Better Buildings
U.S. DEPARTMENT OF ENERGY

EMIS: Crash Course

Jessica Granderson, Guanjing Lin, Erin Hult
Lawrence Berkeley National Laboratory

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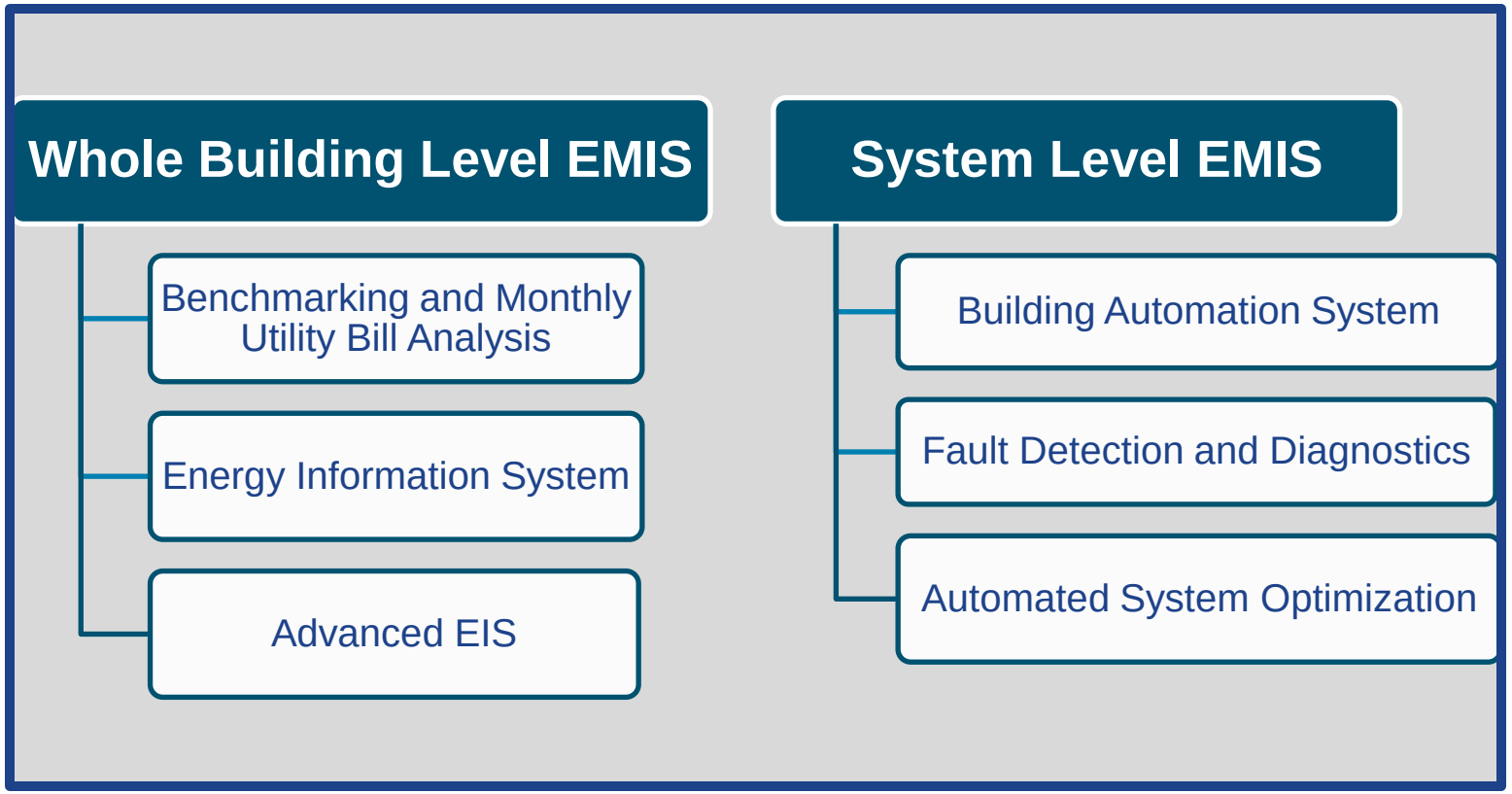
U.S. DEPARTMENT OF ENERGY

Crash Course Outline

- What is EMIS
- EMIS Family
  - Benchmarking and Monthly Utility Bill Analysis
  - EIS and Advanced EIS
  - Building Automation System
  - FDD and ASO
- Selecting a Tool
- Conclusions

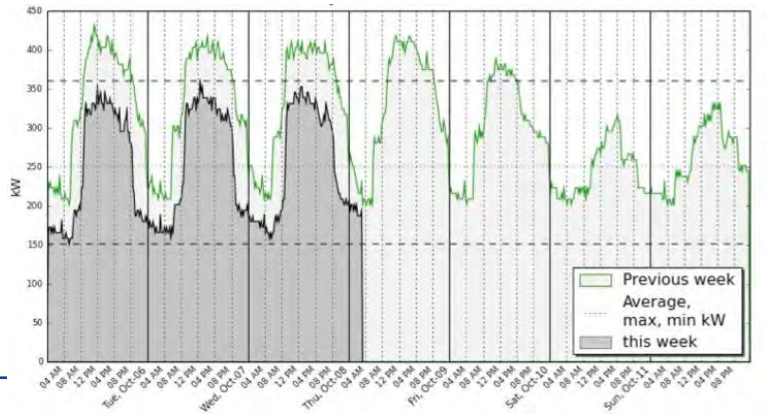
What is EMIS?

Energy Management Information Systems (EMIS)



Motivation

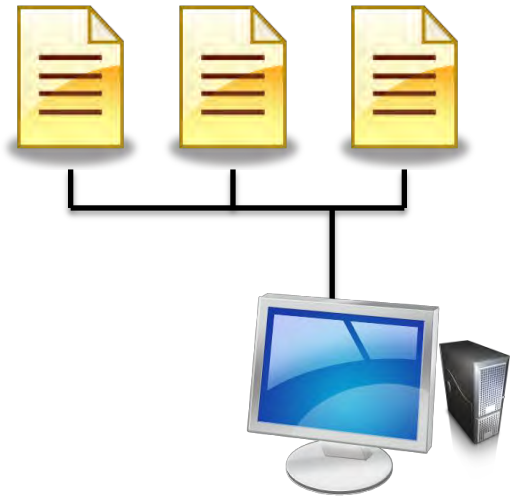
- Energy performance monitoring and reporting has come to the forefront of the national energy dialogue
  - Zero-energy and smart grid initiatives
  - EISA 2007, federal and state labeling and reporting mandates
- Optimal performance requires higher granularity data, more timely analysis than monthly utility bills
- Energy Management and Information Systems (EMIS), broad family of tools that store, analyze, and display energy use or building systems data



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

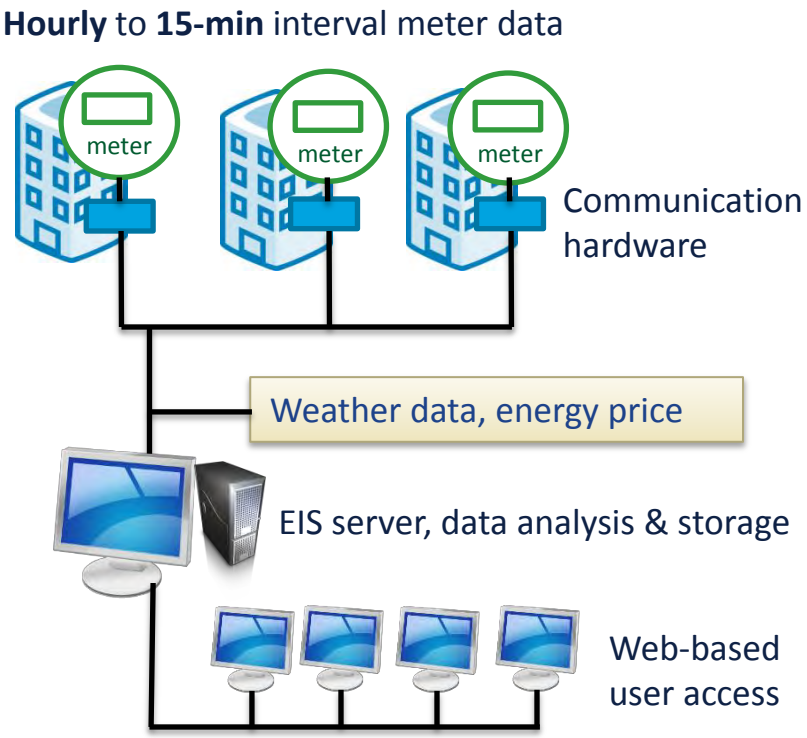
- EPA Portfolio manager
- EnergyCAP
- Ecova
- Facility Dude
- Metrix
- NOESIS
- Energy Print
- FirstView

- 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 Building Dashboard
- Noveda Energy Flow Monitoring
- NorthWrite Energy Worksite
- Pulse Energy
- IBIS
- EnerNOC EfficiencySmart
- Schneider Energy Operation
- JCI Panoptix
- EFT Energy Manager
- eSight Enterprise

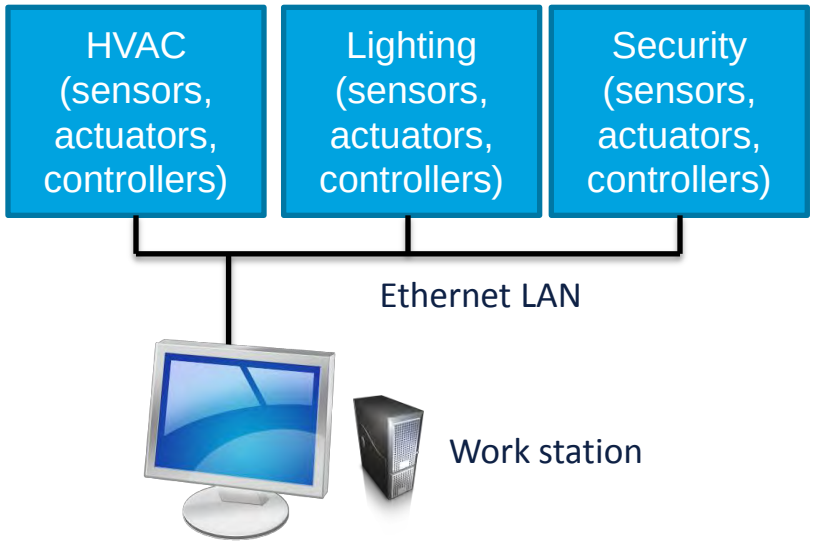
- Benefits
  - Provide **granular energy consumption** history and patterns
  - **Adjust** electrical **demand** in **real time**
  - Make alarms when **energy exceeds the expectation**
  - Take **weather and occupancy changes** into account
- Energy savings enabled with EIS[1]
  - Median annual portfolio 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)

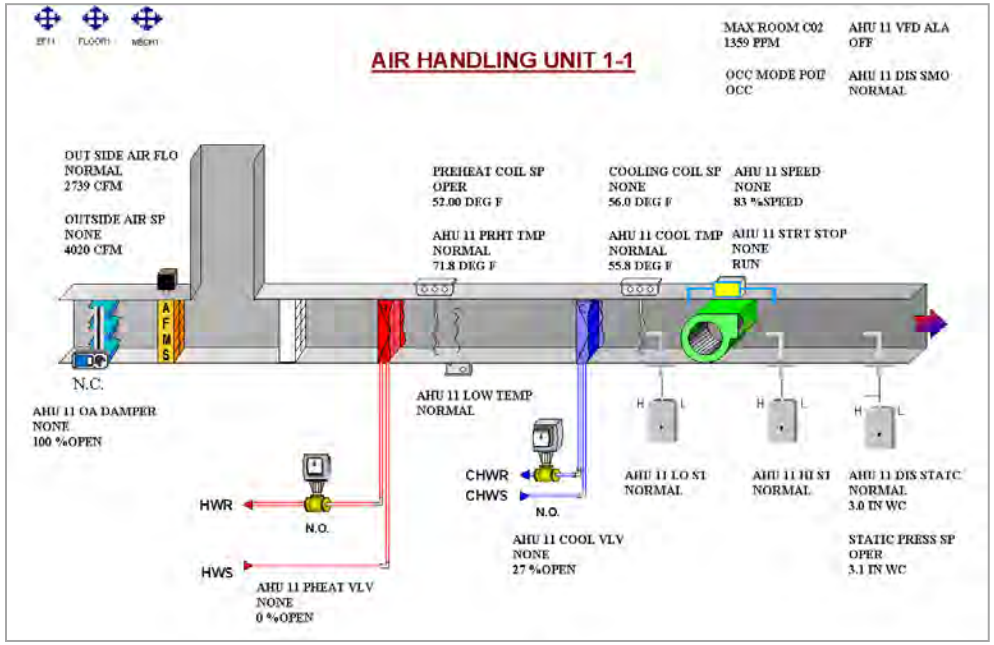
- A tool to **operate building** HVAC, and possibly lighting and security **systems**, using e.g., controllers, sensors, and actuators
- **Interval system** or **component** data
- Applications
  - Maintain indoor temperature, humidity, lighting conditions
  - Troubleshoot system-level performance
  - 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

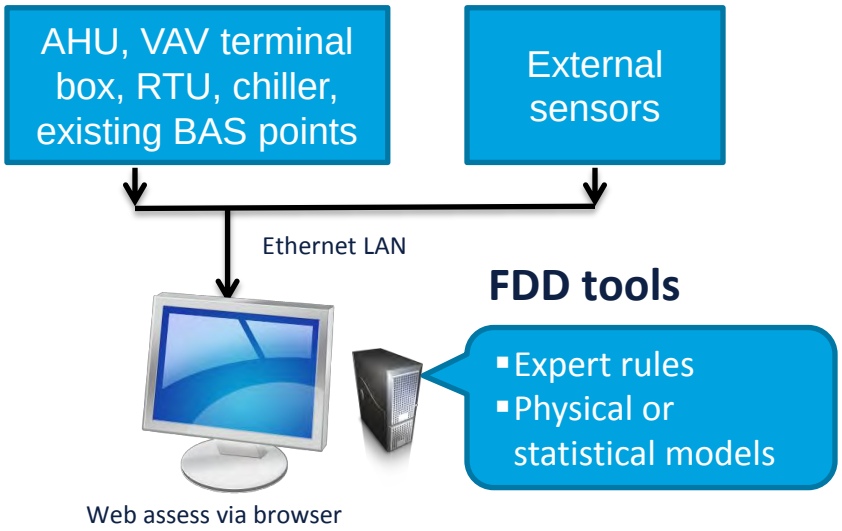
- Benefits
  - Improves **occupant comfort**
  - Monitors **system operational parameters** (e.g., setpts, schedules)
  - Enables implementing **efficient control** strategies
- Energy savings enabled
  - 10-15% result from installation of a new BAS[1]
- Costs
  - New BAS - **$$$$**, average $4.00/sf,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



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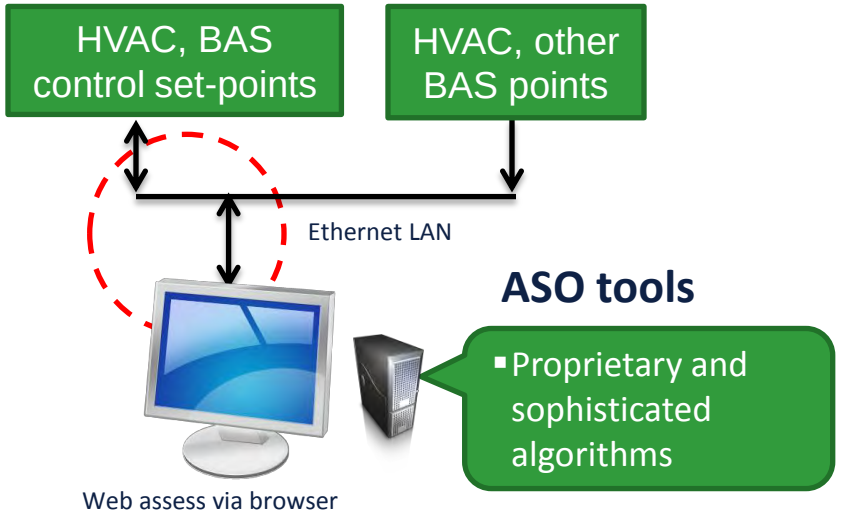
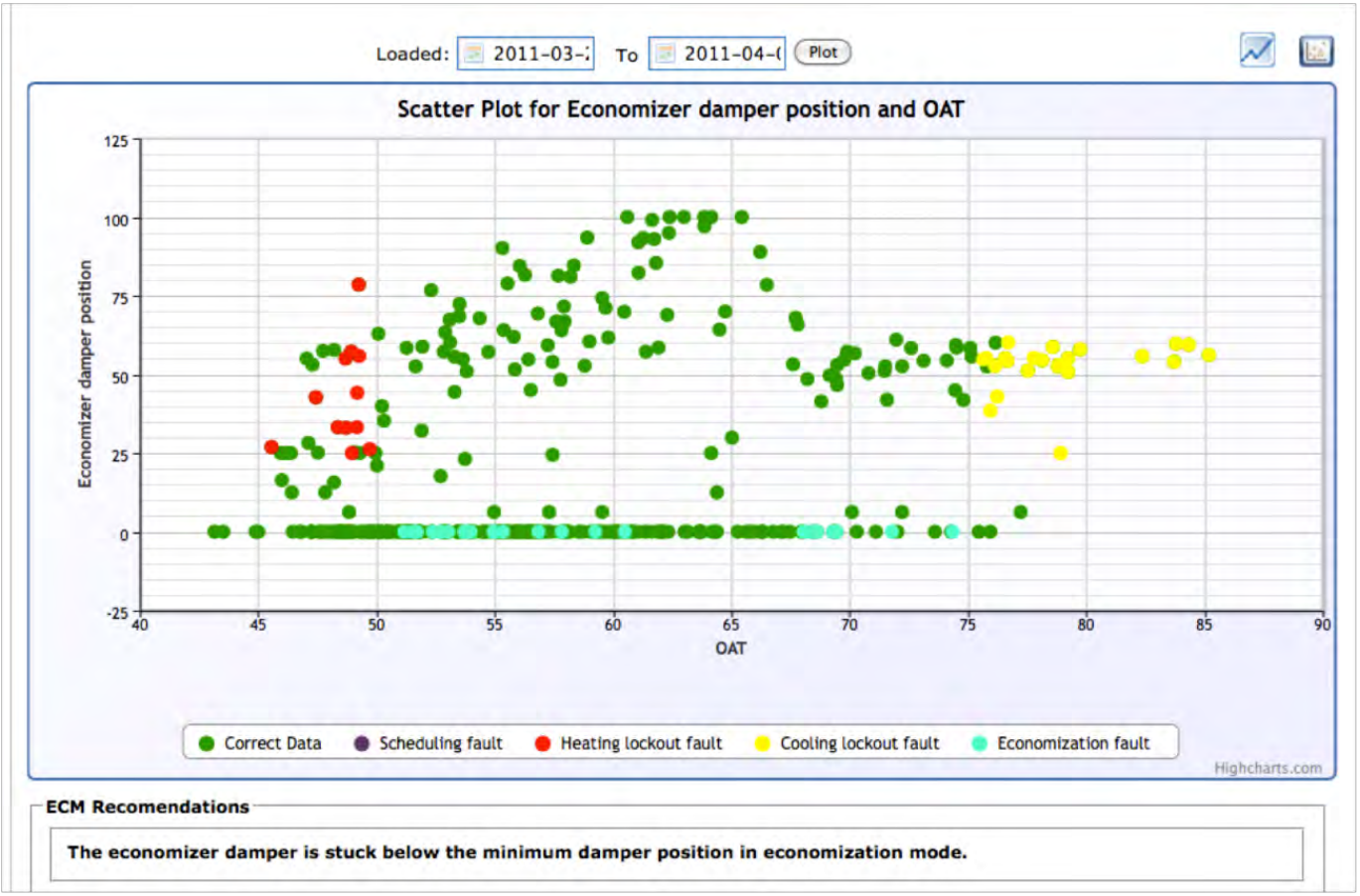


Fault Detection and Diagnosis (FDD)



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

Graphic Source: Serious Energy

Fault Detection and Diagnosis (FDD)

Examples

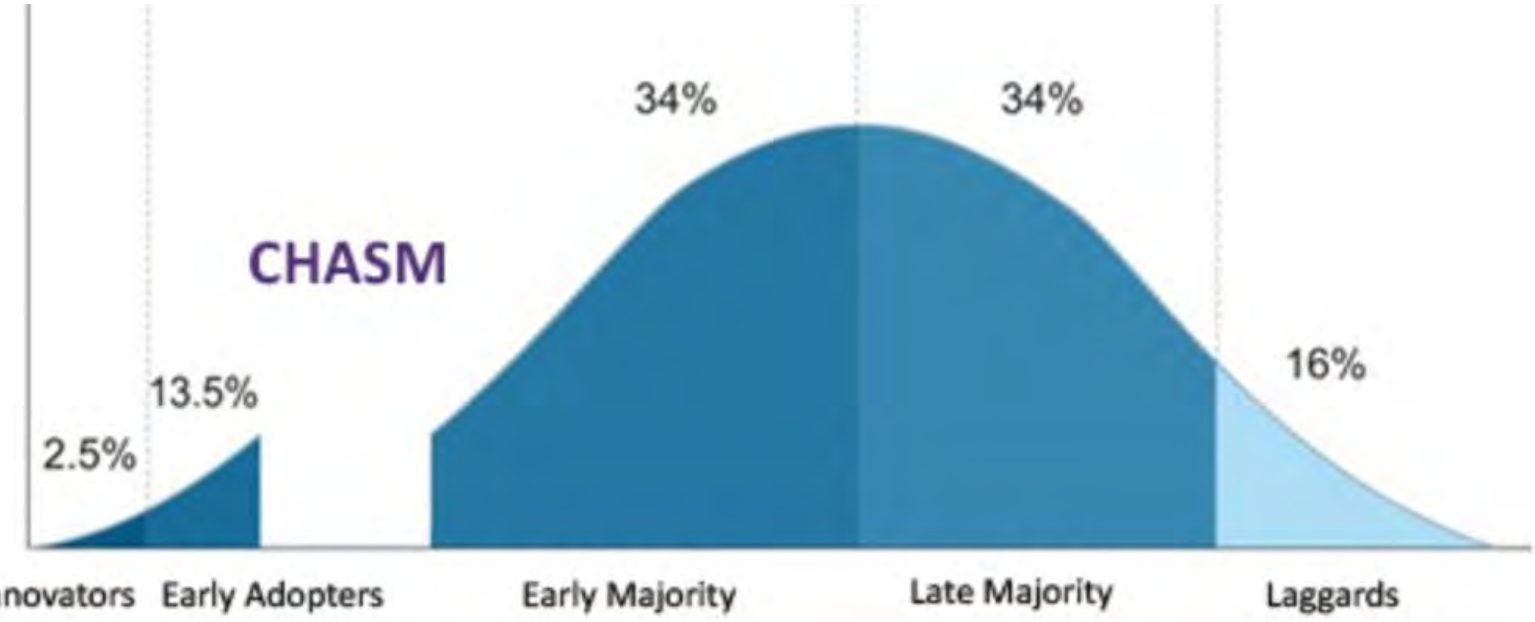
- Cimetrics InfoMetrics
- EZENICS
- Sky Foundry Sky Spark
- ClimaCheck
- Sensus MI
- FDSI Insight
- EffTec EffTrack

- 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 Tools

- 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 Tool: 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	$$$	-

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

CBECS: Commercial Building Energy Consumption Survey

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 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

Conclusions

- EMIS include
  - Whole building energy focus tools: benchmarking, EIS, and advanced EIS
  - System focus tools: BAS, FDD, and ASO
- Benchmarking and utility bill analysis are low-cost tools to track and analyze monthly energy data
- EIS and advanced EIS are moderate to expensive tools to track and analyze interval energy data (hourly or less)
- BAS, FDD, and ASO are moderate to expensively priced tools to track and analyze system and component operational parameters
- In selecting a tool, consider
  - Organizational goals, roles and responsibilities, current facility characteristics, specific energy management activities, and measurement needs

THANK YOU

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Jessica Granderson
JGranderson@lbl.gov
510.486.6792

Guanjing Lin
GJLin@lbl.gov
510.486.5979