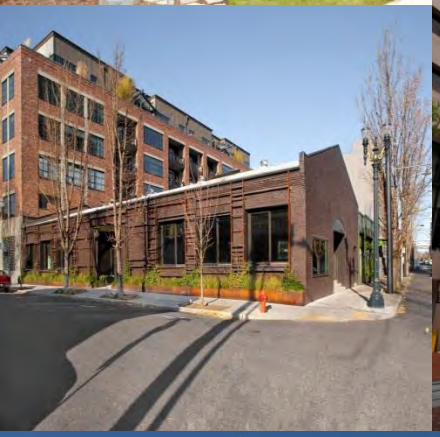
Using Analytics to Achieve High Performance Buildings

Building Energy Simulation Forum

October 18, 2017

EnergyTrust of Oregon



Who we are

Energy Trust is an independent nonprofit dedicated to helping 1.5 million utility customers invest in energy efficiency and clean, renewable power.

We provide:

- Information
- Technical services
- Engineering studies
- Cash incentives
- Contractor connections

Energy Trust New Buildings

- New construction
- Major renovation
- Tenant build-out
- Additions or expansions

Energytrust.org/commercial

New Buildings Training & Education

Allies for Efficiency (AFE)

- Case study presentations on high-performance design and construction projects
- Take place 3-5 times per year in Portland + regionally

High Performance Design Trainings

- Advanced training events for designers, architects and/or engineers
- Take place 2 – 3 times per year
- Content is focused on specific techniques or technologies

Building Energy Simulation Forum (BESF)

- Advanced energy modeling presentations
- Topics relevant to energy modelers / analysts, and engineers
- Take place every other month

Upcoming Building Energy Simulation Forum Trainings

BESF usually takes place the third Wednesday of every other month at the Ecotrust Building at noon.

December 13, 2017:
TBD

Upcoming Allies for Efficiency Trainings

November 14, 2017

38 NW Davis

Portland, Oregon

Training & Education Webpage

energytrust.org/commercial/commercial-training-events/

Boost your knowledge with Energy Trust's continuing education opportunities and special training events. Trainings include real-world examples, case studies, and detailed technical information presented by experts from the fields of architecture, engineering, construction and development, as well as specialists in a variety of building types and market sectors. Attendees may be eligible for continuing education units, CEUs.

Find Upcoming Trainings and Events

Questions?

Have questions about upcoming training and education opportunities *or* about becoming an Energy Trust New Buildings Ally?

Contact Kirsten.Vogel@clearesult.com

Thank You

Kirsten Vogel
Market Outreach Specialist
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EnergyTrust of Oregon

Better Buildings
U.S. DEPARTMENT OF ENERGY

USING ANALYTICS TO ACHIEVE HIGH PERFORMANCE BUILDINGS

Hannah Kramer, P.E.
Lawrence Berkeley National Laboratory Affiliate

Building Energy Simulation Forum
Portland, October 18, 2017

Supported by DOE Building Technologies Office, J. Hibbs

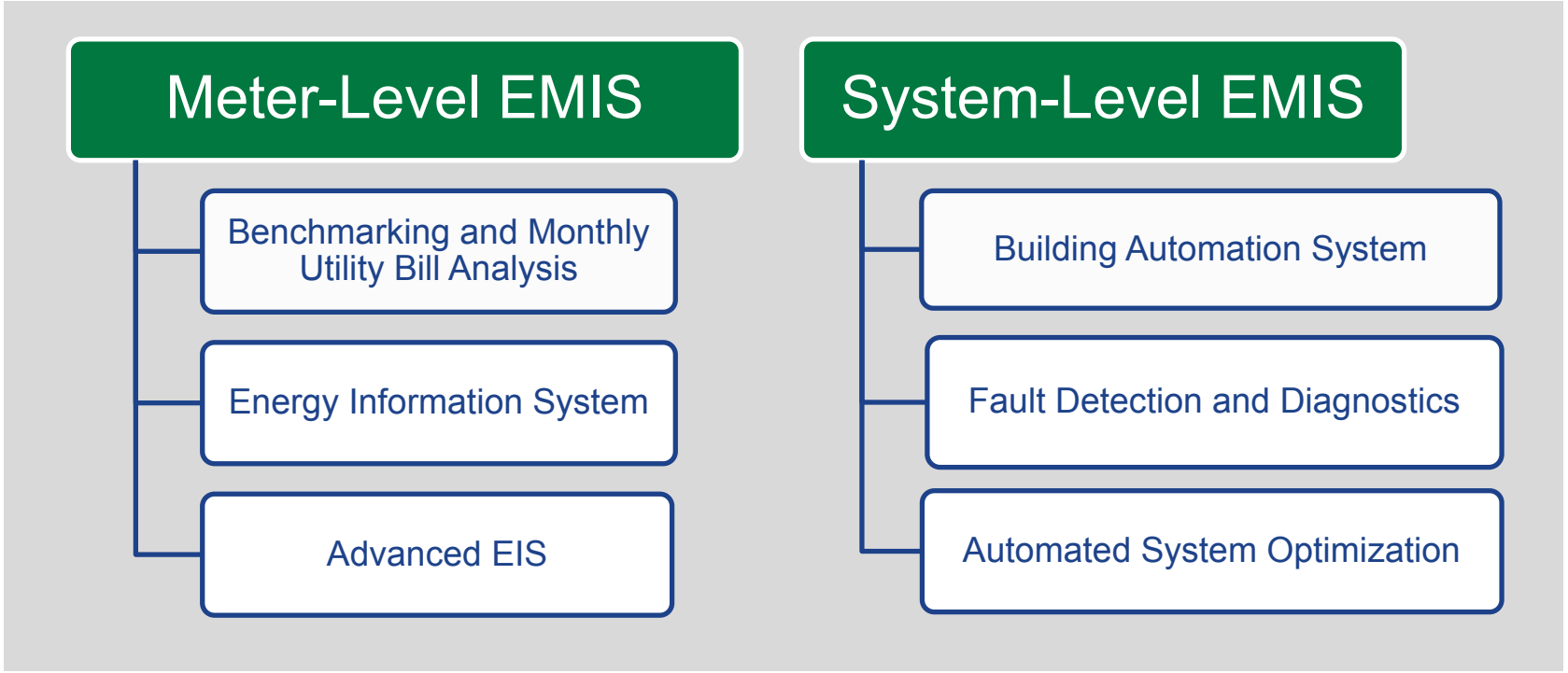
U.S. DEPARTMENT OF ENERGY

Why Energy Management and Information Systems (EMIS)?

- Data is everywhere and getting cheaper
- Need more granular data than monthly to manage energy
- BAS generally don't have embedded fault detection
- Continuously monitoring and automating the analysis is transformative

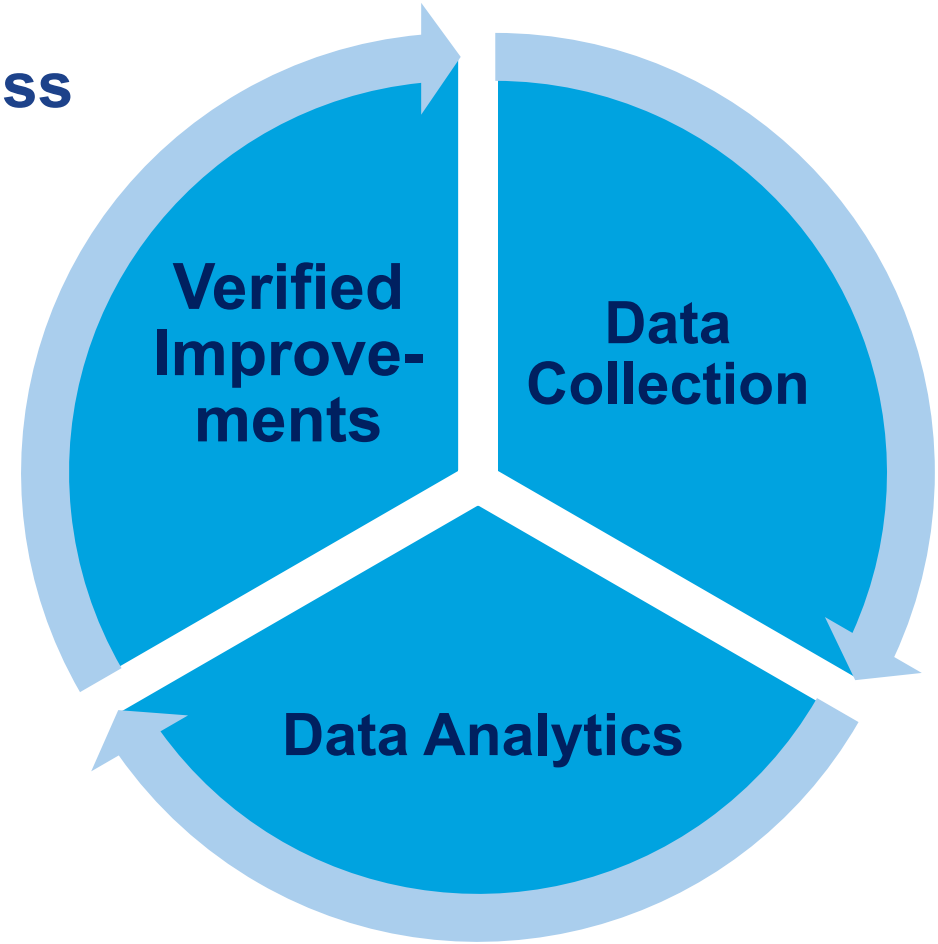
Energy Management and Information Systems

EMIS: Data analysis tools (not simulation)

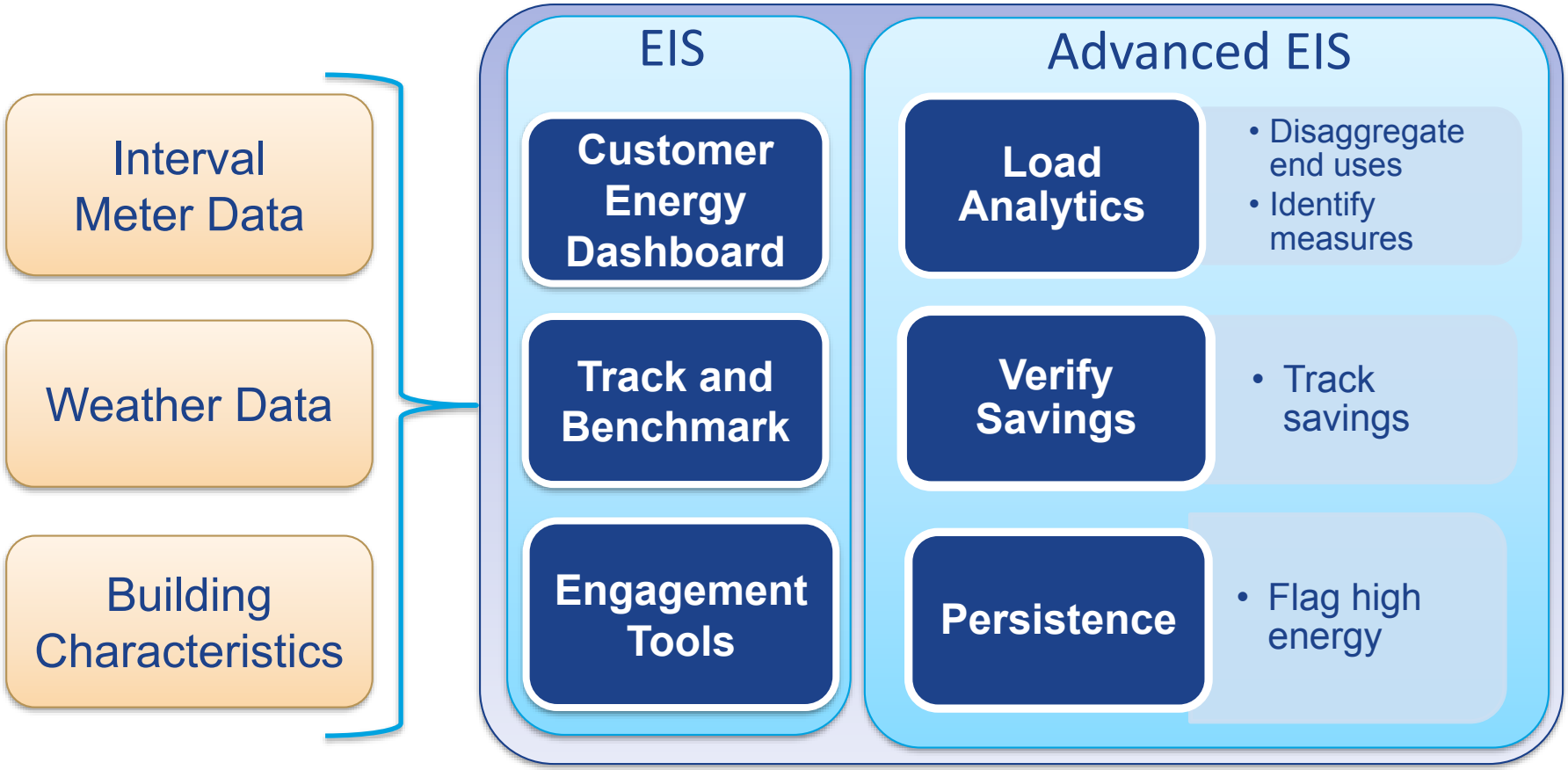


Monitoring-based Commissioning (MBCx)

MBCx Process



Meter-level Energy Information Systems



Energy Information Systems (EIS) and Advanced EIS

Examples

- Aquicore
- Climatec
- Connexx Energy
- EFT Energy
- Energy Hippo
- EnerNOC
- eSight
- Gridium
- Lucid-BuildingOS
- MACH Energy
- Powerhouse Dynamics
- Schneider Electric
- Trane

What can I see that I couldn't see before?

- Real-time or near real-time feedback
- Indicators of opportunity
- Weather-corrected savings; alarm when energy exceeds predicted use

Energy savings potential

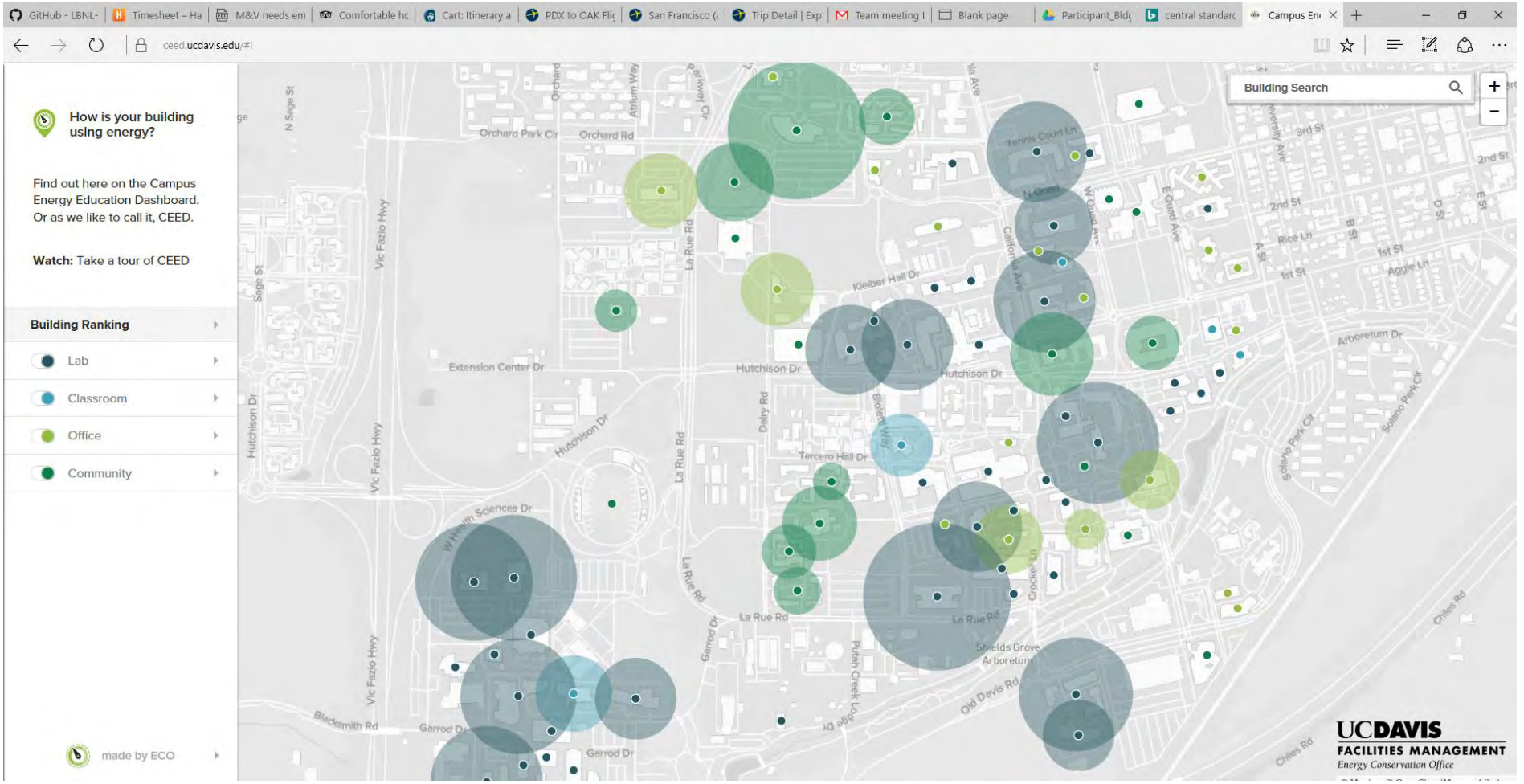
- Median savings: 8-17% (LBNL EIS Study[1])

Costs - $ to $$

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

[1] Building Energy Information Systems: Synthesis of Costs, Savings, and Best-practice Uses. Granderson, J., Lin, G. *Energy Efficiency* 9(6)(2016) pp.1369-138. http://eis.lbl.gov/pubs/eis-synth-EE.pdf

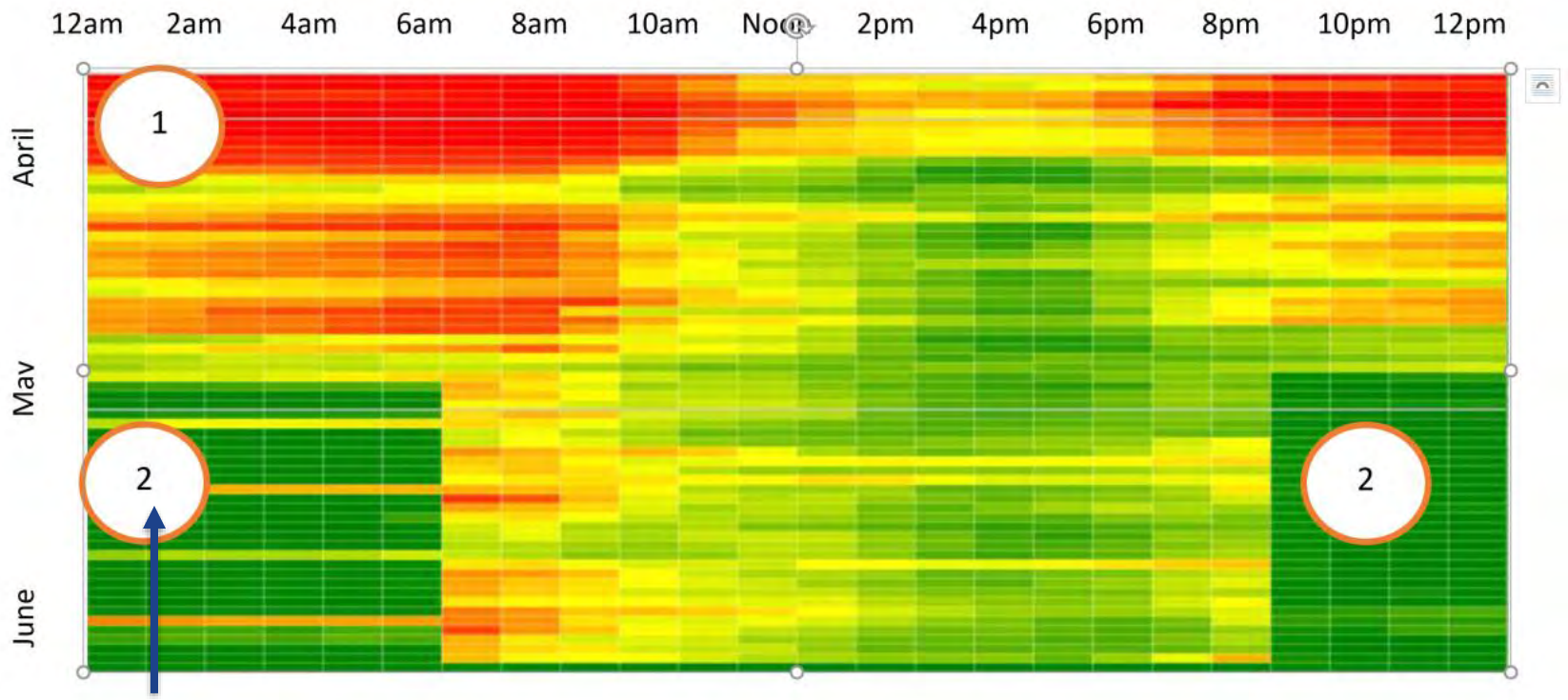
EIS: Portfolio View



Graphic Source: UC Davis CEED

EIS: Heat Map

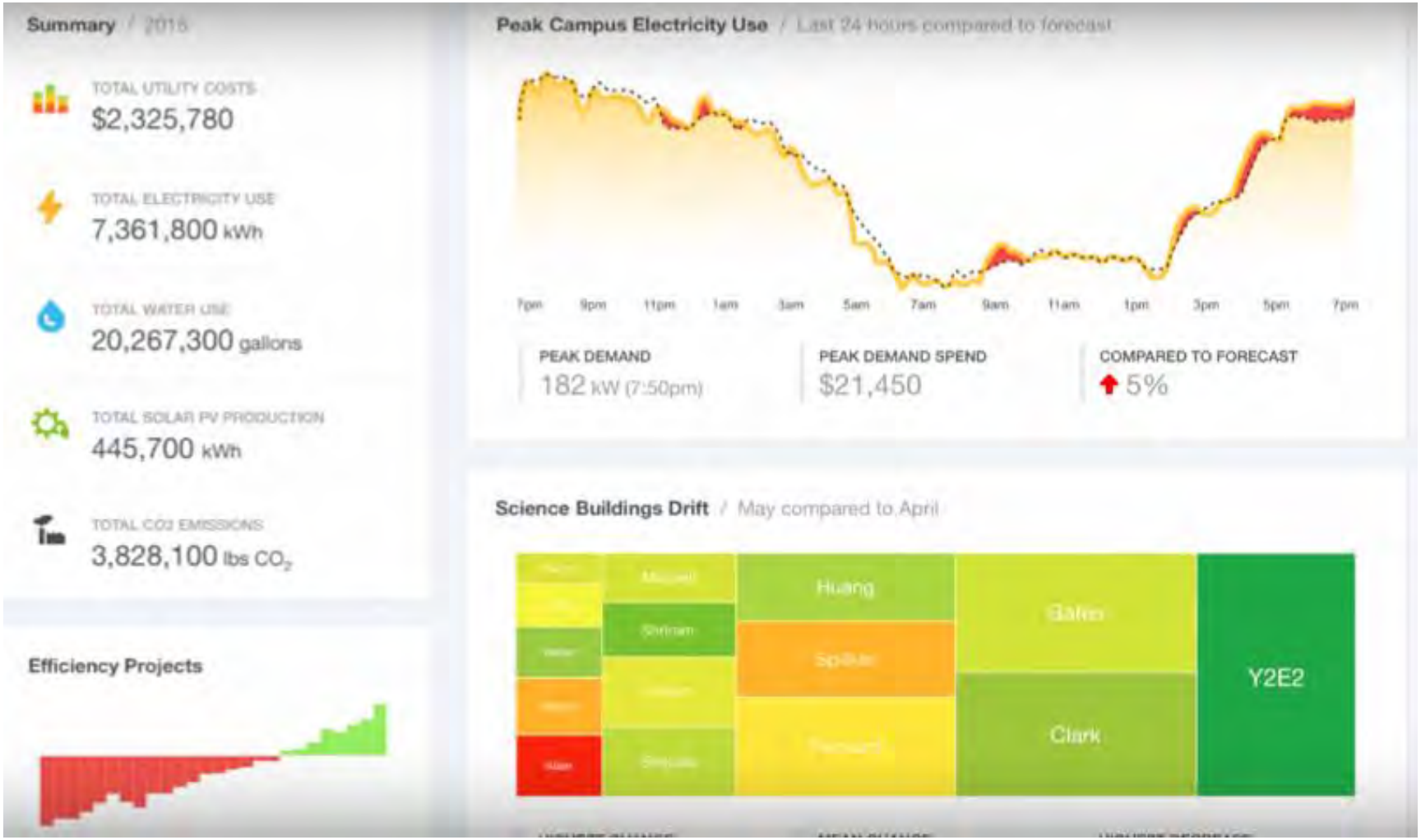
1. High unoccupied energy use



Source: Lucid

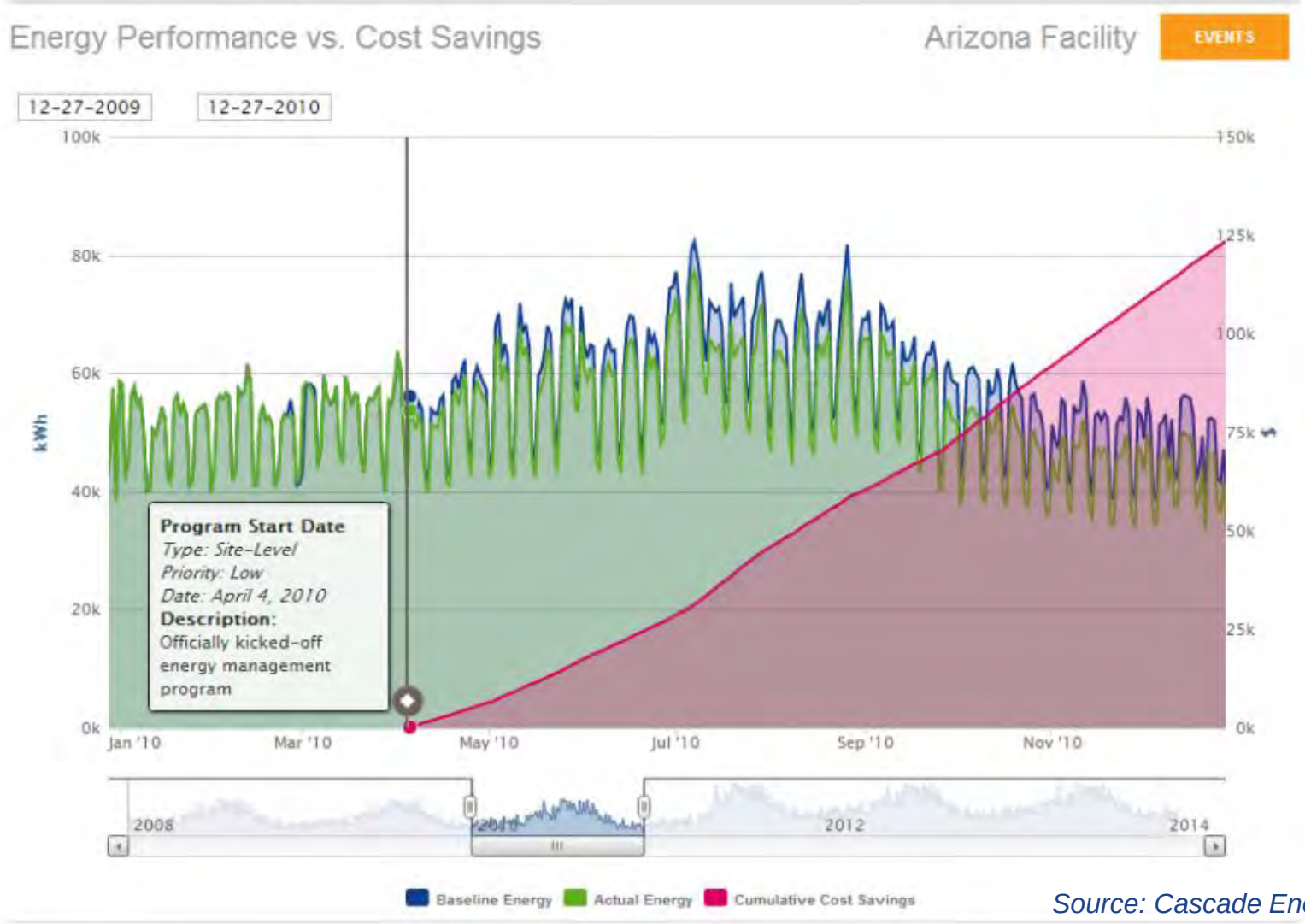
Problem fixed! Low unoccupied energy use, with clean start/stop

Advanced EIS: Energy Use Predictions (energy data-driven models, not simulation)



Graphic Source: Lucid

Advanced EIS: Verification of Savings



Source: Cascade Energy

Advanced EIS: Workplace Competition

Source: PECI

Fault Detection and Diagnostics (FDD)

Examples

- BuildPulse
- Cimetrics
- CopperTree Analytics
- Ecorithm
- Enerliance/YARDI
- ICONICS
- Ezenics
- KGS Buildings-Clockworks
- Sky Foundry-SkySpark

What can I see that I couldn't see before?

- Automatically identify HVAC system or equipment level faults without manual checks
- Detect hidden energy waste
- Prioritize faults based on fault frequency or estimated fault cost

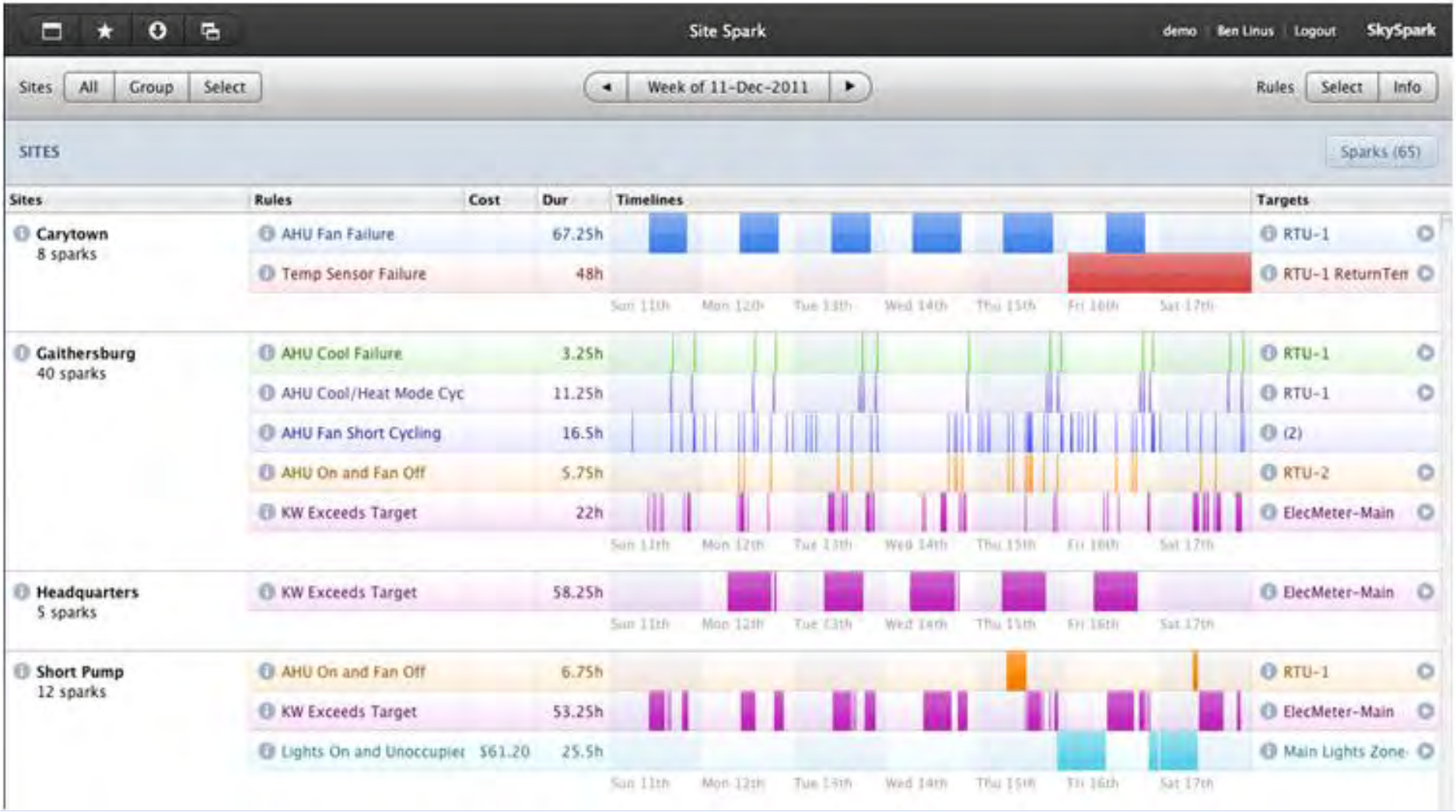
Energy savings potential

- Estimated 5-25% of whole building energy use reduction from correcting faults

Cost-$$$

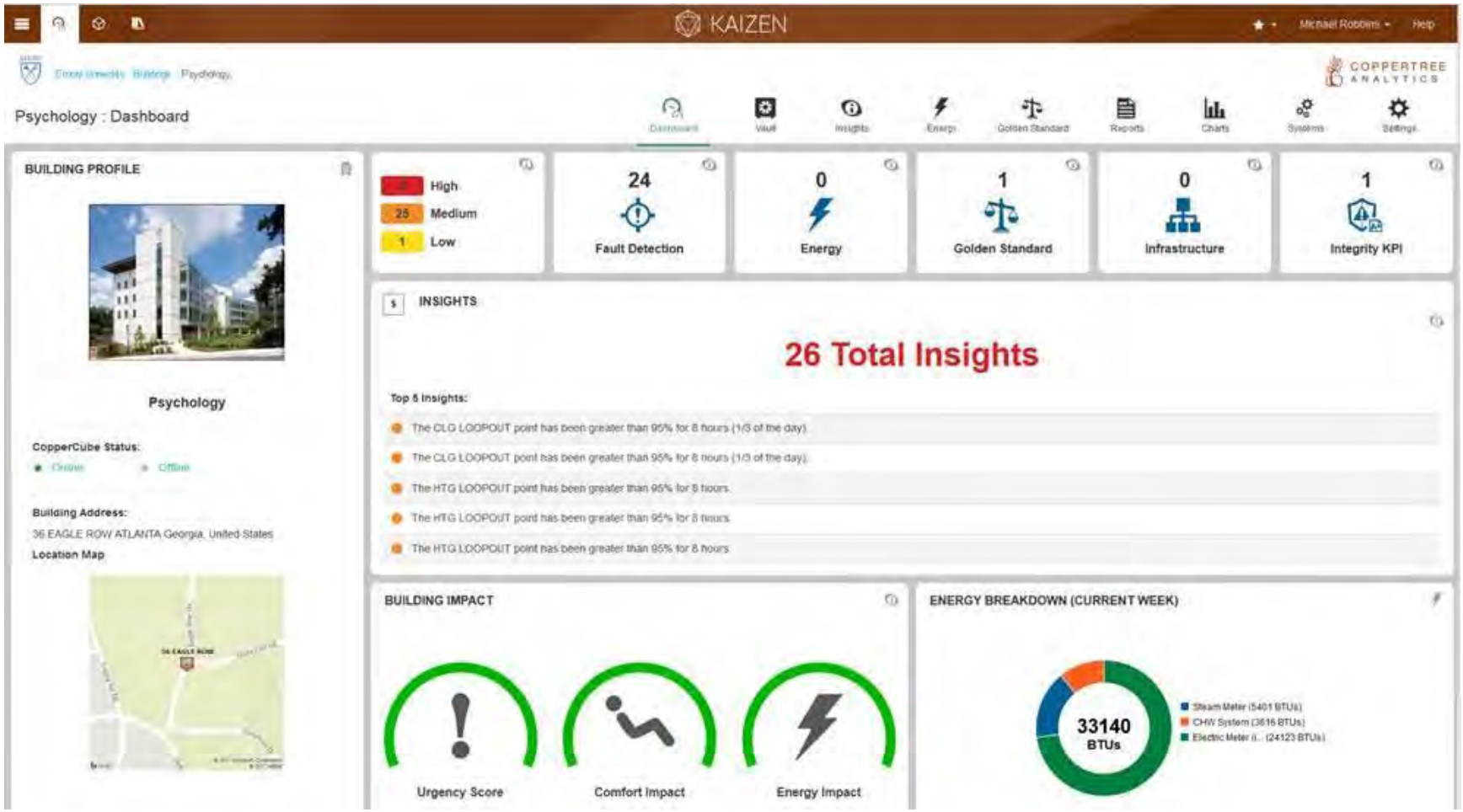
- Labor to set-up and map BAS points
- Configuration costs to customize FDD rules

Example: Fault Detection and Diagnostics



Graphic Source: SkyFoundry

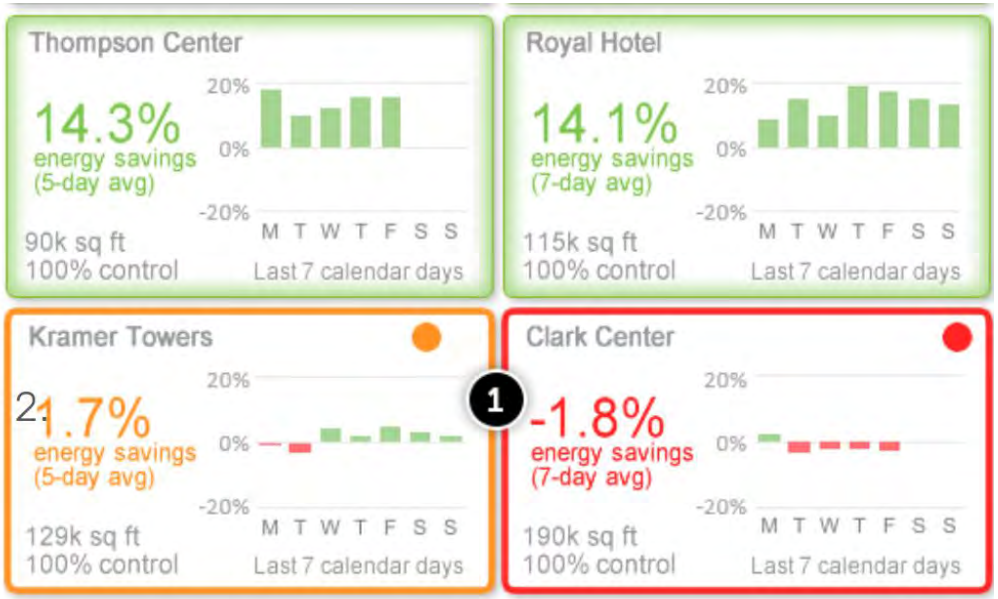
Example: Fault Detection and Diagnostics



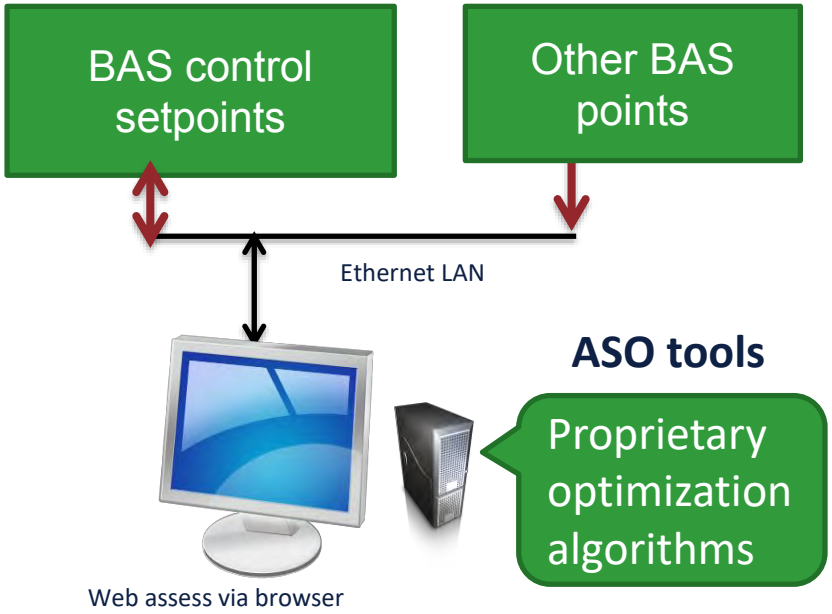
Graphic Source: Emory University

Automated System Optimization (ASO)

ASO – a tool to dynamically change HVAC BAS settings to optimize energy use and/or comfort

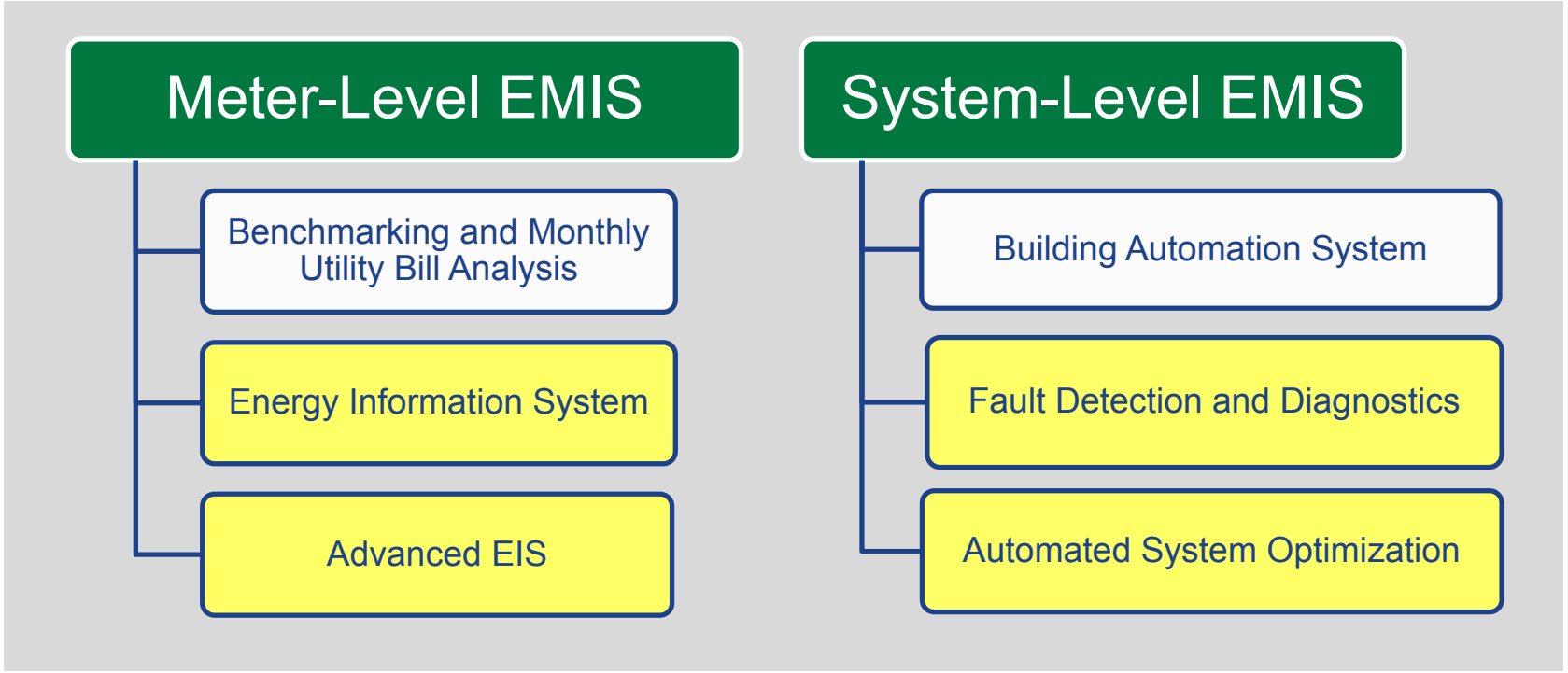


Graphic Source: BuildingIQ

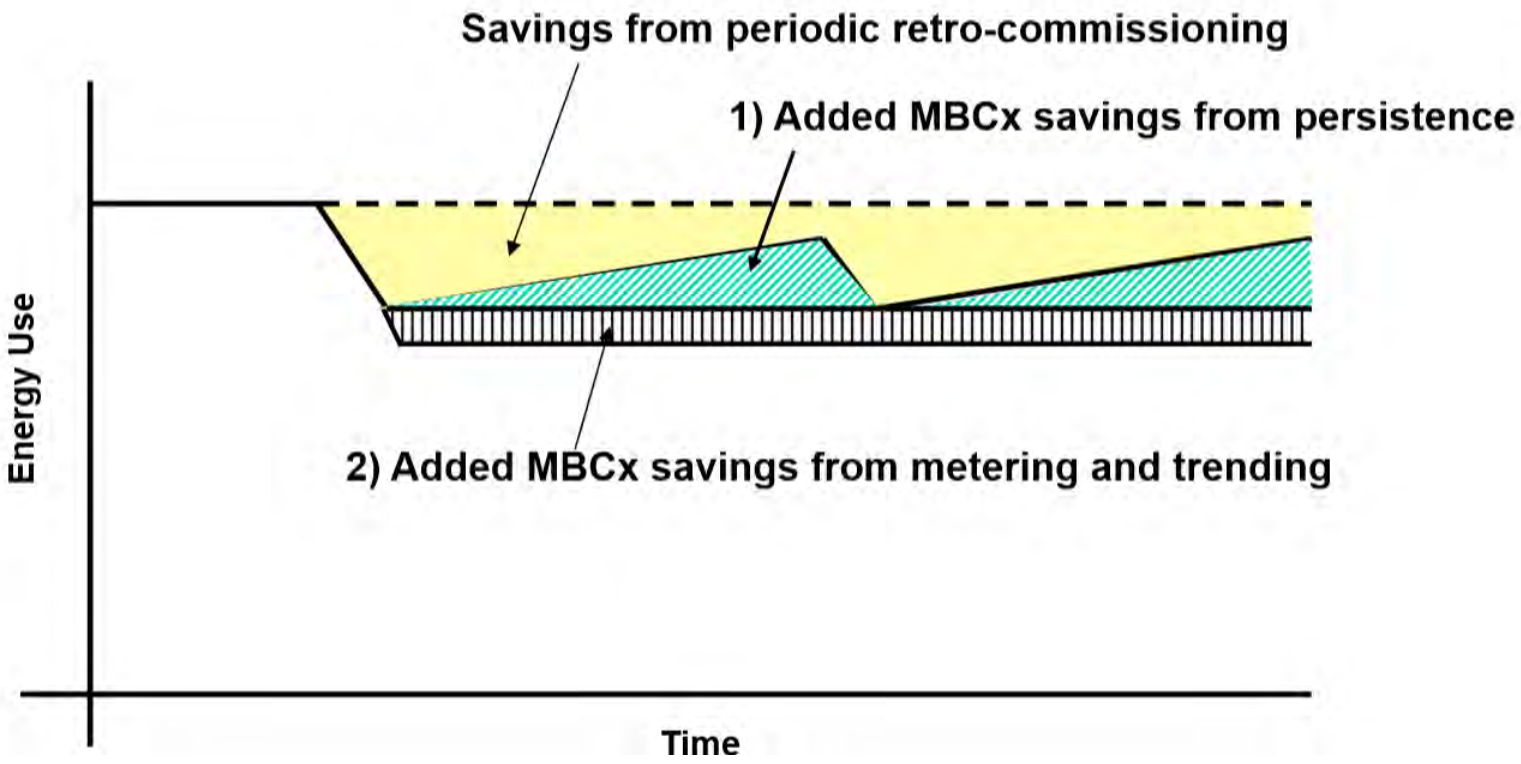


Energy Management and Information Systems

EMIS: Data analysis tools (not simulation)

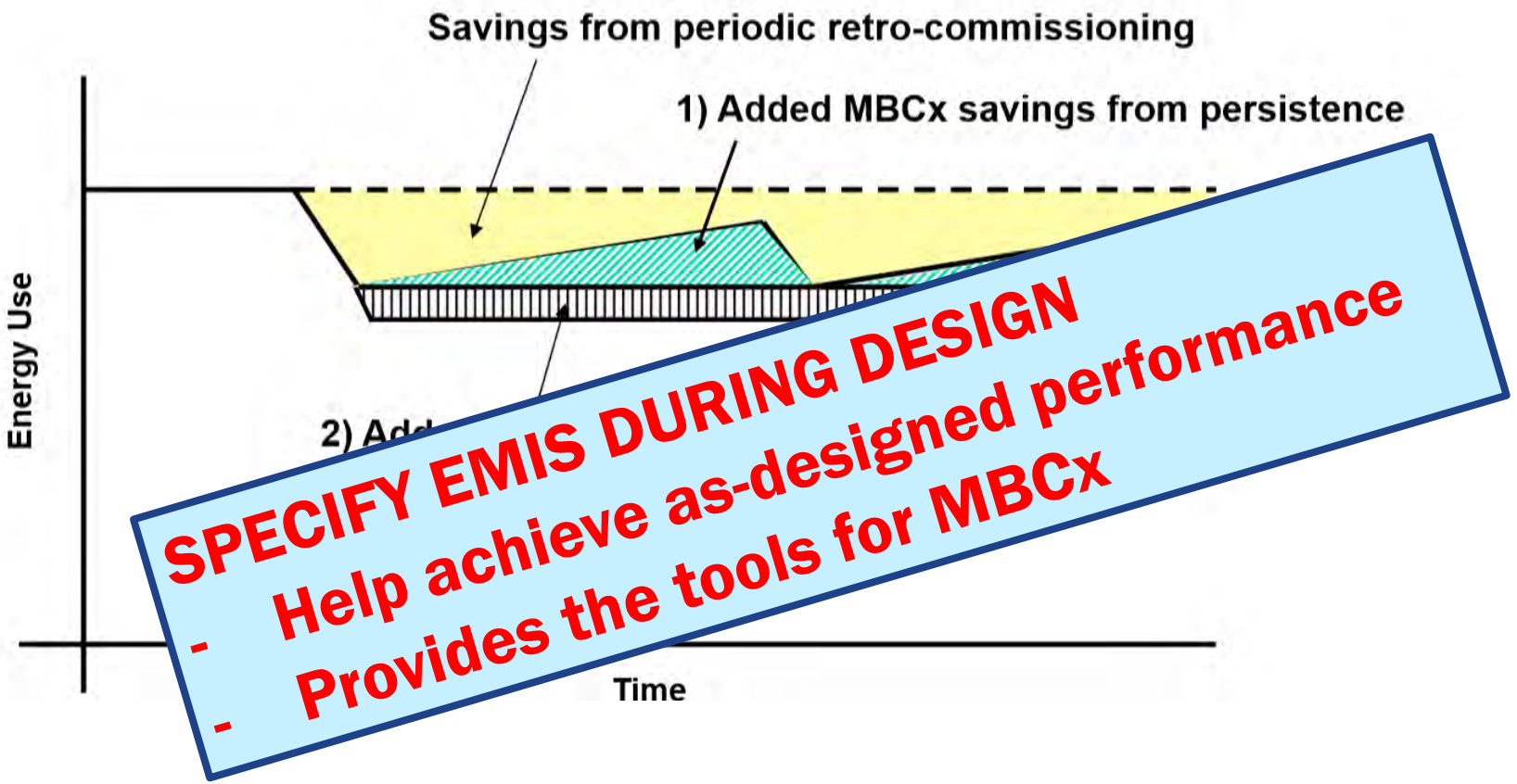


MBCx Savings



Source: *Monitoring-based Cx: An Update*
Karl Brown, CIEE June 2011, Presentation to the California Cx Collaborative

MBCx Savings



Source: *Monitoring-based Cx: An Update*
Karl Brown, CIEE June 2011, Presentation to the California Cx Collaborative

Specifying an EMIS

- RFP Template
- Tech Spec Template
- Evaluation & Selection Criteria

70+ EMIS commercially available

https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/emis_proc_spec_BBA_FINAL_021815_508.pdf

Specification Should Address These Issues

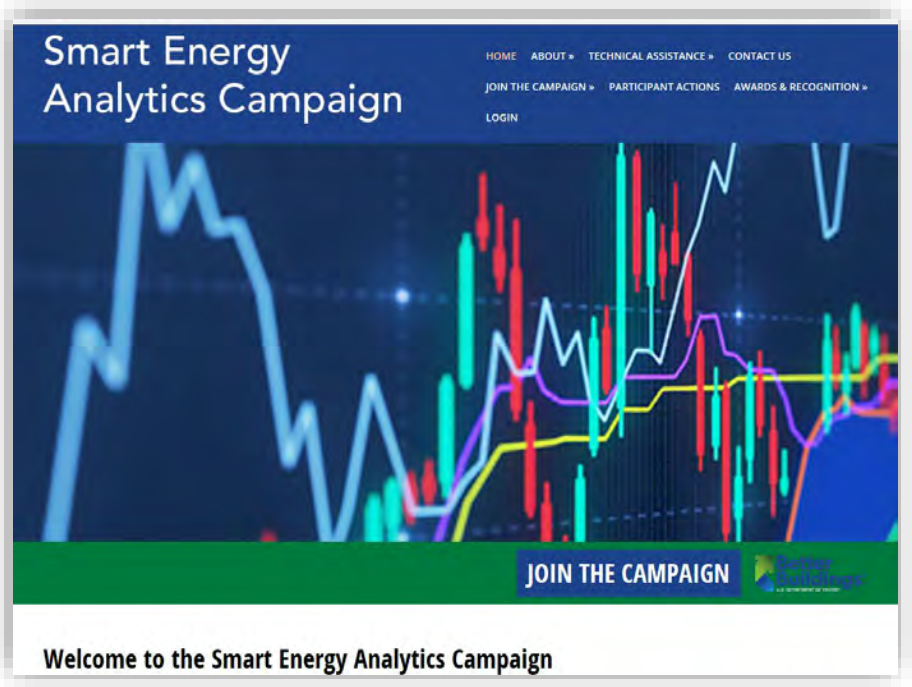
- Data security protocols?
- Data management /data warehouse an option?
- How ‘realtime’ is the data feed?
- How are gaps in data handled?
- User ability to change/create charts and metrics?
- Reporting capability is flexible enough to meet needs?

Smart Energy Analytics Campaign

U.S. DEPARTMENT OF ENERGY

Smart Energy Analytics Campaign launched 2016

- Facilitate adoption of EMIS and monitoring-based commissioning
- Participants use EMIS and share results
- Research report summarizing the EMIS and MBCx industry



Smart Energy Analytics Campaign: To date

48 Organizations

185 Million square feet

2,400 buildings

$9M annual savings

5% whole building energy savings

from 15 organizations (414 buildings) reporting

Walmart

MGM RESORTS INTERNATIONAL

OHSU

WHOLE FOODS MARKET

EMORY UNIVERSITY

NYC Department of Education

Sprint in partnership with CBRE

macy's

PROVIDENCE Hood River Memorial Hospital

smart-energy-analytics.org

Campaign Participation

- Gain national recognition for leading edge facility management
- Receive technical assistance from Lawrence Berkeley National Laboratory
- Access peer network groups
- Learn how to maximize the benefits analytics

Technical Resources

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

http://smart-energy-analytics.org

EMIS Selection

- What's important to owners
  - Desire to start big picture with EIS or in the details with FDD
  - Flexibility for future expansion
  - Consolidation of energy management interfaces
  - Some want to be able to program EMIS in-house
- Find a Product or Service List
  - 48 EIS, 23 FDD, 7 ASO, 34 Service Providers

Fault Detection and Diagnosis Systems

Product
BuildPulse
Analytika
Climacheck Online (RTU)
AxcessEEM

Energy Information Systems

Vendor	Product
Agilis Energy	Agilis Energy
Alaska Housing Finance Corporation	Building Monitoring System (publicly available, Open Source)
Aquicore	AQ-Optimization
Building IQ	Energy WorkSite
Buildings Alive	Buildings Alive

Products used by Campaign Participants to Date

EIS Products

- EnergyCAP
- EnerTrac
- Honeywell Enacto
- ICONICS
- Inductive Automation
- Interval Data Systems
- Lucid BuildingOS
- New City Energy
- OSIsoft PI
- Parasense
- Periscope
- Schneider Ion Enterprise
- SkySpark
- Tableau
- The Energy Detective
- Trane Energy Performance
- Vykon Energy Suite
- Wonderware

FDD Products

- CopperTree Analytics
- Ecorithm
- ICONICS
- Interval Data Systems
- KGS Clockworks
- Parasense
- Powerhouse Dynamics
- SkySpark
- Trane Building Performance

ASO Products

- BuildingIQ

Case Studies: Smart Energy Analytics Campaign Recognition

U.S. DEPARTMENT OF ENERGY

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™

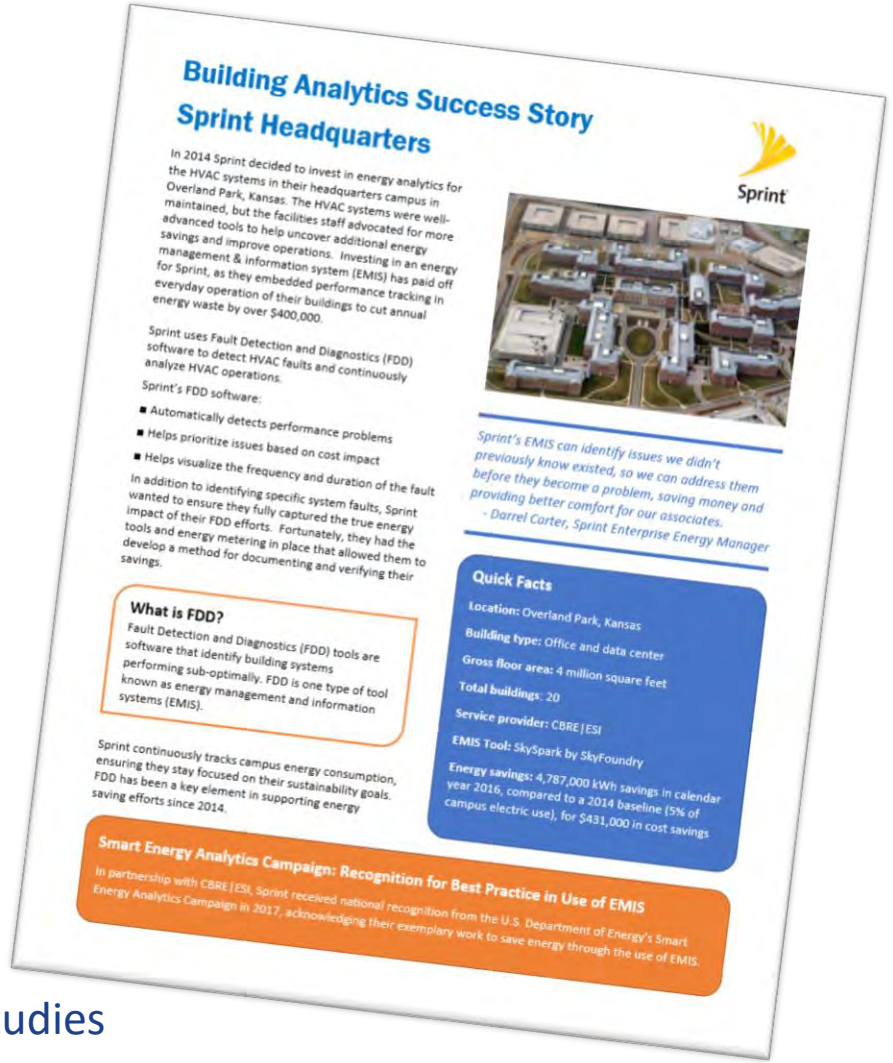
Aurora Public Schools

Carleton

CPCC CENTRAL PIEDMONT COMMUNITY COLLEGE

Campaign Participant Success Stories

- 2 page case study published for those recognized
- Shared through DOE and supporting partner networks



Building Analytics Success Story
Sprint Headquarters

Sprint

In 2014 Sprint decided to invest in energy analytics for the HVAC systems in their headquarters campus in Overland Park, Kansas. The HVAC systems were well-maintained, but the facilities staff advocated for more advanced tools to help uncover additional energy savings and improve operations. Investing in an energy management & information system (EMIS) has paid off for Sprint, as they embedded performance tracking in everyday operation of their buildings to cut annual energy waste by over $400,000.

Sprint uses Fault Detection and Diagnostics (FDD) software to detect HVAC faults and continuously analyze HVAC operations.

Sprint's FDD software:

- Automatically detects performance problems
- Helps prioritize issues based on cost impact
- Helps visualize the frequency and duration of the fault

In addition to identifying specific system faults, Sprint wanted to ensure they fully captured the true energy impact of their FDD efforts. Fortunately, they had the tools and energy metering in place that allowed them to develop a method for documenting and verifying their savings.

What is FDD?

Fault Detection and Diagnostics (FDD) tools are software that identify building systems performing sub-optimally. FDD is one type of tool known as energy management and information systems (EMIS).

Sprint continuously tracks campus energy consumption, ensuring they stay focused on their sustainability goals. FDD has been a key element in supporting energy saving efforts since 2014.

Sprint's EMIS can identify issues we didn't previously know existed, so we can address them before they become a problem, saving money and providing better comfort for our associates.
- Darrel Carter, Sprint Enterprise Energy Manager

Quick Facts

Location: Overland Park, Kansas

Building type: Office and data center

Gross floor area: 4 million square feet

Total buildings: 20

Service provider: CBRE|ESI

EMIS Tool: SkySpark by SkyFoundry

Energy savings: 4,787,000 kWh savings in calendar year 2016, compared to a 2014 baseline (5% of campus electric use), for $431,000 in cost savings

Smart Energy Analytics Campaign: Recognition for Best Practice in Use of EMIS

In partnership with CBRE|ESI, Sprint received national recognition from the U.S. Department of Energy's Smart Energy Analytics Campaign in 2017, acknowledging their exemplary work to save energy through the use of EMIS.

https://smart-energy-analytics.org/case-studies

Campaign Recognition: Salt Lake City

- Energy Performance in a Single Site
  - Public Safety Building; 167,000 sq ft
  - Designed for ZNE
  - Overventilation, simultaneous heating and cooling
  - Reduced electric consumption by 8%, gas consumption by 57% for total Btu savings of 35%
  - Simple payback 1.5 years

Campaign Recognition: Commonwealth of Kentucky: Best Practice in Expansion of EMIS

- 2016 - 2.5M sq.ft. added to EIS/FDD system (20M sq ft total)
- Comprehensive EMIS
  - 1,350 meters, 142,000 BAS points
  - Top level building dashboard (public)
  - EIS and FDD
  - ECM savings tracking and work order system integration
- *High Performance Buildings Standard*
  - Monitoring points, point naming conventions, data collection frequency
  - "Our goal is to have a better specification that leads to better controls delivery…."

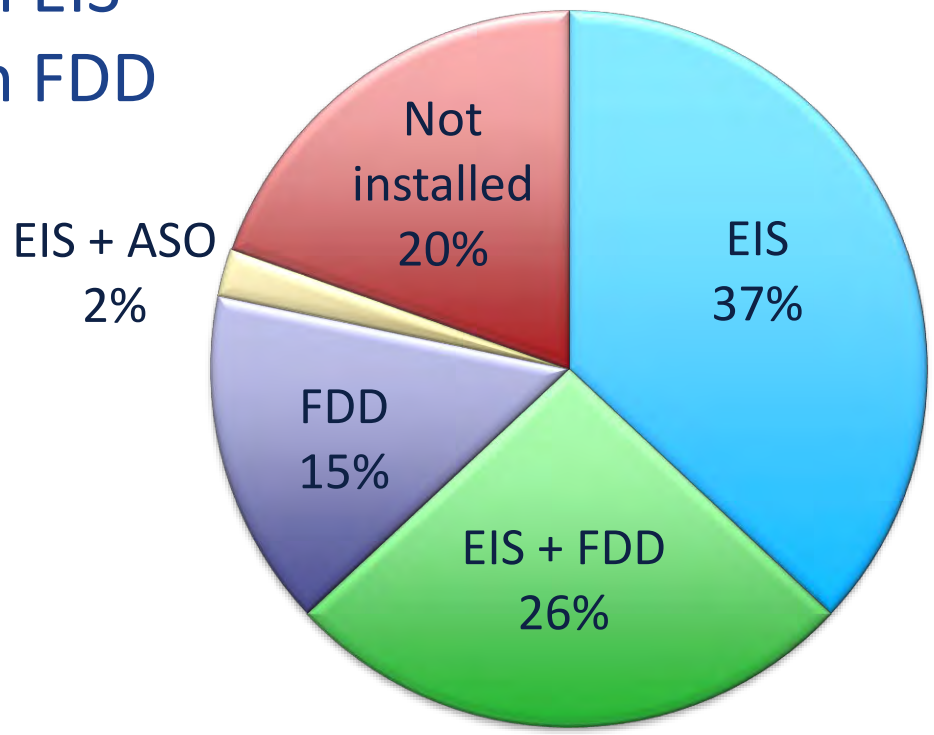
COMMONWEALTH ENERGY MANAGEMENT & CONTROL SYSTEM CEMCS

Smart Energy Analytics Campaign Year 1 Report

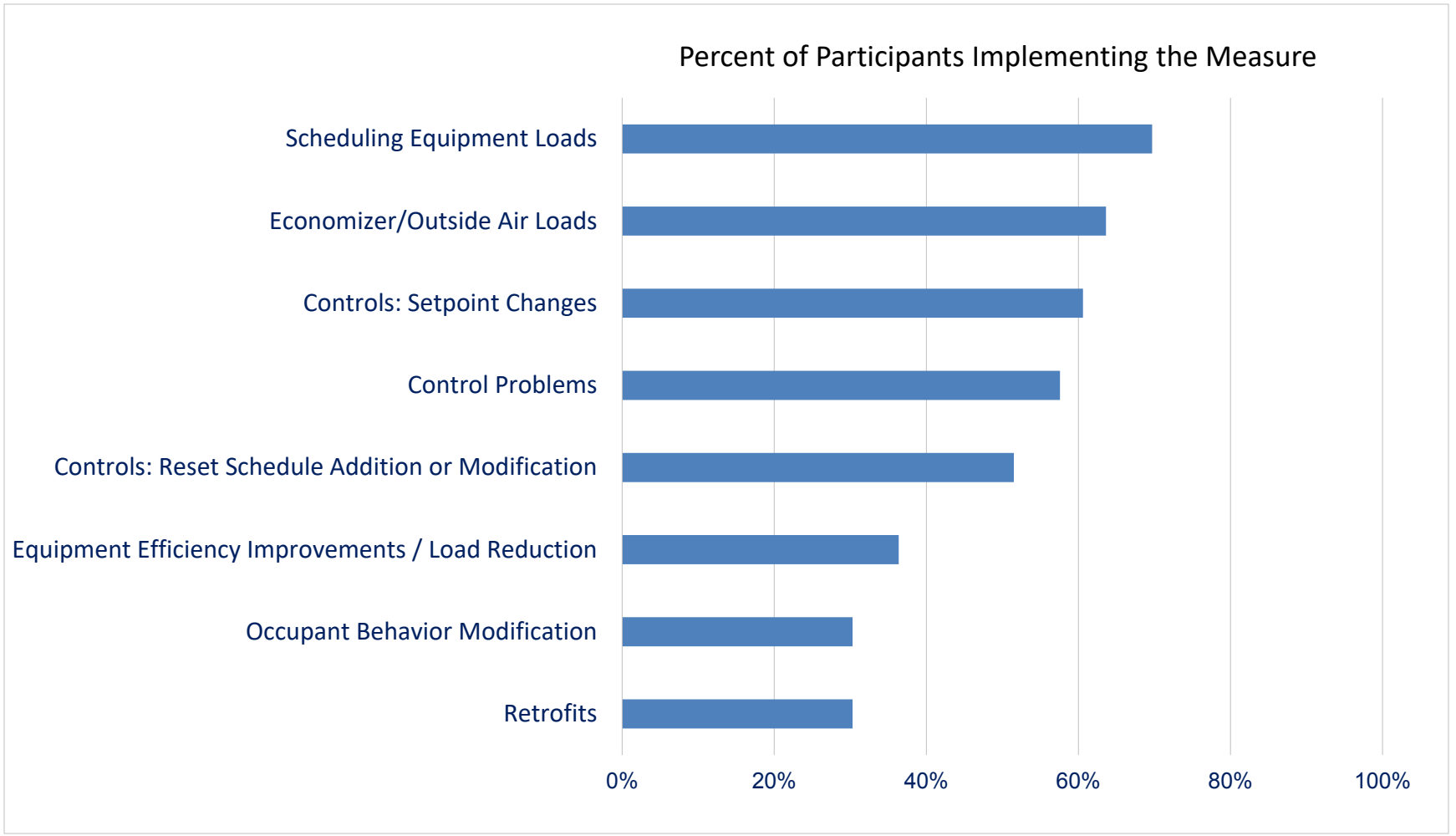
U.S. DEPARTMENT OF ENERGY

EMIS Type Implemented by Participants

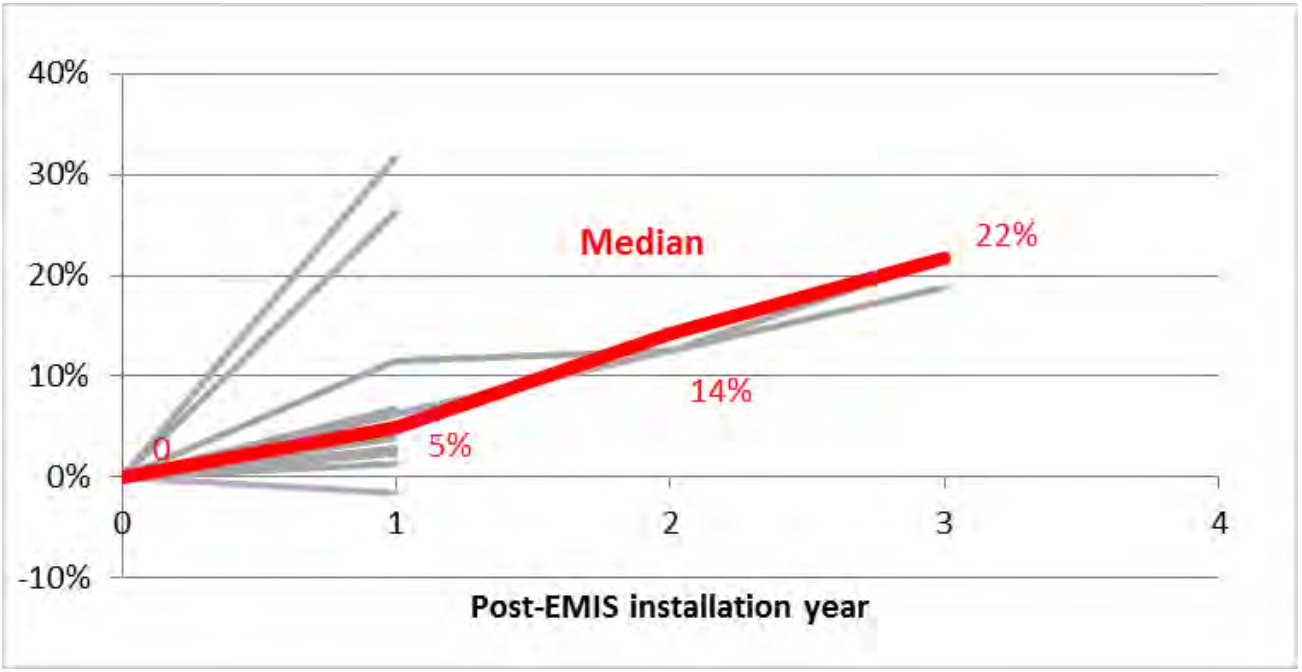
65% with EIS
41% with FDD



Top Measures Implemented from EMIS Insights

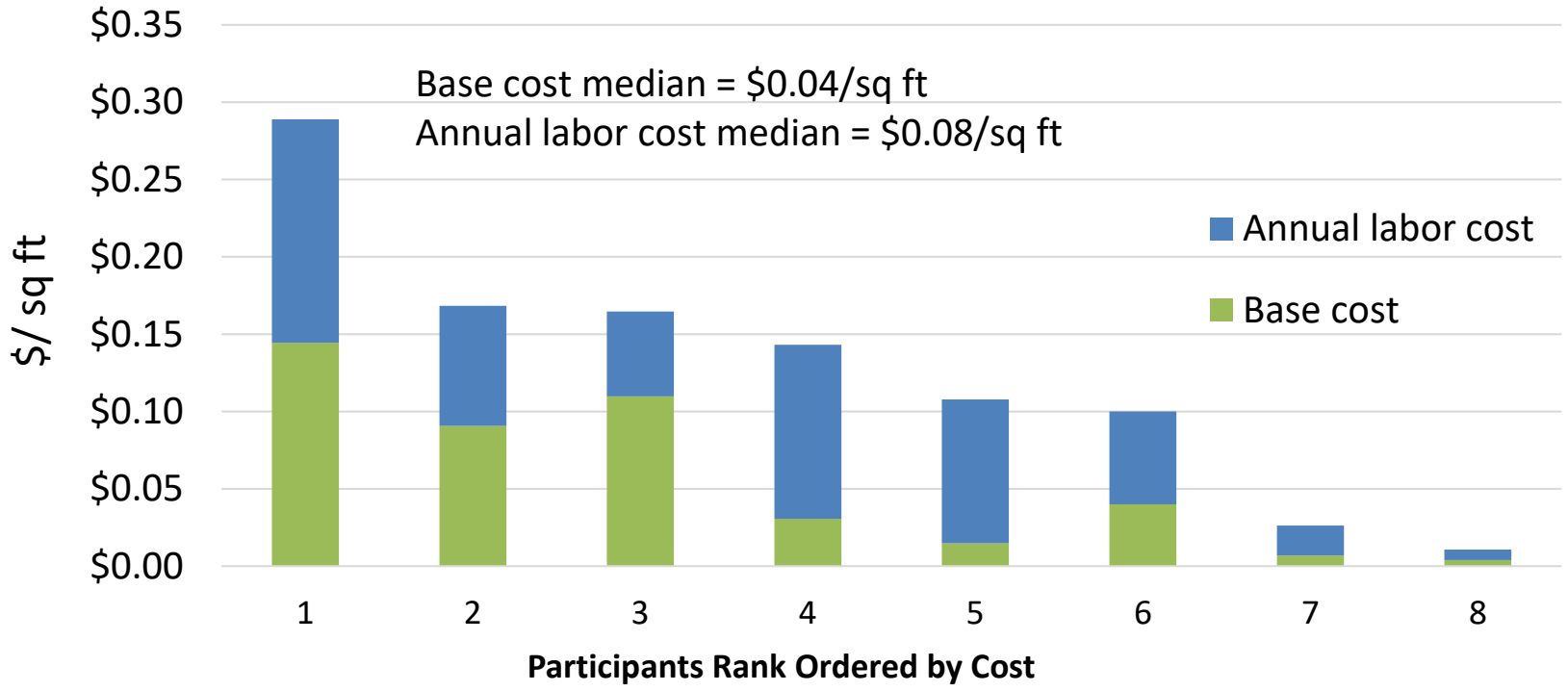


Energy Savings Increase over Time
(15 organizations, 414 buildings, 39 million sq ft)



Percent reduction in participant 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 participant portfolios.

EMIS Base Cost and Labor Cost
(8 organizations, 66 buildings, 50 million sq ft)

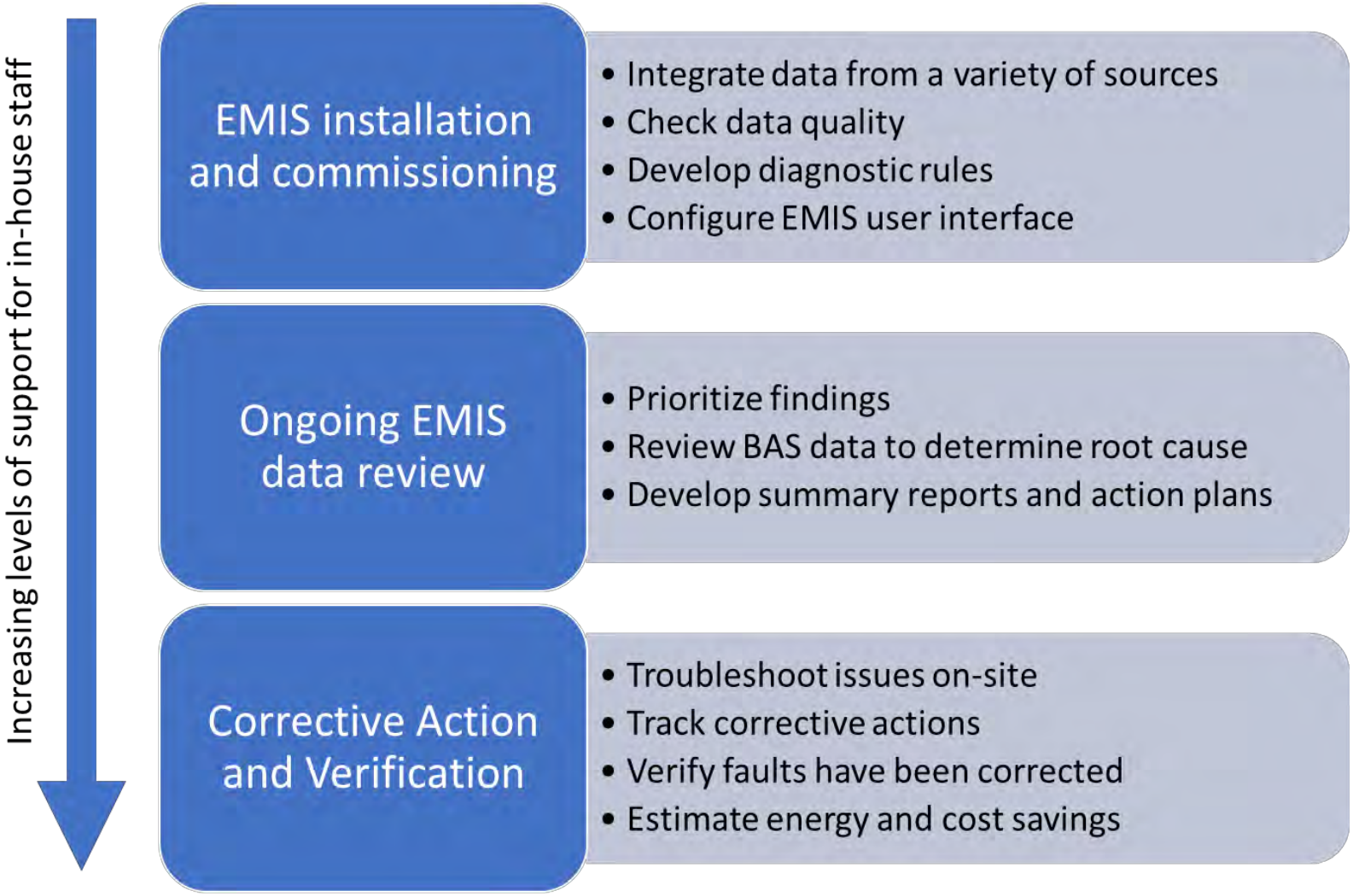


Base cost: Includes EMIS software, installation, and configuration

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: $0.01/sq ft

Support Options for MBCx



Upcoming Smart Energy Analytics Campaign Webinars

Open Invitation

Getting the Most out of Your EIS

Nov 16, 10 am PT

Registration

LBNL presentation
plus featured guests:

Carleton

Aurora Public Schools

Campaign Participants Only

FDD Peer Network: Use of Service Providers to Support FDD

Dec 7, 11 am PT

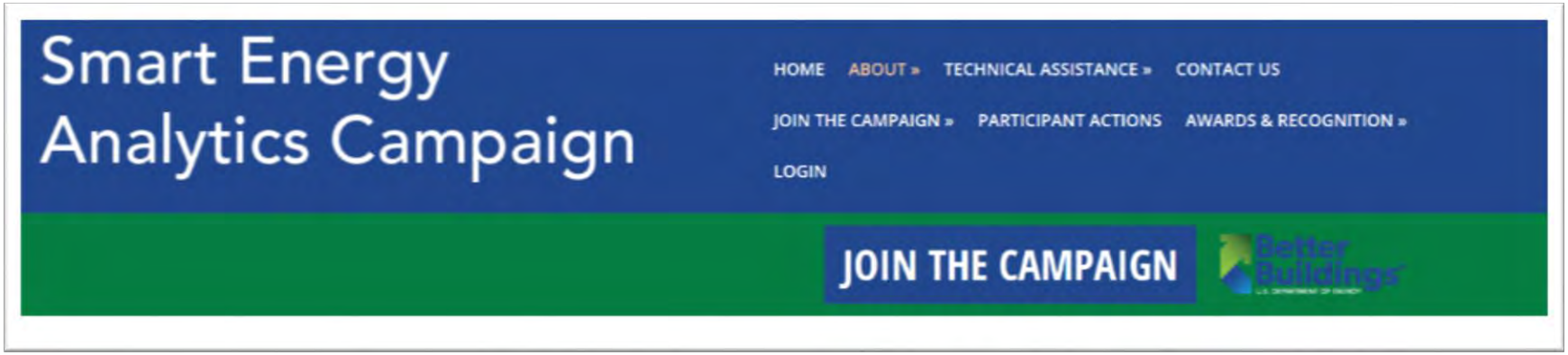
LBNL presentation
plus featured guests:

Kentucky UNBRIDLED SPIRIT

CPCC CENTRAL PIEDMONT COMMUNITY COLLEGE

Take aways

- Growing expectation for analytics by large owners
- MBCx needed to achieve & maintain high performance buildings
- Use EMIS tools to perform MBCx effectively
- New or existing EMIS implementation, consider joining the Campaign



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Thank You!

Hannah Kramer, P.E.
hkramer@lbl.gov

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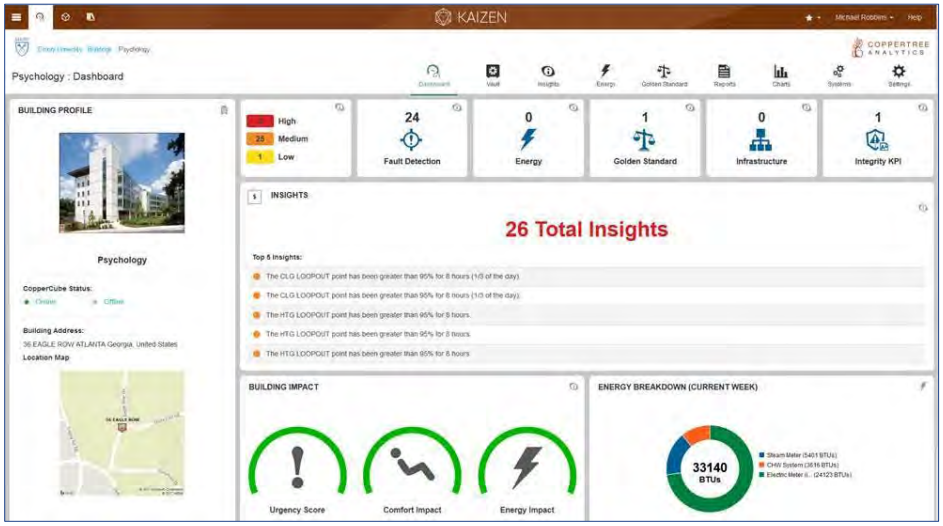
Additional Case Studies

U.S. DEPARTMENT OF ENERGY

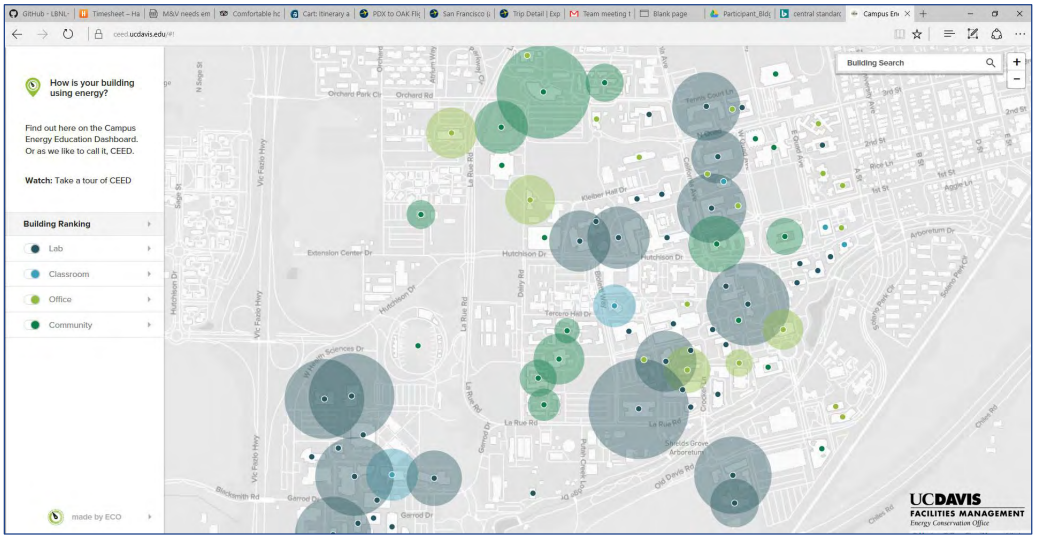
Campaign Recognition: Emory University

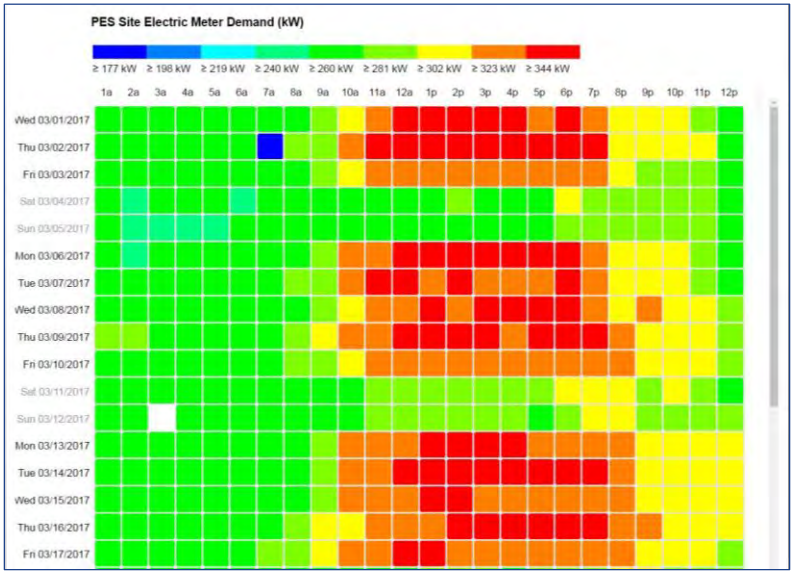
- Energy Performance in a Portfolio
  - 20 buildings, 2.7 million sq ft
  - 25% reduction in whole building energy use
  - Reduction driven through in-house existing building Cx paired with FDD algorithms



Campaign Recognition: UC Davis

- Innovation in the Use of EMIS
  - 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

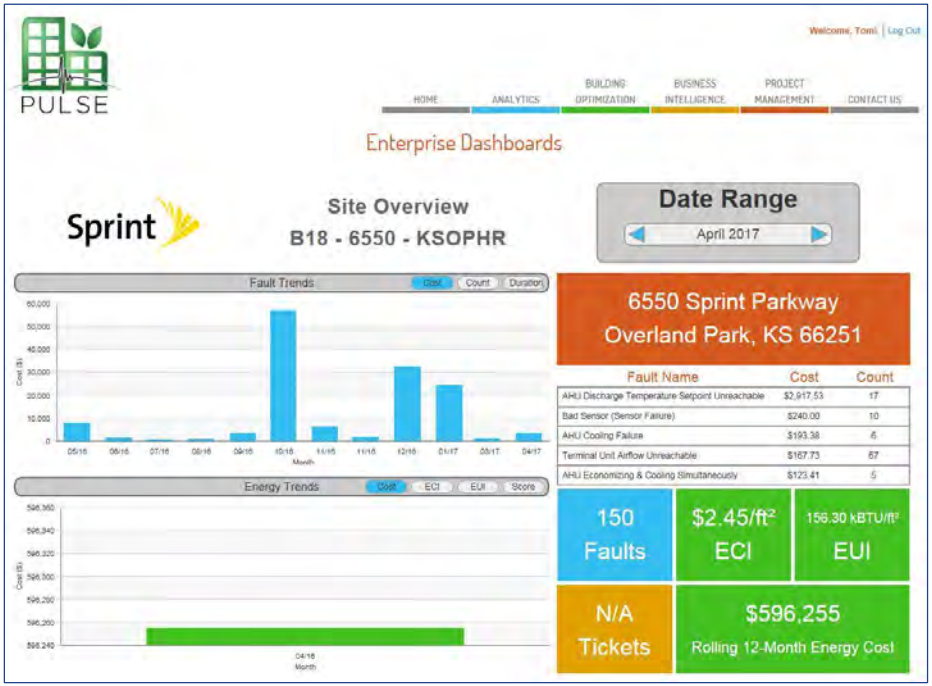




Campaign Recognition: Sprint in partnership with CBRE

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

Sprint
in partnership with
CBRE



Campaign Recognition: MGM Resorts International

- Largest Portfolio Using EMIS
  - 38 million sq ft

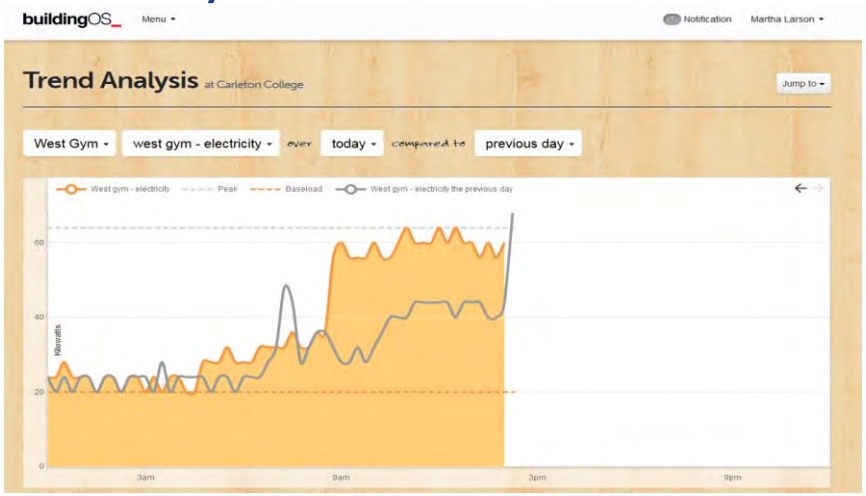
"When issues arise involving major HVAC equipment, the first call is to the EMIS team to see if it can be diagnosed in the EMIS system. This process saves an enormous amount of money in avoided service calls and unnecessary equipment replacement."

– Chris Magee, VP Sustainable Facilities

Campaign Recognition: Carleton College

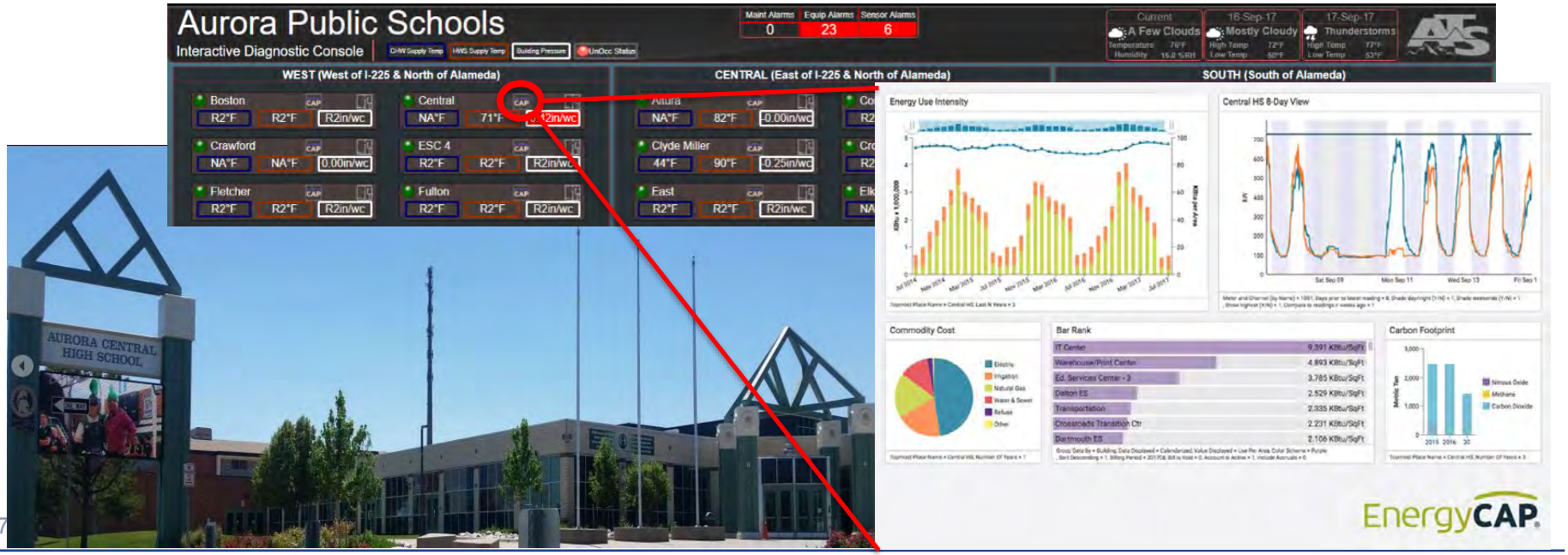
- Exemplary New Installation of EIS - Tie
- 1.6 m sq.ft. campus
- Tracking consumption and renewables
- Using EIS for project M&V
- Weekly energy team meetings built around EIS analytics

Carleton



Campaign Recognition: Aurora Public Schools

- Exemplary New Installation of EIS – Tie
- Tracking electric, gas, water, waste for 50 schools
- Public dashboards
- Diagnostic Console for maintenance technicians



Better Buildings U.S. DEPARTMENT OF ENERGY

U.S. DEPARTMENT OF ENERGY

Campaign Recognition: Central Piedmont Community College

- Exemplary New Installation of FDD
- Engaging two third party providers to support MBCx pilots
- Dashboard tracks high priority issues and key performance metrics
- Actively monitoring corrective actions to ensure follow through

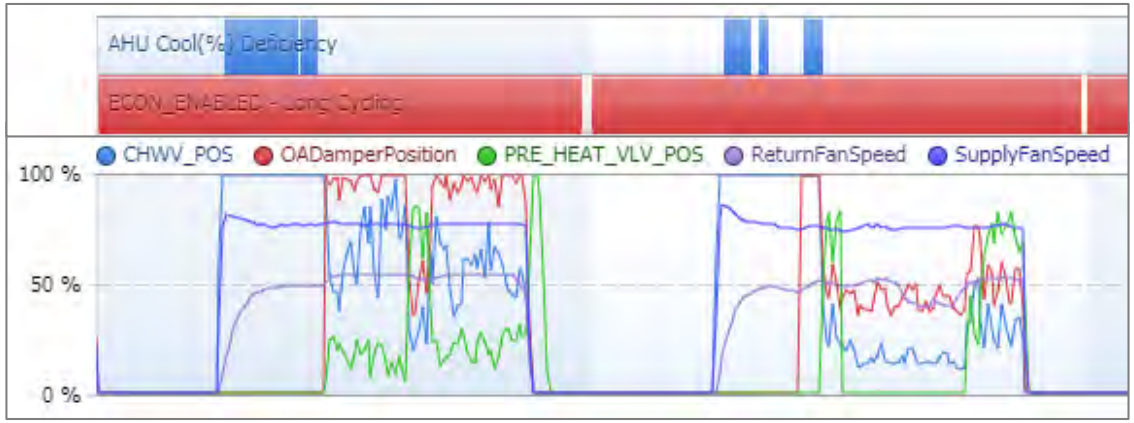


Image: SkySpark software, by SkyFoundry