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.

**Whole Building Level EMIS**
- Benchmarking and Monthly Utility Bill Analysis
- Energy Information System
- Advanced EIS

**System Level EMIS**
- Building Automation System
- Fault Detection and Diagnostics
- Automated System Optimization

* 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

- Fault Detection and Diagnostics
- Benchmarking and Monthly Utility Bill Analysis
- 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 $
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**

- 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\(^1\)

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\(^1\)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 programmed to tracking key **system** performance metrics
    - 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)

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1The building performance tracking hand book, CaCX, 2011
Building Automation System (BAS)

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

BAS, a screenshot of an AHU with system parameters

Graphic Source: Siemens (left), Automated Logic (right)
Building Automation System (BAS)

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 - $-$$\(^2\)

Examples
- Siemens Apogee
- Johnson Control
- Honeywell
- Emerson DeltaV
- Schneider Electric TAC Vista
- Novar Opus EMS
- Tridium Niagara
- Automated Logic WebControl

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\(^1\)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
  
  *15-minute* and *less interval system* or *component* data (i.e. air temp.& pressure, airflow rate, VFD speed)

  - **FDD tools**
    - **Expert rules**
    - **Physical or statistical models**

  - **AHU, VAV terminal box, RTU, chiller, existing BAS points**
  - **External sensors**
  - **Ethernet LAN**
  - **Web assess via browser**

  ![FDD tools diagram]

- 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, VFD speed)

  - **ASO tools**
    - **Proprietary and sophisticated algorithms**

  - **HVAC, BAS control set-points**
  - **HVAC, other BAS points**
  - **Ethernet LAN**
  - **Web assess via browser**

  ![ASO tools diagram]
Fault Detection and Diagnosis (FDD)

Rule-based Automated FDD software, a screenshot showing identified economizer faults, cooling/heating lockout
Fault Detection and Diagnosis (FDD)

**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\(^\text{%}\)^\(^1\), or whole building energy use by 2-11\(^\text{%}\)^\(^2\)

**Costs-$$**
- Hardware investment and labor to set-up & tuning
- High configuration costs to custom FDD rules for non-standard HVAC system

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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

<table>
<thead>
<tr>
<th>EMIS tools</th>
<th>Data scope</th>
<th>Key uses</th>
<th>Costs</th>
<th>Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Whole building</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benchmarking &amp; Utility Bill Analysis</td>
<td>Monthly utility bills</td>
<td>• Peer-to peer comparison</td>
<td>Free - $</td>
<td>2.4% (median) (whole building, enabled savings)</td>
</tr>
<tr>
<td>EIS &amp; Advanced EIS</td>
<td>Hourly or 15-min meter data</td>
<td>• Energy dashboard/kiosk</td>
<td>$$-$-$$</td>
<td>8% (median), 0-33% (range) (whole building, enabled savings)</td>
</tr>
<tr>
<td>BAS</td>
<td>15-min or less interval sub-system data</td>
<td>• Building system control</td>
<td>$$$$</td>
<td>10-15% (whole building)</td>
</tr>
<tr>
<td>FDD</td>
<td></td>
<td>• Auto system or component fault notification</td>
<td>$$$</td>
<td>2-11% (whole building, potential savings)</td>
</tr>
<tr>
<td>ASO</td>
<td></td>
<td>• Optimal HVAC settings prediction</td>
<td>$$$</td>
<td>-</td>
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**Note:** Costs are approximate and subject to change. Energy savings may vary based on building characteristics and operational methods.
Adopting an EMIS
Determining a Performance Monitoring Approach & Selecting 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:

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

Set organizational goals

Establish roles & responsibilities

Understand organizational conditions

Define activities to meet goals

Identify required sensing, metering

Select a tool(s)
Determining a Performance Monitoring Approach & Selecting 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

- 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)

- **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

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EMIS Best Practices
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
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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