COOLNOMIX® at Fort Bliss and Joint Base Anacostia-Bolling

Validating the Energy Savings of A Compressor Control Retrofit

Tech Transfer Session

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Josef Mueller and Joe Milando, Cool Green Power

Energy Exchange Tech Theater
Wed. Aug. 16, 2017

Department of Defense Energy and Water
Technology Proving Ground

Validate Emerging Energy Technologies

Through Field Demonstrations at U.S. Military Installations

Planning | Installation | Monitoring | Analysis | Tech Transfer

PROJECT TEAM

VENDOR

CoolGreenPower™
More Savings, Smarter Cooling

EVALUATOR

Fraunhofer USA

DoD DEMO SITES

TeamBliss

Fort Bliss
El Paso, TX
(Dry Climate)

JOINT BASE ANACOSTIA-BOLLING
WASHINGTON DC

Joint Base Anacostia-Bolling
Washington DC
(Humid Climate)

TECHNOLOGY BACKGROUND

COMMERCIAL BUILDING SITE ENERGY END USE


10%
SPACE COOLING


TO OPEN
Chocolate Fat Free Milk
TruMoo
Chocolate
Fat Free Milk
VITAMIN A&D
SELL BY
JAN 26 481007 07:10
4.5%
REFRIGERATION

$580M

Est. annual DoD spend on cooling and refrigeration.

$60M savings opportunity


COMPRESSORS use
a major fraction of
cooling energy
INLET
4
R6-02D

ENERGY SAVINGS OPPORTUNITY

OVERSIZED

Most HVAC&R systems are **oversized** for typical conditions, leading to **inefficient part-load operation**.

BETTER CONTROLS

Relay-based controls could **reduce compressor runtime** to prevent overcooling.

SAVINGS

Could provide energy savings of **+15%**
Up to **$60M/yr** potential for DoD.

COOLNOMIX®

A Sensor-based Compressor Control Retrofit

What is COOLNOMIX®?

COOLNOMIX® is a hardware-based retrofit add-on that saves energy by controlling compressor runtime on AC and Refrigeration systems with excess part-load capacity.

THERMOSTAT — **COMPRESSOR**

wall temperature

THERMOSTAT — **COOLNOMIX** — **COMPRESSOR**

wall temperature

supply air temp.
return air temp.
relay

COOLNOMIX® TECHNOLOGY

SIMPLE
Relay control installs in-line with thermostat.

FAST
1-2 hour install by HVAC technician.

SECURE
No network connections. No controls integration required.

AFFORDABLE
<$1,000 installed

SAVES ENERGY
Wired sensors measure supply and return air temperature to optimize compressor runtime to save energy.

CONTROLS COMFORT
Sensors reduces overcooling to save energy, while maintaining desired setpoints.

COOLNOMIX® COMPATIBILITY

Works With Vapor-Compression Systems

COOLING

Packaged Rooftop Units

Walk-in Refrigeration Units

Ducted Systems with Air Handling Units

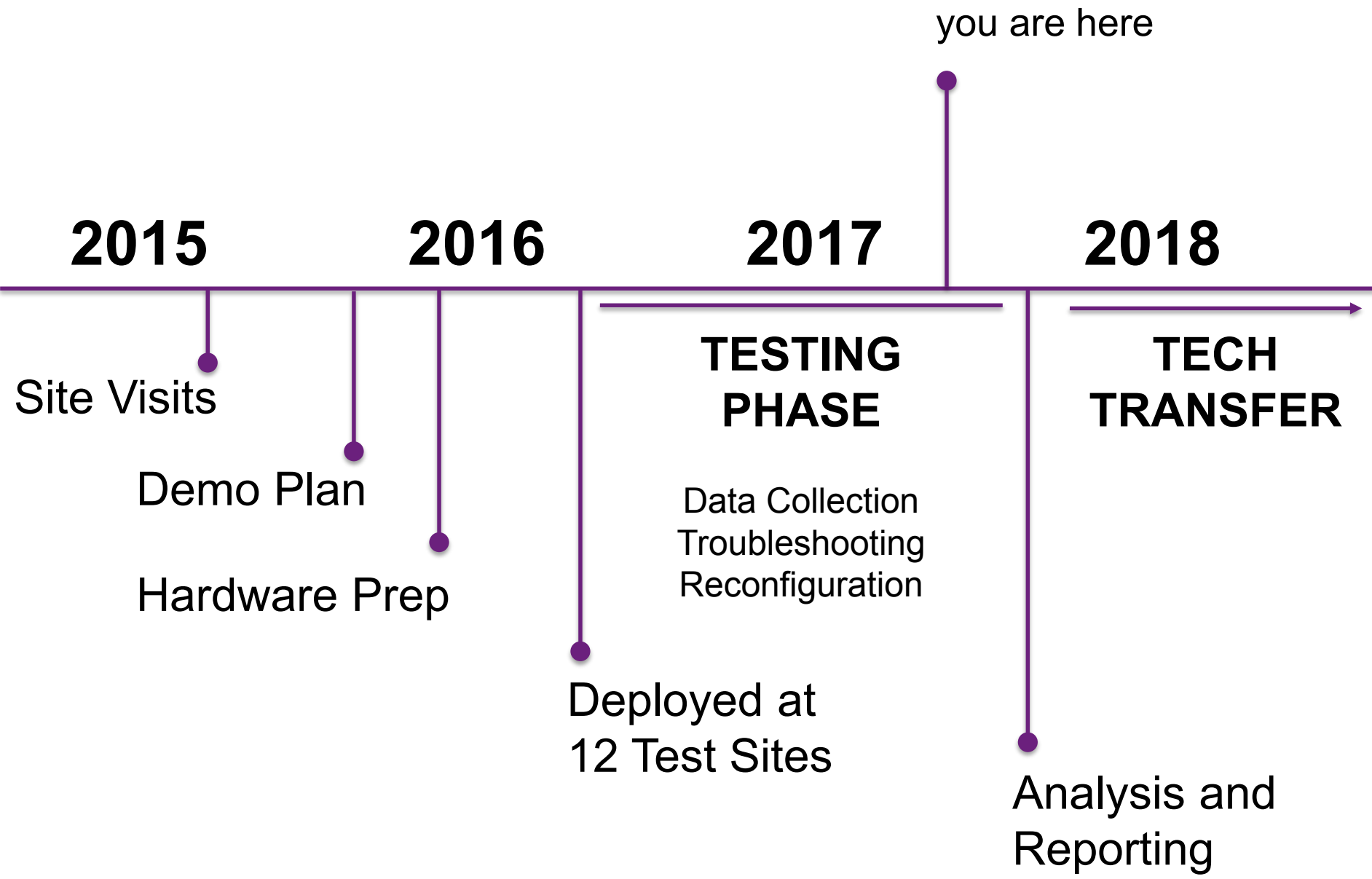
Wall-mounted Split Systems

REFRIGERATION

Food and Beverage Refrigeration

Retail Refrigerated Display Cases

DOD/ESTCP DEMONSTRATION


you are here
2015
2016
2017
2018
Site Visits
Demo Plan
Hardware Prep
Deployed at
12 Test Sites
TESTING
PHASE
Data Collection
Troubleshooting
Reconfiguration
Analysis and
Reporting
TECH
TRANSFER

KEY DEMO TARGETS

ENERGY SAVINGS
15%+ reduction in end-use energy consumption.

COMFORT
Maintain comfortable setpoint temperatures.

SCALABILITY

and…**DON'T BREAK STUFF**

AIR CONDITIONING TEST SITES

JBAB

Post Office

Honor Guard

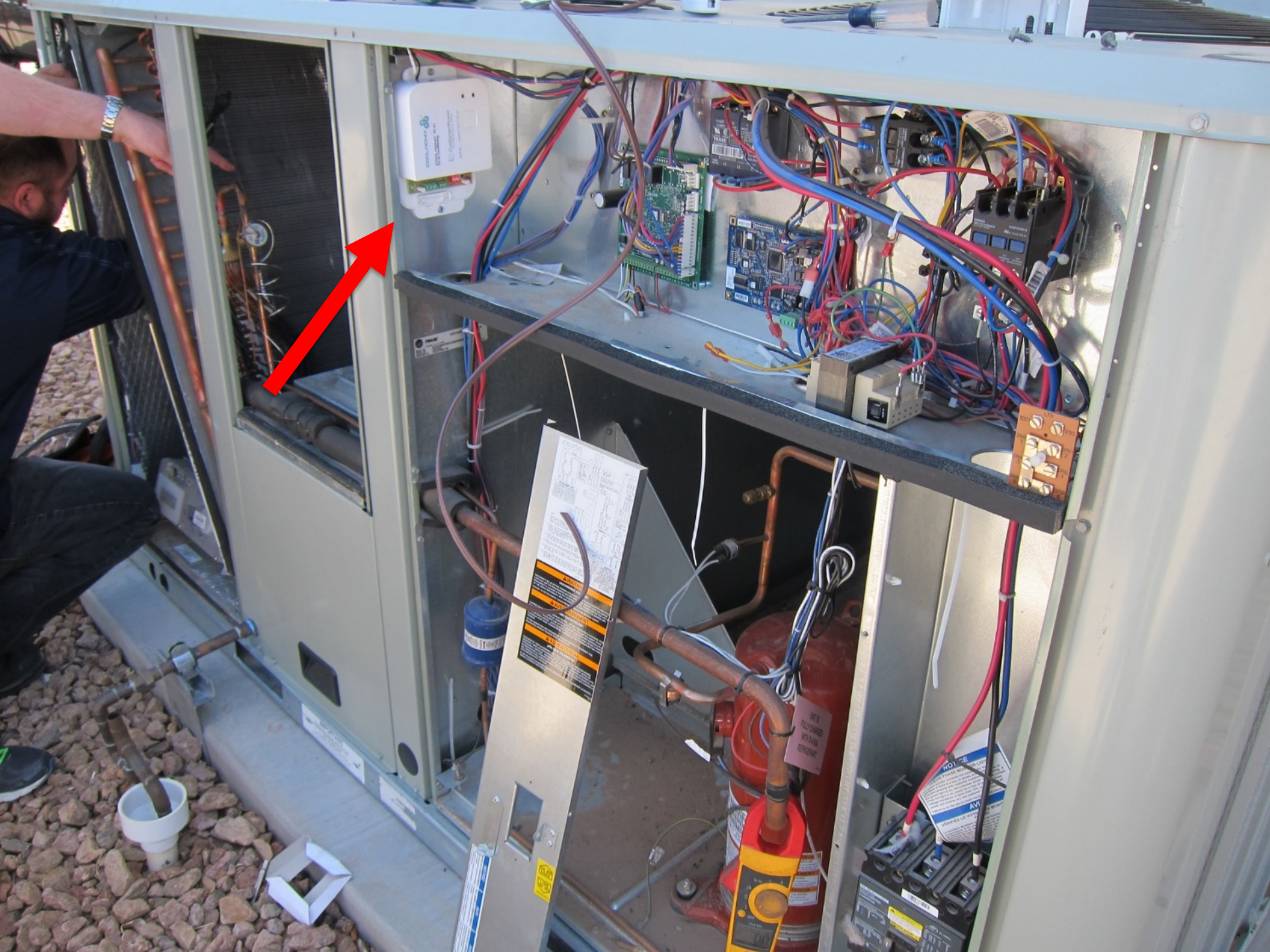
Cheshire Break Room

Ft. Bliss

GSA Transportation Motor Pool

DPW Basement Office

TEMF Office



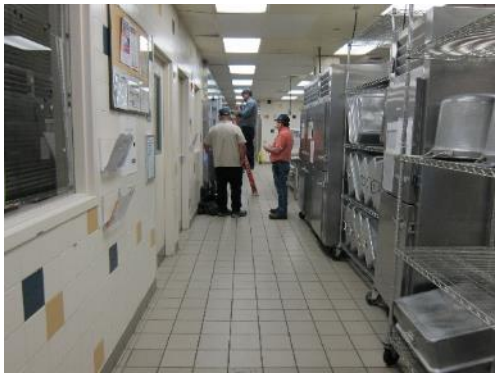
REFRIGERATION TEST SITES

JBAB

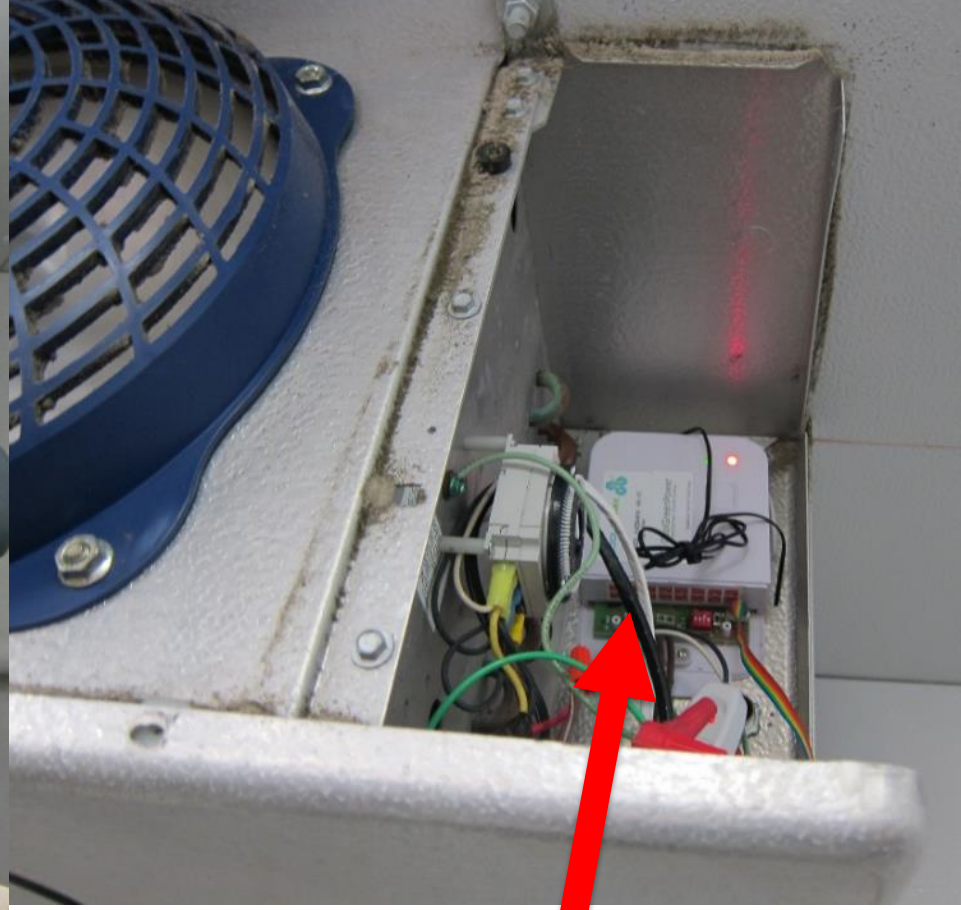
Bolling Club Dining Facility

Potomac Lanes Bowling Center - Food Service

Ft. Bliss



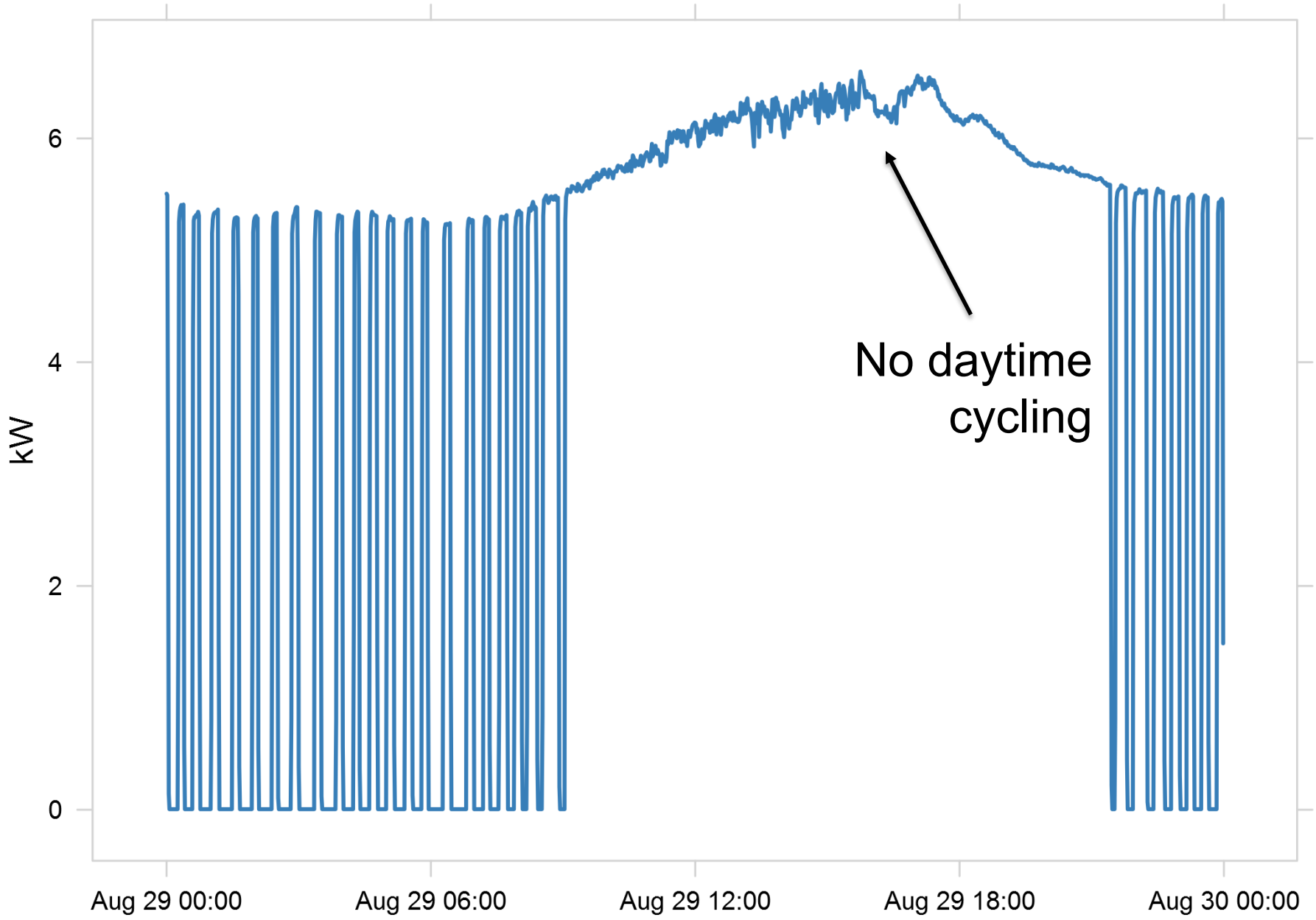
Dining Facility



WHEN THINGS GO WRONG

LESSONS LEARNED


UNDERSIZED?
TRANE


6
4
2
0
kW
Aug 29 00:00
Aug 29 06:00
Aug 29 12:00
Aug 29 18:00
Aug 30 00:00
No daytime cycling


KeepRite
MAINTENANCE


DIRTY FILTERS


LOOSE FAN
BELT
WARNING
PIÈCES ROTATIVES
LUBRICATION
See user's manual for maintenance procedures.
LUBRIFICATION
Voir le manuel de l'utilisateur pour les procédés d'entretien.
CORRECT ROTATION SHOWN
See wiring label for motor speed connections or to reverse blower rotation.
TOP VIEW
LE SENS CORRECT DE LA ROTATION EST INDIQUÉ
Voir l'étiquette de câblage pour les connexions de vitesse du moteur ou pour inverser le sens de rotation du souffleur.


REFRIGERANT CHARGE
FLUKE 902
HVAC CLAMP METER
TRUE RMS
OFF
AC/DC
MIN MAX
132.1
YELLOW JACKET
R-410A
YELLOW JACKET®
TEST AND CHARGING MANIFOLD
Ritchie
ENGINEERING COMPANY INC.
Date Code 2010


SUITABLE FOR
WET LOCATIONS
TOO HOT
TOO COLD
JUST RIGHT
JOHNSON CONTROLS
PEAK


DISCONNECTED WIRES
RTISSEMENT
shock. Can cause injury or
TICE TO INSTALLER
supplied and approved
unit nameplate.
Use only
electric heate


EXTRA PARTS
& WIRING


SETPOINTS
Air conditioner unit settings
16C 61F
17C 62F
18C 64F
19C 66F
20C 68F
21C 70F
22C 72F
23C 73F
24C 75F
25C 77F
26C 79F
27C 80F
28C 82F
29C 84F
30C 86F
31C 88F
AC Input
CN2
MODE
ON KXK
1 2 3 4
Temperature


COOLNOMIX
COOLNOMIX AC-01
For Air Conditioning
CoolGreenPower
More Savings, Smarter Cooling
AC-01 501
Questions? Call (617)-505-1004.
Air conditioner unit settings

USABILITY


SENSOR
PLACEMENT


WARNING
WARNING


72°
Cool On
Fan
On
System
DO NOT TOUCH
UNDER ANY
CIRCUMSTANCES

TECH TRANSFER DISCUSSION

TECH TRANSFER DEVELOPMENT

TECHNICAL

Screening tool

Revise manuals

Installation checklist

Commissioning checklist

Install kit

DIFFUSION

Webinars

Blog posts

Newsletters

Fact sheets

Specs list

Purchasing templates

PROCUREMENT WITHIN DoD

Discretionary Funding

small purchases

DD FORM 1391

specs and performance data

informed by final technical report

GSA Schedule / Vendor Lists

Other?

AWARENESS: DIFFUSION ACROSS DoD

ESTCP Outreach

webinars, blog, podcast, social media

IMCOM newsletter

Energy Exchange Conference

Direct Outreach to Energy Managers

DIFFUSION OUTSIDE of DoD

TECHNICAL CONFERENCES

UTILITY EFFICIENCY PROGRAMS

ESCOS

GSA

Others?

ESCOs

Great vehicle for installing at DoD at scale

but… risk averse

Needs high confidence in savings and
avoids “unproven” emerging technologies

Looking for deemed savings, backed by utility incentives

ESTCP results may help with engagement

UTILITY EFFICIENCY PROGRAMS

Goal: qualify for incentive and rebate programs

Challenge: requires high confidence in energy savings to qualify.

Large scale pilots needed.

Results from ESTCP may be used to gain credibility with utility programs and secure a large scale pilot program.

LEARN MORE

coolgreenpower.com

cse.fraunhofer.org

BACKUP SLIDES

Technology Transfer

Target Audience	Planned Tech Transfer Tool/Action	Status of Implementation
DoD End-Users, - Energy Managers - Facility Managers - Data Center Managers	Seek approval for GSA Schedule Identify Energy Managers for direct outreach Pilot ESTCP Technology Adoption Documents - Fact Sheet: a 1-2 page teaser on "why they should care" DoD specific Web section Monthly DoD Webinar	Planning stage, interviewing GSA consultants Assigned resource to DoD outreach Under development Under development
GSA Technology Deployment	Distribute Fraunhofer final report to GSA Green Proving Ground (GPG) leaders Conduct webinar for GPG leaders to validate that COOLNOMIX should be included in the GPG Technology Portfolio for broad deployment	Planning stage

Technology Transfer

Target Audience	Planned Tech Transfer Tool/Action	Status of Implementation
ESPC Contractors (e.g., ESCOs)	Qualify as an Energy Conservation Measure	Planning stage
	Become listed as an approved measure with IMCOM	Planning stage
	Performance validation by ESCO AmecFosterWheeler at USPS Cocoa	May – Sep 2017
UESC	Submission to utility incentive programs – e.g., California ET program, ComEd SmartIdeas	Underway
Outsourced HVAC&R maintenance firms	Setup and support firms as resellers / installers	Conversations with initial firm managing seven bases

Technology Transfer

Target Audience	Planned Tech Transfer Tool/Action	Status of Implementation
Utility Incentive Programs	Air conditioning evaluation with a California utility.	Extended test will complete in Jan – Feb 2018
Utility Incentive Programs	As part of their DeployMass program. the MA Clean Energy Center has formally approved independent tests at four school districts in Massachusttts	Fall 2017 with reports by year end.

Social Media Content

Videos

- Explaining how the technology works: http://www.coolgreenpower.com/how-coolnomix-works-1/
- Describing the benefits of the technology http://www.coolgreenpower.com/about-coolgreenpower-coolnomix-1/
- Requesting permission to create video interviews with energy managers at JBAB and Ft. Bliss plus ESTCP Technology Transfer office

Press releases

Work with PR expert to create news stories

Twitter, Facebook and LinkedIn content based upon preliminary results and final results as well as new site installations and uses of the product

- Work with ESTCP for the ESTCP twitter feed

We would welcome working with the Program Office on a blog and or PODcast

APPLICATIONS

AIR CONDITIONING

Packaged and ducted air conditioning comprises a large portion of cooling on DoD bases.

REFRIGERATION

Walk-in refrigeration is common among dining facilities for storing food and beverage.

EXISTING SOLUTIONS FALL SHORT…

EXPENSIVE
Hardware retrofits, like variable speed motors are labor and capital intensive.

COMPLEX
Integration of advanced controls with existing control systems is difficult. May require network connections.

IMPRECISE
Other controls lack sensors, so climate control is not guaranteed.

SLOW
Long payback periods. Risky investment for older equipment.

FINDINGS TO DATE

Verified Install Time

- Install takes 1-3 hours by a trained HVAC technician
- Base technicians completed six installs in three days, including training, commissioning

Verified Compatibility and Reliability

- COOLNOMIX® running reliably for over one year at both bases
- COOLNOMIX® compatible with most cooling and refrigeration equipment
- Caused no problems with existing equipment

Data Confirms COOLNOMIX® Operation

- Observed relay action (compressor cycling) as designed
- Temperature control appears to be functioning as designed

Energy Analysis

- To be completed end of 2017

Energy managers interested in pursuing initial rollout once final report completed.

PERFORMANCE OBJECTIVES

Objective	Metric	Success Criteria
A. Cooling Electricity Usage	weather-normalized seasonal cooling energy usage (kWh/CDD)	≥15% reduction in weather and humidity normalized unit energy consumption relative to pre-retrofit baseline
B. System Economics	%, $, years	simple payback: <5 year (threshold) <2 year (stretch target)
C. Climate Control	% time at target temperature/humidity conditions	refrigeration: food kept at 32-40°F, no freezing, no food spoilage AC: setpoints maintained as frequently as pre-retrofit (typ. 72°F), no adverse humidity impact
D. Ease of Installation	time to install (hrs), satisfaction	install in 3 hrs untrained, 1 hr trained; compatibility with target systems; staff satisfied
E. Reliability	% uptime, maintenance staff satisfaction	% of time system is working, does not reduce reliability of existing equipment
F. Short-Cycle and Frost Prevention	claimed features perform as designed	≥ 3min cycle duration, no frost accumulation
G. Facility Satisfaction	staff satisfaction	system acceptable to personnel, DoD staff to report any issues with performance or food spoilage
H. Warranty Compatibility	yes/no voids warranty by manufacturer	system does not void manufacturer's warranty

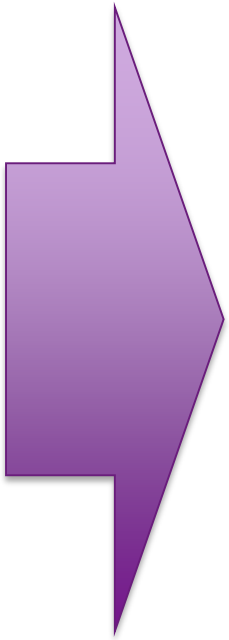
TEST DESIGN AND OBJECTIVES

Test method: Weather-normalized, activity-adjusted, seasonal ON/OFF testing.

Demonstrate at least **15% energy savings** relative to the baseline

Demonstrate ability to maintain space conditions and end-user satisfaction relative to pre-retrofit conditions

Demonstrate scalability through ease of installation, reliability, and compatibility with existing hardware



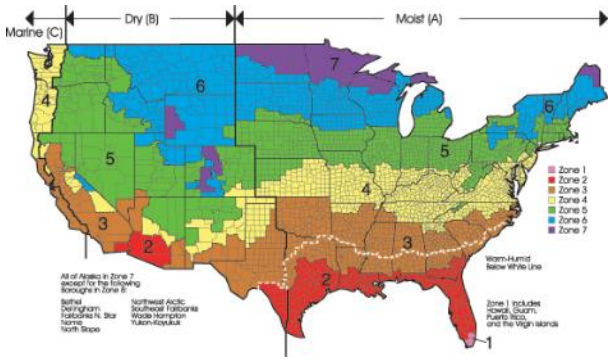
Validate Technology

Findings and Guidelines

Technology Transfer

User Acceptance

TECHNICAL APPROACH



Two Demo Sites / distinct climates for diverse climatic operating conditions over several seasons

Hot/Dry: Ft. Bliss, El Paso, TX

Hot/Humid: Joint Base Anacostia-Bolling, Washington, DC

Two Applications per Site:

Air Conditioning (x3 units): Single Zone Rooftop Units

Refrigeration (x3 units): Walk-in Refrigeration Units

Multiple-tests of each type are important to confirm repeatable results and will enable parallel testing. Single zone provides better ability to isolate energy-related effects.

Monitoring Program:

Collect performance data for multiple seasons [summer, fall, winter]

Run ON/OFF experimental design. System will be bypassed for 50% of each season to evaluate effects

ENVIRONMENTAL MONITORING

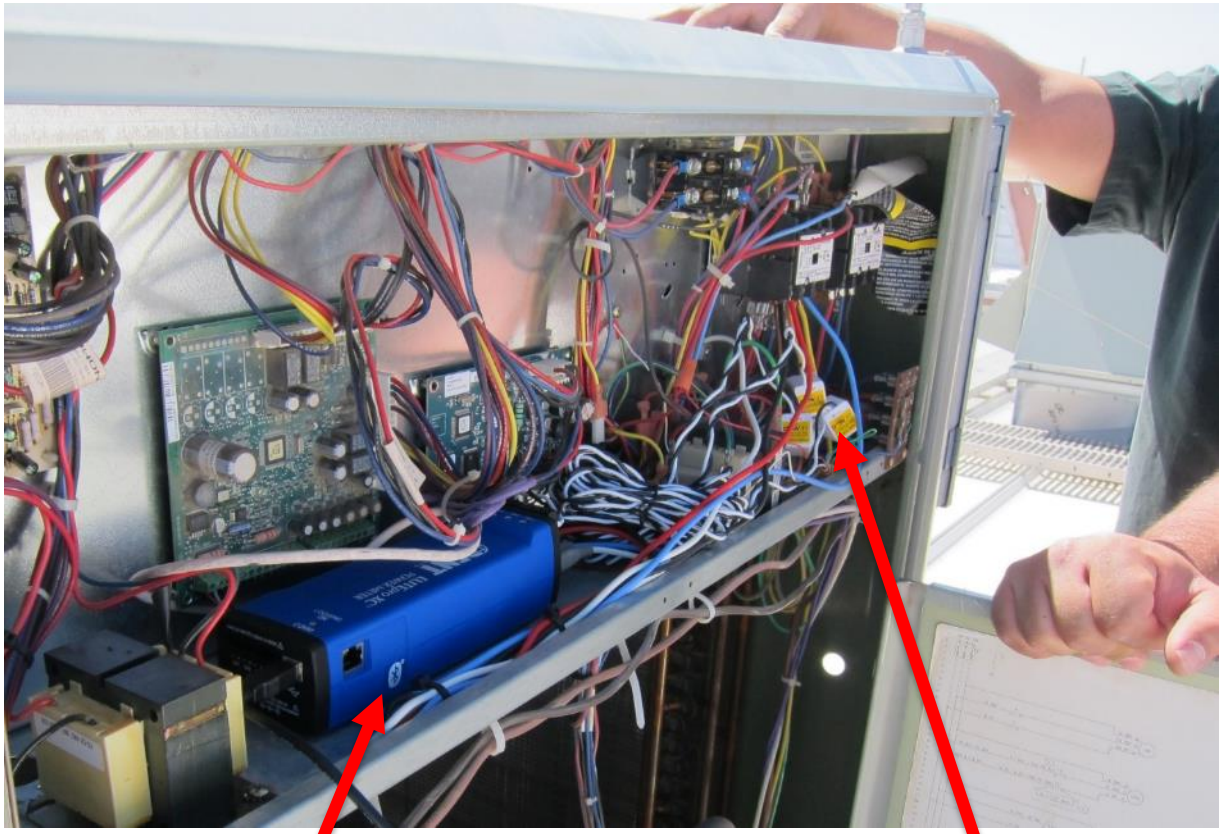
Data Collection Systems

Split Core Current Transformers
for submetering power draw & energy consumption of AC, Compressor, and Fan

Temperature & Relative Humidity
sensors for monitoring space conditions, verifying that space conditioning requirements are satisfied

Occupancy Sensors, Activity Sensors
[door opening/closing on Walk-In Refrigeration], to correlate energy use with local activity

Electricity Monitoring in AC & R Units



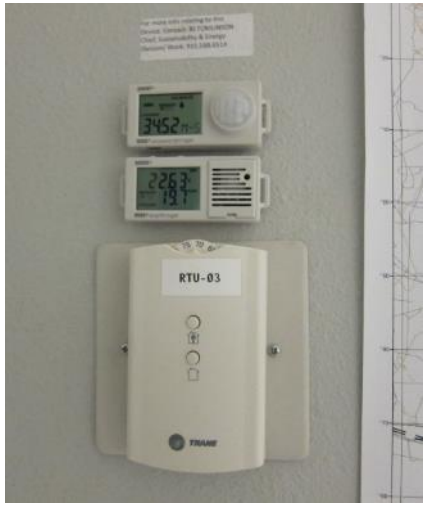
1 min. sampling
150 days of logging

Real Power
Current
Voltage
(for each phase)

Submetering Data Logger

3x Current Transformers +
Voltage to measure real power

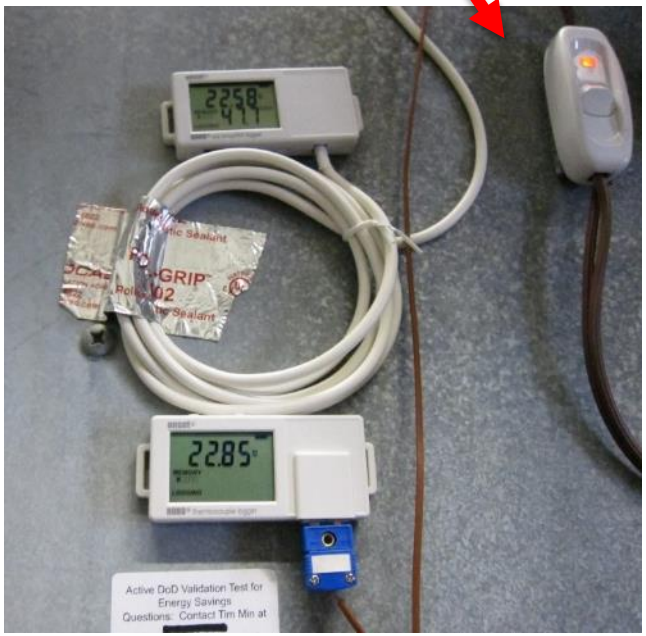
Monitoring of Rooms in AC Applications



Temperature, Humidity, Light & Occupancy Near Thermostats

Door Open / Close

COOLNOMIX Bypass Switch



Temperature in Supply and Return Air

Environmental Monitoring: Refrigeration

Door Open/Close Logger

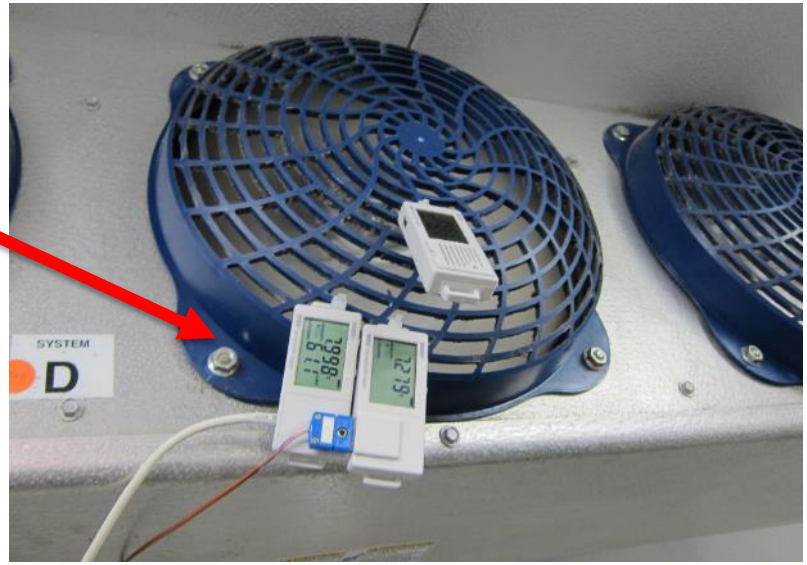
Light, Occupancy, and Temperature Loggers

Environmental Monitoring: Refrigeration

Temperature
& Relative Humidity

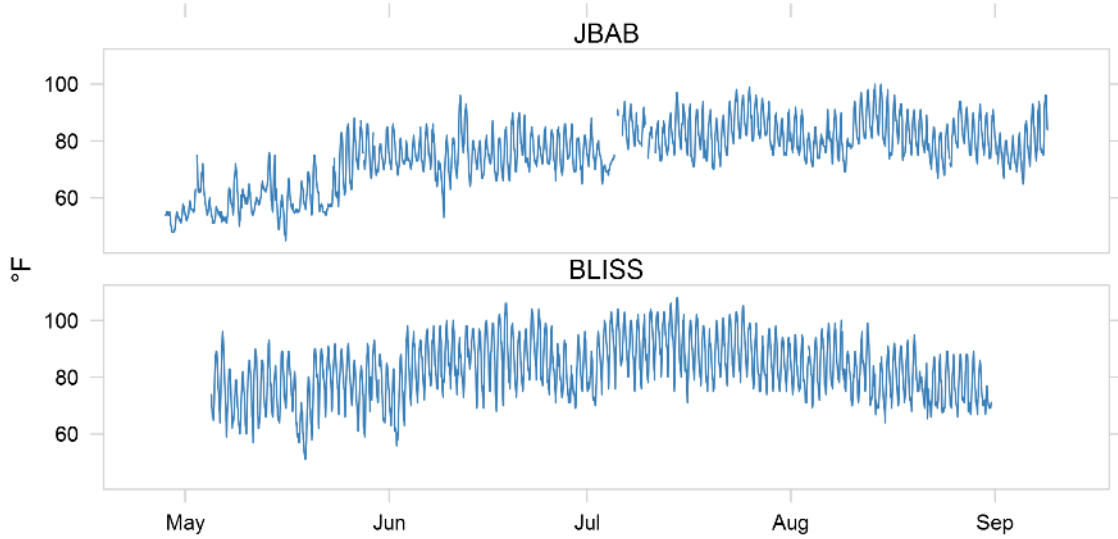
Front and rear of
evaporator

Sampling 2-5 min.
150 days per logger

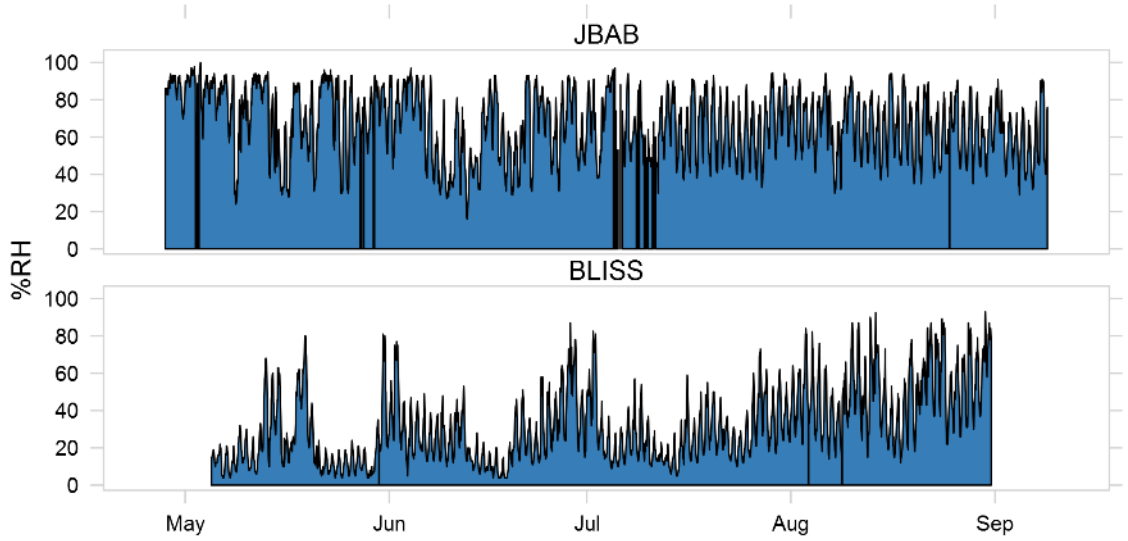


Loggers & COOLNOMIX
both measure supply and
return air temperature

Weather



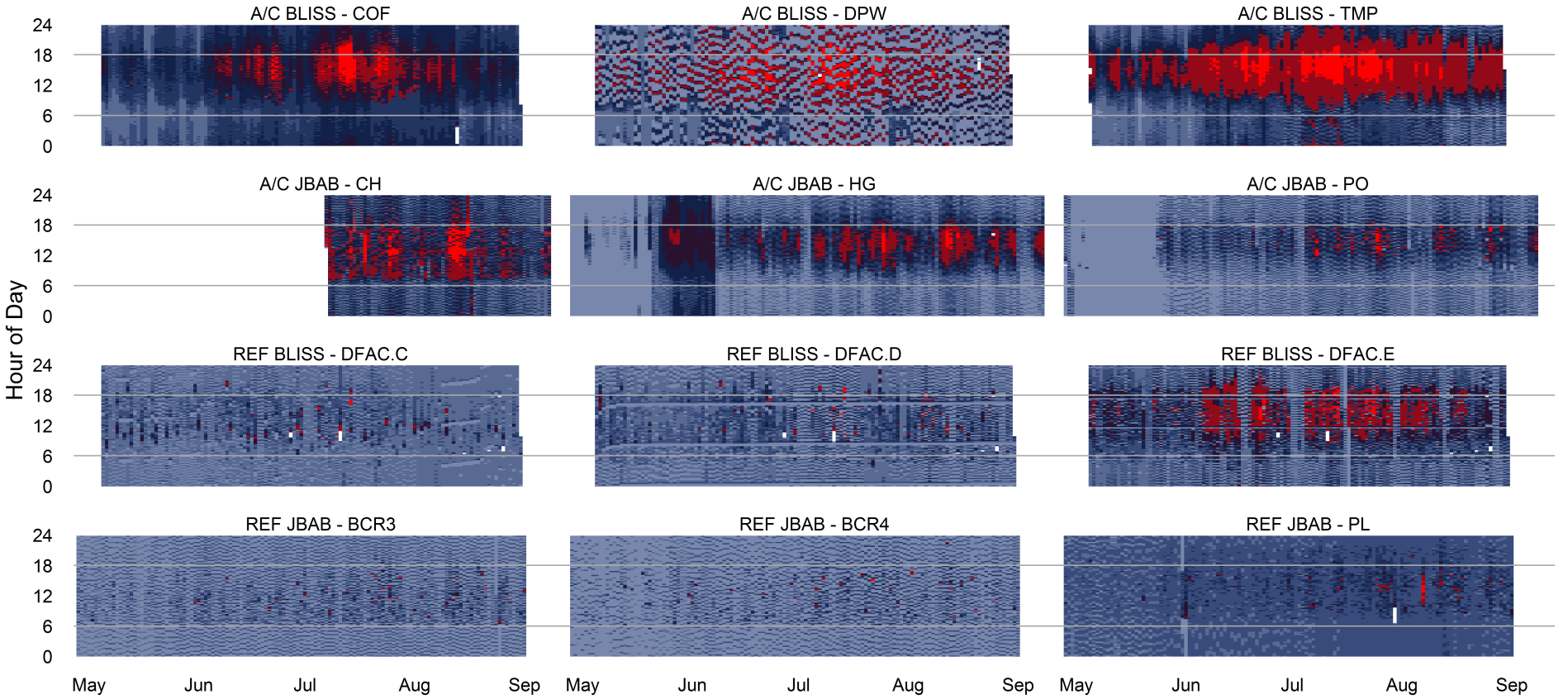
Both locations experienced hot summers. (good)



Humidity was much greater in DC than Texas (also good).

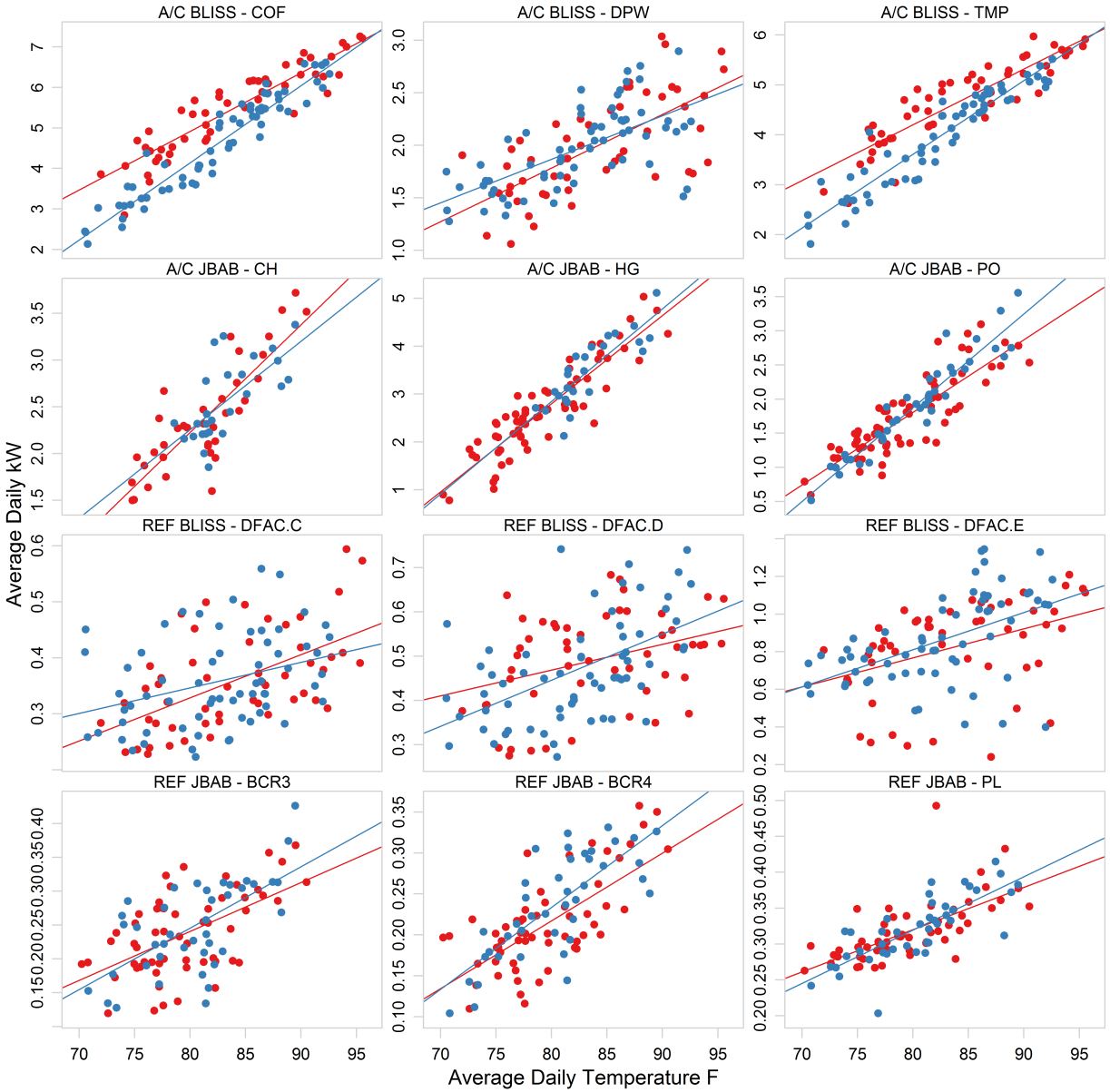
But… Texas had more rain than normal.

Electricity for All Test Sites



Red indicates that some units may be undersized (not cycling). More on this later.

Degree Day Regressions (Preliminary)

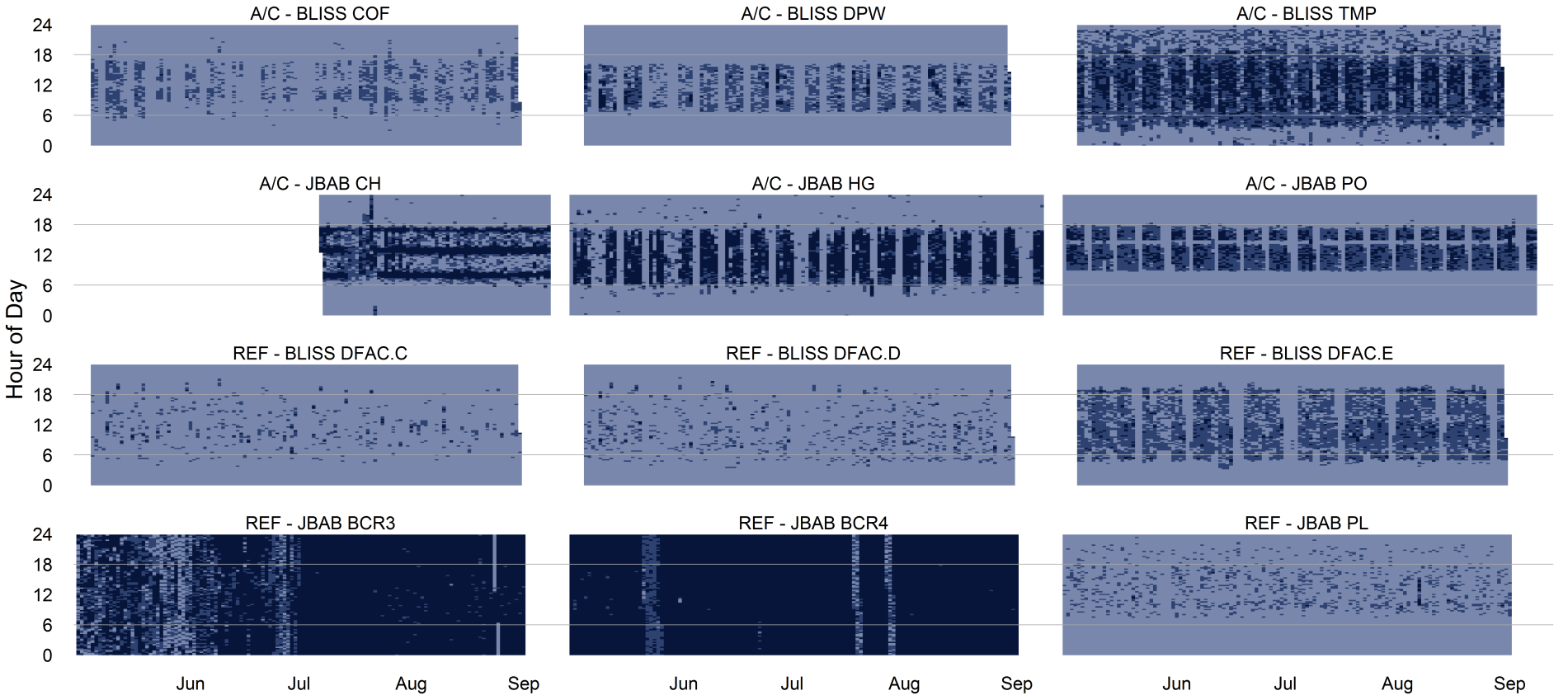


ON/OFF Testing

Differences in slope (kWh/CDD) will be used to calculate energy changes

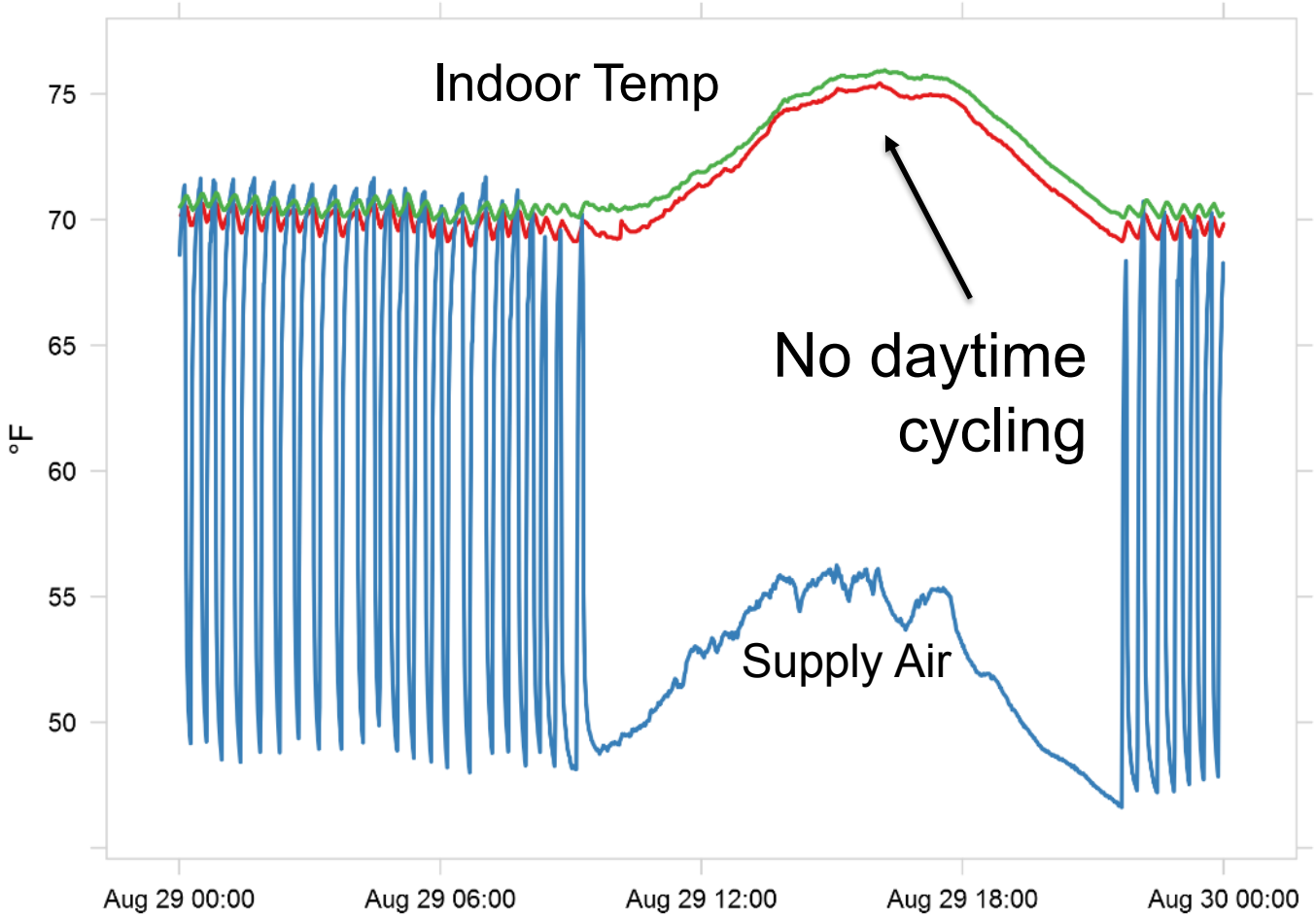
Note: these results are illustrative and are based on incomplete testing data.

Occupancy



Clear occupancy patterns measured, to be used for activity normalization (e.g., weekday vs. weekdays)

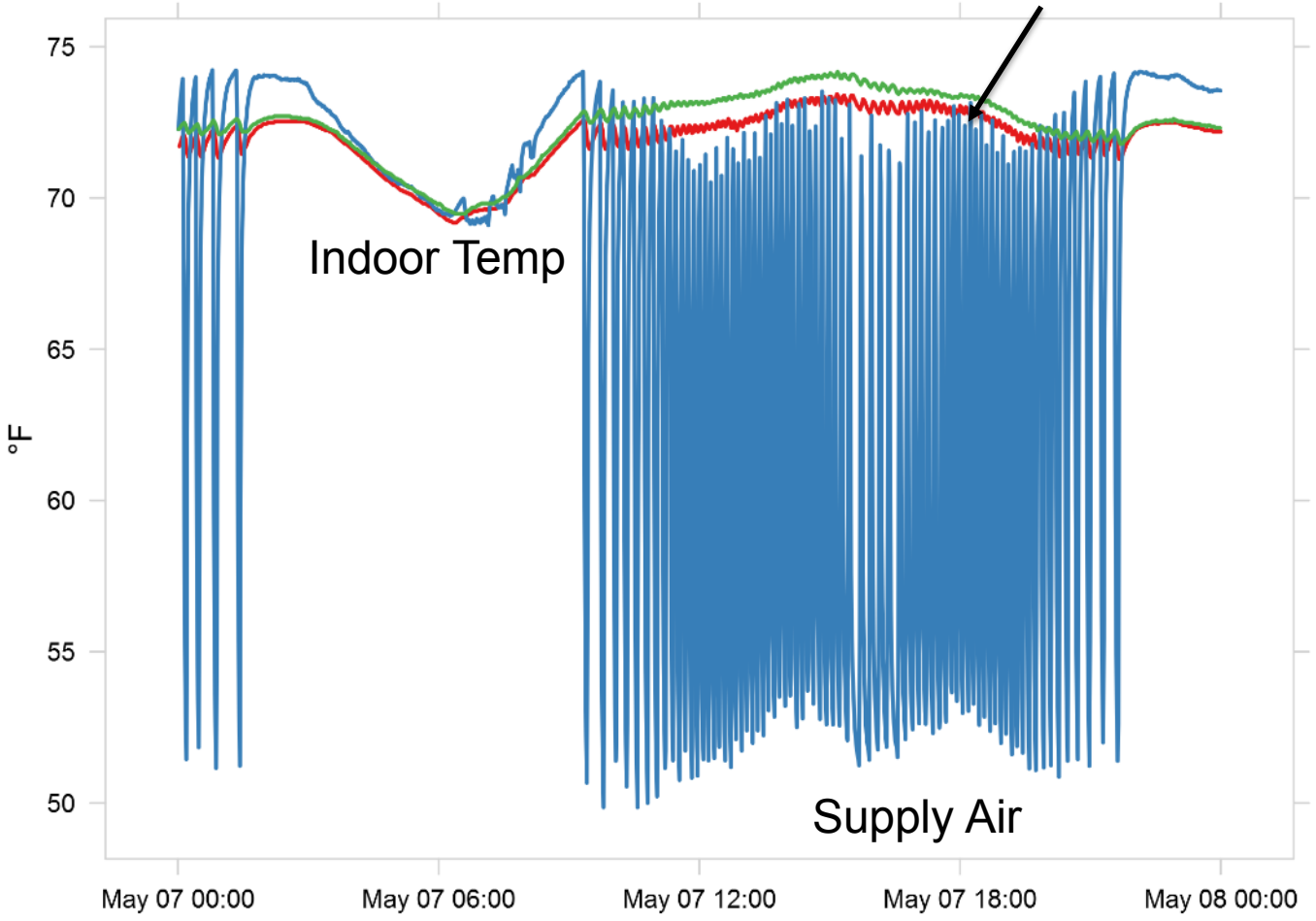
Undersized AC: Temperature



GSA Motor Pool

Undersized AC: Temperature

Same unit on colder day:
daytime cycling occurs

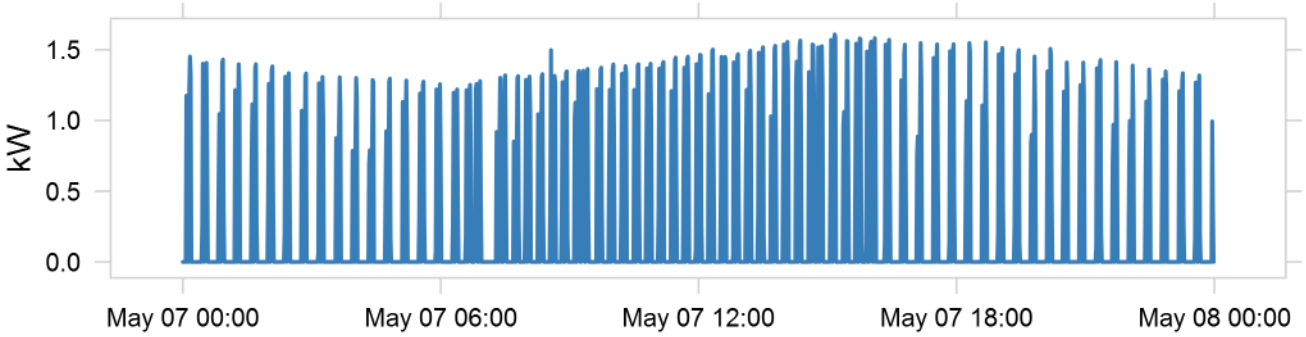


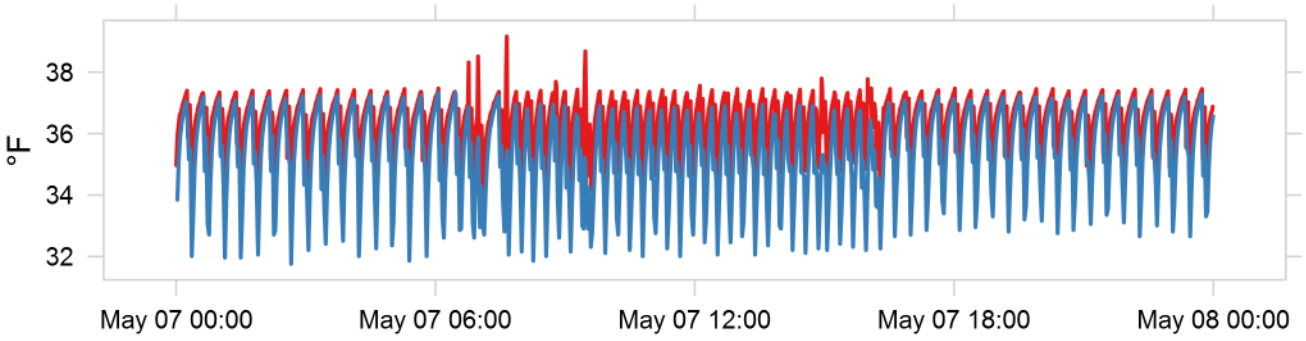
GSA Motor Pool

Critical: must be able to identify units with excess capacity.

Refrigeration: Power & Temperature

Fewer capacity issues.
Cycling coincides with temperature data.
Temperatures in acceptable range.





Publications

Participation

- Exchange Conference 2016

Planned Publications

- Revised guides and best practices
- Final Report
- Cost and Performance Report
- Industry Publication (e.g., conference paper)
- Trade Show Participation (e.g., Exchange Conference, ASHRAE, etc.)
- DoD Webinar / Tech Transfer