

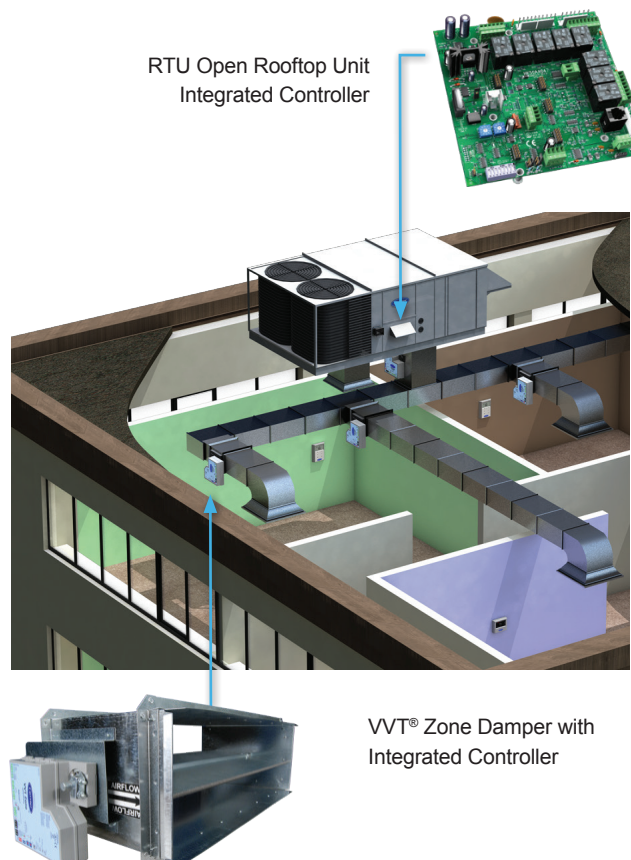
Evaluating Building Automation Systems: Benefits of Pre-Engineered Functions and Features

When building automation systems were first introduced, the advantages of centralized control of the heating, ventilation and air-conditioning (HVAC) systems were widely recognized. As the building automation system evolved to include management of lighting and other building functions through direct digital controls, the building automation system became a tool for operation and data collection designed to enhance occupant comfort and save energy. Today, while most building automation systems provide complete building control and offer local and remote access for monitoring and regulation of equipment, the best of these systems include flexible, factory-installed controllers with built-in features like pre-engineered control algorithms and pre-loaded graphics and automated reports. These features can simplify the design and commissioning of the control system, minimize installation and service costs, and offer engineers and building owners a reliable, energy-efficient, and easy-to-operate system.

An all-encompassing building automation system provides a real-time consolidated view of occupant comfort and energy usage by monitoring HVAC systems and all lighting and ancillary systems, as well as other energy-consuming electrical equipment found in a building. Control of the HVAC equipment is most effectively accomplished through factory-installed controllers, especially when a control designed for a specific type of equipment is factory mounted and integrated, as shown in Figure 1. Factory-installed control components are available on many types of HVAC equipment, including rooftop units, VAV (variable air volume) zoning units, chillers, fan coils, and water source heat pumps. When the application involves multiple pieces of equipment working together, such as large rooftop units and VAV air terminal units, factory-installed controls offer linkage capabilities that allow the units to recognize each other and immediately work together. Factory-installed controllers designed with consistent wiring make installation of multiple system components less complicated and more reliable.

In addition, a factory-installed controller's ability to operate standalone or as part of a system allows for the operation of a small system without the overhead associated with larger systems. Some building automation solutions do not offer this standalone flexibility and require the controller to be part of a larger system. With a standalone equipment controller, general purpose controllers can then be added for managing ancillary equipment like exhaust fans and lighting, allowing control networks to grow. As examples, these general purpose programmable controllers can be added to extend monitoring to electric meters or to control equipment that contains an electromechanical control interface.

Figure 1 - VVT® (Variable Volume and Temperature) Zone Damper with Integrated Controller



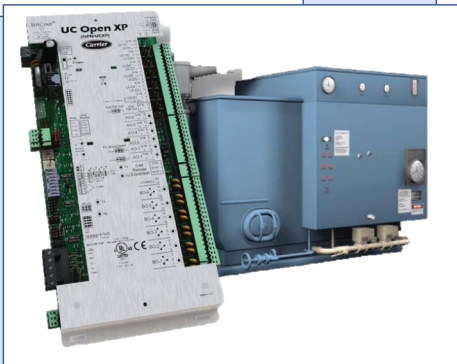
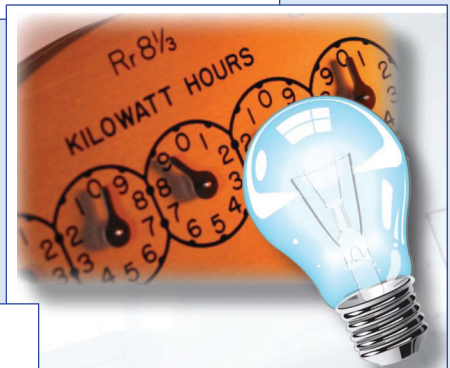
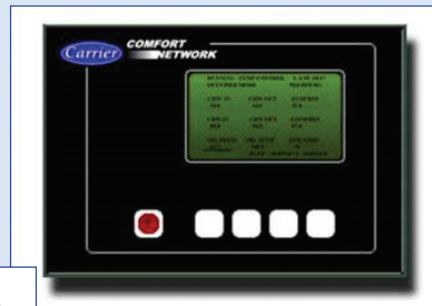
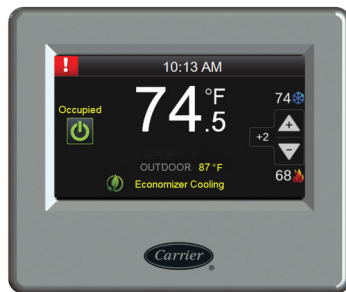
Pre-Engineered Control Strategies Ensure Reliability

The most useful controllers are those that employ pre-engineered control algorithms. These control programs are designed to operate HVAC equipment to its greatest potential and to simplify set-up. Pre-engineered control strategies include documented operation sequences for available functions and can save time typically spent writing detailed specifications for controls. The factory-documented functions also provide owners with information required for service, expanding service options. This documentation of control functions may not be readily available for controls engineered in the field.

Pre-engineered control programs minimize the need for field programming and facilitate the start-up and commissioning process. In most cases, systems that offer built-in control strategies require only that the commissioning team configure the settings for a particular building and enable the features. Control strategies that are provided as built-in features of the control system include routines that have been factory tested for performance. The built-in nature of these features ensures reliable and consistent operation across installations, an important consideration when designing a job for a customer with multiple facilities. The factory-installed controllers also generally offer a host of field configurable options to ensure that the equipment controls can be adapted in the field to meet customer needs.

BUILDING AUTOMATION SYSTEM PROVIDES COMPLETE BUILDING CONTROL

The system is comprised of both hardware and software to provide a seamless architecture to control HVAC systems and could include control and monitoring of lighting, security and fire safety systems in a building.



Some of the most valuable built-in system strategies can promote energy savings by turning off equipment or reducing usage during certain periods: When these control strategies are built in, they have the advantage of having been factory engineered and tested to ensure energy-efficient operation for the building owner. Examples of available pre-engineered control strategies are described below.

Demand Limiting

The goal of demand limiting control is to utilize less power when energy rates are high. Equipment operation is adjusted automatically based on current utility rates. Demand limiting requires that each controller understand the concept of energy demand levels, which are defined by studying the energy billing rates for the building. These energy rates typically increase once certain threshold consumption levels are reached. Once these consumption thresholds are known, demand levels can be defined that tell the attached equipment how to react to the increasing energy rates. A typical response would be for zone set points to be widened so that mechanical cooling and/or heating will be throttled back when energy prices are at their peak.

Demand Controlled Ventilation

Demand controlled ventilation ensures that only the necessary amount of fresh air is delivered to the space, thus eliminating the energy waste caused by over-ventilation and over-treatment of outdoor air. The most effective method of implementation is to control at the zone level rather than in the return air stream. With this method, the individual zones can be satisfied; when the ventilation required is based on an average in the return duct, some zones might not be satisfied. This strategy requires the coordination and control of multiple pieces of equipment.

Set Point Control

Set point control limits the amount of adjustment that occupants can make to the configured zone set points. Since zone set points should already be configured to ensure occupant comfort and energy savings, set point control prevents users from unnecessarily over-cooling or over-heating the space. As an added energy savings feature, systems can automatically revert user-adjusted set points back to the configured set points at the end of each day.

APPLICATION FLEXIBILITY DEPENDS ON ABILITY TO EXPAND AND ADAPT

A building automation system with a scalable network architecture can be applied to any size facility, including store front retail, single and multi-story commercial buildings, and multi-building campuses, and can be installed on any manufacturer's equipment.

For new installations, flexibility is enhanced with general purpose controllers that easily integrate with ancillary equipment, so the system can expand or change without extensive, expensive modifications.

Retrofit applications require a system that uses an open protocol like BACnet but can also support backward compatibility to older, proprietary systems.*

*Control systems built on the open BACnet protocol meet industry standards and provide assurance through testing and certification. Some controls are also capable of exchanging information with third party protocols such as LonWorks† and Modbus** for additional flexibility. Selecting controls that communicate using certified open protocol standards helps to ensure that systems are not proprietary to one supplier. Utilizing a common communication protocol is the first step in enabling an open system in which data can be shared between controls components and systems.*

* Sponsored by ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers).

† Registered trademark of Echelon Corporation.

** Registered trademark of Schneider Electric.



Free Cooling and Integrated Economizer

Control strategies that utilize outside air instead of mechanical heating and cooling contribute to energy savings. Routines such as integrated economizer control optimize the use of the economizer on equipment such as rooftop units and air handlers in order to provide maximum free cooling when outside air conditions are ideal (Figure 2). In addition, a night-time free cooling routine ensures that suitable outside air is used to pre-cool zones prior to occupancy, minimizing the amount of mechanical cooling that is needed to cool the space. Heating and cooling lockout routines prevent mechanical cooling and heating based on outside air conditions.

Static Pressure Reset

This energy-saving routine optimizes fan speeds during partial load conditions where full load design static pressure is no longer needed. Zone damper positions are monitored to ensure that they are getting sufficient air and the system can dynamically decide when the supply duct airflow can be reduced while still maintaining sufficient system pressure.

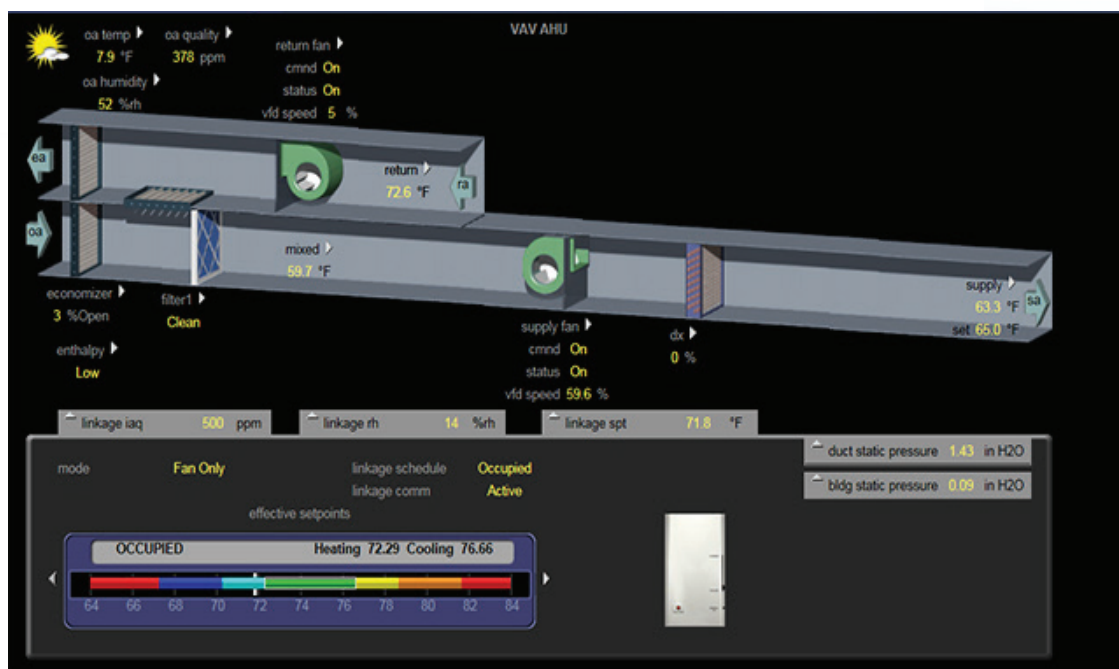
Air-Side and Water-Side Linkage Routines

These routines ensure energy savings by only operating air source equipment, pumps, cooling towers, and boilers in conjunction with building demands. These routines automatically and intelligently review zone/load demand and send the demand to the heating and cooling sources. In this situation, the load pulls on the heating and cooling sources. In contrast, some less sophisticated systems push heating and cooling downstream before intelligently deciding what the load requires to satisfy local conditions.

Customizable Features

In addition to built-in energy savings and features, it is important to ensure that your system is capable of being customized to the application. Consider that evolving standards, such as ASHRAE 90.1 and Automated Demand Response (ADR), may require a field installation to be customized, so ensure a degree of flexibility is available to implement your own system energy saving features.

Figure 2 - Economizer Control Maximizes Free Cooling



Pre-Loaded Graphics and Reports Enhance User Interfaces

Building owners require an interface that will make daily functions easy to perform. Graphics and reports must be clear enough to enable facilities staff to respond quickly to alarm conditions and changing usage requirements. An effective building automation system provides a comprehensive view of the entire building, including detailed performance and energy usage data, building schedules, equipment trends, and system alarms.

Alarm Management

The methods available for managing alarms can be as important as the data collection that generates the alarms. A system that is easily configured to perform alarm actions can enable personnel to respond effectively. Built-in alarm delivery systems allow the selection of notification by e-mail, print, audio file, or pop-up messages on a PC. Some systems include an always-visible alarm button that changes color based on the severity of active alarms, making it unlikely that alarms will be overlooked.

CONSIDER THE IMPORTANCE OF INSTALLATION AND SERVICE SUPPORT IN SELECTION OF A CONTROL SYSTEM

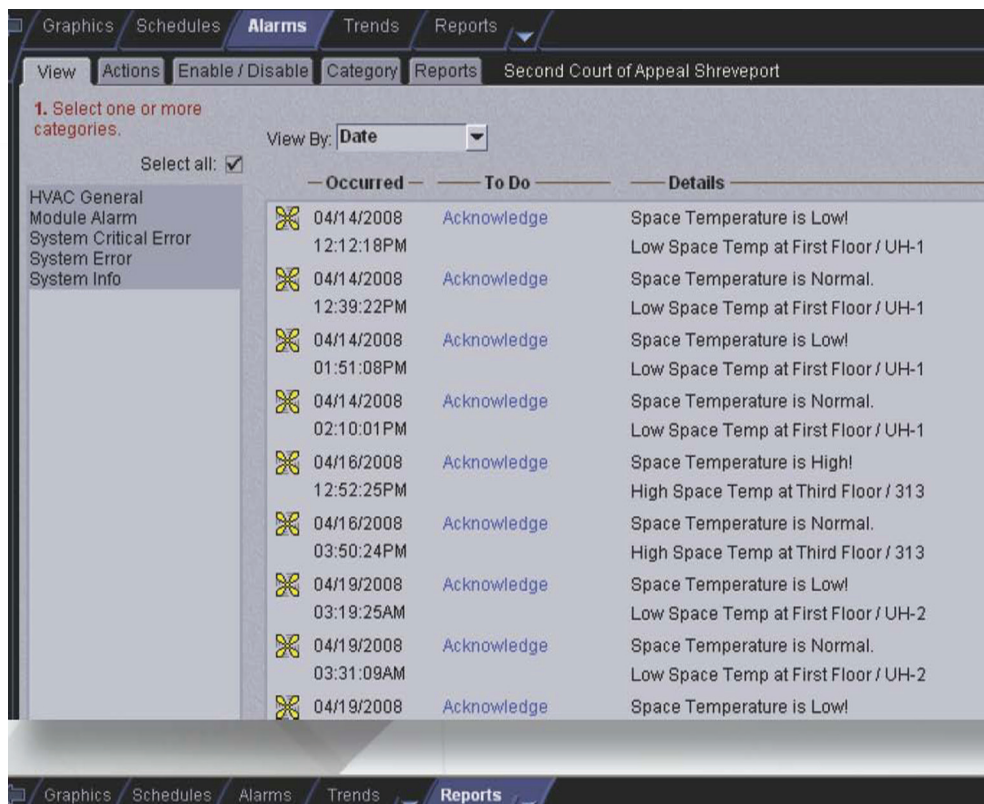
Choosing a manufacturer that offers factory-trained and certified installers provides assurance to customers and owners that their system will perform reliably and efficiently.

A service network of qualified technicians will help to protect the investment and ensure satisfaction.

The most intuitive systems offer the capability to view alarm events from the entire system through a single screen, sorting alarms by date, type, or incident or searching for alarms based on date and time.

Figure 3 illustrates a sample alarm viewing screen taken from a building automation solution that uses a system-wide color scheme. In the example shown, the alarms are identified as yellow, indicating non-critical alarms that need to be acknowledged. In this system, critical alarms would have been identified as red.

Figure 3 - Sample Alarm Viewing Screen



Scheduling

The ability to customize schedules is essential to providing occupant comfort and ensuring equipment operating efficiency. A building controls system that makes it easy to create and change schedules will maximize the use of the schedule feature and encourage the creation of schedules to meet specific date or holiday requirements as well as weekly routines. Some systems complete this function by simply dragging a start and stop time onto a schedule graph.

Area Scheduling is a feature that allows the creation of schedules at the building, area or zone level. With this type of feature, schedules added at the building level affect all equipment in the building. Schedules added at an area level affect all pieces of equipment in that area. Schedules added at a zone level affect only the equipment in that zone. Finally, schedule groups can be defined for even greater flexibility. (See Figure 4.) A schedule applied to a schedule group will affect all pieces of equipment in that group. An example of a display screen for this type of feature is shown in Figure 5.

Figure 4 - Sample Screen Showing Areas Identified for Scheduling

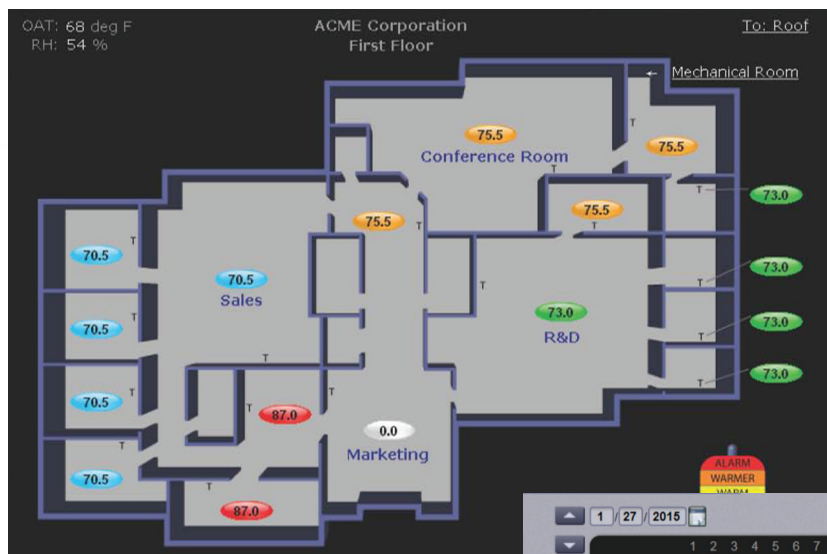
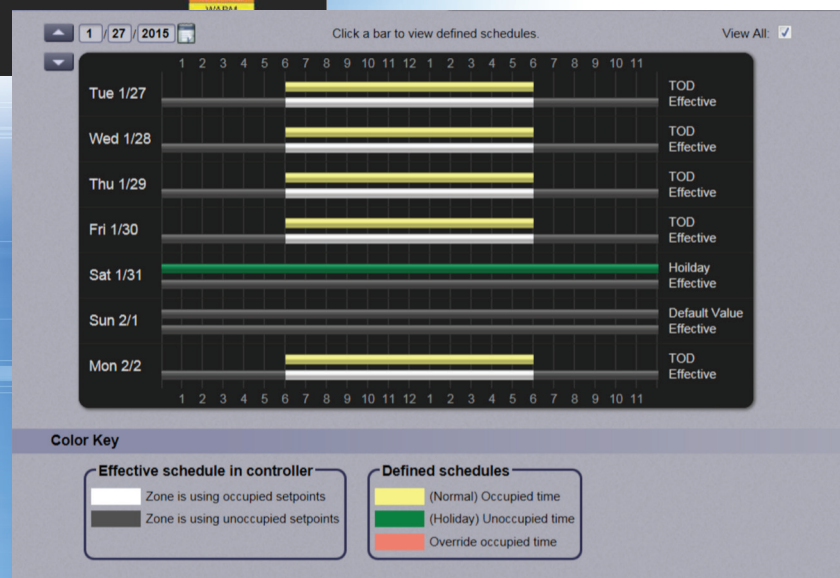


Figure 5 - Sample Area Scheduling Screen

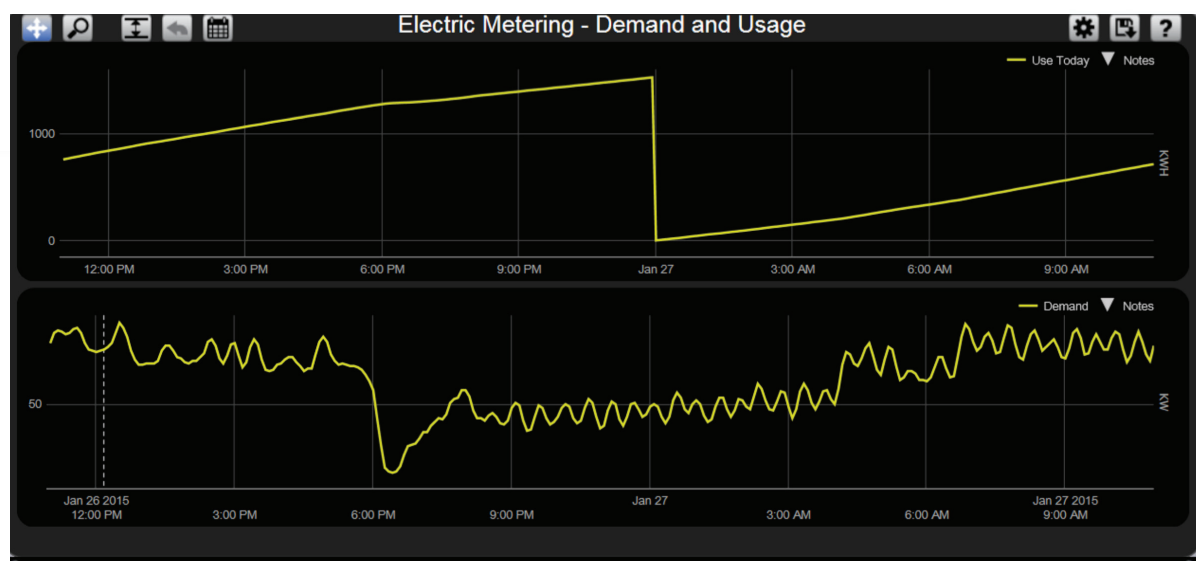


Trending

Collecting data to track performance is an important function of every building automation system. A state-of-the-art system provides automatic trending capabilities, saving a history of equipment operation without special set-up and then automatically generating trend graphs. Trends can easily be modified to sample at different time intervals.

Some systems allow the creation of comparison trend graphs, displaying multiple graphs on the same page, as shown in Figure 6. The ability to graph multiple trend points simultaneously can aid in troubleshooting equipment operation.

Figure 6 - Sample Trending Screen Showing Demand and Usage



A BUILDING AUTOMATION SYSTEM CAN CONTRIBUTE TO EARNING POINTS FOR LEED* GREEN BUILDING CERTIFICATION PROGRAM

A building automation system can be a valuable tool that can contribute to earning LEED points. Collection and analysis of data is essential for some prerequisites or credits that are based on measuring performance or energy consumption or require a review of building operations.

- A building automation system can provide the systems control and logging required to execute the commissioning plan. Credit for enhanced commissioning requires a review of building operations. A building automation system that controls, monitors, and trends and logs building system operation can help identify operational problems and provide recordable data.

- One of the best technologies for determining if the building is operating efficiently is a building automation system, which monitors energy use and provides usage trends. A sophisticated building automation system can meter and track the use of energy at the building and individual system level.
- A building automation system can track energy and water consumption data. Building control systems can be configured to measure and record energy usage and monitor the performance of fans, compressors, heating devices, and all other energy-using systems in the building. Data can be collected and used to develop trend logs.

*LEED is a registered trademark of the U.S. Green Building Council.

Built-In Graphics and Reports

Systems that include built-in graphics, trends, and alarms will reduce set-up time. Some systems can even tailor the graphics to the equipment and automatically generate graphics that represent the customer's specific equipment and options ordered. In addition to saving time, built-in graphics that are consistent and easily interpreted make the control functions simple enough to be understood and operated by key building personnel at every level.

Another advantage of a system that provides many built-in features is that it enables plug-and-play installation of user interfaces. Installation time can be dramatically reduced when the commissioning agent can utilize the user interface to discover the system components that are available within the system. Manually implementing these same features in the field can cost installation time and sacrifice quality and usability.

Built-in reports features can make it easy to view performance and operating data without intensive set-up and can provide a comprehensive view of functions such as scheduling and alarm management.

Web-Based Connections

In addition to local wall-mounted interfaces, some controls systems offer remote web-based connection. This means that all the information managed on the control system can be distributed over corporate intranets, the internet (with accompanying passwords and security), and web-enabled cellphones and tablets.

The level of access provided can be especially useful to off-site managers responsible for one or several buildings. The right system will allow the managers to perform remote diagnostics, respond to alarms or make simple changes in the controller settings, without the need for the addition of special tools or add-ons. Service technicians can also access the system remotely to provide maintenance and troubleshooting service.

Conclusion

A building automation system can provide total management and control of building operations. By allowing facilities staff to monitor and regulate all building systems, including heating and cooling, lighting, and security, a building automation system can help ensure occupant comfort and energy savings. A controls system that includes built-in graphics, pre-engineered control strategies, and other automated features can make it even easier to deliver total system comfort and control. The best of these systems go beyond a control system to provide a dynamic, integrated building solution.

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