Product Characterization Report
California Energy Product Evaluation (Cal-EPE) Hub

Technology Sector
Energy Management and Information Systems

Product Category
Building Automation Systems

Last Updated
12/19/2018

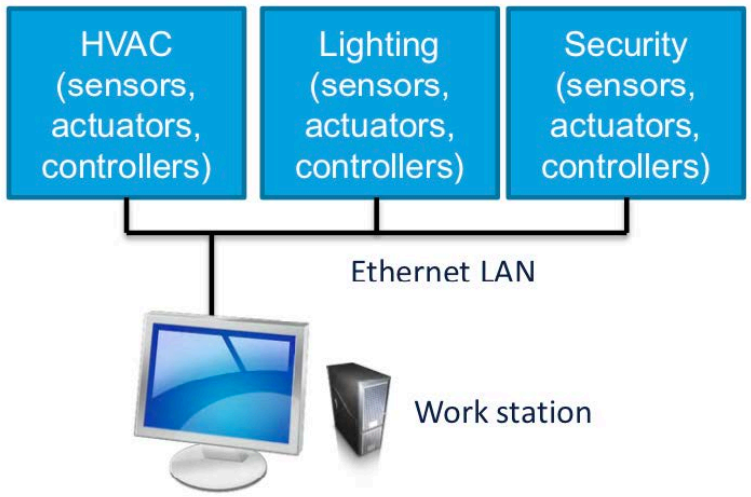
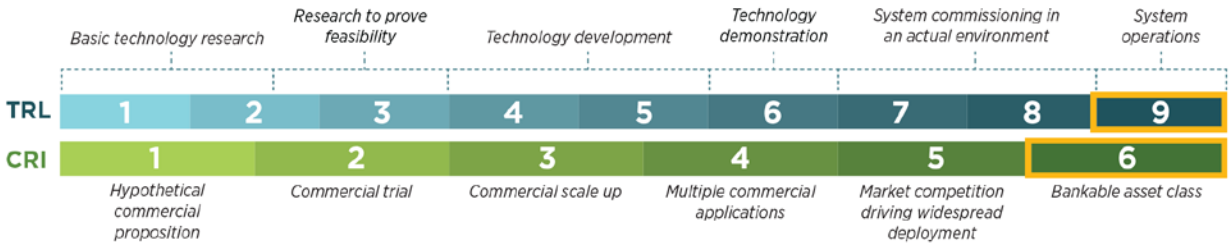


Figure 1: Schematic diagram of a building automation system (source: LBNL).

Product Category Overview

Building automation systems (BAS) provide the ability to automatically control multiple building systems, improving system operation and regulating indoor conditions to maintain occupant comfort. These systems are present in most large and medium-sized commercial buildings. While their primary purpose is to maintain indoor environmental conditions, modern BAS also provide significant data gathering and reporting capabilities, thus enabling equipment troubleshooting and energy management. BAS can enable the use of automated system optimization tools that continuously change the operating parameters of building systems in order to improve energy use and comfort. BAS can provide data to advanced energy information systems and fault detection and diagnostics (FDD) systems in order to facilitate more energy efficient and reliable building system performance.

Characterization at a Glance



Product Category Characterization

Energy Benefits

BAS are primarily a tool to operate building systems. Usually this means the HVAC system, but other additional systems can also be operated by a BAS, including lighting and security systems. The level of

control that BAS provide over building systems enables the implementation of complex energy efficiency and demand management strategies. Also, by monitoring operational parameters of building systems, BAS can enable early detection of system-level operational issues and reduce their negative impacts on energy consumption.

Non-Energy Benefits

BAS control building systems in order to provide adequate indoor environmental conditions to the occupants, including air temperature, humidity, and ventilation and light levels. Improved indoor environmental conditions can improve comfort and productivity. By enabling early detection of some operational issues, BAS can provide operational and maintenance savings.

Product Category Differentiation

N/A

Installation Pathway and Dependencies

BAS can be installed in both existing buildings and new construction.

List of Products

Table 1: Summary of manufacturers and products for the product category. Note: systems from different manufacturers have similar capabilities between them, with the main differentiating feature being proprietary communications protocols; however, all systems also have the ability to use non-manufacturer-proprietary protocols such as BACnet.

Manufacturer	Model	Type	Differentiating Feature
Siemens	Apogee	BAS	• Ability to integrate building systems from multiple manufacturers. • Integration of HVAC, lighting and security systems.
Johnson Controls	Metasys	BAS	• Ability to integrate building systems from multiple manufacturers. • Integration of HVAC, lighting and security systems.
Honeywell	Enterprise Buildings Integrator	BAS	• Ability to integrate building systems from multiple manufacturers. • Integration of HVAC, lighting and security systems.

Quantification of Performance

A literature search was conducted and a sample of published study results are summarized in Table 2.

Table 2: Summary of results from literature review

Location	Application	Results	Reference
N/A	Field studies BAS	Up to 15% (of whole building energy use) energy savings can result from installation of new BAS.	[1]

References

[1] California Energy Commission, "Enhanced automation: Technical options guidebook," California Energy Commission, 2003.

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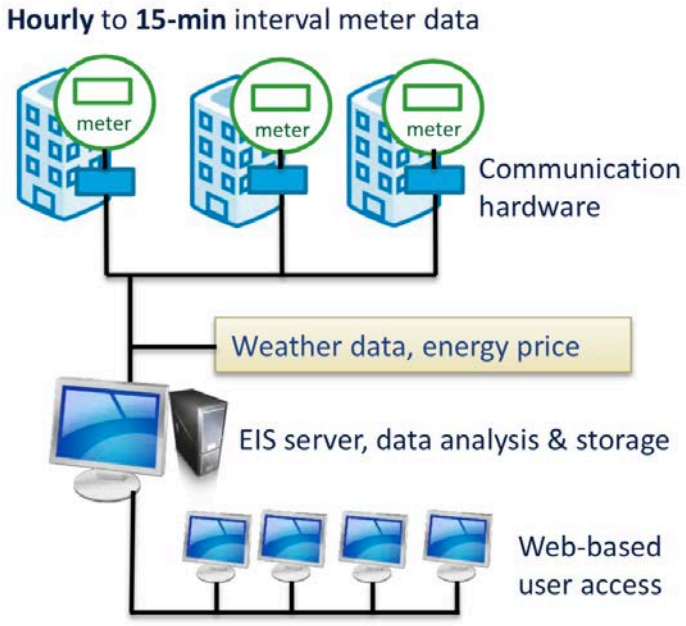


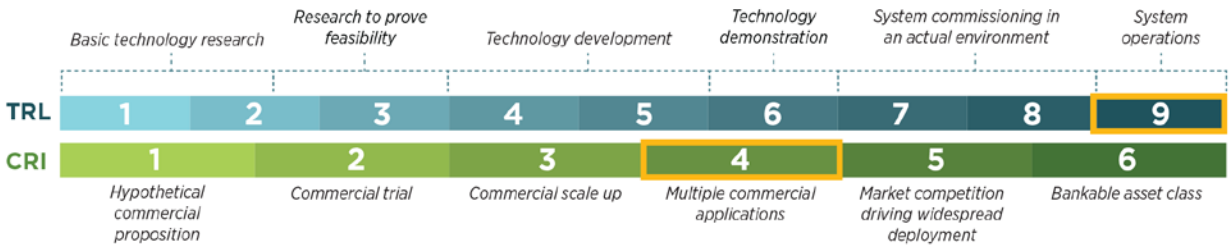
Figure 1: Schematic diagram of an energy information system (source: LBNL).

Product Category Overview

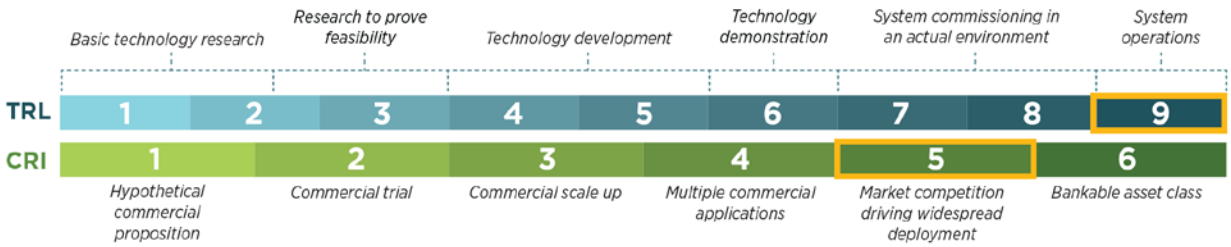
Energy information systems (EIS) take inputs from energy metering hardware and compute, report, and display a variety of metrics that characterize the energy performance of buildings. They can, for example, generate notifications when energy use exceeds expectations, or identify opportunities for operating the building in a more energy efficient way. More advanced EIS can also integrate data from other sources, such as weather data, data from building automation systems (BAS), or electricity prices; they can also automatically detect unusual energy consumption patterns. EIS are often best suited to situations in which there is someone who will review EIS output and act accordingly to improve building energy performance, for example in buildings that are sufficiently large to have dedicated operations or facility management personnel or organizations large enough to have an energy management team.

Characterization at a Glance

Advanced EIS:



All Other EIS:



Product Category Characterization

Energy Benefits

EIS can provide energy consumption history and patterns at different levels of detail, including making adjustments for weather and occupancy changes, enabling the adjustment of electricity demand in real time through integration with BAS in order to optimize energy consumption. EIS can alert building operators when energy consumption exceeds expected values. EIS often include dashboards that allow visualization of energy-related data. In general, EIS allow tracking and benchmarking of energy use and peak energy demand at the whole building and submeter level. Advanced EIS can have automated data analysis features that allow the detection of anomalies in energy use, tracking, and verification of energy savings from energy efficiency measures (with reference to a modeled baseline).

Non-Energy Benefits

By enabling more energy-efficient operation of buildings, EIS can also result in lower operations and maintenance costs through reduced use of energy-consuming equipment.

Product Category Differentiation

EIS can be divided into the following major categories of products:

- EIS. These systems allow data visualization, whole building, and submeter level energy tracking and benchmarking and peak load analysis.
- Advanced EIS. These systems have additional features to standard EIS—such as automated interval data analysis with baseline modeling—that enable the detection of energy anomalies, and tracking and verification of energy efficiency measures.

Installation Pathway and Dependencies

These systems are generally aimed at existing buildings but are also suitable for new construction, especially when relying on advanced sensing equipment.

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List of Products

Table 1: Summary of manufacturers and products for the product category.

Manufacturer	Model	Type	Differentiating Feature
Obvius	Building Manager Online	EIS	• Energy dashboard • Alerts
Lucid	Building Dashboard	EIS/Advanced EIS	• Energy dashboard • Alerts • Advanced analytics
EFT Energy	Energy Manager AutoStart	Advanced EIS	• M&V • Energy budgeting/forecasting • Energy optimization • Energy anomaly detection

Quantification of Performance

A literature search was conducted and a sample of published study results are summarized in Table 2.

Table 2: Summary of results from literature review

Location	Application	Results	Reference
California	Field tests EIS	Depending on field site: 30% reduction in average daily gas use; 35% demand reduction; 18% reduction in portfolio energy use; 30% reduction in whole building energy use.	[1]
Several	Review of prior field studies EIS	Depending on field site: 12% reduction of electricity use; 19% reduction in natural gas; 14% reduction in summer electricity use; 10% reduction in summer gas use; 12% lighting electricity savings; 13% annual electricity savings.	[2]

References

[1] J. Granderson, M. A. Piette and G. Ghatikar, "Building energy information systems: user case studies," *Energy Efficiency,* no. 4, pp. 17-30, 2011.

[2] J. Granderson, G. Lin and M. A. Piette, "Energy information systems (EIS): Technology costs, benefits, and best practice uses," 2013.

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Technology Sector
Energy Management and Information Systems

Product Category
Fault Detection and Diagnostics Systems

Last Updated
12/19/2018

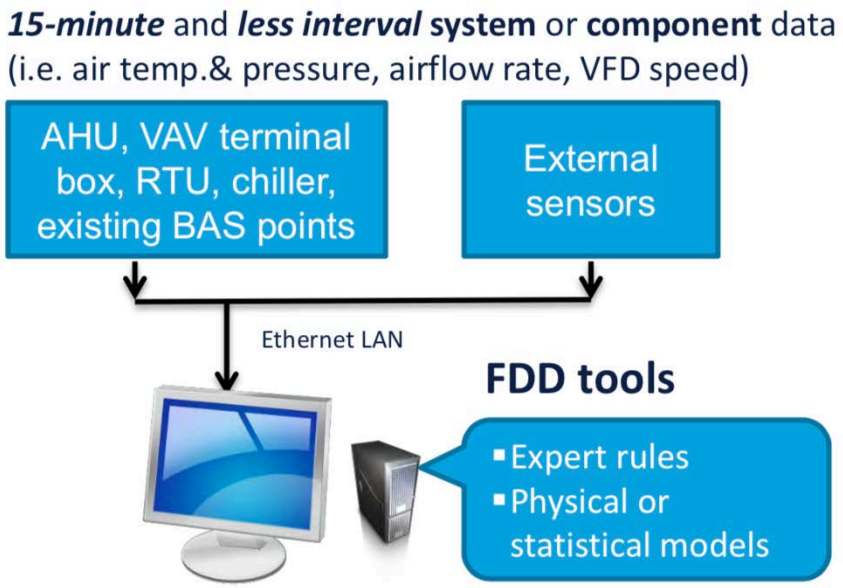
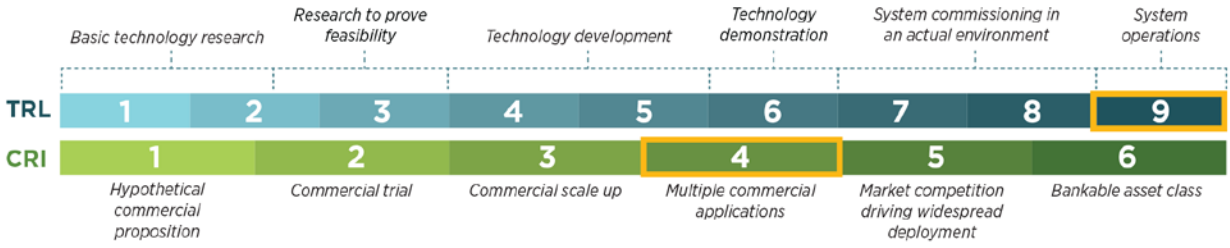


Figure 1: Schematic diagram of a fault detection and diagnostics system (source: LBNL).

Product Category Overview

Fault detection and diagnostics systems (FDD) consist of specialized hardware and software that continuously monitors data from one or more pieces of equipment, usually mediated through a building automation system, in order to detect possible or probable malfunctions or other deviations from desired and efficient building system operation. Early identification of faults can prevent equipment failure, extend equipment life, and reduce energy costs and equipment wear-and-tear. Although building systems themselves can also have the capacity to detect some types of faults (e.g. indicators for when to replace HVAC filters), FDD systems are usually more sophisticated, can use data from a broader set of sources, and aren't associated with a single piece of equipment.

Characterization at a Glance



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Product Category Characterization

Energy Benefits

FDD tools are generally aimed at identifying HVAC system or equipment faults and are sometimes able to isolate root causes of those faults. These tools reduce the analysis time that is needed to identify HVAC system or equipment faults and can prioritize faults based on fault frequency or estimated cost. Faster identification enables early correction of faults, which can decrease HVAC energy use by up to 30% or whole building energy use by 2-11%.

Non-Energy Benefits

Early detection and correction of faults can also result in lower operations and maintenance costs through reduced wear and tear on the HVAC system.

Product Category Differentiation

FDD technology can be available stand-alone or integrated into advanced energy information systems.

Installation Pathway and Dependencies

FDD systems can be put in place in both existing buildings and new construction.

List of Products

Table 1: Summary of manufacturers and products for the product category.

Manufacturer	Model	Type	Differentiating Feature
Cimetrics	Analytika	FDD	• Automated fault detection and root-cause analysis. • Predictive analytics (scenario building).
EZENICS	AFDDI	FDD	• Continuous analysis, detection and prioritization of faults.

Quantification of Performance

A literature search was conducted and a sample of published study results are summarized in Table 2.

Table 2: Summary of results from literature review

Location	Application	Results	Reference
Richland, Washington, USA	Full scale laboratory tests FDD.	Up to 30% decrease in HVAC energy use.	[1]
N/A	Review of prior FDD studies. FDD.	2%-11% reduction in whole building energy use.	[2]

References

[1] M. Brambley, R. Pratt, D. Chassin and S. Katipamula, "Diagnostics for outdoor air ventilation and economizers," *ASHRAE Journal,* vol. 40, no. 10, pp. 49-55, 1998.

[2] TIAXLLC, "Energy impact of commercial building controls and performance diagnostics," 2005.

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