Better Buildings
U.S. DEPARTMENT OF ENERGY

Synthesis of EMIS Resources

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Supported by the DOE Building Technologies Office, K. Taddonio and A. Jiron

U.S. DEPARTMENT OF ENERGY

Resource Contents

- Summary of ~40 publications

The energy management process	•How to plan an energy management program?
Existing building commissioning	•What is Existing Building Commissioning (EBCx)? •What is the role of EMIS in EBCx?
Technology descriptions, business case	•What is an Energy Management Information System (EMIS)? •What are the benefits and costs?
Technology evaluations, vendor lists	•What are the market offerings? •How is the functionality compared to peers?
Hardware needs	•What are the hardware needs for EMIS? •How is a metering plan defined?
Analysis approaches	•What analyses can be applied using EMIS?
Tool applications, best practices	•What lessons could be learned from others?

Resource Template

Image

Title: xxxx, year

Summary: xxxx

Highlights: (three conclusive sentences)

- xxxx
- xxxx
- xxxx

Key words: single-word descriptors that characterize the resource and its content

Authors/Publisher: XXXX

Category: [Standard, Specification][Handbook, Guidebook][Technical report] [Case study, Fact sheet]

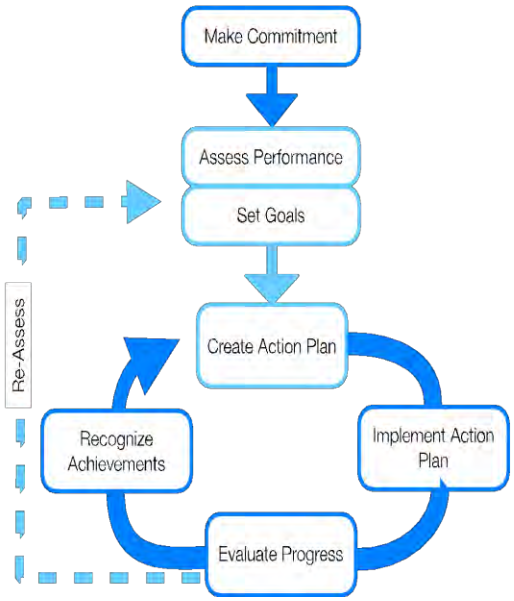
Availability: Download from [URL]

[Journal name][URL]

For purchase from XXX consulting company [URL]

For general purchase

Energy Management Process



Title: ENERGY STAR Guidelines for Energy Management, 2013

Summary: This guideline contains a step-by-step roadmap for continuous improvement, based on best practices from the nation's leaders in energy management.

Highlights:

- Understanding current energy use is critical for identifying opportunities.
- Performance goals promote continuous energy improvement.
- Reaching the goals depends on the people who implement the projects.

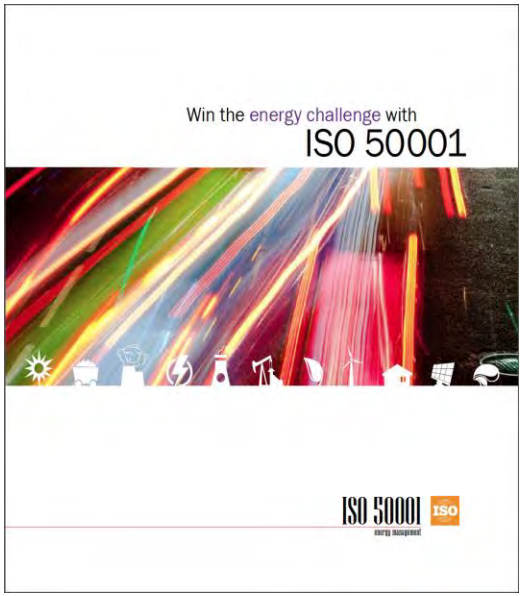
Key words: Energy management framework

Publisher: U.S. Environmental Protection Agency

Category: Handbook, Guidebook

Availability: Download from http://www.energystar.gov/buildings/tools-and-resources/energy-star-guidelines-energy-management

Energy Management Process



Title: Win the Energy Challenge with ISO 50001, 2011

Summary: This document provides an overview of the content, targeted audiences, and benefits of ISO 50001, an international standard specifying requirements of an "energy management system" for energy efficiency-focused organizations.

Highlights:

- ISO 50001 provides benefits for small and large organizations in industrial and commercial sectors.
- ISO 50001 is based on the Plan-Do-Check-Act continual improvement framework.
- ISO 50001 focuses on business practices and processes to operationalize continuous energy management.

Key words: Energy management framework

Publisher: International Organization for Standardization

Category: Standard, Specification

Availability: Download from http://www.iso.org/iso/home/standards/management-standards/iso50001.htm

Existing Building Commissioning

FINAL REPORT

Monitoring-Based Commissioning:
Benchmarking Analysis of 24 UC/CSU/IOU Projects

Evan Mills, Ph.D.
Paul Mathew, Ph.D.

Lawrence Berkeley National Laboratory
Berkeley, California

Report Prepared for:
California Energy Commission
Public Interest Energy Research (PIER)
Technology Demonstration Program

June 2009

LBNL-1972E

Title: Monitoring-Based Commissioning: Benchmarking Analysis of 24 UC/CSU/IOU Projects, 2009

Summary: This report summarizes results from 24 campus MBCx projects. It also presents effective benchmarking metrics for project screening and post-completion evaluation, and a quality assurance checklist for data collection and processing.

Highlights:

- MBCx is an approach that combines permanent building-energy-system monitoring with standard EBCx practices to provide substantial, persistent energy savings.
- A reliable way to maximize the absolute level of savings is to target projects for implementation at high energy use intensity (EUI) sites.
- Across the 24 campuses, MBCx resulted in median energy savings of 10%.

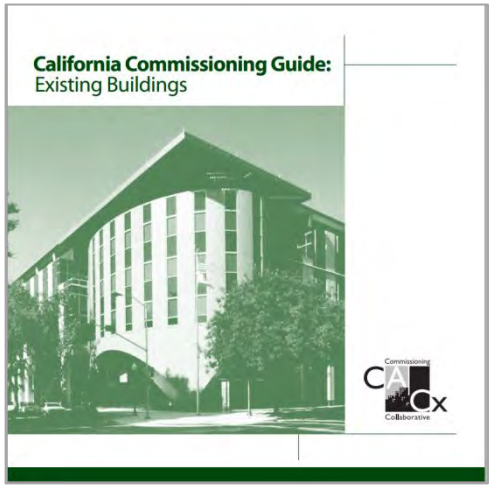
Key words: Commissioning, monitoring, benchmarking, data quality

Authors/Publisher: Mills and Mathew/Lawrence Berkeley National Laboratory

Category: Technical report

Availability: Download from
http://cx.lbl.gov/MBCx.html

Existing Building Commissioning



Title: California Commissioning Guide: Existing Buildings, 2006

Summary: This guide provides an overview of the existing building commissioning process and discusses the goals, benefits, and costs, in commercial buildings.

Highlights:

- The range of EBCx costs is $0.13–0.45/square foot (sq. ft.)
- The ranges of energy and non-energy savings from EBCx are $0.11–0.72/sq. ft. and $0.10–0.45/sq. ft., respectively.
- The typical EBCx process includes four phases: planning, investigation, implementation, and hand-off.

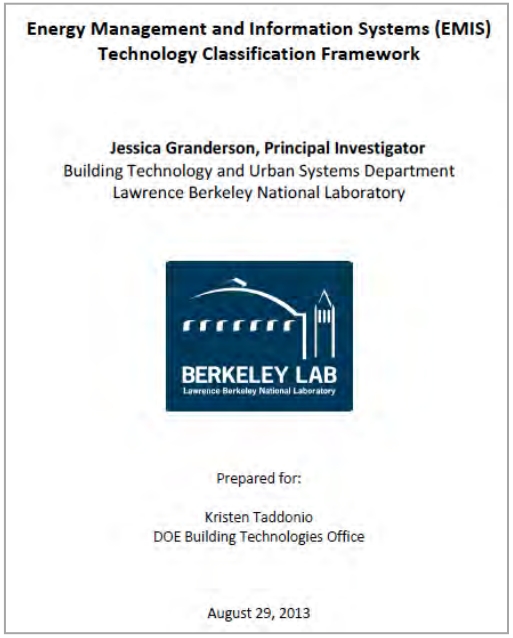
Key words: Commissioning, existing building, persistence of savings

Authors/ Publisher: Tudi Haasl et al./California Commissioning Collaborative

Category: Handbook, Guidebook

Availability: Download from http://www.cacx.org/resources/documents/CA_Commissioning_Guide_Existing.pdf

Technology Descriptions, Business Case


Energy Management and Information Systems (EMIS) Technology Classification Framework

Jessica Granderson, Principal Investigator
Building Technology and Urban Systems Department
Lawrence Berkeley National Laboratory

BERKELEY LAB
Lawrence Berkeley National Laboratory

Prepared for:

Kristen Taddonio
DOE Building Technologies Office

August 29, 2013

Title: Energy Management and Information Systems (EMIS) Technology Classification Framework, 2013

Summary: This report provides a common reference that can be used to understand key distinguishing factors and core attributes of different technologies in the EMIS family.

Highlights:

- Benchmarking and utility bill analysis are tools to track and analyze monthly energy data.
- EIS and advanced EIS are tools to track and analyze interval energy data (hourly or less).
- BAS, FDD, and ASO are tools to track and analyze system and component operational parameters

Key words: EMIS, terminology, whole-building focused, system focused

Author/Publisher: Jessica Granderson/Lawrence Berkeley National Laboratory

Category: Technical report

Availability: Download from http://www4.eere.energy.gov/alliance/sites/default/files/uploaded-files/emis-technology-classification-framework.pdf

Technology Descriptions, Business Case

Title: An Introduction to Energy Management Systems, 2012

Summary: This white paper covers all aspects of energy management information systems, including their definition, functionality, benefits, and decision process.

Highlights:

- Energy expenditures are one of the first considerations when making an EMIS purchase decision.
- Getting an EMIS for one building is different than procuring one for a campus or portfolio of buildings.
- EMIS benefits include reduced operational cost, increased productivity, enhanced brand image, and more.

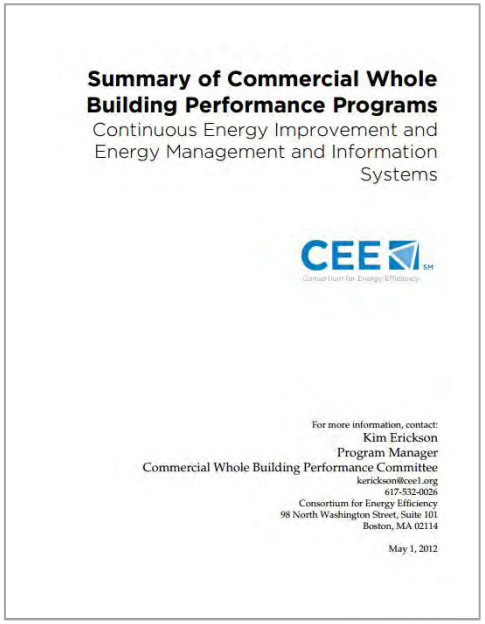
Key words: EMIS, benefits, decisionmaking process, benefits

Author/Publisher: Tom Machinchick/NOESIS Energy

Category: Handbook, Guidebook

Availability: Download from https://www.noesisenergy.com/site/content/introduction-energy-management-systems

Technology Descriptions, Business Case



Title: Summary of Commercial Whole Building Performance Programs, 2012

Summary: This report summarizes 24 whole building energy programs for commercial buildings implemented by utility organizations. For each program, the summary includes the role of EMIS, success factors, barriers, and lessons learned.

Highlights:

- The most common roles of EMIS in utility programs was to 1) identify energy savings opportunities, and 2) measure energy use and savings.
- Importance of training personnel is a common theme. "*EMIS is 90% about the people and 10% about the technology*" – Stakeholder Quote
- Buildings with 50,000 square feet or more are the target customers of 24 programs.

Key words: EMIS, utility programs, continuous energy improvement

Author/Publisher: Kim Erickson/Consortium for Energy Efficiency

Category: Technical report

Availability: Download from http://library.cee1.org/sites/default/files/library/9235/CEE_CommBldg_WBCEIEMISProgSummPublicVersion_1May2012_0.pdf

Technology Descriptions, Business Case

Title: Portfolio Manager DataTrends Series, 2012

Summary: Series of fact sheets showing trends in characteristics and performance of buildings benchmarked using the U.S. Environmental Protection Agency's Portfolio Manager tool to show how different buildings may benefit from benchmarking.

Highlights:

- Benchmarked buildings achieved on average 2.4% energy savings per year, with greatest savings in retail, office, and warehouse buildings.
- Higher EUI was correlated with higher achieved % energy savings.
- Key drivers of energy use include the number of operating hours, workers per square foot, and cooling degree days.

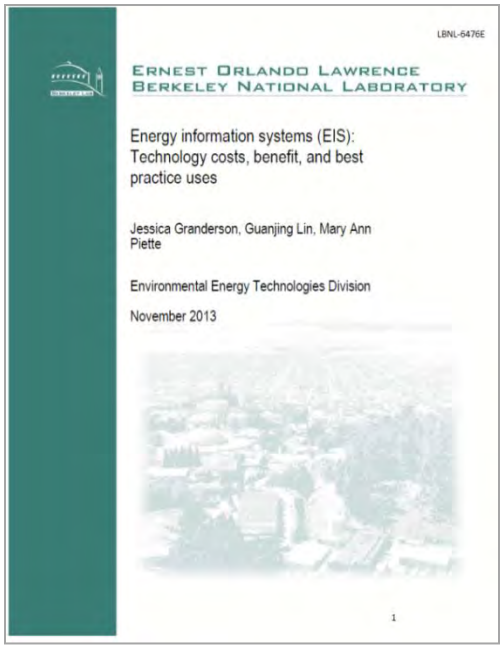
Key words: Benchmarking, energy use, Portfolio Manager

Publisher: U.S. Environmental Protection Agency

Category: Fact sheet, Case study

Availability: Download from http://www.energystar.gov/buildings/about-us/research-and-reports/portfolio-manager-datatrends

Technology Descriptions, Business Case



Title: Energy Information Systems: Technology Costs, Benefits, and Best Practice Uses, 2013

Summary: This report presents an assessment of the value proposition for EIS based on data from over two dozen organizations. It answers three common questions: what are the costs, what have users saved, and which practices drive deeper savings?

Highlights:

- Although capital projects were critical, median building and portfolio savings of 17% and 8%would not have been possible without use of the EIS.
- Median 5-yr cost of software ownership (excluding metering) is $150K, $1800/point, and .06$/sf.
- Extent of efficiency projects, EUI prior to EIS installation, and depth of metering were strongly associate with larger energy savings.

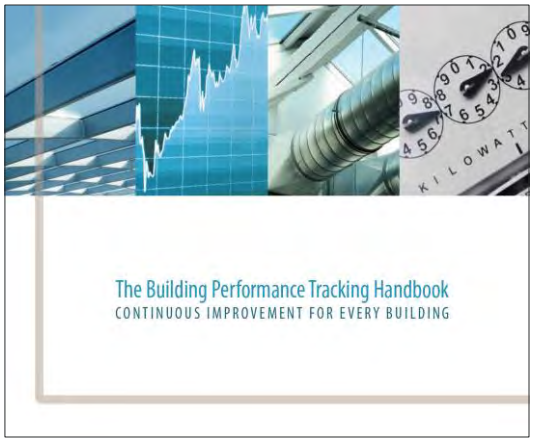
Key words: EIS, costs, energy savings, benefits, best practices

Authors/Publisher: Jessica Granderson et al./Lawrence Berkeley National Laboratory

Category: Technical report

Availability: Download from
http://eis.lbl.gov/pubs/lbnl-6476e.pdf

Technology Descriptions, Business Case



Title: Building Performance Tracking Handbook, 2011

Summary: This handbook presents the basic concepts behind building performance tracking: how it works, the business case, available tool types (i.e., benchmarking, EIS, FDD, and BAS), and common metrics. It puts the technical tools and concepts into understandable terms.

Highlights:

- Benchmarking and utility bill analysis are low-cost tools for monthly energy tracking.
- EIS and advanced EIS are moderate to expensive tools that provide hourly energy tracking and deeper insights than monthly tracking.
- Using existing BAS to track key operational performance metrics is an inexpensive way to manage system performance.

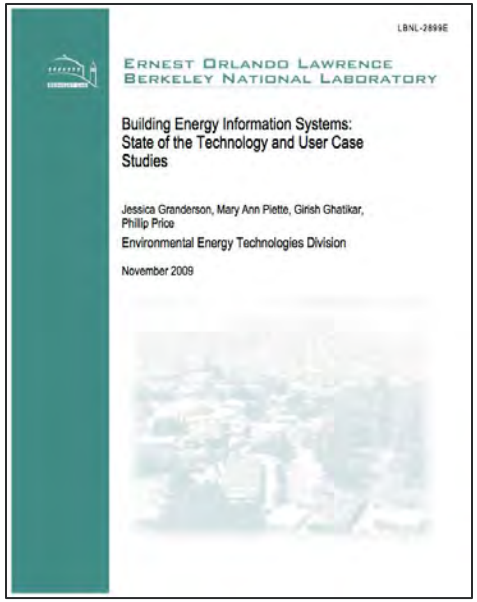
Key words: EMIS, whole building energy tracking, system energy tracking

Authors/Publisher: Portland Energy Conservation, Hannah Friedman et al./California Commissioning Collaborative

Category: Handbook, Guidebook

Availability: Download from http://www.cacx.org/PIER/handbook.html

Technology Descriptions, Business Case



Title: Building Energy Information Systems: State of the Technology and User Case Studies, 2009

Summary: This article defines an EIS characterization framework and then applies this framework to 30 commercial EIS tools and discusses how EIS are used in four case studies.

Highlights:

- Outlines distinguishing capabilities of EIS systems designed for visualization, energy analysis, advanced analysis, financial analysis, demand response, and remote control and management.
- The characterization framework includes feature descriptions that may help users identify and specify their needs.
- Three of four case studies reported wanting more engagement with the EIS, but had to contend with resource and staff constraints.

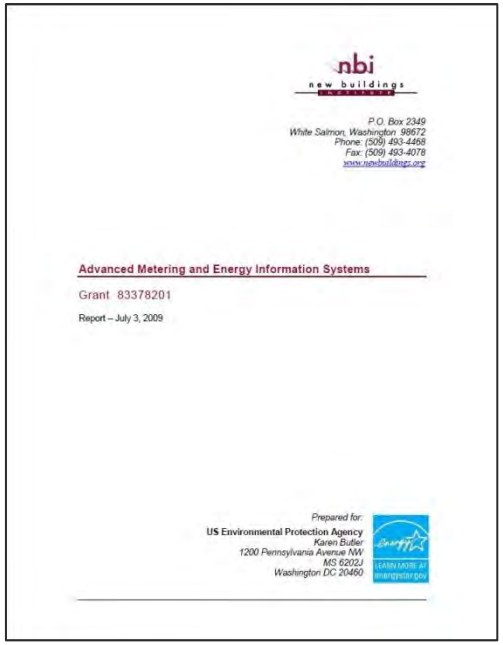
Key words: EIS, anomaly energy detection, performance monitoring

Authors/Publisher: Jessica Granderson et al./Lawrence Berkeley National Laboratory

Category: Technical report

Availability: Download from http://eis.lbl.gov/pubs/beis-case-studies.pdf

Technology Descriptions, Business Case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new buildings

P.O. Box 2349
White Salmon, Washington 98672
Phone: (509) 493-4468
Fax: (509) 493-4078
www.newbuildings.org

Advanced Metering and Energy Information Systems

Grant 83378201

Report – July 3, 2009

Prepared for:
US Environmental Protection Agency
Karen Butler
1200 Pennsylvania Avenue NW
MS 6202J
Washington DC 20460

Title: Advanced Metering and Energy Information Systems, 2009

Summary: This paper provides an overview of energy information system components (i.e., meter and sensors, data acquisition system, communication service, remote database, and software). It also characterizes the costs for a "basic" owner-installed EIS consisting of whole building electric and gas data.

Highlights:

- Internal energy data can come from owner-installed meters or utility meters.
- Meter installation costs can be estimated at $800 per electricity meter and $900 per natural gas meter.
- The total cost range of a "basic" EIS was $2,500–$4,000, with an annual ongoing charge of $0–$240.

Key words: EIS, advanced metering, costs

Publisher: New Building Institute

Category: Technical report

Availability: Download from http://newbuildings.org/advanced-metering-and-energy-information-systems

Technology Descriptions, Business Case

Title: Advanced Automated HVAC Fault Detection and Diagnostics Commercialization Program, 2008

Summary: This report summarizes six FDD technology development and demonstration projects, as well as one FDD market connection project. It covers project goals, approach, outcomes, and recommendations.

Highlights:

- System-level FDD focuses on hardware or operational faults in HVAC subsystems (e.g., AHU, VAV box, RTU).
- The estimated payback of a FDD system in a five-ton rooftop unit is between five and seven years.
- "There is a lack of common definition or industry standards of what constitutes FDD capabilities within control systems in larger buildings."

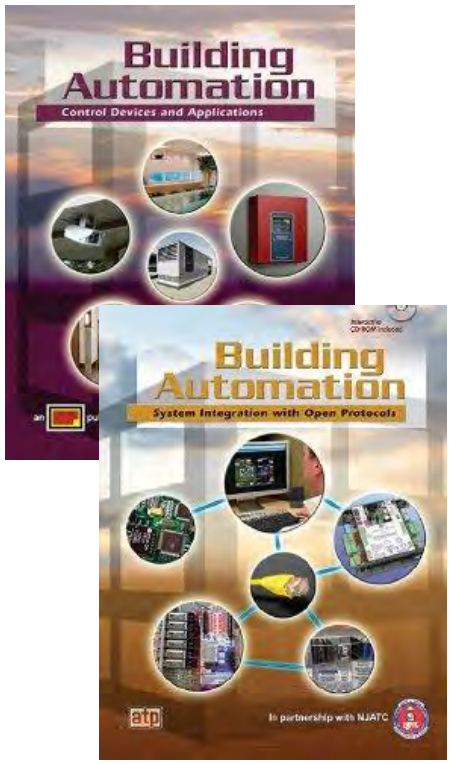
Key words: FDD, AHU, VAV, RTU

Authors/Publisher: D. Frey and V. Smith/California Energy Commission

Category: Fact sheet, Case study

Availability: Download from http://www.energy.ca.gov/2013publications/CEC-500-2013-054/CEC-500-2013-054.pdf

Technology Descriptions, Business Case



Titles:

- Building Automation: Control Devices and Applications, 2008
- Building Automation: System Integration with Open Protocols, 2009

Summary: These two-book series introduces the control devices and open communication protocols used for building automation, and presents how these technologies are implemented in common building automation scenarios.

Highlights:

- Alarming, scheduling, and trending are common functions of building automation systems.
- BACnet was originally designed as a system-to-system interoperable protocol.
- LonWorks was developed as an device-to-device interoperable protocol.

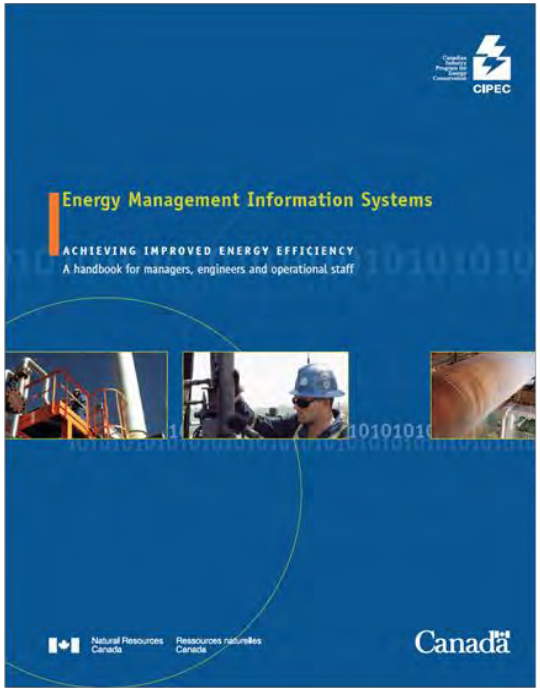
Key words: BAS, control devices, control signals, control functions

Publisher: American Technical Publishers

Category: Handbook, Guidebook

Availability: For general purchase

Technology Descriptions, Business Case



Title: Energy Management Information Systems: Achieving Improved Energy Efficiency, 2004

Summary: This general handbook covers the definition of an EMIS , successful design implementation and use, reporting, analysis, and metering. It also provides a checklist to help assess the effectiveness of an EMIS.

Highlights:

- "Energy is a variable operating cost, not a fixed overhead charge."
- Effective energy data analysis should have data on influencing factors (e.g., outside temperature, control settings).
- An effectively designed EMIS should use existing infrastructure as much as possible.

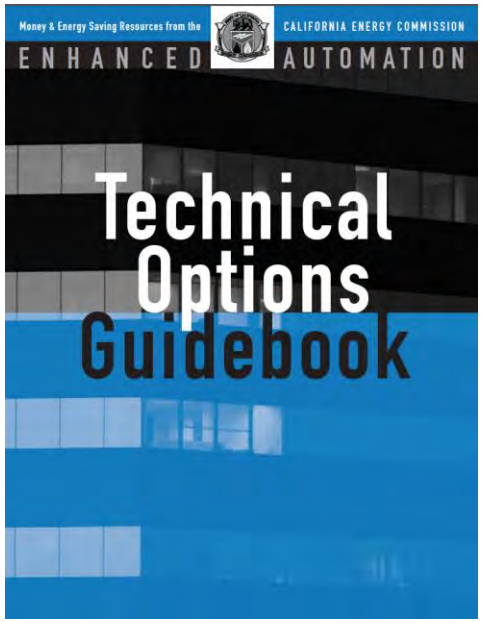
Key words: EMIS, EMIS design, energy reporting, data analysis, metering

Publisher: National Resource Canada

Category: Handbook, Guidebook

Availability: Download from http://0101.nccdn.net/1_5/08f/21d/114/EMIS_eng.pdf

Technology Descriptions, Business Case



Title: Enhanced Automation: Technical Options Guidebook, 2003

Summary: This guidebook introduces enhanced automation (EA) technologies (e.g., lighting and HVAC control technologies, building automation system, and energy information systems), and discusses associated costs and benefits. It also provides guidelines for decision making and implementation.

Highlights:

- Lighting technologies (e.g., occupancy sensor, dimming lighting) can achieve 2%–15% kilowatt-hour (kWh) savings and 2%–15% peak kW savings.
- HVAC measures (e.g., time and temperature control, demand-response ventilation) can save 2%–15% of total building energy use.
- BAS or EIS is the key component of enhanced automation.

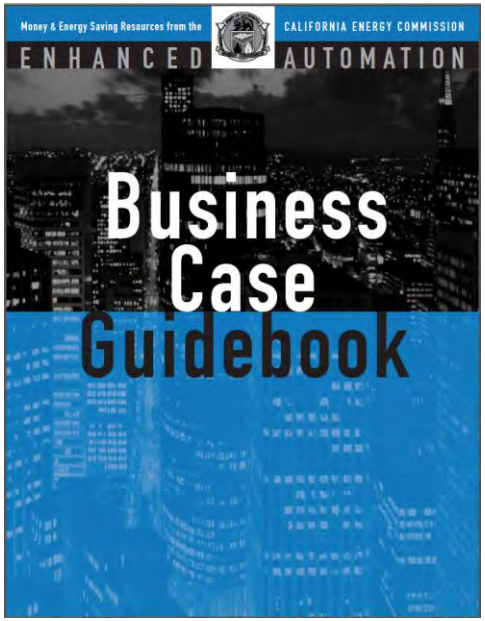
Key words: BAS, EIS, lighting control, HVAC control, technology introduction

Publisher: California Energy Commission

Category: Handbook, Guidebook

Availability: Download from http://www.energy.ca.gov/enhancedautomation/

Technology Descriptions, Business Case



Title: Enhanced Automation: Business Case Guidebook, 2003

Summary: This guidebook familiarizes financial decision makers with enhanced automation (EA) technologies and provides assessment tools for selecting the appropriate level of automation for a business. It includes a spreadsheet tool to calculate net present value and payback to help make the business case for a proposed system.

Highlights:

- Businesses with 20,000 square feet of space or more are most likely to benefit from EA .
- An average cost of $1,100 per point can be used to estimate BAS costs.
- The potential for average annual energy savings from an enhanced automation retrofit ranges from 5¢ to 30¢ per square foot.

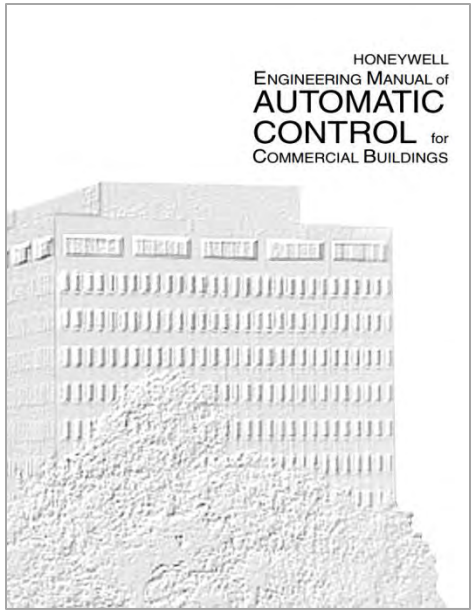
Key words: BAS, EIS, lighting control, HVAC control, economic assessment

Publisher: California Energy Commission

Category: Handbook, Guidebook

Availability: Download from http://www.energy.ca.gov/enhancedautomation/

Technology Descriptions, Business Case



Title: Honeywell Engineering Manual of Automatic Control for Commercial Buildings, 1997

Summary: This resource presents control theory and fundamentals, different types of controls (i.e., pneumatic and DDC), and how the controls are applied to HVAC systems (e.g., AHU, chillers, distribution systems) in commercial buildings.

Highlights:

- Pressure, temperature, humidity, and rate of flow are the most commonly controlled variables in HVAC systems.
- HVAC control systems usually use two control modes: proportional control and proportional-integral control.
- Types of airflow control include space pressurization, zone pressurization, and exhaust air control.

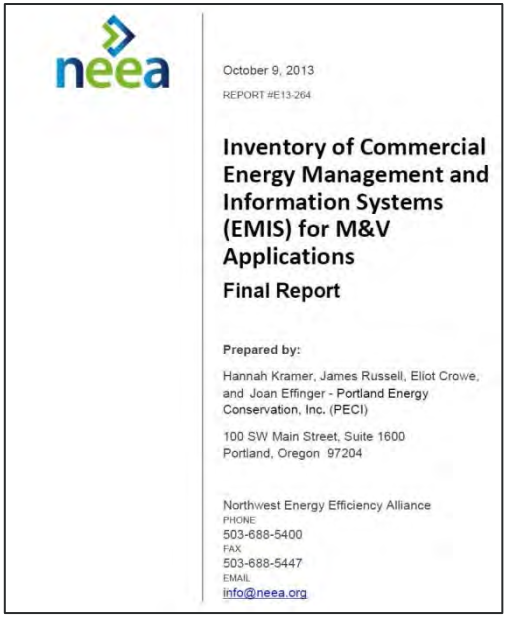
Key words: BAS, automatic control, control process, control application

Publisher: Honeywell

Category: Handbook, Guidebook

Availability: Download from https://customer.honeywell.com/resources/techlit/TechLitDocuments/77-0000s/77-E1100.pdf

Technology Evaluations, Vendor Lists


neea

October 9, 2013

REPORT #E13-264

Inventory of Commercial Energy Management and Information Systems (EMIS) for M&V Applications

Final Report

Prepared by:

Hannah Kramer, James Russell, Eliot Crowe, and Joan Effinger - Portland Energy Conservation, Inc. (PECI)

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Title: Inventory of Commercial Energy Management and Information Systems (EMIS) for M&V Applications, 2013

Summary: This report introduces EMIS and studies 14 EMIS tools that can support utility programs and financial transactions for energy efficiency by providing automated savings calculations.

Highlights:

- All 14 EMIS tools can develop a baseline model to account for key drivers of energy use using a year of post-implementation energy use data.
- Five EMIS tools can estimate annual savings using less than a year of post-implementation energy use data.
- Details of the specific M&V methods used are provided for eight of the 14 tools.

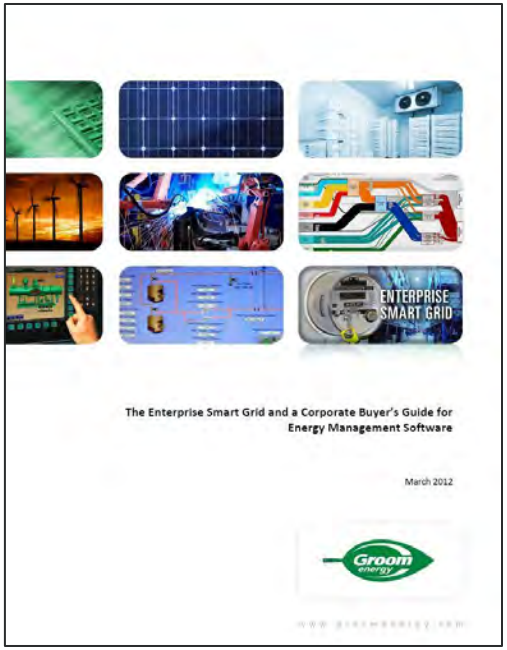
Key words: EMIS, tool evaluation, vendor list, M&V, baseline model

Authors/Publisher: Hannah Kramer et al. / Northwest Energy Efficiency Alliance

Category: Technical report

Availability: Download from http://neea.org/docs/default-source/reports/inventory-of-commercial-energy-management-and-information-systems-for-m-v-applications.pdf?sfvrsn=6

Technology Evaluations, Vendor Lists



Title: The Enterprise Smart Grid and a Corporate Buyer's Guide for Energy Management Software, 2012

Summary: This report provides an overview of the EMIS industry, lists recommendations for companies making software purchases, and names ten leading providers of EMIS solutions.

Highlights:

- EMIS solutions with sub-metering are helping to drive behavioral changes that reduce energy consumption.
- Most organizations start with basic visibility from utility bills, then move to interval metering and sub-metering.
- Vendor differences are particularly pronounced when considering the data sources (e.g., utility bills, interval meters), vertical expertise (e.g., retail, office), and geographic strength (e.g., national, international).

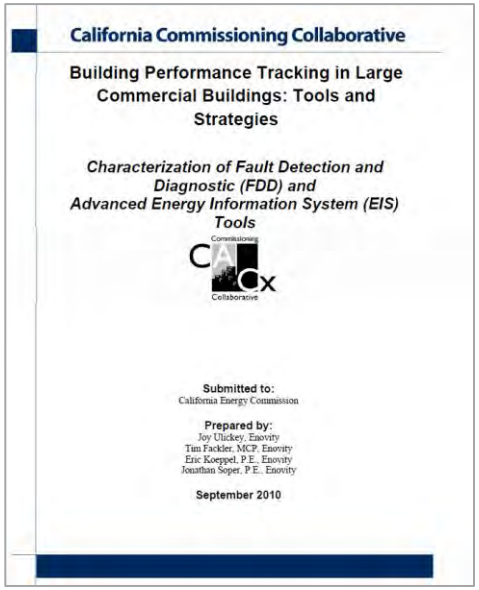
Key words: EMIS, tool evaluation, top 10 vendors to watch

Publisher: Groom Energy

Category: Technical report

Availability: Purchase from Groom Energy
http://www.groomenergy.com/enterprise_smart_grid_research.html

Technology Evaluations, Vendor Lists


California Commissioning Collaborative

Building Performance Tracking in Large Commercial Buildings: Tools and Strategies

Characterization of Fault Detection and Diagnostic (FDD) and Advanced Energy Information System (EIS) Tools

Submitted to:
California Energy Commission

Prepared by:
Joy Ulickey, Enovity
Tim Fackler, MCP, Enovity
Eric Koeppel, P.E., Enovity
Jonathan Soper, P.E., Enovity

September 2010

Title: Building Performance Tracking in Large Commercial Buildings: Tools and Strategies—Characterization of Fault Detection and Diagnostic (FDD) and Advanced Energy Information System (EIS) Tools, 2010

Summary: This report characterizes nine whole-building energy anomaly detection and system-level FDD tools based on categories like configuration, cost, capabilities, and reporting.

Highlights:

- FDD technology is still at early stages of adoption.
- Tool vendors have three business models: service-based (i.e., no software, vendor engineer analyzed the data), programmed directly into the BAS, and software as service.
- The majority of the investigated tools lack diagnostic capability.

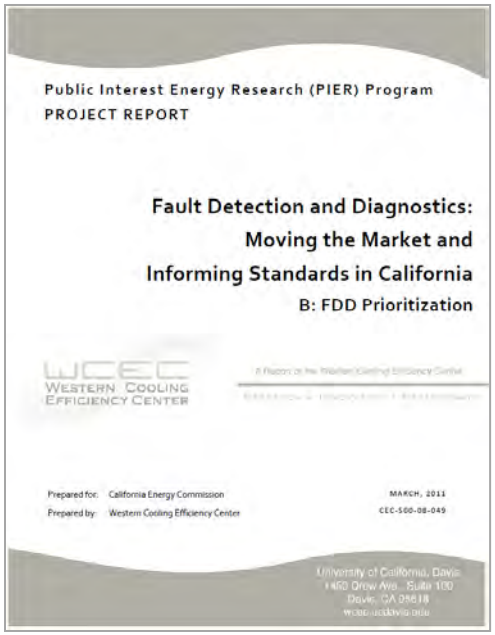
Key words: FDD, advanced EIS, energy anomaly, tool assessment

Authors/Publisher: Joy Ulickey et al./California Energy Commission

Category: Technical report

Availability: Download from
http://www.cacx.org/PIER/documents/Subtask_4-3_Report.pdf

Technology Evaluations, Vendor Lists



Title: Fault Detection and Diagnostics: Moving the Market and Informing Standards in California—B: FDD Prioritization, 2011

Summary: This report describes various RTU faults, outlines nine RTU FDD tools, and classifies the tools in different ways (e.g., faults detected, required data, FDD models).

Highlights:

- Faults with the largest energy impact on RTUs include compressor valve leakage, condenser coil fouling, economizer malfunction, etc.
- Air side (e.g., mixed air temperature), refrigerant cycle (e.g., suction pressure), and power data (e.g., kWh) are the main input data.
- A qualitative model (i.e., comparing power profile to expected values) is a cost-effective approach for some fault types, since it requires only one meter.

Key words: FDD, RTU, Title 24

Authors/Publisher: Kristin Heinemeier et al./California Energy Commission

Category: Technical report

Availability: Download from http://www.performancealliance.org/Portals/4/Documents/CommitteeWorkspace/AFDD/PIER-NBI-WCEC%20DRAFT%20FDD%20Report.pdf

Hardware Needs

Title: Metering Best Practices: A Guide to Achieving Utility Resource Efficiency, 2011

Summary: This guide provides background information on the importance of metering, state-of-the-art metering and communication technologies, and guidance on major approaches. It focuses on how and why to implement metering, rather than on software to analyze the resulting data.

Highlights:

- Program goals, analysis methodologies, and evaluation criteria (e.g., costs, savings) are key elements for developing a metering plan.
- The data communication options for metered data include phone modem, local area network, BAS, and wireless network.
- Start with smaller metering demonstrations and always keep the end goal in mind during system design.

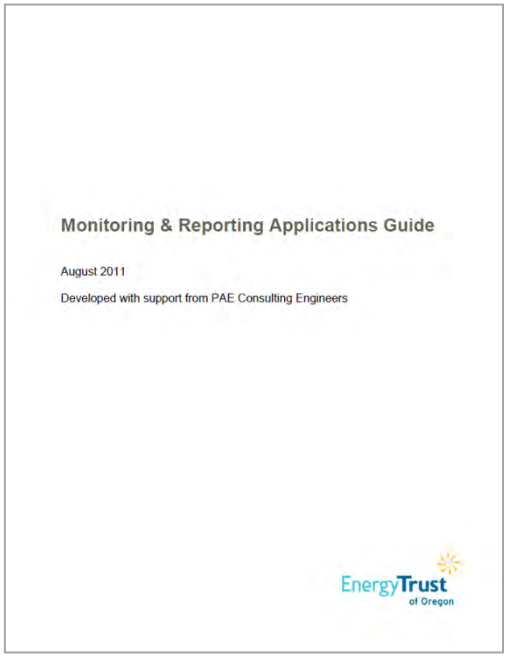
Key words: Metering, federal sector, costs, data analysis

Authors/Publisher: G. P. Sullivan et al./U.S. Department of Energy

Category: Handbook, Guidebook

Availability: Download from http://www1.eere.energy.gov/femp/pdfs/mbpg.pdf

Hardware Needs



Title: Monitoring & Reporting Applications Guide, 2011

Summary: This report introduces the elements of a monitoring and reporting plan, presents typical electric and natural gas metering technologies, and provides example metering designs and costs for a small building and a more complex office building.

Highlights:

- Level of monitoring (i.e., whole-building, system, or end-use) should be selected in the monitoring plan.
- Positive displacement diaphragm meters and rotary meters are common natural gas meters at the whole building level.
- The metering system design should consider the flexibility of future system expansion.

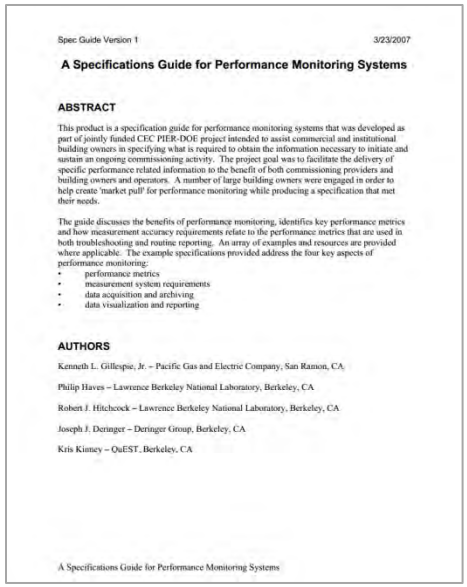
Key words: Metering plan, metering design, metering technology

Publisher: Energy Trust of Oregon

Category: Handbook, Guidebook

Availability: Download from http://energytrust.org/library/forms/NBE_MR_Applications_Guide_v01.pdf

Hardware Needs



Spec Guide Version 1 3/23/2007

A Specifications Guide for Performance Monitoring Systems

ABSTRACT

This product is a specification guide for performance monitoring systems that was developed as part of jointly funded CEC PIER-DOE project intended to assist commercial and institutional building owners in specifying what is required to obtain the information necessary to initiate and sustain an ongoing commissioning activity. The project goal was to facilitate the delivery of specific performance related information to the benefit of both commissioning providers and building owners and operators. A number of large building owners were engaged in order to help create 'market pull' for performance monitoring while producing a specification that met their needs.

The guide discusses the benefits of performance monitoring, identifies key performance metrics and how measurement accuracy requirements relate to the performance metrics that are used in both troubleshooting and routine reporting. An array of examples and resources are provided where applicable. The example specifications provided address the four key aspects of performance monitoring:

- performance metrics
- measurement system requirements
- data acquisition and archiving
- data visualization and reporting

AUTHORS

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A Specifications Guide for Performance Monitoring Systems

Title: A Specifications Guide for Performance Monitoring Systems, 2007

Summary: This guide identifies key performance metrics for basic, intermediate, and advanced levels performance monitoring. It discusses the associated measurement system requirements (i.e., data points, meters and sensors, accuracy), data acquisition requirements, and graphic requirements.

Highlights:

- The performance monitoring system can be contained within a BAS or an EIS, or as a combination of the two.
- Basic-level performance metrics include whole building EUI, chilled plant efficiency, natural gas heat rate, and more.

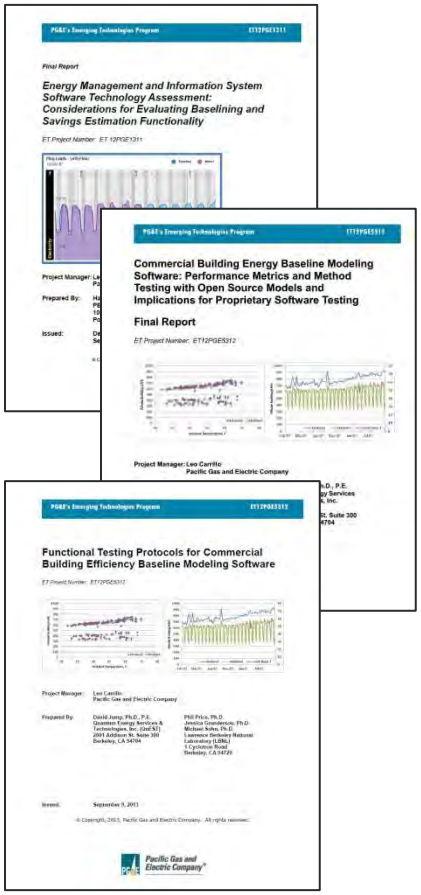
Key words: Metering, sensing, performance monitoring metrics

Authors/Publisher: Kenneth L. Gillespie et al./Lawrence Berkeley National Laboratory

Category: Handbook, Guidebook

Availability: Download from http://www.northcarolina.edu/info/vendors/Performance_Monitoring_Spec_Guide_Version_1_2007-03-23.pdf

Analysis Approaches



Titles:

- Energy Management and Information System Software Technology Assessment, 2013
- Commercial Building Energy Baseline Modeling Software, 2013
- Functional Testing Protocols for Commercial Building Efficiency Baseline Modeling Software, 2013

Summary: This series of reports outlines the need, develops the methods, and describes the procedures and protocols to evaluate whole-building baseline modeling accuracy of EMIS software.

Key words: EMIS, baseline modeling, model accuracy

Authors/Publisher: Hannah Kramer et al./Pacific Gas and Electric Company

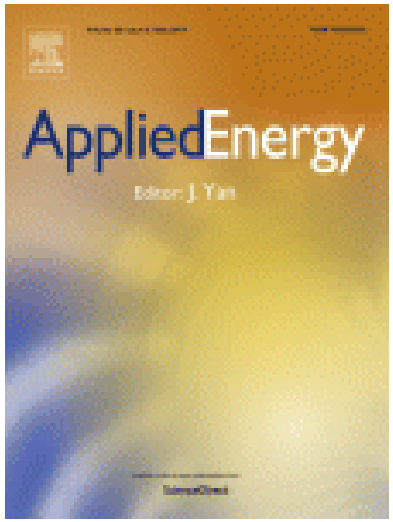
Category: Technical report

Availability: Download from

http://www.etcc-ca.com/sites/default/files/reports/ET12PGE1311_EMIS_SoftwareBaselineModeling_PECI.pdf

http://www.etcc-ca.com/reports/commercial-building-energy-baseline-modeling-software-performance-metrics-and-method-testing

Analysis Approaches



Title: Review of building energy-use performance benchmarking methodologies, 2011

Summary: This article provides an overview of benchmarking research and methodology, including technical detail on statistical methods used to compare building energy use.

Highlights:

- The article provides technical details on common approaches, including ENERGY STAR.
- Ordinary Least Square (i.e., simple regression analysis) is the most popular mathematical method used in existing benchmarking systems.
- Internal and public benchmarking systems can be used, depending on whether the resulting benchmarking system can be used in public.

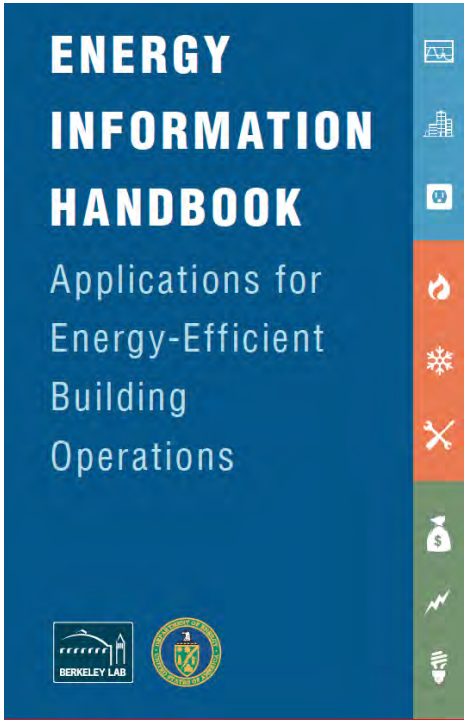
Key words: Benchmarking, mathematical methods

Authors: William Chung

Category: Technical report

Availability: Applied Energy
http://www.sciencedirect.com/science/article/pii/S030626191000485X

Analysis Approaches



Title: Energy Information Handbook, 2011

Summary: This instructional handbook covers 18 data analysis methods for improved efficiency, with step-by-step guidance, state of commercialization, required data, and applicable building systems.

Highlights:

- The most basic methods include simply tracking, utility cost/carbon accounting, internal rate of return, and benchmarking.
- 'Fundamental' methods include load profiling, peak load analysis, PV monitoring, baselines, loading histograms, lighting/cooling/heating efficiency, and energy signature.
- The advanced methods include energy savings, cumulative sum, and anomaly detection.

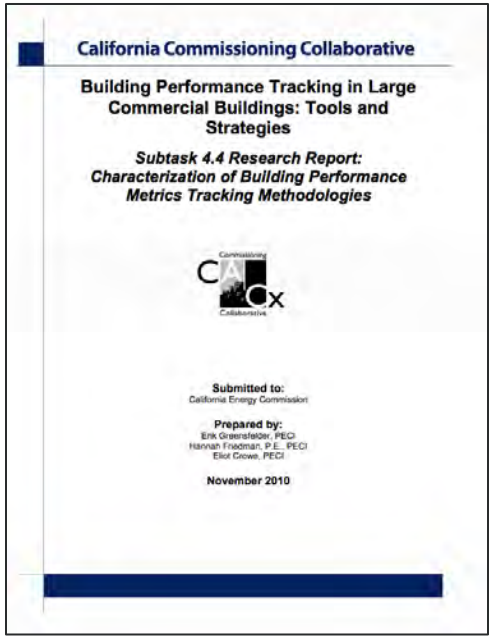
Key words: EIS, data analysis methods, data requirements

Authors/Publisher: Jessica Granderson et al./Lawrence Berkeley National Laboratory

Category: Handbook, Guidebook

Availability: Download from http://eis.lbl.gov/energy-information-handbook.html

Analysis Approaches



Title: Building Performance Tracking in Large Commercial Buildings: Tools and Strategies; Subtask 4.4 Research Report: Characterization of Building Performance Metrics Tracking Methodologies, 2010

Summary: This report summarizes literature and stakeholder interviews on recommended building performance metrics. A process for selecting appropriate metrics is also outlined.

Highlights:

- Recommended basic metrics include energy use/sf-yr, energy use per operating hour/sf, and utility cost/sf.
- Recommended advanced metrics include normalized demand use or cost, plant efficiency, and normalized maintenance cost.
- EIS requirements for tracking of performance metrics are outlined.

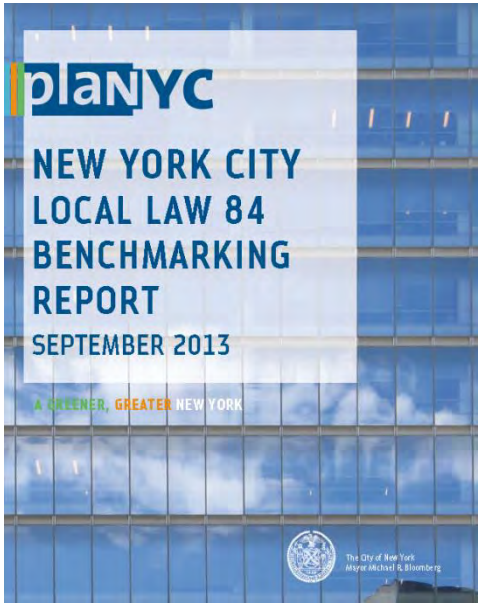
Key words: Benchmarking, energy baseline, performance metrics, continuous commissioning

Authors/Publisher: Erik Greensfelder et al./California Energy Commission

Category: Technical Report

Availability: Download from http://www.cacx.org/PIER/documents/Subtask_4-4_Report.pdf

Tool Applications, Best Practices



Title: New York City Local Law 84 Benchmarking Report, 2013

Summary: This report summarizes results from New York City's legislation which requires energy and water use disclosure for buildings greater than 50,000 square feet. It covers benchmarking benefits, changes in performance from 2012, and recommendations to improve compliance and data quality.

Highlights:

- Median ENERGY STAR score improved from 64 in Year 1 to 67 in Year 2, possibly due to higher motivation for compliance in better buildings.
- Energy use intensity is 55% higher in office buildings built today versus those built in 1900, but only 7% higher in multifamily buildings.
- Retail and office building energy use intensity varied by a factor of 5, suggesting significant improvement may be possible.

Key words: Benchmarking, energy use, year-over-year comparison

Editors/Authors: PLANYC, City of New York

Category: Technical report

Availability: Download from http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/ll84_year_two_report.pdf

Tool Applications, Best Practices

Title: Energy-Smart Buildings, 2013

Summary: This case study presents a smart building pilot program (i.e., FDD, alarm prioritization, and load analysis and dashboarding) conducted by Microsoft at its corporate headquarters.

Highlights:

- Over $1 million of annual savings is estimated from continuous commissioning and FDD.
- Prioritizing alarms enables engineers to focus on the most critical events.
- Displaying energy use and benchmarks on the intranet can encourage employees to save energy.

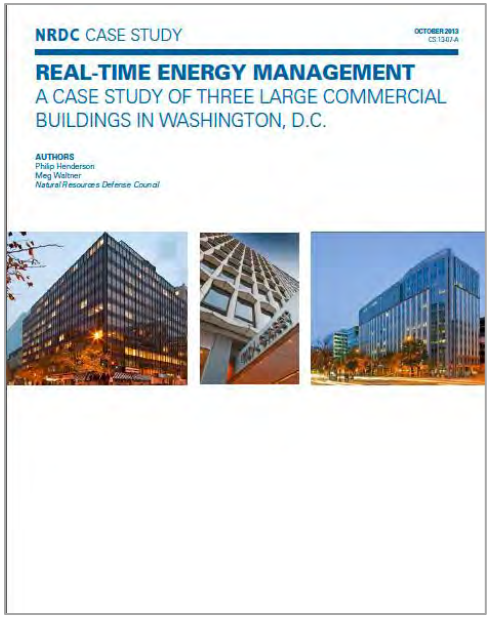
Key words: EIS, FDD, campus energy management

Publisher: Accenture

Category: Fact sheet, Case study

Availability: Download from http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Energy-Smart-Buildings.pdf

Tool Applications, Best Practices



Title: Real-Time Energy Management: A Case Study of Three Large Commercial Buildings in Washington, D.C., 2013

Summary: This case study presents a successful energy management program implemented in three large, multi-tenant office buildings. The program includes two key elements—energy use monitoring and anomaly identifying—as well as system operational parameters tracking and alarming.

Highlights:

- 13% annual electricity savings was achieved by the program across three already efficient buildings (average ENERGY STAR score 78).
- Electricity costs were reduced an average ~$73,000 per building in the first year, while total project expenses only averaged ~$48,000 per building.
- Savings are attributed to operational improvements (e.g., set point correction) suggested by the program.

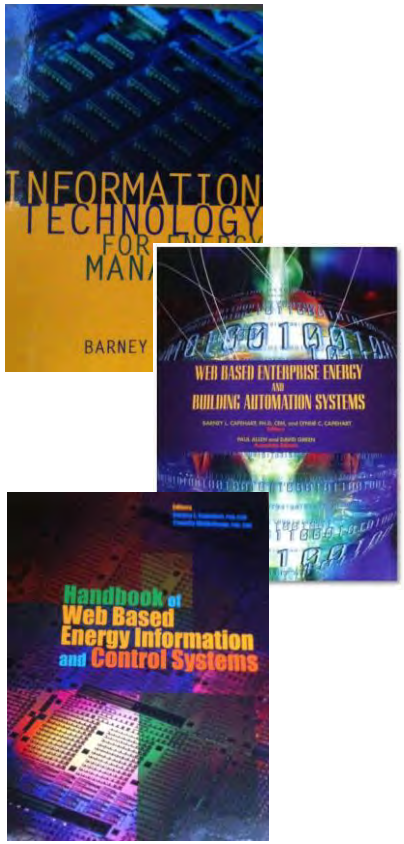
Key words: EIS, FDD, large commercial buildings, energy service company

Authors/Publisher: Philip Henderson et al./Natural Resources Defense Council

Category: Fact sheet, Case study

Availability: Download from http://www.nrdc.org/business/casestudies/files/tower-companies-case-study.pdf

Tool Applications, Best Practices



Titles:

- Information Technology for Energy Managers, 2004
- Web Based Enterprise Energy and Building Automation Systems, 2007
- Handbook of Web Based Energy Information and Control Systems, 2011

Summary: This series of edited volumes collects more than 120 articles and case studies covering technological advancements in the EMIS field, advanced applications of EMIS, and integration of energy information systems with existing building automation systems.

Highlights:

- Today it is possible to store the data from 100,000 points sampled every minute, for ten years, for about the cost of the average textbook.
- EMIS must conform to existing standards (e.g., BACnet, LonWorks) so that integration between related systems is a straightforward process.
- Information from the EIS provides feedback to the operator to make sure the BAS is working properly.

Key words: EMIS practice, information technology, building commissioning

Editors: Barney Capehart, Timothy Middelkoop, and Lynne Capehart

Category: Fact sheet, Case study

Availability: For general purchase

Technology Descriptions, Business Case

Building Performance Tracking Success Story

The Aventine

Glenborough's Aventine facility in La Jolla, California is a living example of how multiple tools and strategies can be combined to create a successful building performance tracking story. The result: an ENERGY STAR® score of 100, a Leadership in Energy and Environmental Design (LEED) Platinum certification, and HVAC issues addressed before they turn into tenant complaints.

Glenborough uses the following tools and services to support its building performance tracking goals:

- **Benchmarking:** ENERGY STAR Portfolio Manager to track progress towards energy savings goals and to prioritize energy-savings investment across their portfolio
- **Third Party Utility Bill Analysis Services:** Contract with Constellation Energy to analyze monthly utility bills and to provide alerts when usage is off-target
- **Automated System Optimization:** Optimum Energy's OptimumM/M services track chilled water plant performance and automatically optimize settings based on load
- **Building Automation System (BAS):** Alerton BAS to track key HVAC system performance indicators and follow up on alerts reported through other performance tracking tools

The combination of these tools enables Glenborough to 1) directly track system performance and 2) identify anomalies in energy use, thereby covering the two key elements of building performance tracking.

Performance tracking tools do not guarantee improved building performance on their own. Equally important are the management strategies that support the use of tools.

What is Building Performance Tracking?

The process of monitoring facility data on a regular basis to continually improve building energy performance. The four steps below detail the fundamental process for tracking, analyzing, diagnosing, and resolving issues with heating, ventilation, and air conditioning (HVAC) and lighting systems.

1. Collect data and track performance
2. Detect performance issues
3. Diagnose issues and identify solutions
4. Fix issues and verify results

Building performance is tracked on an ongoing basis and incorporated as part of standard processes.

The Aventine in La Jolla, CA

"Decisions made now will be with the building for five, ten, maybe even twenty-five years."

—Carlos Santamaria, LEED AP
Director of Engineering, Glenborough, LLC

Quick Facts

FACILITY NAME:	Aventine
OWNER:	Glenborough, LLC
WEBSITE:	www.glenborough.com
LOCATION:	La Jolla, CA
TYPE:	Multi-tenant commercial office
GROSS SQUARE FOOTAGE:	250,000
ENERGY USE INDEX:	26.4 kBtu/ft²
ENERGY STAR® SCORE:	100
LEED RATING:	Platinum

PERFORMANCE TRACKING STRATEGIES:

- Energy Benchmarking
- Utility Bill Analysis
- Building Automation System (BAS)
- Automated System Optimization

Title: Building Performance Tracking Success Stories, 2011

Summary: This series of fact sheets shows four building performance tracking success stories that include facility conditions, implemented EMIS tools, results, and lessons learned.

Highlights:

- "It's critical to have people who understand the data and know what to do with it."
- "Software is the tool, not the solution."
- "Achieve buy-in and participation from corporate management and site engineers."

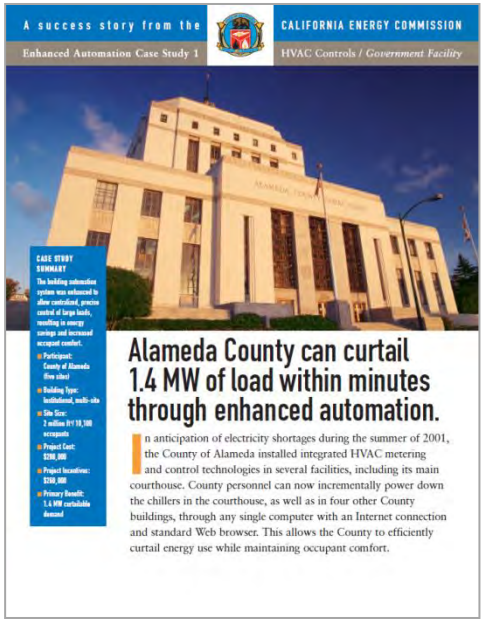
Key words: Benchmarking and utility bill analysis, EIS, FDD, BAS, performance tracking

Authors/Publisher: Hannah Friedman et al./California Commissioning Collaborative

Category: Fact sheet, Case study

Availability: Download from http://www.cacx.org/PIER/handbook.html

Tool Applications, Best Practices


A success story from the CALIFORNIA ENERGY COMMISSION

Enhanced Automation Case Study 1 | HVAC Controls / *Government Facility*

Alameda County can curtail 1.4 MW of load within minutes through enhanced automation.

In anticipation of electricity shortages during the summer of 2001, the County of Alameda installed integrated HVAC metering and control technologies in several facilities, including its main courthouse. County personnel can now incrementally power down the chillers in the courthouse, as well as in four other County buildings, through any single computer with an Internet connection and standard Web browser. This allows the County to efficiently curtail energy use while maintaining occupant comfort.

Title: Enhanced Automation Case Studies, 2003

Summary: This series of fact sheets shows what 12 medium and large businesses were able to achieve with advanced lighting and HVAC control technologies, and EMIS tools.

Highlights:

- "Because of our new metering capability, we have greater understanding of and control over our energy costs, and are able to more effectively manage our budgets."
- "Access to energy usage profiles allows us to verify emergency load curtailments and monitor the performance of longer-term efficiency improvements."
- "The BAS upgrades have dramatically cut down our tenant complaint calls by 95% and have therefore greatly reduced our maintenance costs."

Key words:, EIS, lighting control, HVAC control

Publisher: California Energy Commission

Category: Fact sheet, Case study

Availability: Download from http://www.energy.ca.gov/enhancedautomation/

Abbreviations

AHU	Air handling unit
ASO	Automated system optimization
BAS	Building automation system
CSU	California State University
DDC	Direct digital control
EA	Enhanced automation
EBCx	Existing building commissioning
EIS	Energy information system
EMIS	Energy management information system
EUI	Energy use intensity
FDD	Fault detection and diagnosis
IOU	Investor-owned utility
IPMVP	International performance measurement verification protocol

Abbreviations

MBCx	Monitoring-based commissioning
M&V	Measurement and verification
RTU	Rooftop unit
VAV	Variable air volume
UC	University of California

THANK YOU

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