

Managing Campus Wide Energy *Getting Beyond the Spreadsheet*



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Learning Objectives

1

Plan for the implementation of building data analytics on a large campus.

2

Understand hurdles that may be encountered and how they can be overcome.

3

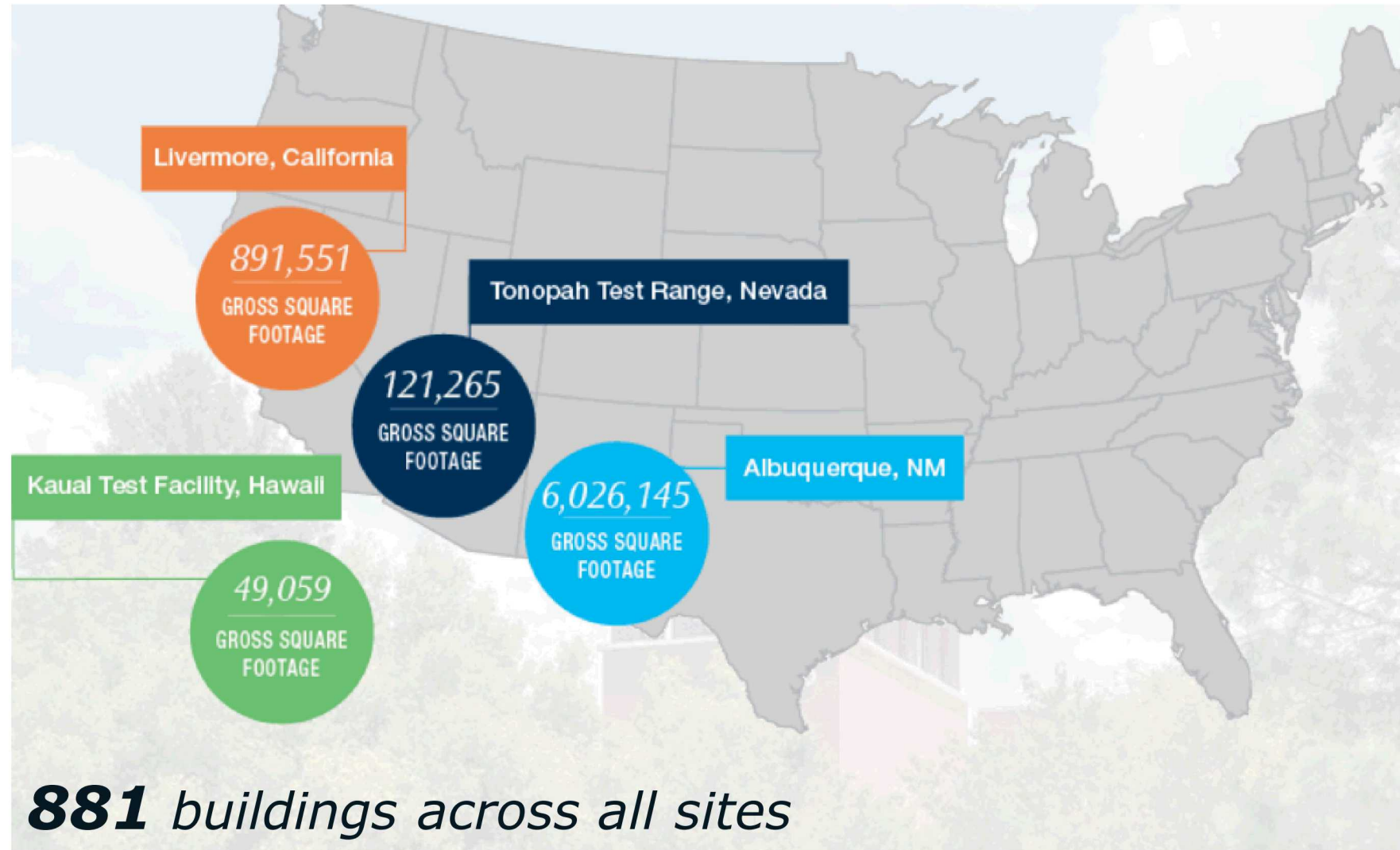
Evaluate the resulting benefits that can be gained from detailed energy meter monitoring.

4

Identify potential issues that can be uncovered with a building analytics tool.



Sandia National Laboratories Overview



About Sandia National Laboratories

- Grew out of World War II effort to develop first atomic bombs
- Began in 1945 as the Z Division, the ordinance, design, testing and assembly arm of Los Alamos National Laboratory
- Department of Energy (DOE), National Nuclear Security Administration (NNSA) Laboratory



Photo Credit to Sandia National Laboratories



Sandia National Laboratories Mission & Facilities

Research & Development

-  Nuclear Weapons
-  National Security Programs
-  Defense Nuclear Proliferation
-  Energy & Homeland Security
-  Advanced Science & Technology

Types of Facilities

-  Clean Rooms, Data Centers
-  Chemical Bio, Radiological Labs
-  **700+** fume hoods
Manufacturing R&D, Testing
-  Chilled Water & Hot Water Plants
-  Offices, High Security, Cafeterias, Warehouses, and High Bays



Sandia Energy Management Program and Goals

Energy Mission

Reduce energy, natural resources, environmental impact, and energy costs as a commitment to the Federal government, DOE/NNSA, and our local community.



Energy

Secure & Sustainable Energy Future

Drivers and Goals

1. Reduce EUI for all sites **10% below 2015**
2. Guiding Principles for High Performance Sustainable Buildings (HPSB) for **15% of buildings**
3. **RCx** for **33 buildings** and **energy audits** for **60 buildings** every 4 years (top 75% energy use)
4. Advanced metering for buildings **greater than 5,000 square feet**
5. Monthly energy management and benchmarking (measure, manage, & report)



Data Analytics Overview

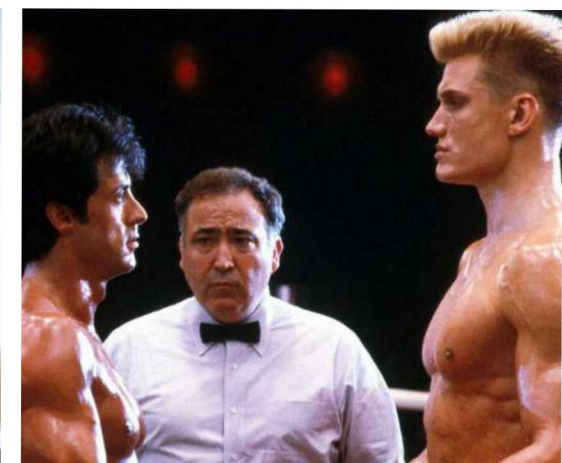
- Deploying analytics software for the NM and CA campuses
- Energy meter monitoring – 700+ energy meters
- Detailed BAS monitoring – currently 15,000 points
 - Vision for 120,000+ BAS points
- *A lot of data = a lot of spreadsheets!*



*Ongoing Cx
Proactive
Maintenance*

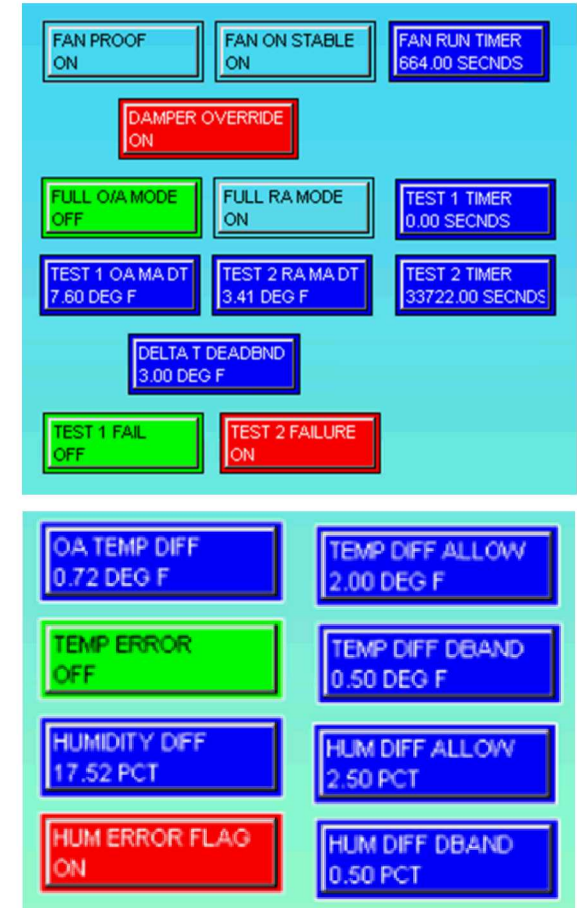
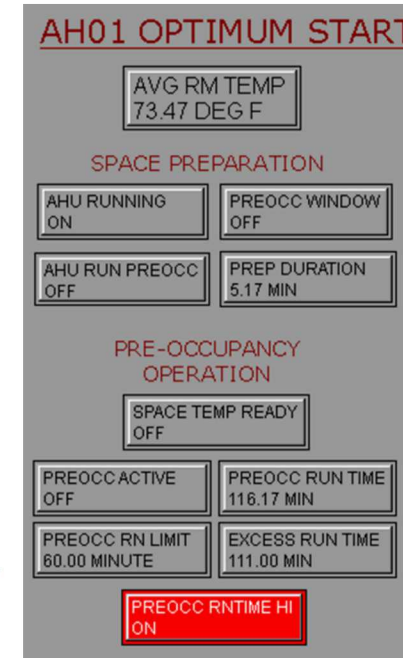


CHALLENGES



#1 – Navigating the Options

- Evaluated BAS solution
 - Challenging to diagnose
 - Couldn't see the patterns
- Large number of FDD/EIS options available
 - Met with vendors, viewed demos, researched capabilities
 - Met with organizations using analytics



Solution: Utilize the BAS for control and critical alarms, implement a 3rd party software tool onsite focused on data analytics



#2 – BAS and Network Limitations

- Architecture is 20+ years old, RS485 network
- Limited ability to add more trends
- Worked with BAS vendor to evaluate potential upgrades
 - Performed tests with BAS vendor and Analytics vendor on full IP Based Ethernet platform
 - Tested integration options including BACnet, and Web APIs



Solution: CSV data transfer solution at this time - moving toward BAS upgrade with Ethernet, new controllers, and upgraded BAS platform



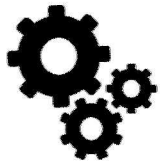
#3 – Getting Buy-in – Integrating Analytics

Presented to top management



- Results from BAS Analytics pilot project
- Benefits of data driven approach to managing operations and energy
- Benefits for on-going commissioning and energy audits
- Benefits of proactive maintenance and energy savings

Challenges



- Staff not familiar with technology, already busy
- Alarms (Failure) vs Faults (Inefficiencies, Issues, Opportunities)
- Exploratory process – current conditions vs. root cause

Solution: Get buy-in from stakeholders, perform training, designate energy team member as first point of responsibility



#4 – Data and Issue Overload – Prioritize Faults

*Hundreds
of faults
every day*

Rule	Duration	Tue 4th	Thu 6th	Sat 8th	Equips
① AHU Cool and Econ Conditions	15.43hr				① NM Bldg 0729 (BAS) AH-01
① AHU DAT Sp Not Met	2.25hr				① NM Bldg 0729 (BAS) AH-01
① AHU Econ and High OAT	15.25hr				① NM Bldg 0729 (BAS) AH-01
① AHU Econ and MAT Not Equal OAT	15.5hr				① NM Bldg 0729 (BAS) AH-01
① AHU No Econ and Low OAT	18.5hr				① NM Bldg 0729 (BAS) AH-01
① AHU On During Scheduled Unocc	1.08hr				① NM Bldg 0729 (BAS) AH-01
① Data Gap (Non-Meter Points)	2592hr				① x 7
① Data Gap (SiteMeter Points)	144hr				① NM Bldg 0729 (BAS) CHW Meter
① Equipment On Chillers Off	2.94hr				① NM Bldg 0729 (BAS) CHW PUMP 1
① Equipment Short Cycling	73hr				① x 5
① VAV Flow Error	32.75hr				① NM Bldg 0729 (BAS) VAV-2019
① Zone Reheat Failure	14.25hr				① x 3
① Zone Temp too Cold	6.25hr				① x 2
① Zone Temp too Hot	54hr				① NM Bldg 0729 (BAS) VAV-2040A

Solution: Refine rules for different user groups, use tracking system to note status/progress of issues



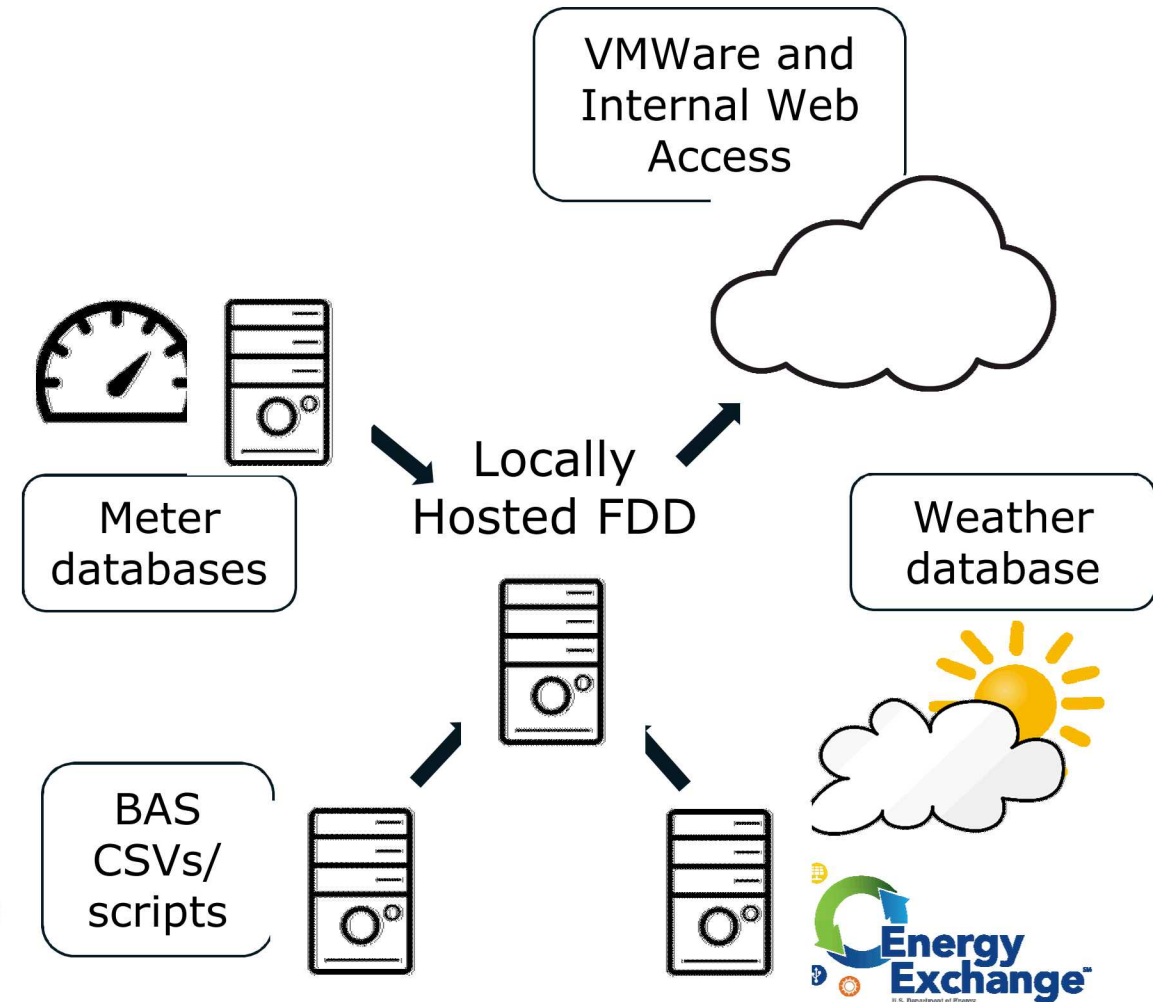
TRIUMPHS



#1 – Integration of Various Data Sources

- Successful integration of multiple data sources
- CSV, SQL, API restful; will add active BAS connection
- *Reduce time spent analyzing data in spreadsheets!*

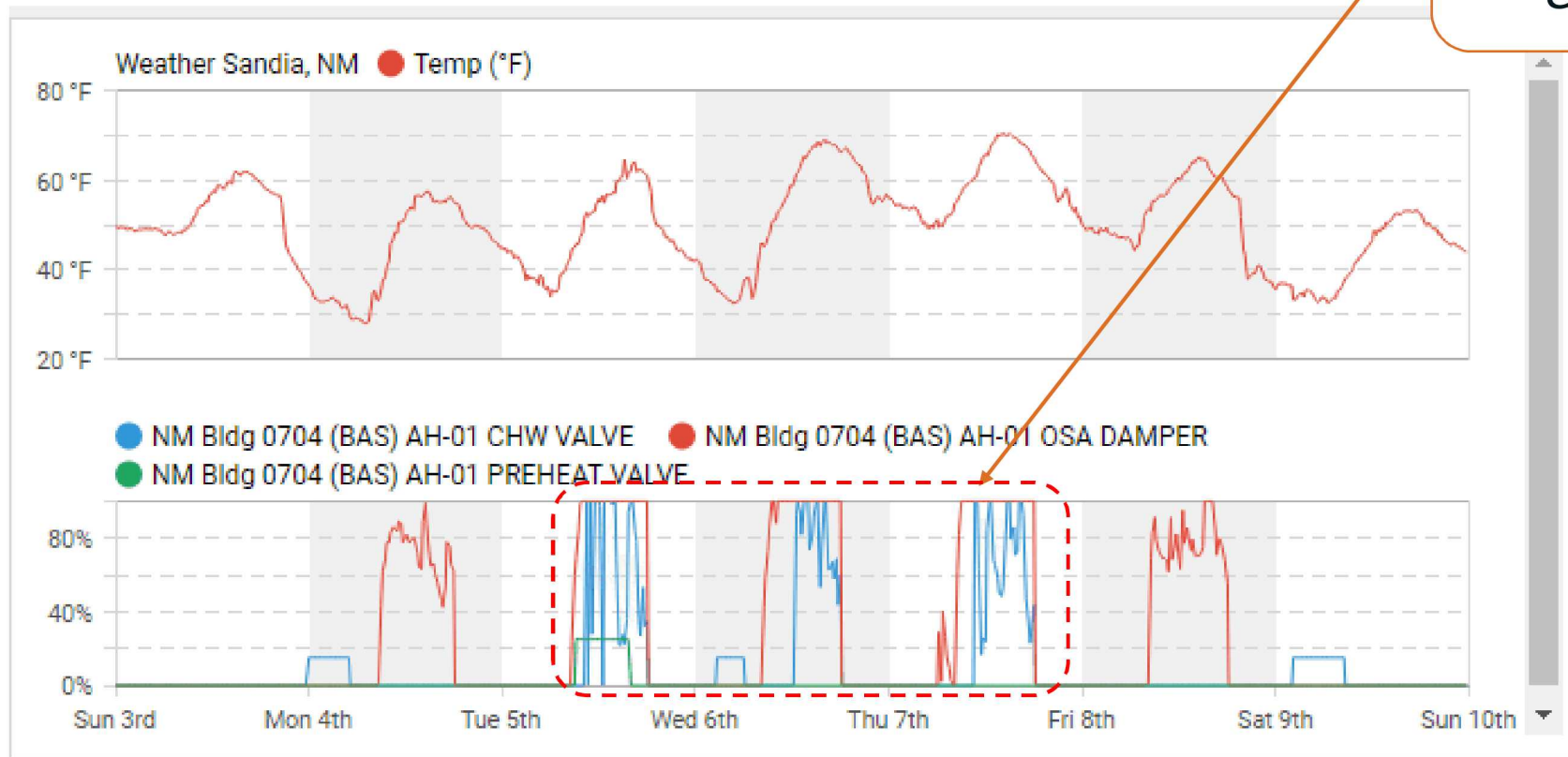
*Meter and BAS data
from 2 campuses*



#2a – Identify Operational Issues

- Fault #1: AHU Cool and Heat
- Fault #2: AHU Econ and Heat

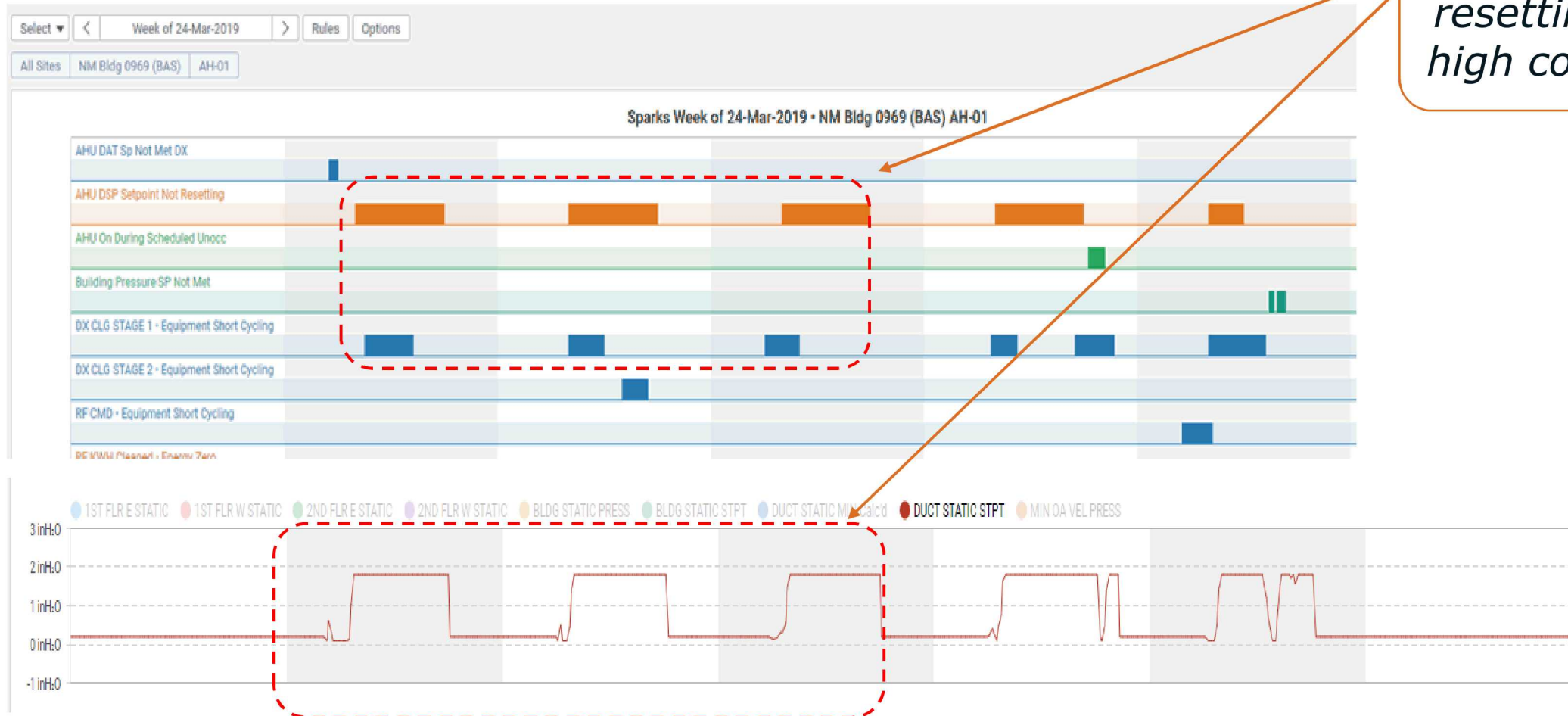
Simultaneous heating and cooling, should be economizing



#2b – Identify Operational Issues

- Fault: AHU Duct Static Pressure Not Resetting

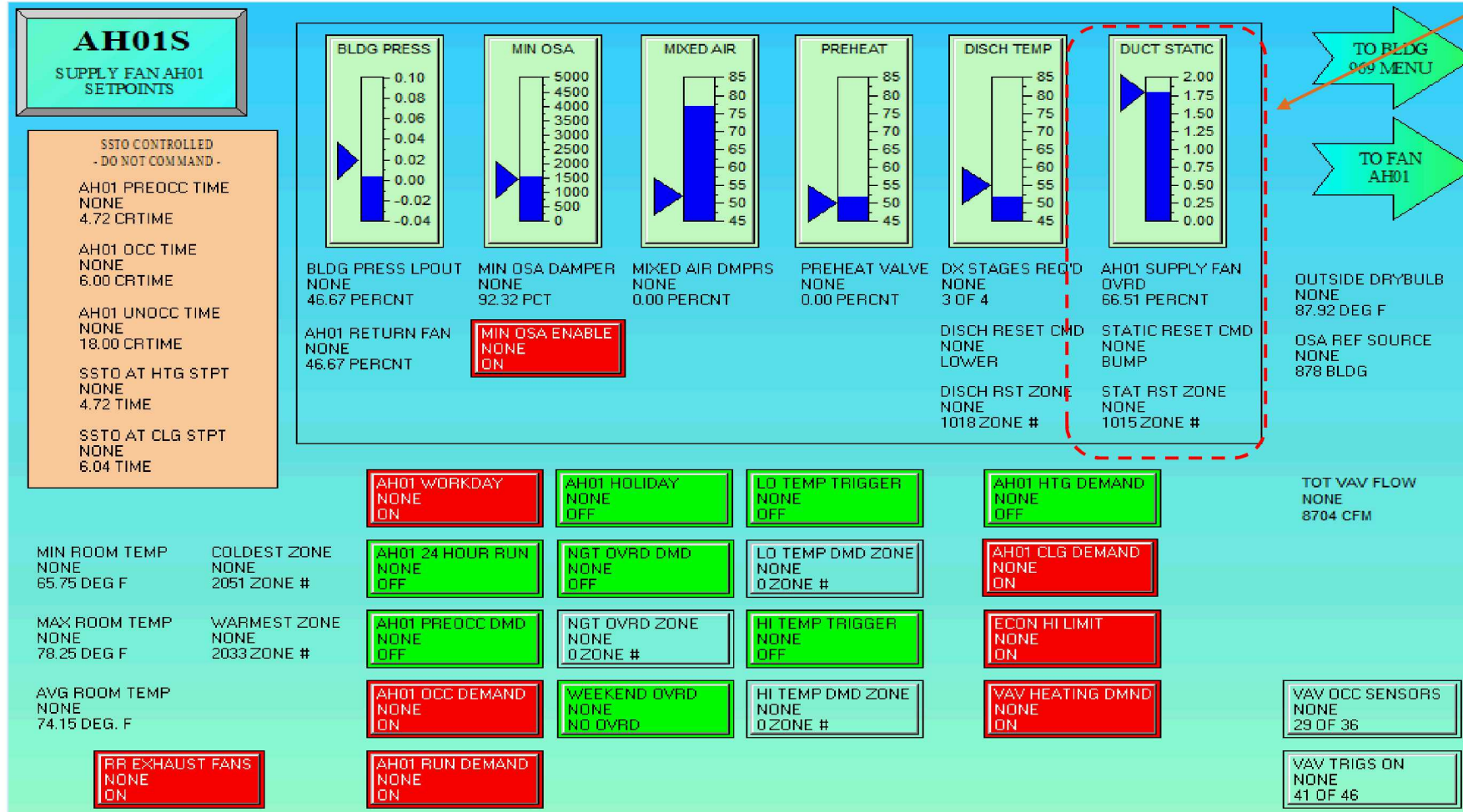
*Air Handler Fault:
Static pressure not
resetting and is at
high constant level*



#2b – Identify Operational Issues

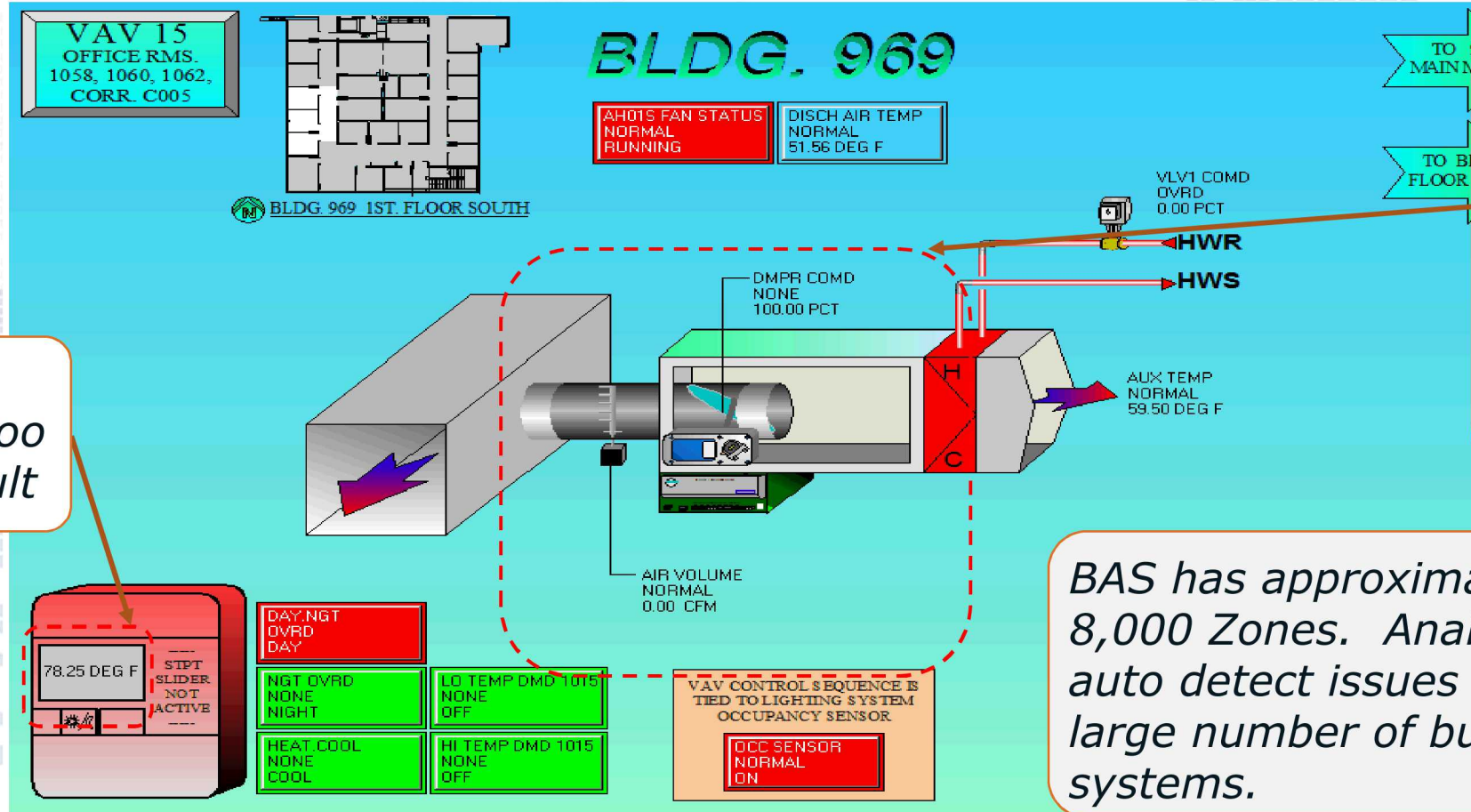
BAS Shows AHU Static Pressure Setpoint is met

No BAS alarm so operation looks normal to facilities staff



#2b – Identify Operational Issues

Related Zone Faults: Zone Air Flow Setpoint Not Met & Zone Temp Too Hot



Zone Airflow Fault:

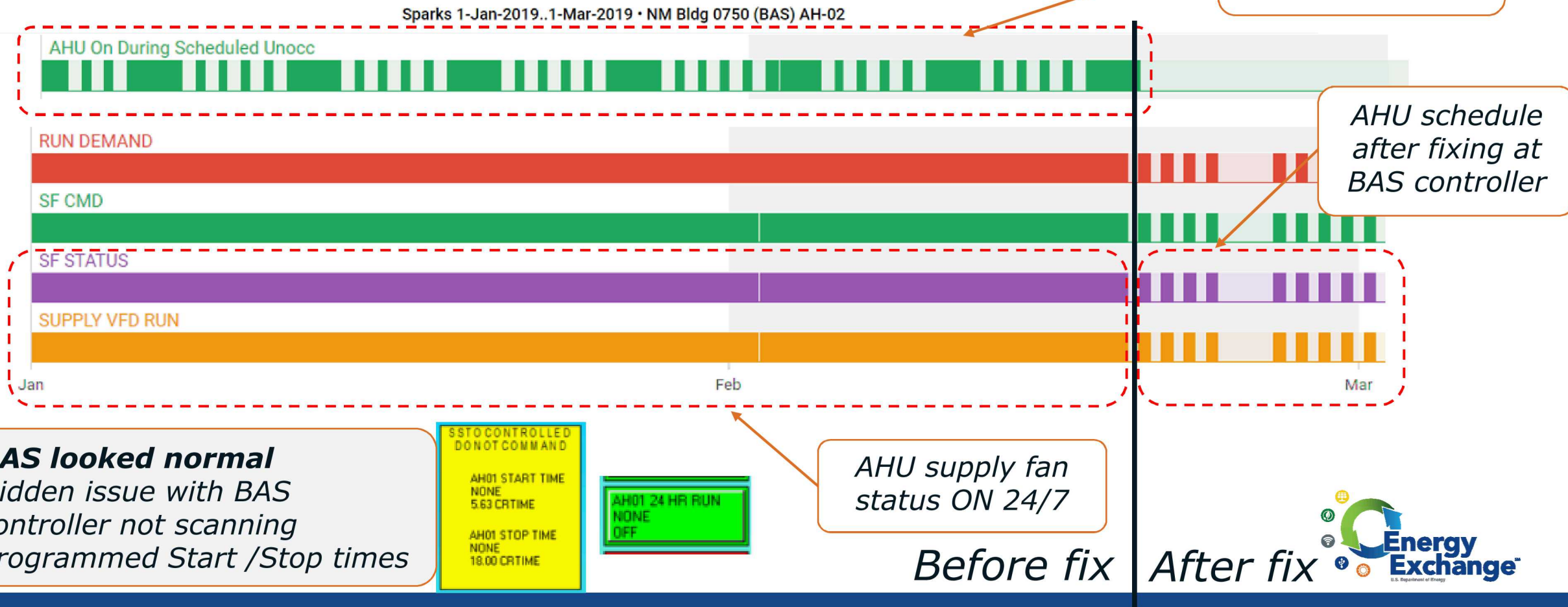
- Damper 100% open
- No Air Flow is driving increase in air handler static pressure setpoint
- Causes excess energy

BAS has approximately 8,000 Zones. Analytics auto detect issues across large number of building systems.



#2c – Identify Operational Issues

- Fault: AHU On During Scheduled Unoccupied



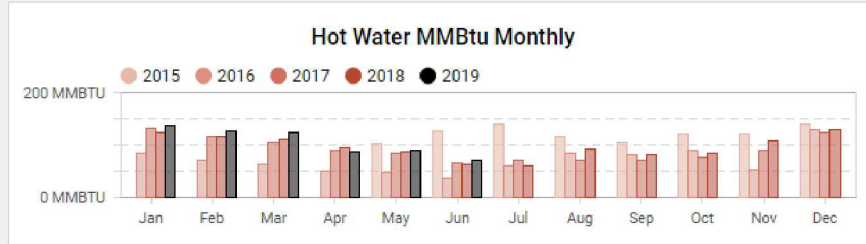
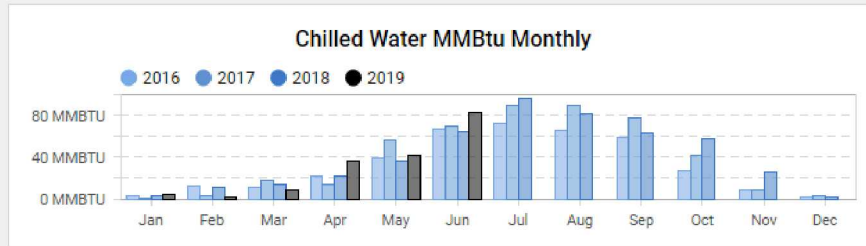
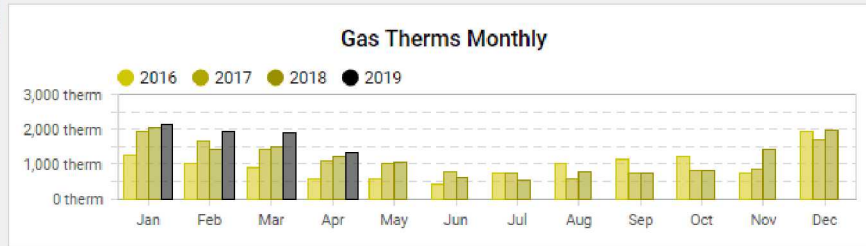
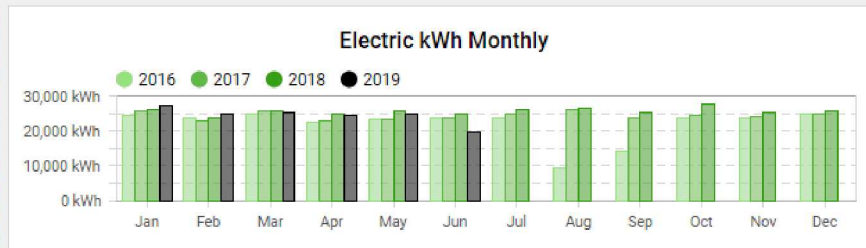
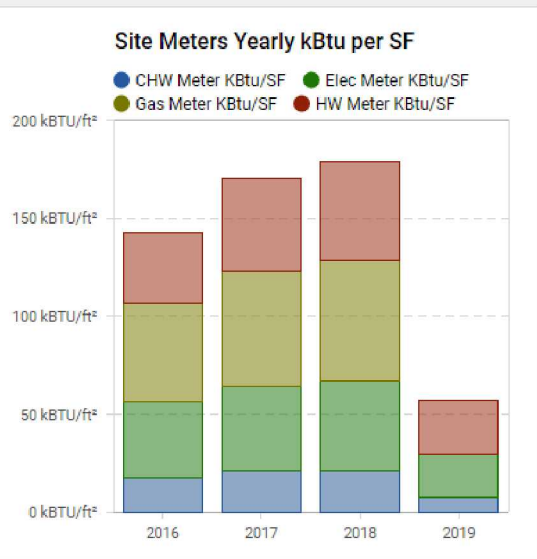
#3a – Energy Monitoring and Dashboards

Detailed Site Monitoring – 205 sites



CA Bldg C940 (BAS)

- Area: 22,789 ft²



#3b – Energy Monitoring and Dashboards

Key Performance Indicators

Swivel

Table

CA KPI

NM KPI

<

2019

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Rules

Options

All Sites

Site	Elec kBTU/Sf	Elec KWh	Elec KWh Delta Prev Year	Elec KWh Prev Year
NM Bldg 0827	168 kBTU/ft ²	1,604,110 kWh	6%	1,546,833 kWh
NM Bldg 9963	166 kBTU/ft ²	71,349 kWh	23.7%	61,518 kWh
NM Bldg 0518	146 kBTU/ft ²	2,301,100 kWh	-1.3%	2,352,210 kWh
NM Bldg 0720	137 kBTU/ft ²	629,424 kWh	-4.3%	255,406 kWh
NM Bldg 0755	135 kBTU/ft ²	408,609 kWh	1%	428,437 kWh
NM Bldg 0899	132 kBTU/ft ²	1,318,194 kWh	-20.7%	1,703,480 kWh
NM Bldg 0888	128 kBTU/ft ²	112,480 kWh	120.8%	20,170 kWh

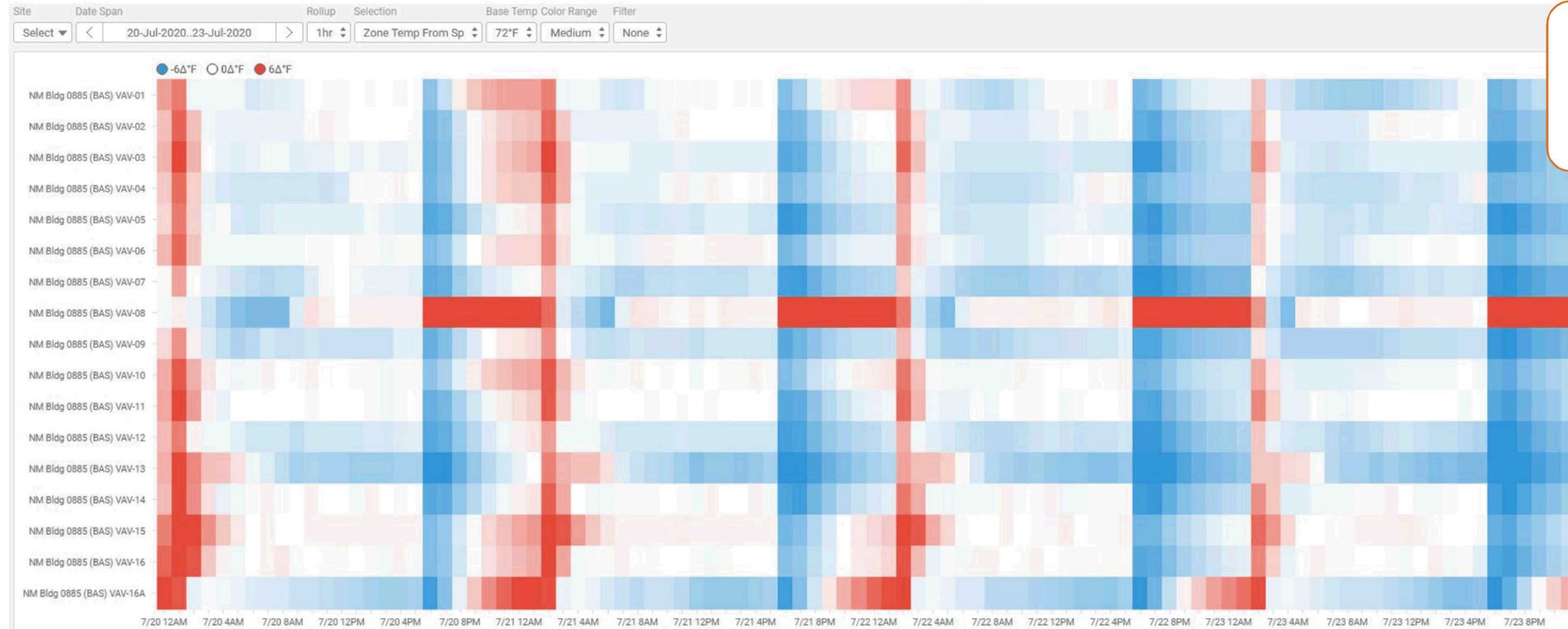


#3c – Energy Monitoring and Dashboards



Operator
Dashboard:
Building Summary

#3d – Energy Monitoring and Dashboards



Zone
Temperature
Heat Maps



#3e – Energy Monitoring and Dashboards

Operator
Dashboard:
AHU DATs

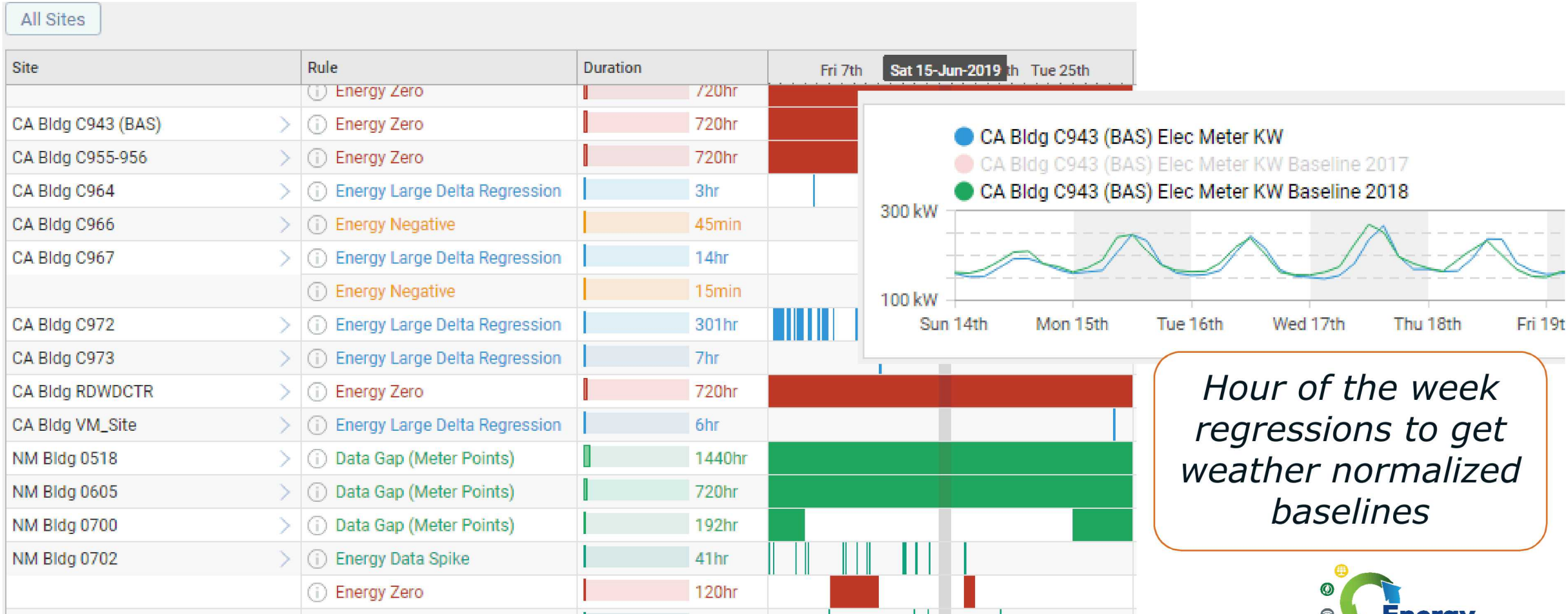


#3f – Energy Monitoring and Dashboards

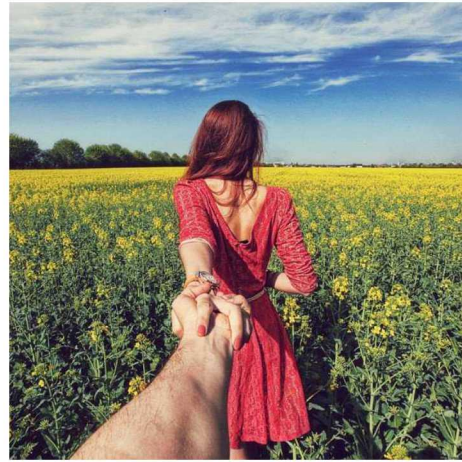
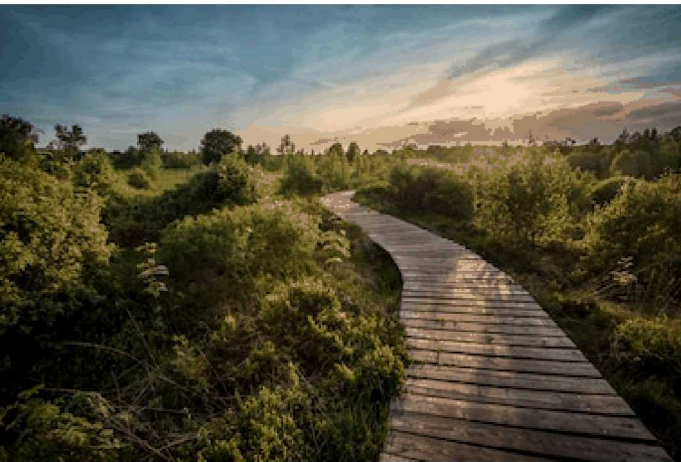
*Operator
Dashboard:
AHU Supply Fans*



#4 – Identify Meter Issues



THE PATH FORWARD



Benefits – Eliminate Drift

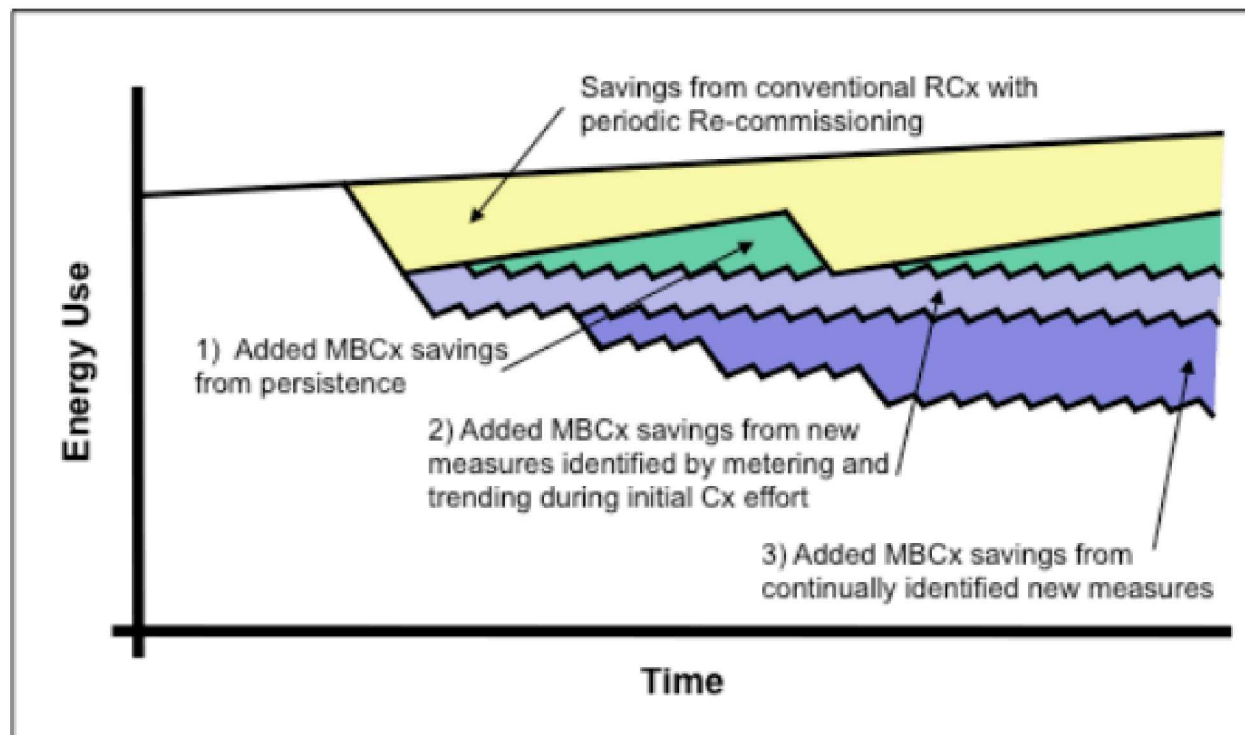


Figure 1. MBCx provides three streams of additional energy savings relative to RCx – conceptual illustration

(E. Mills, P. Mathew, "Monitoring--based Commissioning: Benchmarking Analysis of 24 University Buildings in California", 2012)

Median simple payback of 2.5 years and median source energy savings of 11%



Key Steps to Get Started

- 1 Identify stakeholders
- 2 Evaluate system capabilities and gaps – start plans for upgrades
- 3 Assess tool options
- 4 Start with a pilot
- 5 **Plan for action** – identify key roles and responsibilities



Questions?



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