AABC Commissioning Group
AIA Provider Number 50111116

Case Studies and the Effective Use of Building Analytics

Course Number: CXENERGY1822

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

As digital controls and smart meters become commonplace in commercial buildings, facilities teams have access to overwhelming amounts of data. This data does not typically lead to insights and corrective actions unless it is analyzed and prioritized in automated ways. Analytic software and diagnostic tools usage are increasing to help uncover hidden operational opportunities, which is enticing for decision makers looking for short paybacks.

Learning Objectives

At the end of the this course, participants will be able to:

1. Learn about case study and other resources developed by Lawrence Berkeley National Laboratory that address common questions on Energy Management and Information Systems.

2. Learn about details on the energy savings findings, technical assistance delivered and solutions being pursued by the participants in the Smart Energy Analytics Campaign.

3. Understand the research being gathered to update the world's largest database on commissioning case studies.

4. Understand the need for updating those foundational documents with new data that reflects the advance in the tools, technologies supporting data management in commercial buildings.

Agenda

- Motivation to use EMIS
- Features of EMIS and MBCx
- Smart Energy Analytics Campaign
- Case Studies from the Smart Energy Analytics Campaign
- Commissioning Study update

Motivation to Use EMIS

- Data is everywhere and getting cheaper
- EMIS adopters have shown significant savings and improvements in persistence of savings

But….

Lots of data = high value?

Which data?

What kind of EMIS?

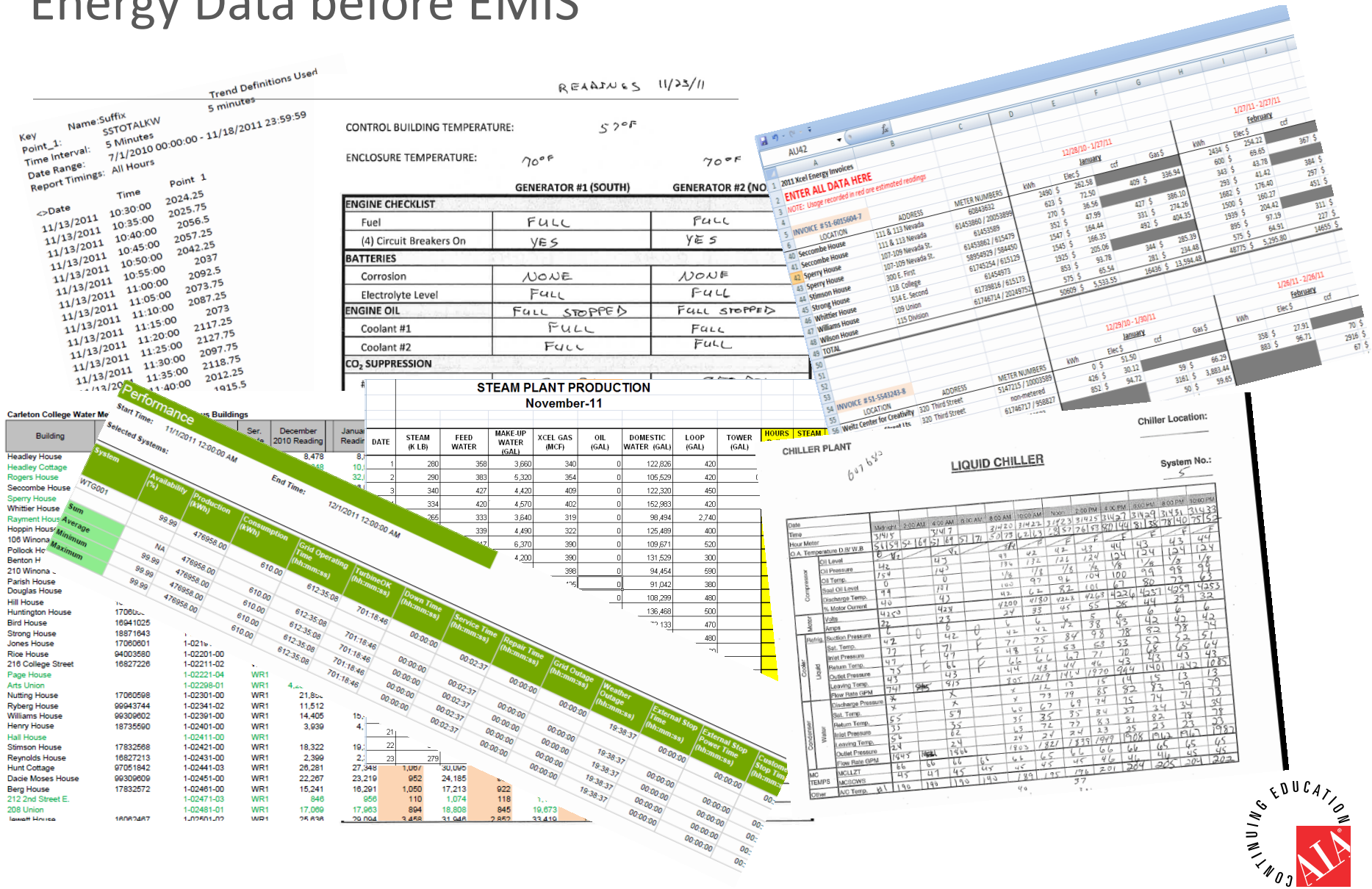
How do I set it up?

How often should the data be analyzed?

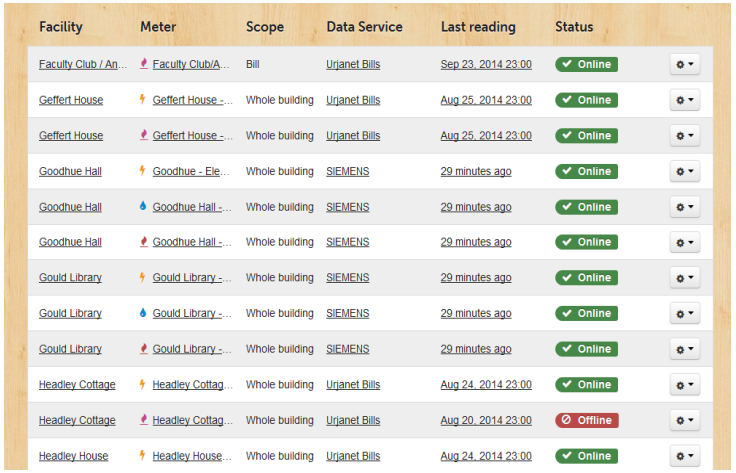
What should I look for?

What is the cost benefit?

Energy Data before EMIS



Energy Data after EMIS



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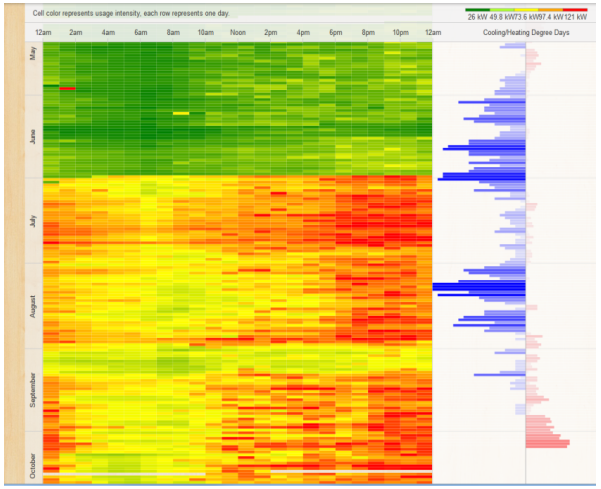
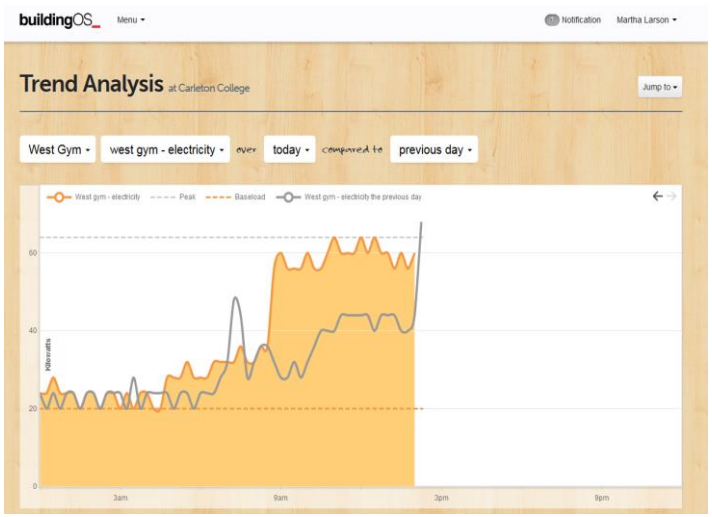
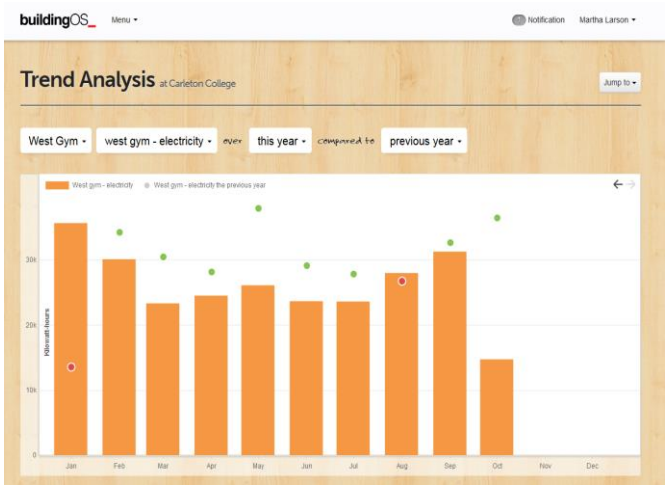




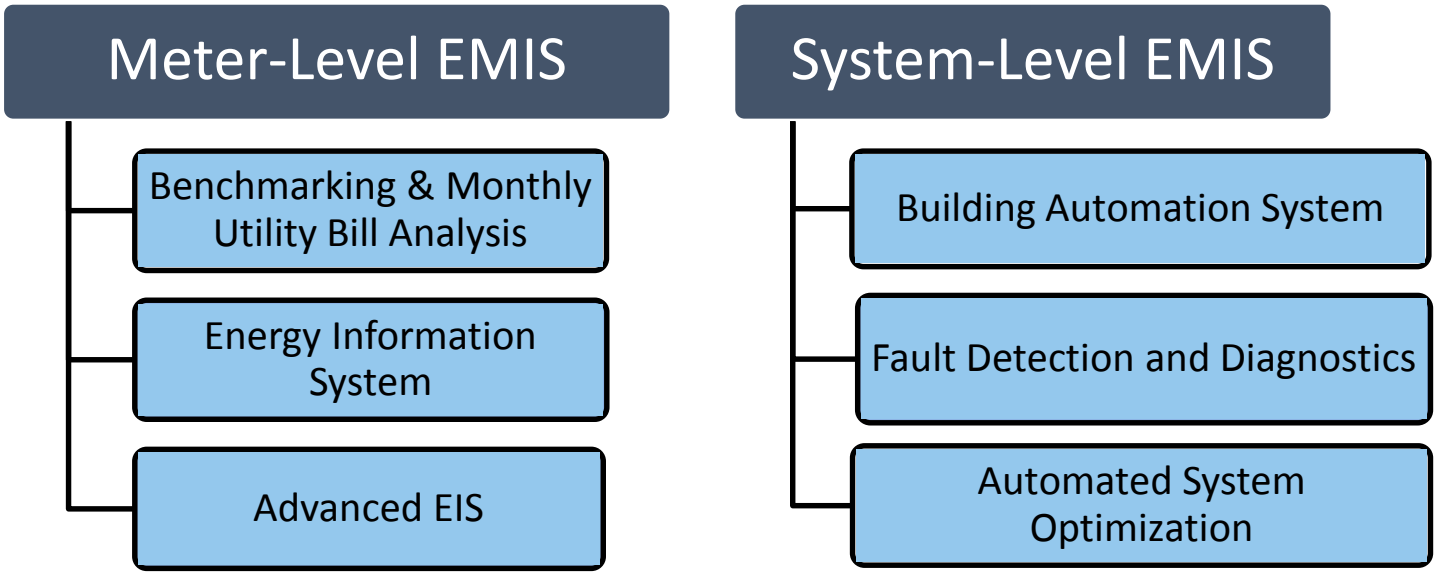


Lucid Building OS

Energy Management and Information Systems

What are EMIS

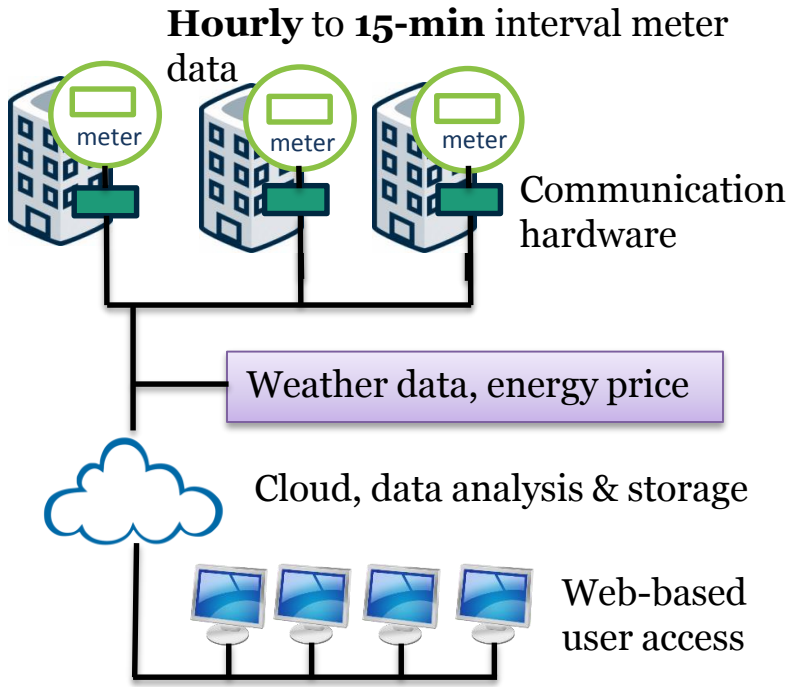
EMIS are a broad family of tools to monitor, analyze, and control building energy use and system performance



The boundaries can be fuzzy; some tools cross categories, e.g., energy information systems with FDD capabilities

Energy Information Systems (EIS) and Advanced EIS

- A web-based tool to display and analyze **interval whole-building and submetered energy data**
  - Key uses
    - Data **visualization** (i.e. energy dashboard)
    - Whole building & sub meter level energy **benchmarking**
    - Energy **anomaly detection**, excessive use vs. 'typical'
    - Project **savings verification**
  - Savings potential enabled with EIS[1]
    - Median decrease in energy: 8-17%



[1]Granderson, J, Lin, G, Piette, MA. Energy information systems (EIS): Technology costs, benefits, and best practice uses. Lawrence Berkeley National Laboratory, November 2013. LBNL-6476E

EIS and Advanced EIS Examples

- Energent
- Energy ICT
- EnerNOC
- eSight Energy
- Gridium
- ICONICS
- Lucid BuildingOS
- MACH Energy
- Noveda Technologies
- Schneider Electric
- Switch Automation
- Trane Building Advantage

Benefits

- Review load profiles on a regular basis
- Track savings in real time, alarm when energy exceeds expectations
- Take weather and occupancy changes into account

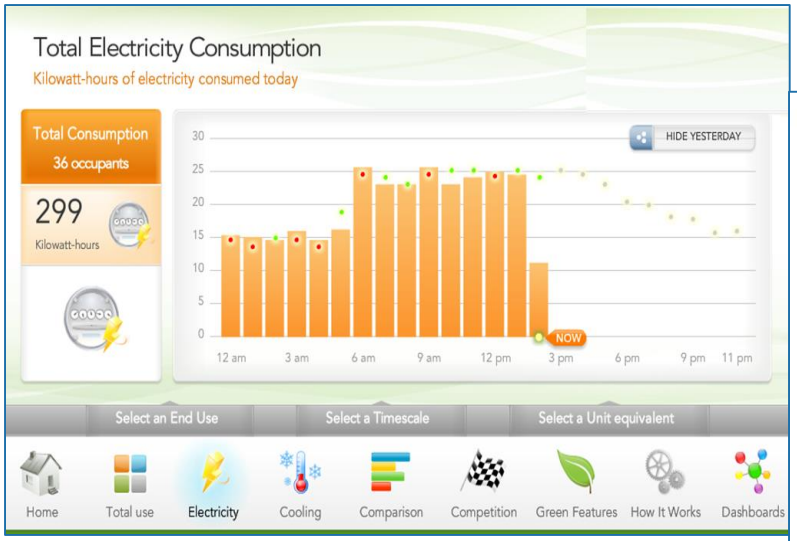
Energy savings potential

- Median decrease in energy: 8-17%

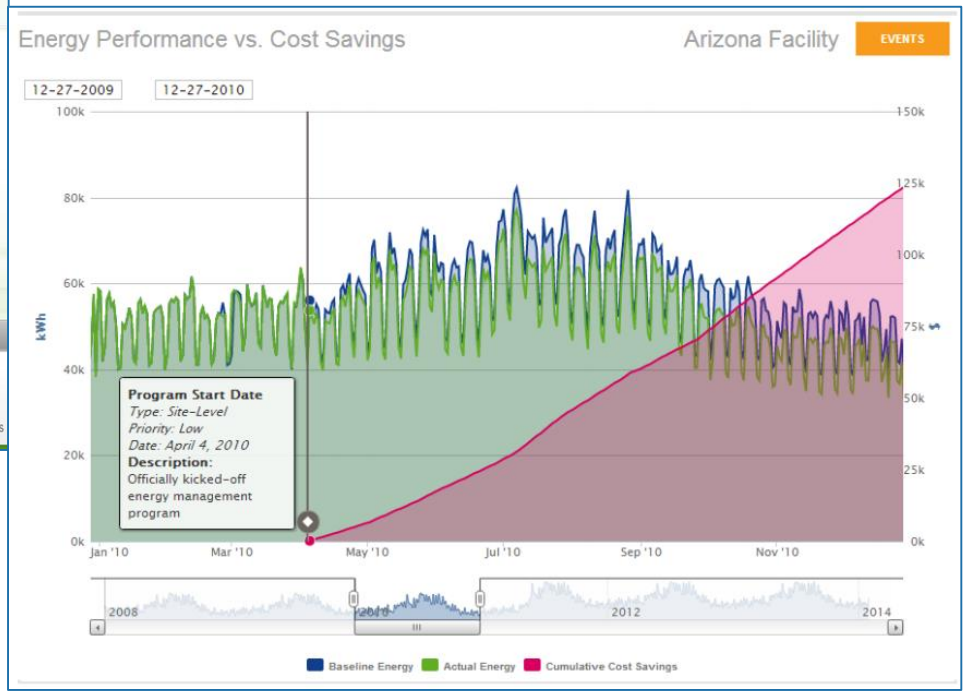
Costs - $ to $$

- 3rd party software (SaaS or installed on-site)
- Service contractor (Software + service package)

EIS and Advanced EIS Screenshot



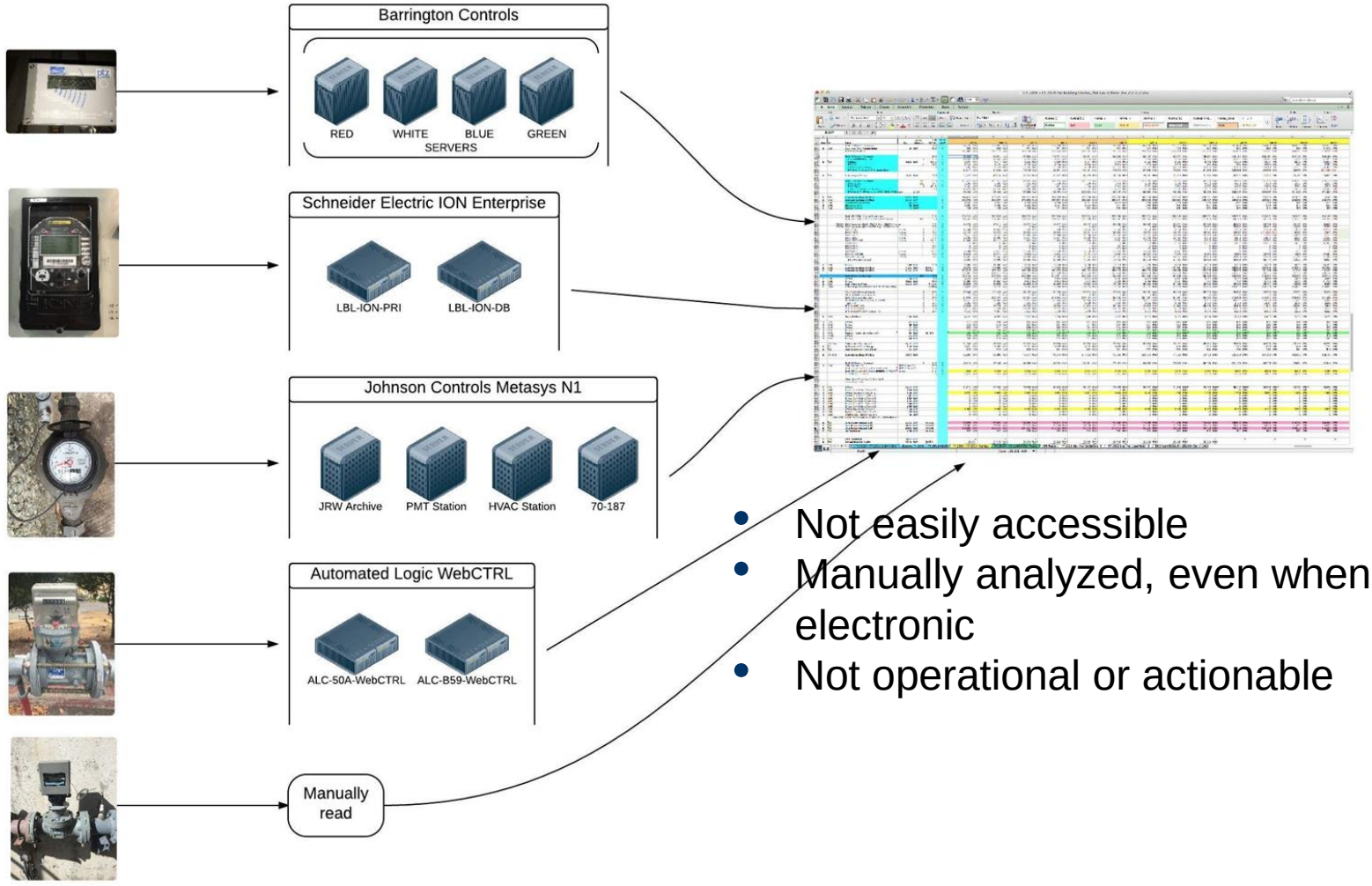
EIS, a bar graph tracking energy use pattern at an hourly interval



Advanced EIS, showing cumulative savings

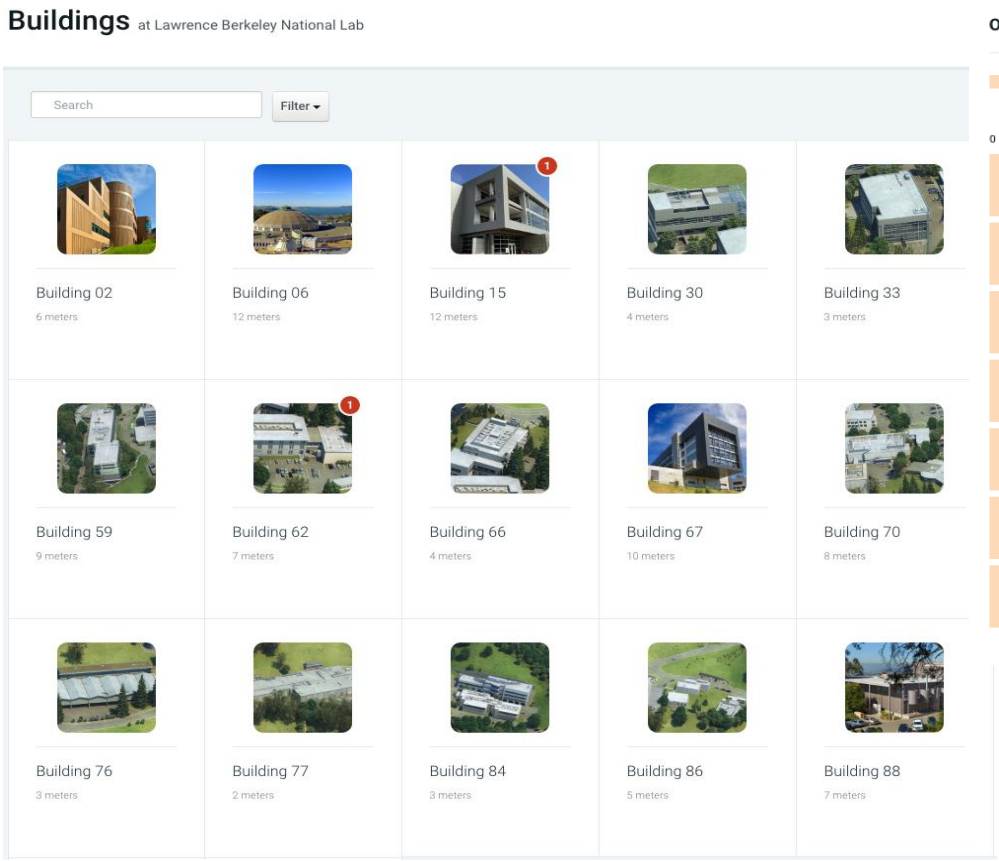
Source: Lucid Building OS (left), Cascade Energy(right)

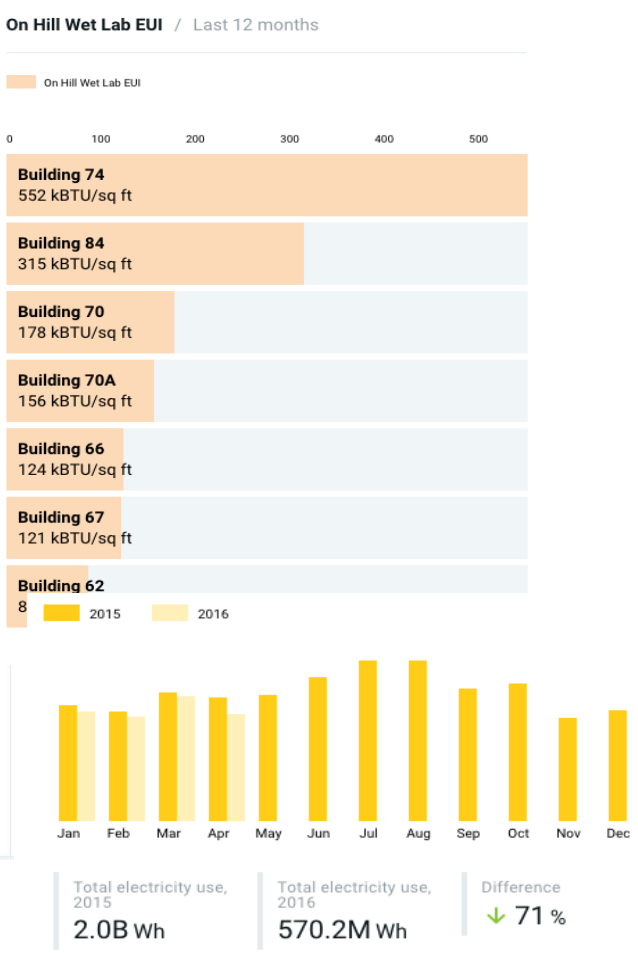
EIS Implementation *before – large amount of building information, but not actionable*



- Not easily accessible
- Manually analyzed, even when data is electronic
- Not operational or actionable

EIS Implementation *after – an actionable data platform*

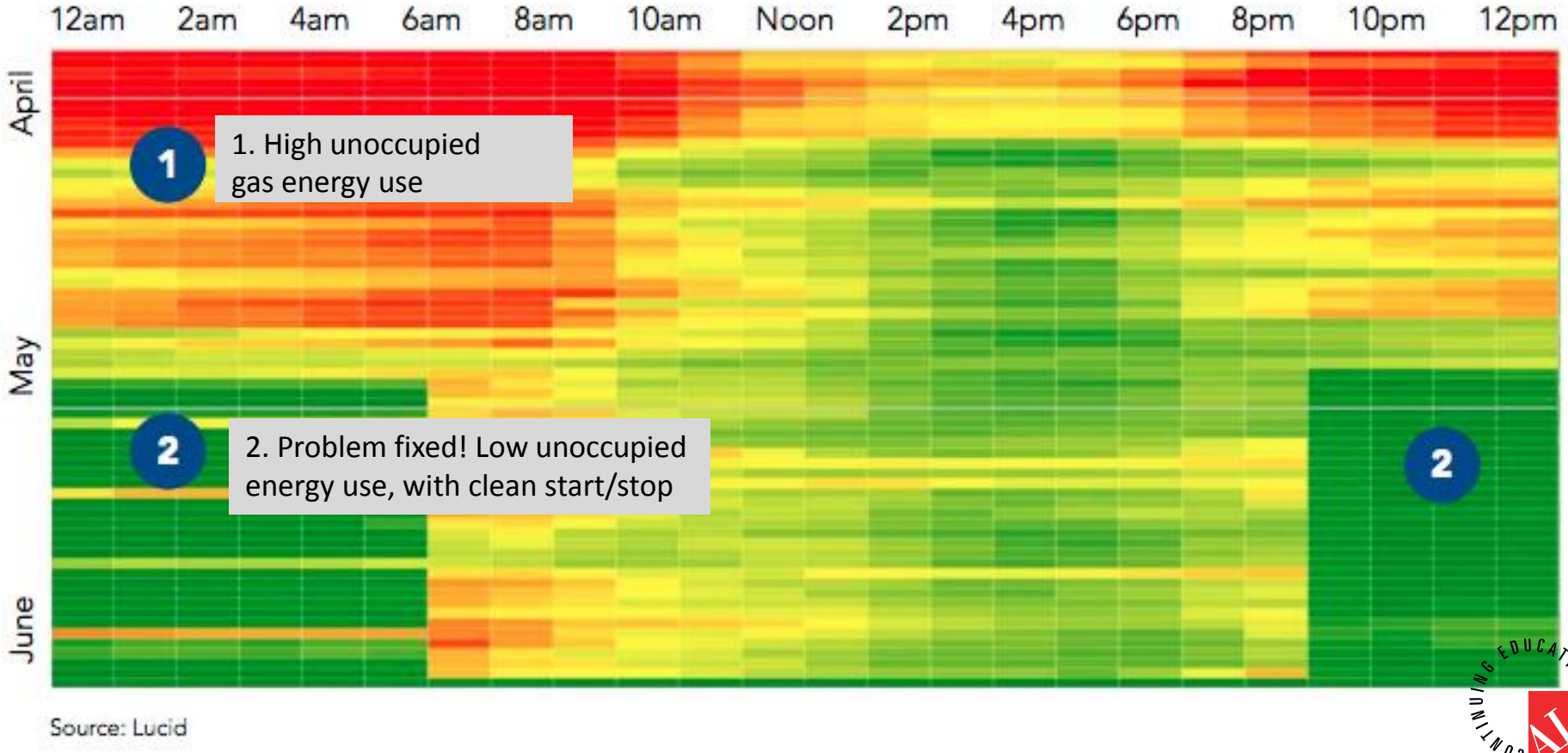




Source: Lucid Building OS/LBNL

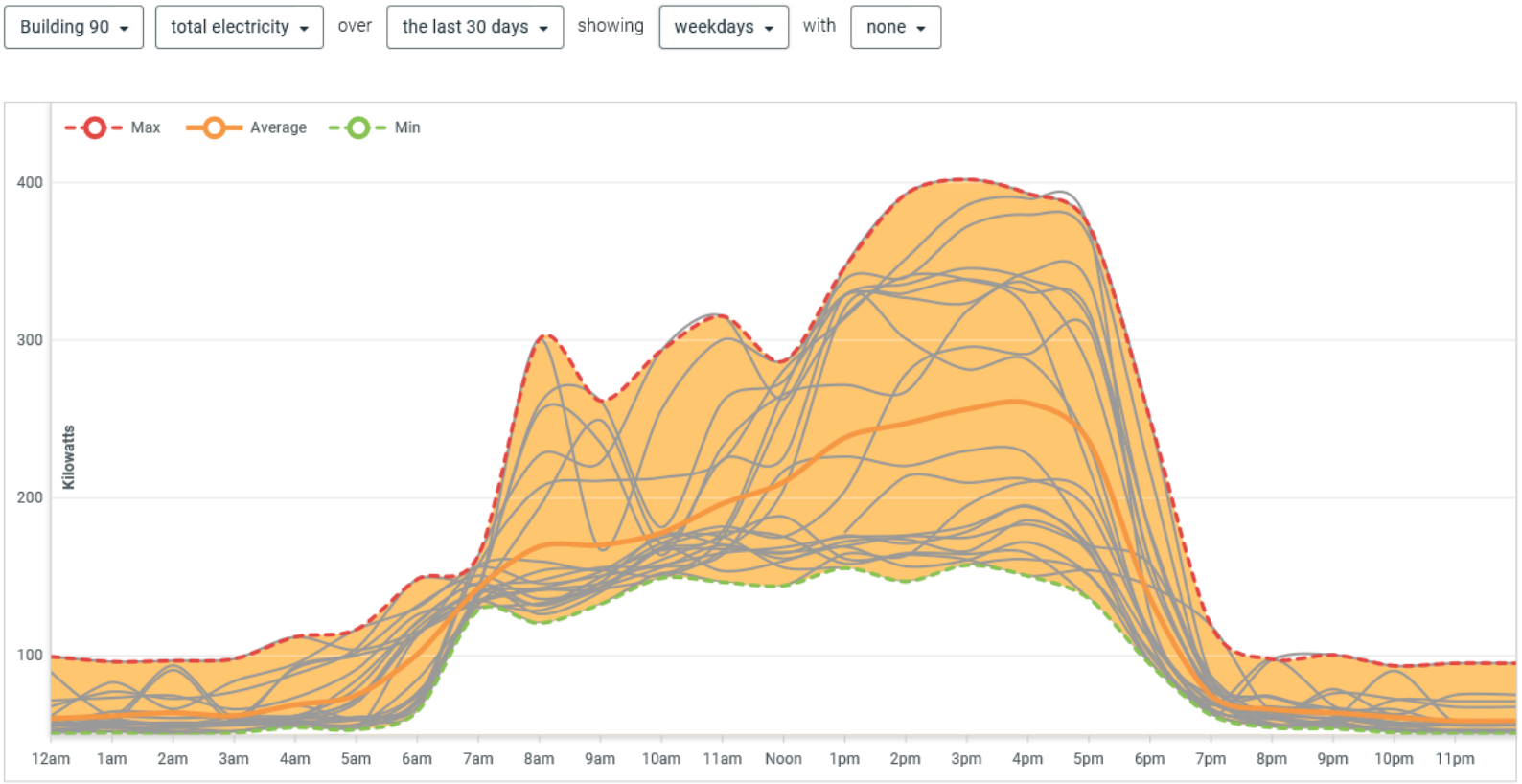
EIS Identifies Savings Opportunity: Heat Map

- High unoccupied gas use in April → Nighttime setback control



EIS Identifies Savings Opportunity: Load Profile

Load Profile Analysis



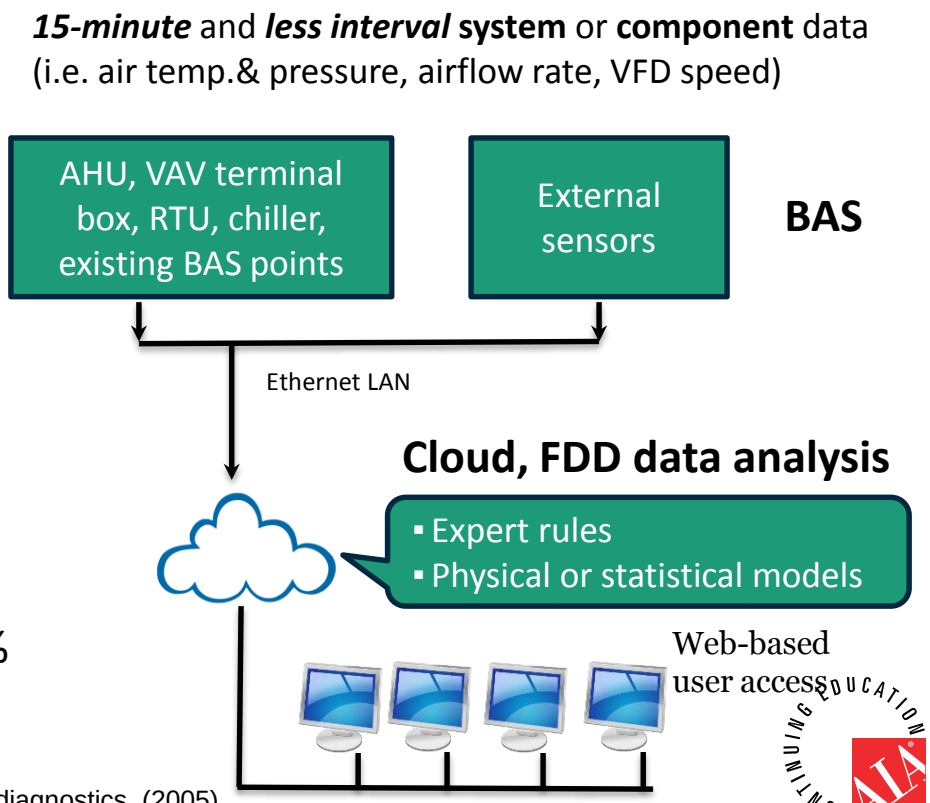
Source: LBNL/Lucid

Fault Detection and Diagnosis (FDD)

- FDD – a tool to automatically identify HVAC system or equipment level faults, and sometimes root causes

- Key uses
  - **Automatically detects problems with** less analysis time
    - Improper set points
    - Faulty sensors
    - Improper economizer operation
    - Under/over ventilation
    - Malfunctioning dampers, valves, or actuators
  - **Prioritize faults** based on fault frequency or estimated fault cost

- Savings potential enabled with FDD[1]
  - Whole building energy savings of 2-11%



[1] TIAXLLC, Energy impact of commercial building controls and performance diagnostics, (2005)

Fault Detection and Diagnosis (FDD) Examples

- BuildPulse
- Cimetrics
- CopperTree Analytics
- Enerliance/YARDI
- EZENICS
- FacilityConneX
- ICONICS
- KGS Buildings
- Powerhouse Dynamics
- Sky Foundry

Benefits

- **Automatically** detects problems at the system or equipment level with **less analysis time**
- **Prioritize faults** based on fault frequency or estimated fault cost

Energy savings potential

- Correcting faults can decrease whole building energy use by 2-11%

Cost-$$$

- Labor to set-up & tune, potentially add sensors/meters
- High configuration costs to custom FDD rules for non-standard HVAC system

Fault Detection and Diagnosis (FDD) Screenshot

Top 5 Issues

Energy

Building	Equipment	Notes	Cost/Qtr.
Anon Hospital	AHU_6_CAVs	Low Damper Position – opportunity for static pressure reset.	$11,120
Anon Hospital	AHU_11	No supply temp reset. Cooling valve issues.	$7,778
Anon Hospital	AHU_6	No supply temp reset. Cooling valve issues.	$6,163
Anon Hospital	AHU_5	Supply temp lower than setpoint. No supply temp reset. Cooling valve issues.	$5,029
Anon Hospital	AHU_4	Supply temp lower than setpoint. No supply temp reset. Cooling valve issues.	$4,318

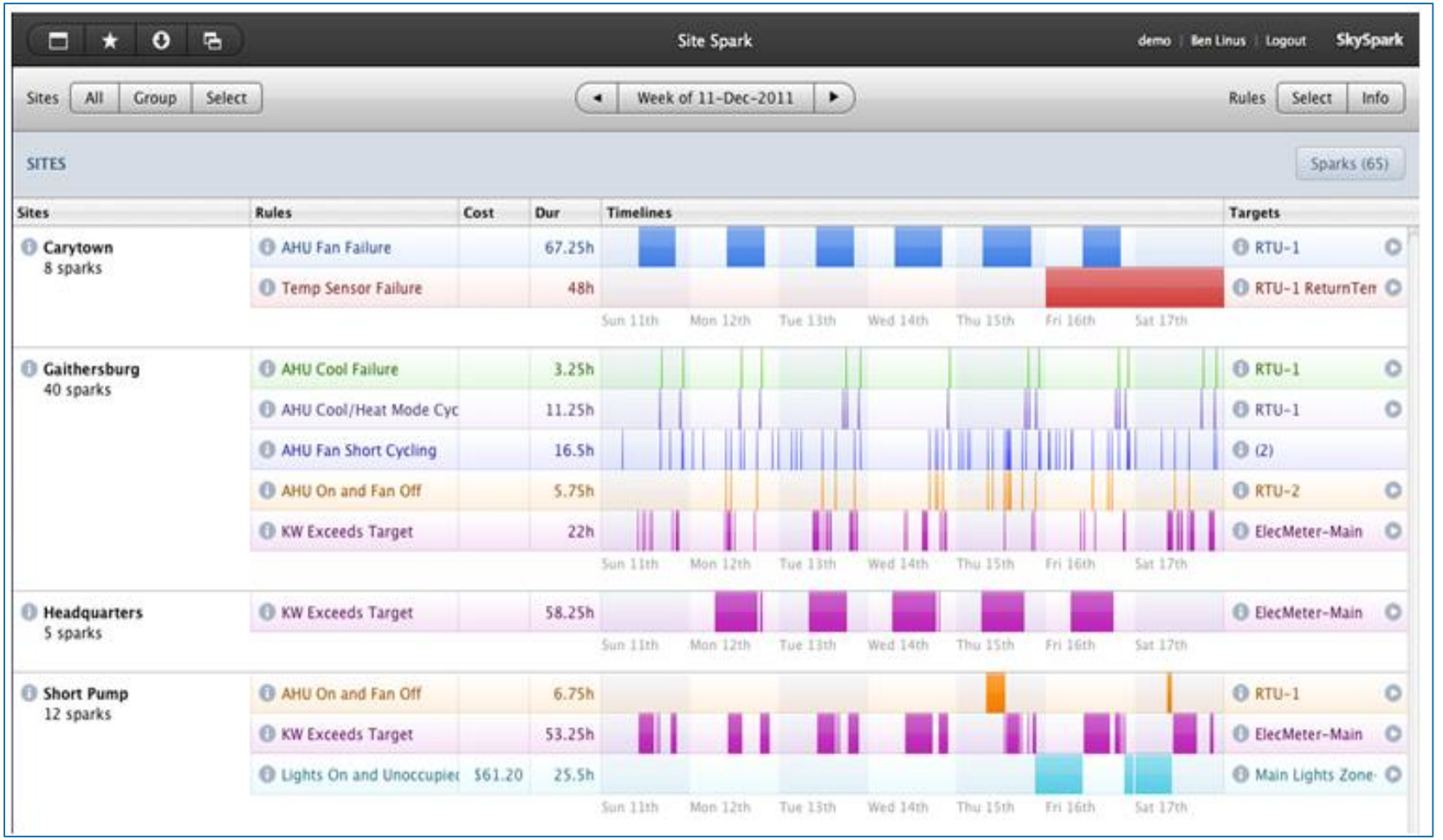
Recommended Actions

- The AHU 6 static pressure is being driven by one zone – you could get over $11,000 savings by lowering it
- Review temperature performance and air flow balance of CAV units with high comfort priorities
- Check AHU 4, 5, 6, and 11 for leaking cooling valves
- Check flat-lined temperature sensor in zone served by CAV1_16
- Explore why AHU 10 and 11 have such low static pressure
- Check CAV8_2 and CAV3_11 for stuck reheat valve – valve fully open, but temperature can't reach setpoint

FDD, showing top 5 faults and recommended actions

Source: Schneider Electric

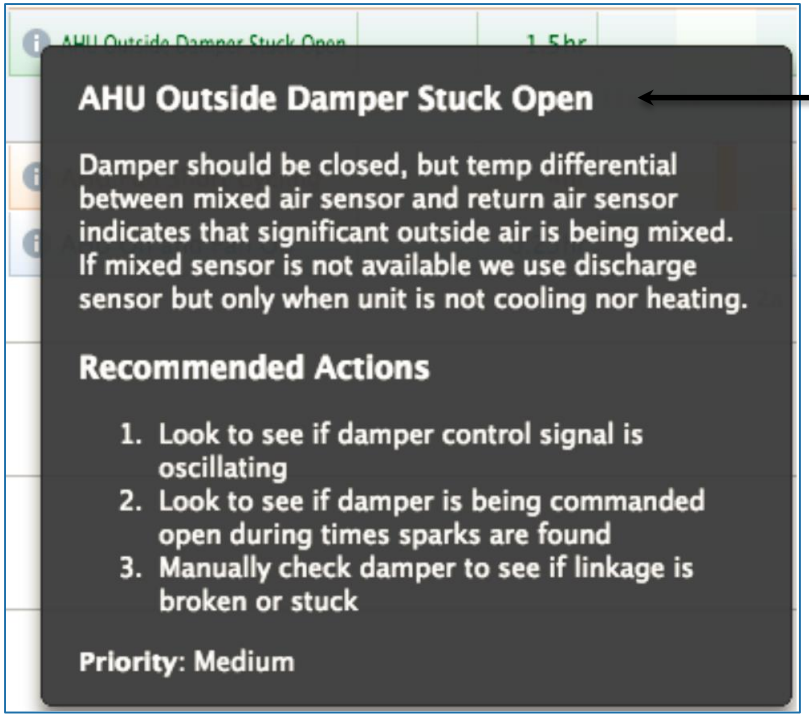
Fault Detection and Diagnosis (FDD) Screenshot



Source: SkyFoundry

FDD Identifies Savings Opportunity: Outdoor Air Usage

Outside Damper Stuck Open, FDD tool alert



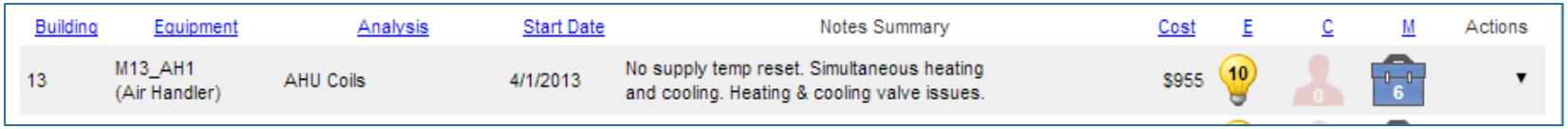
Fault description

Source: SkyFoundry

FDD Identifies Savings Opportunity: Simultaneous Heating and Cooling

- Email notification informed facility engineer of an issue
- Facility engineer issued a work order under existing service contract
- O&M contractor found failed pilot-positioner on a pre-heat valve

Result: valve was fixed with two weeks by contractor



Building	Equipment	Analysis	Start Date	Notes Summary	Cost	E	C	M	Actions
13	M13_AH1 (Air Handler)	AHU Coils	4/1/2013	No supply temp reset. Simultaneous heating and cooling. Heating & cooling valve issues.	$955	10	0	6	▼

Source: Nick Gayeski, KGS Buildings, Using Building Automation Data to Improve Building Performance, 2016, Energy Exchange

Monitoring Based Commissioning (MBCx) Process and Benefits

- MBCX implemented in conjunction with EBCx or after EBCx to make sure benefits persist
- MBCx usually focuses on HVAC and lighting systems
- EMIS tools that support MBCX - EIS, FDD, BAS
- MBCx can reduce building energy waste by up to 15%, improve occupant comfort, and extend mechanical life
- The MBCx Plan Template is available to help building staff drive a step-by-step process tailored for their organization

Smart Energy Analytics Campaign

Smart Energy Analytics Campaign

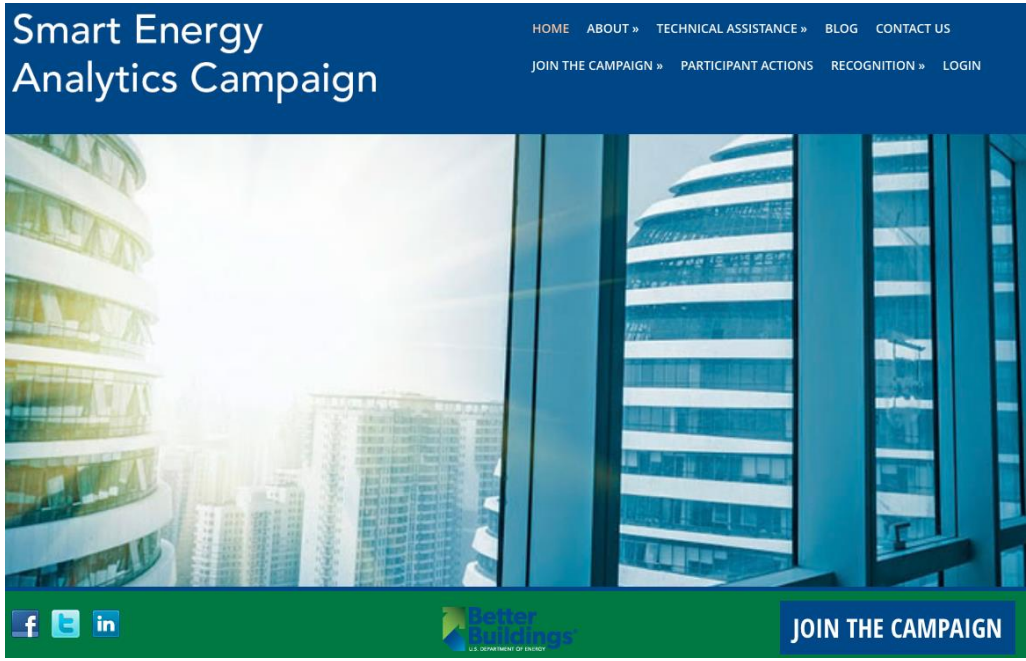
The Smart Energy Analytics Campaign is designed to increase voluntary adoption of these technologies by owners and operators of public and private sector buildings

Smart Energy Analytics Campaign Goals

- Facilitate the adoption of EMIS and MBCx
- Participants use EMIS and share results
- Produce research reports summarizing the EMIS and MBCx industry

Benefits of Smart Energy Analytics Campaign Participation

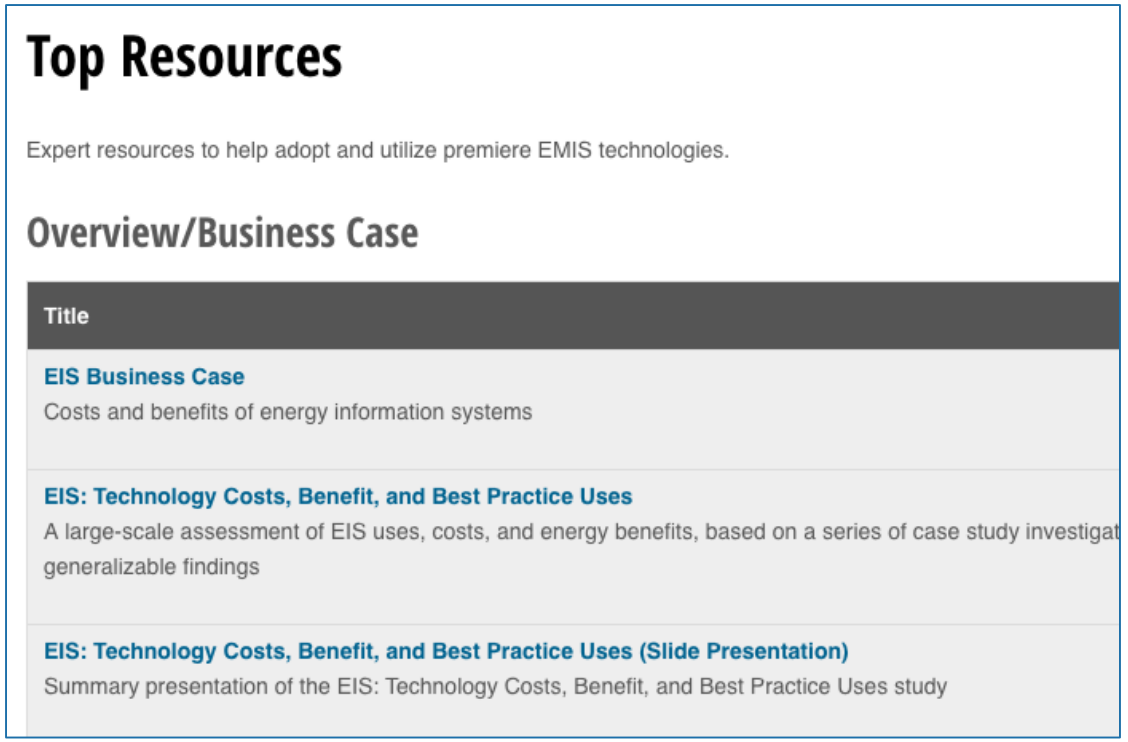
- Gain national recognition for leading edge energy management
- Receive technical assistance from Lawrence Berkeley National Laboratory
- Access peer network groups
- Contribute to EMIS and MBCx research



CONTINUING EDUCATION AIA

Benefits of Smart Energy Analytics Campaign Technical Assistance

- 1 on 1 Technical Support
- FDD Peer Network
- Top Resources
- Webinars
- Case Studies
- Utility Incentive List
- Find a Product or Service



Case Studies from Smart Energy Analytics Campaign

Smart Energy Analytics Campaign Participants Recognized

Spring 2017
(Use of Existing EMIS)

MGM RESORTS INTERNATIONAL™

Salt Lake City

EMORY UNIVERSITY

Sprint
in partnership with
CBRE

UCDAVIS

Fall 2017
(New or expanded EMIS installation)

Kentucky UNBRIDLED SPIRIT™

Aurora Public Schools

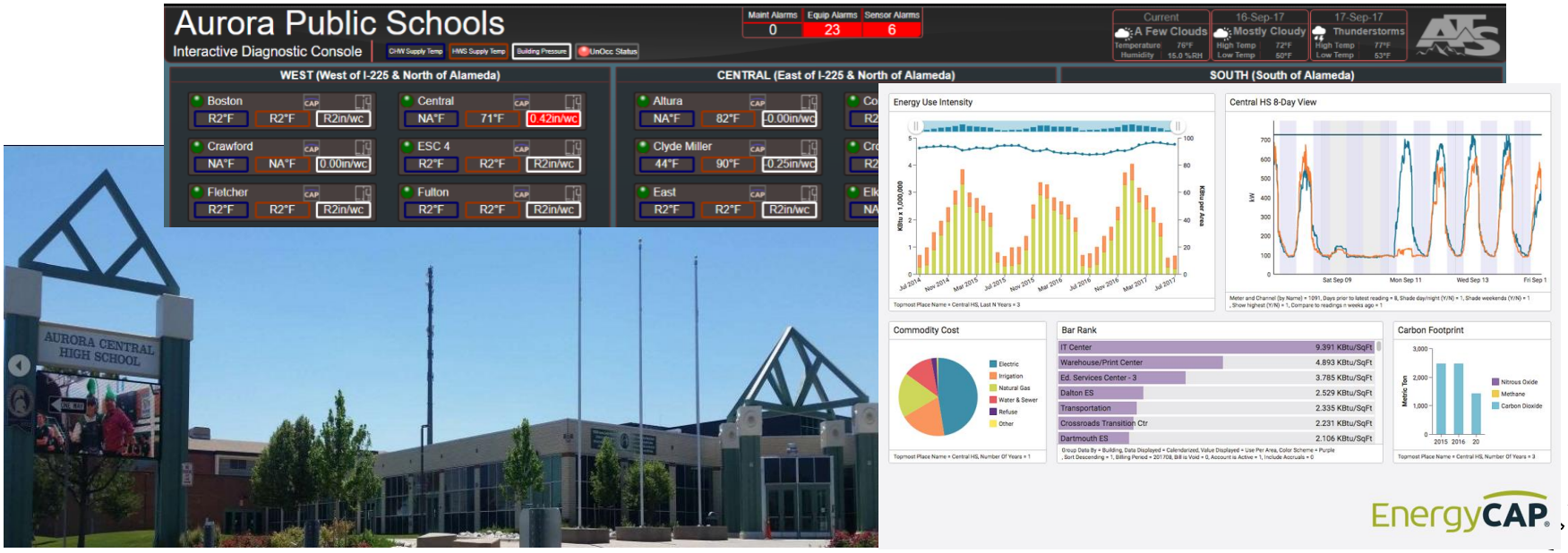
Carleton

cpcc CENTRAL PIEDMONT COMMUNITY COLLEGE

CONTINUING EDUCATION AIA

Case Study: Aurora Public Schools

- Tracking electric, gas, water, & waste for 50 schools
- Public dashboards
- Diagnostic Console for maintenance technicians



Source: Aurora/EnergyCAP

Case Study: MGM Resorts International

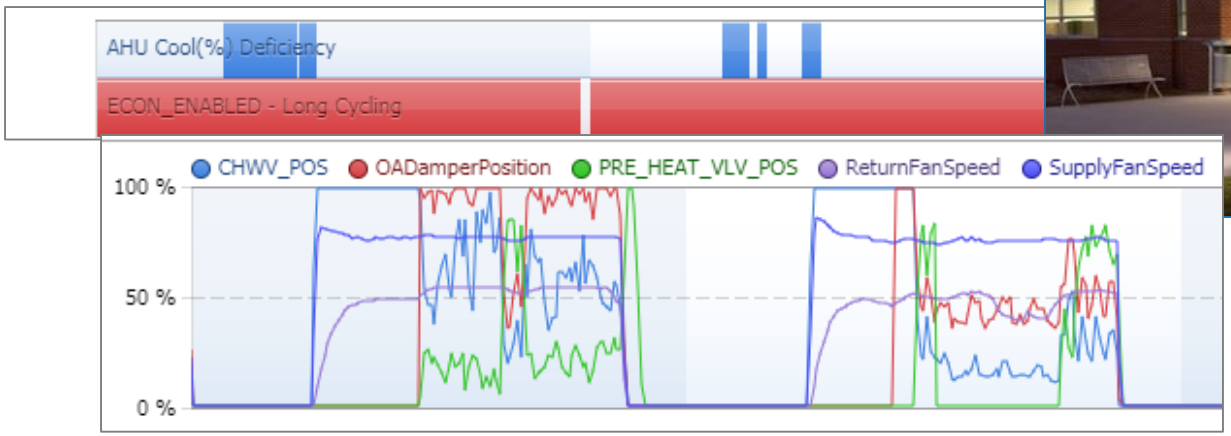
- 8 million sq ft, recognized for largest portfolio using analytics

"When issues arise involving major HVAC equipment, the first call is to the [analytics] team to see if it can be diagnosed. This process saves an enormous amount of money in avoided service calls and unnecessary equipment replacement." – Chris Magee, VP Sustainable Facilities

Case Study: Central Piedmont Community College

- Engaging third party providers to support pilots
- Dashboard tracks high priority issues and key performance metrics
- Actively monitoring corrective actions to ensure follow through

CENTRAL PIEDMONT COMMUNITY COLLEGE



Source: SkySpark by SkyFoundry

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Case Study: Commonwealth of Kentucky

- Best Practice in Expansion of EMIS
- 2016 - 2.5m sq.ft. added to EIS/FDD system (20m sq.ft. total)
- Building analytics and diagnostics
- Tools & services for Agencies:
  - Building Dashboard
  - Baselining and Benchmarking
  - BAS Operational Analysis
  - Remediation
  - Energy Savings Project Tracking
  - New Construction sequence review
- Development of *High Performance Buildings Standard*

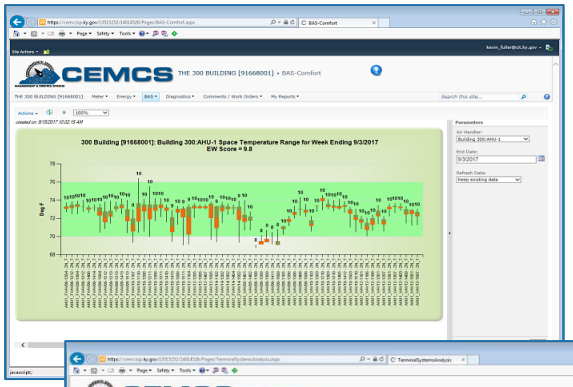
COMMONWEALTH ENERGY MANAGEMENT & CONTROL SYSTEM CEMCS

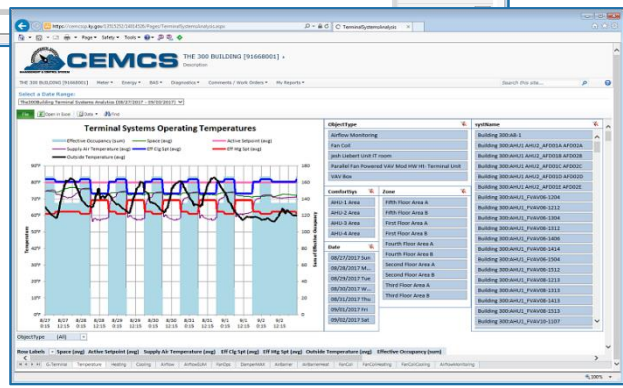
CONTINUING EDUCATION AIA

Case Study: Commonwealth of KY
EMIS Provider Interval Data Systems

- MBCx Provider for Commonwealth of KY
- 1,350 meters, 142,000 BAS points
- MBCx Services
  - Operational analysis & recommendations
  - BAS (re)programming design/implementation
  - New construction SOO design review
  - Owner's representative
- EMIS includes
  - FDD management driven by system metrics
  - Automatic energy savings tracking
  - Asset/document management
  - ECM tracking & work order system integration

Interval Data Systems, Inc.
Experience Better Automation





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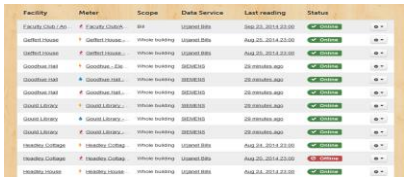
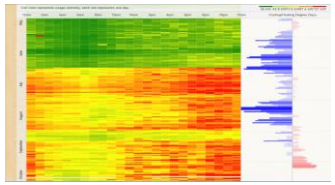
Case Study: Carleton College

- 1.6 m square foot campus
- Tracking consumption and renewables
- Using EIS for project M&V
- Weekly energy team meetings built around smart energy analytics

Carleton



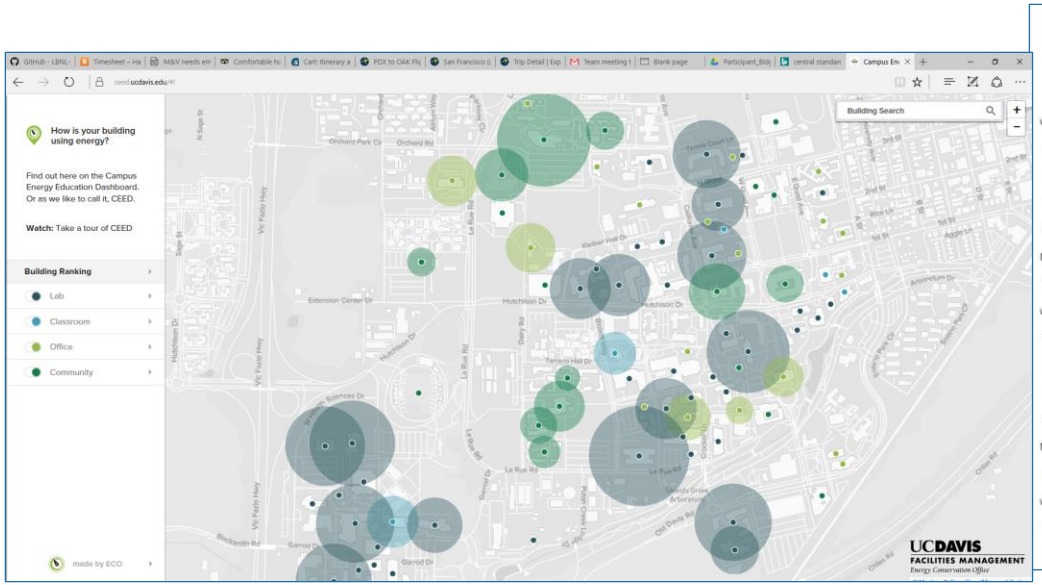


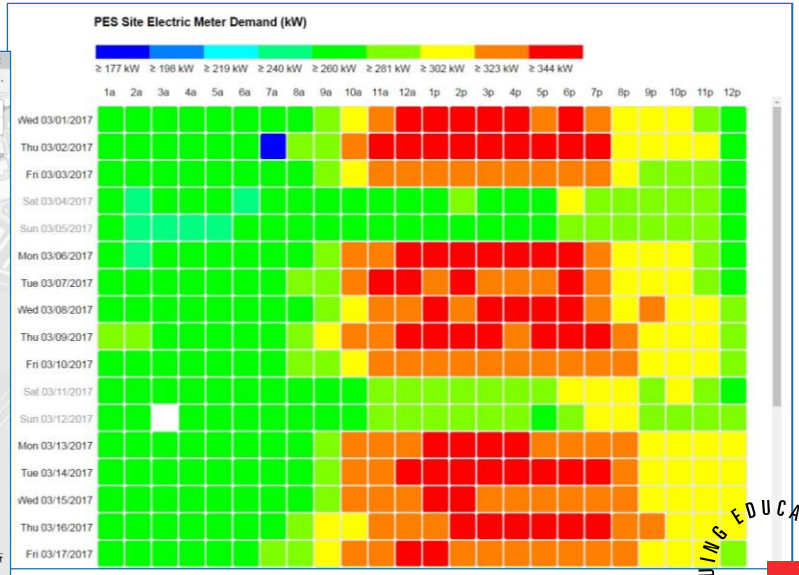
Source: Lucid Building OS

CONTINUING EDUCATION AIA

Case Study: University of California, Davis

- Innovation in the Use of Analytics
  - 100 buildings, 8 million sq ft
  - One building achieved 22% energy savings for $44,500 cost savings, another building achieved 24% energy savings for $130,500 cost savings

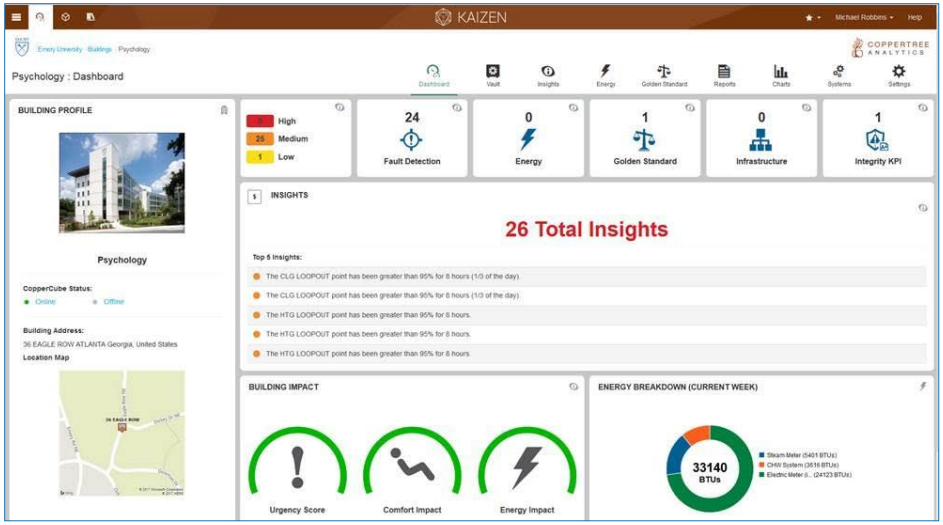




Source: UC Davis ThermOOstat, CEED

Case Study: Emory University

- Energy Performance in a Portfolio
  - 20 buildings, 2.7 million sq ft
  - 25% reduction in whole building energy use
  - Reduction driven through in-house existing building Cx paired with FDD algorithms



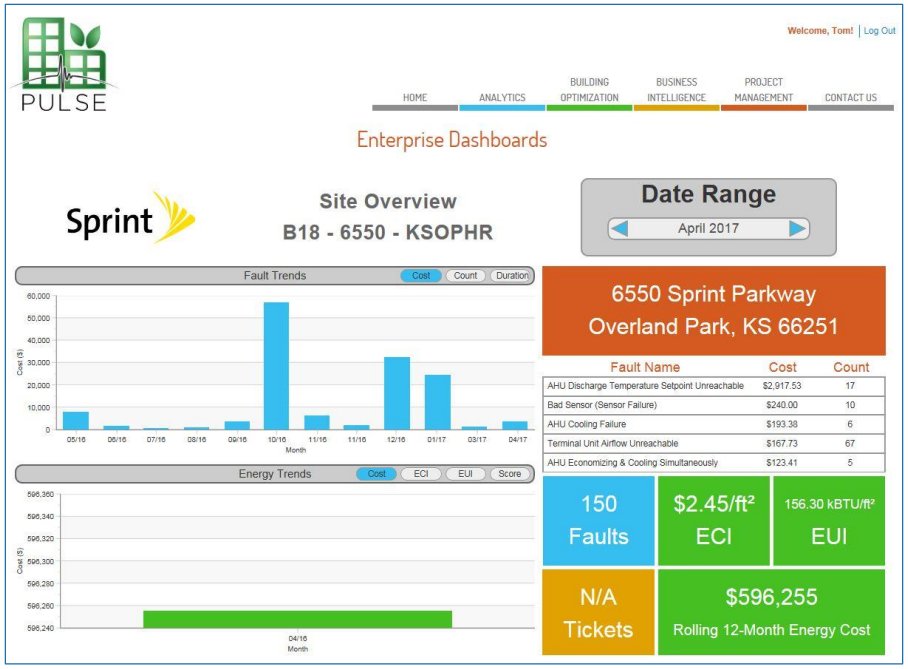
Source: Emory University/CopperTree Kaizen

Case Study: Salt Lake City

- Energy Performance in a Single Site
  - 167,000 sq ft building
  - In one year, building reduced electric consumption by 8%, gas consumption by 57% for total Btu savings of 35%
  - Simple payback 1.5 years

Case Study: Sprint in association with CBRE|ESI

- Best Practice in the Use of EMIS
  - 4 million sq ft portfolio implemented FDD
  - $431,000 cost savings (relative to 2014 baseline)
  - 4.7 million kWh energy savings, 5% of campus electric use



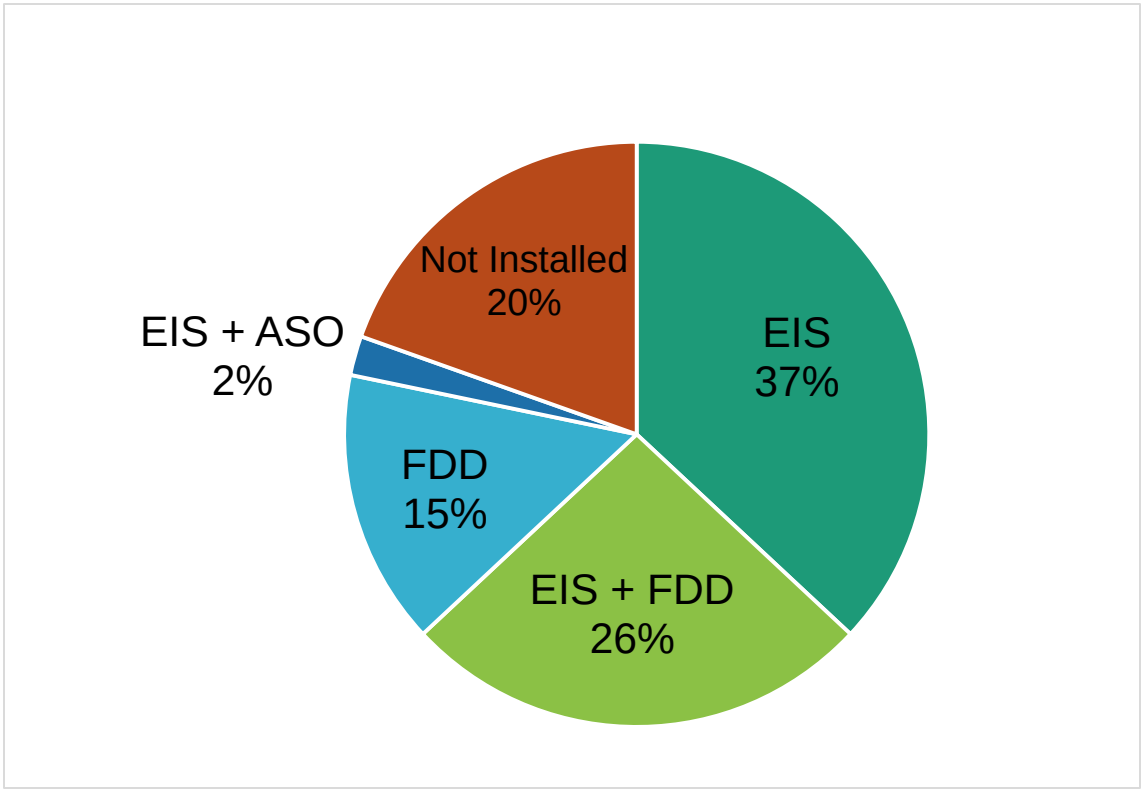
Source: Sprint

Year One Reporting from Smart Energy Analytics Campaign – Participant's Data

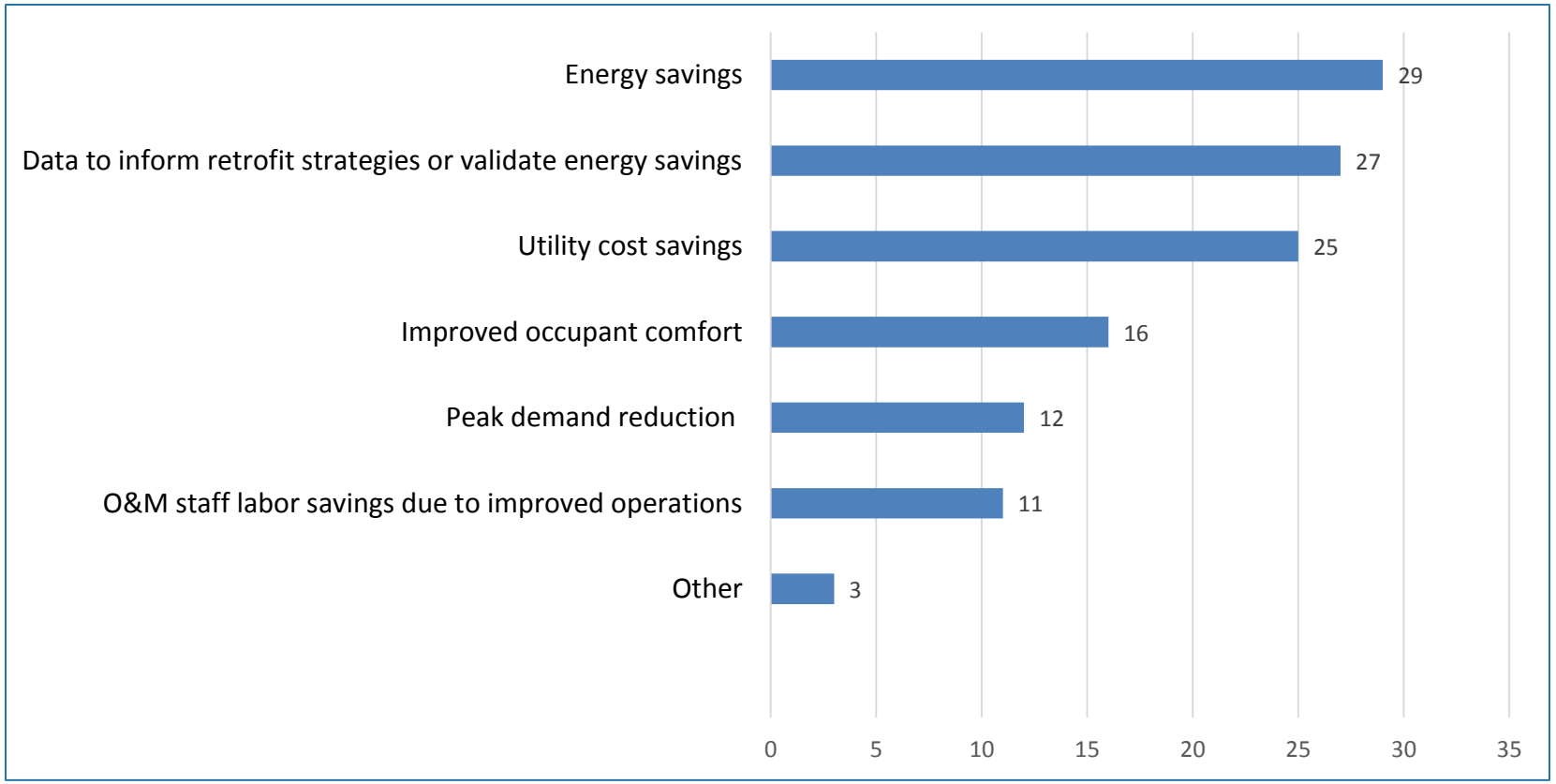
As of September 2017

- 48 participants in Campaign with EMIS
- 2300 buildings, 185 M sq ft
- Savings from 15 portfolios reporting (414 buildings, 39 M sq ft)
  - 400,000 MMBtu/year
  - $9M/year

Year One Reporting from Smart Energy Analytics Campaign – Type of EMIS Installed by Participants



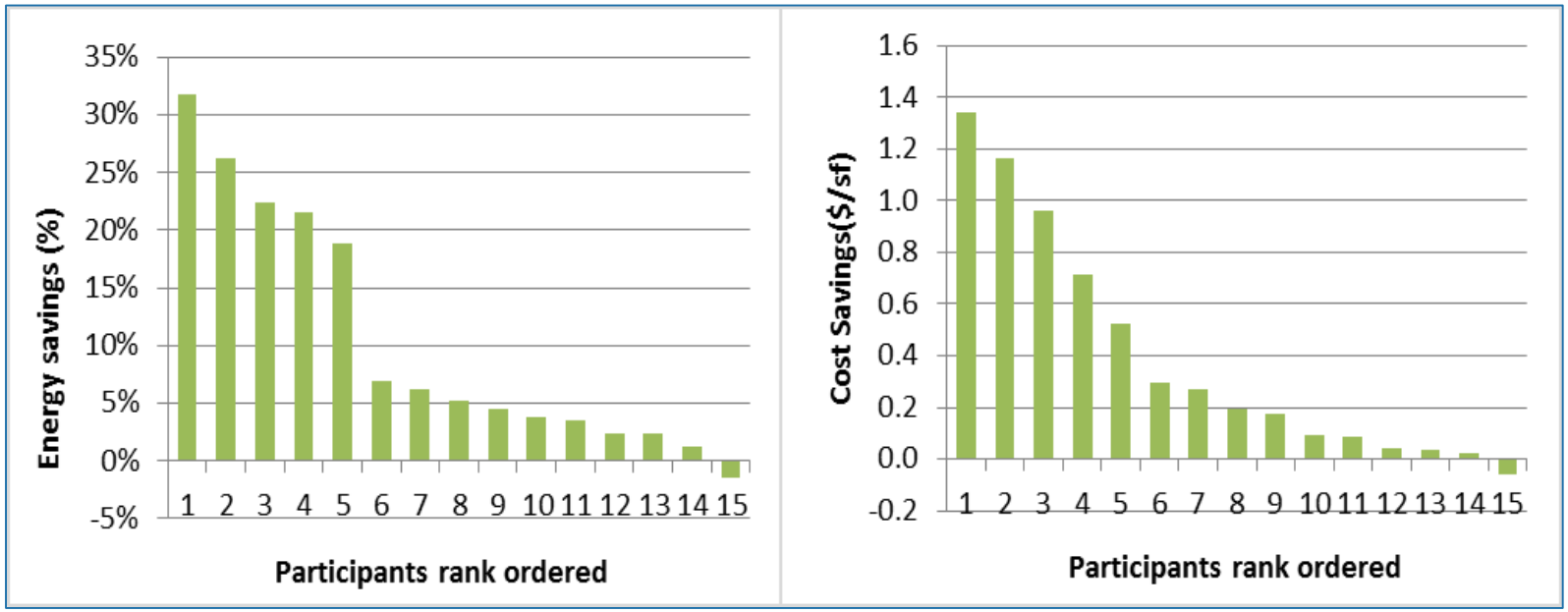
Year One Reporting from Smart Energy Analytics Campaign – Benefits



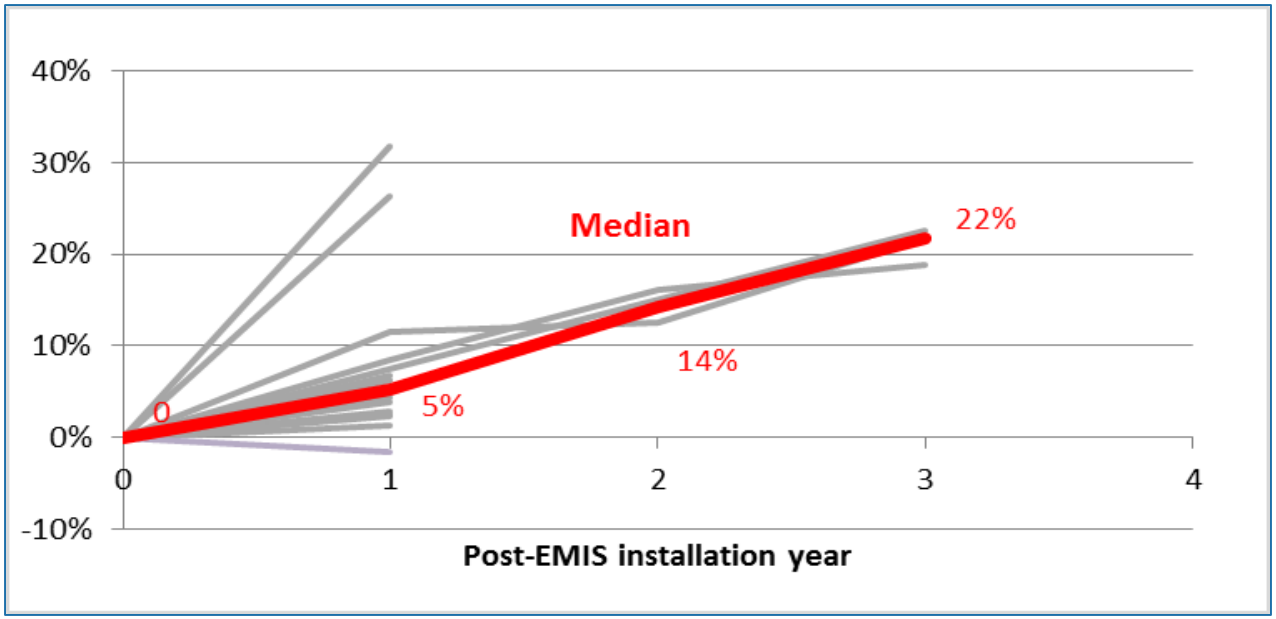
(Participants may select multiple benefits)

Year One Reporting from Smart Energy Analytics Campaign – Energy Savings

Energy Savings by Participant
15 organizations, 414 buildings, 39 million sq ft

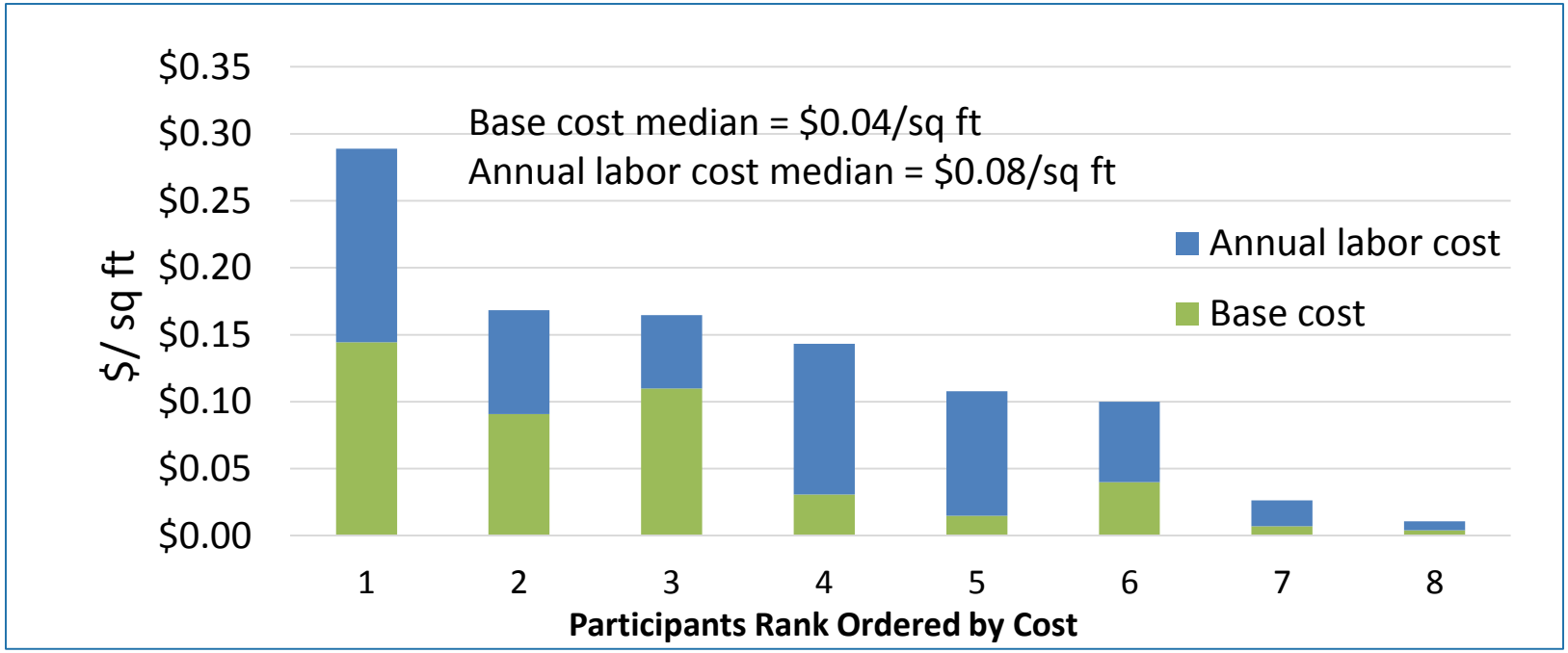


Year One Reporting from Smart Energy Analytics Campaign – Savings over Time



Percent reduction in participant's energy use, relative to the year before EMIS installation; Gray lines indicate savings for each of 15 participant portfolios, and the red line represents median savings across all participants

Year One Reporting from Smart Energy Analytics Campaign – Costs



Base cost: Includes EMIS software, installation, and configuration
Annual labor cost: Includes time spent by in-house staff, consultants, or service contractors reviewing EMIS reports, identifying opportunities for improvement, and implementing operational measures.
Recurring software cost: Median $0.01/sq ft

Smart Energy Analytics Campaign – Current Status

- 64 participants
- 4000+ buildings
- 326M Sq ft
- New recognition awarded to five participants - read about them in Campaign blog smart-energy-analytics.org/blog

Commissioning Study Update

Commissioning Study Update - Background

- The Cost-effectiveness of Commercial Buildings Commissioning (2004), and its update in 2009 is routinely cited by owners and commissioning providers to make the case for implementing Cx in new and existing buildings, and by policymakers as key background for deployment programs

- However, owners, utilities, EE service providers and policy makers desire updated numbers that account for:
  - Advances in commissioning (such as EMIS)
  - Addition of systems being commissioned today (such as the envelope)
  - New building types (such as data centers)

Commissioning Study Update – Why now?

- Existing utility programs have matured, new programs and program types have emerged that use RCx as a core component.

- Outside of utility programs RCx has grown in popularity
  - High prevalence of RCx occurring in Smart Energy Analytics Campaign portfolios
  - City ordinances have created new stimulus (eg. NY & SF) to understand building performance and improvement opportunities

- New construction Cx is required in some energy codes and in building rating programs

Commissioning Study Update - Goal

- Quantify energy and co-benefits of Cx for existing buildings and new construction, expanding on existing database of 643 buildings (>100 M sf)
- Identify systems being commissioned, measures identified in the process
- Determine the role/influence of EMIS in supporting commissioning
- Characterize the role and reach of commissioning certifications
- Compare/contrast with prior findings – what has changed, stayed the same?

Commissioning Study Update – Timeline & Stakeholders

- Data for study supplied by Building Commissioning Association members, utilities
- Data collection now closed, analysis of data continues through Summer 2018
- Presentation of results Fall 2018

Recommended Resources

- Primer on Organizational Use of EMIS
- Using EMIS to Identify Top Opportunities for Commercial Building Efficiency
- MBCx Plan Template
- EIS : Technology Costs, Benefit, and Best Practice Uses
- Characterization and Survey of Automated Fault Detection and Diagnostic Tools
- Smart Energy Analytics Campaign
- Success Stories from Campaign

This concludes The American Institute of Architects Continuing Education Systems Course

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