BERKELEY LAB
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U.S. DEPARTMENT OF ENERGY

Air tightness requirements for high performance homes in mild climates

AIVC Workshop

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Building AMERICA
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STATE OF CALIFORNIA
ENERGY COMMISSION

What is air tightness link to “high performance”

Control building air flows to achieve:

- Less energy use & less peak load – climate-related
- Good IAQ:
  - Moisture
  - Health
  - Odour
  - Comfort (drafts)
  - Clean (leaky homes are dusty homes)

Air Flow = mechanical ventilation & natural infiltration (**tightness and weather**)

What is a “Mild” climate?

California

City	HDD	CDD
Oakland	**1485**	**166**
San Francisco	**1494**	**80**
Los Angeles	**719**	**323**
Sacramento	*1386*	*674*
Fresno	*1420*	*1092*

New Zealand

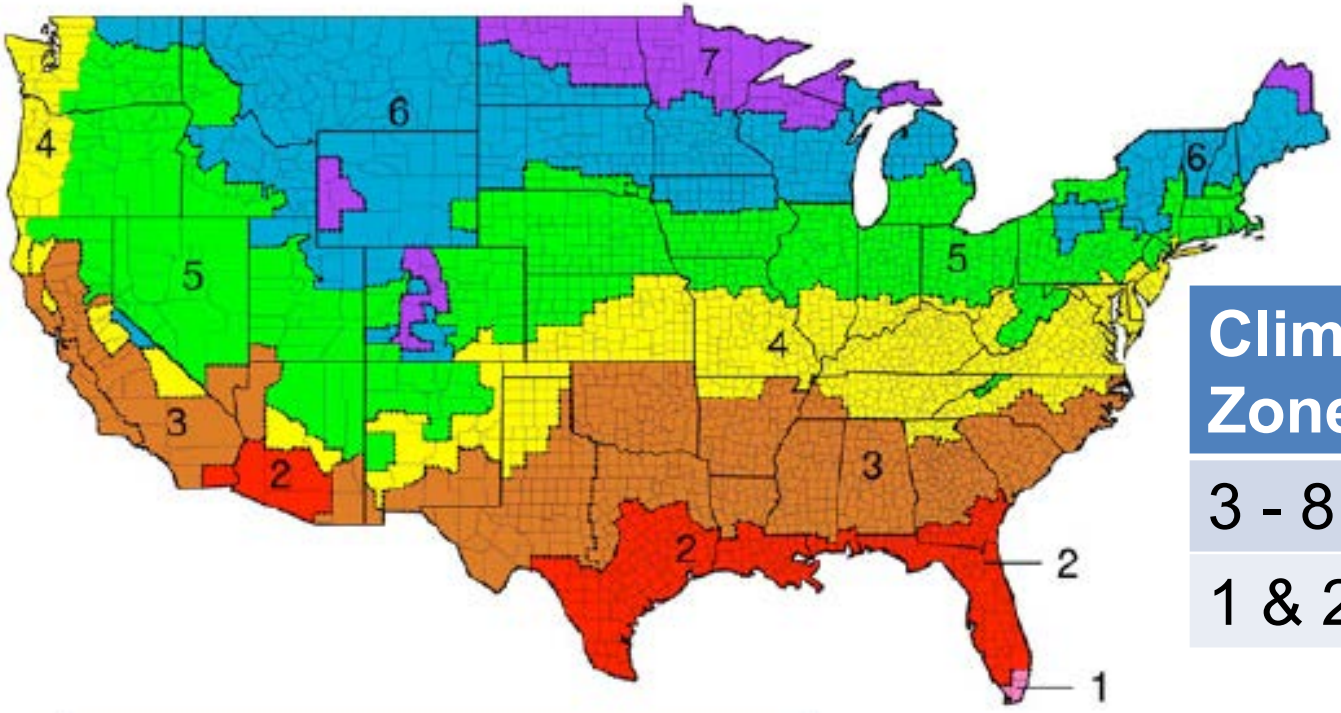
City	HDD	CDD
Auckland	**1234**	**159**
Christchurch	*2607*	*59*
Wellington	**1625**	**80**

Australia

City	HDD	CDD
Sydney	**692**	**633**
Melbourne	**1283**	**340**
Perth	**793**	**782**

Mild = HDD + CDD
< 1800

US Residential Air Tightness Requirements – International Energy Conservation Code



Climate Zone	Maximum Leakage
3 - 8	3 ACH50
1 & 2	5 ACH50

All of Alaska in Zone 7
except for the following buroughs in Zone 8:

- Bethel
- Dellingham
- Fairbanks N.Star
- Nome
- North Slope
- Northwest Arctic
- Southeast Fairbanks
- Wade Hampton
- Yukon-Koyukuk

Zone 1 includes:

- Hawaii
- Guam
- Puerto Rico
- Virgin Islands

California always has to be special!

Does not use IECC – has its own energy code

No leakage limit

Typical new home: 5 ACH50

High performance (30% better than code) in Fresno: Target 4.4. ACH50 – actual 3.5 ACH50

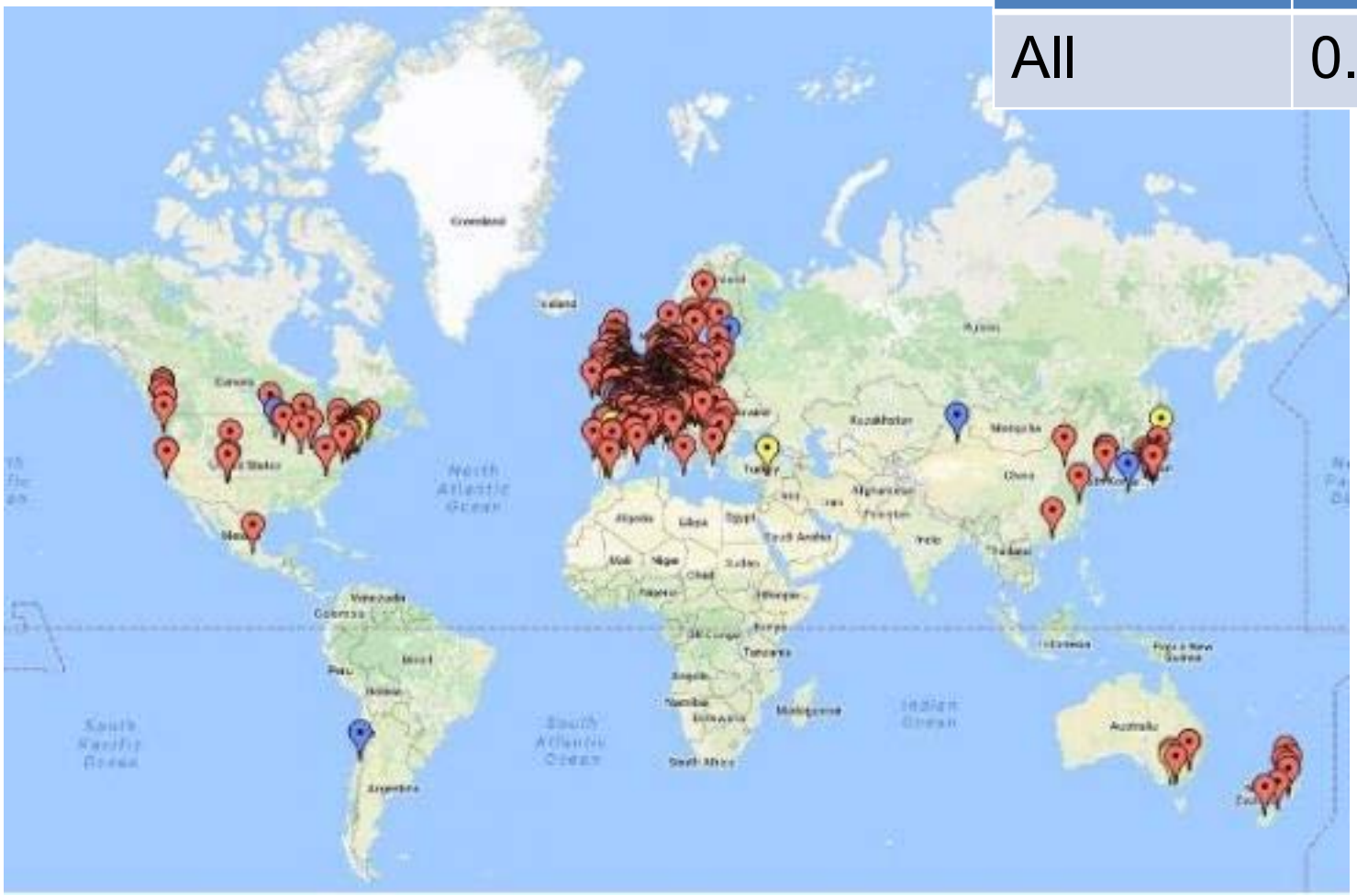
Canada Air Tightness Requirements (*not mild climates!*)

	Maximum Leakage
HOT2000	1.5 ACH50
Vancouver	3.5 ACH50

City	HDD	CDD
Edmonton	5734	23
Vancouver	2903	44
Toronto	3892	292

Passive House Air Tightness

Climate Zone	Maximum Leakage
All	0.6 ACH50



How little is too little leakage?

- Measured pollutants in homes indicate 0.3 to 0.4 air changes per hour (ACH) as a reasonable minimum
  - Possibly higher needed for odour/moisture control
- How leaky does my home need to be to get this annual average air change rate?
  - Average US climate about 8-10 ACH50 (much of NZ)
  - Los Angeles about 11-13 ACH50
  - Edmonton about 6-7 ACH50

So… what's the problem?

Even in a "mild climate": **Variability**

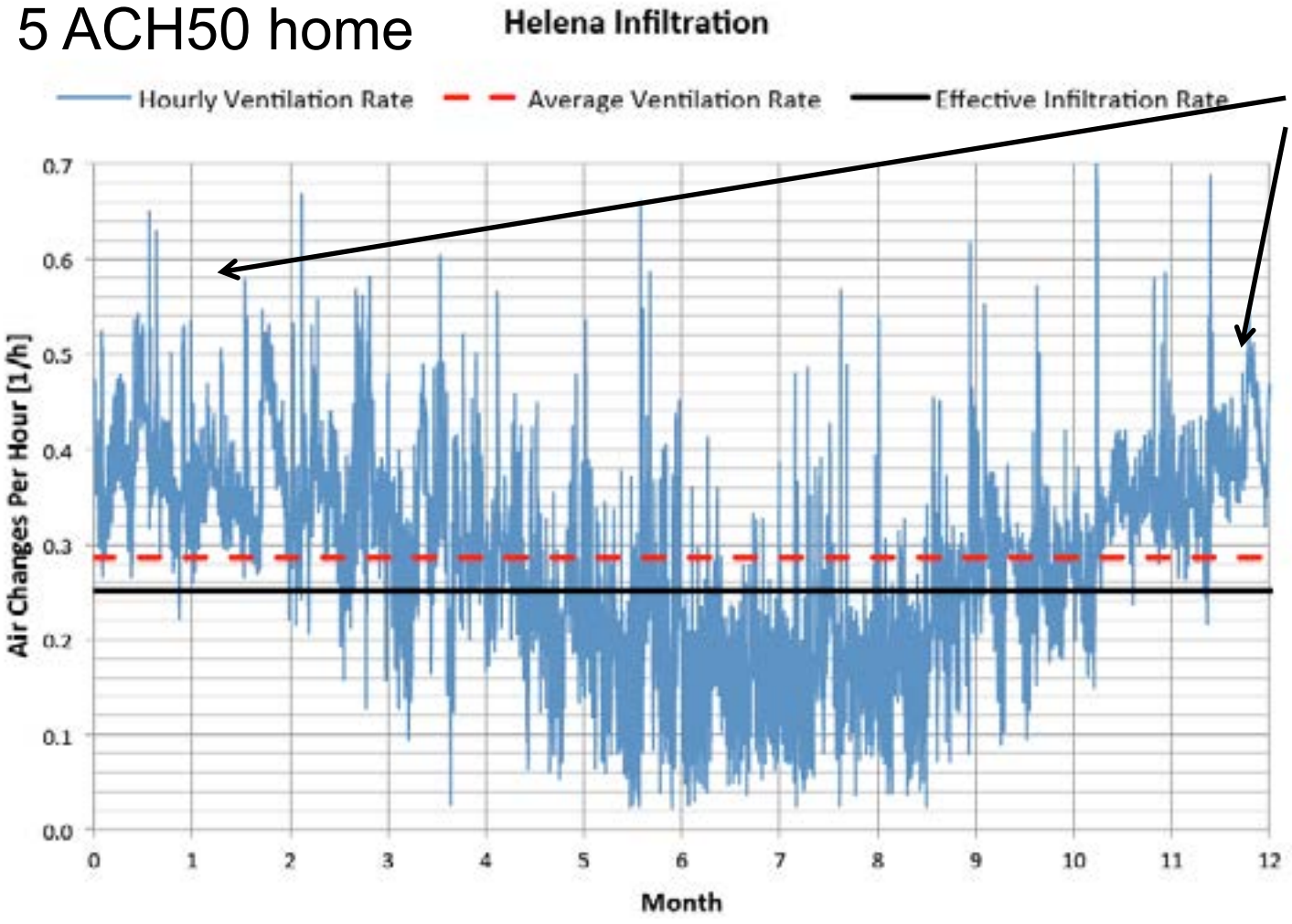
- A leaky home uses more energy and has more peak consumption
  - Or… in unheated NZ homes warmer during cold weather?
- Not just how much ventilation, but when it happens
  - More ventilation when its cold, less when its mild
- Not enough ventilation in summer – potential IAQ issues

Tighter allows non-energy advantages:

- Control of outdoor pollutants (particles, ozone)
- Better control for moisture
- Better control enables smart ventilation approaches
- Less drafts – more comfort

Infiltration in a cold climate

5 ACH50 home



Too low in summer

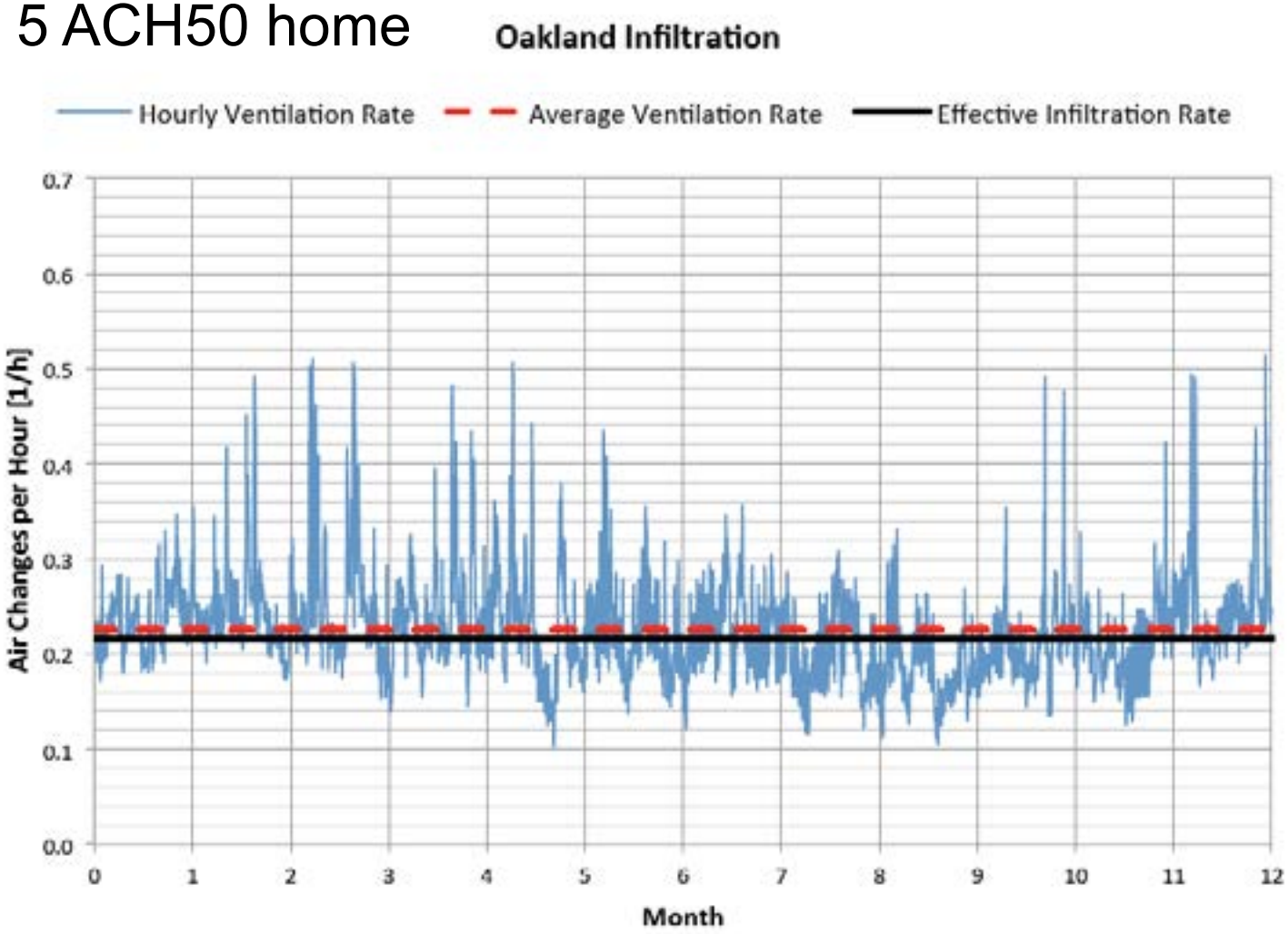
Higher in winter – bigger peak load

Average ~ 0.3
In winter ~ 0.4

About 30% more energy use than a tight house with mechanical ventilation with same annual total air flow

Infiltration in a mild climate

5 ACH50 home



Small summer-winter change

Doesn't have the extra penalty of more infiltration in winter

Too low all year – needs mechanical ventilation

Mechanical Ventilation

For dwelling unit:

- Less extremes of ventilation
- Never gets too low (IAQ & moisture)
- Never gets too high (comfort, energy and peak demand)
- Based on home size and occupancy. E.g., ASHRAE 62.2:
  0.15 L/s/m^2 + 3.5 L/s (bedrooms +1)

For “wet” rooms (very important for NZ homes):

Mechanical exhaust from kitchens and bathrooms

Combining Natural Infiltration and Mechanical Ventilation

Two approaches:

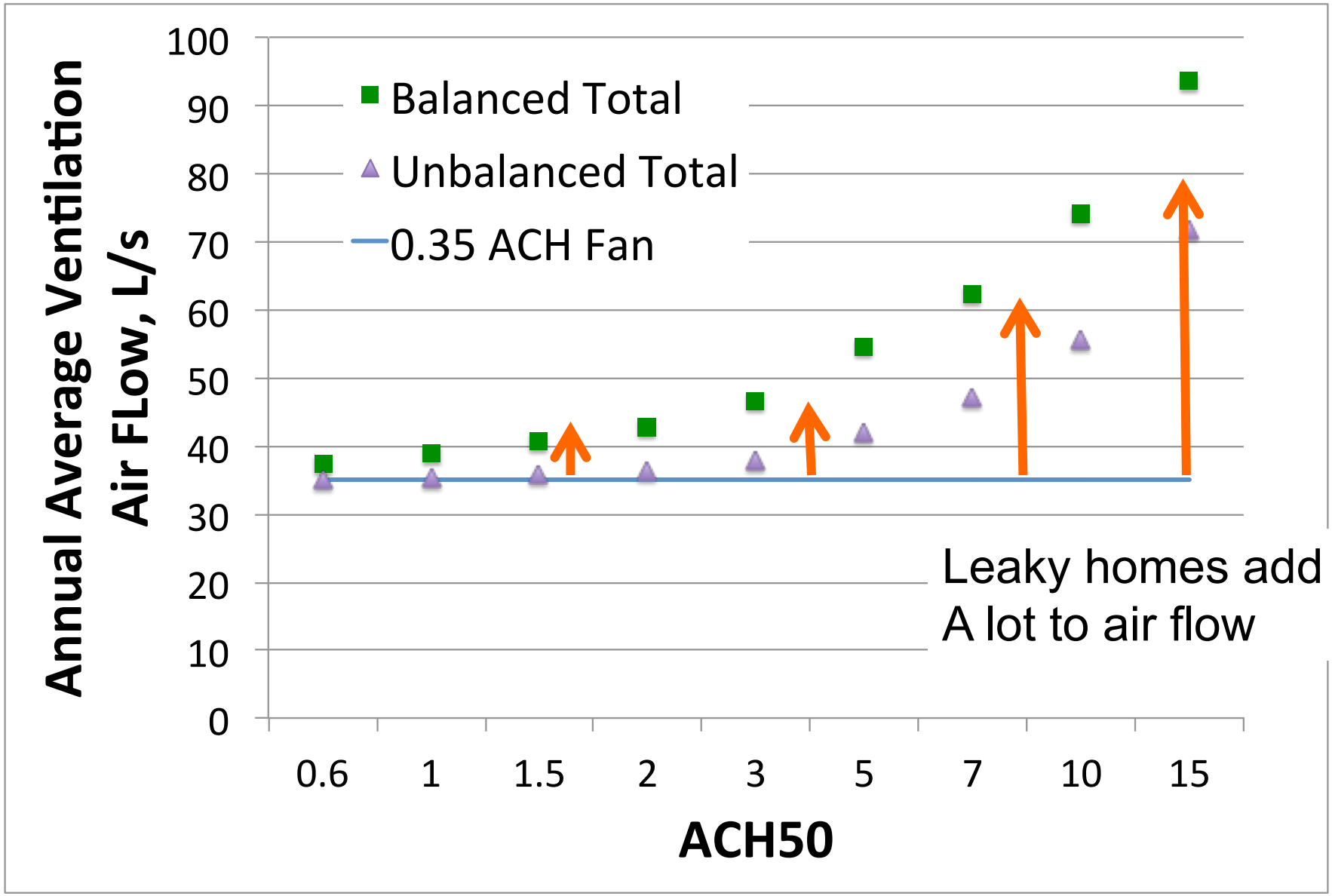
#1. Some ventilation standards specify mechanical ventilation air flow requirements: either total for the dwelling or for each room/space in the dwelling

- No infiltration/mechanical ventilation tradeoff
- A tighter envelope always saves energy

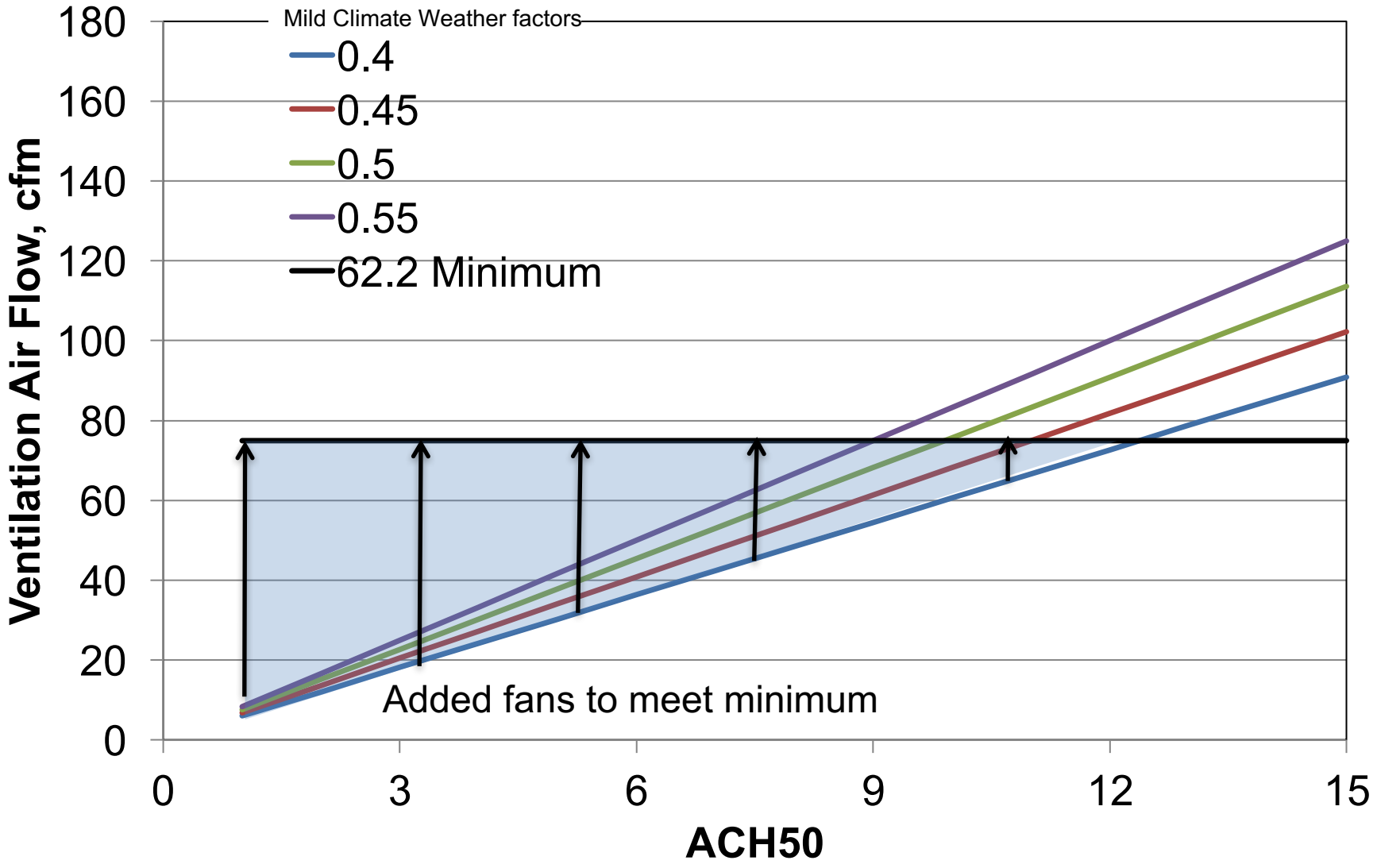
#2. ASHRAE 62.2 allows infiltration to be included to reach the required total

- Aims for same total ~ 0.3 ACH
- Leakier envelope means adding a smaller fan
- Reduces energy impact of tightening in mild climates

Fixed fan size - no Infiltration Credit



Airtightness and 62.2

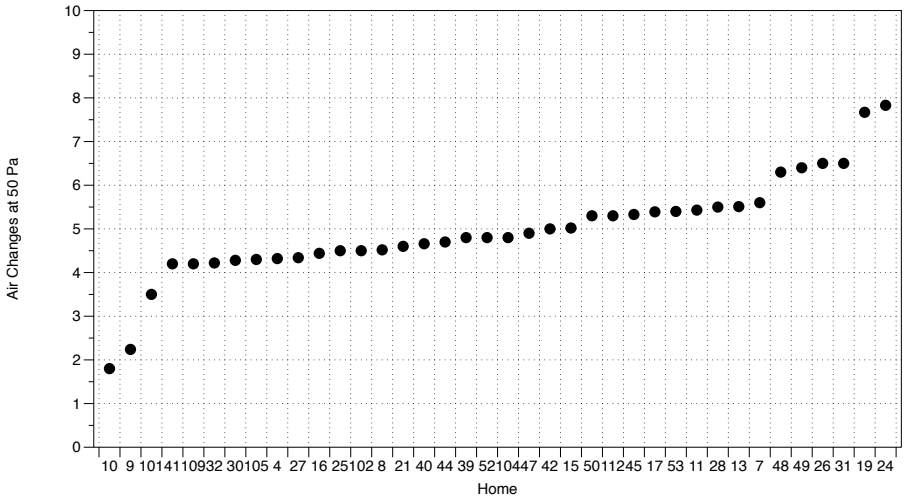


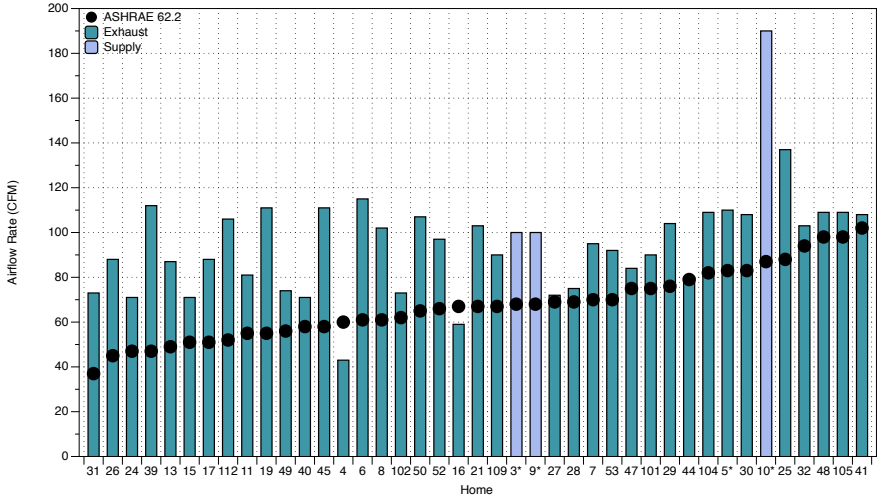
Building Practice in California – mild climates

Envelope leakage mostly 4 to 5.5 ACH50

Tightening to 3 ACH 50 would save only 2-5% of space conditioning energy in mild CA climates

Builders not fan sizing with infiltration credit: typically 80 cfm (40 L/s)





CA energy code strongest in US – next iteration: Net Zero

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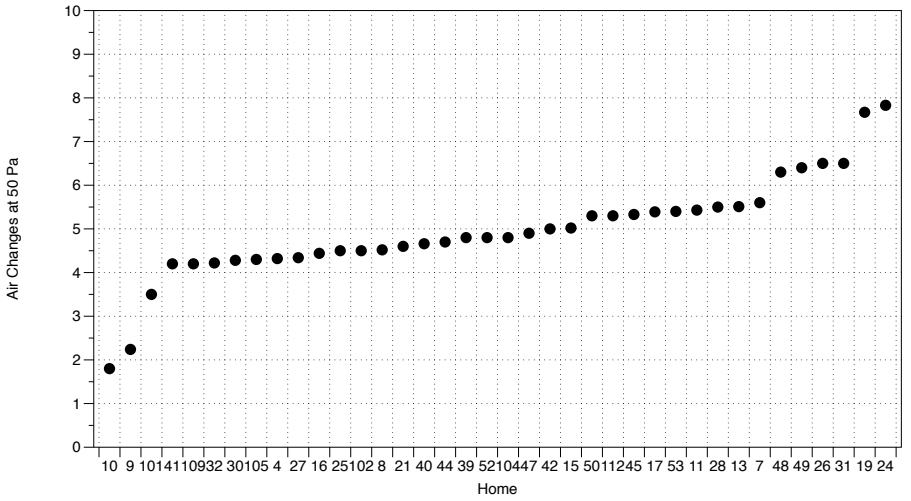
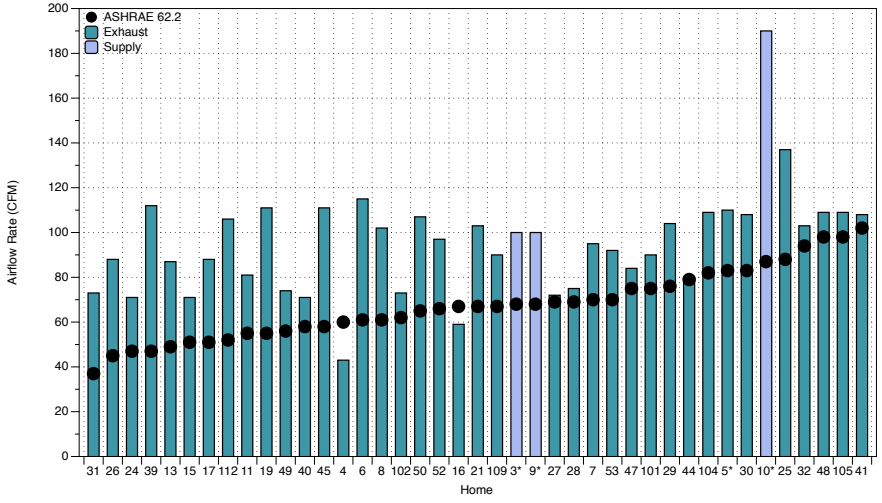
Builders not fan sizing with infiltration credit: typically 80 cfm (40 L/s) – but almost all turned OFF!





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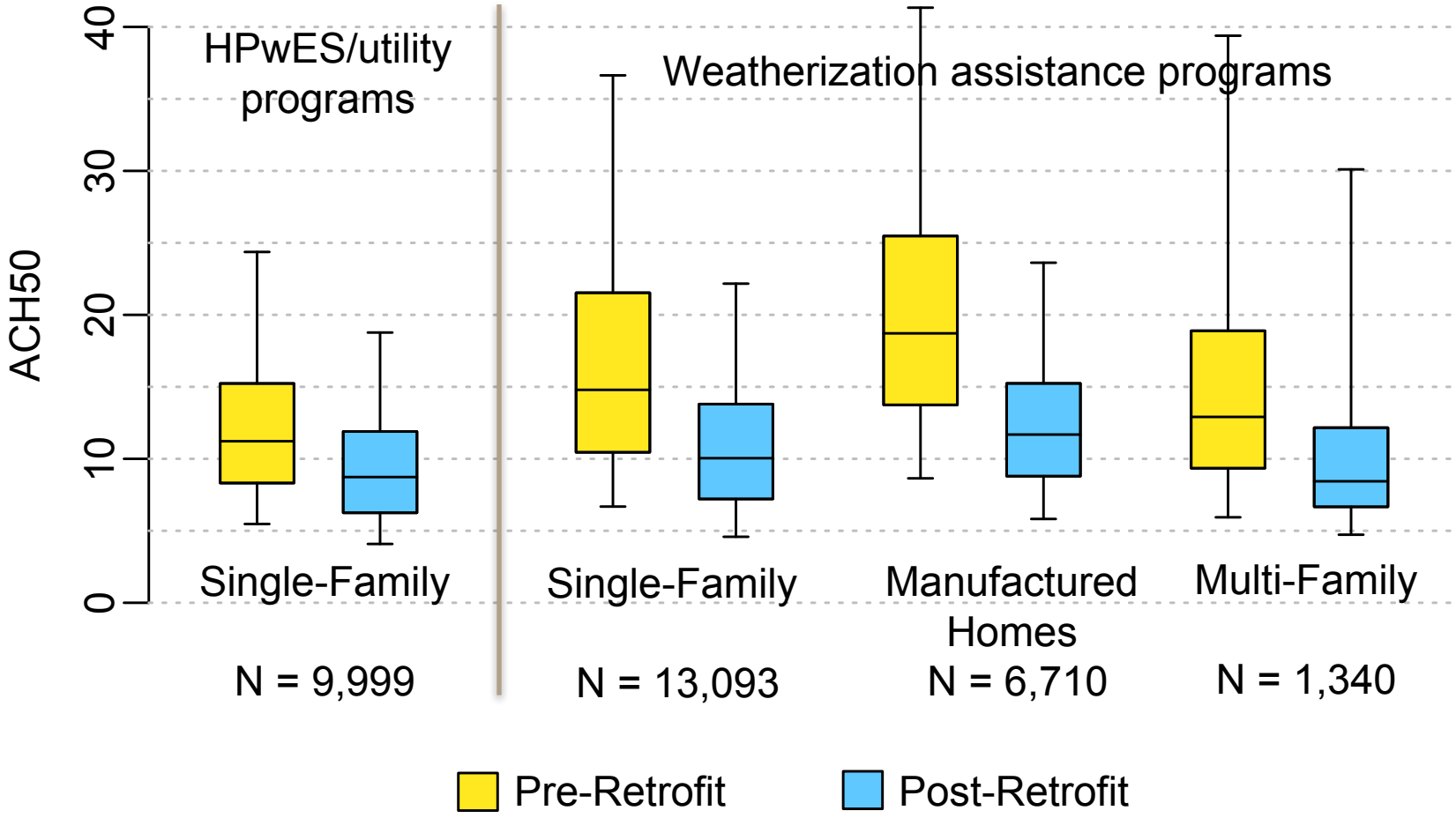
Outdoor Contaminants?

A tighter envelope reduces all of the following:

- Particles
  - Most indoor particles from outdoors
  - A tighter envelope is a better filter
    - 5 ACH50 removes 70% of outdoor particles
  - Open windows – no reduction
- Ozone
  - Envelope a good ozone remover – 95% less than outside
  - Open windows only 50% less than outside

Retrofits – reducing air leakage



Median:	-20%	-30%	-35%	-28%

Mechanical ventilation approaches for high performance homes in mild climates

Unbalanced exhaust:

- Inexpensive
- Easiest for retrofit
- Dual-duty: have a kitchen or bath fan operating continuously

Balanced:

- Heat recovery – more effect on peak for mild climates
- Exhaust from kitchen and bathroom
- Supply to bedroom/living space
- Be careful about fan power (~120W vs. 12W for exhaust)

Smart Ventilation:

- Typically 40% energy savings
- Time shifting for peak avoidance – good for GHG and infrastructure
- Sense operation of other systems
- Potential to directly control pollutants
- OR…. for same energy – ventilate more when occupied

High Performance Home Leakage Summary

- Mild climates don't need to meet very low air tightness requirements for energy reasons
- Tightening helps more for peak load reduction & outdoor pollutants
- Setting a target in the 3-4 ACH50 range is reasonable and achievable for new homes
- Tightening existing homes: target 40-50% reduction
- HRV marginal for energy in mild climates – may be desirable for peak reduction
- Require mechanical ventilation operation!