

Climate Appropriate – Where Are We?

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Affiliates Forum, May 20 2014
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University of California Davis

CA Energy Efficiency Strategic Plan

- Accelerate market penetration of “*climate appropriate*” HVAC
- 15% penetration by 2015
- 70% of systems installed in 2020 to be optimized for California’s climate



CA | Energy Efficiency
Strategic Plan

January 2011 Update

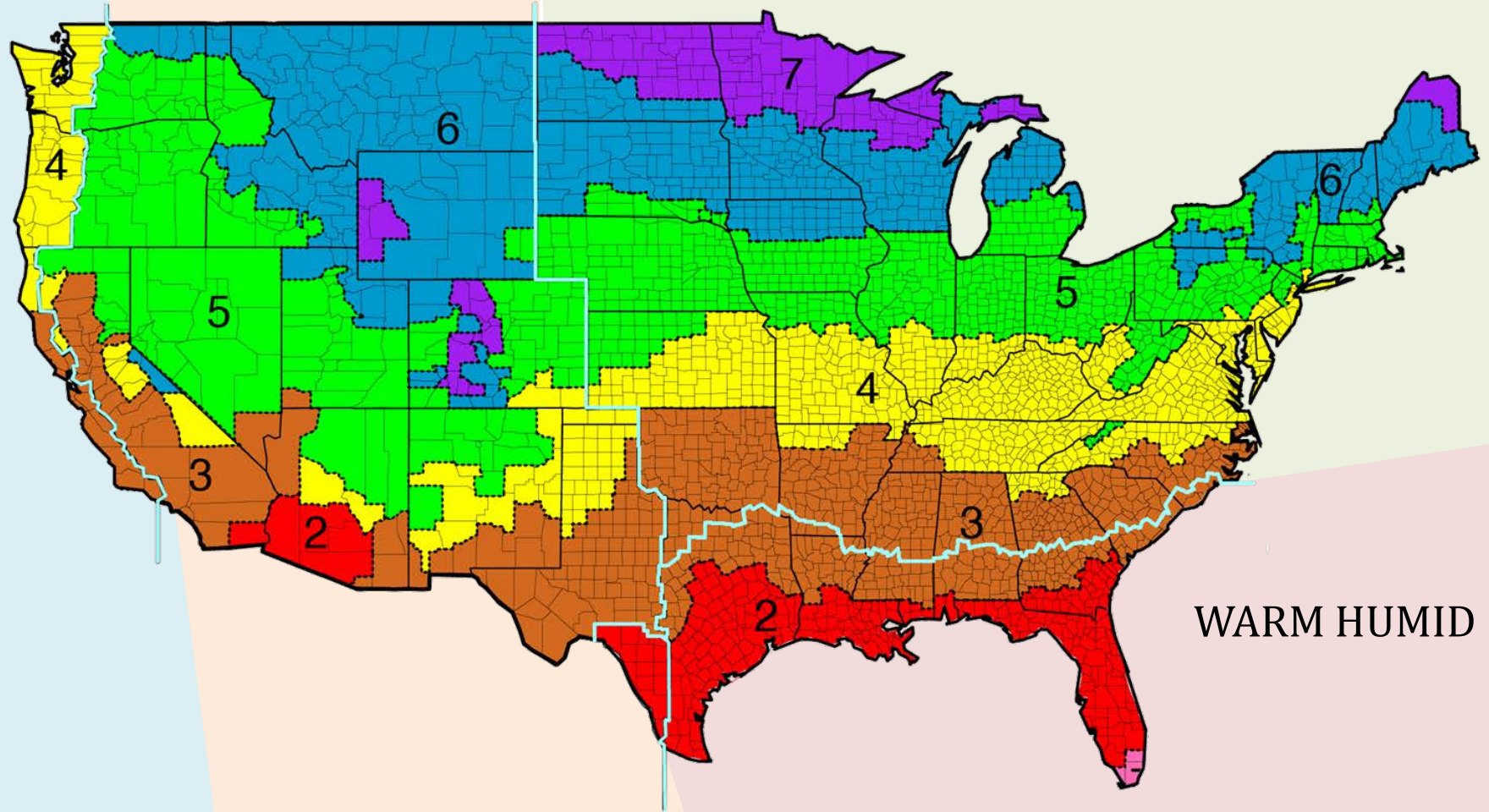
www.Engage360.com

Engage 360SM

MARINE (C)

DRY (B)

MOIST (A)



WARM HUMID

Climate Appropriate Commercial Cooling

- Laboratory test for **Munters EPX 5000 DOAS** indicates *20% savings* for whole building HVAC peak demand
Field testing now in progress
- **Climate Wizard & Coolerado side-by-side** field evaluation marks *EER=40+ at peak, EER=80+* at part load.
- Field evaluations for **DualCool** as new installation and retrofit show *40% energy savings at peak*, consistent with laboratory testing.
- Field experience with all technologies identifies integration and maintenance challenges. Some solutions are technical, most require institutional adaptations.

SIDE-BY-SIDE EVALUATION OF TWO **INDIRECT EVAPORATIVE** **AIR CONDITIONERS** INSTALLED AS ADDITION TO EXISTING PACKAGED ROOFTOP UNITS

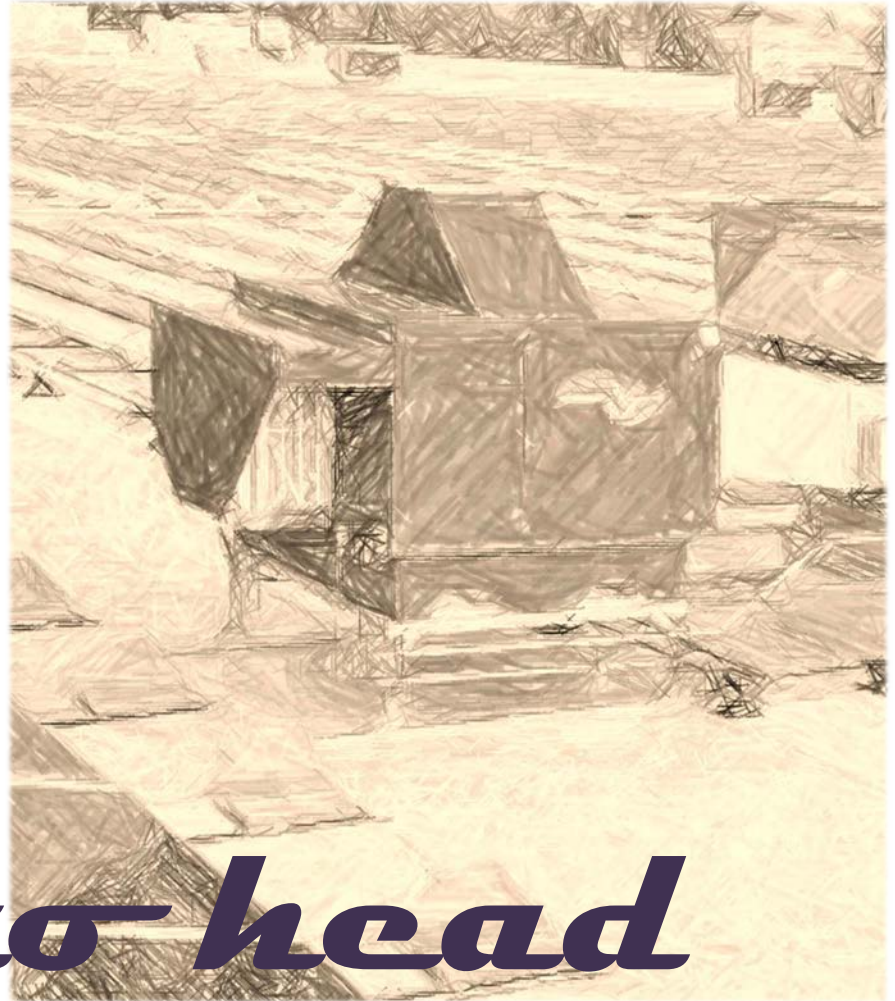




- Coolerado M50 (ea)
- Indir. Evaporative (Maisotsenko Cycle)
- 1280 cfm (ea)
- 208
- 100% outside air
- Variable speed
- No sump
- 0.75 kW (ea)

- Climate Wizard CWH15
- Indir. Evaporative
- 2500 cfm
- 460/3/60
- 100% outside air
- Variable speed
- Sump water quality controlled
- 1.8 kW



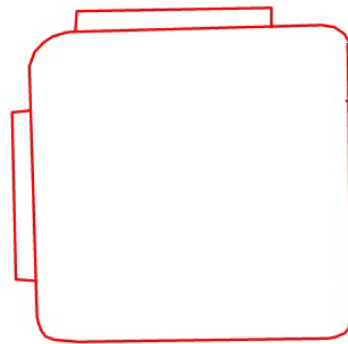


Head to head

97609 40 16009

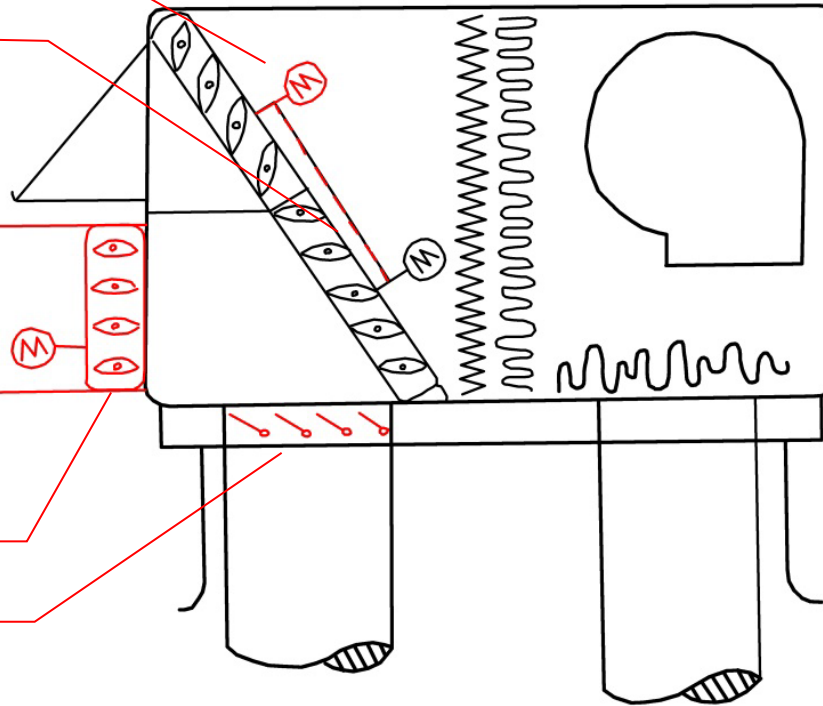
(N) ACTUATOR FOR (E) OSA DAMPER

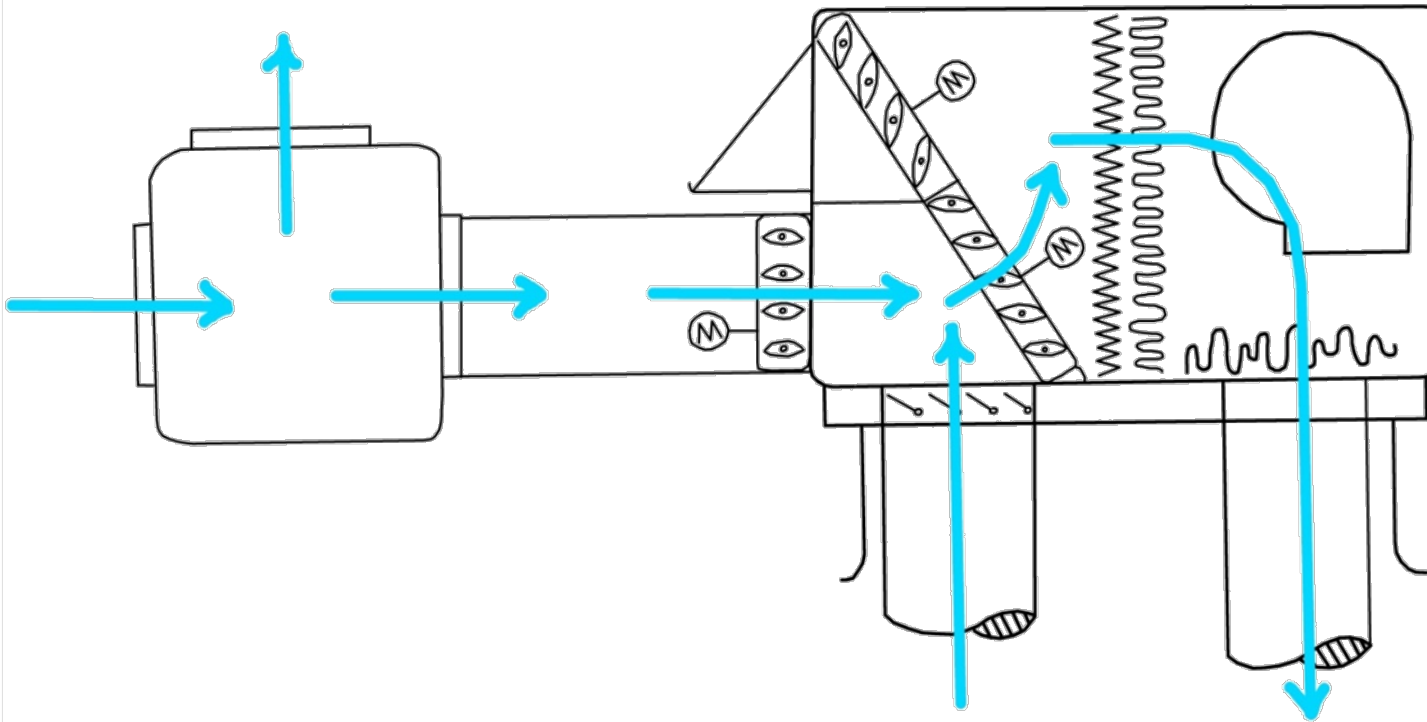
DECOUPLE (E) DAMPER LINKAGE



(N) MOTORIZED DAMPER

(N) GRAVITY RELIEF DAMPER







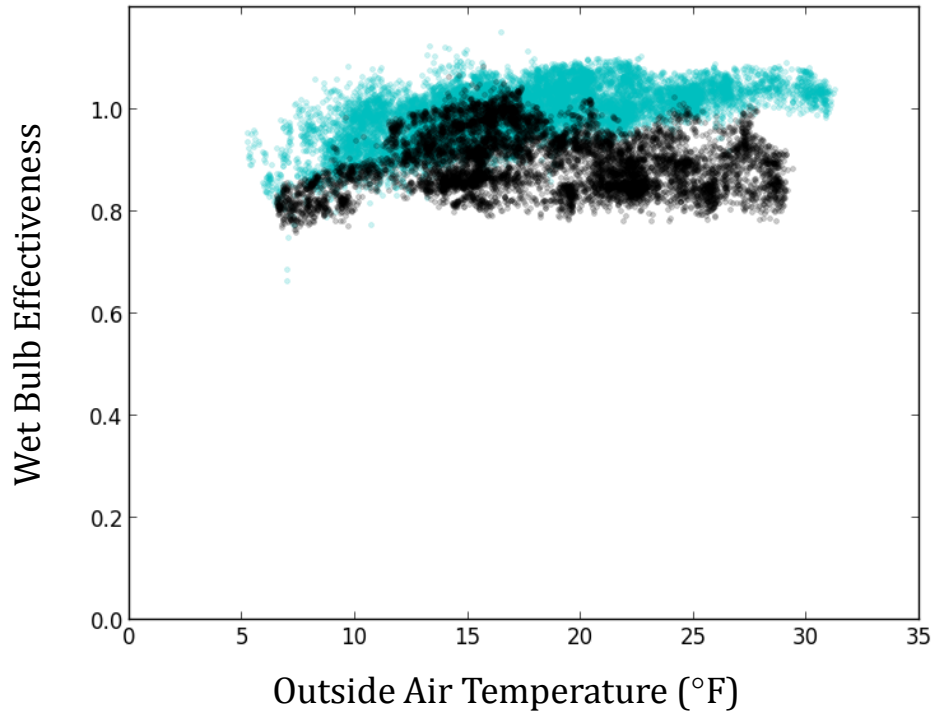


Exceptional Performance

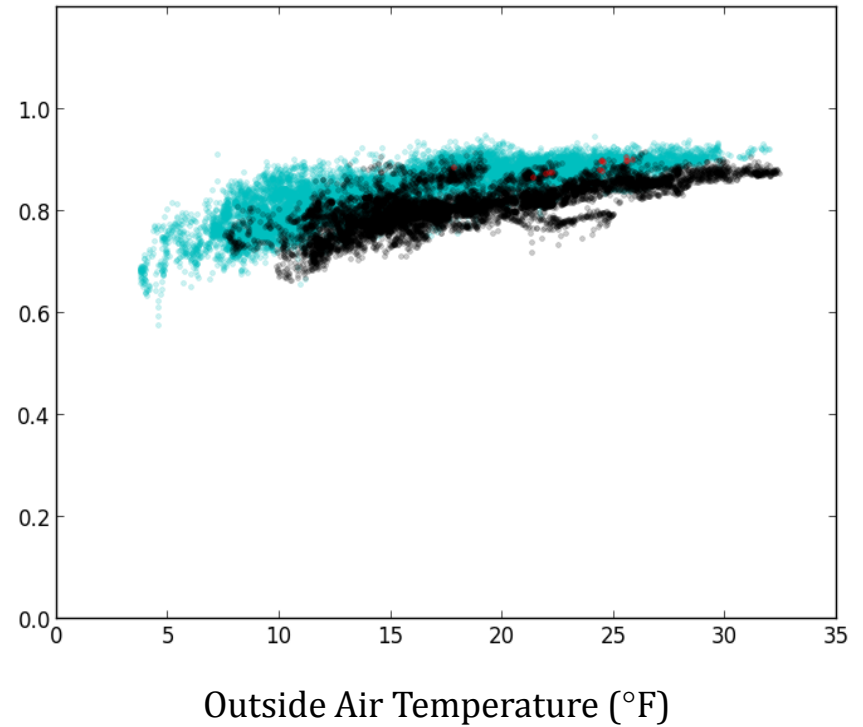
Too close to call

Wet Bulb Effectiveness

Climate Wizard CWH15



Coolerado M50



● IEC Part

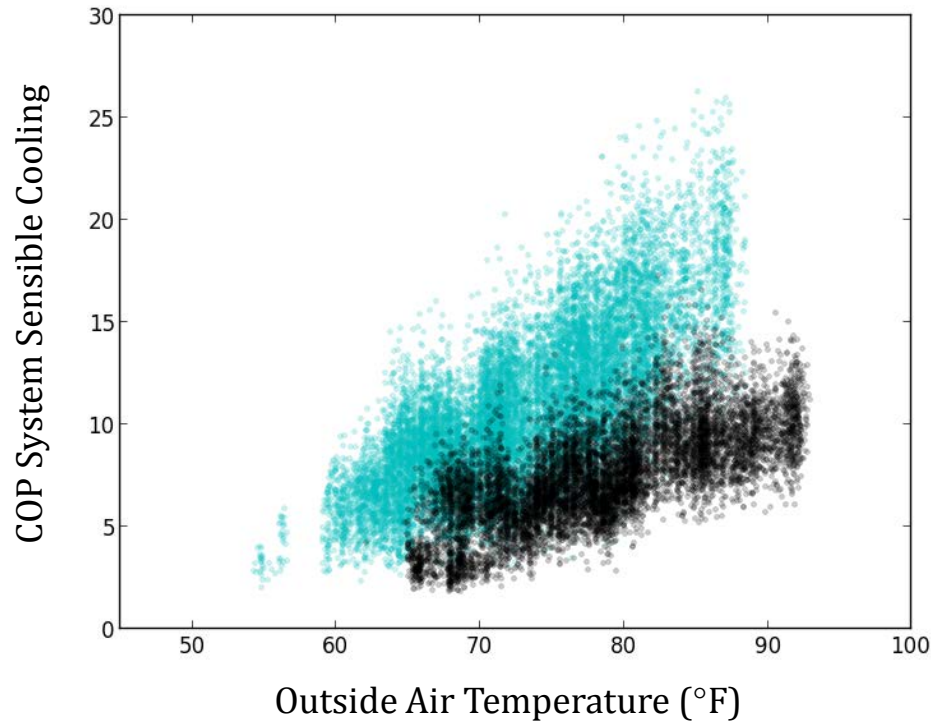
● IEC Full

● IEC Full + DX1

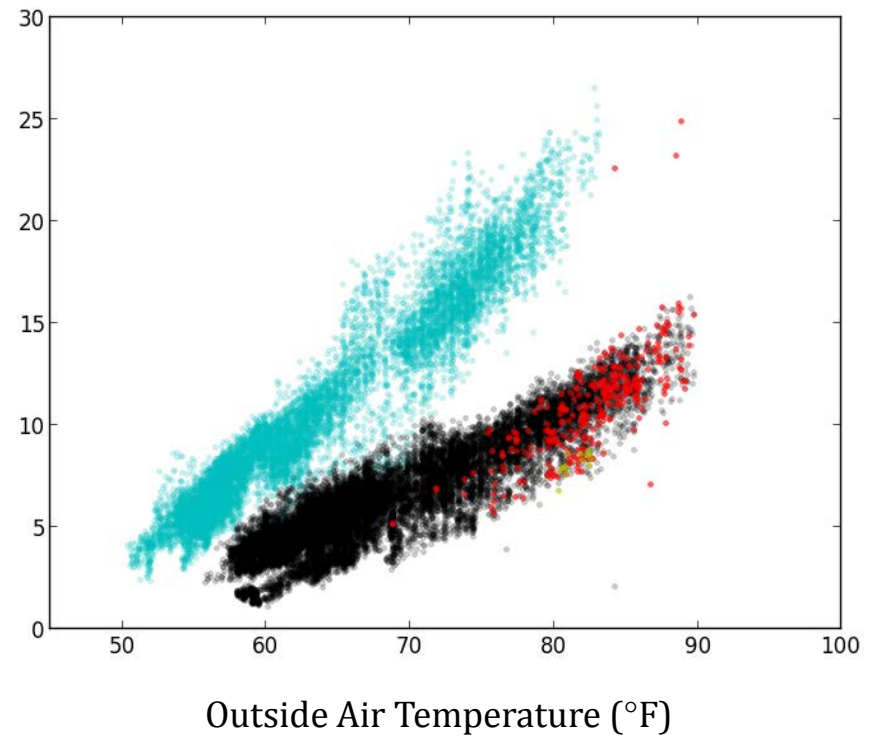
● IEC Full + DX2

Coefficient of Performance (System Sensible)

Climate Wizard CWH15



Coolerado M50



● IEC Part

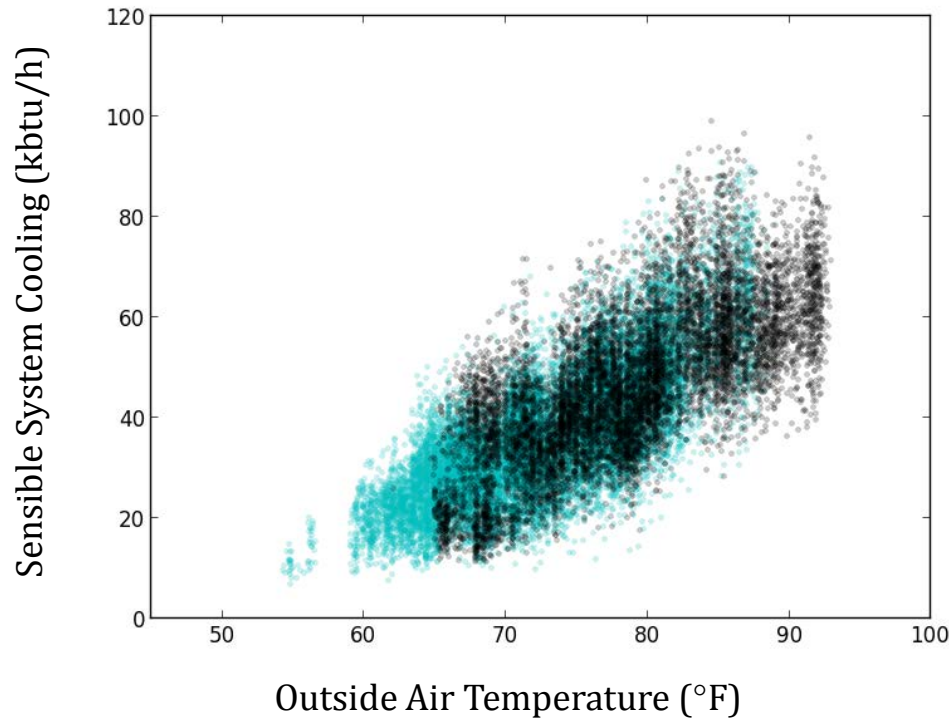
● IEC Full

● IEC Full + DX1

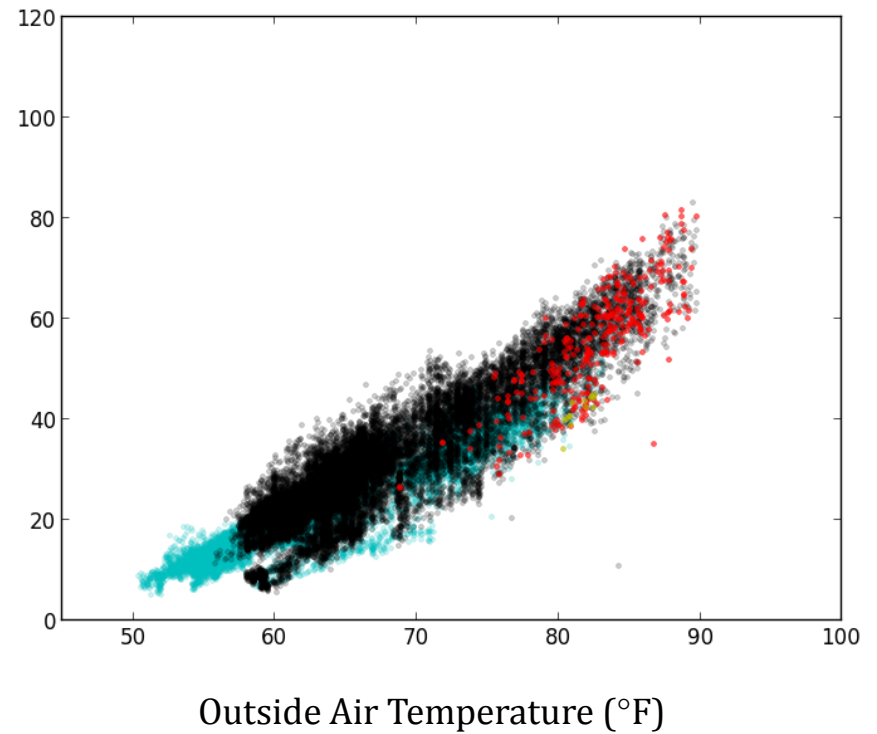
● IEC Full + DX2

System Sensible Cooling Capacity

Climate Wizard CWH15



Coolerado M50



● IEC Part

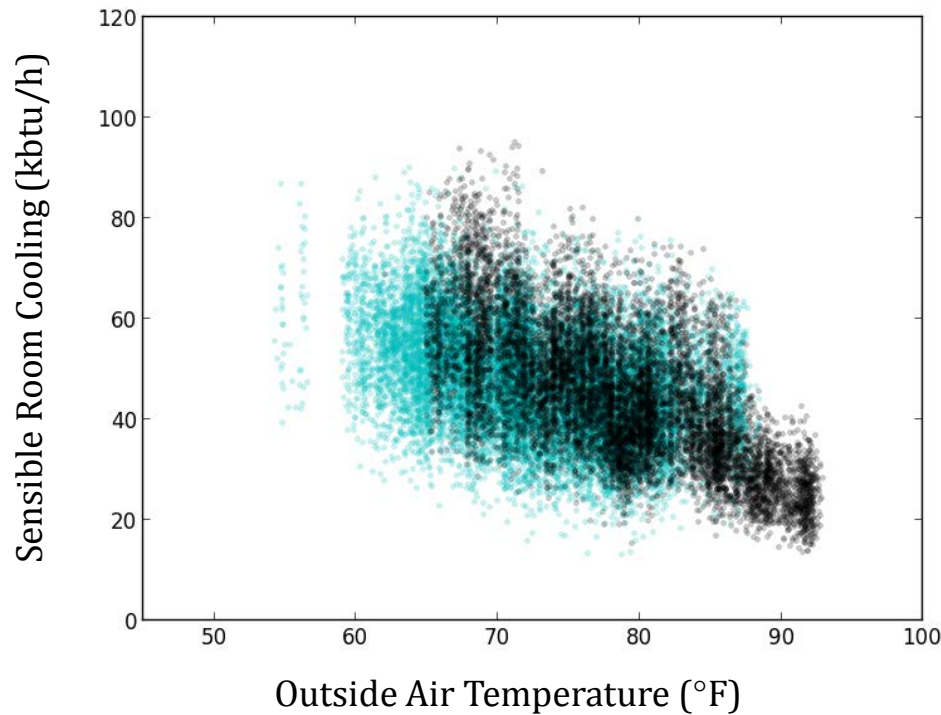
● IEC Full

● IEC Full + DX1

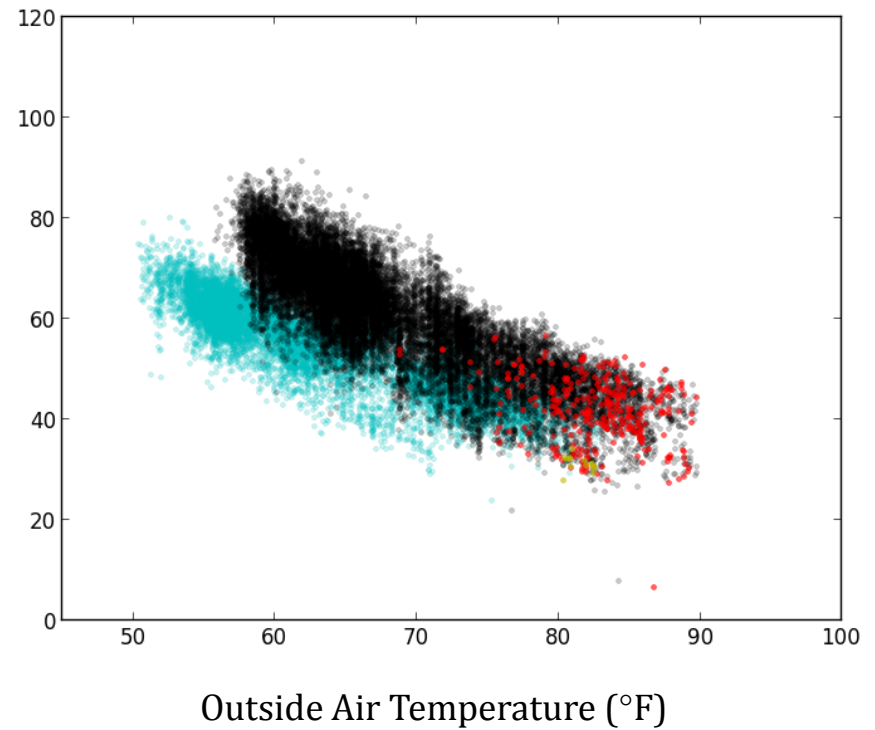
● IEC Full + DX2

Sensible Room Cooling Capacity

Climate Wizard CWH15



Coolerado M50



● IEC Part

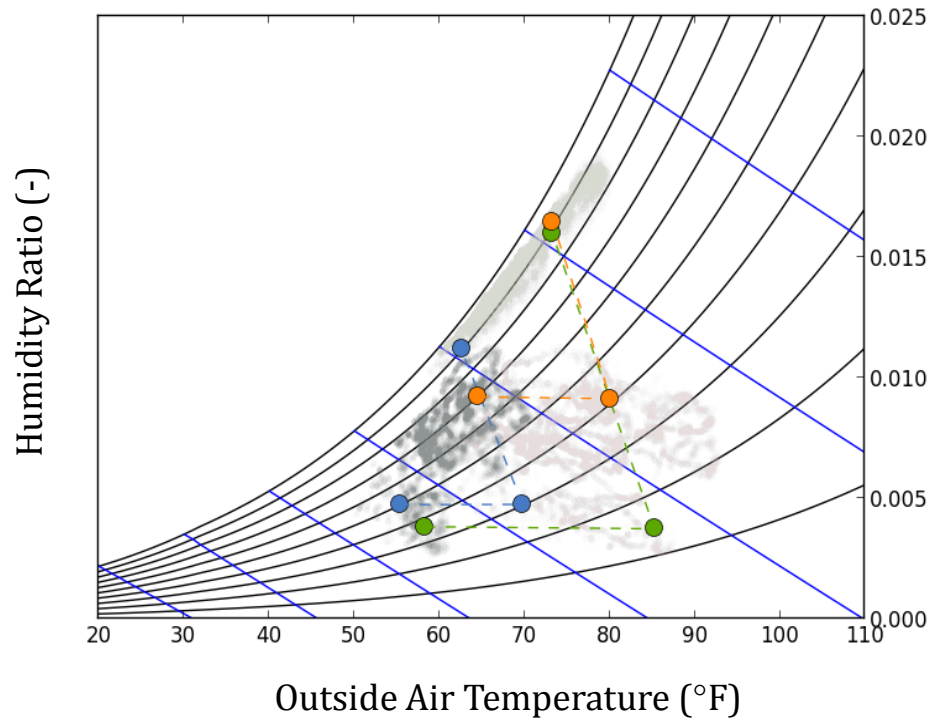
● IEC Full

● IEC Full + DX1

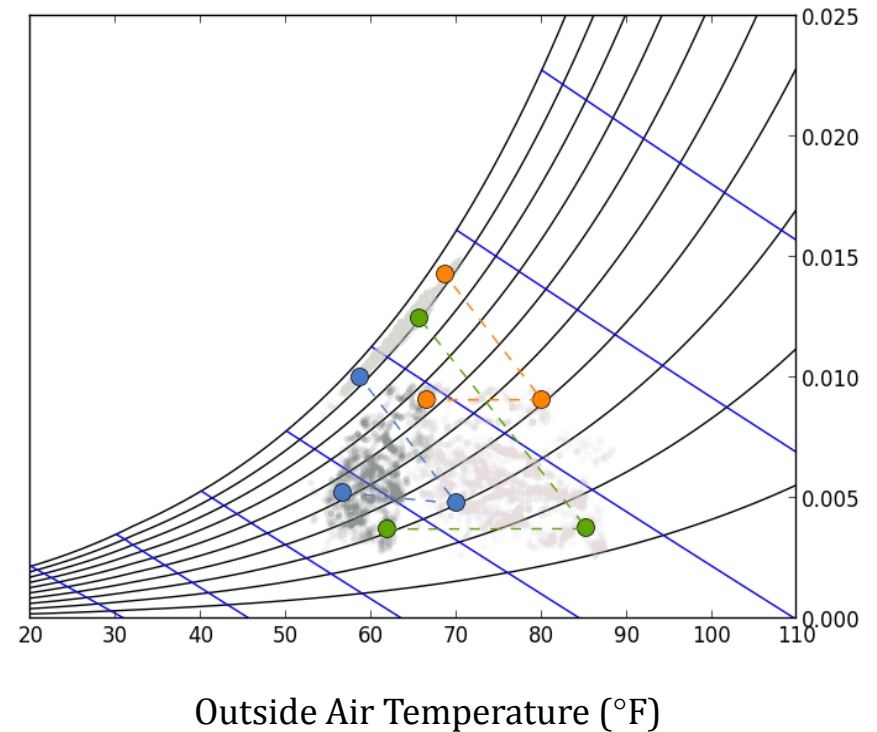
● IEC Full + DX2

Sensible Room Cooling Capacity

Climate Wizard CWH15



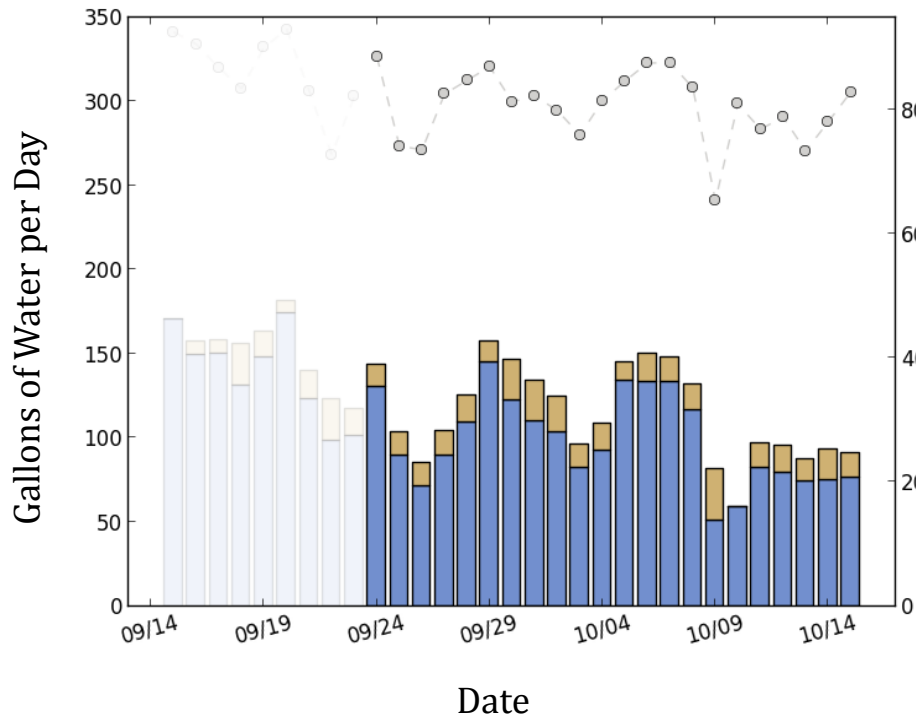
Coolerado M50



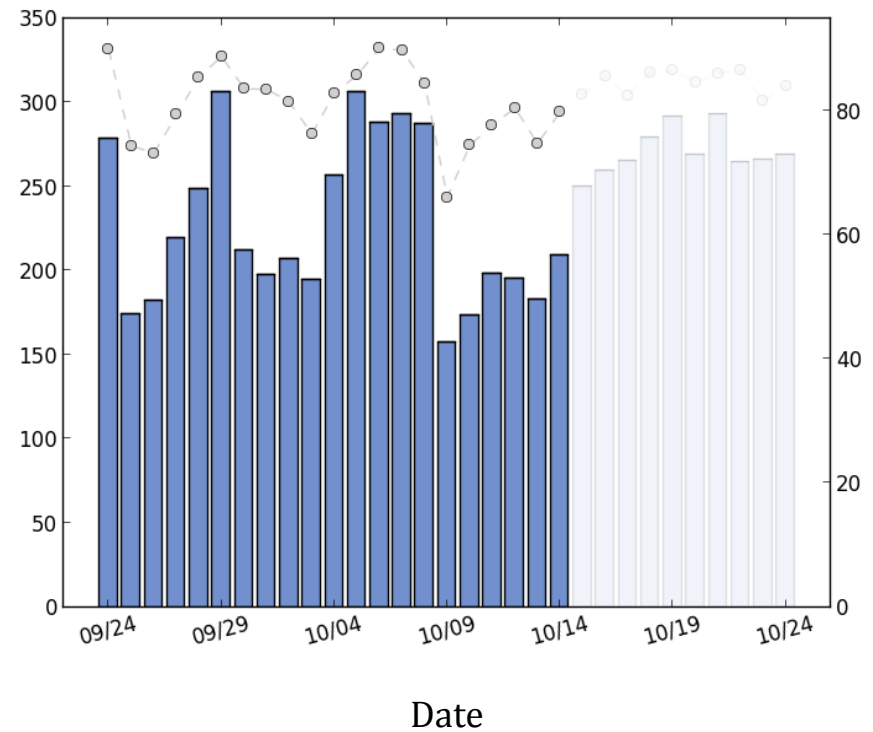
Efficient Water Use

Sensible Room Cooling Capacity

Climate Wizard CWH15



Coolerado M50



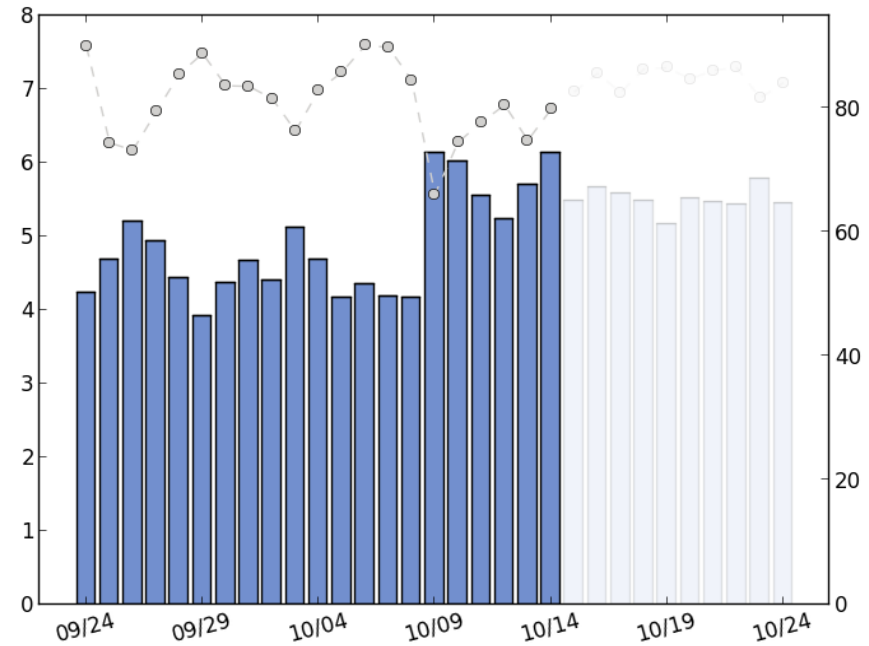
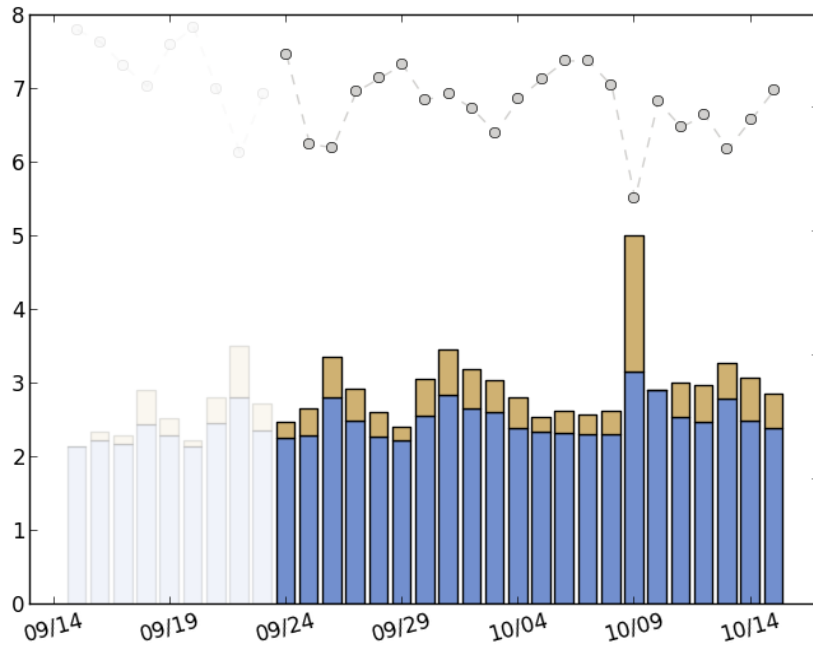
Supply Water Drain Water Daily Max OA Temp

Sensible Room Cooling Capacity

Climate Wizard CWH15

Coolerado M50

Gal of Water / Ton hr of Sensible IEC System Cooling



Supply Water

Drain Water

Daily Max OA Temp

Success not without Challenges

- Complex retrofit solution
 - Maintain economizer operation
 - Provide for ventilation without cooling
 - Heating
 - Requires balancing several airflow streams
 - Must maintain appropriate airflow for DX
- System performance is sensitive to downstream pressure
- Most significant challenges related commissioning, maintenance, filters

Recommendations going forward...

- Option to install in parallel in stead of series
 - Still requires controls integration to maintain ventilation appropriately
- Unitary DOAS system to include indirect evaporative cooling
- Hybrid air conditioner



MUNTERS EPX 5000 HYBRID DOAS LABORATORY ASSESSMENT

G&E APPLIED TECHNOLOGY SERVICES, LA

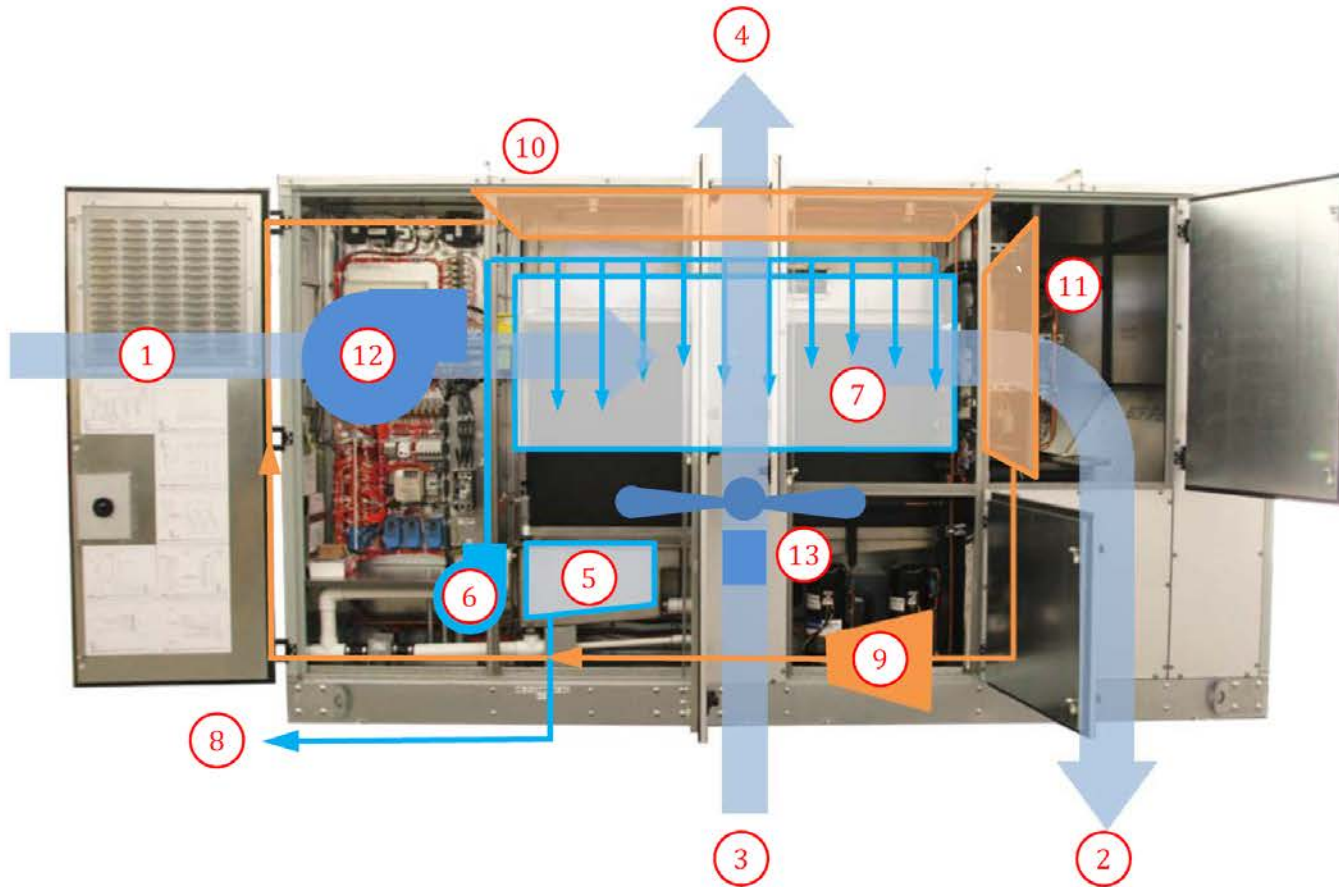
TORY LAYOUT PLAN

IMPLEMENTATION AND DESIGN OF EXPERIMENTS

A Unitary Hybrid Air Conditioner

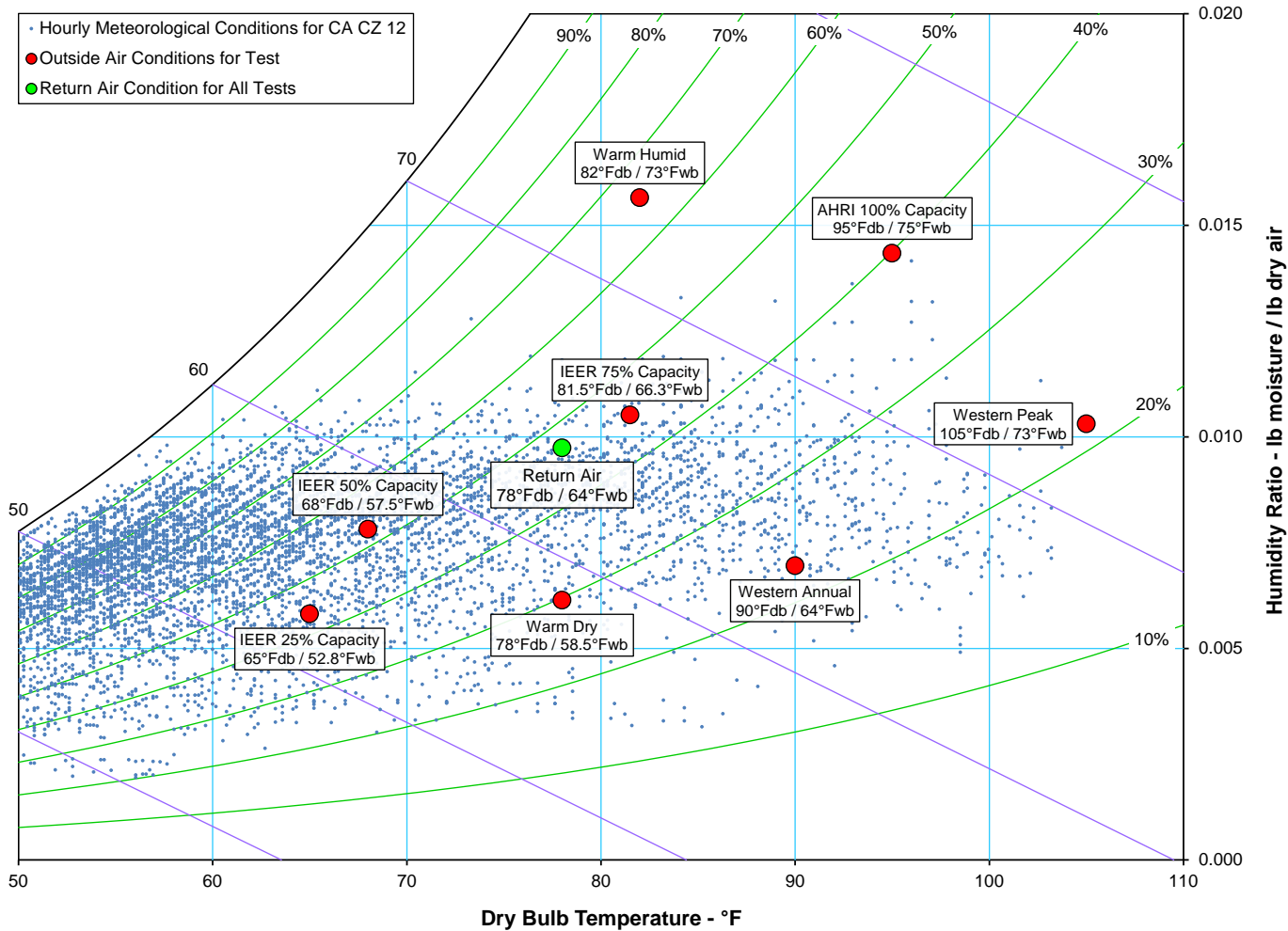
Unitary Hybrid DOAS



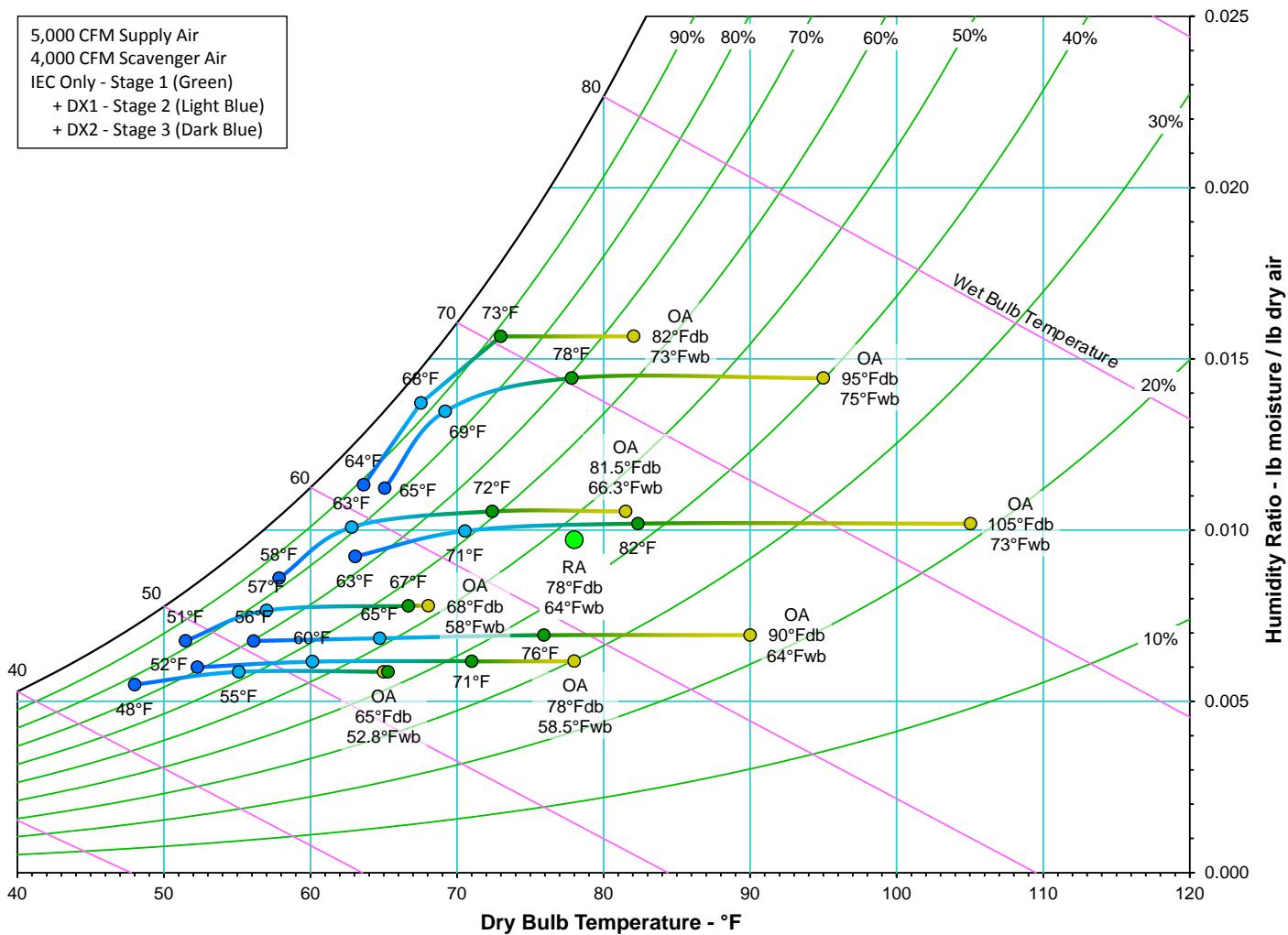


①	<i>Outside Air (Primary Inlet)</i>	⑤	<i>Sump</i>	⑩	<i>DX Condenser</i>
②	<i>Supply Air</i>	⑥	<i>Circulation Pump</i>	⑪	<i>DX Evaporator</i>
③	<i>Return Air (Secondary Inlet)</i>	⑦	<i>EPX (Indirect Evap. Heat Exch.)</i>	⑫	<i>Blower (Primary Air)</i>
④	<i>Exhaust Air</i>	⑧	<i>Drain</i>	⑬	<i>Fan (Secondary Air)</i>
		⑨	<i>Compressors</i>		

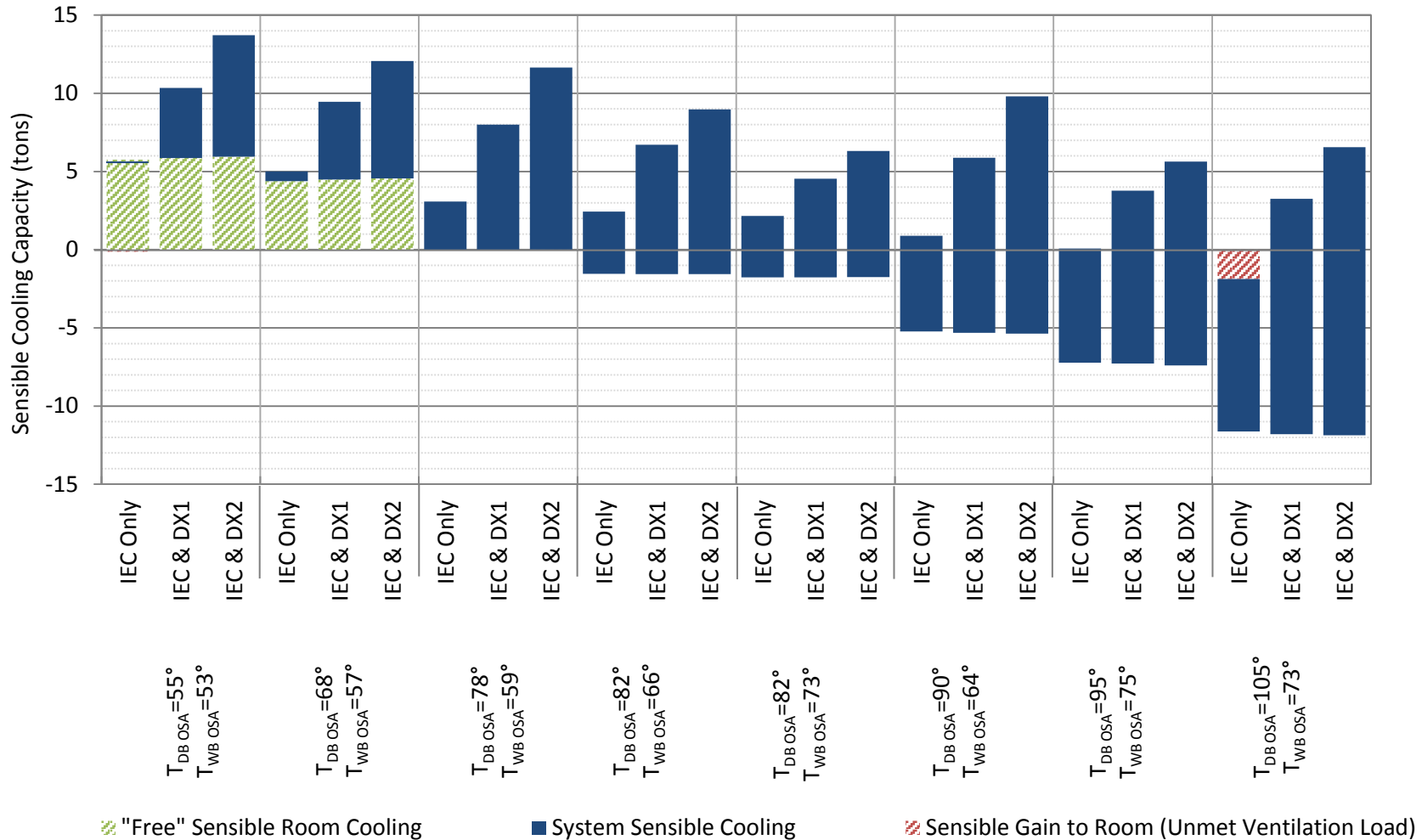
Wide range of standard test conditions



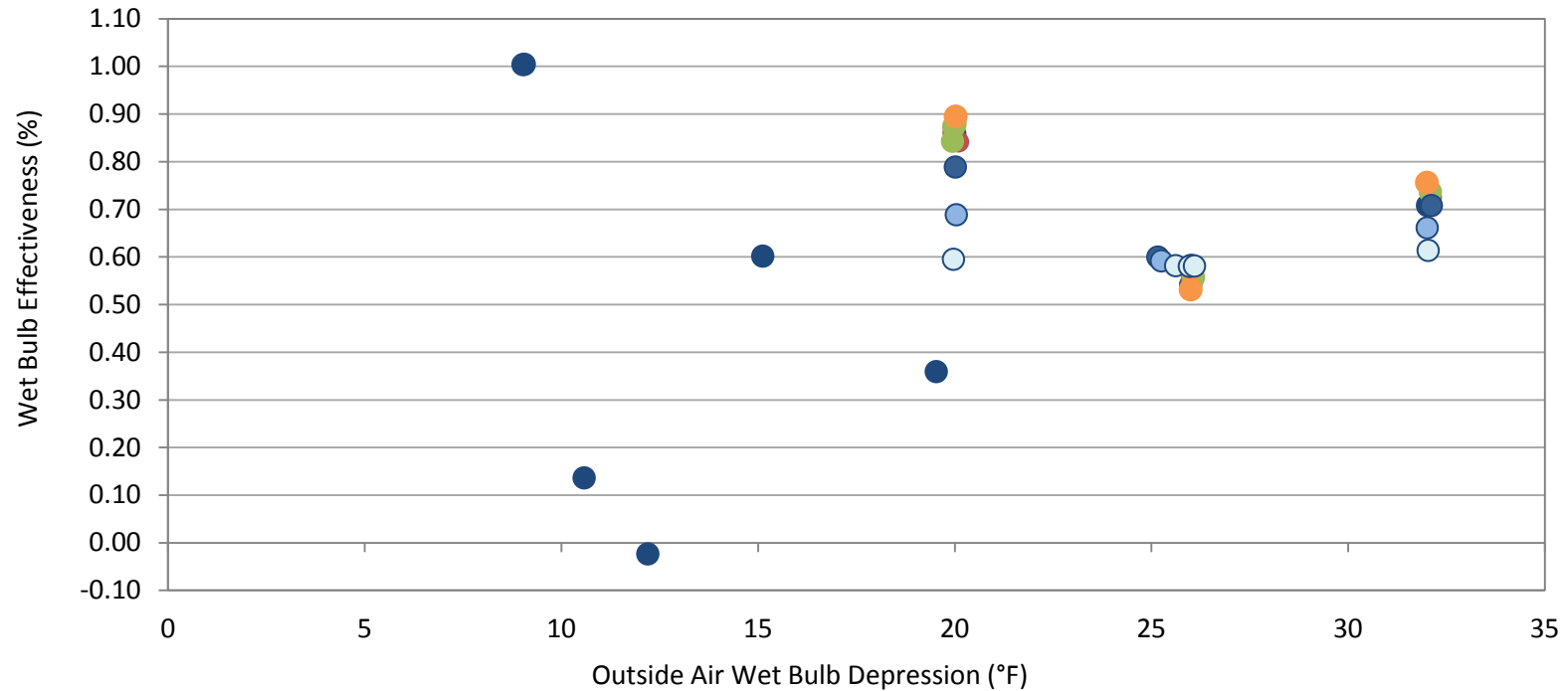
Performance in each mode of operation



Sensible capacity by mode and condition



Wet Bulb Effectiveness



● SA=5000 cfm, RA=4000 cfm

● SA=4000 cfm, RA=3200 cfm

● SA=5000 cfm, RA=6000 cfm (OSAF=33%)

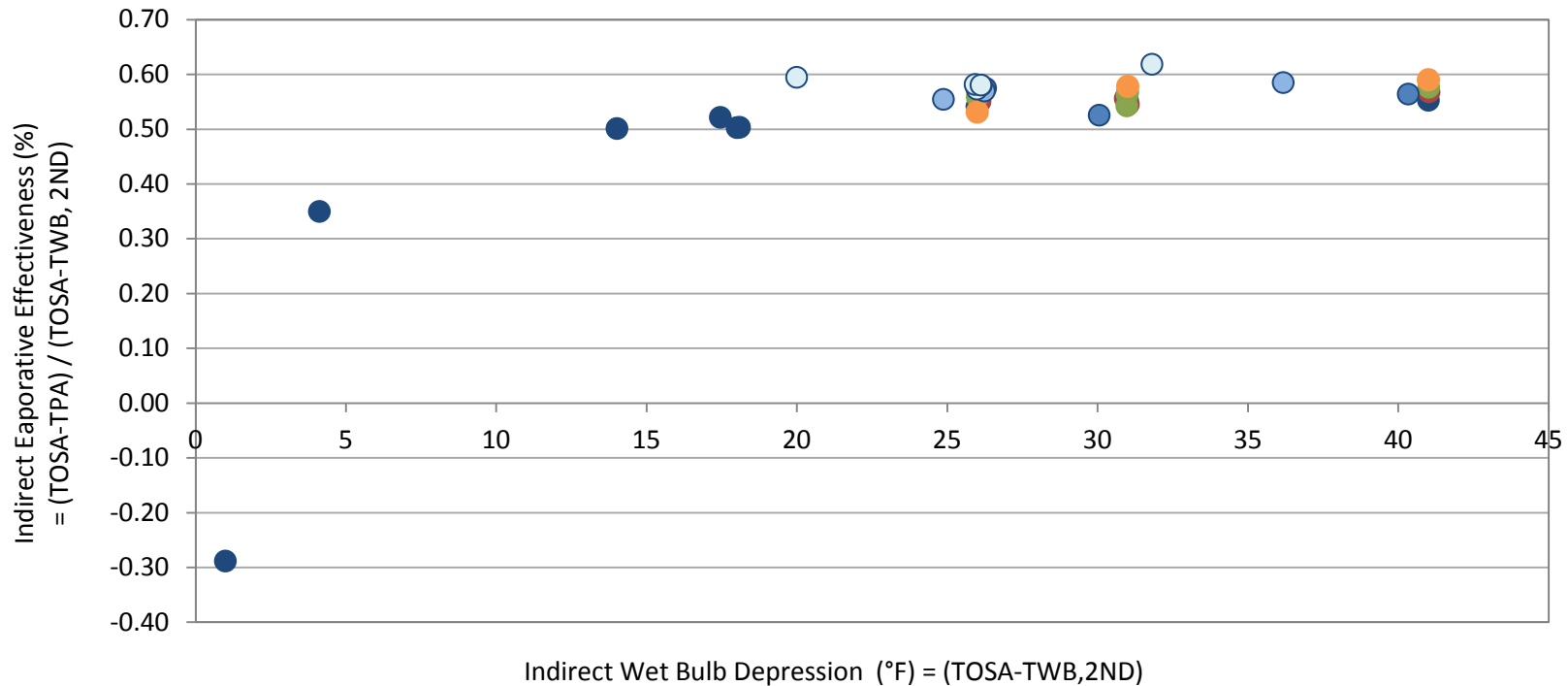
○ SA=5000 cfm, RA=6000 cfm (OSAF=100%)

● SA=4500 cfm, RA=3600 cfm

● SA=3500 cfm, RA=2800 cfm

● SA=5000 cfm, RA=6000 cfm (OSAF=66%)

Indirect Evaporative Effectiveness



● SA=5000 cfm, RA=4000 cfm

● SA=4000 cfm, RA=3200 cfm

● SA=5000 cfm, RA=6000 cfm (OSAF=33%)

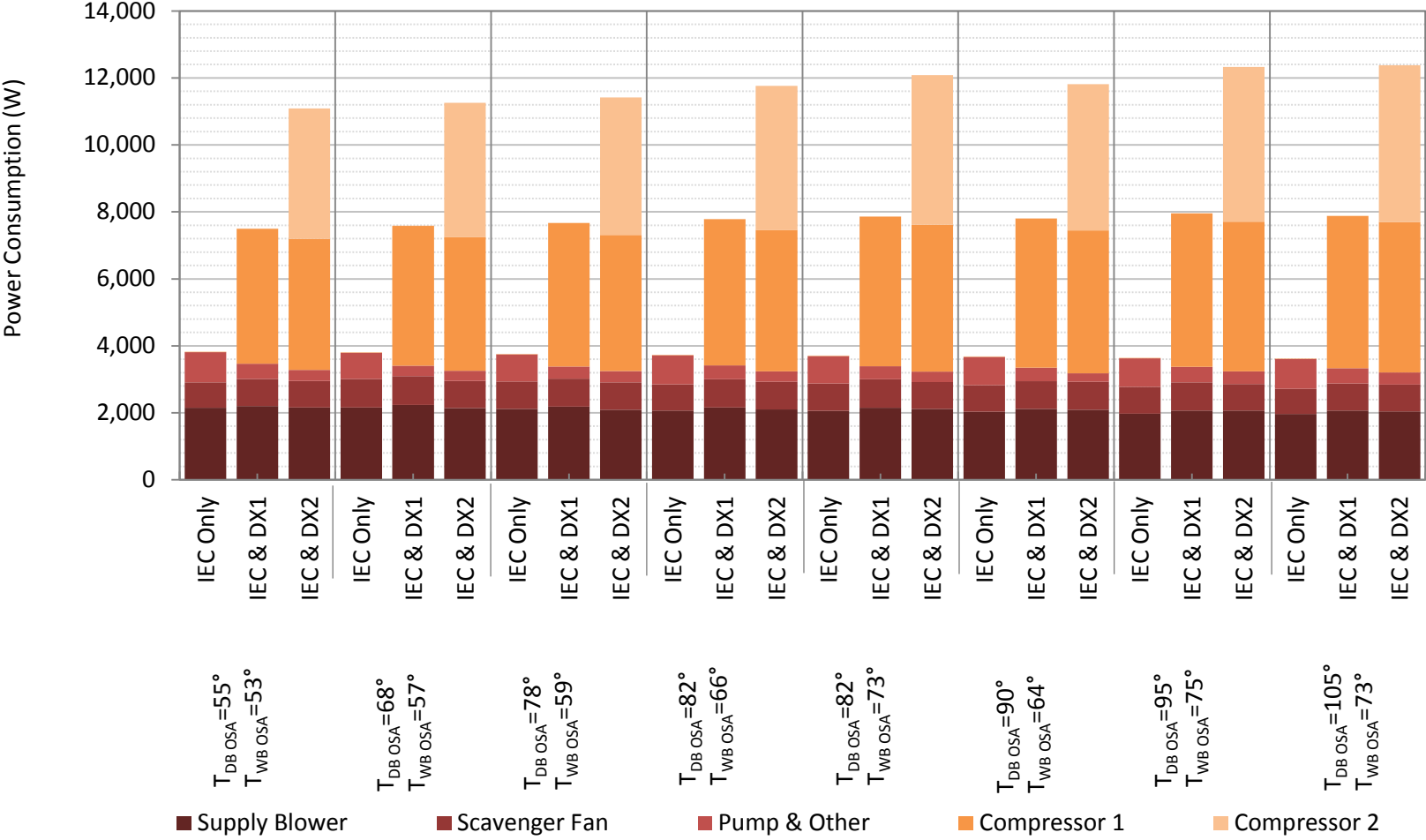
○ SA=5000 cfm, RA=6000 cfm (OSAF=100%)

● SA=4500 cfm, RA=3600 cfm

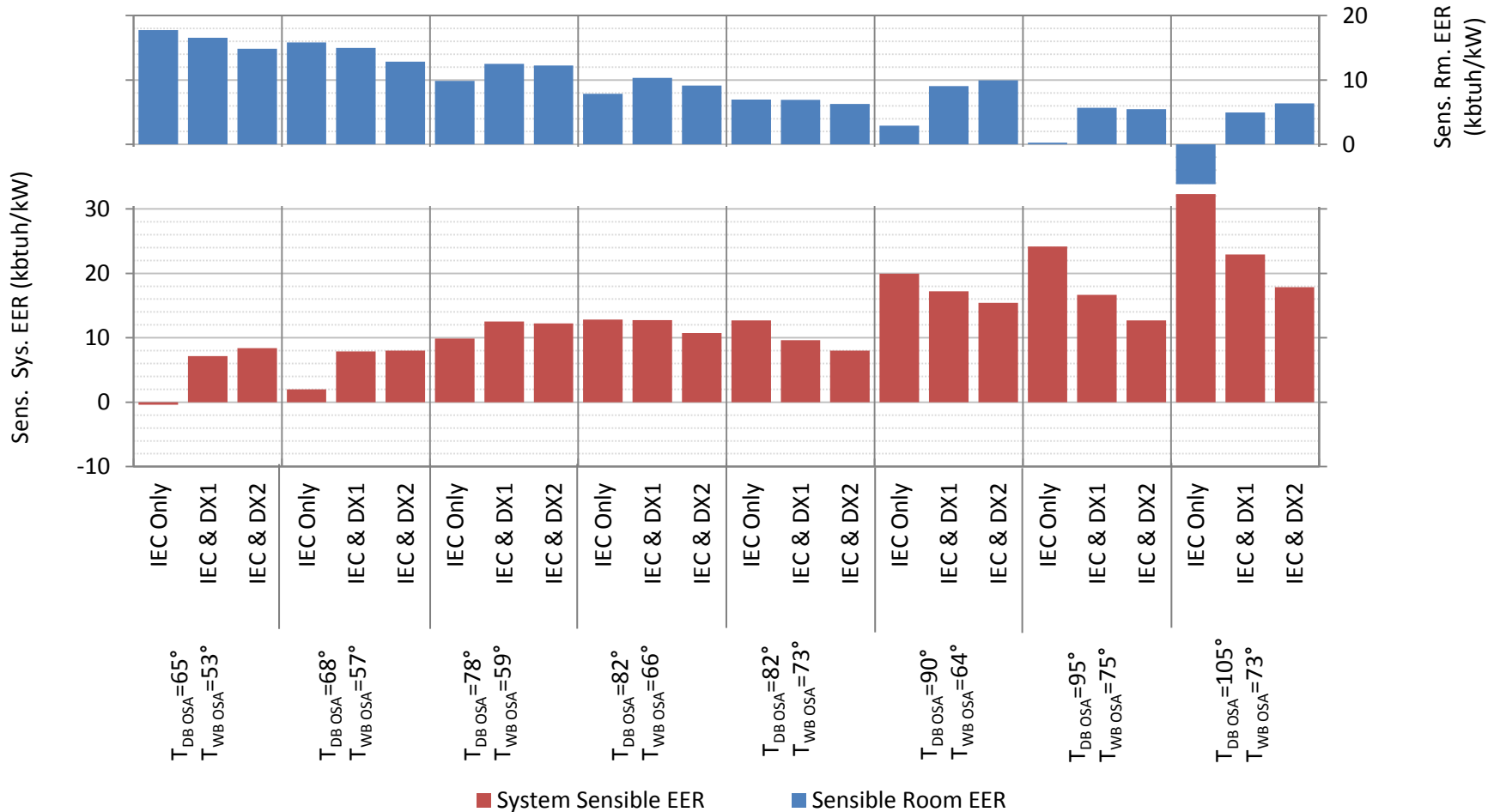
● SA=3500 cfm, RA=2800 cfm

● SA=5000 cfm, RA=6000 cfm (OSAF=66%)

Component power draw for each test



Very High Efficiency for Ventilation Cooling



ONE MACHINE

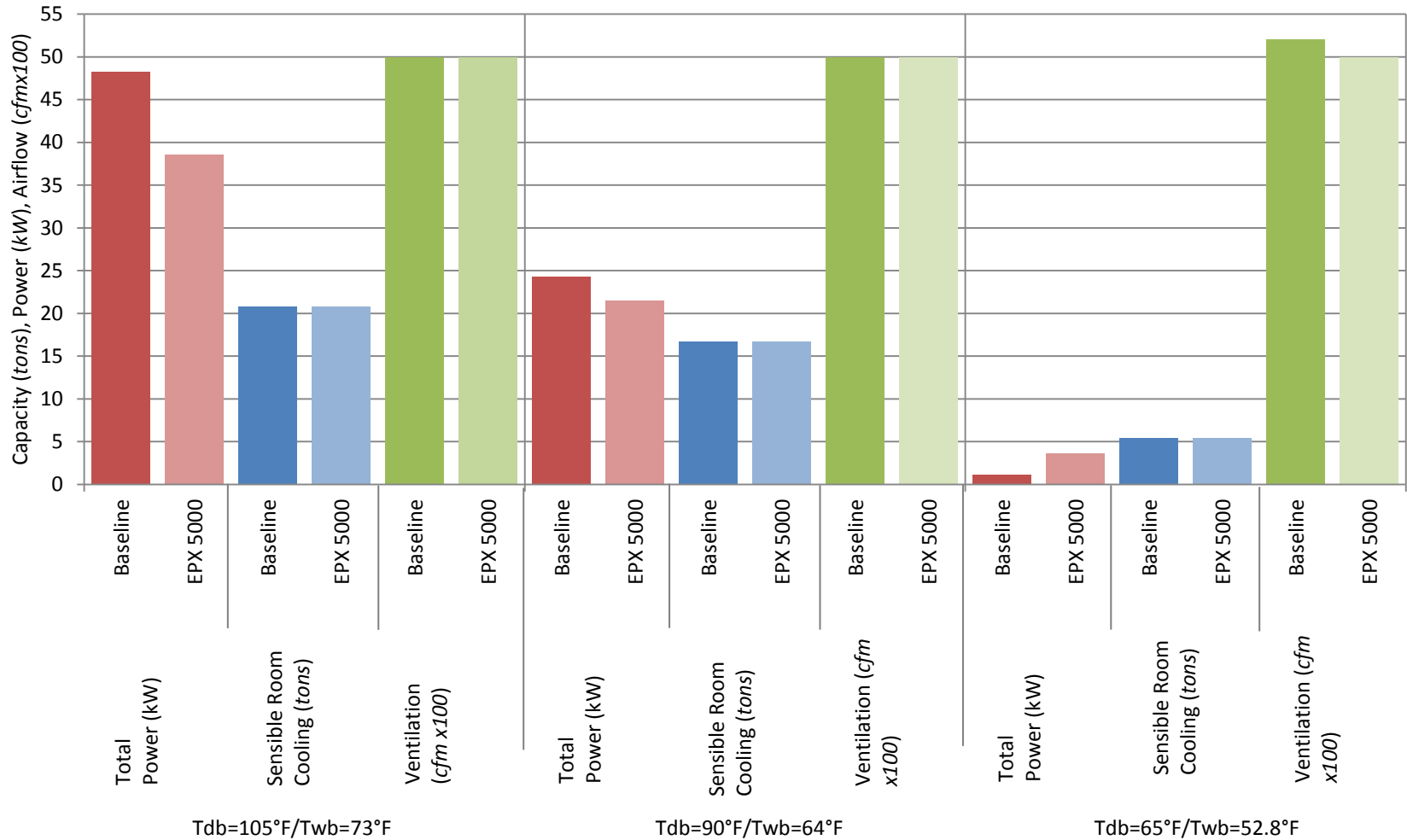
20%

WHOLE-BUILDING
ON-PEAK HVAC
DEMAND SAVINGS

MUNTERS EPX 5000



Whole building HVAC kW ↓ 20%





Challenges for field application

- Not all applications can utilize return air
- Needs to operate as priority for cooling
- Should supply to a zone that requires cooling
- Regular filter service is critical
- Must offset ventilation from other rooftop units
- Install requires building air balance
- Best annual savings when other rooftop units switch to AUTO
- Thermostat placement is very important
- Recommend application as part of QM program for whole building HVAC

THE WESTERN COOLING CHALLENGE TARGET: *HYBRID ROOFTOP PACKAGE UNIT*

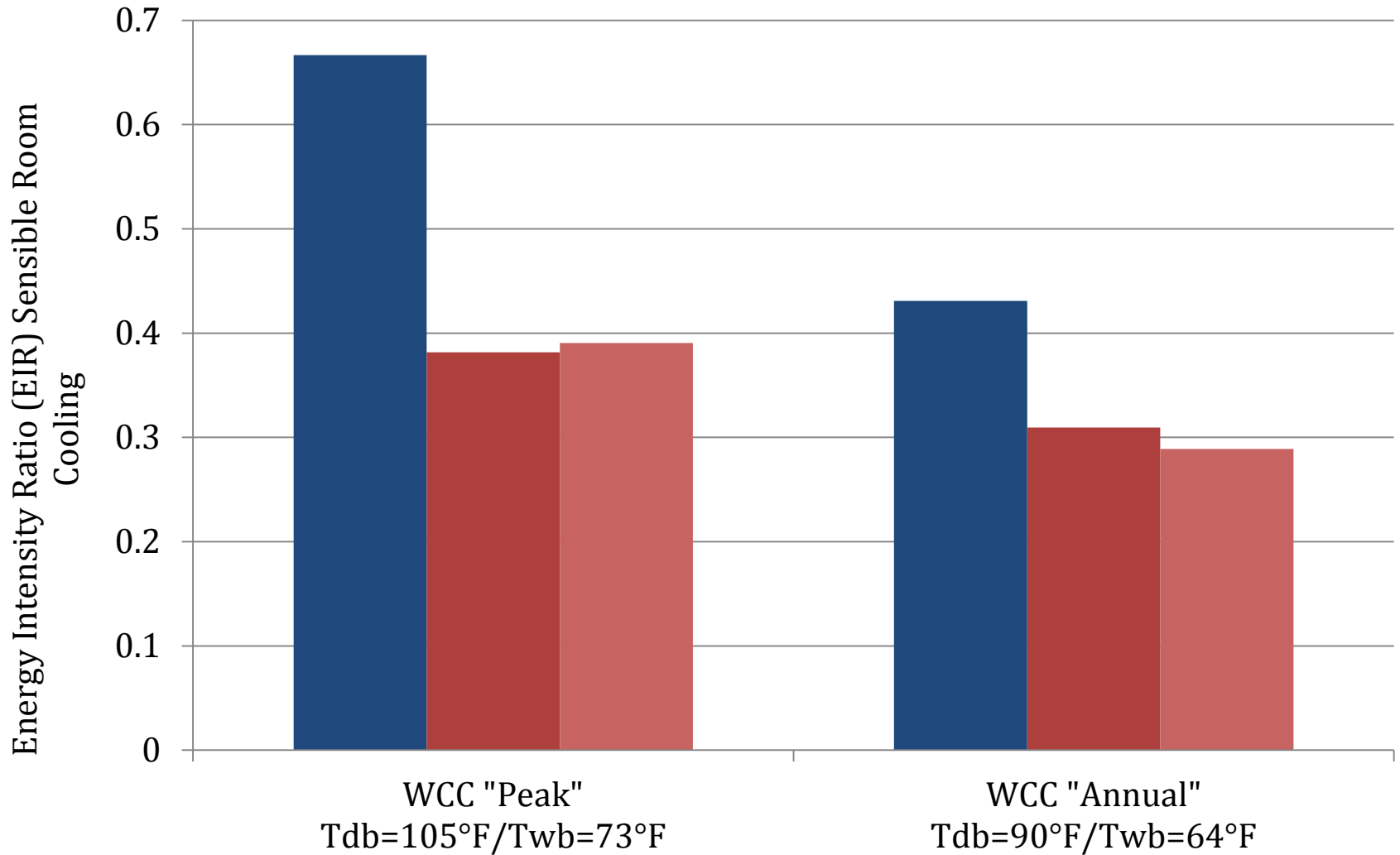




TRANE®



**INTEGRATED
COMFORT INC.**



■ Standard Baseline RTU
 ■ Trane Voyager DC, IEC+DX2
 ■ Trane Voyager DC, IEC+DX1

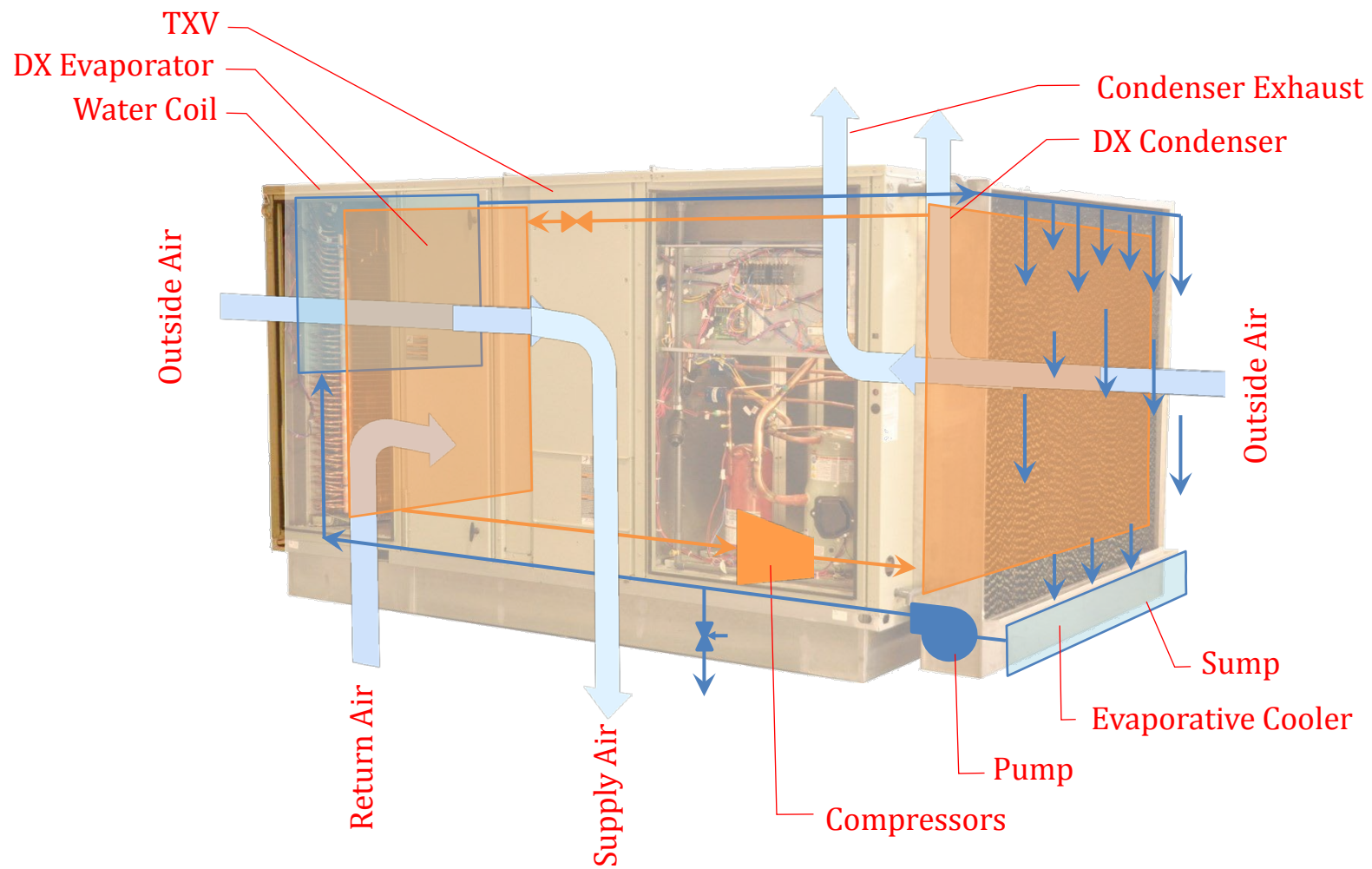
Dual Cool® Patented Dual Evaporative Pre-Cooling



TRANE®



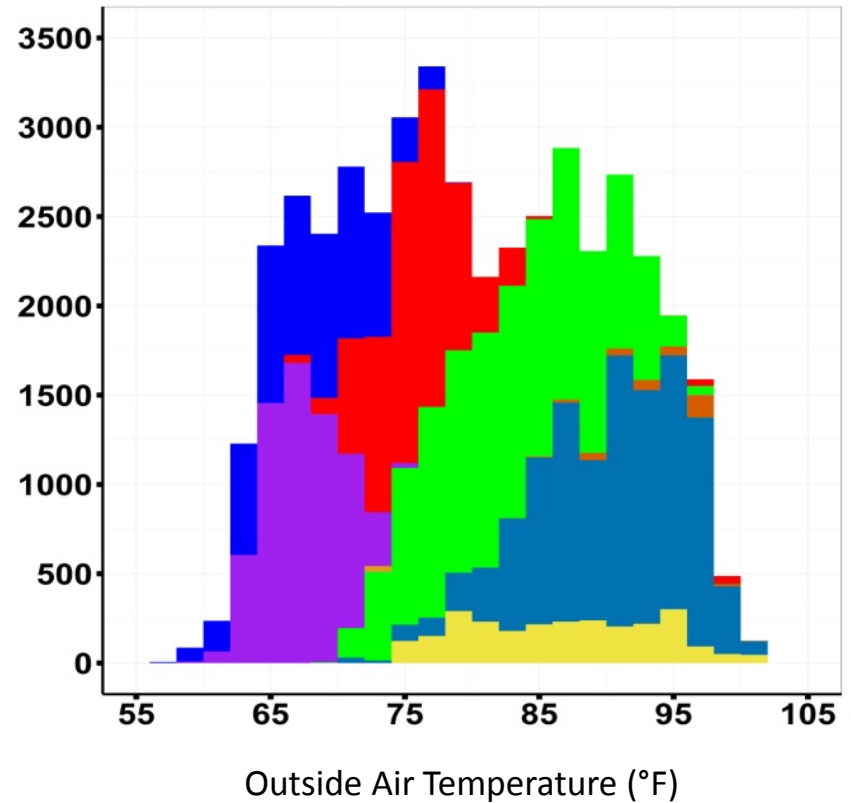
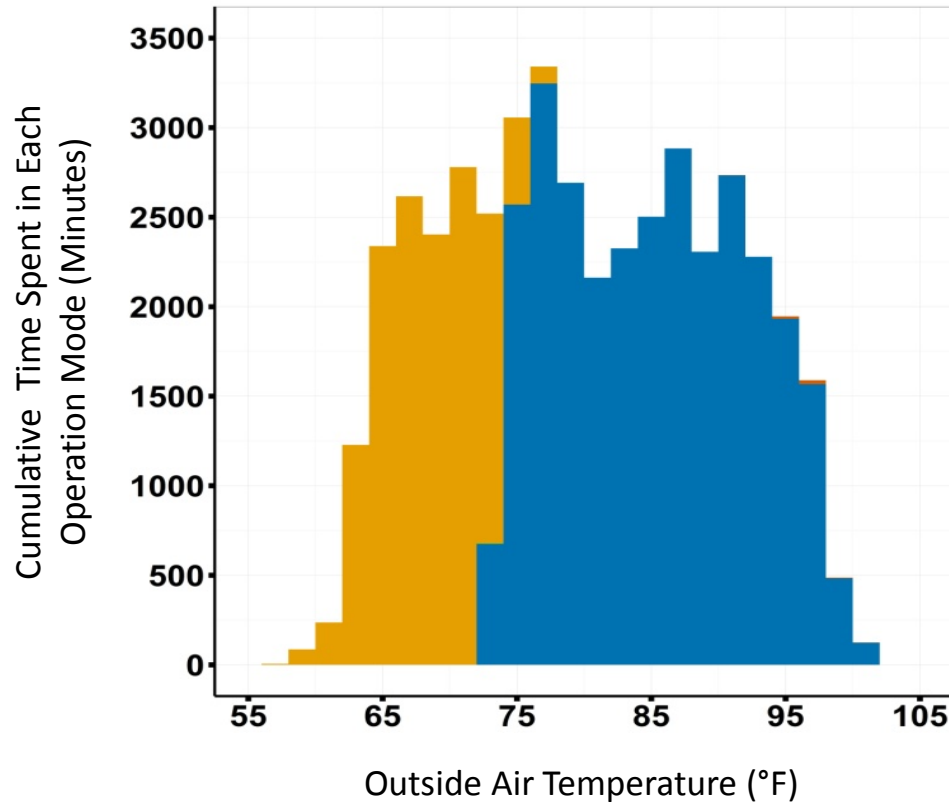
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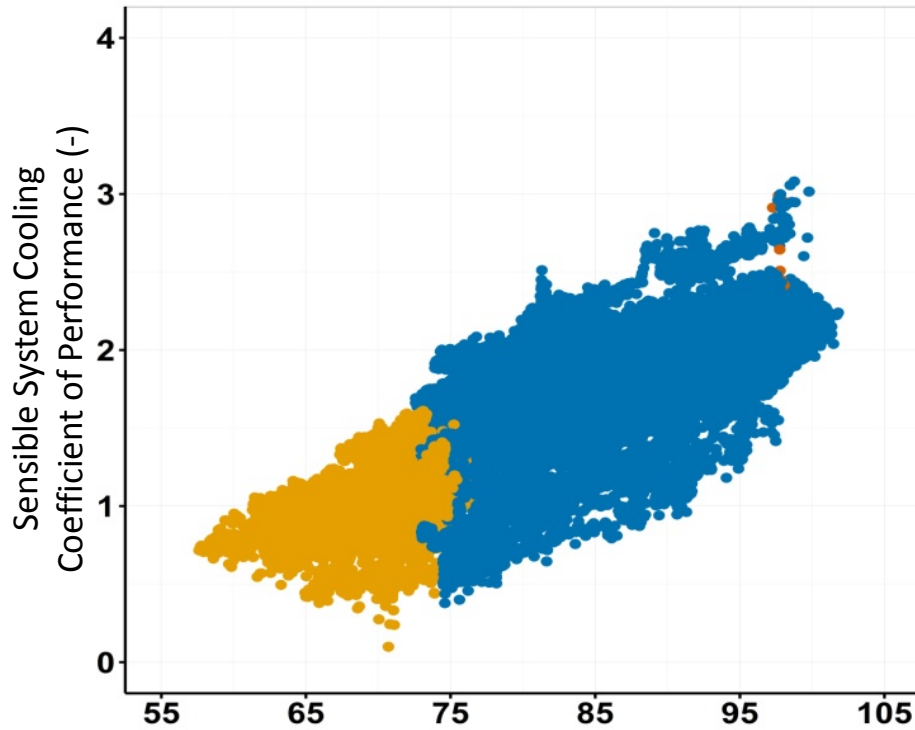


Distribution of Operating Modes

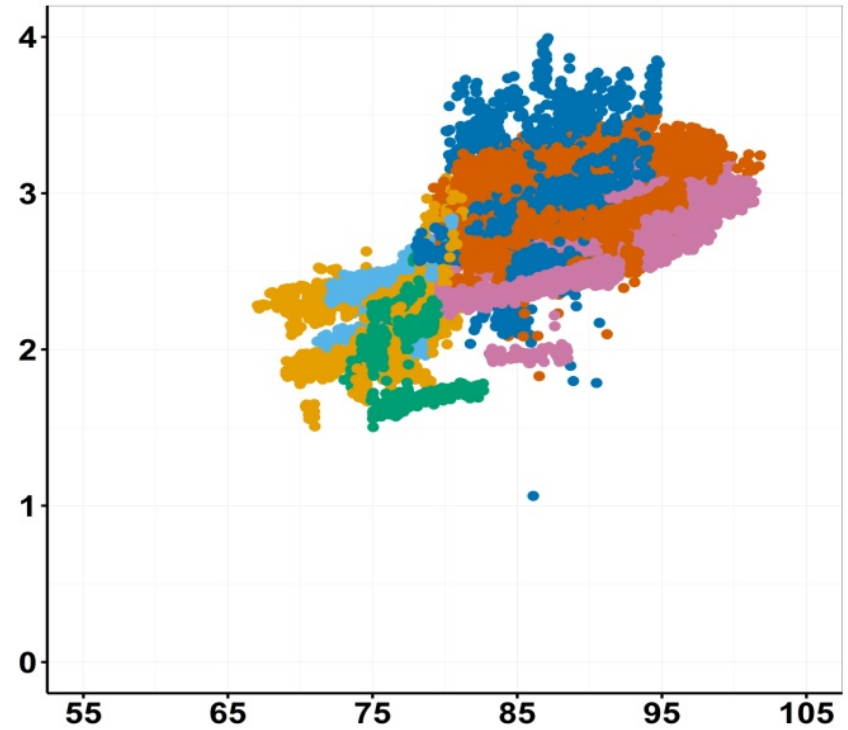


Coefficient of Performance

DualCool Unit (RTU 7)

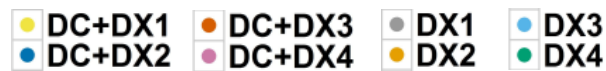


DualCool Unit (RTU 11)



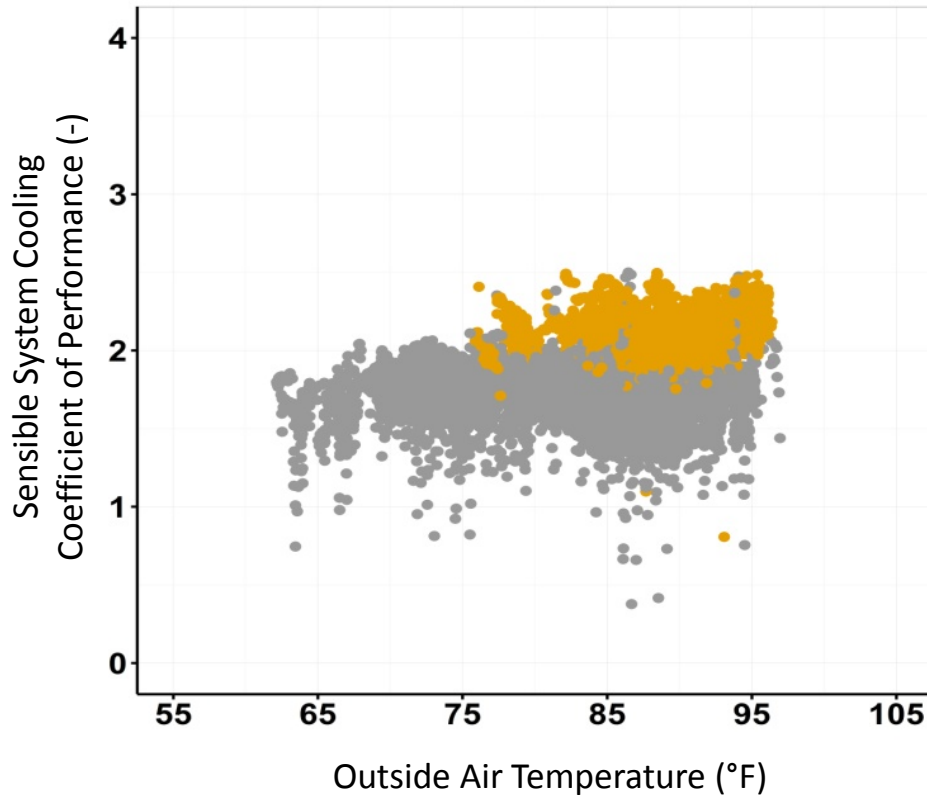
Outside Air Temperature (°F)

Outside Air Temperature (°F)

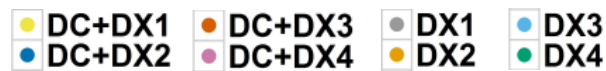
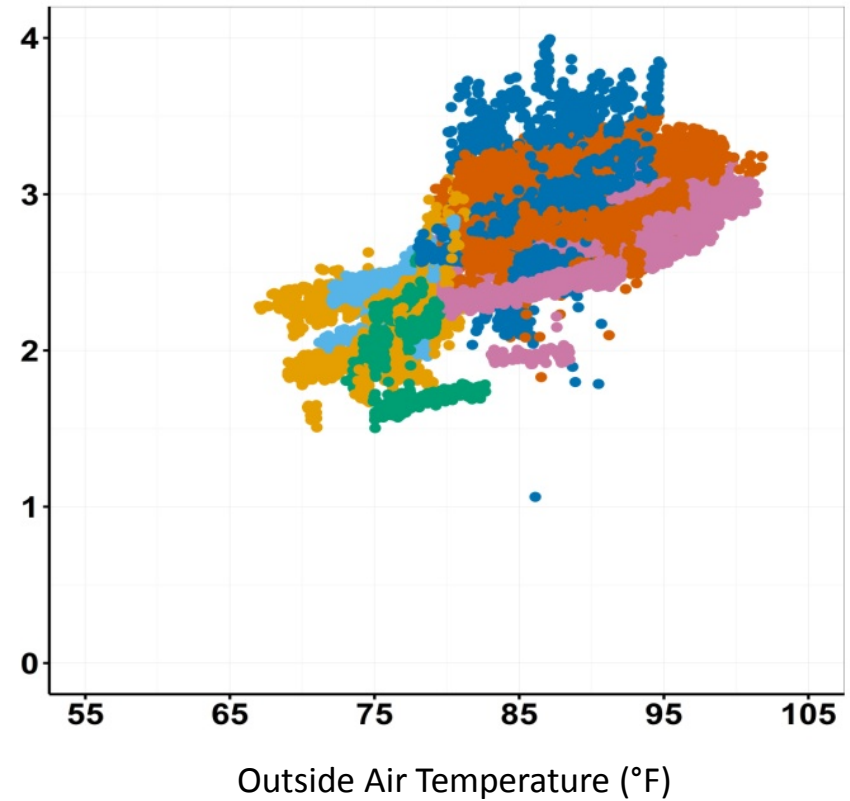


Coefficient of Performance

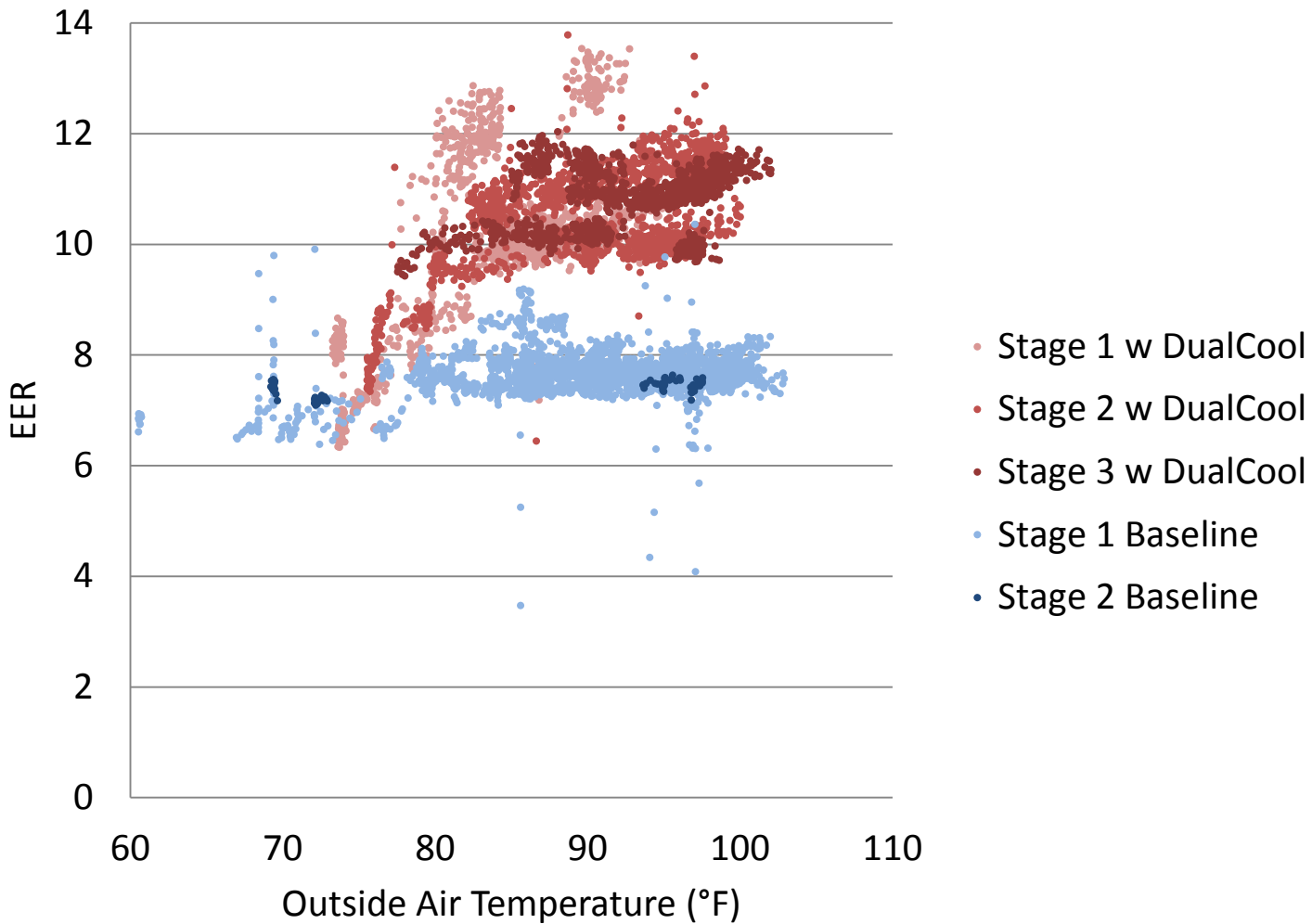
"Baseline" Unit (RTU 20)



DualCool Unit (RTU 11)



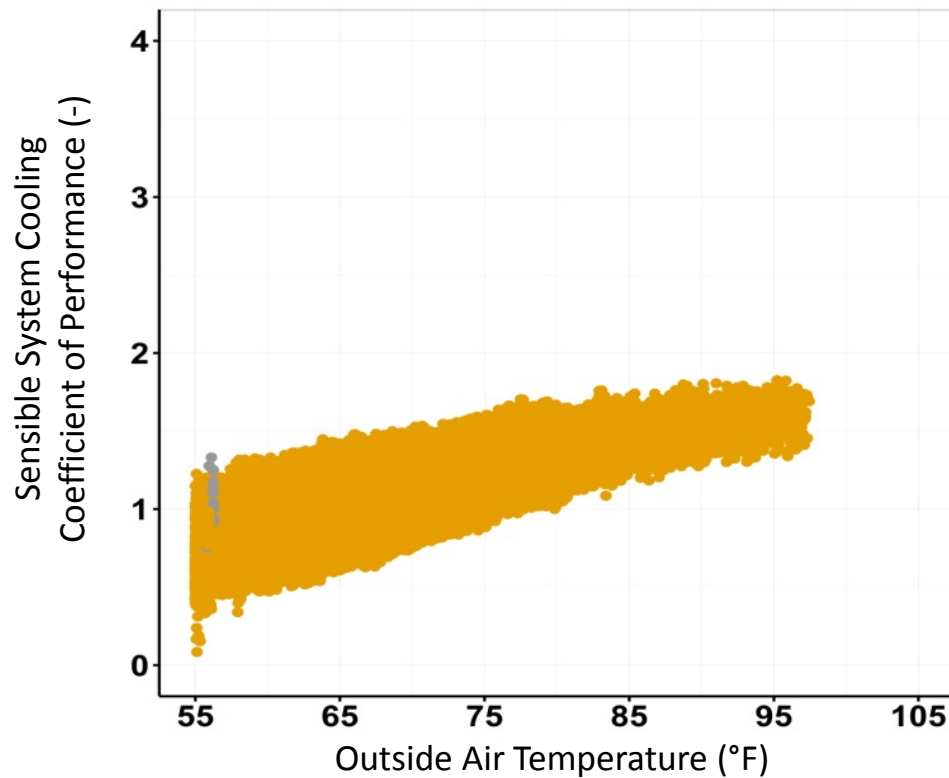
EER Performance Comparison



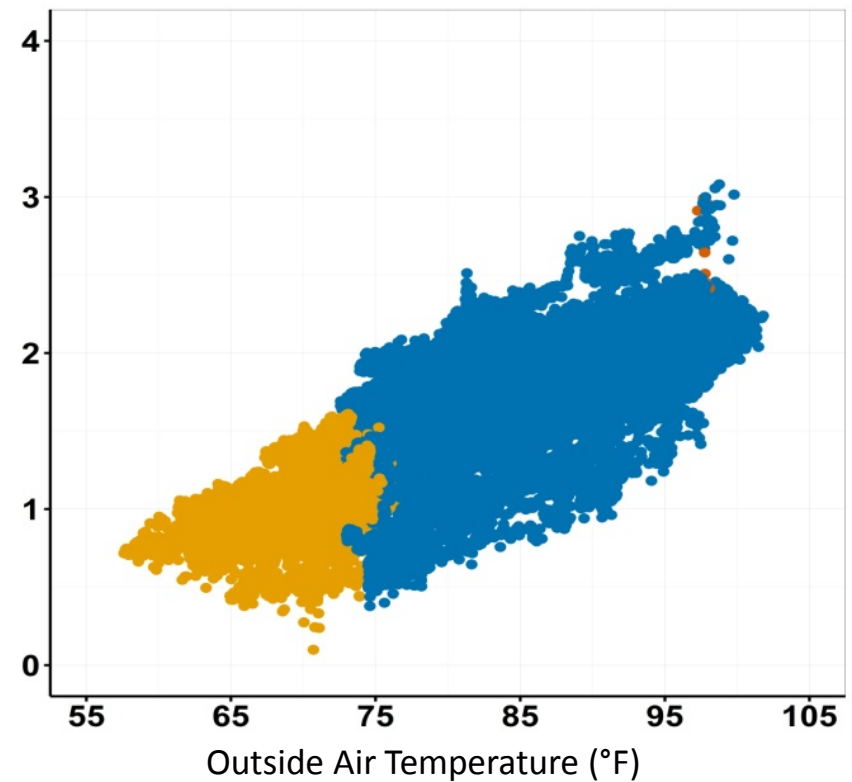
SCE, TGT PALMDALE, DC RETROFIT RTU 21 & BASELINE RTU 11, 2013 AUG 11,14,18,20,23

Pre-Post Comparison: COP \uparrow 50% at Peak

(RTU 7) Pre-DualCool



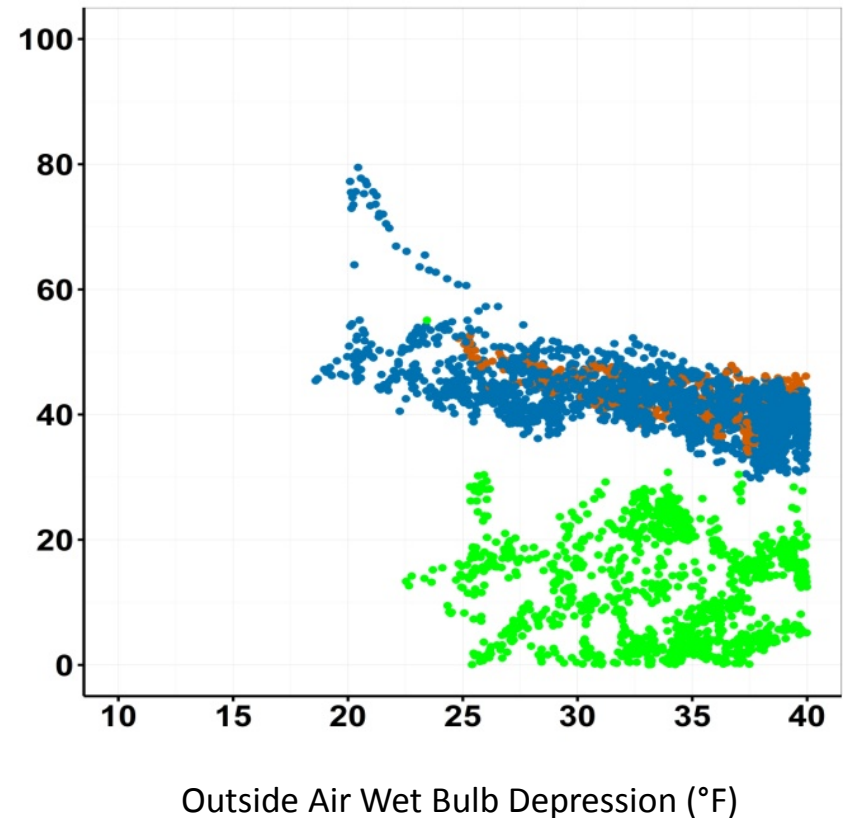
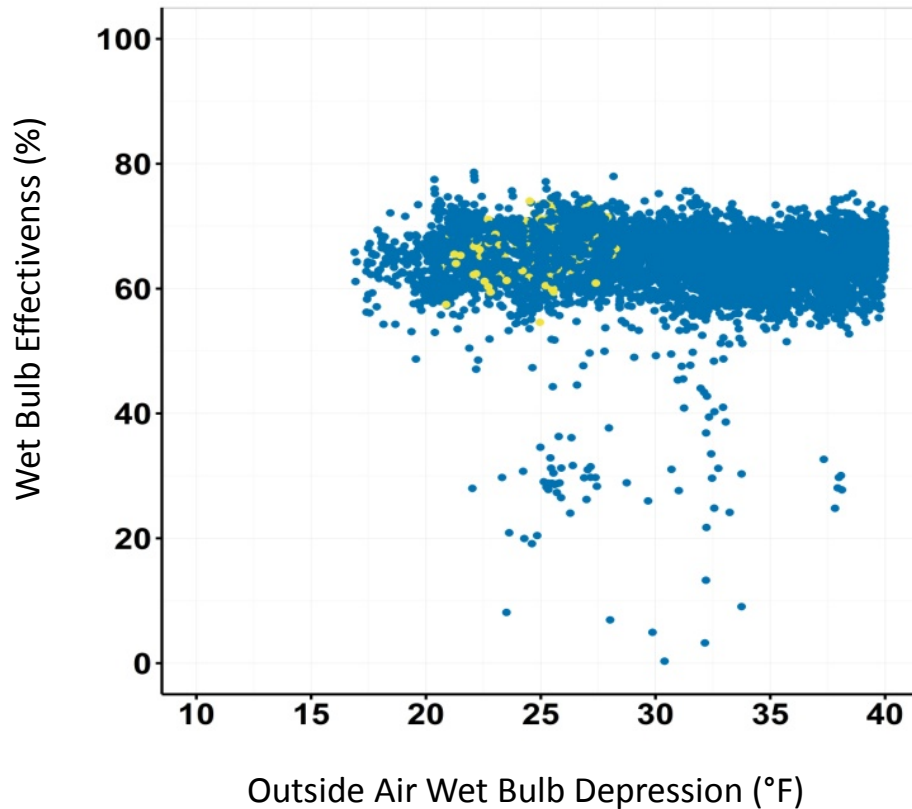
(RTU 7) Post-DualCool



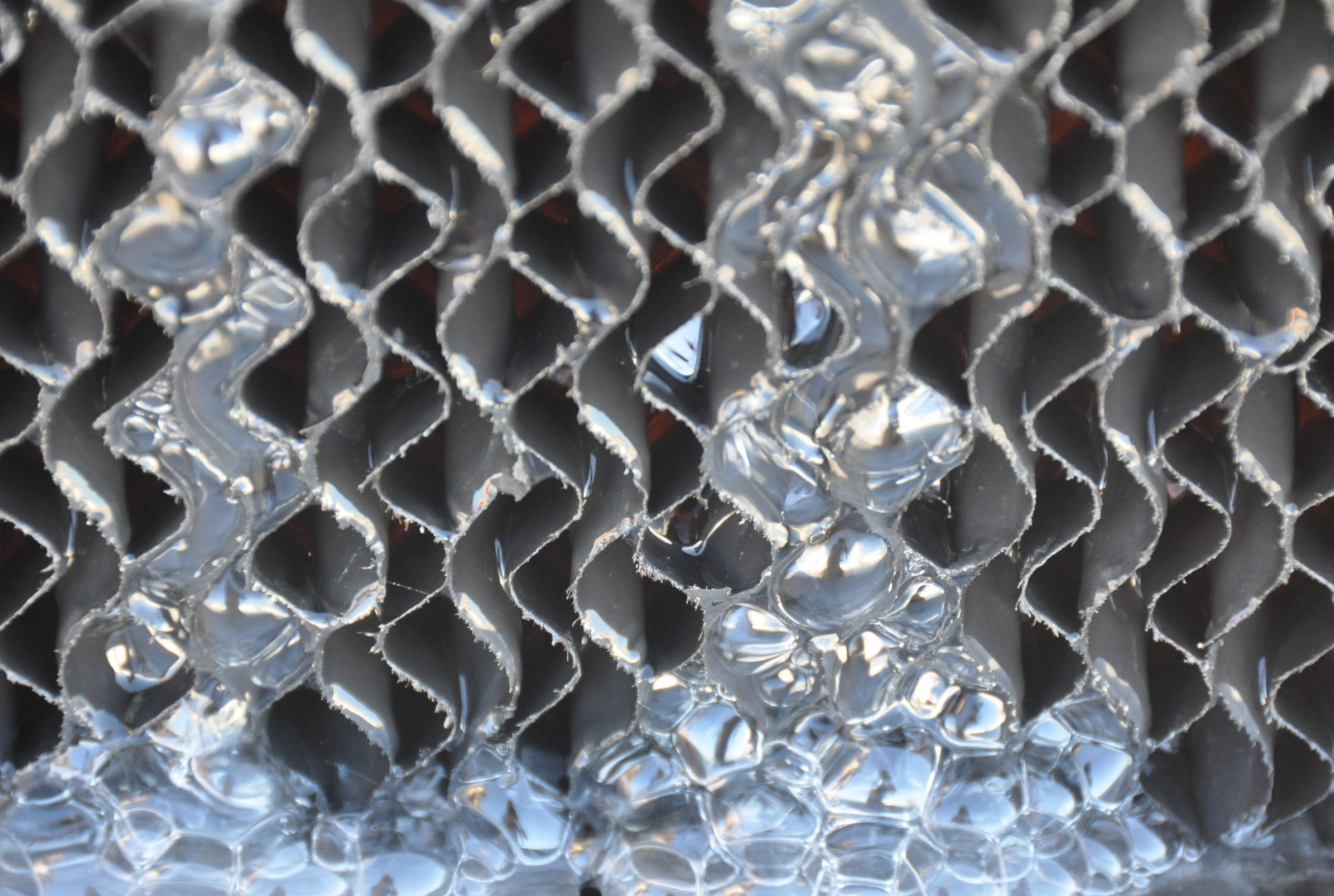
Wet Bulb Effectiveness for Indirect Evaporative Cooling

RTU 7

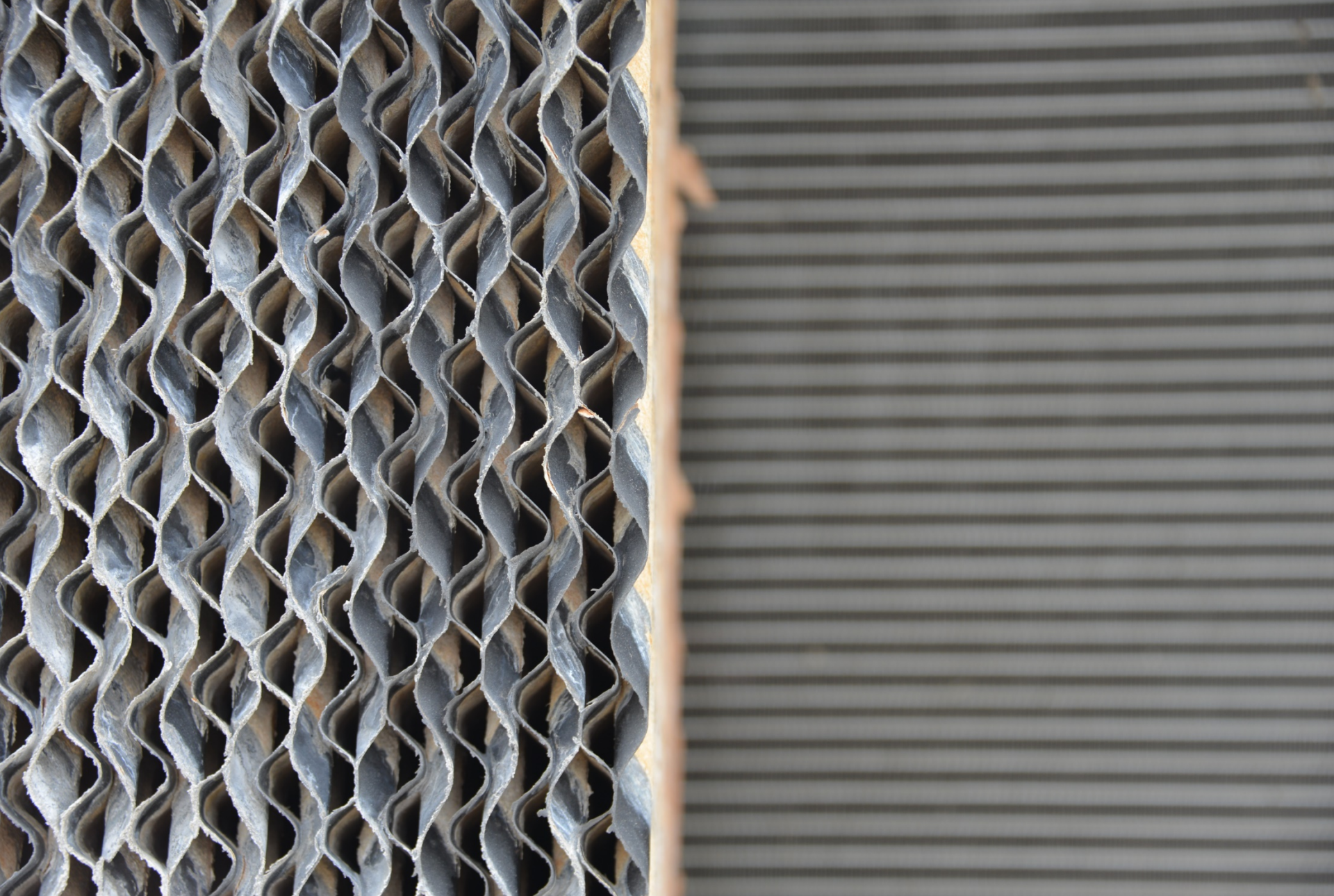
RTU 11







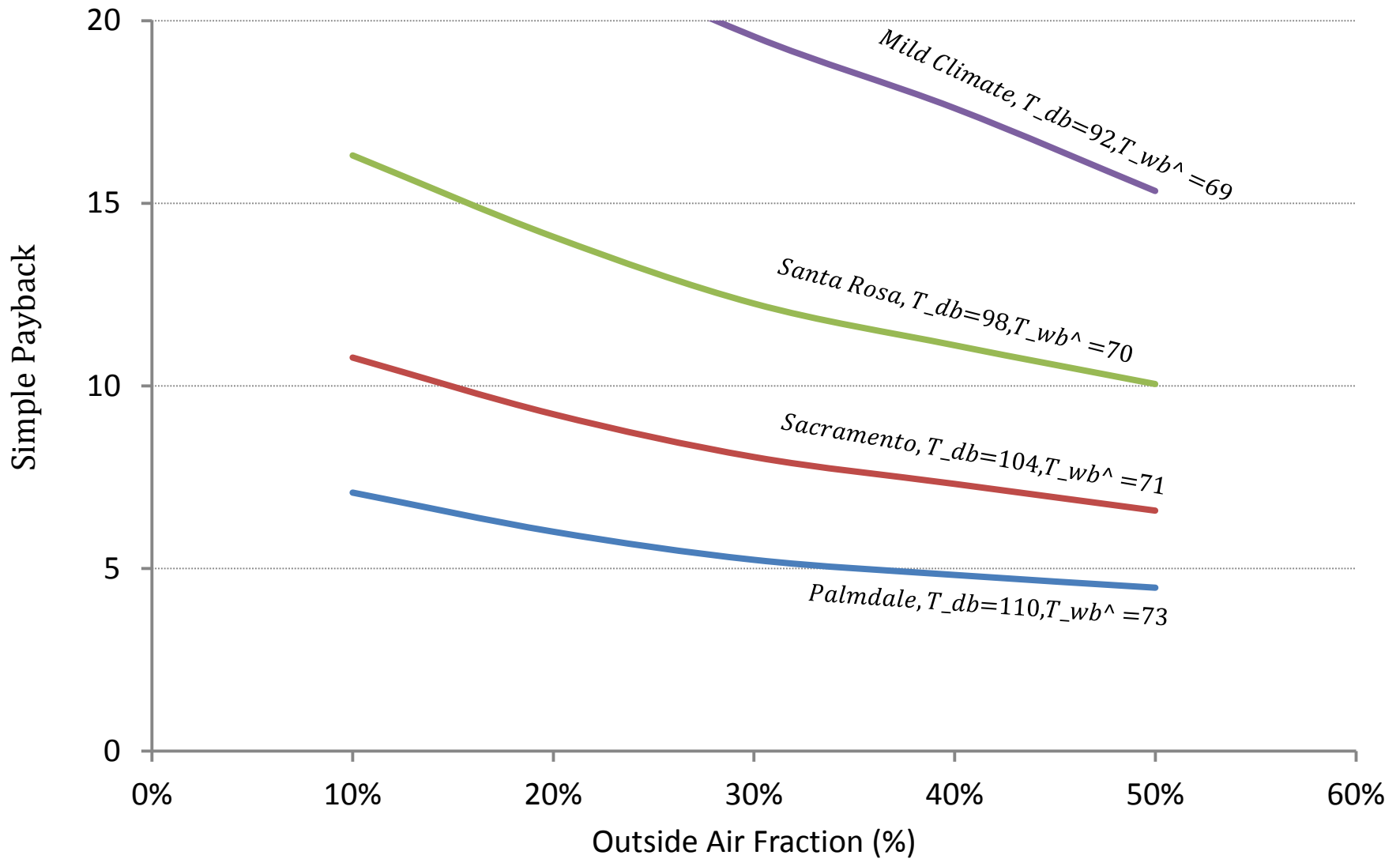




Some opportunities for further improvement

- Admire simple approach (cost effective) but results in some limitations
- Optimization for temperature changeover selection
- Outside air temperature measurement
- Optimize integration with economizer mode
- DualCool operation without compressors?
- Need attention seasonally
 - Coil cleaning, sump washout, winterize

Simple Payback for Retail without Incentives





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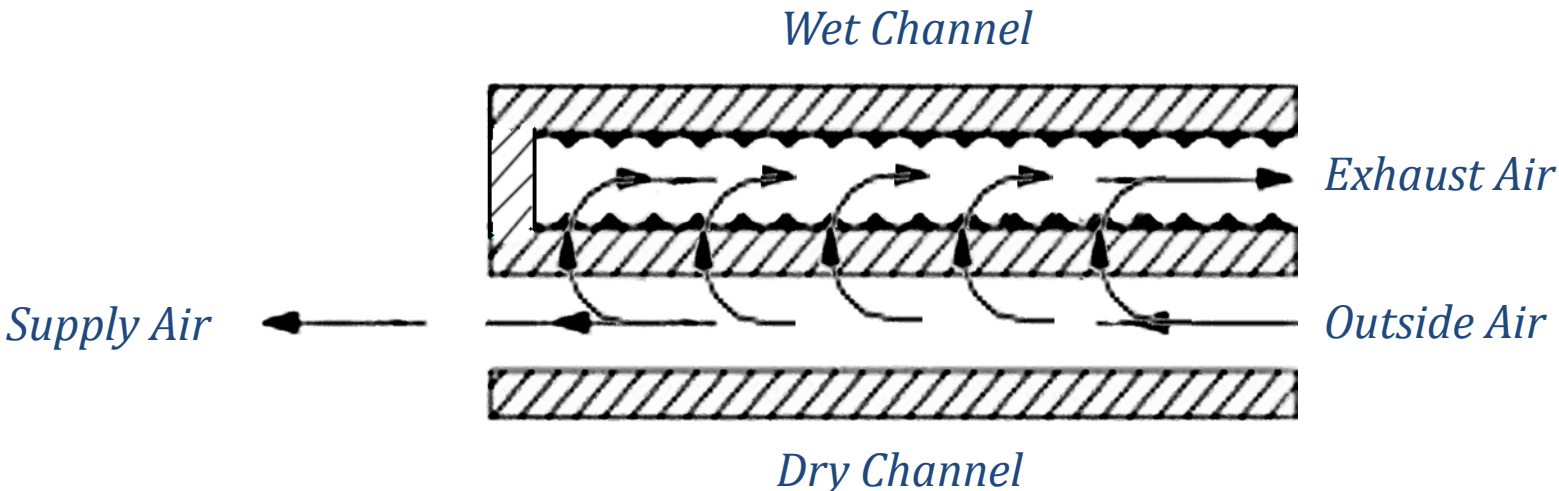
| TECHNOLOGY TOPICS |
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MULTI-TENNANT LIGHT
COMMERCIAL |

Indirect Evaporative Cooling

Separation of Mass Transfer & Heat Transfer



Coolerado - Maisotsenko Cycle (Concept)



Seeley Climate Wizard (Concept)

