Better Buildings
U.S. DEPARTMENT OF ENERGY

EMIS: Crash Course to Successful Use

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U.S. DEPARTMENT OF ENERGY

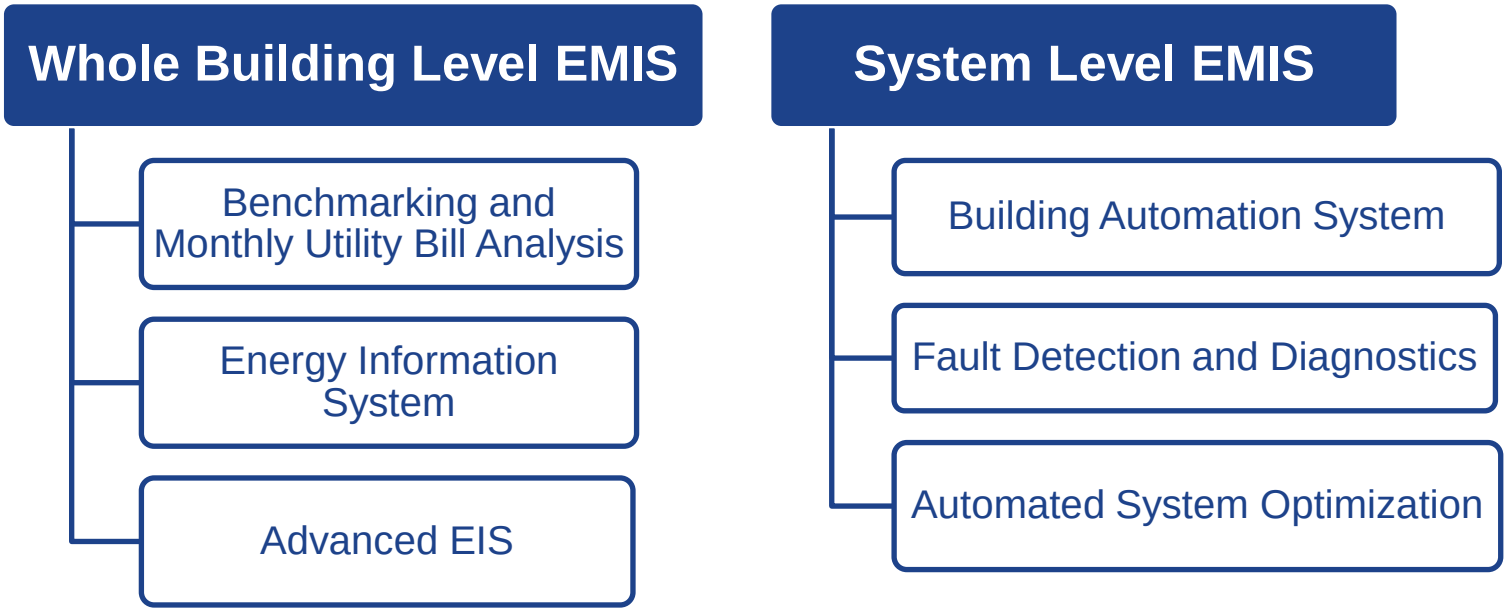
Crash Course Outline

- What are EMIS ?
  - Benchmarking and Monthly Utility Bill Analysis
  - EIS and Advanced EIS
  - Building Automation System
  - FDD and ASO
- Adopting an EMIS
- EMIS Best Practices
- What's Next: Campaign to increase adoption of EMIS + ongoing commissioning

What are EMIS?

What are Energy Management and Information Systems (EMIS)?

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

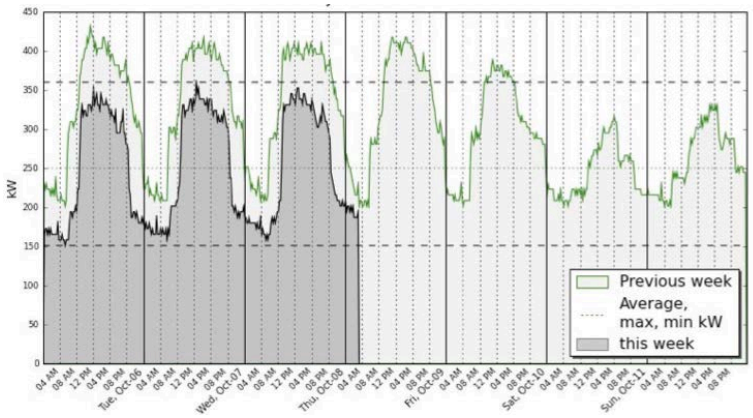


* The boundaries can be fuzzy; some tools cross categories, e.g., energy information systems with FDD and benchmarking capabilities

Motivation to use EMIS

- Energy performance monitoring and reporting has come to the forefront of the national energy dialogue
  - Zero-energy and smart grid initiatives
  - EISA 2007, federal and state labeling and reporting mandates

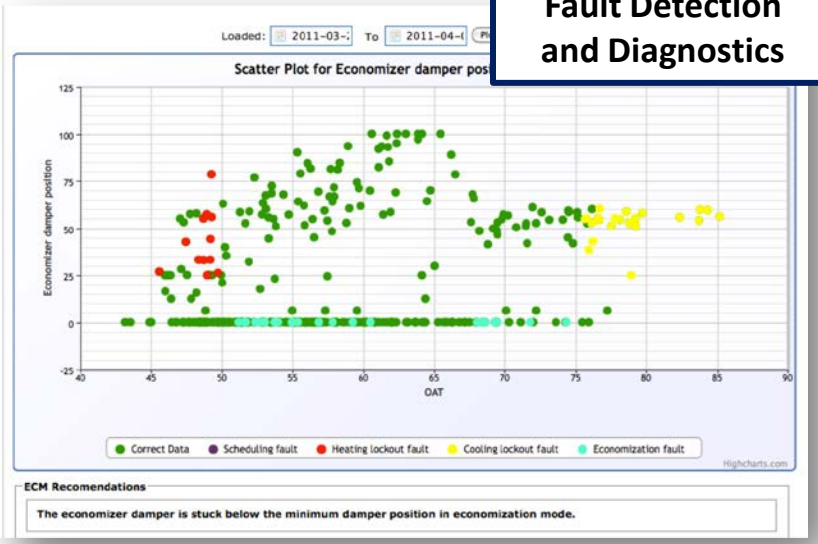
- Optimal performance requires higher granularity data, more timely analysis than monthly utility bills



Screenshots of some EMIS

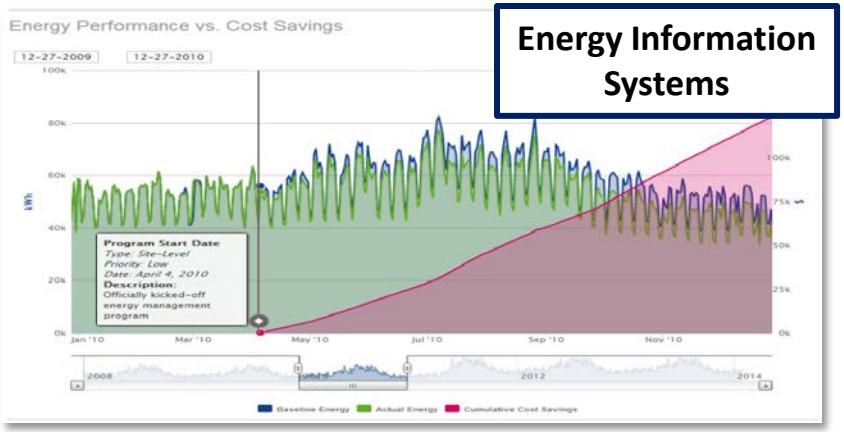
Benchmarking and Monthly Utility Bill Analysis

Fault Detection and Diagnostics



Building automation system (BAS)

Energy Information Systems



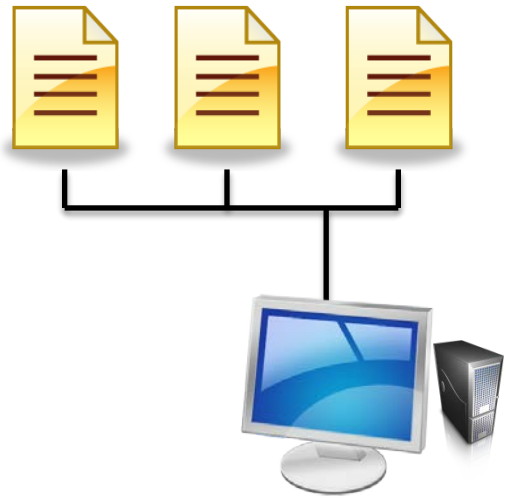
Benchmarking and Monthly Utility Bill Analysis

- A tool **comparing** a building's performance to peer groups or to historical **performance**, and sometimes validating and **managing** utility **bills**.

- **Monthly whole-building** use, utility bills

- Applications
  - Utility bill reconciliation
  - Energy use and cost tracking
  - Benchmarking against a portfolio or through ENERGY STAR
  - Sustainability reporting (i.e greenhouse gas emission)

Monthly **whole-building** energy use (i.e. utility bills)



Web assess via browser

Benchmarking and Monthly Utility Bill Analysis

Utility bill analysis software, a screenshot including ENERGY STAR, carbon footprint, cost trend, and usage trend

Graphic Source: Facility Dude

Benchmarking and Monthly Utility Bill Analysis

Examples

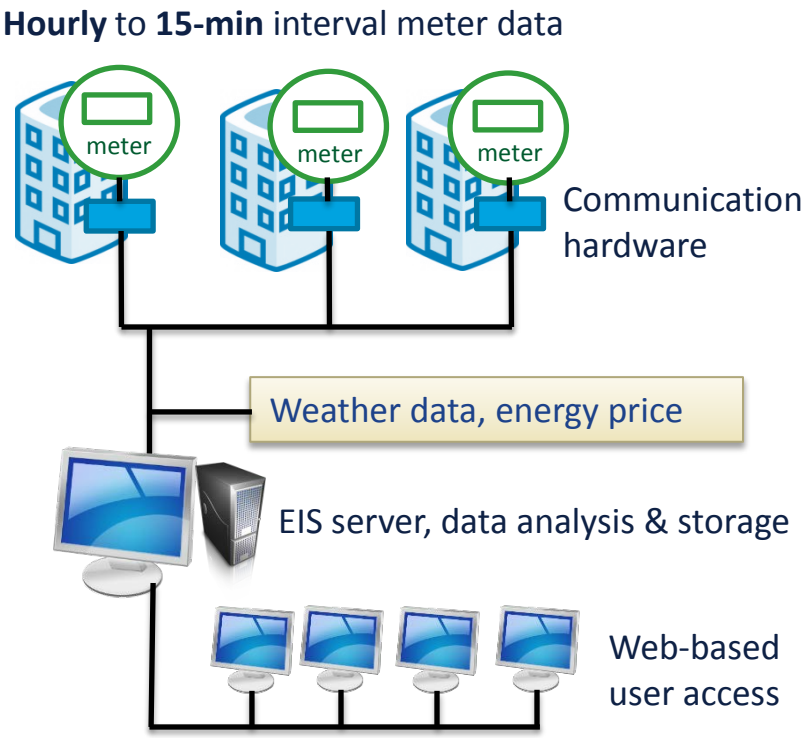
- EPA Portfolio Manager
- EnergyCAP
- Ecova
- Facility Dude
- Metrix 4
- Energy Print

- Benefits
  - Provides info to set **energy goals** and to track progress
  - Reveals **need for improvement** (by internal and/or external comparisons), helps prioritize
  - **Assists in streamlining** bill payment processing
- Energy savings enabled with benchmarking
  - Average annual energy savings of 2.4%[1]
- Costs- free or **$**

[1]Portfolio Manager DataTrends Series, EPA, 2012

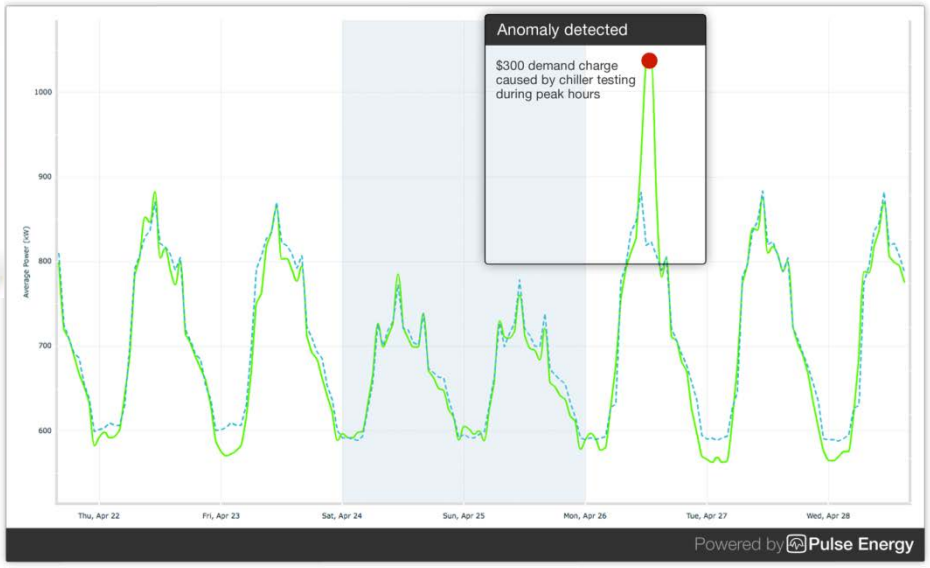
Energy Information System (EIS) and Advanced EIS

- A web-based tool to display and analyze **interval whole-building and submetered energy data**
- EIS applications
  - Data **visualization** (i.e. energy dashboard)
  - Whole building & submeter level energy **tracking & benchmarking**
  - **Peak** load **analysis**
- Advanced EIS applications
  - **Automated** interval data **analysis** with **baseline modeling**
    - Energy anomaly detection (i.e. scheduling, changes in load profile, excessive energy use)
    - Project savings verification
    - Cumulative sum



Energy Information System (EIS) and Advanced EIS

EIS, a bar graph tracking energy consumption pattern



Advanced EIS, a time series graph identifying excessive energy use with a predictive energy model

Graphic Source: Lucid Design Group (left) Pulse Energy (Right)

Energy Information System (EIS) and Advanced EIS

Examples

EIS

Advanced EIS

- Obvius Building Manager Online
- Lucid BuildingOS
- Noveda Energy Flow Monitor
- NorthWrite Energy Worksite
- IBIS
- EnerNOC EfficiencySmart
- Schneider Energy Operation
- EFT Energy Manager
- eSight Enterprise

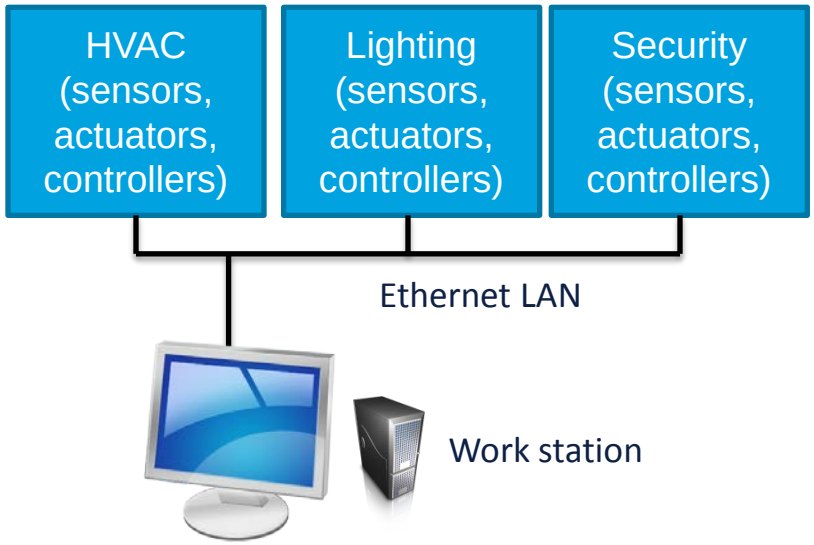
- Benefits
  - Provide **granular energy consumption** history and patterns
  - **Adjust** electrical **demand** in **real time**
  - Make alarms when **energy exceeds the expectation**
  - Take **weather and occupancy changes** into account
- Energy savings enabled with EIS[1]
  - Median annual portfolio savings of 8%
  - Range in annual portfolio savings of 0-33%
- Costs-**$$** to **$$$**
  - Up-front and ongoing software costs
  - Median **5-yr software** cost for a **portfolio**
    - $3600/bldg, $0.06/sf, $1800 /pt[1]

[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

Building Automation System (BAS)

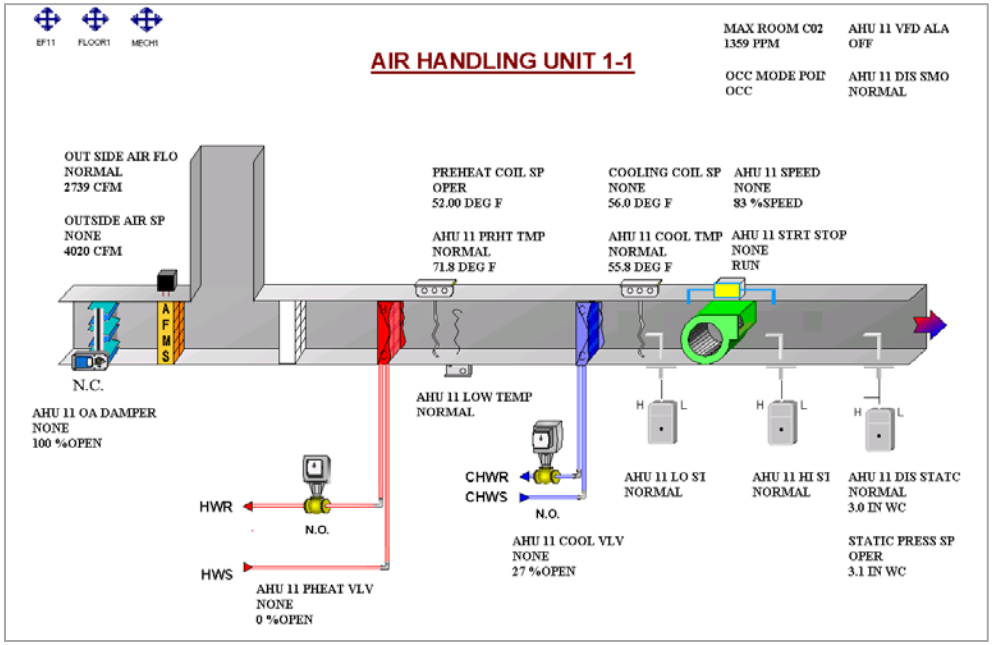
- A tool to **operate building** HVAC, and possibly lighting and security **systems**, using e.g., controllers, sensors, and actuators
- **Interval system** or **component** data
- Applications
  - Maintain indoor temperature, humidity, lighting conditions
  - Troubleshoot system-level performance
  - Modern BAS can be programed to tracking key *system* performance metrics[1]
    - Cooling plant efficiency (kW/ton)
    - Heating plant efficiency (%)
    - Outside air ventilation (cfm/person)

15-minute and ***less interval*** **system** or **component** data (i.e. air temp.& pressure, lighting levels, VFD speed)

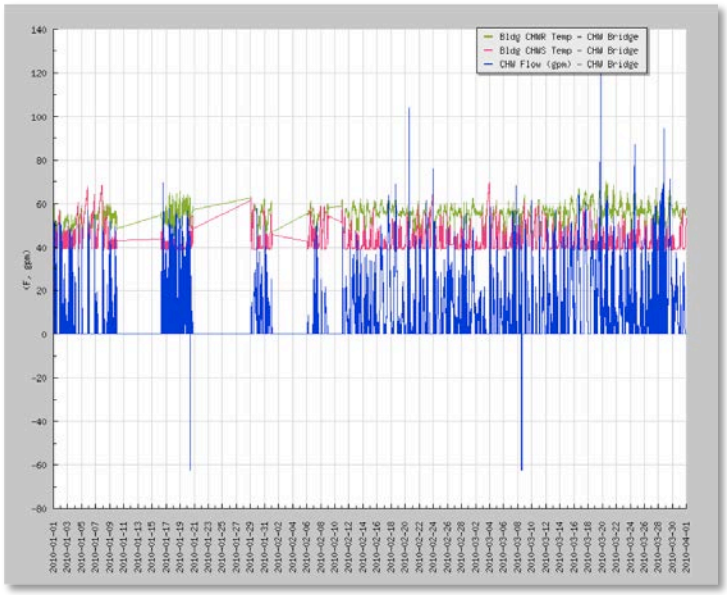


[1]The building performance tracking hand book, CaCX, 2011

Building Automation System (BAS)



BAS, a screenshot of an AHU with system parameters



BAS, a trend graph showing chilled water supply and return temperatures, and flow, 5-min samples

Graphic Source: Siemens (left), Automated Logic (right)

Building Automation System (BAS)

Examples

- Siemens Apogee
- Johnson Control Metasys
- Honeywell Enterprise Buildings Integrator™
- Emerson DeltaV
- Schneider Electric TAC Vista
- Novar Opus EMS
- Tridium Niagara
- Automated Logic WebControl

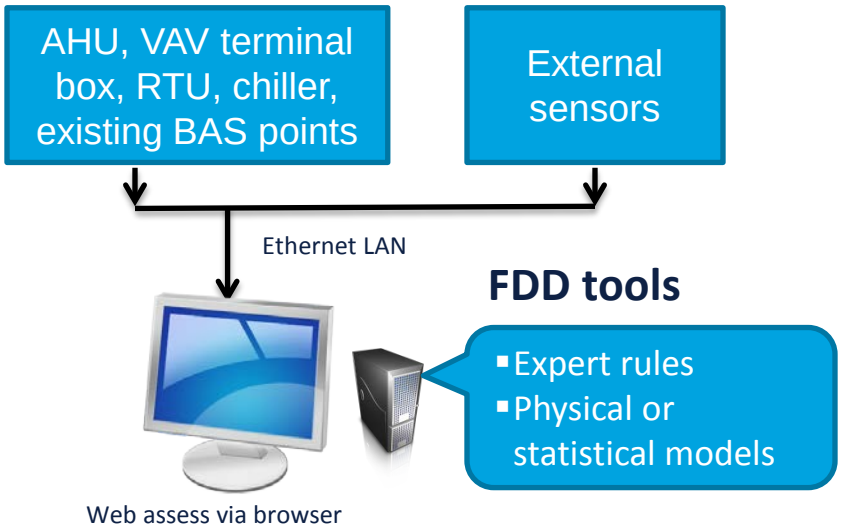
- Benefits
  - Improves **occupant comfort**
  - Monitors **system operational parameters** (e.g., setpoints, schedules)
  - Enables implementing **efficient control** strategies
- Energy savings enabled
  - 10-15% result from installation of a new BAS[1]
- Costs
  - New BAS - **$$$$**, average $4.00/sf, $1100 /pt[1]
  - Data integration, calibration to perform system tracking with existing BAS - **$-$$**[2]

[1]Enhanced automation – technical options guidebook, CEC, 2003
[2]The building performance tracking hand book, CaCX, 2011

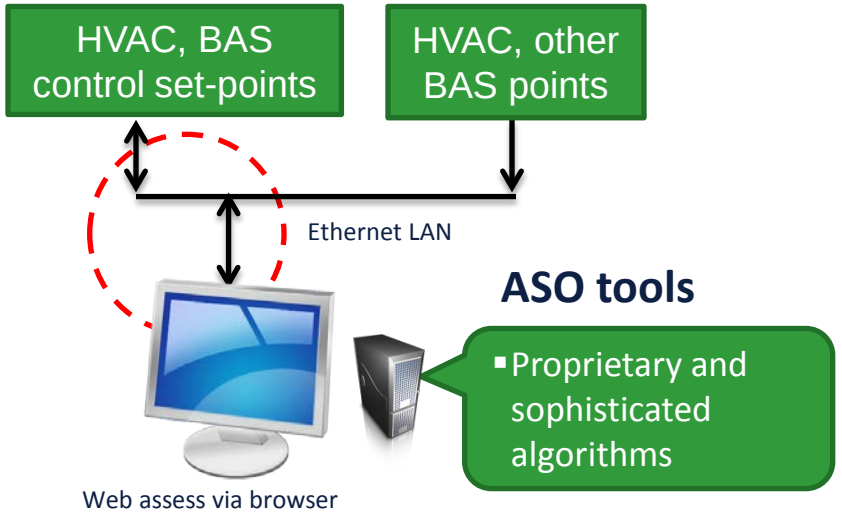
Fault Detection and Diagnosis (FDD) & Automated System Optimization (ASO)

- **Interval system** or **component** data
- FDD – a tool to automatically identify HVAC **system** or **equipment level faults**, and sometimes isolate **root causes**
- ASO – a tool to dynamically **change** HVAC BAS **settings to optimize** energy use and/or comfort

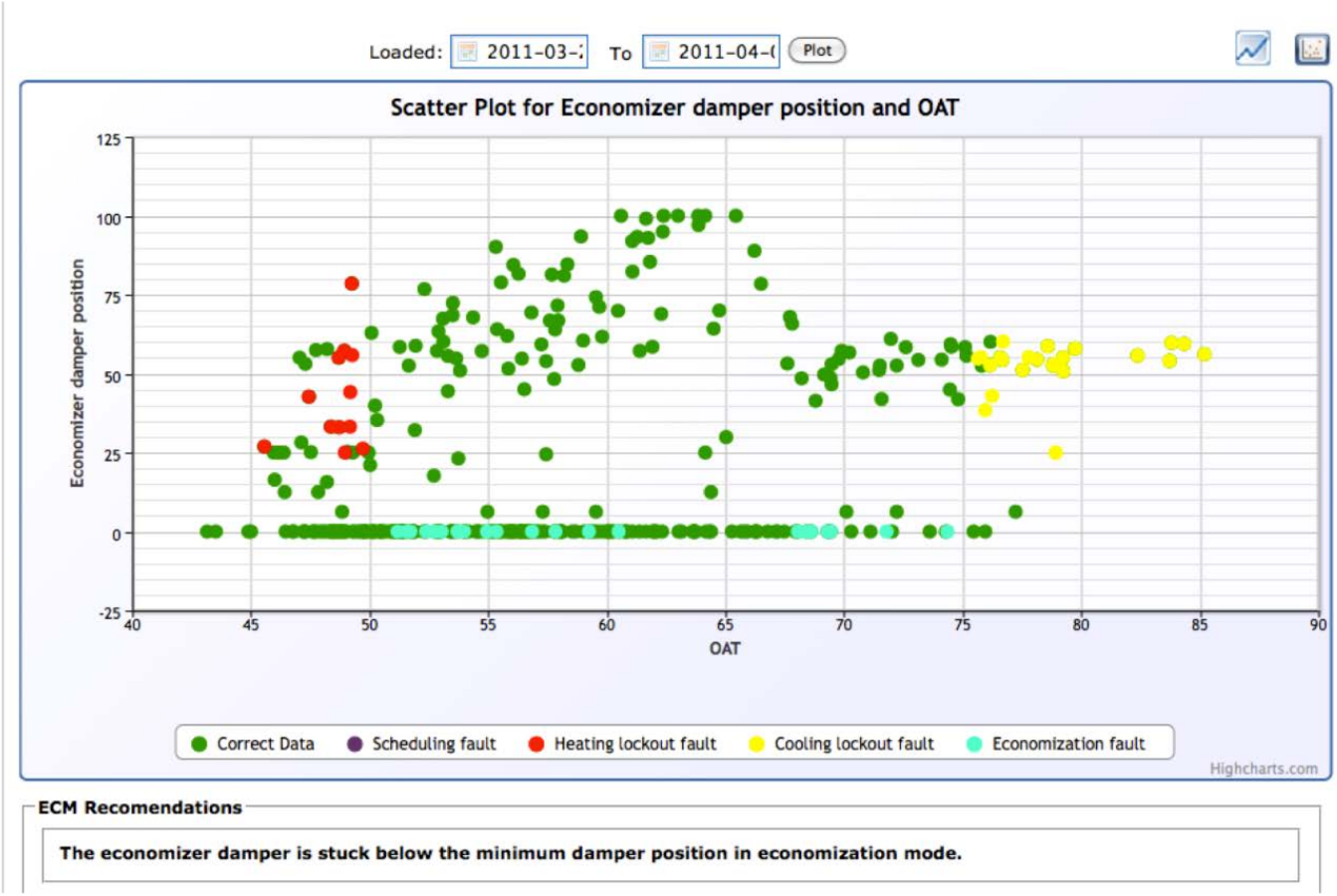
15-minute and ***less interval*** **system** or **component** data (i.e. air temp.& pressure, airflow rate, VFD speed)



15-minute and ***less interval*** **system** or **component** data (i.e. air temp.& pressure, VFD speed)



Fault Detection and Diagnosis (FDD)



Rule-based Automated FDD software, a screenshot showing identified economizer faults, cooling/heating lockout

Graphic Source: Serious Energy

Fault Detection and Diagnosis (FDD)

Examples

- Cimetrics InfoMetrics
- EZENICS
- Sky Foundry Sky Spark
- ClimaCheck
- Schneider Building Analytics
- FDSI Insight

- 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
  - Faults can increase *HVAC* energy use by up to 30%[1], or *whole building* energy use by 2-11%[2]
- Costs-**$$$**
  - Hardware investment and labor to set-up & tuning
  - High configuration costs to custom FDD rules for non-standard HVAC system

[1] Brambley, R. G. Pratt, D. P. Chassin, and S. Katipamula, Diagnostics for outdoor air ventilation and economizers, ASHRAE Journal 40(10) (1998) 49-55
[2] TIAXLLC, , Energy impact of commercial building controls and performance diagnostics, (2005)

State of the Technologies

- Benchmarking and utility analysis, mature technologies, under used
- BAS, mature technologies, common in larger buildings
- EIS, rapidly evolving, emerging technology, early stages of adoption
- FDD, still maturing, increasingly offered in advanced EIS
- ASO, still maturing, limited number of offerings on the market

Selecting a Technology: Summary of EMIS Tools

	EMIS tools	Data scope	Key uses	Costs	Energy Savings
Whole building	**Benchmarking & Utility Bill Analysis**	Monthly utility bills	▪ Peer-to peer comparison ▪ Utility bill analysis	Free - $	2.4% (median) (whole building, enabled savings)
Whole building & system	**EIS & Advanced EIS**	Hourly or 15-min meter data	▪ Energy dashboard/kiosk ▪ Benchmarking ▪ Energy anomalies alert ▪ Demand response ▪ Auto M&V	$$-$$$	8% (median), 0-33% (range) (whole building, enabled savings)
System	**BAS**	15-min or less interval sub-system data	▪ Building system control ▪ Manually troubleshooting by investigating trends	$$$$	10-15% (whole building)
	FDD		▪ Auto system or component fault notification ▪ Fault causes identification	$$$	2-11% (whole building, potential savings)
	ASO		▪ Optimal HVAC settings prediction	$$$	-

Adopting an EMIS

Determining a Performance Monitoring Approach & Selecting a Tool(s)

- Set organizational goals
- Establish roles & responsibilities
- Understand organizational conditions
- Define activities to meet goals
- Identify required sensing, metering
- Select a tool(s)

Set quantifiable performance goals

- Goal examples
  - Lower energy use by 20% over the next 3 years
  - Achieve a building EUI of 70 kBtu/sqft/year
  - Achieve an EPA ENERGY STAR rating of 75
- Benchmarking can help in setting goals
  - Comparing EUI to past performance, similar buildings with data from U.S. CBECS data or through online tools (e.g. ENERGY STAR, EnergyIQ)
  - Comparing energy cost per square feet either to historical performance or to regional peers
- See Primer on Organizational Use of EMIS for more information :

http://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/A_Primer_on_Organizational_Use_of_EMIS_V1.1.pdf

Determining a Performance Monitoring Approach & Selecting a Tool(s)

- Set organizational goals
- **Establish roles & responsibilities**
- Understand organizational conditions
- Define activities to meet goals
- Identify required sensing, metering
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- Define roles and responsibilities
  - Who will do what
    - Energy and sustainability managers
    - Operations and maintenance staff
    - Third-party service contractor
  - How often
  - What is the accountability and reporting structure
  - What are the central vs. on-site duties

Determining a Performance Monitoring Approach & Selecting a Tool(s)

- Set organizational goals
- Establish roles & responsibilities
- **Understand organizational conditions**
- Define activities to meet goals
- Identify required sensing, metering
- Select a tool(s)

- Understand facilities and personnel
  - Building characteristics
    - Building size & energy spend, small vs. large
    - Number of sites, a few vs. large portfolio
    - Geographic diversity, close vs. dispersed, aggregated into campuses
  - System conditions
    - Meters, sensors & other monitoring infrastructure
    - Operations, high level controls, schedules
  - Data resources
    - Utility bills vs. interval data, centralized BAS trend logs
  - Staff knowledge base

Determining a Performance Monitoring Approach & Selecting a Tool(s)

- Set organizational goals
- Establish roles & responsibilities
- Understand organizational conditions
- **Define activities to meet goals**
- Identify required sensing, metering
- Select a tool(s)

- Define specific monitoring & analysis activities, e.g.,
  - Track monthly performance, refer worst for further investigation
  - Conduct monthly review meetings for accountability
  - Detect energy anomalies and respond daily
  - Conduct continuous Cx of HVAC and lighting
  - Document and verify project-specific savings, progress toward the goal annually

Determining a Performance Monitoring Approach & Selecting a Tool(s)

- Set organizational goals
- Establish roles & responsibilities
- Understand organizational conditions
- Define activities to meet goals
- **Identify required sensing, metering**
- Select a tool(s)

- Consider sensing and metering issues
  - Think about the degree to which energy use/operational parameters are captured
    - Whole-building
    - System level
    - Panel/sub-panel level
    - Circuit level
    - Component level
  - Types of measuring needed for planned activities
    - Electricity, natural gas, steam, water meters
    - Temperature, pressure, and flow sensors
  - Identify supplemental measuring needed

Determining a Performance Monitoring Approach & Selecting a Tool(s)

- Set organizational goals
- Establish roles & responsibilities
- Understand organizational conditions
- Define management activities
- Identify required sensing, metering
- **Select a tool(s)**

Select a tool or set of tools

- Investigate market offerings & existing technology review resources
- Look for examples from your industry with similar scope and objectives
- Develop a specification of key technology requirements

EMIS Best Practices

EMIS Use Best Practices #1

- Scaling EMIS usage in a portfolio
  - Start with monthly tracking or whole-building interval data analysis, then move into system-specific investigations
  - Begin with the features that only require existing data, or data with little additional cost and effort
  - Begin small, with a pilot to demonstrate effectiveness, then expand it in the portfolio
  - Standardization (e.g. data format, name convention) supports scaling

EMIS Use Best Practices #2

- Managing and responding to EMIS findings
  - Integrate of EMIS into standard business practices
  - Allocate sufficient labor hours to *regularly review* EMIS analysis and reporting, detect anomalies
  - Establish a *standard* set of *processes* to take actions to fix problems identified
  - Communicate the results to organization leadership and employees

EMIS Use Best Practices #3

- Managing cash flow
  - "Triage" portfolios by focusing on sites with highest EUI
  - Implement *no- and low-cost* measures first
  - Identify project "bundles" of like-measures that can be deployed across many sites in a single effort
  - Use EMIS to quantify achieved savings and to justify future efforts
  - Consider participation in demand response programs to generate additional revenue

What's Next?

What's Next?

- Voluntary campaign to increase adoption of EMIS, ongoing commissioning, FDD for cost-effective energy savings.

- Planning underway, launching back half of CY'16.

- Participants will receive **resources** and **technical assistance** from Lab and apply for recognition **awards**
- Areas of assistance:
  - How to justify EMIS
  - How to set up, configure
  - How to get value over time
  - How to make best use of data
- Contact us today to find out more and participate!

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THANK YOU

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