Keith O'Hara

- Eco Performance Builders
- Home Performance all electric retrofits
- General, HVAC, and Insulation contractor
- Design/Build/Commission

All Electric High-Performance Retrofits

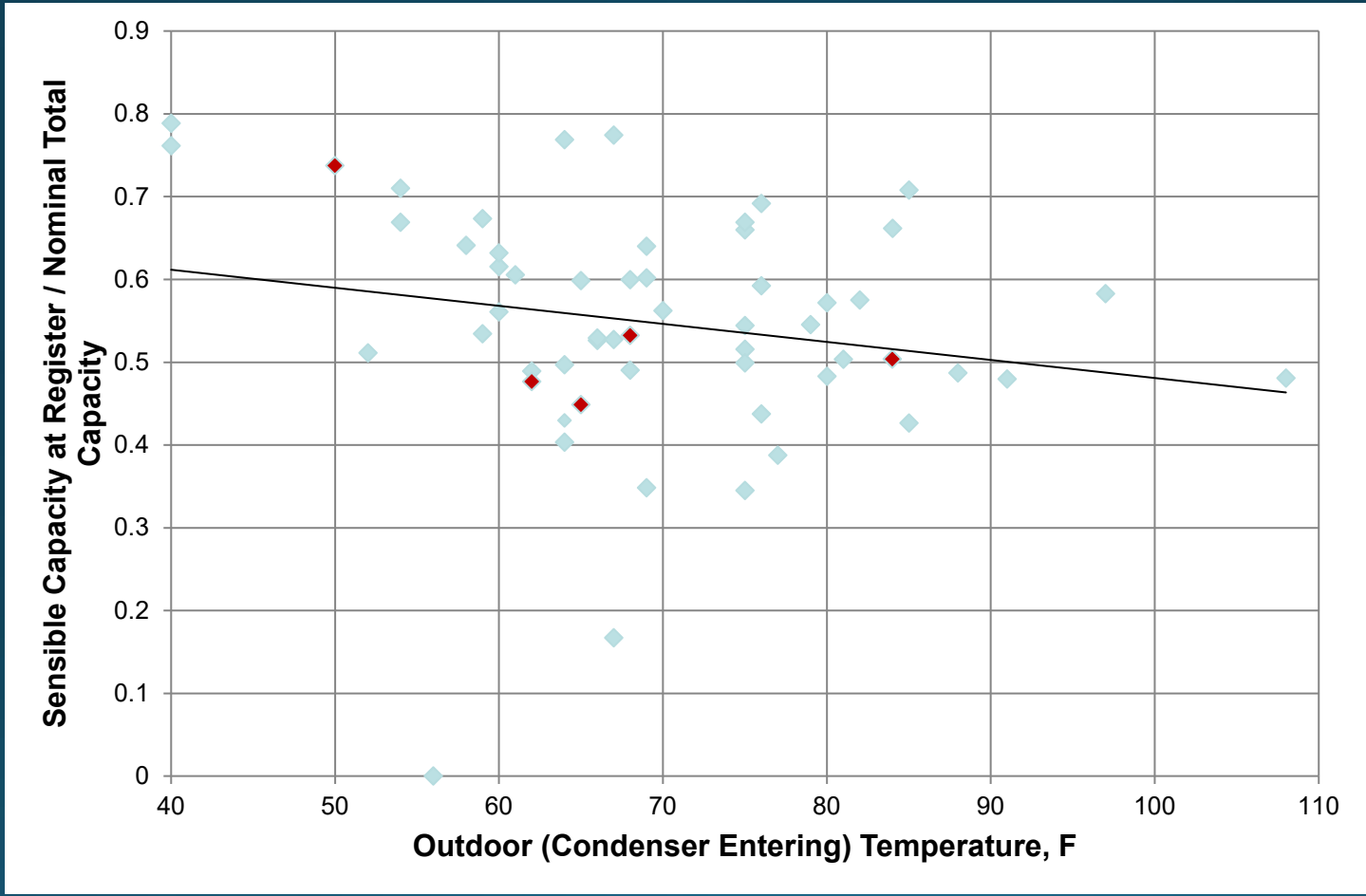
Goals:

- Great indoor air quality
- Comfort
- Efficiency
- All electric

All Electric High Performance Retrofits

All electric retrofits
Ducted heat pump
Attic insulation removal
Air seal and insulate attic
Vapor barrier/condition
Ventilation
Heat Pump water heater

State of the Industry
CEC Study on HVAC Performane




ECO PERFORMANCE
BUILDERS
Comfortable, Efficient, Healthy Homes

Commissioning

Supply Airflows (use only Energy Conservatory FlowBlaster)	Temp (F)	CFM	Flow Correction	Constant	Delta T	Calculation	Btu/Hr	Calculation
Supply Grille #1 Room:	51.5	143.0	1.01	1.08	20.5	Delta SG1 -Weighted Return Temp	3208	BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #2 Room:	50.5	134.0	1.01	1.08	21.5	Delta SG2 -Weighted Return Temp	3153	BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #3 Room:	53.0	96.0	1.01	1.08	19.0	Delta SG3 -Weighted Return Temp	1992	BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #4 Room:	52.0	113.0	1.01	1.08	20.0	Delta SG4 -Weighted Return Temp	2468	BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #5 Room:				1.08		Delta SG5 -Weighted Return Temp		BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #6 Room:				1.08		Delta SG6 -Weighted Return Temp		BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #7 Room:				1.08		Delta SG7 -Weighted Return Temp		BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Airflow (continued from page 1)	Temp (F)	CFM	Flow Correction					
Supply Grille #8 Room:				1.08		Delta SG8 -Weighted Return Temp		BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #9 Room:				1.08		Delta SG9 -Weighted Return Temp		BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #10 Room:				1.08		Delta SG10 -Weighted Return Temp		BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #11 Room:				1.08		Delta SG11 -Weighted Return Temp		BtuH (delta x 1.08 x CFM x Flow Correction)
Supply Grille #12 Room:				1.08		Delta SG12 -Weighted Return Temp		BtuH (delta x 1.08 x CFM x Flow Correction)
Totals		486.0	**CFM Total (Indicated airflow)**				10820	**Total Btu/Hr Delivered** (sum entire column)

Total Delivered BtuH as measured at supply grilles	10820	BtuH (1)					
Heat Pump Capacity at test condition -or- Sum of furnace rated output & (Furnace Fan Watts × 3.4)	12110	BtuH (2)	Gas furnace tests- Calculate % Sensible Delivered energy and leave EER sections blank				
Total Delivered BtuH(1) ÷ by capacity BtuH(2)	89%	% Sensible Delivered energy		Manuf. EER		Measured System Power	Delivered EER
Manufacturer System Power at test condition (indoor + outdoor) AC & Heat Pumps only	930	Watts = →		13.0	Manuf capacity divided by kW (x1000)	960	Measured System Pwr (Watts) = → 11.3
Delivered EER divided by Manufacturer EER	86.6%	% Sensible Delivered EER					Delivered BtuH divided by measured power (kW x 1000) = Delivered EER

ECO PERFORMANCE BUILDERS

6) **Room temperature stratification testing at 3' AFF, center of all rooms**

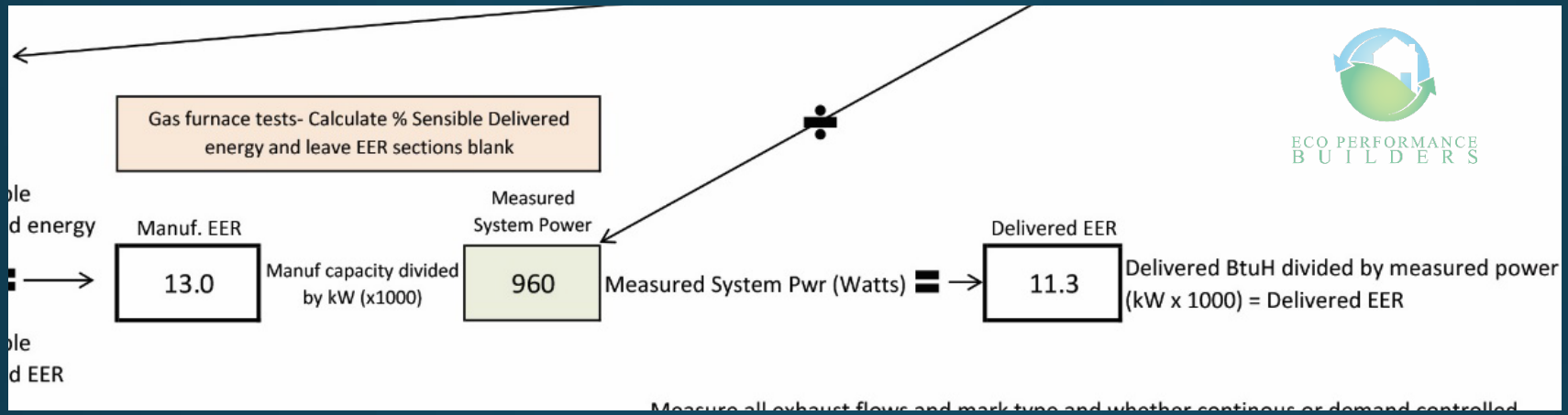
All temps after continuous minimum 15 minutes of system operation, system running, all doors open

#1 Room:	71.0	(F)		Pascals across door
#2 Room:	70.0	(F)		Pascals across door
#3 Room:	70.0	(F)	0.5	Pascals across door
#4 Room:	69.0	(F)	2.5	Pascals across door

7) Measure all exhaust flows and mark type and whether continous or demand controlled

	Ventilation Location	CFM Flow	Supply or Exhaust / continuous or switched
#1 Room:	Up Bath	116	exh / continuous
#2 Room:			
#3 Room:			
#4 Room:			
#5 Room:			

Commissioning



All Electric High-Performance Retrofits

Barriers:

- Our housing stock
  - Is leaky
  - Is poorly insulated
  - Has terrible duct systems
  - Some has knob and tube wiring
  - A lot have asbestos ducts
  - Need the air handler relocated
  - Has small crawlspaces
  - Has small attics
  - Small accesses

All Electric High-Performance Retrofits

Barriers continued:

- Space for equipment and return
- Space for outdoor units
- Complicated houses are tough
- Attic insulation should be removed
- Finding workers is very difficult
- Current supply acquisition issues
- Supply and labor prices are increasing
- Heat pump water heater location & noise issues

All Electric High-Performance Retrofits

Barriers continued:

- The HVAC industry is largely unaware of how poorly their equipment performs and how to design, install or commission properly.
- Good people that don't know their work isn't good.
- Pricing issues are a part of this.
- Going off of old myths about equipment and duct sizing and selection.

Fixing Houses

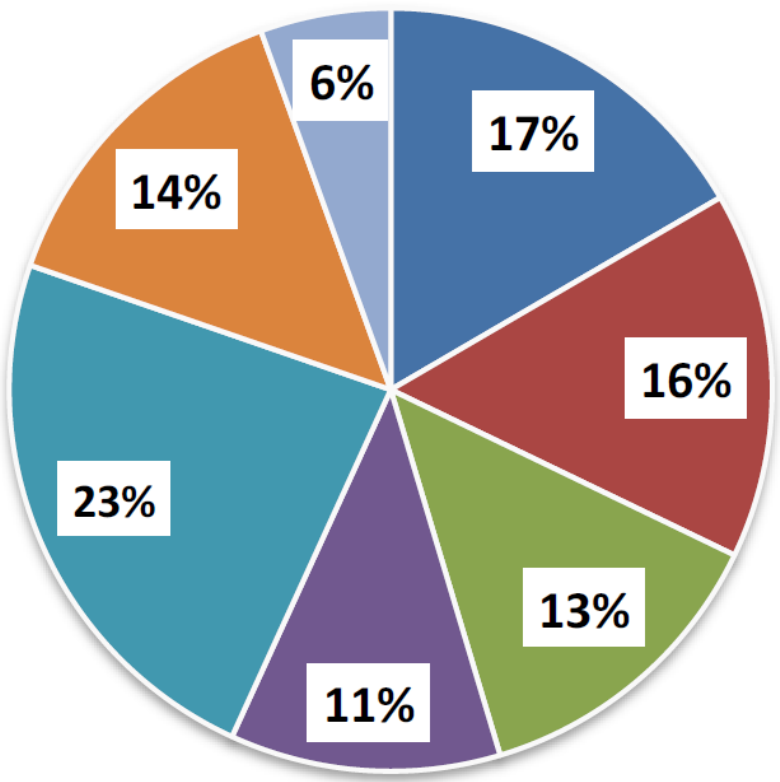
There are a lot of houses
They're all different
None were designed for us to fix them!

ECO PERFORMANCE BUILDERS

Attics

HVAC Systems

Energy Losses



- Walls
- Windows
- Ceiling
- Duct Insulation
- Air Leakage
- Duct Leakage
- Floor

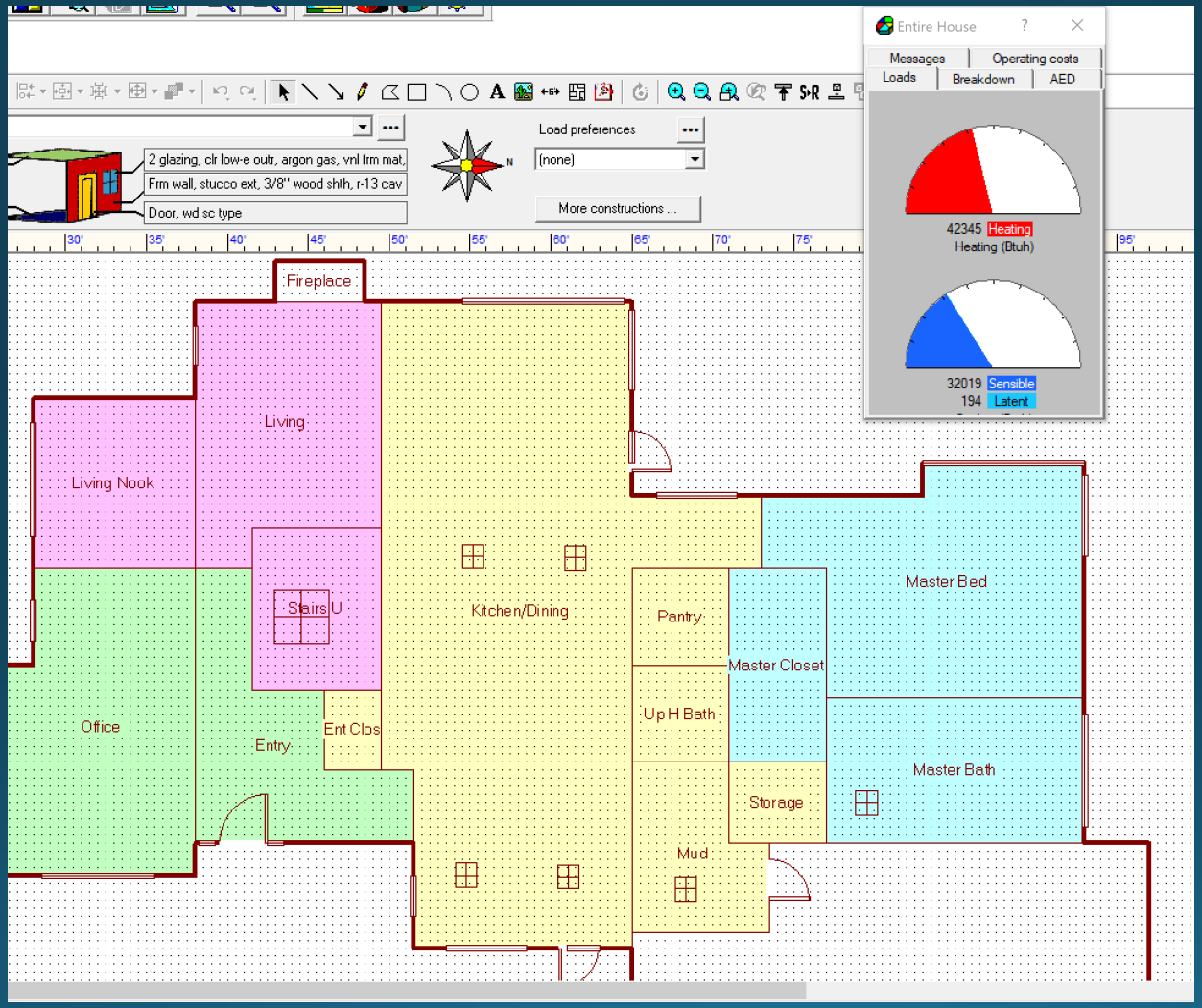
Multi Zones

Multi Zones

Ductless Systems

Ductless Systems

Mechanical design for ductless



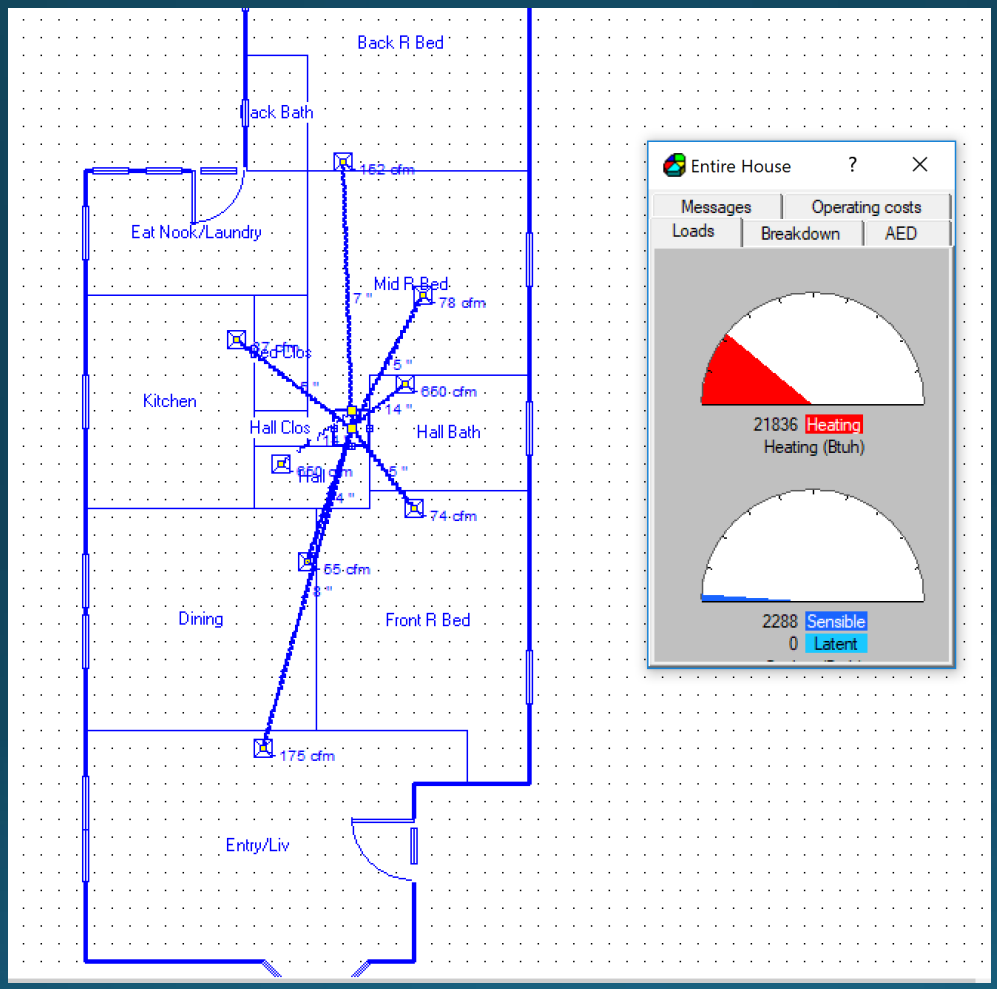
Ducted Mini Splits Work Best in Most Cases

Duct Location Considerations

Duct locations

- Attics with buried ducts
- Ducts as short as possible
- Sealed crawlspace
- Ducts always as short as possible

Mechanical Design



Air Sealing Before and After

Quality and Air Quality

Simple Filtration

Home Ventilation

Minimum standard

- Continuous running low flow bath fan(s)
- Ducted range hood with good flow and low noise

The great solution

- Balanced HRV/ERV ducted to bedrooms and bathrooms

Electrification

Why does it have to be so complicated with ducts, insulation, etc?

- Smaller systems
  - Smaller ducts to fit in the space
  - Less air = one central return
  - Lower watt draw
    - Battery capable, peak demand, etc.
  - Low noise
  - Better comfort.
  - Panel space / capacity
  - Less energy usage
  - We're already in there and it will be much harder later.
  - Lower equipment cost and easier to purchase
  - Less grid impact
  - Air sealing and insulation is fantastic load shifting battery
  - People will tell their riends that it's great!