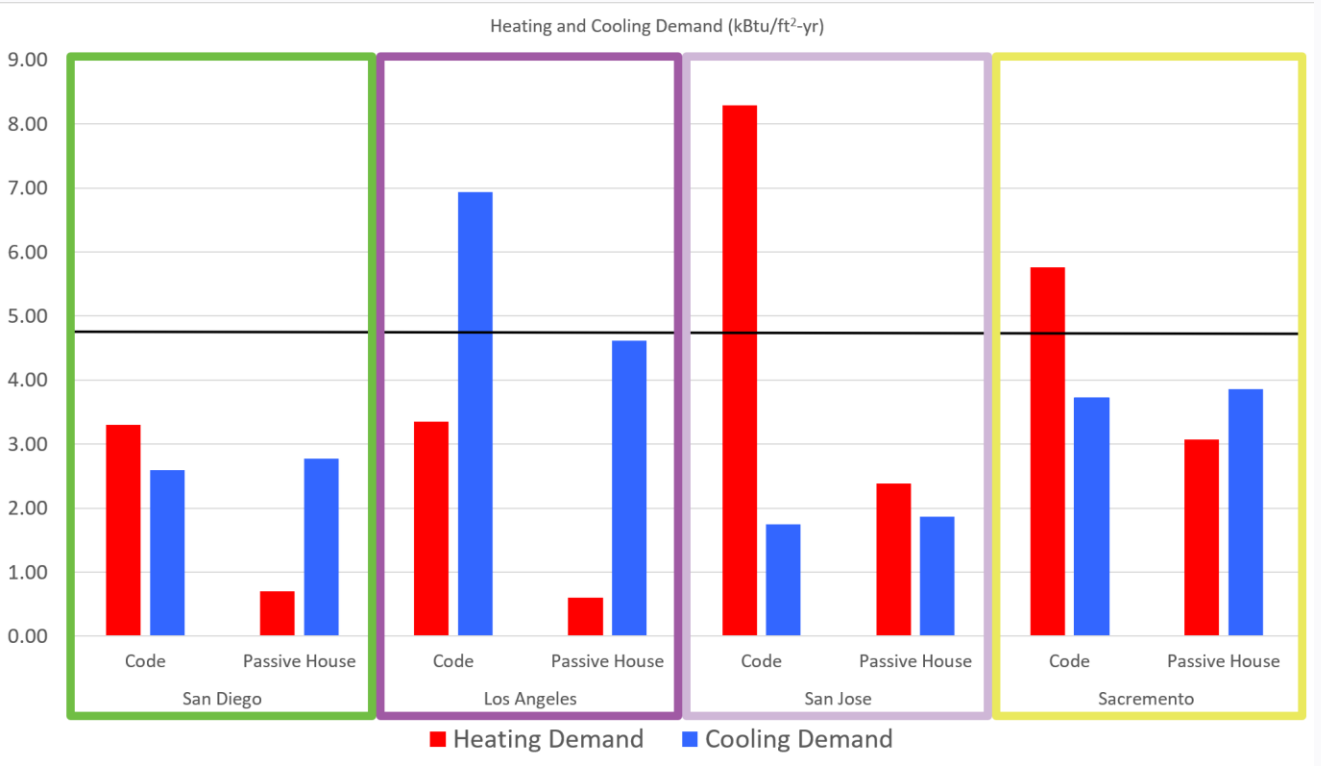
Start with foundational elements, then add…



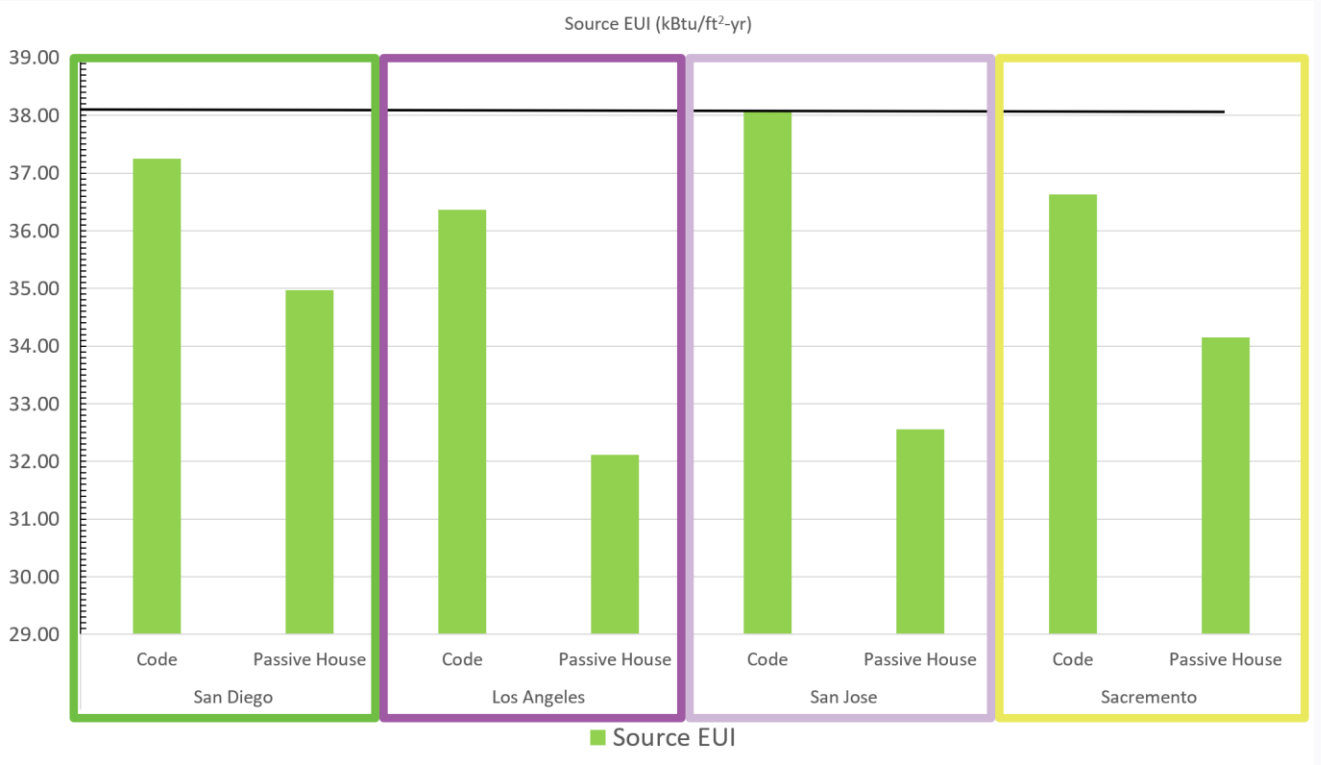
California Climate Zones



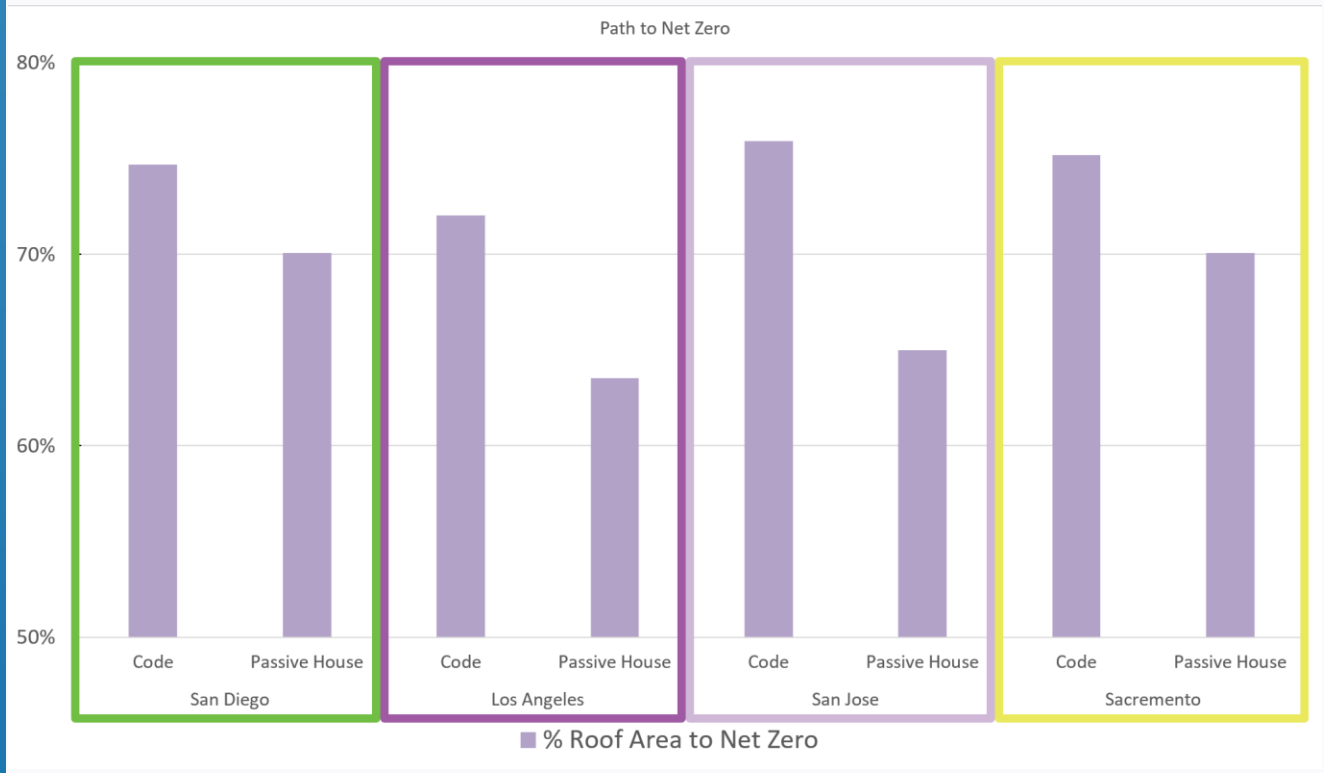
Heating and Cooling Demand



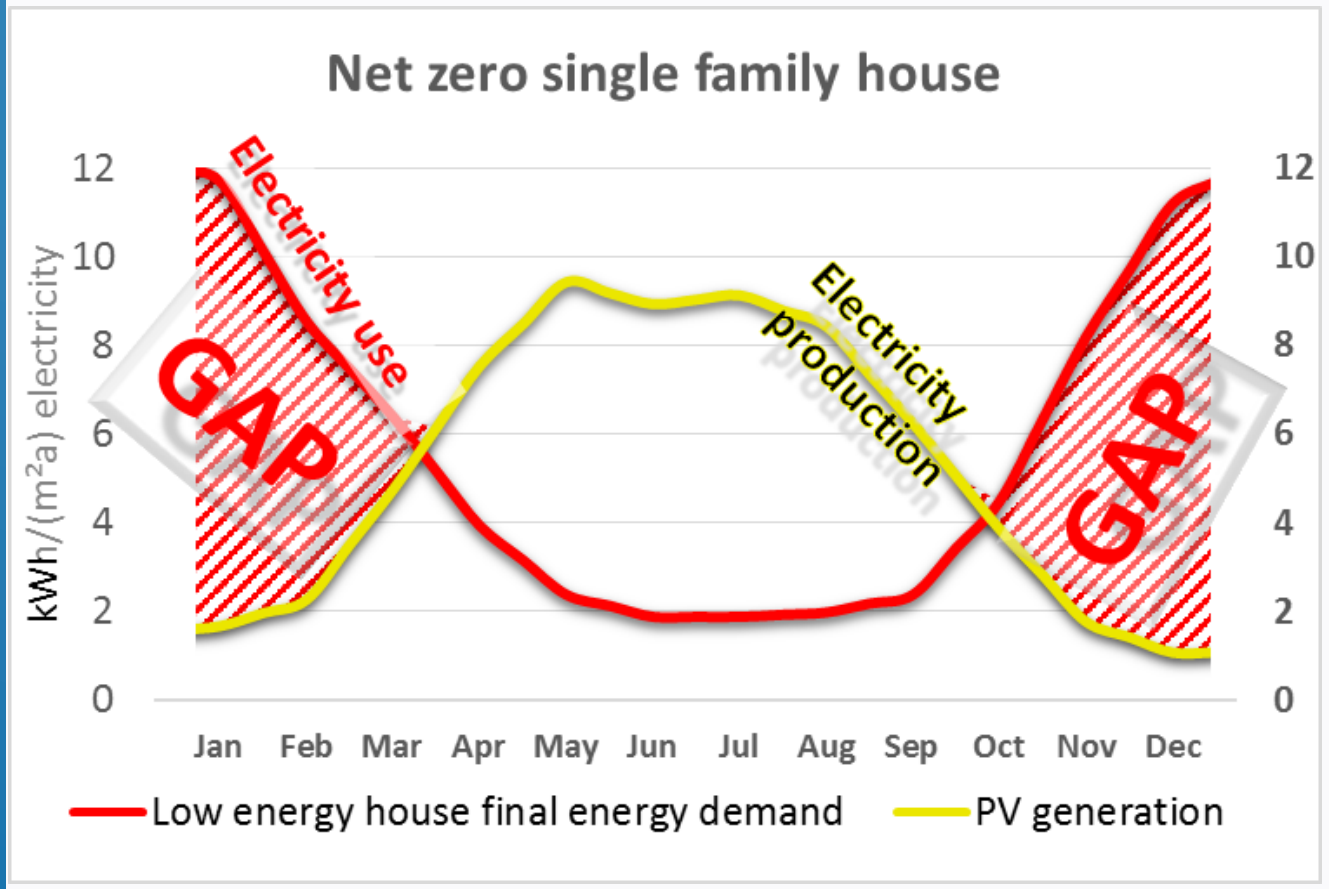
Source Energy Use Intensity (EUI)



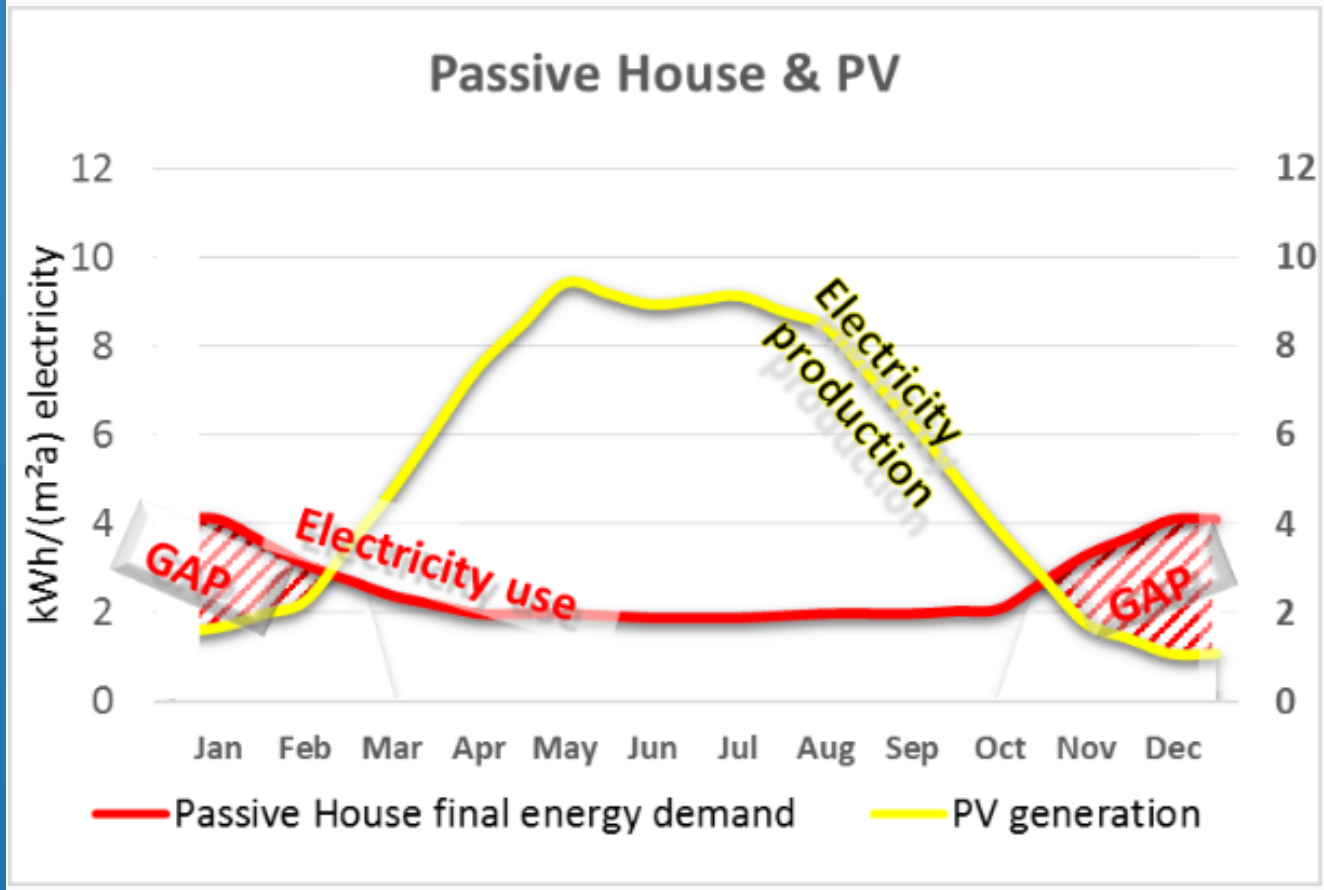
Path to Net Zero Energy



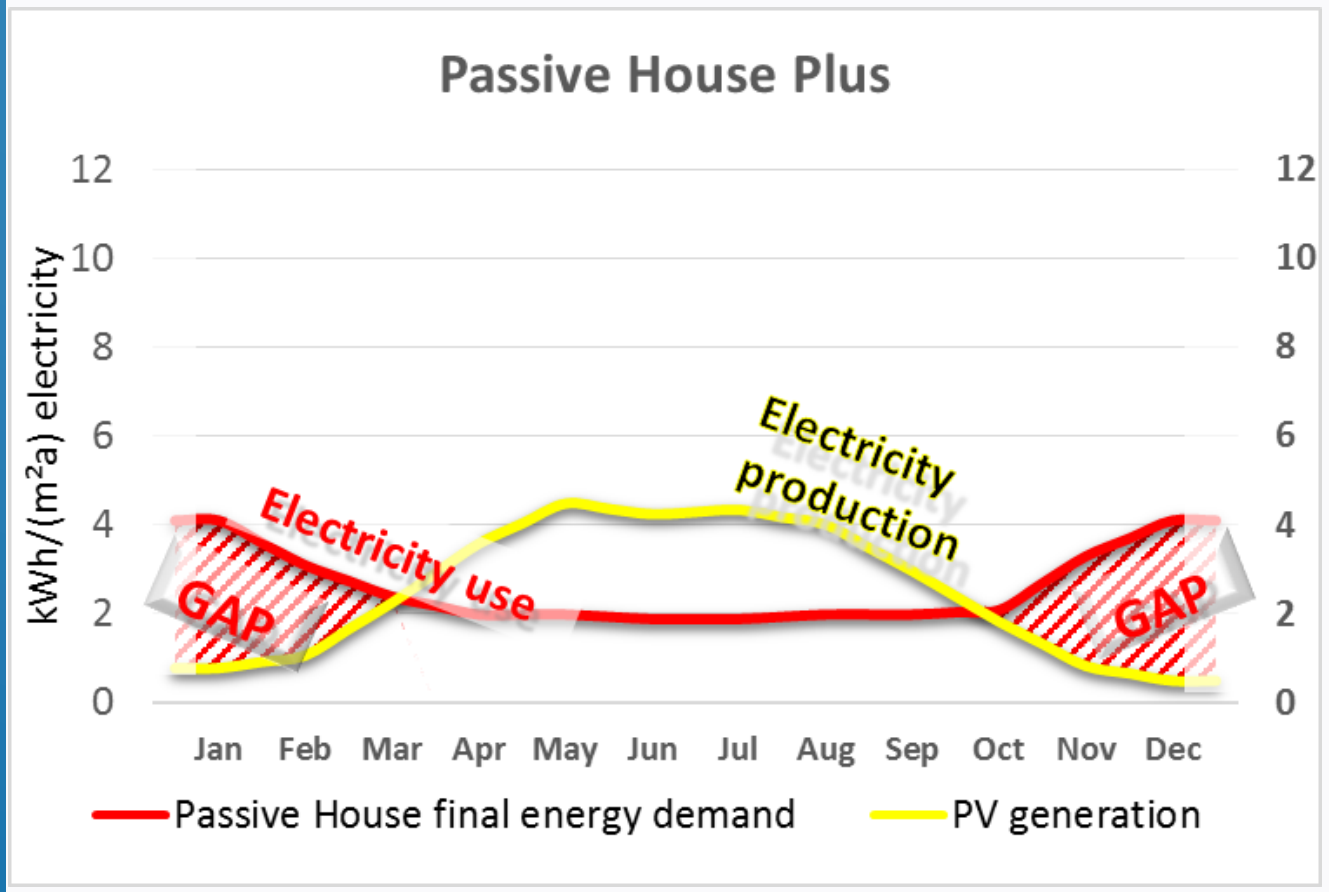
Net Zero – Big Picture



Net Zero – Big Picture

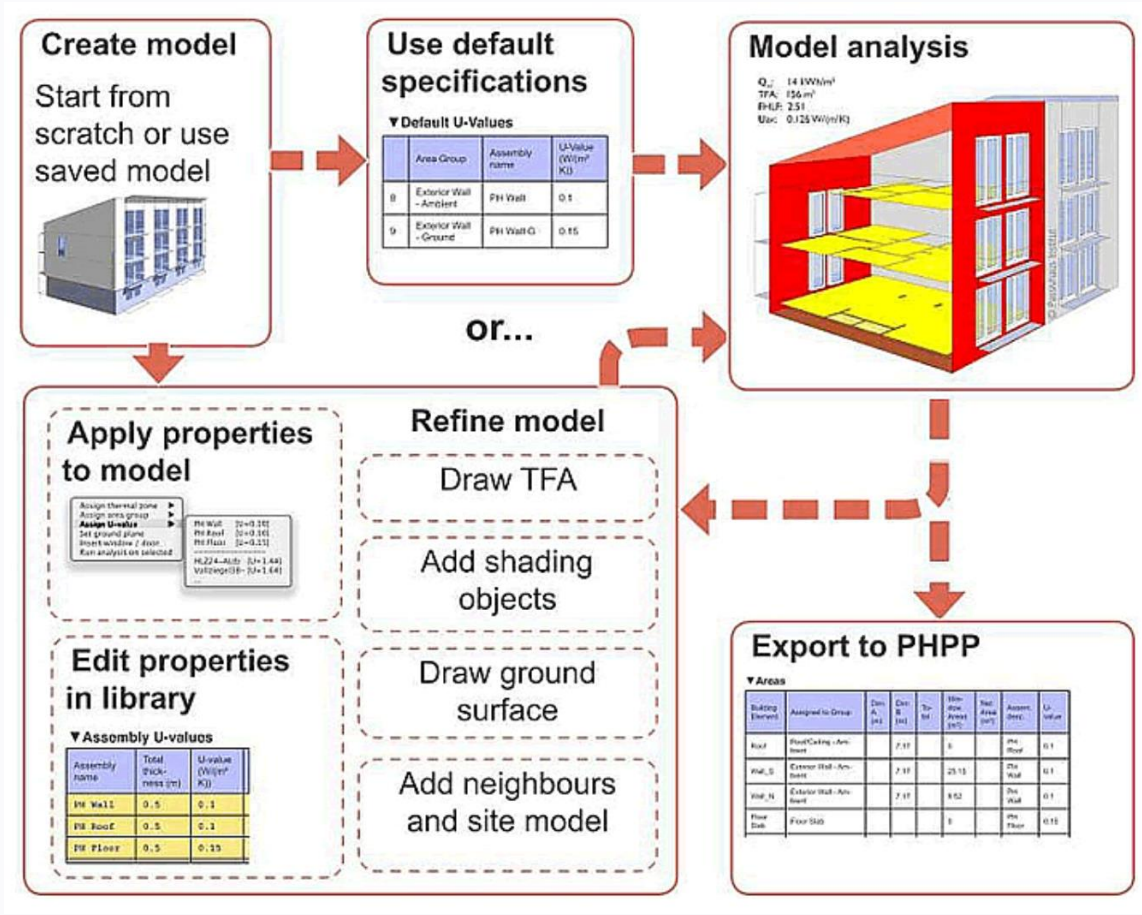


Net Zero – Big Picture



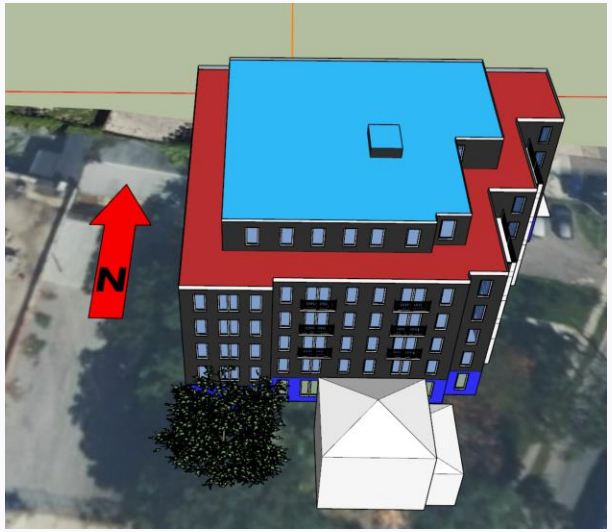
Simulations

Standard Multifamily



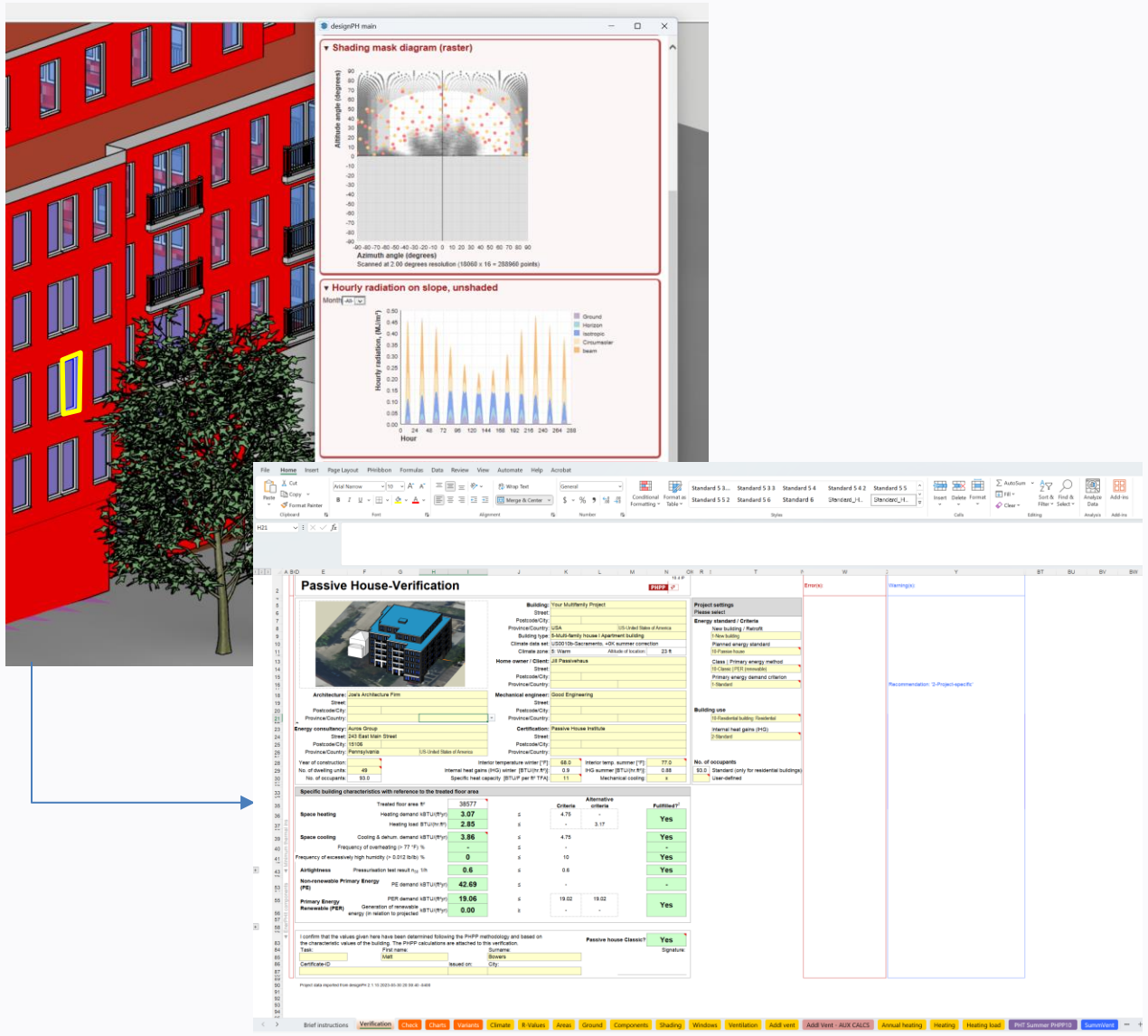
Simulations

Standard Multifamily



Simulations

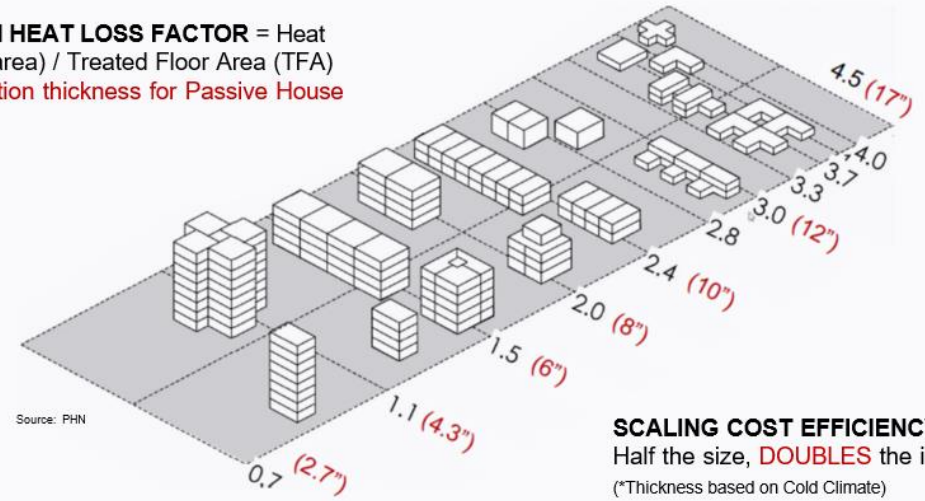
Standard Multifamily



Building Data

- 49 Unit Residential
- 43,000 GSF (38,500 Treated Floor Area)
- All Electric
- Centralized Heating and Cooling with Heat Pump Systems
- Centralized Domestic Hot Water with a Heat Pump DHW and domestic water circulation loop
- Heat Loss Form Factor – 1.1 – REALLY GOOD

FORM HEAT LOSS FACTOR = Heat Loss area) / Treated Floor Area (TFA)
Insulation thickness for Passive House



SCALING COST EFFICIENCY =
Half the size, DOUBLES the insulation*
(*Thickness based on Cold Climate)

Model Inputs (1 of 3)

TABLE 170.2-A ENVELOPE COMPONENT PACKAGE – Multifamily Standard Building Design

Multifamily				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Roof/Ceiling	Option B (meets § 170.2(a)1Bii)	Below Roof Deck Insulation [1,2] (With Air Space)		NR	NR	NR	R19	NR	NR	NR	R19	R19	R13	R19	R19	R19	R19	R19	R13
		Ceiling Insulation		R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38
		Radiant Barrier		NR	REQ	REQ	NR	REQ	REQ	REQ	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	75	NR	75	NR
		Steep-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0. 75	0.75	0.75	0.75	0.75	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	NR	16	16	16	16	16	16	NR
	Option C (meets § 170.2(a)1Biii)	Ceiling Insulation		R 38	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38
		Radiant Barrier		NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
		Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	75	NR	75	NR
		Steep-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0. 75	0.75	0.75	0.75	0.75	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	NR	16	16	16	16	16	16	NR
	Option D (Non Attic Roof)	Metal Building U-factor		0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
		Wood Framed and Other U-factor		0.028	0.028	0.034	0.028	0.034	0.034	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
		Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	0.63	0.63	0.63	NR	0.63	0.63	0.63	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	NR	0.75	0.75	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	75	75	75	NR	75	75	75	NR
		Steep-sloped	Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	0. 75	0. 75	0. 75	0. 75	0. 75	0. 75	0. 75	0. 75	0. 75	0.75	0.75	0.75	0.75	0.75	NR
			Solar Reflectance Index (SRI)	NR	16	16	16	16	16	16	16	16	16	16	16	16	16	16	NR

Model Inputs (2 of 3)

Walls	Metal-Building, any fire rating	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
	Framed (wood, metal) and other >1hr fire rating	0.059	0.059	0.059	0.059	0.059	0.065	0.065	0.059	0.059	0.059	0.051	0.059	0.059	0.051	0.051	0.051
	Framed (wood, metal) and other, ≤1hr fire rating[3]	0.051	0.051	0.051	0.051	0.051	0.065	0.065	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
	Mass Light[4,5]	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.059 R 17
	Mass Heavy	0.253	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.184	0.253	0.211	0.184	0.184	0.160
Floors/Soffits	Slab Perimeter, Three Habitable Stories or less	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	U 0.58 R 7.0
	Wood Framed	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19
	Raised Mass	U 0.092 R 8.0	U 0.092 R 8.0	U 0.269 R 0	U 0.269 R 0	U- 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.092 R 8.0	U 0.138 R 4.0	U 0.092 R 8.0	U 0.092 R 8.0	U 0.138 R 4.0	U 0.092 R 8.0
	Other	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039

Model Inputs (3 of 3)

Quality Insulation Installation (QII) for buildings up to three habitable stories			Yes	Yes	Yes	Yes	Yes	Yes	NR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fenestration	Curtain Wall/ Storefront	Maximum U-factor	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.38
		Maximum RSHGC, three or fewer habitable stories	NR	0.26	NR	0.26	NR	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.26	NR
		Maximum RSHGC, four or more habitable stories	0.35	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.26	0.25
		Minimum VT, four or more habitable stories	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
	NAFS 2017 Performance Class AW[5]	Maximum U-factor	0.38	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.38
		Maximum RSHGC, three or less habitable stories	NR	0.24	NR	0.24	NR	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	NR
		Maximum RSHGC, four or more habitable stories	0.35	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
		Minimum VT, four or more habitable stories	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
	All Other Fenestration	Maximum U-factor	0.30	0.30	0.30	0.30	0.30	0.30	0.34	0.34	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
		Maximum RSHGC, three or less habitable stories	NR	0.23	NR	0.23	NR	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	NR
		Maximum RSHGC, four or more habitable stories	0.35	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	Maximum Window to Floor Ratio		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Maximum Window to Wall Ratio		40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
	Maximum Skylight Roof Ratio		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Exterior Doors[6]	**Maximum U-factor**	Dwelling Unit Entry	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
		Common Use Area Entry Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
		Common Use Area Entry Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

Mechanical Component Package

TABLE 170.2-K MECHANICAL COMPONENT PACKAGE – Multifamily Standard Building Design

Multifamily			Climate Zone															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Unitary (serving one dwelling unit)	If Balanced Ventilation System[1]	HRV or ERV Sensible Recovery Efficiency	0.67	0.67	NR	NR	NR	NR	NR	NR	NR	NR	0.67	0.67	0.67	0.67	0.67	0.67
		HRV or ERV Fan Efficacy (W/cfm)	0.6	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6	0.6	0.6	0.6	0.6	0.6
		Non-HRV or Non-ERV Fan Efficacy (W/cfm)	NR	NR	NR	0.4	0.4	0.4	0.4	0.4	0.4	0.4	NR	NR	NR	NR	NR	NR
	If Heat Pump, HSPF[2]/HSPF2		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
	If Dual-Fuel Heat Pump, AFUE		MIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	MIN
	Refrigerant Charge Verification or Fault Indicator Display		NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
	SEER/SEER2		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
Central (serving multiple dwelling units)	If Balanced Ventilation Systems[1]	Sensible Recovery Efficiency or Effectiveness	0.67	0.67	NR	NR	NR	NR	NR	NR	NR	NR	0.67	0.67	0.67	0.67	0.67	0.67
		Bypass Function	REQ	REQ	NR	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ
Central System Air Handlers	Central Fan Integrated Ventilation System Fan Efficacy		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Duct Insulation	Ducts in Unconditioned Space		R-8	R-8	R-6	R-8	R-6	R-6	R-6	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
Water Heating	All Buildings		System Shall meet Section 170.2(d)															

Passive House “Upgrades”

San Jose – Improvements needed to achieve Passive House Performance:

- Improved windows U-0.28 / SHGC 0.23
- 75% Heat Recovery (PH Minimum)
- 0.6 ACH50 @50 Pa

San Diego – Improvements needed to achieve Passive House Performance:

- 75% Heat Recovery (PH Minimum)
- 0.6 ACH50 @50 Pa

Los Angeles – Improvements needed to achieve Passive House Performance:

- Improved windows U-0.31 / SHGC 0.23
- Exterior Shading Devices
- 75% Heat Recovery (PH Minimum)
- 0.6 ACH50 @50 Pa

Sacramento – Improvements needed to achieve Passive House Performance:

- Improved windows U-0.27 / SHGC 0.23
- 80% Heat Recovery
- 0.6 ACH50 @50 Pa

Summary

Energy – In every California climate tested, Passive House squeezes out additional consumption.

Renewables – the path to zero is easier and cheaper with Passive House certification.

Thermal Comfort -- Passive House is also a comfort standard.

Balanced Ventilation

- Indoor Air Quality
- Odor Control
- Occupant Comfort

Air Tightness

- Long term building assembly durability
- Should not cost more, it is mainly craftsmanship
- Systems work better
- Consistent temperatures
- Dramatically improved acoustics

It Takes a Village to Decarbonize:

How CEDA aligns with Passive House Initiatives

September 12, 2023

CEDA

WILLDAN

WHAT IS CEDA?

The California Energy Design Assistance (CEDA) program promotes the electrification and decarbonization of new building construction or major renovation. CEDA works in collaboration with project teams to reduce energy demand, consumption, and carbon emissions.

The CEDA Program partners with the PG&E Code Readiness (CR) Team to support code advocacy initiatives through the collection of new construction project data to evolve future code cycles and support the long-term sustainability goals of California.

WHY COLLABORATE WITH CEDA?

- Be eligible for **measure incentives** and a **design team stipend**
- Participate in a **low-commitment** program that helps confirm your energy model and add new ideas
- Demonstrate commitment to high-performance building practices and design

ENERGY MODELING INCENTIVES

Design team incentives

+

Decarbonization measures incentives

+

Incentives to encourage Passive House modeling and design teams to participate in the collection the documentation and data and submit to CEDA

= Win-Win!

HIGH-PERFORMANCE MEASURES

Examples of high-performance measure types to help your teams evaluate decarbonization opportunities and available incentives

Space heating system

Heat pumps, VRF systems, controls, heat pump chillers and heat pumps for VAV reheat systems

Service water heating

Central heat pump water heaters, distributed heat pump water heaters, water heater controls and distribution systems

Plug Loads

Heat pump clothes dryers, induction cook tops, electric commercial kitchens

Process Loads

Heat pump pool heaters, high temp heat pumps for industrial processes, microwave or other electric drying processes

Refrigerant Systems

Low GWP refrigerants for heat pumps, VRF, chillers, water heaters, reduced refrigerant leakage

MEASURE INCENTIVES

CEDA offers incentives for participating in project discovery meetings and Design Team led data collection.

Additional incentives reward buildings of the future that implement high performance measures and electrification.

Incentives are also available for the installation of traditional above code minimum energy efficiency measures

Amount calculated during free analysis

Inducement Process:

Thank you!

CaliforniaEDA.com

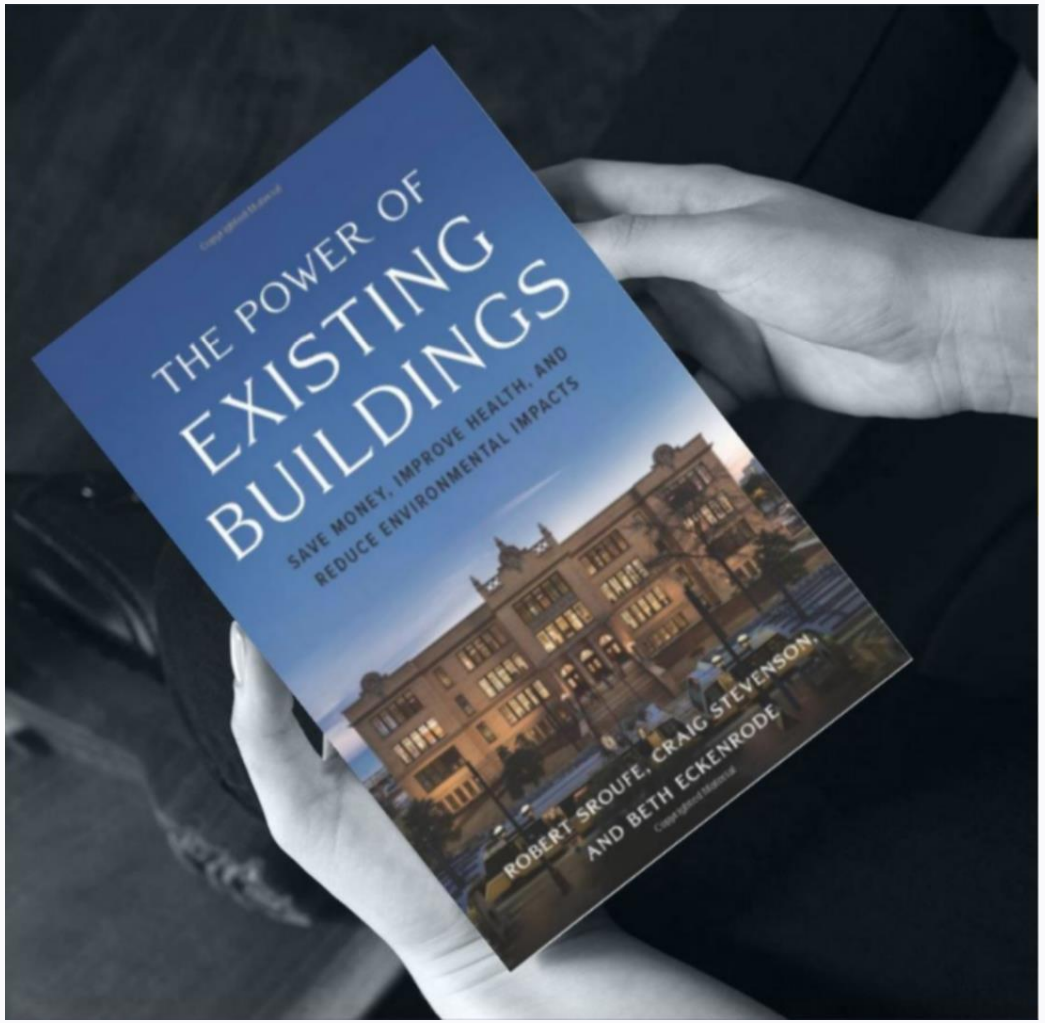
877.939.1874

WILLDAN

Design and retrofit the highest performing buildings at the lowest possible cost

Theory Into Practice

Our vision



Q&A

AUROS Group

Beth Eckenrode

412-506-6777

beth.eckenrode@aurosgroup.com

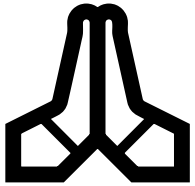
AUROS Group

Matt Bowers

412-506-6777

Matthew.bowers@aurosgroup.com

Thank You



- For sharing information about the CEDA Program
- Other PH Multifamily Programs of potential interest
  - Fannie Mae Green Building Loans
  - CEC's Build Program
  - CA Energy Smart Homes
  - Multifamily Energy Savings Program (MESP)
  - Sacramento Municipal Utility (SMUD) Program
  - Southern California Edison (SCE) Multifamily Resources
- Inflation Reduction Act possibilities

  The landmark Inflation Reduction Act contains $4.5 billion in rebates that will reduce the cost of building affordable all-electric, multi-family Passive House buildings, as well as tax credits that can be worth as much as $5,000 per unit.

Links in the Chat

Two Documents from Passive House Network

CALIFORNIA PH MULTIFAMILY RESOURCES:
List (with links) of Subsidy Programs that may be used for Passive House Multifamily Buildings in California

Safe at Home:
How all-electric, multi-family Passive House buildings deliver comfortable, cost-effective climate resilience

Plus: We will soon email attendees a link to information and registration for an upcoming webinar on **Optimizing Decarbonization Potential in Retrofitting Multifamily Buildings**

Thank you

For your Time and Attention

PASSIVE HOUSE CALIFORNIA

TRI-COUNTY REGIONAL ENERGY NETWORK
SAN LUIS OBISPO • SANTA BARBARA • VENTURA

PassiveHouseCal.org
Info@passivehousecal.org

For more Info: 3c-ren.org
For Questions: info@3c-ren.org

The Building Blocks of Decarbonization

Maximize Efficiency

Minimize Embodied Carbon

Electrify Everything

Clean Energy

Zero Carbon Building

For the People – For the Planet

The Question is not Why — It is WHY NOT