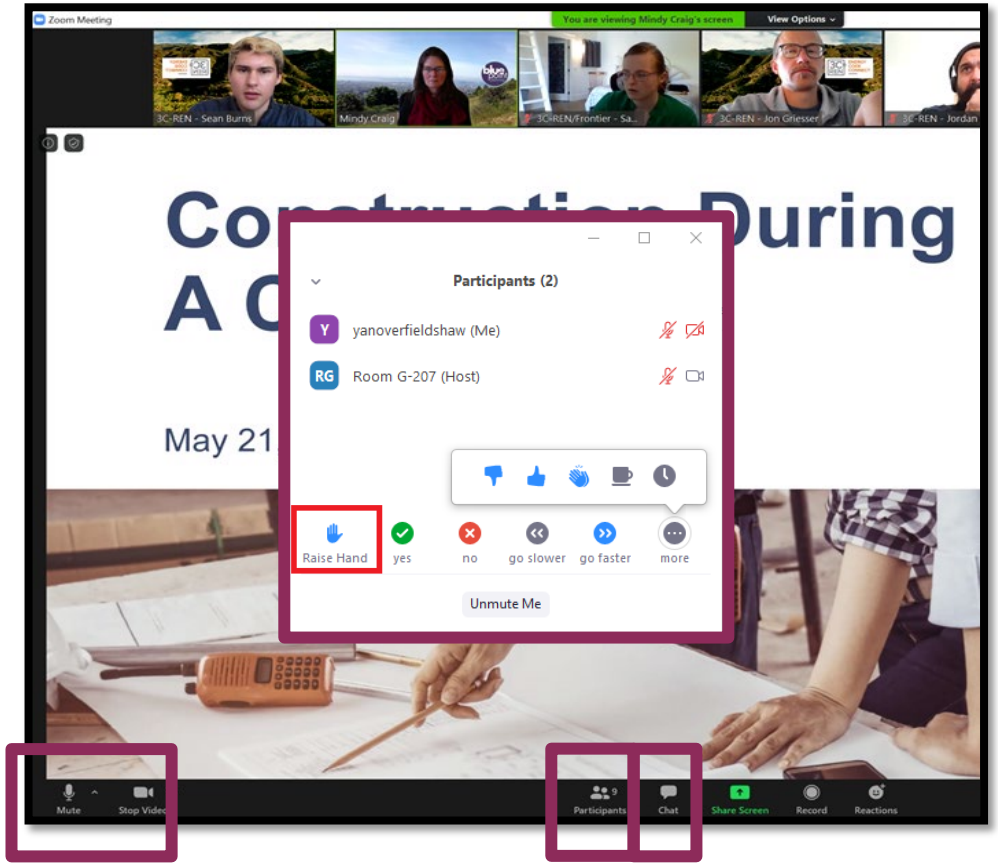
Building Electrification, Passive House PER & California

Ken Levenson, Executive Director, The Passive House Network

September 24th, 2024

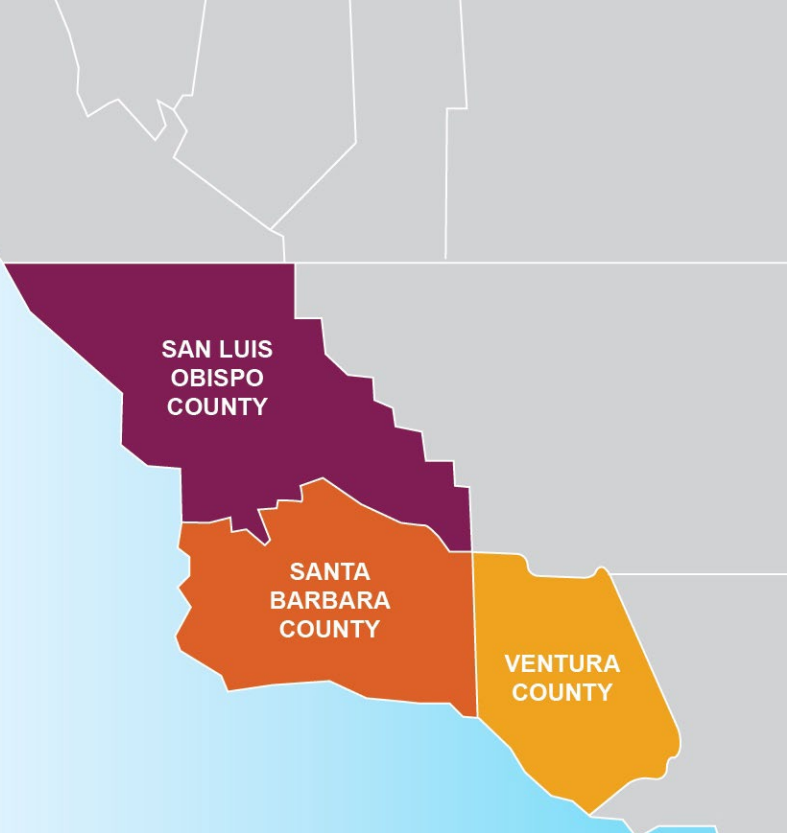
Zoom Orientation

- Please be sure your full name is displayed
- Please mute upon joining
- Use "Chat“ box to share questions or comments
- Under "Participant" select "Raise Hand" to share a question or comment verbally
- The session may be recorded and posted to 3C-REN's on-demand page. Feel free to ask questions via the chat and keep video off if you want to remain anonymous in the recording.



3C-REN: Tri-County Regional Energy Network

- Three counties working together to improve energy efficiency in the region
- Services for –
  - **Building Professionals:** industry events, training, and energy code compliance support
  - **Households:** free and discounted home upgrades
- Funded by ratepayer dollars that 3C-REN returns to the region



3C REN ENERGY CODE CONNECT

3C REN BUILDING PERFORMANCE TRAINING

3C REN HOME ENERGY SAVINGS

3C REN ENERGY CODE CONNECT

- Serves all building professionals
- Three services –
  - **Energy Code Coach**
  - **Training and Support**
  - **Regional Forums**
- Makes the Energy Code easy to follow

Energy Code Coach:
3c-ren.org/codes
805.781.1201

Event Registration:
3c-ren.org/events

BUILDING PERFORMANCE TRAINING

- Serves current and prospective building professionals
- Expert instruction:
  - **Technical skills**
  - **Soft skills**
- Helps workers to thrive in an evolving industry

Event Registration:
3c-ren.org/events

3C REN HOME ENERGY SAVINGS

Multifamily (5+ units)

- No cost technical assistance
- Rebates up to $750/apartment plus additional rebates for specialty measures like heat pumps

Single Family (up to 4 units)

- Sign up to participate!
- Get paid for the metered energy savings of your customers

Enrollment:
3C-REN.org/contractor-participation

Electrification

Passive House PER & California

The Network

Global Knowledge. Regional Context. Local Applications

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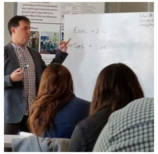













Passive House Seattle – The Passive House Network

Passive House Rocky Mountains – The Passive House Network

Passive House Minnesota – The Passive House Network

Passive House Pennsylvania – The Passive House Network

Passive House Washington DC – The Passive House Network

New Jersey Passive House – The Passive House Network

Passive House Empire State – The Passive House Network

Passive House Northeast – The Passive House Network

PHCA Passive House California

North American Certifiers Circle – Passive House Certifier – Passive House Institute accredited

International Passive House Association – iPHA

Passive House Institute

Designer – Certified Passive House Designer

Certified Passive House Tradesperson – Tradesperson

Certified Passive House – Passive House Institute

Description:
An introduction to Passive House with a deeper look at how Passive House design considers the California electrical grid, renewables, and building electrification in making climate -specific optimized designs - with local case studies.

Learning Objectives:

1. Explain Passive House principles and benefits.
2. Describe the Passive House strategy of Primary Energy Renewable and how it supports electrification .
3. Outline how Passive House optimization is influenced by current and future power supply.
4. Describe case studies of homes that achieve all - electric Passive House outcomes and the strategies and outcomes.

Instructor:
Ken Levenson, Executive Director, The Passive House Network. Ken was a practicing architect for over three decades, completing early Passive House projects in New York City. Committed to accelerating Passive House growth and knowledge sharing, he co - founded 475 High Performance Building Supply, was a founding member of the Phius Passive House Alliance, a co -founder of New York Passive House and of NAPHN, which would become The Passive House Network (PHN). Today, as Executive Director of PHN, Ken continues to focus on driving building industry culture change with Passive House education.

Agenda

The Passive House Network

- The Electrification Imperative
- Passive House Overview
- PER & Certification Classes
- Electrified Systems
- Examples
- Resources

The Electrification Imperative

Electrify Everything

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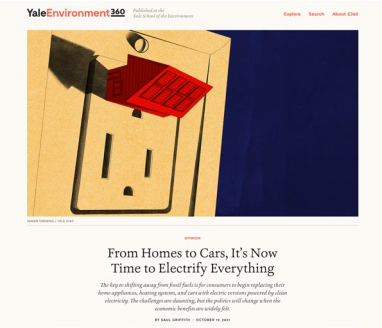
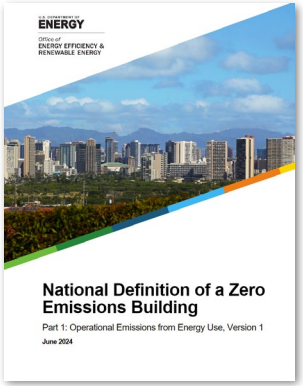
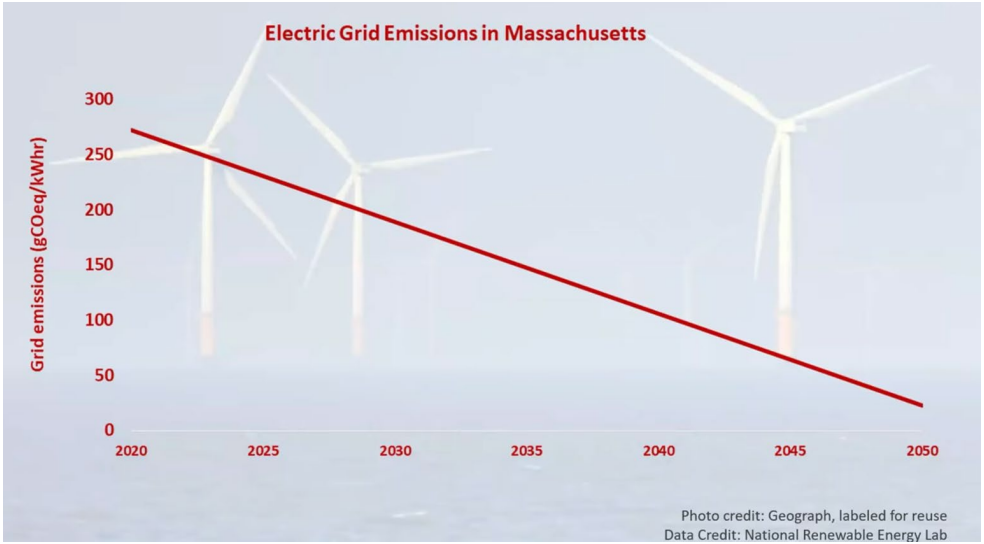




1. Energy efficient.
2. Free of on-site emissions from energy use.
3. Powered solely from clean energy.

The Grid is decarbonizing & Elec Systems Improving



Systems Improvements:

- Cold Climate Heat Pumps
- Domestic Hot Water Heat Pumps
- Induction Cooktops
- Other systems

Gas is Going Away

- 54 California cities have enacted gas-reduction/ban policies

Map credit: Ciaralou Agpalo Palicpic
Publication by: spglobal.com

Health (combustion and pre -combustion)

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Combustion

- Air pollutants
  - Gaseous pollutants (CO, NO2, formaldehyde, etc.)
  - Ultrafine particles and PM2.5
  - Metals
  - Moisture, odors
- Increased asthma symptoms
- Increased upper respiratory diseases in children

Pre-Combustion Appliance Leakage

- Harvard T.H. Chan School of Public Health report found that gas used in homes throughout the greater Boston area contains at least 21 different hazardous air pollutants that may impact air quality and health. **Before combustion.**

More than doubling electrical power infrastructure

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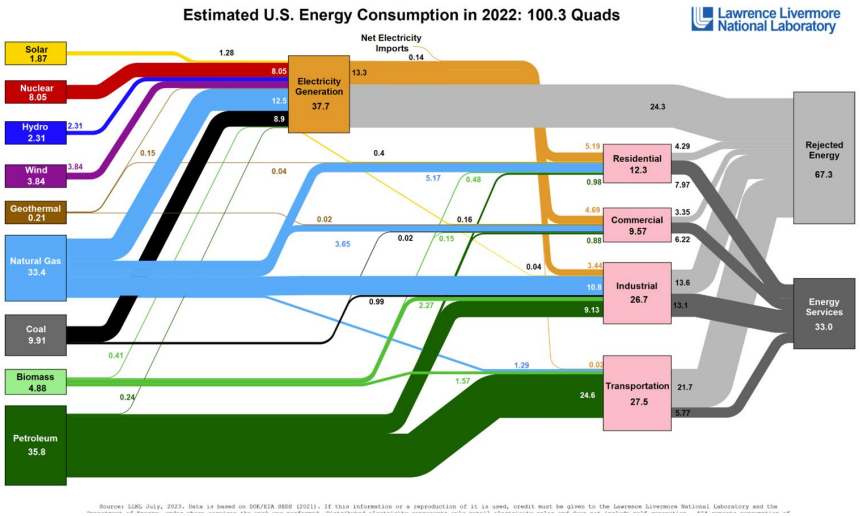
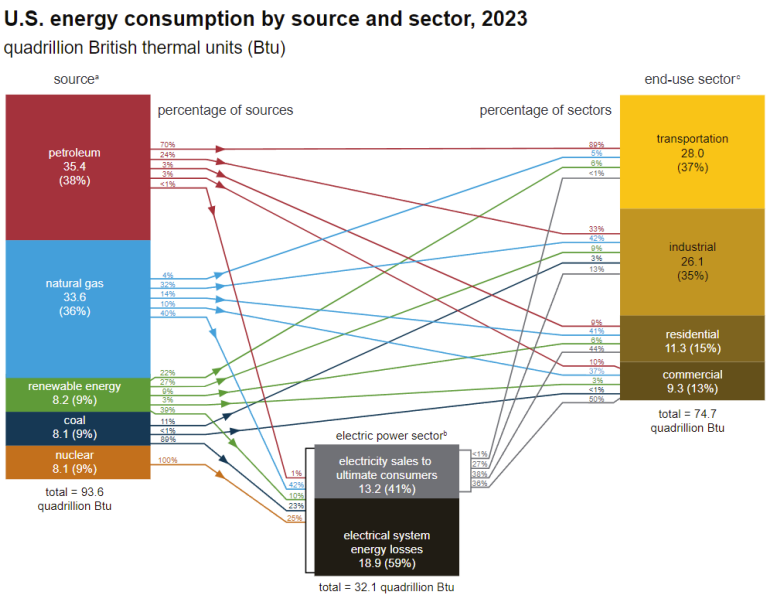
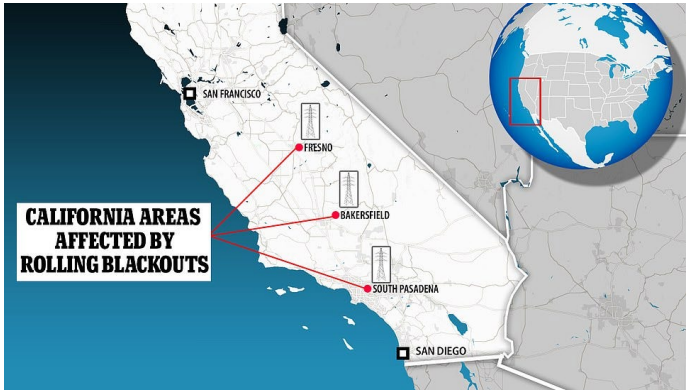
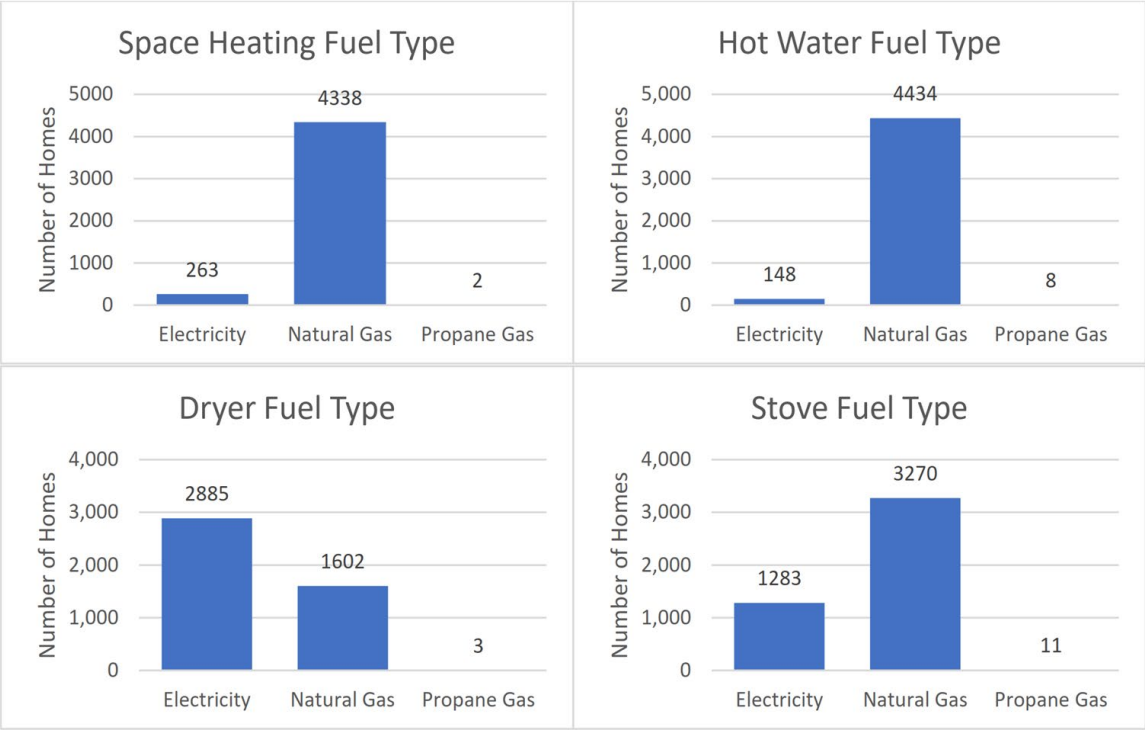




Power grids under stress

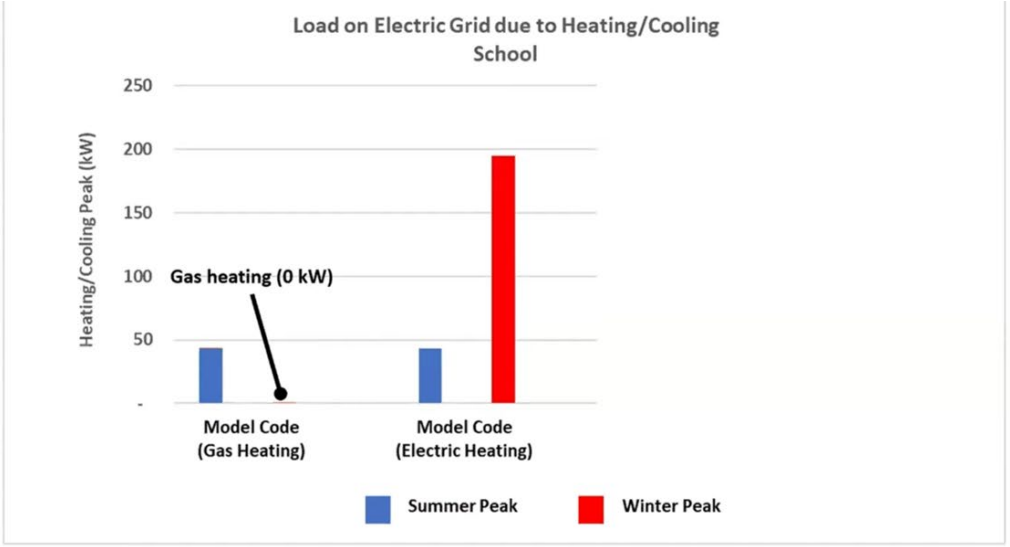


Home Electrification Landscape



BayREN Home Energy Score Electrification Checklist Pilot Report

Shifting to Electric per Code = 4x Winter Peaks!



Here is the study!

https://www.mass.gov/info-details/final-stretch-code-guideline-materials?auHash=cyHdJ0-aKeSKJLbQxVafygKhfAQT_0NW7kiF-sgWGMk#stretch-energy-code-study-report

If you build to model codes (IECC/ASHRAE) and swap from gas to electric heat pump space heating, the result is x4 new winter peak (woops!)

Credit: Massachusetts DOER

Is “Net Zero” Building the Answer?

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Problems with Net Zero:

1. Focused on supply rather than demand reduction.
2. Favors low-rise buildings.
3. Encourages inefficient land use.
4. False sense of accomplishment.

ASHRAE’s recently installed photovoltaic (PV) system.

“Net Zero” is generally a Misnomer

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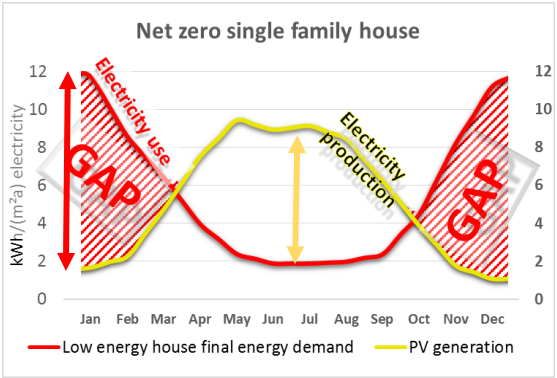
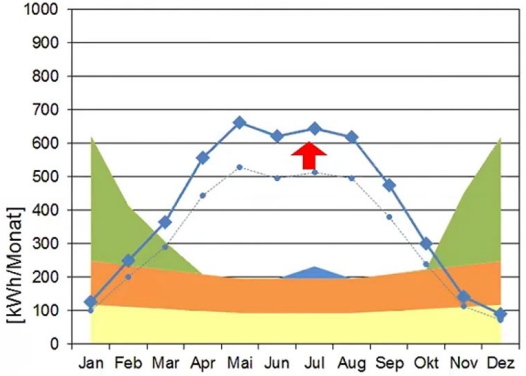
Based on mismatch of supply & demand.

It doesn’t include storage losses.

Doesn’t reflect true cost.





Performance Gap + Seasonal Mismatch =

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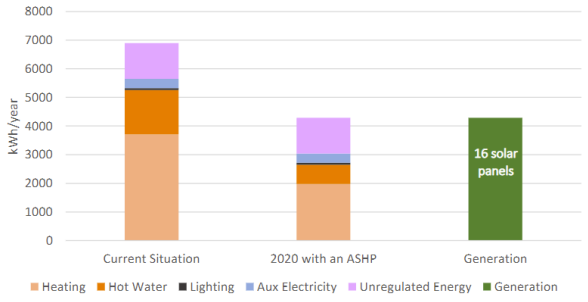


Figure 1 - Average new build energy demand - current situation and from 2020 with an ASHP

Net Zero as Typically Designed

Performance Gap of Typical Designs

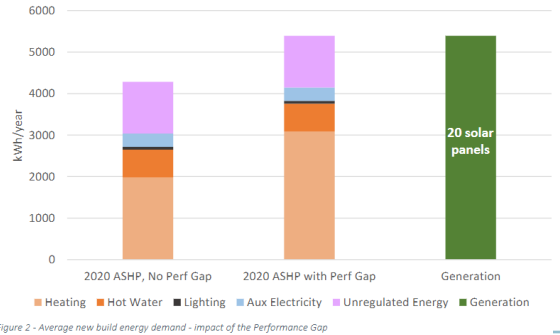
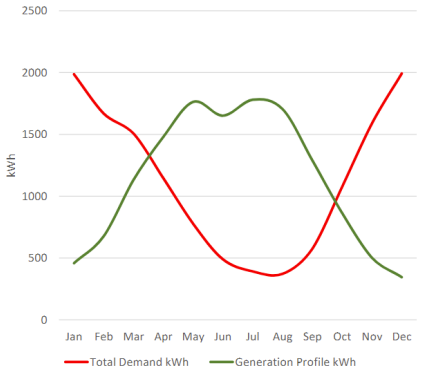


Figure 2 - Average new build energy demand - impact of the Performance Gap



Supply & Demand Mismatch Demands Long-Term Storage

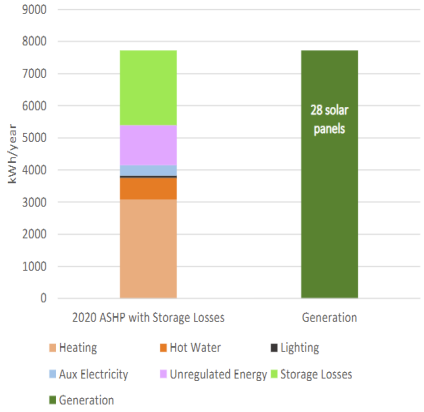


Figure 3 - Average new build energy demand - impact of storage losses

Zero Energy with Storage Losses

40% increase in solar required to hit "Net zero"

Credit: PassivhausTrust UK

Passive House Enables Optimized Alignment

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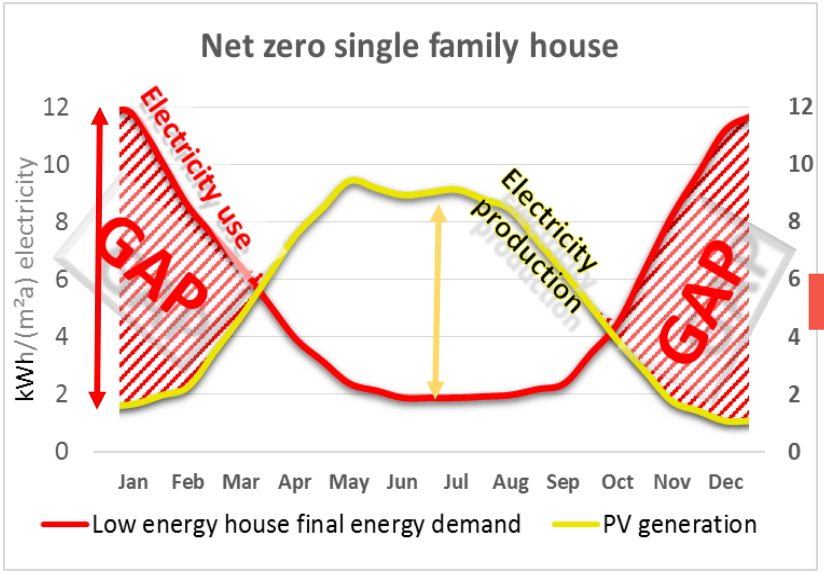
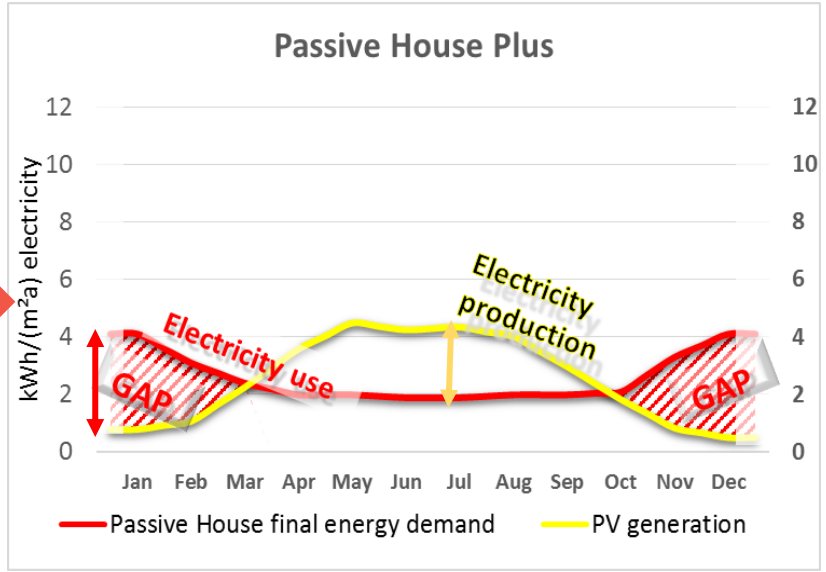


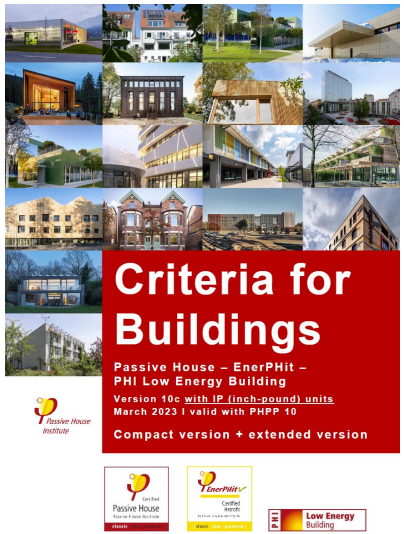


Passive House reduces demand and tunes it to the power supply.

Credit: Passive House Institute

Passive House Overview

What is Passive House?



- Passive House is a building standard
- Applies to new & existing buildings
- The most rigorous energy efficiency certification available
- Performance -based approach
- Focuses on mastering the drivers of building performance.

How we use fundamental elements matters

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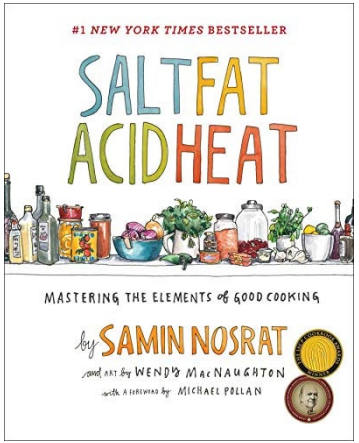
"I was working as a physicist. I read that the construction industry had experimented with adding insulation to new buildings and that energy consumption had failed to reduce. This offended me – it was counter to the basic laws of physics. I knew that they must be doing something wrong. So I made it my mission to find out what, and to establish what was needed to do it right."
- Wolfgang Feist



Passive House uniquely masters the elements of high -performance building.

Compelling Logic of Passive House

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Building industry is disconnected from the drivers of building performance.

Passive House connects the dots and transforms industry expectations & capacity

Passive House empowers the builders and designers to deliver high-performance core solutions.

Project Types – Not Just Houses!

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The House at Cornell Tech

Star Garment Factory

Betances V

Power of a simple idea

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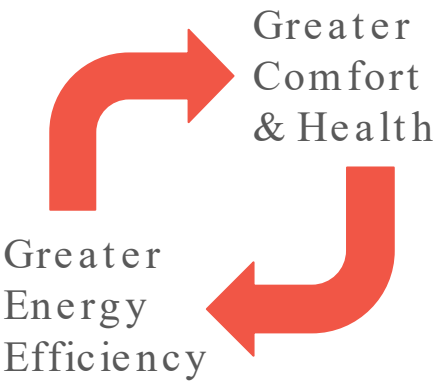
"A Passive House is a building, for ***which thermal comfort*** *(ISO 7730)* ***can be achieved*** *solely* ***by post -heating or post -cooling of the fresh air mass****, which is* ***required to achieve sufficient indoor air quality*** *conditions –* ***without the need for additional recirculation*** *of air."*

– Passive House Institute



5 Principles of Construction (the drivers)

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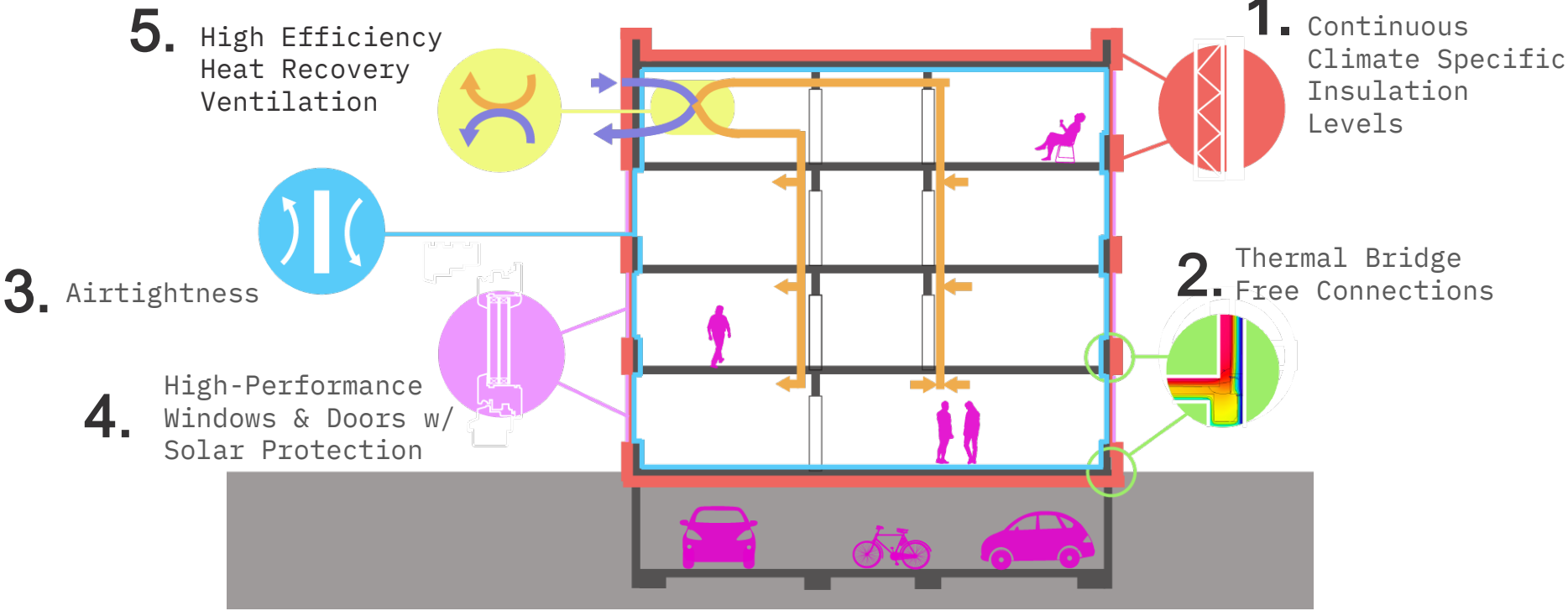

These are the 5 things builders must focus on most intently.

Right size Heating & Cooling Systems

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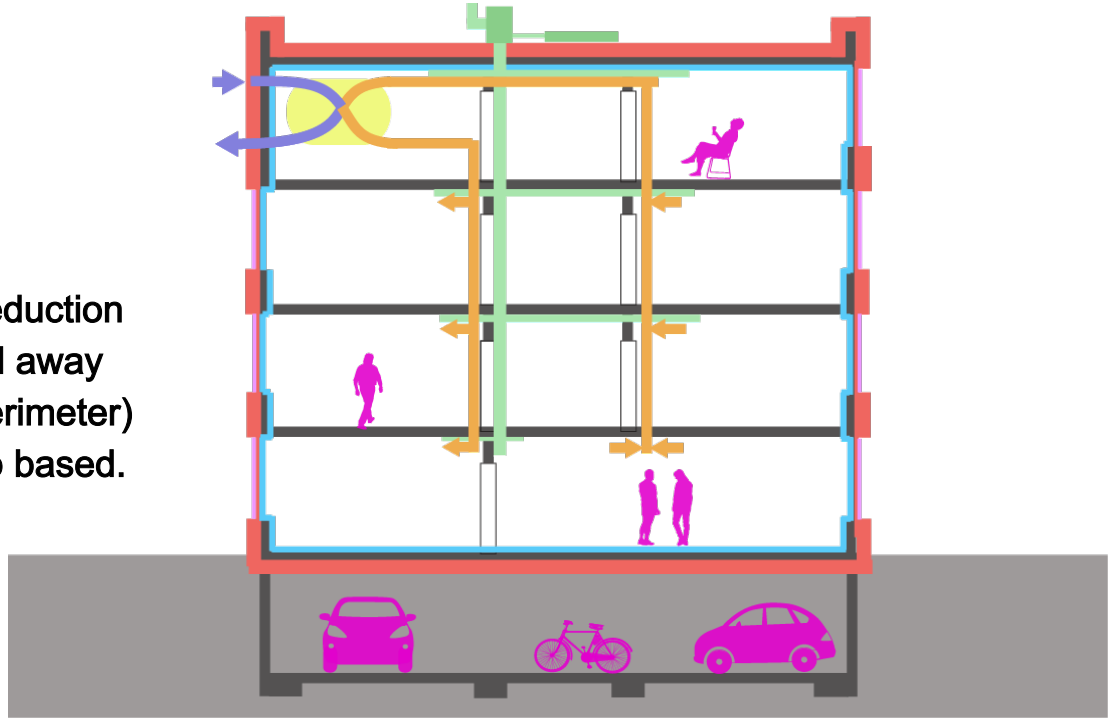
75% equip sizing reduction
Efficient distribution (Pulled away from perimeter)
Often all -electric, heat pump based.



Energy Modeling: Calculating Predictable Performance

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https://passivehouse.com/04_phpp/04_phpp.htm

Window area orientation (main orientations)	Global radiation	Shading	Dirt	Non-vertical radiation incidence	Glazing fraction	SHGC	Solar irradiation reduction factor
Standard values →	kWh/(ft²yr)	0.75	0.95	0.85			
North	14	0.56	0.95	0.85	0.58	0.50	0.26
East	33	0.79	0.95	0.85	0.63	0.50	0.40
South	62	0.81	0.95	0.85	0.74	0.50	0.49
West	34	0.81	0.95	0.85	0.63	0.50	0.41
Horizontal	53	1.00	0.95	0.85	0.00	0.00	0.00
Total or average value for all windows.						0.50	0.43

Heating degree hours [°F.day/yr]: 7440

Go to glazing list | Go to window frames list

Qua n-tity	Description	Deviation from north	Angle of inclination from the horizontal	Orien- tation	Window rough ope Width	Height	Installed in Selection from 'Areas' worksheet	Glazing Selection from 'Components' worksheet	Frame Selection from 'Components' worksheet	g-Value Perpen-dicular radiation	U-Value Glazing	Frames (avg.)	Ψ Glazing edge (Avg.)	Installation si user determined value f "1": Ψ from 'Compo "0": in the case of abut left	right	bottom
		°	°		ft	ft		1-Sorting: LIKE LIST	Sort: AS LIST	-	BTU/hr.ft².F	BTU/hr.ft².F	BTU/hr.ft².F			BTU/hr.ft².F or 1/0
1	W104	90	90	East	3.00	4.86	4-Wall_9351_E	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W107	90	90	East	3.00	4.85	4-Wall_9351_E	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W106	90	90	East	3.00	4.85	4-Wall_9351_E	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W105	90	90	East	3.00	4.85	4-Wall_9351_E	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	D125	90	90	East	3.00	6.67	4-Wall_9351_E	01ud-Triple-insulated-Kr08	03ud ADS75 Door	0.50	0.11	0.32	0.029	1	1	1
1	W155	90	90	East	3.00	4.06	4-Wall_9351_E	01ud-Triple-insulated-Kr08	01ud Sil82+Fixed	0.50	0.11	0.19	0.018	1	1	1
1	W135	270	90	West	2.33	3.50	5-Wall_9544_W	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W134	270	90	West	3.00	4.85	5-Wall_9544_W	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W133	270	90	West	3.00	4.85	5-Wall_9544_W	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W132	270	90	West	3.00	4.85	5-Wall_9544_W	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W156	270	90	West	3.00	4.06	5-Wall_9544_W	01ud-Triple-insulated-Kr08	01ud Sil82+Fixed	0.50	0.11	0.19	0.018	1	1	1
1	W140	0	90	North	2.33	2.33	6-Wall_9368_N	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W139	0	90	North	2.33	3.50	6-Wall_9368_N	01ud-Triple-insulated-Kr08	02ud Sil82+Operable	0.50	0.11	0.19	0.018	1	1	1

Decouple power & performance with fixed target

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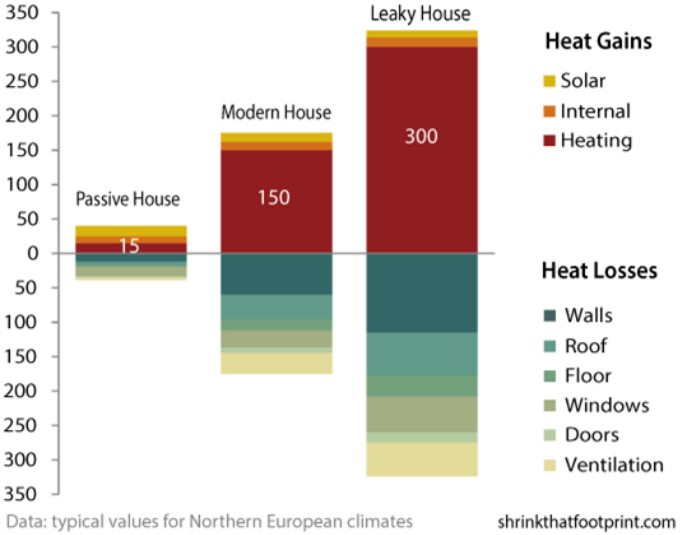
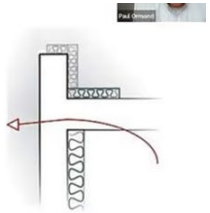
Energy Balance



Certified Passive House
Passive House Institute

Not relative improvement to a baseline.

Problem with codes…



Envelope U-value	Low Air infiltration	Ventilation energy recovery	Thermal bridge mitigation
Unlimited tradeoffs	Only recently added	Many exceptions, low expectations	Completely missing

Title 24 Res Code: a credit given when the rate of the envelope air leakage is less than five air changes per hour at 50 pascals.

Model codes (IECC/ASHRAE) have no (or low) standards w/r/t the four pillars. States must add these as adopting amendments

Credit: Massachusetts DOER

Massachusetts adopts

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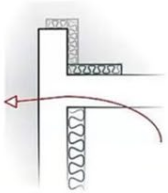
The four pillars that crush space heating

Envelope
U-value

Low Air
infiltration

Ventilation
energy recovery



Thermal bridge
mitigation

These are the four pillars of a thermal code and enable grid-friendly gas to electric swap – these will look familiar to PH experts

Credit: Massachusetts DOER

Net Zero Passive House = 50% reduction in solar

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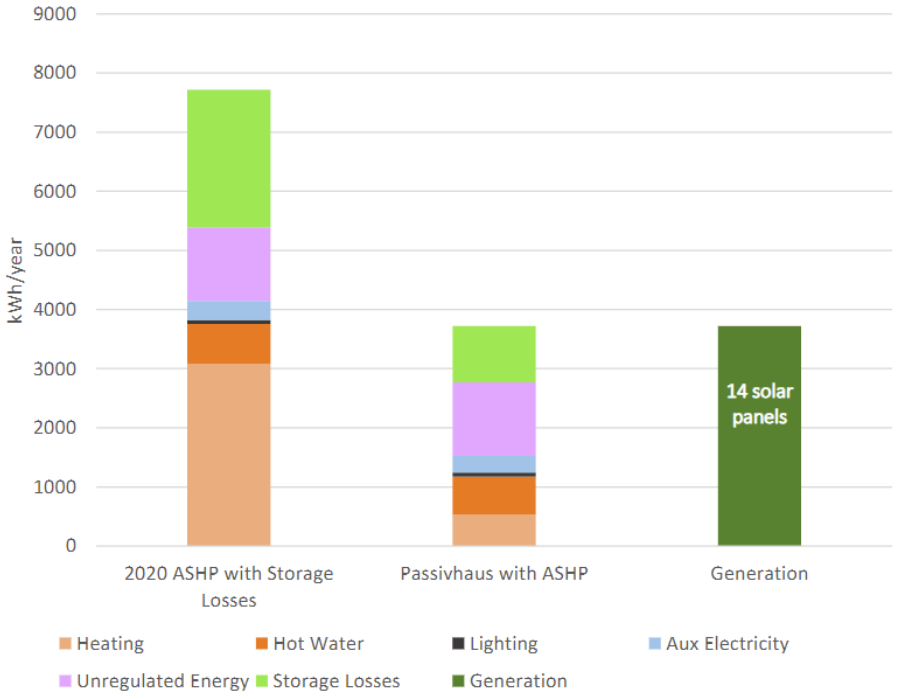
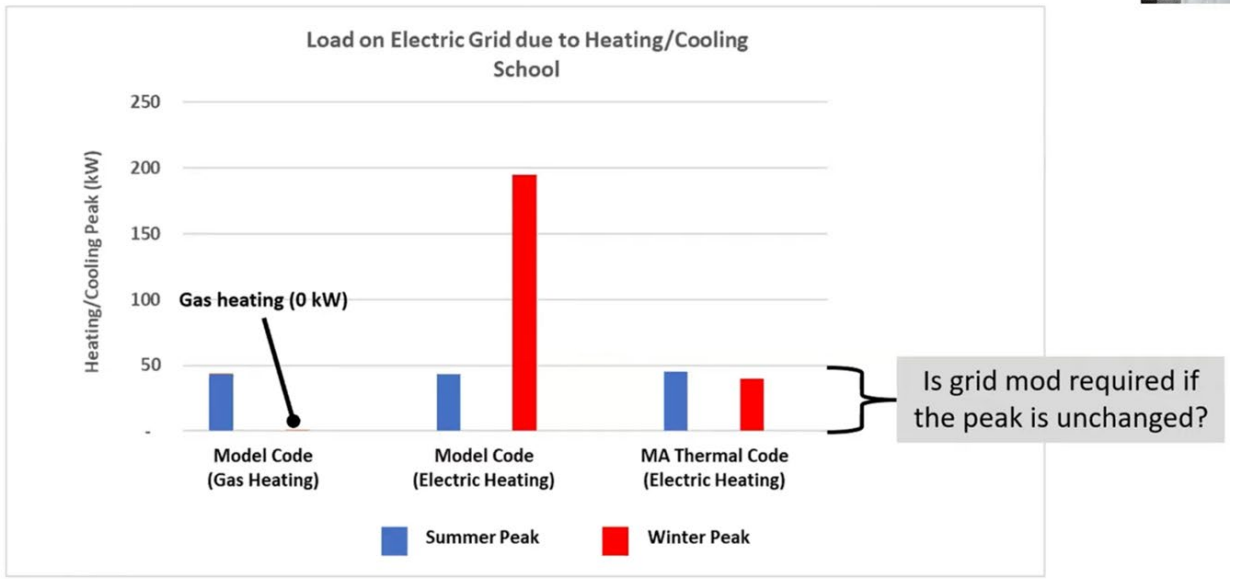


Figure 4 - Average new build energy demand vs Passivhaus

Credit: PassivhausTrust UK

Back to our school…



Crushing heating with thermal codes is essential to accomplish electrification of space heating – there is no new winter peak

Credit: Massachusetts DOER

PER & Certification Classes

Shift Focus: Analysis to fit our all renewable future

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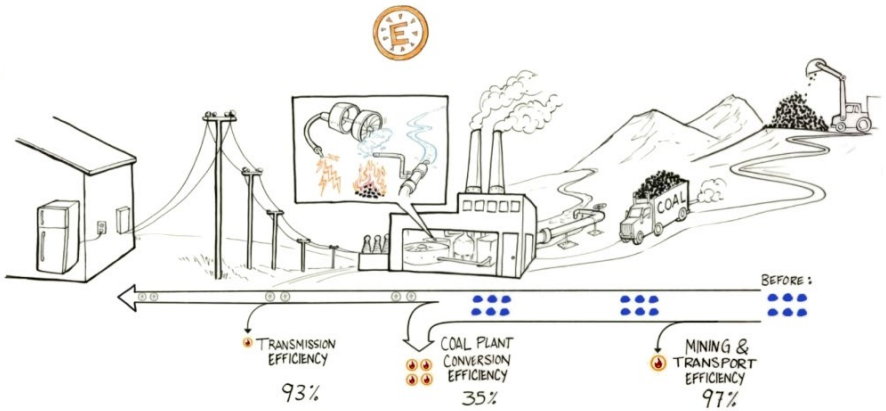
Traditional look at source energy and emissions is not effective in analyzing efficiency of an all -renewable system.



Credit: Bronwyn Barry/PassiveHouseBB

So, how can we properly assess the power supply?

Hint: PER

Shift Focus: Analysis to fit our all renewable future

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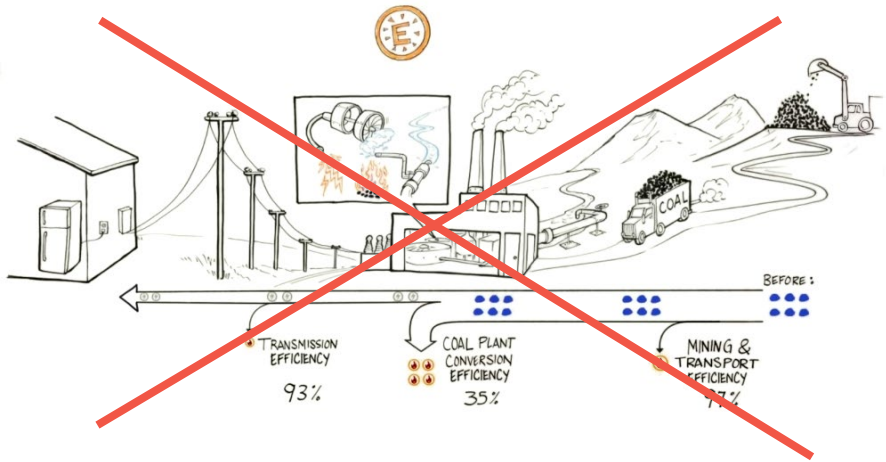
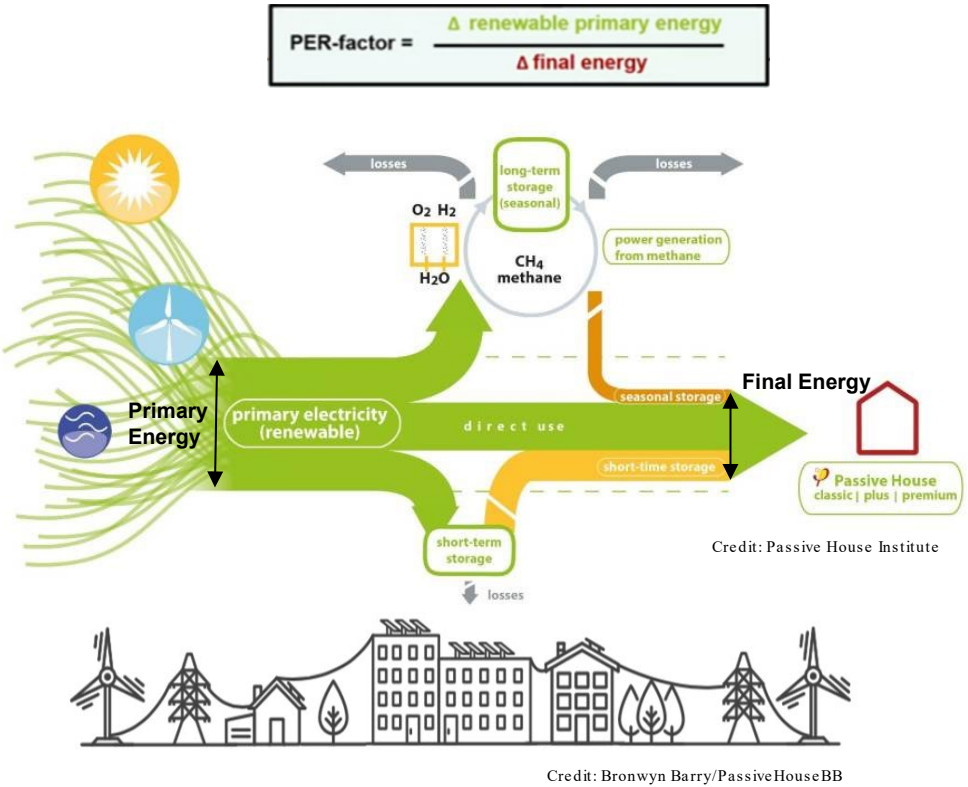
Passive House jettisons the anachronistic emissions analysis and looks at renewable production & utilization.





New Paradigm: not carbon emissions but effectiveness

The Passive House Network

New approach to all -renewable electric system bring new categories of questions.

1. Climate Specific (production)

How effective is the supply? (solar, wind, hydro)

How effective are different methods of renewable supply in my location? (climate/region/grid)

2. Use Specific

How well does our demand match supply? (seasonal alignment)

How do different demand profiles differ in matching supply? (DHW, Heating, Cooling, Dehumidification)

3. Site Specific (Production)

Best way to contribute to supply? (on-site, remote)

How to assess effective on - site use? (floor area or footprint)

4. Assessment Method

What's the best assessment method of supply & demand? (combined like net zero or independently?)

No longer a question of carbon emissions, or achieving "net zero."

Passive House Criteria: Classes & PER

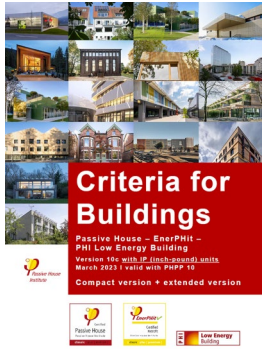


Table 1 Passive House criteria

			Criteria[1]			Alternative Criteria[2]
Heating						
Heating demand	[kBTU/(ft²yr)]	≤	4.75			-
Heating load[3]	[BTU/(hr.ft²)]	≤	-			3.17
Cooling						
Cooling + dehumidification demand	[kBTU/(ft²yr)]	≤	4.75 + variable allowance[4]			
Airtightness						
Pressurization test result n_{50}	[1/hr]	≤	0.6			
Renewable Primary Energy (PER)[5]			Classic	Plus	Premium	
PER demand[6]	[kBTU/(ft²yr)]	≤	19.02	14.26	9.51	±4.75 kBTU/(ft²yr) deviation from criteria...
Renewable energy generation[7] (with reference to projected building footprint)	[kBTU/(ft²yr)]	≥	-	19.02	38.04	...with compensation of the above deviation by different amount of generation[8]

We put a cap on total energy consumption, but how do we best ensure its effectiveness?

PER is the method.

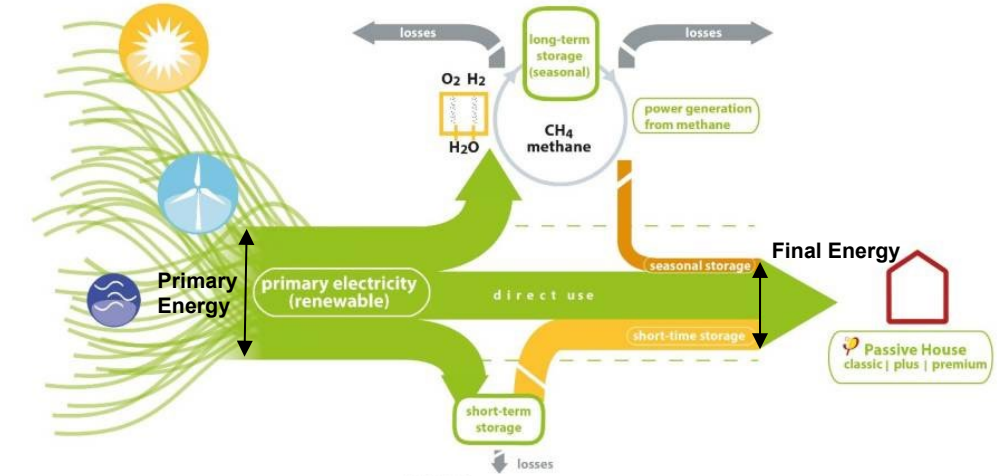
PER Approach: weighting factors to sustainably use renewable energy

The Passive House Network

$$\text{PER-factor} = \frac{\Delta \text{ renewable primary energy}}{\Delta \text{ final energy}}$$

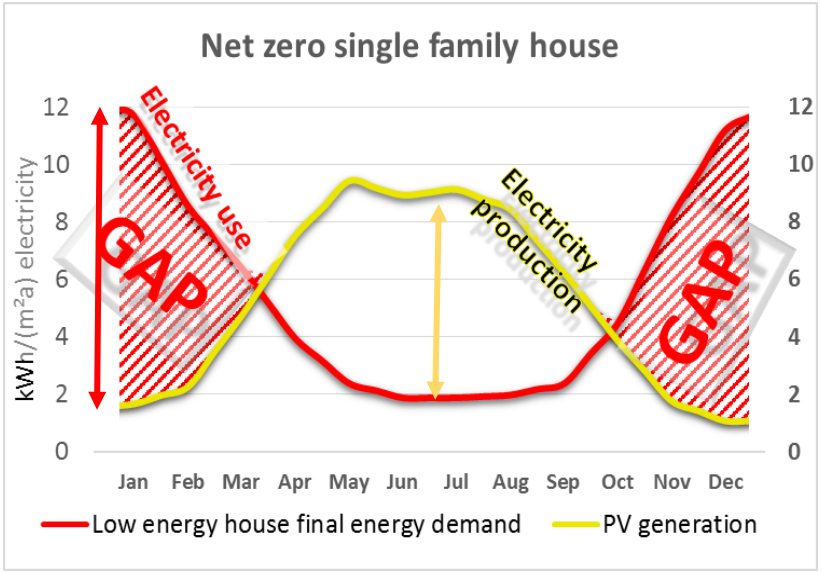
Goals:

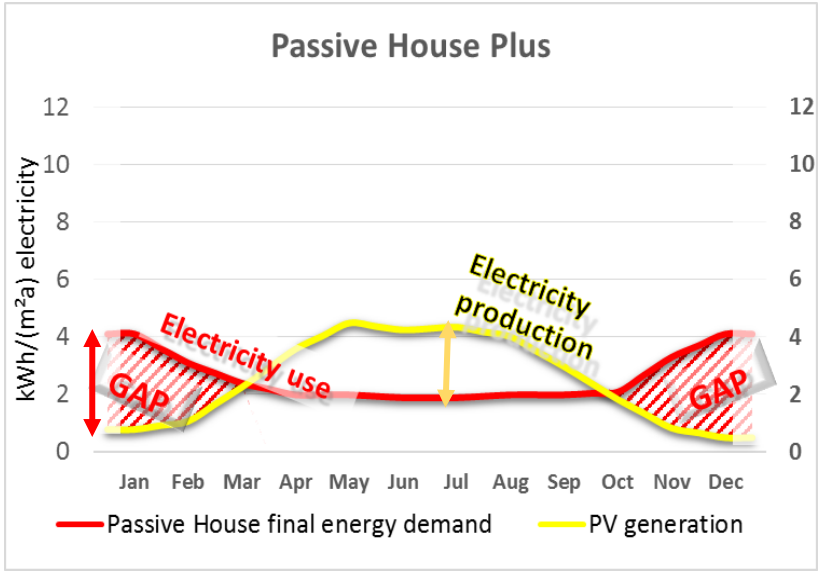
1. Maximizing simultaneity
2. Minimizing storage needs



Mismatch in time of use: Reduce Energy Demand & Gap

The Passive House Network

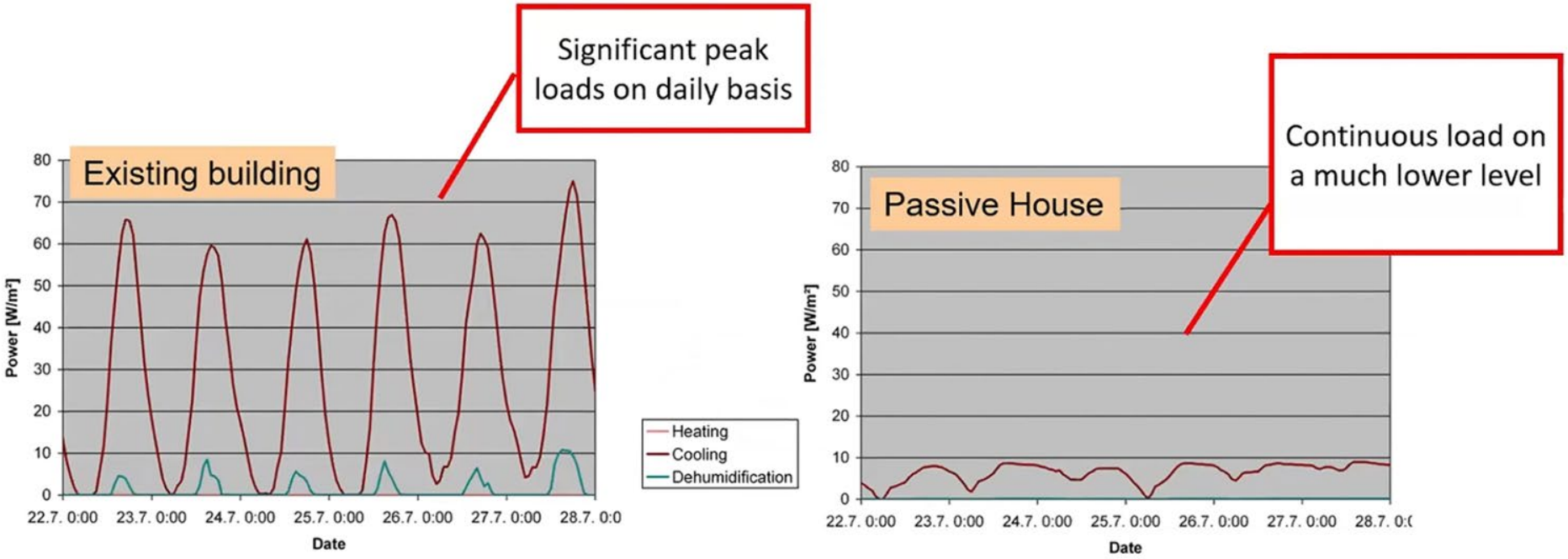




Credit: Passive House Institute

First, Reduce the Loads

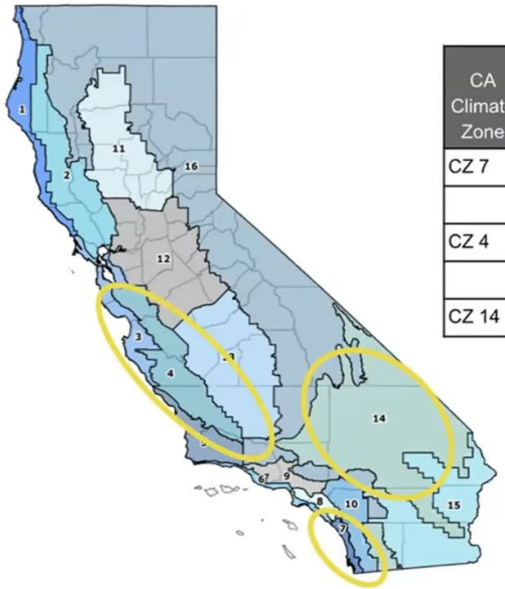
The Passive House Network



Credit: Passive House Institute

Reducing the demand in California

The Passive House Network



2020 CA Building Climate Zones Map
Source: https://gis.data.ca.gov/documents/CAEnergy::building-climate-zones/explore

CA Climate Zone	Energy use per kWh				HVAC Energy use (kWh)		
	T24	PHI	% Reduction		T24	PHI	% Reduction
CZ 7	5,364	4,864	9%		3,053	2,553	16%
CZ 4	8,210	6,201	24%		5,899	3,890	34%
CZ 14	9,882	5,125	48%		7,570	2,814	63%

Source: PHN study for CPUC - April 2023

Passive House 'Classic' *is*
CRUSHING heating & cooling loads in California in 2023!

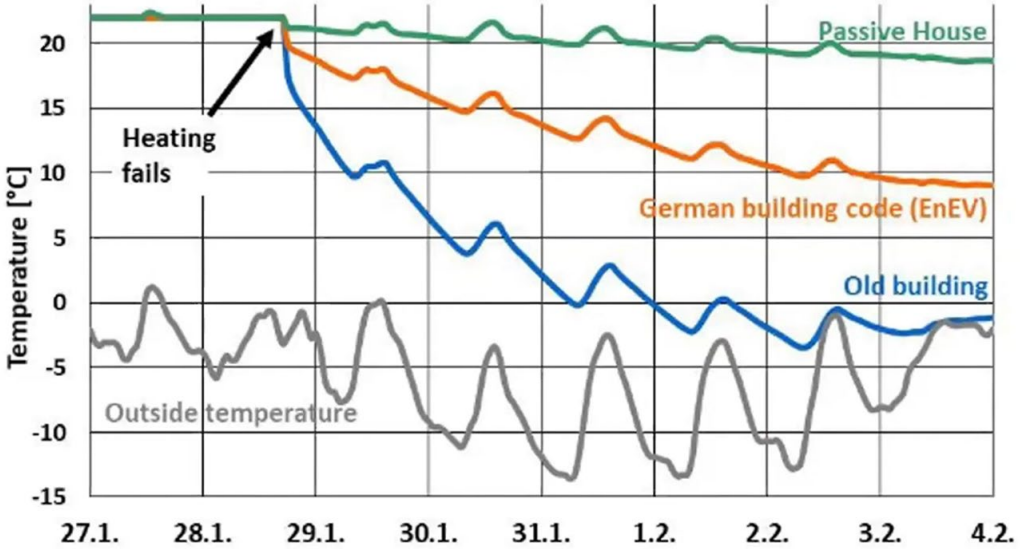
Credit: Bronwyn Barry/PassiveHouseBB

Second: Load Shifting with Thermal Resilience

The Passive House Network

Because thermal temperatures are stable there is much greater flexibility in when the space conditioning happens.

Think thermos.



Credit: Passive House Institute

Passive House Crushes Summer Peak & Shifts Loads

The Passive House Network

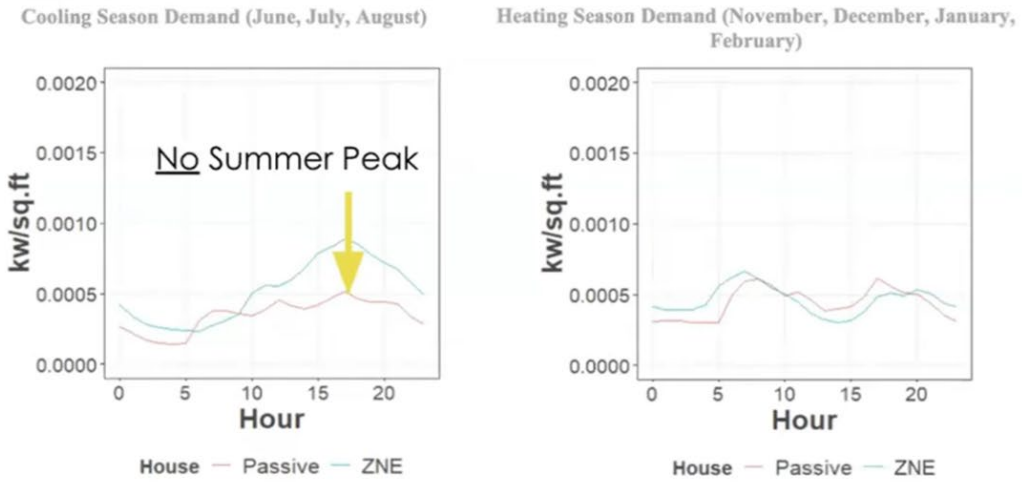


Figure 2. Passive House and ZNE Seasonal Load Comparisons

Hourly monitoring data:

- ❏ 5 ZNE homes vs.
- ❏ 2 Passive House homes

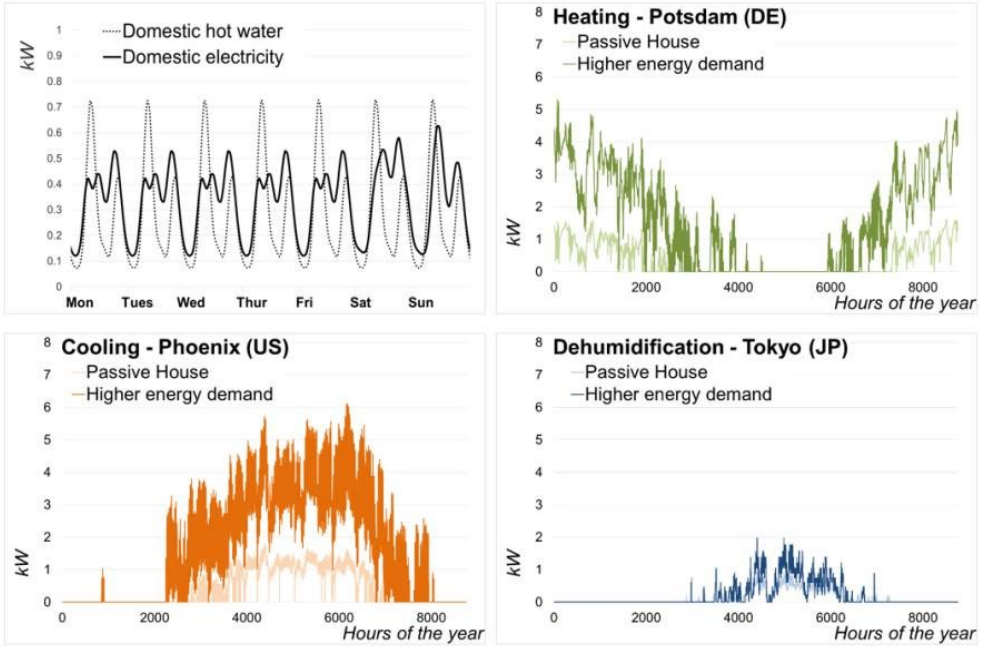
Credit: Bronwyn Barry/PassiveHouseBB

Specific Use Demands & Different Climates:

The Passive House Network

Use Categories

1. Heating
2. Cooling
3. Dehumidification
4. Hot Water
5. Other Elec Uses



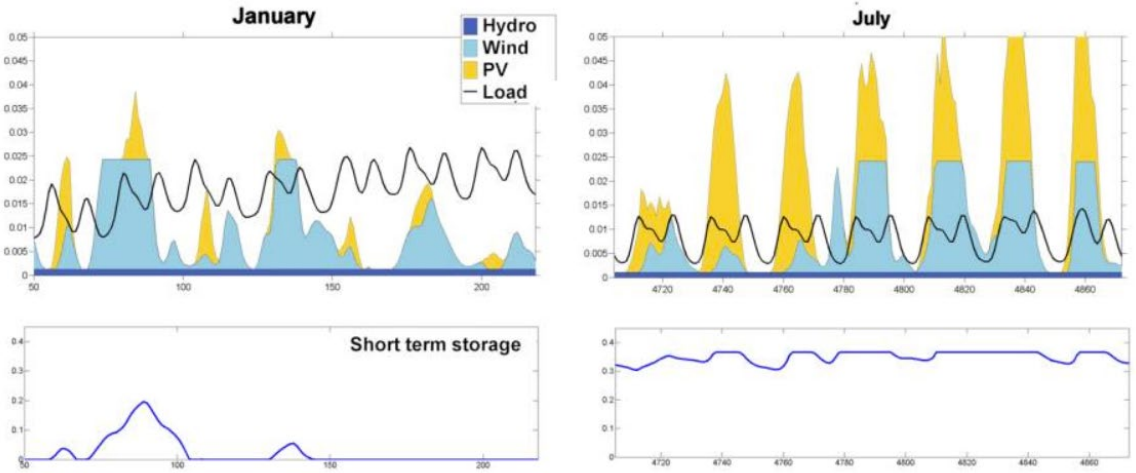
Top left: Load profile for one week of the household electricity and domestic hot water (cold water temperature for Mannheim, Germany, Winter). Top right and below: Exemplary useful energy profiles from different climates for heating, cooling and dehumidification.

Credit: Passive House Institute

Match of Supply to Use Determines Storage Need

The Passive House Network

No storage. Need long term storage.



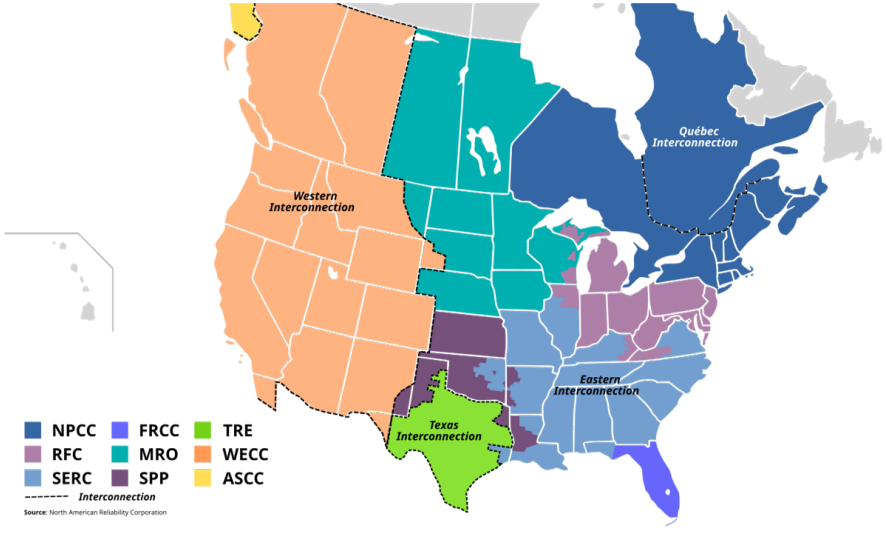
No shortage of short term storage.

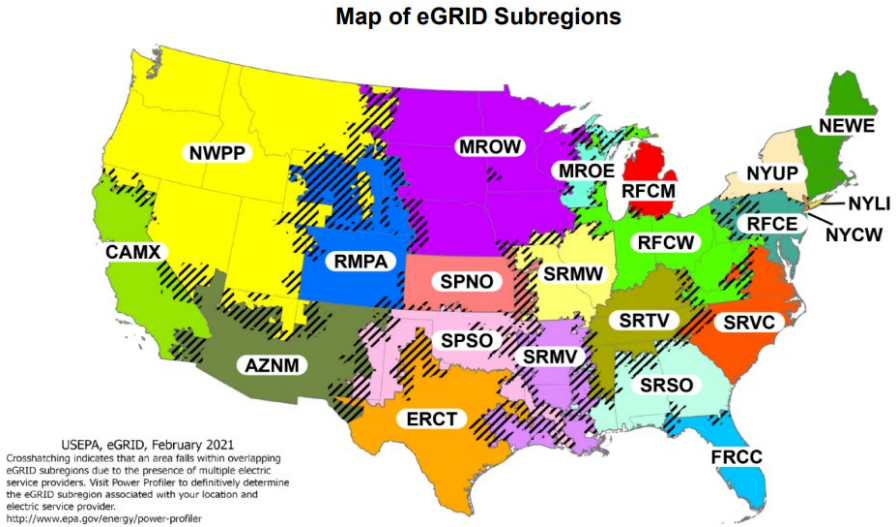
Example of hourly load profiles of RE electricity (cumulative) and electricity demand for a Passive House in Stuttgart. The left represents a week during winter with little RE availability, compared to a week during summer on the right, with much higher RE supply. The two graphs below show the simultaneous storage level of the short-term storage.

Credit: Passive House Institute

Different Grids Have Different Potential Utilization

The Passive House Network





No building stands alone: regions, grids, nations - it all blends.

What your doing and where you're doing it matters.

The Passive House Network

PER weighting factors different for:

- Electricity use → consumer specific
- Location → climate specific

Graphs: Passive House Institute

Electric Factors are regionally, climate, and consumer use specific

Still have fossil fuels: converted to renewable equivalent

The Passive House Network

energy carrier	PER-factor
electricity	climate and consumer specific
gas	1.75 *methane from renewables (power-to-gas efficiency)*
biomass	1.1 with limited budget
CHP *district heating*	*assessment of system efficiency compared to alternative power plant*
heating oil	2.3 *methanol from renewables (power-to-liquid)*

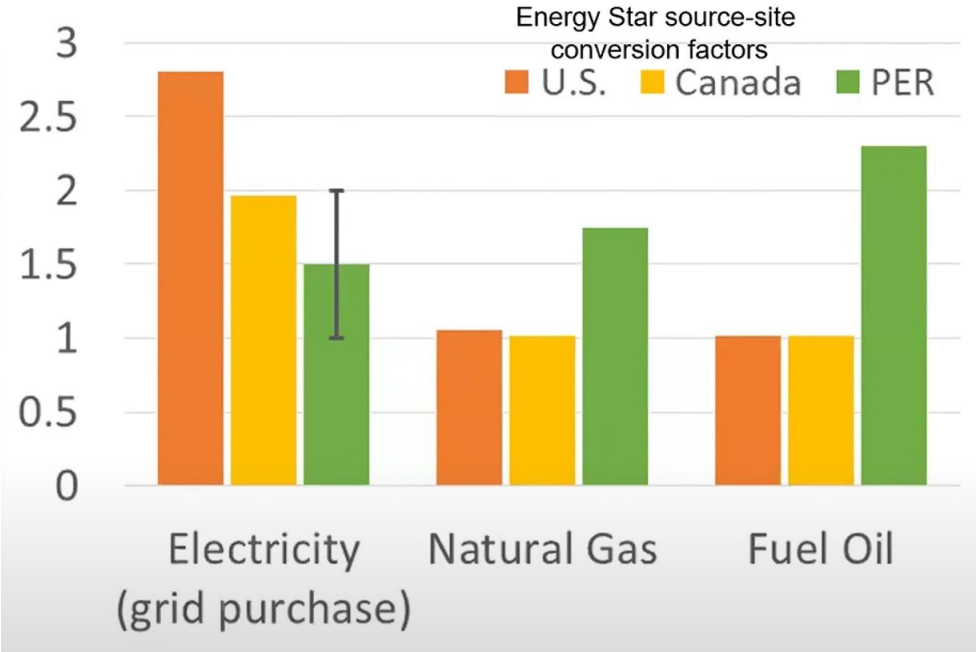
Traditional Weighting vs. PER

The Passive House Network

Figure 1 – Source-Site Ratios for all Portfolio Manager Energy Meter Types

Energy Type	U.S. Ratio	Canadian Ratio	PER factor
Electricity (Grid Purchase)	2.80	1.96	1 - 2 depending on use
Electricity (Onsite Solar or Wind - regardless of REC ownership)	1.00	1.00	
Natural Gas	1.05	1.01	1.75
Fuel Oil (No. 1,2,4,5,6, Diesel, Kerosene)	1.01	1.01	2.3
Propane & Liquid Propane	1.01	1.04	
Steam	1.20	1.33	
Hot Water	1.20	1.33	
Chilled Water	0.91	0.57	
Wood	1.00	1.00	
Coal/Coke	1.00	1.00	
Other	1.00	1.00	

Traditional Conversions vs. PER



Credit: Passive House Institute

Results in PER numbers adjusted to place & use

Credit: Bronwyn Barry/PassiveHouseBB

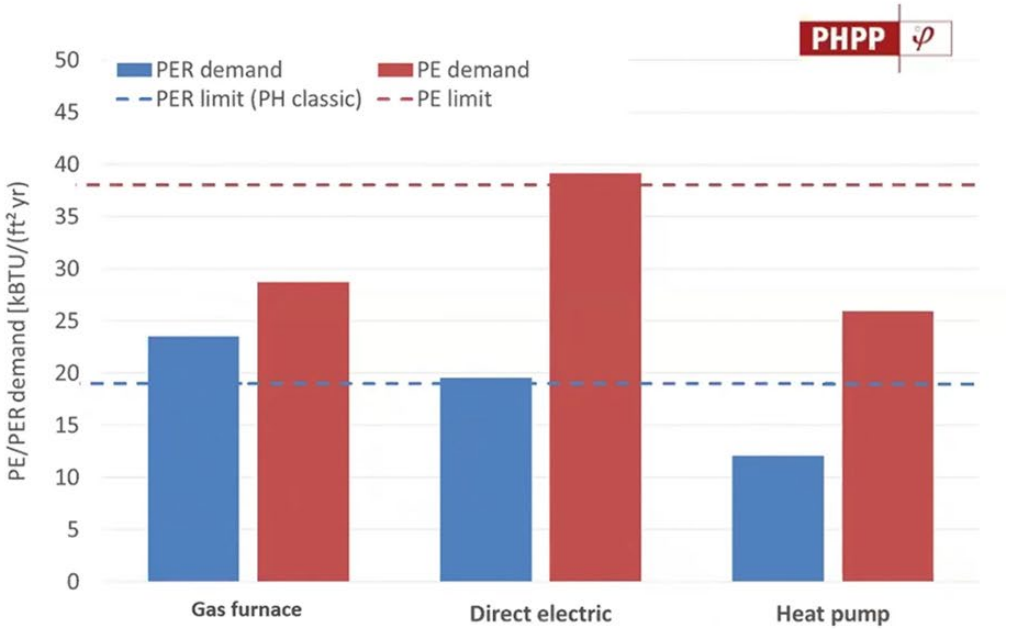
PER Assesment for California's Largest Cities						
Utility	PG&E			SMUD	LADWP	SDG&E
City	San Francisco	San Jose	Fresno	Sacramento	Los Angeles	San Diego
Energy demand	Primary Energy Renewables (PER) factor					
Reference: Treated floor area	kBTU/kBTU					
Heating						
Electricity	1.70	1.70	1.75	1.80	1.50	1.30
District heating: 20-Gas CGS	0.85|1.32|	0.85|1.32|	0.85|1.36|	0.85|1.39|	0.85|1.16|	0.85|1.01|
70% PHC	0.97	0.97	0.97	0.97	0.93	0.93
Wood and other biomass	1.10	1.10	1.10	1.10	1.10	1.10
Natural gas / RE gas	1.75	1.75	1.75	1.75	1.75	1.75
Oil, Coal, Methanol / RE methan	2.30	2.30	2.30	2.30	2.30	2.30
Cooling and dehumidification						
Electricity cooling	1.00	1.00	1.05	1.00	1.15	1.25
Electricity dehumidification	1.05	1.10	1.15	1.00	1.40	1.55
DHW generation						
Electricity (heat pump)	1.25	1.25	1.25	1.25	1.20	1.20
District heating: 20-Gas CGS	0.85|1.32|	0.85|1.32|	0.85|1.36|	0.85|1.39|	0.85|1.16|	0.85|1.01|
70% PHC	0.97	0.97	0.97	0.97	0.93	0.93
Wood and other biomass	1.10	1.10	1.10	1.10	1.10	1.10
Natural gas / RE gas	1.75	1.75	1.75	1.75	1.75	1.75
Heating oil / Methanol	2.30	2.30	2.30	2.30	2.30	2.30
Solar thermal system	0.27	0.28	0.29	0.28	0.30	0.30
Other building energy uses						
Electricity lighting, etc.)	1.25	1.25	1.25	1.25	1.20	1.20
Auxiliary electricity (other)	1.25	1.25	1.25	1.25	1.20	1.20
Gas / RE gas dry/cook	1.75	1.75	1.75	1.75	1.75	1.75
Energy generation	PER					
Reference: Projected Footprint Area	PER factor					
	kBTU/kBTU					
PV electricity	1.00	1.00	1.00	1.00	1.00	1.00
Solar thermal system	0.27	0.28	0.29	0.28	0.30	0.30
User determined energy carrier	0.00	0.00	0.00	0.00	0.00	0.00

Source: PHPPv.9

Credit: Bronwyn Barry/PassiveHouseBB

PER makes fossil use difficult in Berkeley CA

Based on certified Passive House project in Berkeley, California
ID 6064 on www.passivehouse-database.org



Credit: Passive House Institute

Supply : Shifts to Independent Assessment

The Passive House Network

The question is how to most effectively contribute to the power supply?

Supply: Shift to Independent Assessment

The Passive House Network

Net Zero goes away. Instead: How are we utilizing the building footprint?

Calculation of the projected building footprint

Supply: Shift to Independent Assessment

The Passive House Network

Consequently, we don’t penalize tall buildings.

Calculation of the projected building footprint

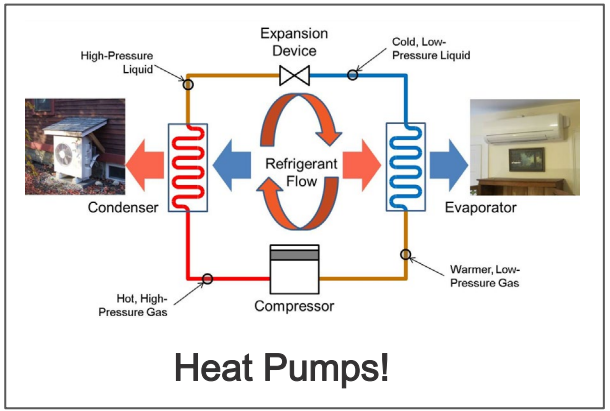
Electrified Systems

What are the systems & options for electrification?

The Passive House Network

Occupancy:

1. Single Family
2. Multifamily



PER Use Categories

1. Heating - Heat Pumps
2. Cooling - Heat Pumps
3. Dehumidification - Heat Pumps
4. Domestic Hot Water - Heat Pumps
5. Other Elec Uses
    a. Ventilation
    b. Cooking (induction)
    c. Clothes Drying (resistance or heat pump)
    d. LED lighting & misc plug loads.
    e. Car

Single Family: Heating, Cooling & Dehumidification

The Passive House Network

Much smaller load and great flexibility in locating distribution outlets: surface mounted, recessed, ducted.

Single Family: Domestic Hot Water

The Passive House Network

Much smaller load and great flexibility in locating distribution outlets: surface mounted, recessed, ducted.

Considerations:

- Heat pump inside is loud.
- If heat exchange is not ducted, will likely cause thermal discomfort.

Packaged unit with heat pump on top of tank & ducted to exterior.

Split unit with heat pump outside similar to AC.

Other Electrical Uses

The Passive House Network

Ventilation Units: Efficiency is critical - both heat recovery & fan power.

CERTIFIED COMPONENT
Passive House Institute

Induction Cooktops & Elec Ovens:

ENERGY STAR

Unvented Condensing or Heat Pump Clothes Dryer

Car

The Passive House Network

Cars are not calculated in the home energy demand of a Passive House.

HOWEVER, the reduction in energy demand Passive House provides, can effectively deliver free car charging.

Multifamily Ventilation

The Passive House Network

Systems can be centralized or decentralized.

Decentralized - unit by unit, can use the residential systems.

Centralized are higher capacity, often roof mounted, with duct risers delivering to whole building.

Swegon

CERTIFIED COMPONENT
Passive House Institute

VENTACITYSYSTEMS
Making Buildings Healthy – Efficient – Smarter

Centralized Certified Units

Multifamily Heating & Cooling & Dehumidification

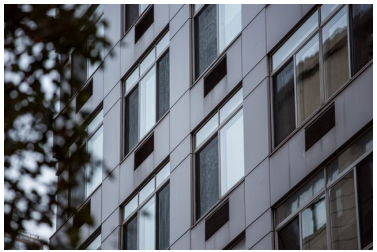
The Passive House Network

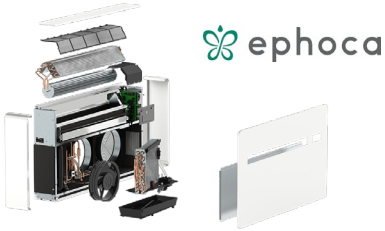
Also heat pump dominated.

Systems can be centralized or decentralized.

To **limit refrigerant lines** , distribution may be through hydronic piping to local distribution coils, OR, by using Package Terminal Heat Pumps.

Centralized Air -Source Heat Pumps With Distribution Zones





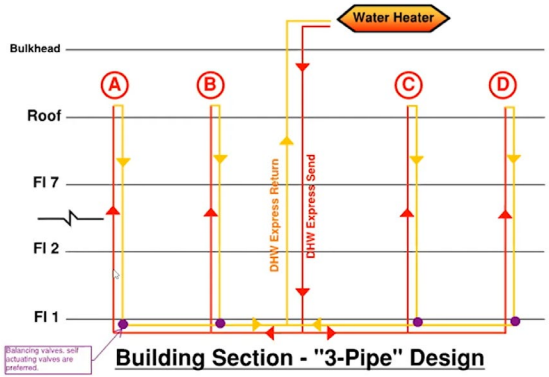
Decentralized Through -Wall Package Terminal Heat Pumps (PTHP)

Multifamily Domestic Hot Water

The Passive House Network

Also heat pump dominated.

Systems can be centralized or decentralized.



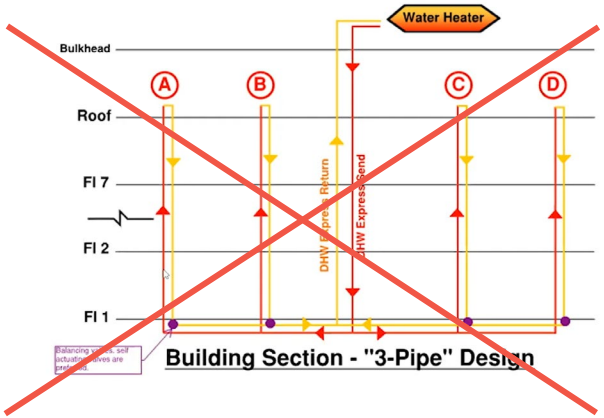
Credit: Steven Winter Associates

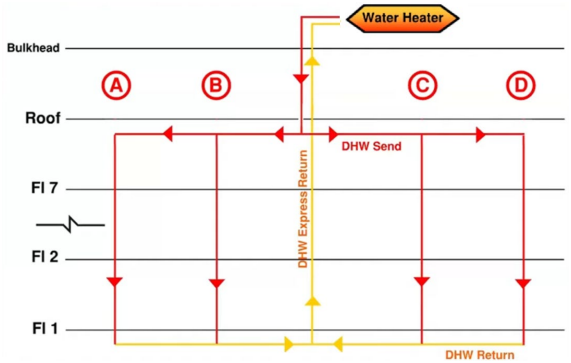
Multifamily Domestic Hot Water

The Passive House Network

Also heat pump dominated.

Systems can be centralized or decentralized.





Credit: Steven Winter Associates

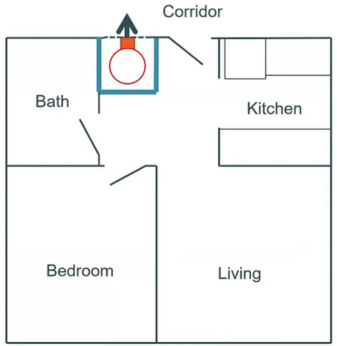
Multifamily Domestic Hot Water: Decentralized

The Passive House Network

Efficient piping runs.

Individual Hot Water Heat Pumps.

Duct to, and access from the corridor, for best performance.



Credit: Steven Winter Associates

Case Studies in California & Beyond

Sunnyvale CA Retrofit

The Passive House Network

- 1500 SF
- Heating load – 4795 BTU/1405 watts
- Cooling load – 2650 BTU/775 watts
- Net zero – 9 kW solar PV system

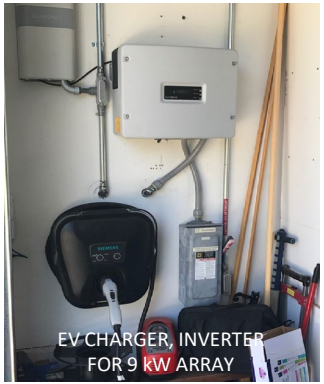
Credit: Bronwyn Barry/PassiveHouseBB

Equipment


INDUCTION COOKTOP WITH DIRECT VENT TO EXTERIOR


80 GA SE ACCELERA 300 HEAT PUMP WATER HEATER


1-TON DUCTED MINI-SPLIT HEAT PUMP (ECM MOTOR)

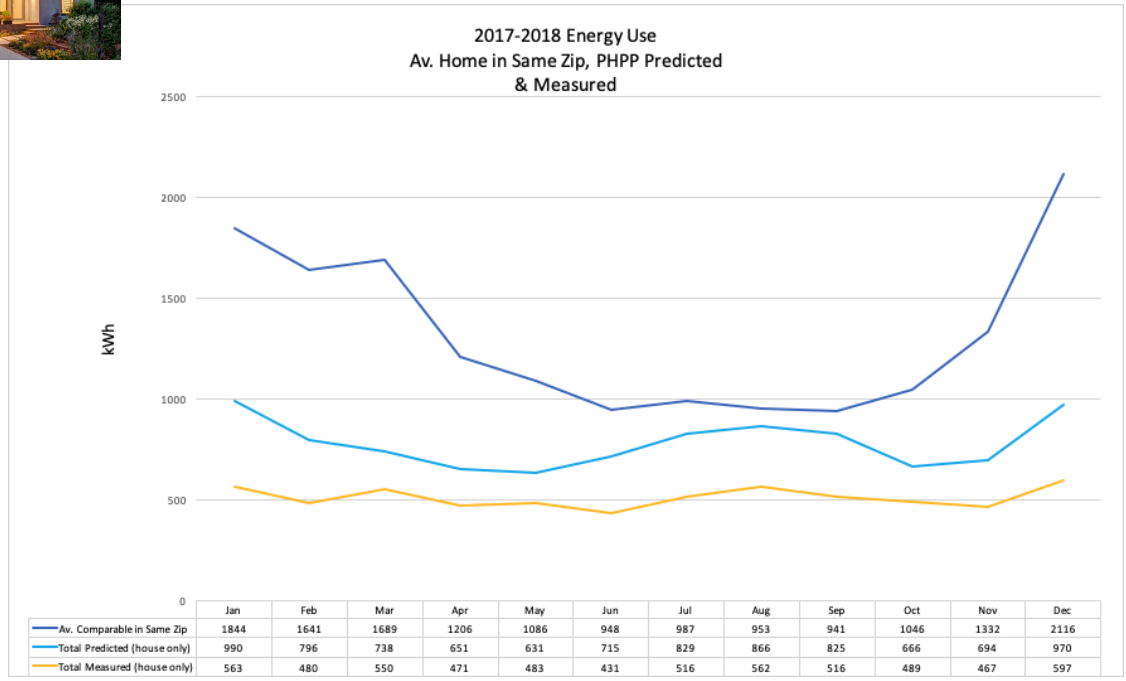

EV CHARGER, INVERTER FOR 9 kW ARRAY


ZEHNDER COMFOAIR 350 HEAT RECOVERY VENTILATOR


FUJITSU COMPRESSOR (VERY LOW DB RATING)

Credit: Bronwyn Barry/PassiveHouseBB

Crushing Heat Demand (& Total Energy)



	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

TOTALS:
Av. Home in Same Zip:
15,788 kWh

Passive House:
6,125 kWh

= 38% of standard

DIFFERENTIAL AT WINTER PEAK:
Av. Home in Same Zip:
2,516 kWh

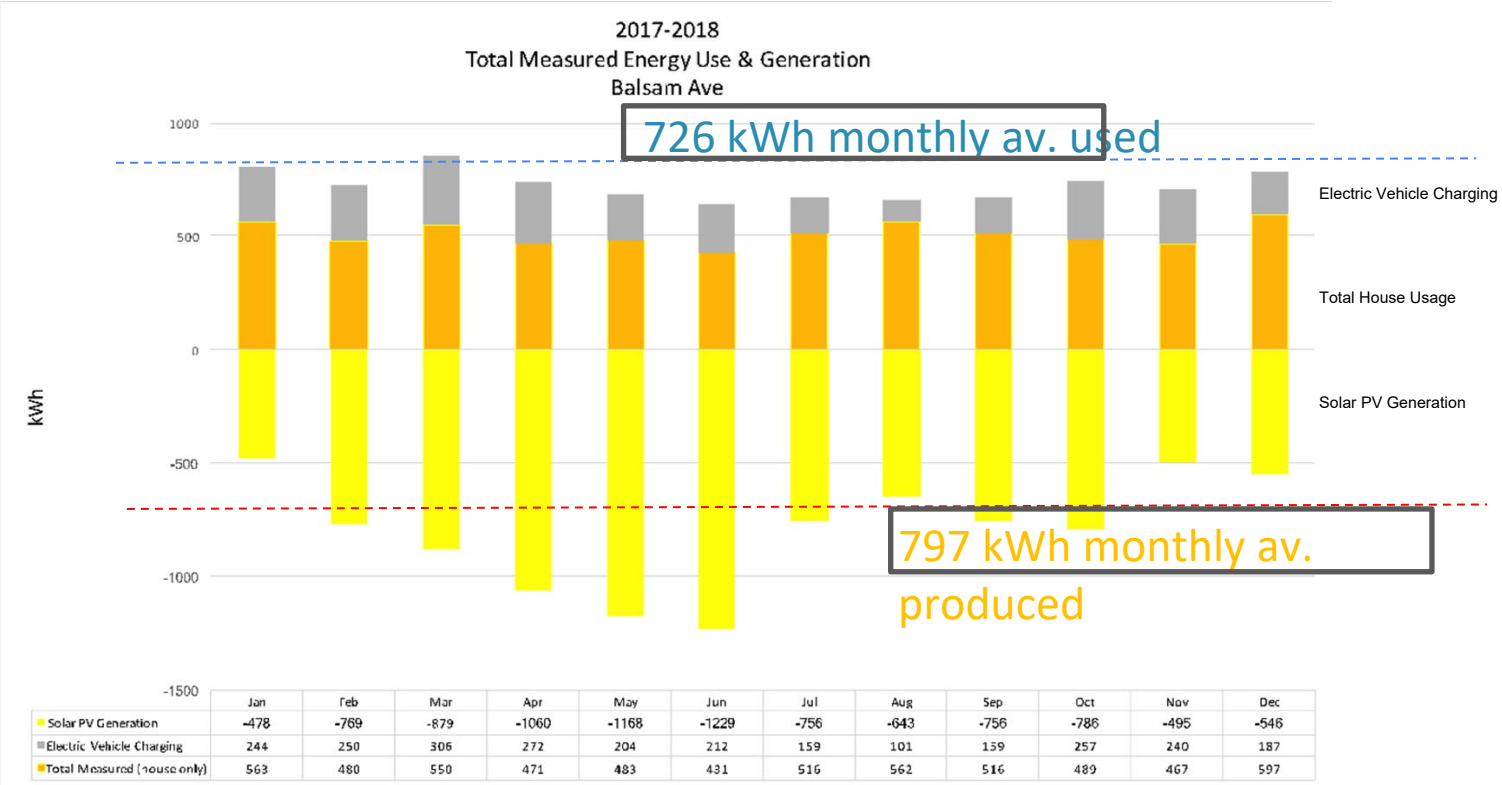
Passive House:
597 kWh

= 23% of standard

Credit: Bronwyn Barry/PassiveHouseBB

Tuned Performance for “True Net Zero” w/ car

The Passive House Network



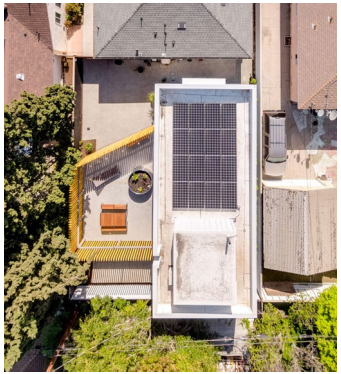
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar PV Generation	-478	-769	-879	-1060	-1168	-1229	-756	-643	-756	-786	-495	-546
Electric Vehicle Charging	244	250	306	272	204	212	159	101	159	257	240	187
Total Measured (house only)	563	480	550	471	483	431	516	562	516	489	467	597

Credit: Bronwyn Barry/PassiveHouseBB

Single Family: Los Angeles

The Passive House Network

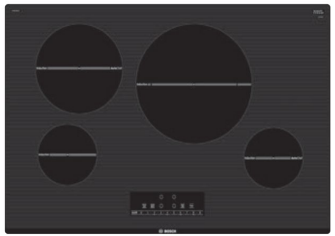
- 1791 SF
- Heating load – 1850 BTU/540 watts
- Cooling load – 5400 BTU/1580 watts
- Net Zero with 9kW Solar PV



Credit: Paravant Architects

Equipment

- Induction cooktop
- Condensing dryer
- Heat pump water heater
- Mini-split heating/cooling
- Heat recovery ventilation
- Exterior shades



Hotel Marcel: Certified Retrofit, New Haven CT

The Passive House Network

- 90,000 SF
- 165 Guest Rooms, Conf Center, Restaurant
- 1.5 MWh microgrid with over 1,000 solar panels

EnerPHit Certified Retrofit Passive House Institute

Credit: Becker + Becker Architects

All Electric Hot Water

The Passive House Network

Mitsubishi Heat20 air source heat pumps

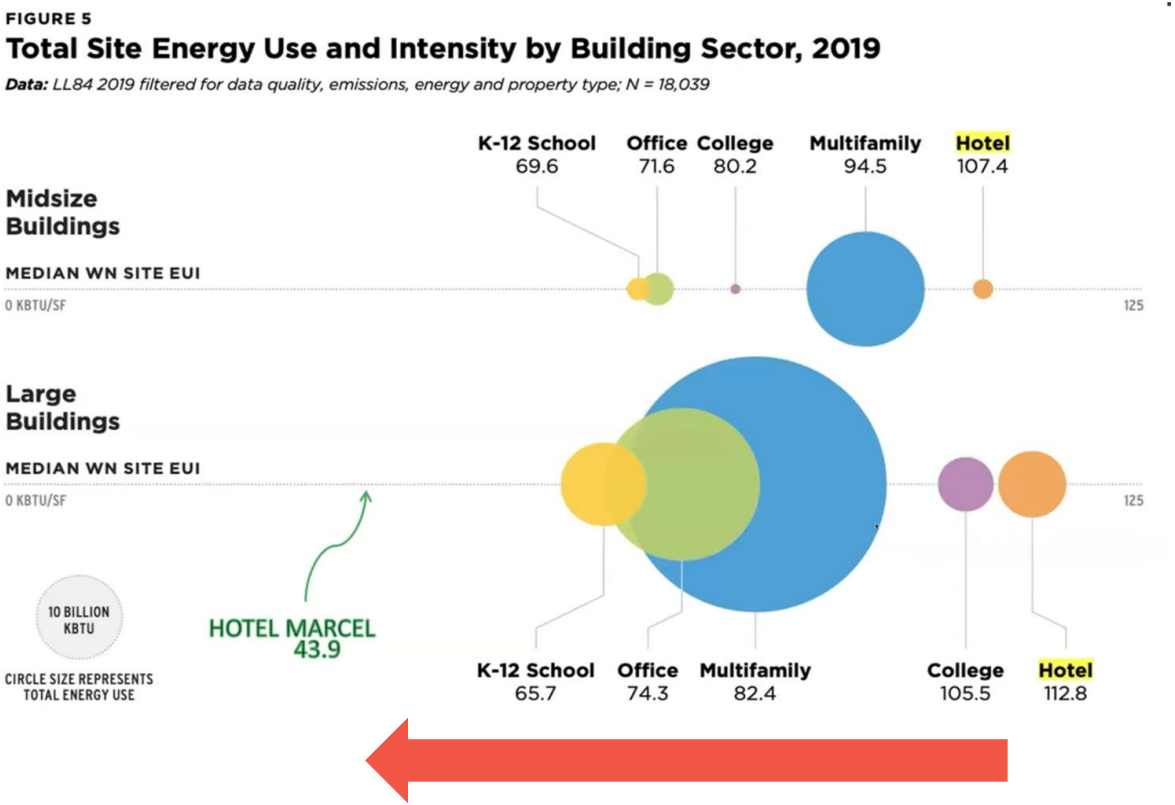
Credit: Becker + Becker Architects

Commercial Electric Dryers & Kitchen!

Electrolux Heat Pump Dryers

60% Reduction in Energy Use

The Passive House Network



Resources

Resources

The Passive House Network

Building Database - https://passivehouse-database.org/index.php?lang=en
Certification Criteria - https://passivehouse.com/03_certification/02_certification_buildings/08_energy_standards/08_energy_standards.html
Certification Guide - https://passivehouse.com/03_certification/02_certification_buildings/09_guide/09_guide.html
Certified Components - https://database.passivehouse.com/en/components/
Certifiers Globally - https://passivehouse.com/03_certification/02_certification_buildings/03_certifiers/01_accredited/01_accredited.html
Certified Passive House Designer Training - https://passivehousenetwork.org/designer-training/
Certified Passive House Tradesperson Training - https://passivehousenetwork.org/tradesperson-training/
ISO 9972 - https://www.iso.org/standard/55718.html
Manager Declaration Sample - https://passipedia.org/_media/picopen/construction_manager_declaration.pdf
North American Certifiers Circle - https://passivehousenetwork.org/wp-content/uploads/2023/01/NACC-Brochure-Jan-2023.pdf
Passipedia - https://passipedia.org/start
Passive House Certification - https://passivehousenetwork.org/certification/
Passive House Definition - https://passipedia.org/basics/the_passive_house_-_definition
Passive House - Historical Review - https://passipedia.org/basics/the_passive_house_-_historical_review
Passive House Planning Package (PHPP) - https://passivehouse.com/04_phpp/04_phpp.htm
PER-Factors for electricity use: Location & application specific decarbonization - https://passipedia.org/certification/passive_house_categories/per___
Primary Energy Renewable PER - https://passipedia.org/basics/energy_and_ecology/primary_energy_renewable_per___
Safe at Home PHN Report - https://passivehousenetwork.org/safe-at-home/
Sample Submission Documents - https://passipedia.org/certification/certified_passive_houses/example_documents
Summer Comfort - https://passipedia.org/planning/summer_comfort
Thermal Comfort - https://passipedia.org/basics/building_physics_-_basics/thermal_comfort
Vancouver Passive House Checklist - https://passivehousenetwork.org/wp-content/uploads/2024/07/Vancouver-Passive-House-Verification-Plan-Checklist-2023.pdf
Ventilation Duct Leakage Testing - https://passivehousenetwork.org/product/multifamily-ventilation-duct-leakage-targets-strategies-and-lessons-learned/

Thank you.

www.passivehousenetwork.org

Questions about Title 24?

3C-REN offers a *free* Code Coach Service

Online:
3c-ren.org/codes

Call:
805.781.1201

Energy Code Coaches are local experts who can help answer your Title 24 questions. Coaches have decades of experience in green building and energy efficiency improvements. They can provide citations and offer advice for your project to help your plans and forms earn approval the first time.

Closing

- Continuing Education Units Available
  - Contact info@3c-ren.org for AIA LUs
- Coming to Your Inbox Soon!
  - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
  - **September 30 – October 4 - Passive Design/Build Boot Camp with Emu Passive – Hands On Training and Exam**
  - October 9- All-Electric Retrofits with Electrical Panel Constraints
  - October 10 – Certified Passive House Designer/Consultant (CPHD) Pacific Fall Hybrid Cohort
  - October 15 – A Builder's Perspective on Zero Net Energy
  - October 18- Building the Future: Electrification Strategies for Electricians
- Visit www.3c-ren.org/events for our full catalog of trainings.

Thank you!

For more info:
3c-ren.org

For questions:
info@3c-ren.org

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SAN LUIS OBISPO • SANTA BARBARA • VENTURA