Agenda

- Welcome and Introductions
- Project updates/announcements
  - Advanced RTU Campaign
  - Retailer Ventilation Guide
- Proactive Plan for HVAC: Pat Hagan, Wawa
- Smart Building Systems and Portfolio RTU management: Brian Walser, Bank of America
- Open discussion and new projects
Advanced Rooftop Unit Campaign (ARC)

High-efficiency RTU solutions
- High-efficiency RTUs
- Advanced RTU control retrofits
- Quality Installation and Quality Maintenance

Results:
- 193 ARC partners
- 40,000 high-efficiency RTUs
- 4 Trillion BTUs annual savings
- $37 million annual savings

www.advancedrtu.org
Advanced RTU Campaign Updates

- Congratulations to ARC award winners!
- New resources:
  - Walgreens case study
  - JCPenney case study
  - RTU Business case document (coming soon)
Retailer Ventilation Guide

- 62.1 and 90.1 are straightforward and easy to apply
Retailer Ventilation Guide

- 62.1 and 90.1 are straightforward and easy to apply
- Great opportunities for energy savings and equipment downsizing – but what is the best approach balance savings with good IAQ
- In review, expected publication – July 2015
High-Impact Technology – Fans

- Fans are everywhere and consume ~ 140 billion kWh per year

- Opportunities for savings
  - Proper system design and sizing
  - Optimal control – off, VSDs
  - High-efficiency fans and motors

- What resources would be useful to help save energy?
  - Design and application guidance
  - Fan selection guidance
  - Specifications
HIT Special Session on Friday

High-Impact Technology Forum: Harnessing American Ingenuity and Innovation

Amy Jiron will moderate three sessions from 9-2
Proactive Plan for HVAC
Pat Hagan, Wawa
Who is Wawa?

- Convenience store chain with over 650 locations, 400+ serving fuel (Mid-Atlantic and Florida)
- Store’s age vary from 52 years to new
- Average sq. ft. range from 3000 to 7000
- Typical HVAC installation 2 to 4 units
- Primarily RTUs but splits and cassettes units also used.
- Energy load same as 40K sq ft building
Hot stores?

<table>
<thead>
<tr>
<th>OAT</th>
<th>84.2 °F</th>
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<tbody>
<tr>
<td>Fan Starts</td>
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<tr>
<td>Hours</td>
<td>10.2</td>
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<tr>
<td>Status</td>
<td>Lennox Alarm</td>
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<tr>
<td>Cool 1</td>
<td>0</td>
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<tr>
<td>Hours</td>
<td>10.2</td>
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<tr>
<td>Status</td>
<td>Dirty Filter</td>
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<td>Cool 2</td>
<td>0</td>
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<td>Hours</td>
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<tr>
<td>Status</td>
<td>Ctrl Temp High</td>
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<td>Heat 1</td>
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<td>Hours</td>
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<td>Heat 2</td>
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<td>Hours</td>
<td>0.0</td>
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<tr>
<td>Status</td>
<td></td>
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</table>

Unit Status: Cooling

<table>
<thead>
<tr>
<th>Control Temp</th>
<th>Active Setpoint</th>
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</thead>
<tbody>
<tr>
<td>74.2 °F</td>
<td>70.0 °F</td>
</tr>
</tbody>
</table>
How you determine next steps?

- BAS provides:
  - Proactive equipment monitoring
    - Provides real-time and historical information
  - Provide a safe and comfortable work environment for our associates
  - Minimize equipment downtime, repair costs, product spoilage, and energy consumption

- Determine the following:
  - Is it a single unit issue or entire store?
  - Door openings, recent deliveries, work being done at store
  - Recent repairs-unit out on parts
  - Vendor visit to check all connections and functions of unit.
  - Discuss options
Reactive vs. Proactive

- Replace as they break
  - More costly
  - Larger impact on store
  - Possible product and sales lose
  - Long term outages 3-5 days

- Scheduled replacement
  - Off season replacement
  - Less impact on store
  - Planned outage
  - Proper equipment installed according to needs.
How Many and When?

- Over 2000 units in operation today.
  - 750 less than 5 years old
  - 375 replaced since 2011
- Factors for change out
  - Age-8-10 + years old
  - Repair totals over 70% of cost of new
  - Run time avg. during cooling season
  - Remodel scheduled
- Recently explored changing all units out of locations depending on how close in age they were.
• Over the last three years Wawa has invested a little over $4M in HVAC replacements in 126 locations.
  
  Wawa expectations
  
  • Lower annual maintenance HVAC budget by 15%
  • Increase lifecycle RTU from 10 years to 13-15 years
  • Test high efficiency units in new stores
  • Partner with BBA on next RTU campaign
  • Gain some energy benefits
Smart Building Systems and Portfolio RTU management
Brian Walser, Bank of America
Smart Building Systems- $iC^3$

Lessons learned from the installation of a 3,500 location smart building control system.

Brian Walser - Director of Energy and Sustainability
Gerald Adolph (Booz Allen & Hamilton) --- “I would define [the] Valley of Death [as occurring] when the amount of money you’re starting to ask for—the bill—starts to add up to the point where management says, ‘What are you guys up to, what are you doing, and what am I going to get out of it?’ But yet it is sufficiently early in the process that you don’t feel you can answer that question. If you are fortunate enough that the questions come when you have an answer, you, in fact, have scooted over the Valley. If not, you are squarely in that Valley.”

http://www.atp.nist.gov/eao/gcr02-841/chapt2.htm Graphic adapted from Congressman Vern Ehlers
The CRE Business Challenge

- Disparate Facility Conditions
- Maintenance Management & Support
- Rapidly Growing Portfolio
- Environmental Impact
- Associate & Client Comfort
- Rising Energy Prices

Growing Corporate Real Estate Challenge
The iC³ Vision

Traditional EMS operations stop here...

Reactive
- Call driven
- Simple fixes
- Field Support

Detection
- Alarm driven
- Trending analysis
- Field support

Predictive
- Condition monitoring
- Planned work
- Intelligent field support

Game Changing!
System Design – Facility Level

Control Capabilities

- **Interior lights** (on/off)
- **Exterior lights** (on/off) & (Amps)
- **Building Health** (Space Temp) (RH) (CO2) (Utility kWh) Override Button(s)
- **HVAC Controller**
  - Discharge Air Temp
  - Amps
  - All Controller points
Implementation

Key Deployment Statistics

- Over 3200 sites installed across 32 states
- Average of 125+ sites installed per month.
- Installations took 1 to 3 days to complete.
- Multi-layered quality control process minimizes installation defects and ensures quality.
- Commissioning process bring sites online to realize same day benefits.

Single Site
- 3-4 HVAC units
- Avg 5500 SF
- 2-3 day install

All Sites
- 3200 sites
- 34 states
- 17.5MMsf
- 12,000 HVAC systems

Enterprise Software
- Commissioning tool
- BMS Screens
- Alarm Mgt tool
- Case Mgt Software
- Fault Detection Software
Some Success!

iC3 Operations Highlights

- 11-17% energy savings
- 30% of events resolved remotely, avoiding costly technician dispatches to facilities
- 20% of events proactively identified
- 53% iC3 supported issues get solved faster and right the first time
- Enabled to support disaster recovery efforts
Leverage technology to use real-time facility data and to develop fault diagnostics.

Develop real-time diagnostic tools to predict system faults.

Progress from “Predictive” to “Optimized” maintenance planning.

Combine predictability with intelligent maintenance routines.

Reduce repair events through optimized maintenance and real-time monitoring.

Enable remote technicians to repair and correct system issues.

Develop technologies to conduct real-time, ongoing HVAC commissioning.

Minimize routine servicing costs and maximize system efficiency.

Extend the life of capital assets and minimize ongoing, expensive capital replacement projects.

Use data analytics to evaluate and improve capital planning budgeting.
The Valley!

- Hard savings not as great as anticipated, and hard to prove R&M savings
- Installation and data quality issues, erodes confidence
- Unnoticed installation cost overruns
- Pushback from field engineers
- The pace of change was faster than the culture could adapt
- Hard to recruit top tier command center employees
- Proactive resolution eliminates the “hero euphoria” of being reactive
- Corporate culture not ready/sold on proactive HVAC management
- Financial collapse, kills all innovation
Climbing out of the valley!

Focused on highest value, incremental changes

- Kept BMS technology in place
- Kept data collection happening
- Built a dashboard for mobile technicians
- Strategically started to use fault detection again
  - Can’t heat/cool report
  - Runtime Faults
  - IAQ (RH/CO2)
  - Energy disaggregation
  - Power Outage
  - What HVAC equipment needs replacing.
- Reduced Truck Roles — Remote equipment schedule management
- Optimization
  - Unit Coordination
  - Price response
  - Outside Air Management
- New HVAC Unit Virtual Quality Control
  - More consistent quality control and commissioning when HVAC equipment is replaced.
Mobile Dashboard

HVAC Performance Data

- Three primary graphs
  - Heating, cooling and space info
  - Supply temperature, Amperage and with heating and cooling commands
  - Humidity and CO2 Levels
- 24 or 7 day trend information

Lighting Runtime Data

- Lighting Graphs
- Lighting Runtime tables

Allows engineers to “self serve” a wealth of knowledge of the current and historical performance of a site’s HVAC or lighting.
CO² Reporting

Percentage Of Hours During The Year At A CO₂ Level

![Bar chart showing the percentage of hours at different CO₂ levels for Customer, Associate, and Unoccupied categories.](chart.png)
Optimization - Unit Coordination

- Learns relationship between thermostat temperatures and RTU on/off staging (no other measurements required)
- Determines RTU staging to minimize energy (based on RTU rated power or measurements if available)

**Supervisory RTU Coordinator**

- Optimizer
- State Observer
- Parameter Estimator

**Disturbances**

- Set-Points
- Temp. & ON/OFFs

**ENVELOPE/ HVAC (RTUs) SYSTEM**

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**Purpose and Objectives**

**Problem Statement:** Advanced controls for SMSCBs (small and medium-size commercial buildings) are rarely implemented because of poor overall economics. Low-touch, low-cost control implementations are needed.

**Target Market and Audience:**
- Market is SMCBs that utilize RTUs for cooling.
- RTUs serve about 60% of commercial floor space & account for ~150 TWh of annual electrical usage (~1.56 Quads primary energy for cooling) & ~$15B in electric bills.
- Audience is companies that can build successful businesses to deliver advanced RTU controls for SMSCBs.
Lessons Learned

• Start with the end in mind, how will the new system affect your current or adapted process?
• Make sure your organization is ready for change.
• The control system features and functions are not nearly as important as how and if you will use those features and functions to save cost.
• The contractor that you use is not nearly as important as having a quality control and acceptance process in place.
• Spend the time necessary to develop a good point naming, and trend set-up, standards.
• Make sure that you have expertise in-house to manage the project, negotiate change orders, and ensure quality.
• Plan to slow/stop implementation after 5%-15% of the sites have been completed and refine your design & install process.
• Use a tune-up tool like FDSI’s tune-up tool to check unit performance before installation of control system.
• Don’t expect that your savings percentage will be the same as projects implemented by other organizations. Estimate you savings based on how you will change your operations. Only “benchmark” information to make sure your savings estimates are reasonable.
What’s next?

- What is your most exciting new project?
- What is your biggest challenge?
- Possible future activities
  - Fan application guidance and specs
  - System level metrics for performance tracking
  - Cold climate HPs
  - VRFs (Can they be cost effective?)
  - Evaporative cooling (Is it ready for prime time?)
  - Other?