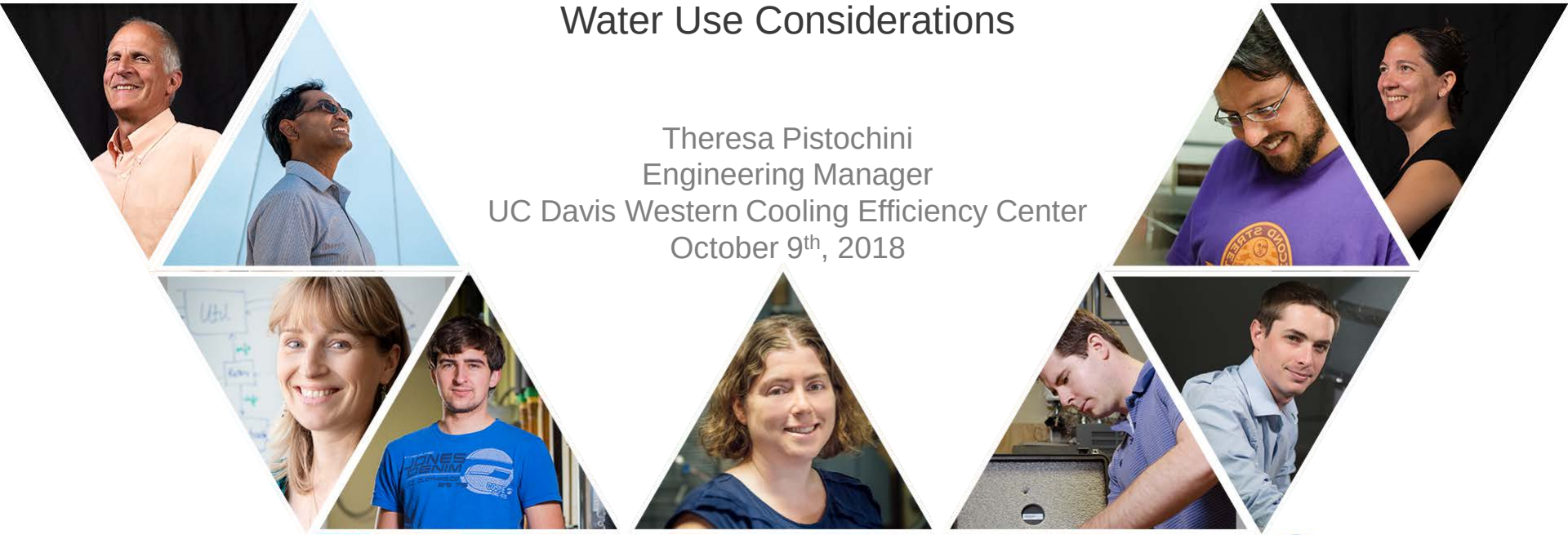

OCTOBER 8 & 9
DOWNEY, CA
ET Summit
Fall 2018
COMMERCIAL + RESIDENTIAL BUILDINGS

Evaporative Cooling Update

Water Use Considerations



Theresa Pistochini
Engineering Manager
UC Davis Western Cooling Efficiency Center
October 9th, 2018

WCEC Team

Key Sponsors:

California Energy Commission
California Utilities
Federal Agencies: DOE, DOD, NASA
Corporate Affiliates

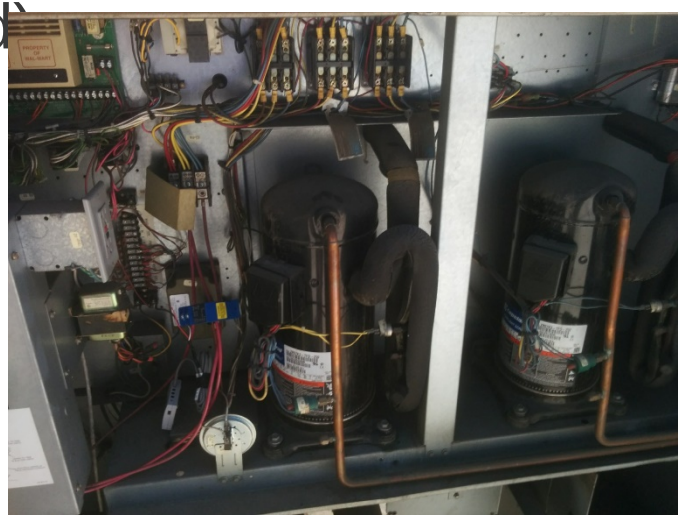
Established April 2007
Energy and Efficiency Institute at UC Davis

Mark Modera, Director
Vinod Narayanan, Associate Director
Theresa Pistochini, Engineering Manager

- 12 R&D Engineers
- Graduate and Undergraduate Students
- Outreach and Support Staff

Agenda

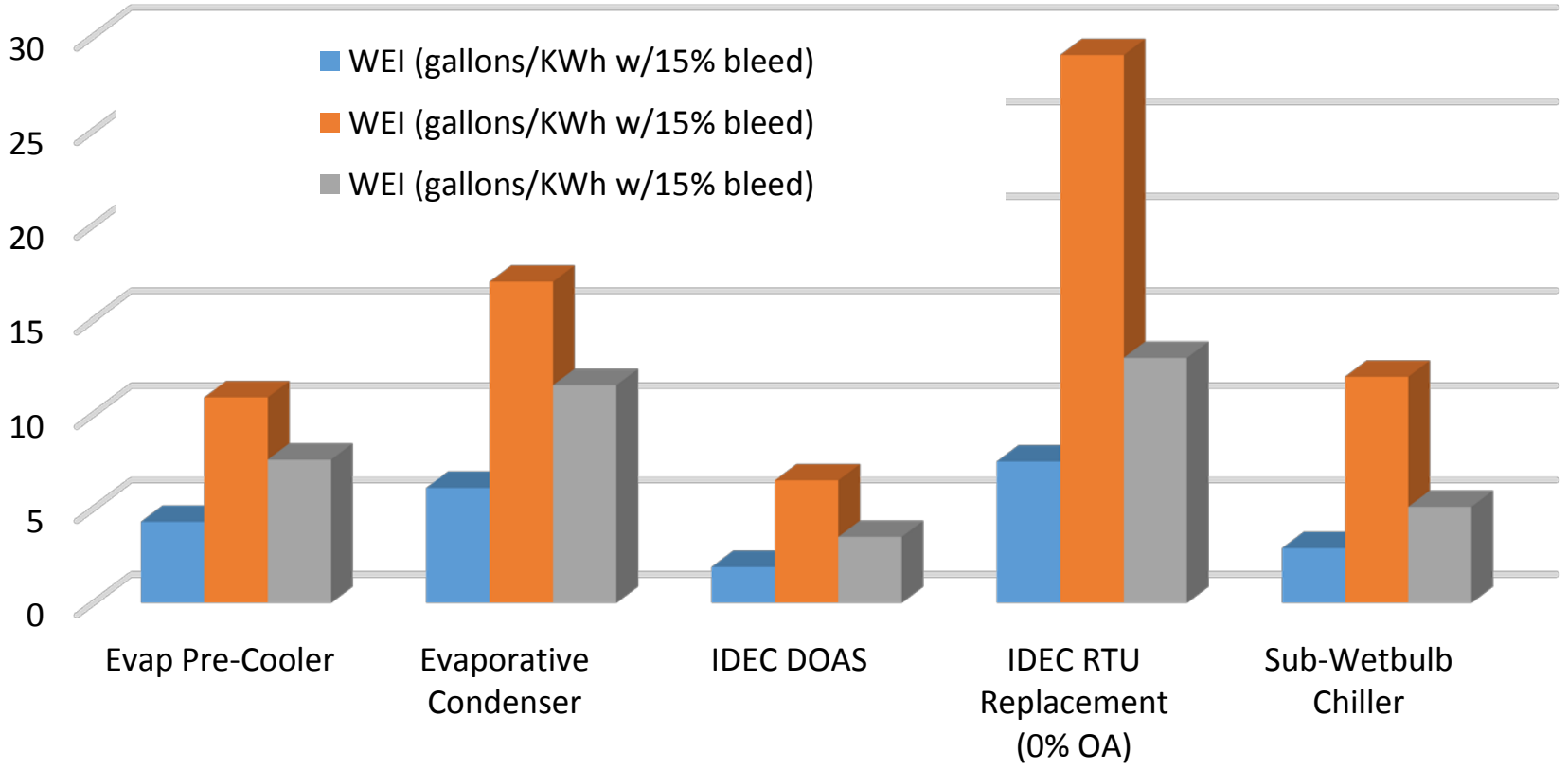
- Market adoption of evaporative cooling in California
- Water use efficiency in evaporative cooling
- Three recent evaporative cooling projects (SCE
  [illegible]ored)



Market adoption in California

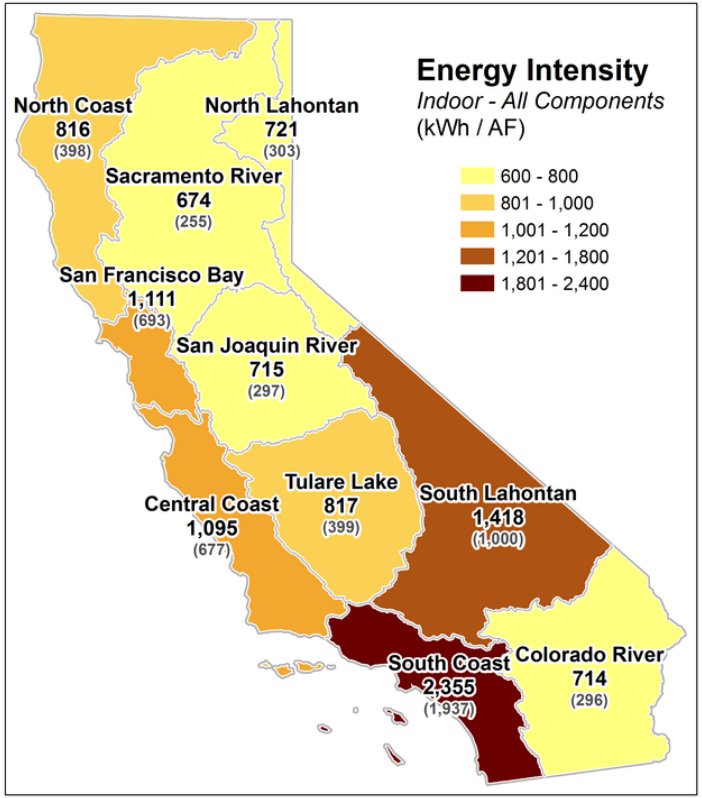
- Utility incentives are available from 20 California utilities
- One manufacturer installed over 380 evaporative pre-coolers on big-box national-chain retail stores, business case can be made without incentives
- Major contract awarded to use evaporative pre-coolers to reduce commercial building energy use by 72.5 MW in SCE territory

Water Energy Intensity (WEI)



Electricity in Water

- Example: 10 Gallons consumed to Save 1 kWh
- Energy consumed for water delivery and treatment of 10 gallons of water is 0.02-0.07 kWh (2-7% of 1 kWh savings)
- Overestimate because it includes electricity for waste water collection and treatment
- Negligible effect

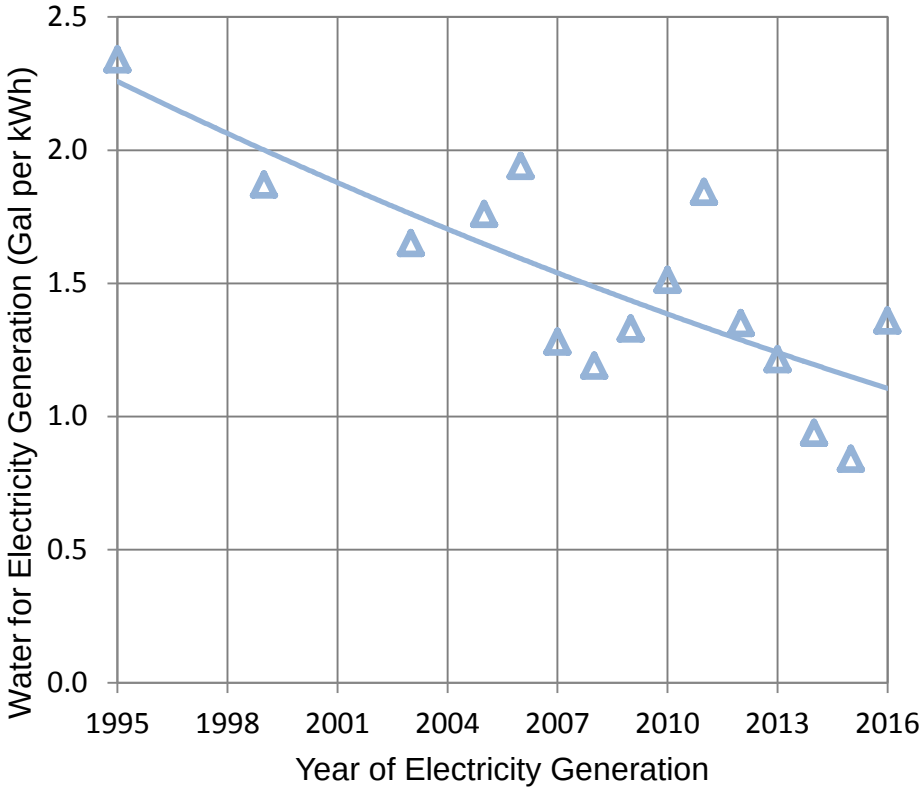


Source: CWEE, 2016. Includes Extraction, Conveyance, Treatment and Distribution (Outdoor – upstream to customer) and Wastewater Collection and Treatment (Indoor – All components)

1 Acre-Foot (AF) = 325,851 Gallons

Water in Electricity

- 2 to 10 gallons consumed to save 1 kWh
- Saving 1 kWh saves 1-2 gallon of water used for electricity production
- Offsets water used for evaporative cooling



Source: Pistochini and Modera: Water-use efficiency for alternative cooling technologies in arid climates. Updated for California's electricity generation mix reported by the Energy Information Administration through 2016.

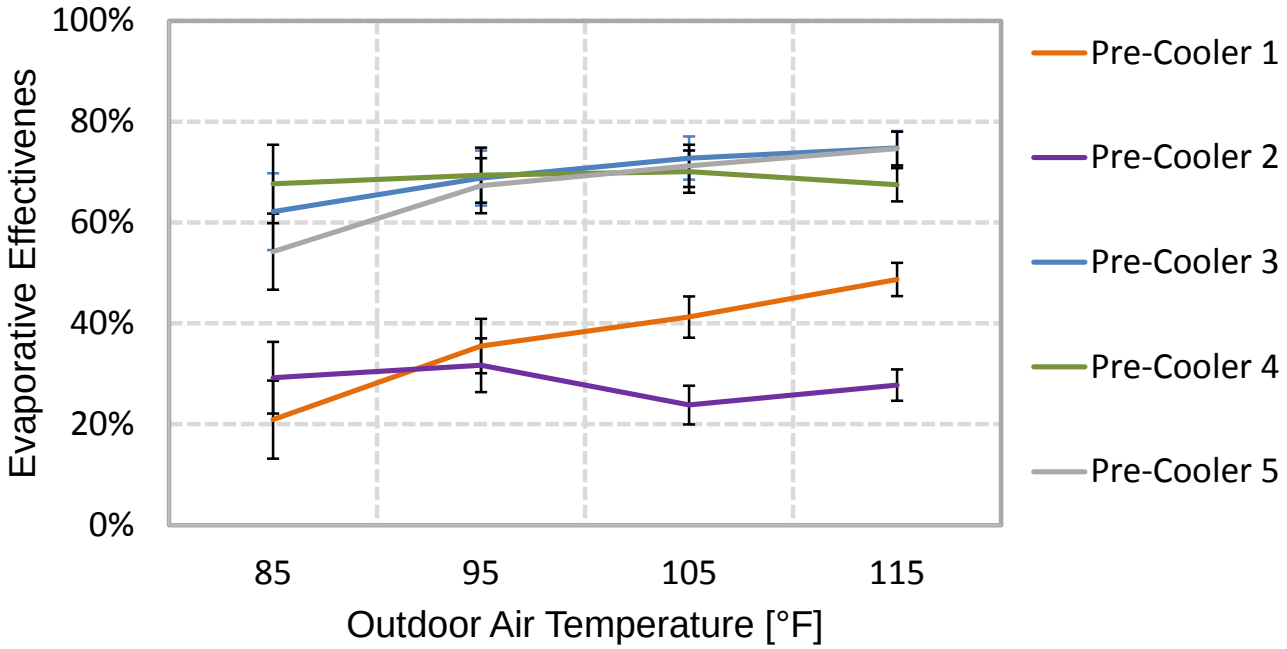
Water and Electricity: Cost Comparison

Metric	WEI = 2 **Gal/kWh**	WEI = 6 Gal/kWh	WEI = 10 Gal/kWh
Value of Electricity Savings (1 kWh)[1]	$0.22	$0.22	$0.22
Value of Monthly Demand Charge Reduction[2] (1 kW)	$0.11	$0.11	$0.11
Total value of electricity savings	$0.33	$0.33	$0.33
Cost of Water[3] at $0.01 per gallon	$0.02	$0.06	$0.10
Cost of Water as a % of electricity savings	6%	18%	30%

[1] PGE Peak Summer Time of Use Pricing, Medium Commercial: https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_A-10.pdf
[2] Monthly Demand Charge Savings of $19.52/kWh amortized over 180 hours a month of estimated evaporative cooler operation
[3] Black and Veatch 2012/2013 50 Largest Cities Water/Wastewater Rate Survey: $0.0037-$0.01821 per gallon in California

ASHRAE Test Standard

- Need to be able to compare performance
- Initiated ASHRAE Method of Test SPC-212



DISPATCHABLE CONDENSER-AIR PRE-COOLERS

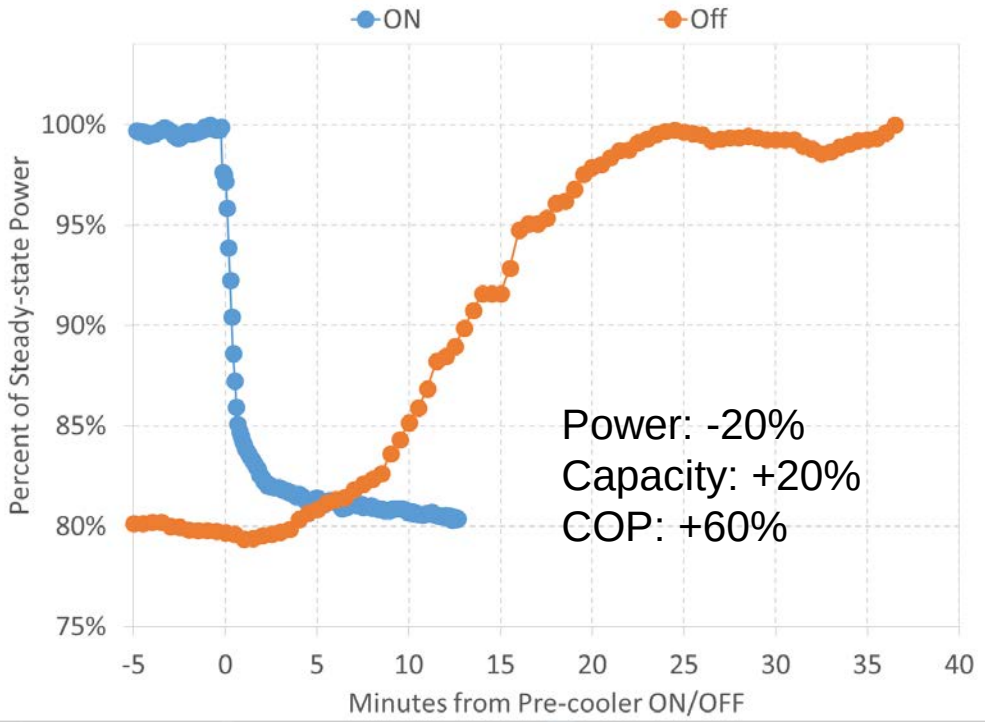
Objective: Demonstrate potential of evaporative condenser-air pre-coolers as a dispatchable load balancing resource.

- Only use pre-coolers during a demand event
- Quantify transient response of turning pre-cooler on/off.
- Laboratory and field test

DISPATCHABLE CONDENSER-AIR PRE-COOLERS

Laboratory testing

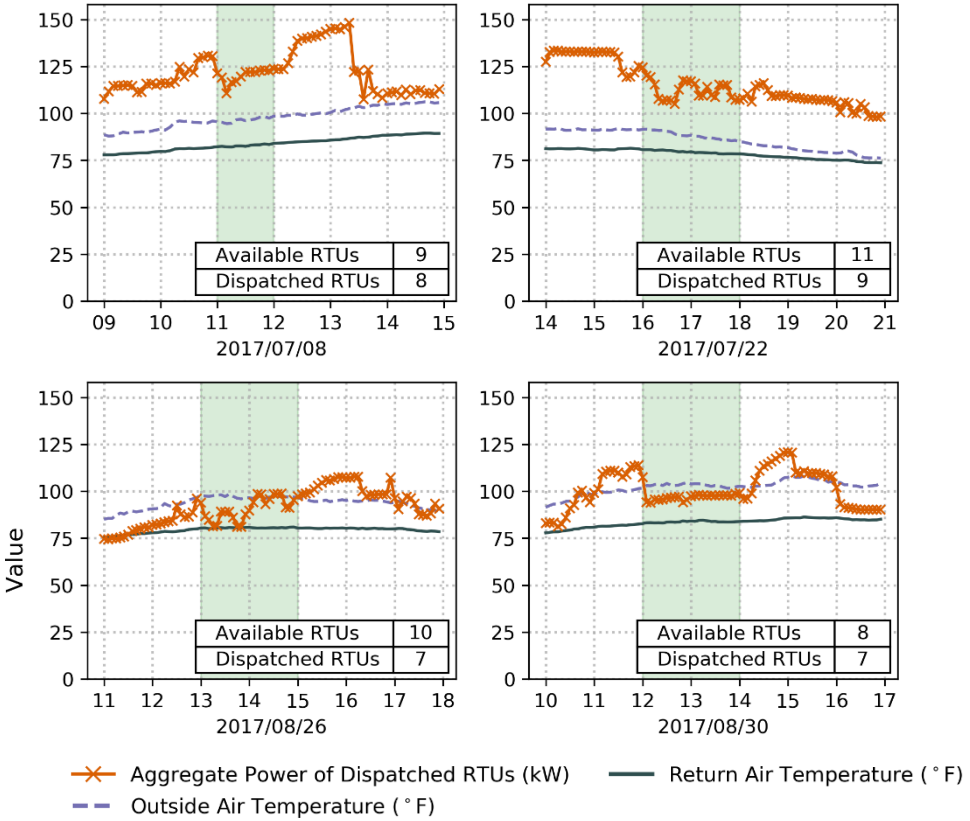
- Tested at 95°F/70°F, 105°F/73°F, 115°F/76°F (DB/WB)
- 4-ton single stage RTU
- Results illustrate a quick power reduction during “ON” response (0.6 min to 50% of difference)
- “OFF” Drying response ~13 minutes to return to 50% of difference



DISPATCHABLE CONDENSER-AIR PRE-COOLERS

Field testing

- Pre-coolers installed on 180 tons of RTUs on big-box retail store
- Demand events simulated through the manufacturer's existing controls in summer 2017
- Difficulty in controls communication, RTUs did not receive signal reliably.
- Successfully dispatched events reduced electricity demand 2-15%
- Water use rates were high at ~11 gal/kWh (manufacturer had bleed rates set too high)



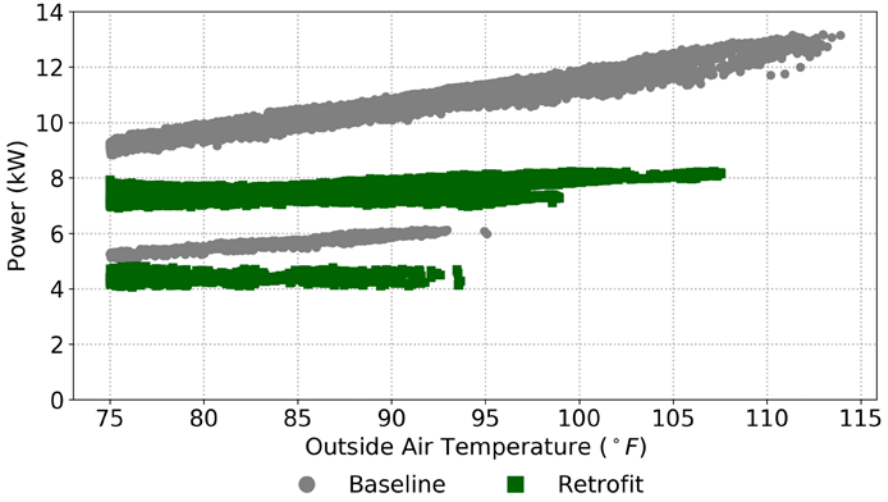
RTU OPTIMIZATION PACKAGE

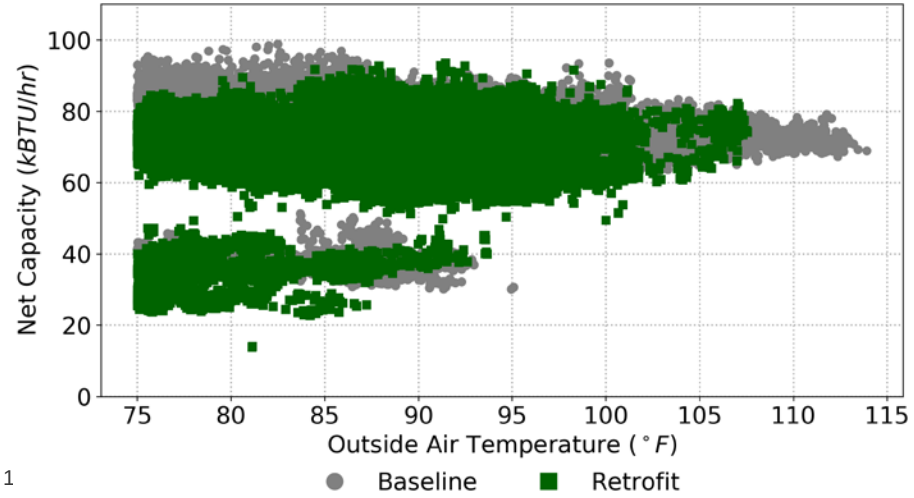
Objective: Demonstrate potential of retrofit controls to further increase efficiency and demand savings of RTUs

- Condenser-air pre-coolers greatest benefit at peak conditions
- Variable speed controls biggest impact at part load
- Combination is beneficial over all operating conditions and maintains capacity at peak

RTU OPTIMIZATION PACKAGE

- Field test on 10-ton two-stage RTU
- Retrofit included:
  - Two 7.5 HP VFDs (one for each compressor, set at fixed 48Hz)
  - Condenser-air pre-cooler with 70% direct evaporative effectiveness
  - Use of existing fan





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For more information, contact Jerine Ahmed at
jerine.ahmed@sce.com.

Questions?

Theresa Pistochini
Engineering Manager
UC Davis Western Cooling Efficiency Center
tepistochini@ucdavis.edu
wcec.ucdavis.edu