Energy management systems for buildings

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Building automation (BAS), also known as building management system (BMS) or building energy management system (BEMS), is the automatic centralized control of a building"s HVAC (heating, ventilation and air conditioning), electrical, lighting, shading, access control, security systems, and other interrelated systems. Some objectives of building automation are improved occupant comfort, efficient operation of building systems, reduction in energy consumption, reduced operating and maintaining costs and increased security.

BAS functionality may keep a buildings climate within a specified range, provide light to rooms based on occupancy, monitor performance and device failures, and provide malfunction alarms to building maintenance staff. A BAS works to reduce building energy and maintenance costs compared to a non-controlled building. Most commercial, institutional, and industrial buildings built after 2000 include a BAS, whilst older buildings may be retrofitted with a new BAS.

A building controlled by a BAS is often referred to as an intelligent building,[1] a "smart building", or (if a residence) a "smart home". Commercial and industrial buildings have historically relied on robust proven protocols (like BACnet) while proprietary protocols (like X-10) were used in homes.

With the advent of wireless sensor networks and the Internet of Things, an increasing number of smart buildings are resorting to using low-power wireless communication technologies such as Zigbee, Bluetooth Low Energy and LoRa to interconnect the local sensors, actuators and processing devices. [2]

Almost all multi-story green buildings are designed to accommodate a BAS for the energy, air and water conservation characteristics. Electrical device demand response is a typical function of a BAS, as is the more sophisticated ventilation and humidity monitoring required of "tight" insulated buildings. Most green buildings also use as many low-power DC devices as possible. Even a passivhaus design intended to consume no net energy whatsoever will typically require a BAS to manage heat capture, shading and venting, and scheduling device use.

Building management systems are most commonly implemented in large projects with extensive mechanical, HVAC, and electrical systems. Systems linked to a BMS typically represent 40% of a building"s energy usage; if lighting is included, this number approaches to 70%. BMS systems are a critical component to managing energy demand. Improperly configured BMS systems are believed to account for 20% of building energy usage, or approximately 8% of total energy usage in the United States.[3][4]

Building management systems have also included disaster-response mechanisms (such as base isolation) to save structures from earthquakes. In more recent times, companies and governments have been working to

find similar solutions for flood zones and coastal areas at-risk to rising sea levels. Self-adjusting floating environment draws from existing technologies used to float concrete bridges and runways such as Washington"s SR 520 and Japan"s Mega-Float.[5]

Analog inputs are used to read a variable measurement. Examples are temperature, humidity and pressure sensors which could be thermistor, 4-20 mA, 0-10 volt or platinum resistance thermometer (resistance temperature detector), or wireless sensors.

A digital input indicates a device is on or off. Some examples of digital inputs would be a door contact switch, a current switch, an air flow switch, or a voltage-free relay contact (dry contact). Digital inputs could also be pulse inputs counting the pulses over a period of time. An example is a turbine flow meter transmitting flow data as a frequency of pulses to an input.

Nonintrusive load monitoring[6] is software relying on digital sensors and algorithms to discover appliance or other loads from electrical or magnetic characteristics of the circuit. It is however detecting the event by an analog means. These are extremely cost-effective in operation and useful not only for identification but to detect start-up transients, line or equipment faults, etc.[7][8]

Analog outputs control the speed or position of a device, such as a variable frequency drive, an I-P (current to pneumatics) transducer, or a valve or damper actuator. An example is a hot water valve opening up 25% to maintain a setpoint. Another example is a variable frequency drive ramping up a motor slowly to avoid a hard start.

Digital outputs are used to open and close relays and switches as well as drive a load upon command. An example would be to turn on the parking lot lights when a photocell indicates it is dark outside. Another example would be to open a valve by allowing 24VDC/AC to pass through the output powering the valve. Analog outputs could also be pulse type outputs emitting a frequency of pulses over a given period of time. An example is an energy meter calculating kWh and emitting a frequency of pulses accordingly.

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