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MARK THROWER MANAGING EDITOR

Making a BEMS work for you

By Wayne Ward, managing director, BSSEC Ltd

Buildings are initially designed to meet an operational need, aesthetic aspirations, performance standards, technical standards and planning constraints. This leads to an often complex and sometimes conflicting requirement of control to maintain efficient operation of the systems within a building.

Smaller buildings may have localised independent controls for energy systems, but for larger or more complex buildings, sites with multiple buildings, or companies with a portfolio of buildings on multiple sites integrated Building Energy Management Systems (BEMS) allow greater knowledge of and control of the energy. Their purpose is to collect information, understand energy use and effect control of equipment for efficient energy consumption.

Key target of a BEMS

As the name suggests, energy management is the key target of a BEMS, as opposed to Building Management Systems (BMS) which can be used to control a wide range of building systems including those related to energy. BEMS are integrated, computerised applications for monitoring and controlling energy-related building services plant and equipment such as heating, ventilation and air conditioning (HVAC) systems, lighting and power systems.

A well-specified and comprehensive BEMS will typically have the following functional requirements:

- be able to gather information from multiple sources such as existing sensor networks, new sensors, available external data sources (e.g. weather forecast), WP3 solutions and other internal or external inputs through open/standard protocols;
- integrate the information to allow a common analysis, presentation and control medium;
- store the data to allow a historical record for further evaluation and comparison;
- be able to generate reports to present the monitored information in an understandable and useable format;
- be able to analyse data to optimise control of the building for internal comfort and energy efficiency;
- be able to generate control strategies from gathered data
- have the facility to prioritise load balancing between multiple energy sources if present such as local generation and grid supplied;
- monitor real time data and make corrective changes to control strategies and equipment operation;
- be able to provide alerts on out of range operation, energy waste, failed inputs or failed components;
- monitor control operation and provide feedback on implementation;
- have the facility to switch between automatic and manual operation;
- have a user-friendly interface to display and have user interaction with real time data, energy use profiles, historical data, energy use charts and graphs, input sources, predictive profiles, alarms, alerts and control strategies;
- provide details of conflict with the building operation, such as when heating and cooling are operating simultaneously and be able to implement changes to prevent this;
- the ability to integrate with equipment control systems to automate responses and input data;

and

• the ability to provide early warnings for any mechanical or electrical failures.

Noting the functional requirements it is clear that BEMS will become increasingly effective as the Internet of Things provides more data collection mediums and equipment control opportunities into the market This will allow solutions to be developed for smaller buildings but also increase the importance of open protocols in data collection and control.

Impacts on energy consumption

It is well known that Building Automation and Control Systems (BACS) can have significant impacts on the energy consumption of buildings, and on the well being of their occupants.

The BS EN 15232:2017 Standard: Energy Performance of Buildings – Impact of Building Automation, Controls, and Building Management was developed to compliment the Energy Performance of Buildings Directive (EPBD) and sets out energy performance classes for building automation and control as follows:

• Class A – High Energy performance building automation and control system (BACS) and Technical Building Management (TBM), typically including individual room control for services such as lighting and HVAC;

• Class B – Advanced BACS and TBM;

• Class C – Standard BACS; and

• Class D – Non energy efficient BACS.

The BS EN 15232:2017 standard includes the following:

• a list of control, automation, and technical management functions that affect the energy performance of buildings;

• a method for defining the minimum requirements for the control, automation, and technical building management functions implemented in different types of buildings;

• detailed procedures for quantifying the impact these functions have on the energy performance of a building;

• a simplified method to obtain an initial estimate of the impact these functions have on the energy performance of buildings

To meet an A Class rating installations would typically have to include:

• **heating** - individual room control with communication between controllers, indoor temperature control of distributed network water temperature, and total interlock between heating and cooling;

• **ventilation**/air conditioning control – Demand- or presence-dependent airflow control at room level, variable set point with load dependent compensation of supply temperature control, room or exhaust or supply air humidity control;

• **lighting** - automatic daylight control, automatic occupancy detection manual on/auto off, automatic occupancy detection manual on/dimmed, automatic occupancy detection auto on/auto off, automatic occupancy detection auto on/dimmed; and

• **sun protection** - combined light, blind, and HVAC control.

One of BS EN 15232's core drivers is an integrated approach to demand-led controls in buildings intended to ensure that different energy-using systems can communicate and be controlled in harmony. The use of open protocols such as BACnet can assist in delivering integration but issues are often found when trying to connect legacy equipment.

Facilitate requirements

A typical BES installation will facilitate the functional requirements and include a software and hardware installation suitable for the complexity and controllability of the building in which it is installed. This may include:

• software: the data collection, evaluation and control software, providing the interpretation of information into the user interface, implementation of control algorithms, control strategy, feedback management and alarms;

• user interface: the dashboard/ terminal for data reporting and interaction with the building automation and control system (BACS). This could be multi-site or stand-alone terminal, cloud based or portable for use on laptops, tabled or smartphone;

• network - hard wire or wireless;

• communications protocol: the 'language' used by the BACS components;

• output devices: these carry out commands from the controller;

• controllers: deliver the system's response from the collected data, using algorithms that apply logic and send commands; and

• sensors: measure values such as temperature, humidity, lighting levels, CO2 levels, room occupancy.

When undertaking an energy audit of a site with a BEMS installation it is important to understand the system installed, access arrangements and what parameters it should be working to, to be able to assess whether it is working as designed and to optimum levels.

When undertaking a building energy audit to BS EN 16247 Part 2 or ISO 50002, include a thorough review if the BEMS system including the following:

• **pre audit** - request energy data, BEMS operating parameters standard setpoints and operating requirements of building users. Review guidance of typical requirements for room use from published data. Review opening/ closing and shift data for the site. Develop energy use profiles from energy data and assess obvious discrepancies. Analyse electricity and gas consumption including 'half-hourly' data, to identify potentially problematic areas.

Arrange read-only access to BEMS system through supervisor terminal or other terminals with access to read pages. Ask details on the manufacturer and model of system, and if unfamiliar with system, review manufacturer information to gain

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an understanding of the system. If necessary, request that someone familiar with the system and system access is available to provide guidance through the system at the time of the audit.

BEMS audit checklist

Prepare a BEMS audit checklist setting out a list of the items to check in relation to the BEMS during the audit

During the site visit:

- assess suitability for purpose – does the installed system meet the client's expectation in terms of control monitoring, management and control. Are there any opportunities to connect additional installed equipment?;
- system graphics – are they providing the required information?;
- sensor and actuator integrity – are they connected and working appropriately?;
- installed plant – is it connected, providing feedback and being controlled appropriately?;
- control strategy and logic – are they suitable for the operational requirements of the building?;
- check the time scheduling and temperature setpoints against operational requirements.
- weather compensation - is data being received and acted upon?;
- plant sequencing and control – are there any conflicts between systems?;
- interaction with any other control systems- is data being transmitted and acted upon?;
- internal comfort – are temperature setpoints correct and relevant to room use. Are they being maintained or is there evidence of poor comfort being experienced?;
- operational constraints- are they suitable for the building/room use? Have there been changes in operations since installation/ commissioning?;
- system access and training- is there system access and has appropriate training been given?;
- maintenance regimes of BEMS – have there been software updates against manufacturers recommended schedules and are there any failed components? Review sensors and setpoints for obvious discrepancies such as outside temperature sensors stating -5oC during summer, and note discrepancies and schedule for further investigation. Check maintenance manuals; and
- are maintenance regimes of plant and equipment up to date? Are there any obvious maintenance issues? Check maintenance manuals.

Deliver maximum efficiency

The overall aim of the audit is a BEMS that operates plant to deliver maximum efficiency against suitable operation activities and occupant comfort. The audit should provide a report that includes identification of energy savings opportunities, recommended remedial measures involving software, hardware or the controlled plant; estimated savings, costs and return on investment; other measures to maintain the efficiency of the system; training shortfalls and a prioritised action plan.

All installations will require maintenance and updating through their lifecycle to maintain optimised efficiency. When changes occur to the operational requirements of the building, change of ownership, change of use, replacement equipment is important to review the BEMS installation to ensure strategy is suitable and the system is operating to the new requirements.

Typical failures include:

- change of use not being factored into BEMS strategies;
- failure of components, sensors, timeclocks, software;
- changed settings to manual and not returning them to automatic;
- settings such as temperature setpoints are altered and not always restored to their original values which leads to excess energy use;
- faulty sensors and erroneous readings not being investigated;
- changes in the use of specific areas of a building without reviewing and setting the BEMS setpoints and time settings for the most efficient operation;
- failure to consider and factor in changes to building layouts such a zoning or removing or adding partitions into the BEMS settings to optimise performance;
- poor maintenance regime of BEMS components, software updating and calibration leading to loss of optimised control and accuracy;
- failure or intermittent network access or stability; and
- poor interoperability.

With the continued drive by national governments to meet climate change objectives, energy costs, energy security requirements and rise of big data, BEMS can provide solutions to meet these drivers. The forecast is for a tripling of the market by 2026 from 2017. However, ensuring data security will be a key factor in mitigating client concerns for both legal obligations and building operational security.

Market forces and technology improvements are providing lower cost solutions, especially in sensors and controllers and BIM protocols are giving impetus to open source protocols allowing a greater connectivity than could be envisaged even three years ago.

Multiple energy inputs

Key future drivers will be the need to integrate multiple energy inputs; energy storage and optimised reuse; implement supply and demand side response; greater automation and Internet of Things interaction; facilitate behaviour change strategies; follow-me technologies; adaptive materials; greater user control and interconnectivity down to single user requirement (employee can control desk space environment through APP control for instance). It is easy to envisage Artificial Intelligence (AI) having a substantial impact on the assessment and control of buildings, analysing, predicting and implementing control strategy on a substantial amount of internal and external data sources with the ability to react to multiple input variable on a real time basis.

With the global market1 for BEMS forecast to rise from $4bn in 2017 to $13.1bn by 2026, it is clear that this is a fast growing market and that there are opportunities and benefits in maintaining effective operation, updating and adapting existing installations and ensuring that they are working effectively. Regular commissioning is recommended to ensure optimised control and understanding of their operation. Auditing is an effective way to maintain their effectiveness and achieve the benefits that clients expect.

Reference

1) https://www.i-scoop.eu/building-management-building-management-systems-bms/building-energy-management-systems-bems/

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ENTRY FORM

BEMS

Please mark your answers on the sheet below by placing a cross in the box next to the correct answer. Only mark one box for each question. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet in ink, return it to the address below. Photocopies are acceptable.

QUESTIONS

1. What is the forecast market for global BEMS in 2026?

- ☐ $4.0 billion
- ☐ $13.1 billion
- ☐ $18.6 billion
- ☐ $112.0 billion

2. What is a recognised standard for a Building Energy Audit?

- ☐ BS EN 28227
- ☐ BS EN 16247 – part 2
- ☐ BS 7671
- ☐ BS EN 18001

3. What would be recognised as an open protocol in relation to BEMS?

- ☐ BACnet
- ☐ Intel
- ☐ VOIP
- ☐ Vodaphone

4. What would lead to failure of a BEMS?

- ☐ Regular software updates
- ☐ Good maintenance procedures
- ☐ Faulty components
- ☐ Regular commissioning

5. What does the BEMS control?

- ☐ Fire Alarm Systems
- ☐ Production lines
- ☐ Internal Environment
- ☐ Telecoms network

6. What does IoT mean in relation to BEMS?

- ☐ Internet of Things
- ☐ Internet of Temperature
- ☐ Internal operating Temperature
- ☐ Instant on Time

7. The control strategy for a building should be?

- ☐ The same for every building
- ☐ Suitable for the operational requirements of the building
- ☐ Based on a standard set of data and never change
- ☐ Have no ability to change to suit local environmental condition

8. The BS EN 15232:2017 standard sets out energy performance classes for?

- ☐ Building automation and control on an A to G basis
- ☐ Building automation and control on an A+ basis
- ☐ Building automation and control on an ad hoc basis
- ☐ Building automation and control on an A to D basis

9. The overall aim of BEMS is to?

- ☐ Deliver maximum energy efficiency against suitable operational activities and occupant comfort.
- ☐ Have full control of all systems within the building
- ☐ Provide information on utility use to the utility companies
- ☐ Lodge data on energy use to national registers

10. To meet class A of BS EN 15232:2017 a BEMS should provide?

- ☐ No control over daylight
- ☐ Individual room control
- ☐ Single setpoint for ventilation
- ☐ Allow outdoor temperature control

Please complete your details below in block capitals

Name ..... (Mr. Mrs, Ms) .....

Business .....

Business Address .....

.....

..... Post Code .....

email address .....

Tel No. .....

Completed answers should be mailed to:

The Education Department, Energy in Buildings & Industry, P.O. Box 825, GUILDFORD, GU4 8WQ. Or scan and e-mail to editor@eibi.co.uk

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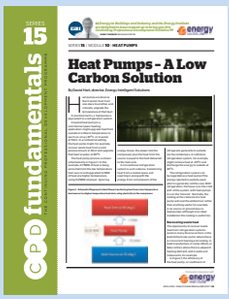

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