Agenda

- Introductions
- HVAC Research Team
  - Marcus Bianchi, NREL – Senior Research Engineer
  - Greg Shoukas, NREL – Research Engineer
  - Michael Deru - Senior Research Engineer
- Speakers
  - Greg Shoukas, NREL
  - Michelle German, LBA Realty
  - Megan Runnion, Ulta
- Discussion
HVAC Resource Map

What is this resource?

The Central Plant Resource Map is an intuitive graphical interface that provides quick access to a broad array of quality information on operations and maintenance best practices and energy and water efficiency measures. The resources cover the central plant, distribution systems, and zone systems. The primary audiences for this resource are facility managers, operations staff, and design engineers who are looking to improve central plant and distribution efficiency but don’t have time to search for these resources.

This Resource Map is not a repetition of guidance provided in codes and standards. It should not be used in lieu of professional engineering services.

Explore HVAC Resources

Use the horizontal navigation above or the interactive diagram to dive into resources on different HVAC components.

The resources listed on this site have been carefully selected to help narrow your search for helpful information.
Analysis of Fault Data Collected from Automated Fault Detection and Diagnostic Products for Packaged Rooftop Units

Greg Shoukas
Marcus V. A. Bianchi
Michael Deru

Buildings and Thermal Sciences Center
Goals for Analyzing AFDD Data

Automated fault detection and diagnostics (AFDD) is a powerful tool that can continuously monitor operating RTU equipment, detect abnormal performance, diagnose problems, and report findings to building operators. Leading up to this effort, there have been no large-scale studies on the installed performance of AFDD systems.

**Objectives**
1. Acquire data sets from building owners that use AFDD systems
2. Gain a better understanding of how RTU AFDD systems operate
3. The types and frequencies of faults identified
4. How building operators interact with these systems
AFDD Companies and the Data Sets

- Three companies (-A, -B, -C)
- Provided NREL five raw data sets
- NREL analyzed the raw AFDD data

- Company (-D) provided a summarized AFDD analysis

- Company-B and Company-C monitor RTUs for the same small-box retail chain
- Characterize faults in different categories
- No economizer fault detection

- Company-D can read fault codes from the RTU control boards
Persistent Faults: Company - A: 15 RTUs at 5 sites

- Detailed information about every RTU monitored
- Daily summarized data for every RTU monitored
- Faults communicated to the building owner via email and a web portal
- Most frequently occurring faults are due to dampers

![Bar chart showing fault hours and cumulative hours of sensor faults, economizer faults, heating faults, and cooling faults relative to max number of consecutive days of economizer faults. Percentage cumulative hours of damper faults are shown as well.](image-url)
Inconsistent Characterization of Faults

**Company–B**
- 12-months of data over 371 sites
- Airside faults are reported
- No additional details related to the faults
- Most prevalent sensor and communication faults
- 24 cooling faults

**Company–C**
- 1-week of data over 123 sites
- Provided additional details pertaining to the faults
- Most prevalent sensor and power/demand faults
- 63 cooling faults

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**Company – B (Small Box Retailer)**
- Sensor Faults, 774
- Power/Phase Faults, 3
- Airside Faults, 10
- Other Faults (Lighting, Hot Water), 74
- Communication Faults, 505

**Company – C (Small Box Retailer)**
- Sensor Faults, 295
- Power/Demand/Phase Faults, 139
- Cooling Faults, 63
- Heating Faults, 32
- Communication Faults, 31
- Other Faults (Lighting, Security), 15
Company-D: Summarized Analysis

- Over 24,000 RTUs from 1,733 sites
- Monitoring RTUs a mostly a big-box retail chain
- Summary taken from 6 years of archived data
- Fault statistics were provided with respect to fault categories, climate zone and RTU age
- Unknown the number of RTUs with/without economizers and VFDs
- Cooling faults are detected most frequently
- Damper faults and sensor faults are detected the least frequently
- Communication with the RTU control boards provides OEM diagnostics at the equipment level
A Few Conclusions

• High fault frequency can be associated with a small number of problematic units
• Comparisons between AFDD companies is difficult
• The types and frequency of reported faults depend on:
  1. Diversity and number of points monitored
  2. The interpretation of a fault’s definition
  3. The diagnostic approaches
• AFDD systems that can communicate with RTU control board:
  1. Leverage existing, on-board fault diagnostics
  2. Characterize equipment faults more specifically and accurately
  3. Identifying the problematic units that may justify early replacement
• Historical archives of AFDD data can provide more reliable diagnoses and fault detection through data analysis

Additional conclusions and recommendations can be found in the full technical report: NREL/TP-5500-77077
https://www.nrel.gov/docs/fy20osti/77077.pdf
Thank you!

www.nrel.gov

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LBA Smart Building Program

PRESENTED BY:
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LBA Realty & LBA Logistics
ABOUT LBA

Who is LBA?
LBA is a full-service real estate investment and management company with 65M SF of office and industrial properties in major markets throughout the U.S.

“Sensible” Sustainability Strategy
LBA’s strategy is to execute first and foremost on the business case for sustainability within our real estate portfolio. The business case for sustainability requires taking a strategic view - considering costs weighed against benefits in the context of improved financial performance, enhanced operating efficiency, employee recruitment and retention, risk mitigation, corporate identity, brand and leadership.

KPI’s & Goals
Focused around energy, water and waste efficiencies, renewable energy, clean tech, innovative technologies and health & wellness.

Long-term Commitment
DOE’s Better Buildings Challenge - 10 year commitment (2013 baseline) to improve energy intensity of the portfolio by at least 20% (on track to achieve goal with annual percentage improvement of 3.9%)

Results
3.06% energy reduction across portfolio
LBA Smart Building Program

Pilot Program

• Have organizational commitment to continuous improvement, including operations and efficiency
• Had a large, sophisticated property that is LEED Certified, ENERGY STAR certified – top performer already
• Wanted to test the concept of enhanced smart building solution (Park Place Office Campus in Irvine, CA) and further enhance performance financially and environmentally

Why We Selected Yardi Pulse

• Proven success
• Offered energy savings and comfort enhancement with no upfront costs to LBA
• Unified platform
• Solution integrated well with our existing systems
• Engineering team and service provider partners helped vet the options – got buy in early
• Interested in innovation and whether we could turn targeted buildings into smart buildings
Yardi Pulse Implementation

• **Team Engagement** – LBA Property Management, Engineering and Yardi Consultant Services

• **Phase 1**: Real-Time Metering (RTM) & Fault Detection and Diagnostics
  • Gain insight into the building
  • Make operational adjustments where needed
  • Results can be seen after a few months
  • Continuous monitoring and adjustments

• **Phase 2**: Active Energy Efficiency (AEE)
  • Energy automation and artificial intelligence
  • System enables optimization of equipment such as HVAC set points
  • Load profiling of building electrical meter and HVAC systems
Yardi Pulse – Operations Dashboard

Portfolio Level Meter Data

Peak Demand Reporting

Asset Level Meter Data
Highlights

Portfolio Program Overview

• LBA has contracted with Yardi for 11 office buildings, totaling 5.9M SF
• Pulse is live at 8 properties with metering analytics and fault detection
• Pulse building optimization has been implemented at 3 of the 8 properties

Program Results (January 2019 – September 2020)

• Consumption Savings – 20.4M kWh
• Cost Savings – Approximately $2.5M
WHAT’S NEXT?

Road Map
• Remainder of portfolio in process (three properties, 1.3 M SF)
• All new office assets are vetted at acquisition

2021 Portfolio Projections
• Consumption Savings – 15.3M kWh
• Cost Savings - $1.9M

“With Active EE working as artificial intelligence software, we are fulfilling our vision of bringing intelligent buildings to life.”

PERRY SCHONFELD
Principal, LBA Realty
AFDD at Ulta Beauty

Megan Runnion – Project Manager, Energy & Sustainability
Background

- 1,200+ stores
- 5,000+ RTUs
  - Mix of system types and manufacturers
- Energy Management Systems in all stores
- Two main energy consuming systems in stores: Lighting & HVAC
- Energy savings & store comfort are priorities
- Goals:
  - Proactively identify, troubleshoot, resolve issues
  - Monitor & track store conditions, unit performance, and maintenance needs
• 297 active alarms
• Utilize EMS monitoring vendors to manage alarms
  • Prioritize critical vs non-critical
  • Troubleshoot, resolve remotely where possible
  • As needed, dispatch via Ulta work order platform
  • Reduce truck rolls where possible – table issues for future PMs
Alarm Management

• Zone temperature limit
• Unit error (Lennox Prodigy error codes)
  • Via tools like handheld application for further descriptions, troubleshooting suggestions
• Sensors
  • CO2
  • Indoor/outdoor humidity
  • Outdoor temperature
• Network health – communication loss
• HVAC performance alerts
• Lighting/HVAC overrides
• Smart breakers
• Dead meter alert
Fault Detection Diagnostics & Optimization

- Fan Cycle: Extended fan runtimes
- Lighting Status: Extended lighting runtimes
- Economizer Free Cooling Loss: Outdoor conditions optimal to economize but use mechanical cooling
- Economizer Outside Air High Temperature: Economizer not operating properly
- Unoccupied kW: Overnight usage higher than expected
  - Do not need utility bills to identify issues
CapEx Planning

- Use data to evaluate HVAC unit condition & prioritize replacements
- The Old Way
  - Unit age
  - Condition survey
- The Better Way
  - Comfort scorecard
    - Zone temp, humidity compliance
  - Fault scorecard
  - HVAC Runtime
  - Unit Performance – Delta T
  - Calls/Tickets
  - Expense history
  - Store EUI
thanks
Questions
New challenges
New project results
Topics for next call