Introductions

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Agenda

- Background

- Impact on FDD from building operational changes during Covid-19

- Q&A
Energy Management and Information Systems (EMIS)

**How EMIS work:**

- **Data Warehouse:** Integrates and organizes building data
- **Monitoring:** Tracks improvements and measures savings
- **Data Analytics:** Transmits actionable information to building engineer
- **Implementation:** Building engineer reviews analytics and makes repairs or improvements

**EMIS TOOLS:** Energy information systems (EIS) help find energy waste using smart meter data. Fault detection and diagnostic tools (FDD) detect and prioritize HVAC system faults. Automated system optimization (ASO) includes control algorithms to minimize energy use across systems.
Proving the Business Case for Building Analytics

Results from scaled implementation of Energy Management and Information Systems, as documented by the Smart Energy Analytics Campaign

BUILDING TECHNOLOGY & URBAN SYSTEMS DIVISION
Lawrence Berkeley National Laboratory

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EMIS Applications Showcase
Highlighting Applications of Energy Management and Information Systems (EMIS)

BUILDING TECHNOLOGY & URBAN SYSTEMS DIVISION
Lawrence Berkeley National Laboratory

By Edith Crowe, Hannah Kramer, Jessica Granderson

October 2020

Proving the Business Case for BUILDING ANALYTICS

Lawrence Berkeley National Laboratory has partnered with commercial building owners across the country to gather data on the costs and benefits of Energy Management and Information Systems (EMIS). EMIS are the technologies behind automated data-driven energy management that help identify, diagnose, and implement building systems improvements. Through this partnership, Berkeley Lab has assembled the largest dataset to date on building analytics costs and benefits, proving the business case for their use at scale.

How EMIS work:

Data Warehouse: Integrates energy system building data

Data Analytics: Provides actionable information to building engineers

Implementation: Building engineers review analytics and design upgrades or operations changes.

Largest Dataset Documents the Costs and Benefits of EMIS

40 DIFFERENT EMIS SOLUTIONS HAVE BEEN INSTALLED

$543 MILLION IN PROJECTED SAVINGS

2 YEARS TO PAYBACK

$95 MILLION IN년 $3 MILLION IN YEAR 1

$6.05/kWh, TES $8.00/kWh, TES

THE WAI-105 Smart Energy Analytics Platform was selected under partnership program funding from the U.S. Department of Energy.

For more information on Energy Management and Information Systems, visit betterbuildingssolutioncenter.energy.gov/smart-energy-analytics-campaign-toolkit
Existing Resources on COVID-19 Mitigation Strategies for Buildings

- ASHRAE Resources
- Market-sector specific resources (healthcare, CRE, Education)
- Technology resources (UV, air filtration, air cleaning)
- Webinars
- Whitepapers/guidance documents

Today’s webinar focuses on the use of fault detection and diagnostics to support building operations during the pandemic.

[https://betterbuildingssolutioncenter.energy.gov/covid19](https://betterbuildingssolutioncenter.energy.gov/covid19)
Mitigation of Risk

- Elimination
  - Minimize people, testing, vaccination

- Substitution
  - Eliminate unnecessary people in areas or buildings

- Engineering controls
  - Barriers, increase ventilation, better filtration, UV-C

- Admin controls
  - More cleaning, physical distancing, web meetings instead of conference rooms

- PPE
  - N95 respirators, personal air cleaners

Source: ASHRAE Commercial COVID-19 guidance
ASHRAE Recommendations

- Increase outdoor air, thus increasing the effective dilution ventilation per person
- Disable demand-controlled ventilation (DCV)
- Further open minimum outdoor air dampers, as high as 100%, thus eliminating recirculation
- Improve central air filtration to the MERV-13 or the highest compatible with the filter rack
- Keep systems running longer hours, if possible 24/7, to enhance the two actions above
- Consider portable room air cleaners with HEPA filters
- Consider UVGI (ultraviolet germicidal irradiation), UV-C

Source: ASHRAE Journal, May 2020
What are the benefits of changes to existing FDD?

- Healthy building
- Healthy occupants
- Reduction in false positive flags from FDD
- Mitigating energy impacts
- Reduced energy consumption
Team and Process

- **Building Facilities Group**
  - Implements O&M measures, coordinates with Ownership, EMIS and Controls Vendors

- **Controls Vendor**
  - Implements building automation system (BAS) programming changes

- **EMIS Vendor**
  - EMIS Vendor implements FDD modifications and additions

- **Changes needs to be coordinated, documented, and updated before, during and after building occupancy during Covid-19**
Summary of Rules Changes

**Modified Rules**
- Economizer/OA
- VFD/Fan speeds/static pressure
- Scheduling
- Flush Modes
- Zone temperature/RH rules
- DCV
- Heat Recovery

**Suspended Rules**
- DCV
- Heat Recovery

**Additional Rules**
- UVC
- Portable Air Cleaners
- Kitchen electric panels
Outside Air Ventilation

Initial Rules

▪ Too much/little outside air based on temperature comparison (MAT/OAT/RAT)
▪ Enthalpy based economizer rule flagged (RAH, OAH)
▪ DCV based on CO₂ not working (RA CO₂)
▪ OA based on schedule not working

Modified Rules

▪ Minimum OA raised from 20% to 40% or higher?
  ▪ How are rules adjusted?
  ▪ How frequently changed?
▪ How does this impact potential rules and savings?
▪ Can existing system meet load demands at design conditions?
Outside Air Ventilation: Standard FDD Rule, 20% min OA

Efficiency:
80% heating
0.8 kW/ton

Utility Rates:
$0.10 kWh
$1/therm

OA control
AHU-1: 10,000 CFM
24 Hours/Day

Results: 1,000 hrs of htg, 1,000 hrs of clg, 945 therms, 5,040 kWh = $1,450/yr
Outside Air Ventilation Modified Rule: 20% min OA raised to 40% min OA

Results: in Boston, no heating required between 0F OAT and 25F at 20% min OA, heating required below 25F with 40% OA min.

In temperate climates there will be little impact.
Outside Air Ventilation

Initial Rules

- Too much/little outside air based on temperature comparison (MAT/OAT/RAT)
- Enthalpy based economizer rule flagged (RAH, OAH)
- DCV based on CO2 not working (RA CO2)
- OA based on schedule not working

Suspended Rules

- Suspend DCV mode rules

Modified Rules

- Temperature comparison based on new minimum OA %
- Enthalpy economizer rule based on new minimum OA%
- OA based on scheduling with new minimum OA%
- Potentially more energy used
- Flag when DCV is on
Occupancy Schedule

Initial Rules
- Rules based on provided Occupancy schedule
  - Systems left in override/in-hand
  - Systems left in cooling/heating 24/7, no setbacks
  - Startup mode not used
    - No pre-cool
    - No optimum stat/stop

Modified Rules
- Rules created based on flush cycle or 24/7 schedule
- How are rules adjusted?
  - how frequently changed?
- How does this impact potential rule and savings if it’s operating more hours/fewer hours?
Occasionally Schedule

OA control
AHU-1: 10,000 CFM
12 Hours/Day

OA control
AHU-1: 10,000 CFM
24 Hours/Day

Results
- Additional heating
- Additional cooling
- Additional fan energy
- More frequent filter replacements
- FDD Rules needs to be modified
Initial Rules

- Rules based on provided Occupancy schedule
  - Systems left in override/in hand
  - Systems left in cooling/heating 24/7, no setbacks
  - Startup mode not used
    - No pre-cool
    - No optimum stat/stop

Modified Rules

- OA rules must be flagged, but not airflow or flush cycles based on occupancy schedule
- Heating and cooling rules based on new occupancy schedule
- Startup modes have newer flags based on % OA more than temperature control. Rules need to be modified
- Potentially more energy used
Initial Rules

- Fans near maximum VFD speed
  - Downstream issues
  - Ducting issues
  - Coils/filter issues
- Fan static pressure lower than setpoint
- DAP setpoint “high”
  - Common cause coils need cleaning

Modified Rules

- Change of filter to MERV 13 increases static pressure drop and requires more fan energy. Modify rule to flag based on new DAP setpoint
- Increased fan speed to increase ACH rates (6 ACH) also requires modified rule
- Increased energy use
Maintain Zone Conditions

**Initial Rules**
- Zone temperature above/below setpoint
- Zone RH above/below setpoint
  - Most zones don’t have RH unless it’s a specifically required condition for the space
- Impacts comfort
- Minimal savings, minimal corrections unless required

**Modified Rules**
- Modified rule flags based on relative humidity outside of the 40% and 60% if appropriate for conditioned space.
- Space specific-is humidification an option and how?
- More energy use in drier climates
UVC

No Initial Rules

- Costs
  - Additional hardware
  - Installation in AHUs
  - Additional BAS points
  - Ongoing electricity for UVC lighting

- Benefits
  - Cleaner coils
  - Reduced pressure drop
  - Electricity costs
  - Maintenance costs

Additional Rules

- Power measurement for lighting
- Time measurement for each UVC lamp
- Less energy and maintenance in most cases
Heat Recovery

Initial Rules
- FDD flags not operable heat wheels
- FDD flags non optimal heat wheel operations
  - Wheel speed

Suspended Rules
- FDD flags not operable heat wheels
- FDD flags non optimal heat wheel operations
  - Wheel speed

Modified Rules
- Keep heat wheels off or bypassed unless preheat is not capable of handling heating load at lower OATs, then the heat wheel must be operated under those conditions
  - Lack of heat wheel usage at night during the winter can result in $100-$1,000 a day in the northeast depending on AHU size
Flush Mode

Initial Rules

▪ FDD based on existing occupancy schedule (time of day/DCV)

▪ FDD setup to determine flush mode based on existing outside air conditions (economizer)

Modified Rules

▪ More complex, work with demand response, or setback, time of day, duration of flush cycle strategies already implemented
**Mitigation Strategy**

- Consider portable room air cleaners with HEPA filters.
- Supervise or shut down food preparation and warming areas, including the office pantry and coffee areas.

**Additional Rules**

- Measure electrical panel usage in kitchen areas. If anything is on, flag it.
- Measure electrical panel with portable air cleaners, if not on, flag it.

Source: ASHRAE May Journal
Energy Impact: Relative Impact of Mitigation

- Outside air ventilation changes
- Hours of operation
- Room air cleaners and additional humidification
- Filtration/ACH changes
- Hours of operation
- UVC
- Shutting off miscellaneous equipment
Summary of Rules Changes

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Summary

- How to Succeed:
  - Coordination of Facilities Department, EMIS Vendor and Controls Vendor
  - Summary list of rules that need to be modified/suspended/added
  - Document dates of FDD and controls changes

- Anything you can monitor you can create a rule for!
  - Document which SOO and rules take priority under Covid-19!
Thank you

- Questions?
  - David Landman (dlandman14@gmail.com)
  - Hannah Kramer (hkramer@lbl.gov)

- Get involved:
  - Building owners, operators, and managers: [join](#) the Better Buildings Alliance or contact [bba@ee.doe.gov](mailto:bba@ee.doe.gov) with questions
  - To join the EMIS Tech Team list, contact Valerie Nibler ([vnibler@lbl.gov](mailto:vnibler@lbl.gov))
Thank you!

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