Building Controls

Energy Manager's Guide to Building Controls

Produced by the **Energy Manager's Association**
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Building a Better World Together

Building Controls Energy Manager's Guide

Introduction

Summary

This EMA Energy Manager's guide is designed to give you some basic information and guidance on understanding the options and how to approach the procurement of building controls. The control of energy in buildings is generally poor, despite the availability of a range of tried and tested systems incorporating both mature and innovative technologies. The main reason for this the application of minimum requirements is the *perceived* overly technical nature of the solutions and hence the resulting complexity issues when operating them.

The BRE Trust is the largest UK charity dedicated specifically to research and education in the built environment; and funded the production of this publication. Set up in 2002 to advance knowledge, innovation and communication for public benefit, the Trust uses all profits made by the **BRE Group** to fund new research and education programmes that will help to meet its goal of **'building a better world together'.**

The Building Research Establishment (BRE) is a world leading multi-disciplinary building science centre with a mission to improve the built environment through research and knowledge generation.

This guide was written by Dr. Andy Lewry; a Fellow of the Energy Managers Association and a Chartered Engineer with 18 years' experience within the Carbon/Energy Management Industry preceded by a further 10 years within the Environmental/Construction Sectors.

Enquiries and sources of further information

BRE has over 100 experts working in all aspects of energy within the built environment which can be contact by:

- Phone - Call 0333 321 88 11
- E-mail - Send to enquiries@bre.co.uk
- Visiting http://www.bre.co.uk/index.jsp

Further information can be found in the publication - IP1/14 Understanding the choices for building controls - available from http://www.brebookshop.com/.

Where to start

Assess the potential for savings

Building energy costs

Energy is 40% of the life costs and 50% of the running costs. Managing these costs effectively requires controls.

Where can I find the potential savings?

BS EN 15232:2012 divides controls into a series of efficiency classes – A to D for a range of building types; with efficiency factors which can converted into potential savings.

Indicative savings

There is a table later in this document containing the indicative savings; but these can be substantial; for example, an office building changing from non energy efficient class D controls to standard class C controls can result in savings of 34%.

Available Technology

Choosing the right equipment

What do classes A-D mean?

Class **D** are non-energy efficient controls, whilst **C** are considered the standard; **B** are advanced and **A** high energy performance.

Which equipment fits into the Classes?

Class **C** are required by Part L of the building regulations and are Environment Zone Controls. Class **B** are pre-programmed Building Energy Management systems (BEMs) and Class **A** programmable BEMs.

Where can I find a specification?

Class **B** can be specified using the Building Environment Zone Controls criteria in the UK Energy Technology List (ETL) – see below.

Choose your supplier

Making the right choice

Pick a manufacturer or supplier that is either:

- On the UK Energy Technology List (ETL)
- A member of the Building Controls Industry Association (BCIA)
- A member of the Energy Services and Technology Association (ESTA)

Building Controls – Q & A

Drivers

What are the benefits?

Building controls, whether stand-alone units or full Building Energy Management systems (BEMS), are designed to provide a comfortable climate for building occupants while ensuring this is delivered with the lowest possible energy consumption.

What are the potential savings?

The indicative savings can be found in BS EN 15232:2012 and are summarised in the table below:

Non-residential building types	**% savings from D**			
	D	**C (Reference)**	**B**	**A**
	Non energy efficient	**Standard**	Advanced	High energy performance
Offices	0	**34**	47	54
Lecture hall	0	**19**	40	60*
Education buildings (schools)	0	**17**	27	33
Hospitals	0	**24**	31	34
Hotels	0	**24**	35	48
Restaurants	0	**19**	37	45
Wholesale and retail trade service buildings	0	**36**	53	62
Other types: - sport facilities - storage - industrial buildings		**N/A**		

* These values are highly dependent on actual heating / cooling/ ventilation demand.

Which regulations apply?

The current building regulations (Part L) requirement is Class C.

What else can the controls do?

Controls can be used to manage heating systems, cooling systems, air conditioning systems, lighting systems and blinds – as well as fire and security systems and lifts. They can also be used to directly collect and display data from meters. Energy data can then be displayed on the BEMS; having good quality data about actual energy consumption is the key to achieving an energy efficient building.

What type of control do I need?

Demand-based control is the most energy efficient; turning things appliances off when not needed or, if this cannot be done, then at least turning them down.

Building Controls – Q & A

Solutions

Which technologies are available?

There are a range of technologies which are summarised below:

Control	Uses and applications
Building management system (BMS)	• A BMS is a computer-based system which integrates building functions, ie heating ventilation and air conditioning (HVAC), fire, security, power systems and lighting. • Available in pre-programmed or programmable formats. • Systems are available for all types of businesses and sizes of buildings.
Building energy management system (BEMS)	• BEMS control and monitor plant such as lighting and HVAC in order to specifically address energy use. • BEMS does not integrate all parts of the building as a BMS does, ie control of security and fire protection systems is not normally included.
Demand control or zone control	• Demand control enables the HVAC system to operate until the demand is satisfied, eg cooling, hot water, radiators and air handling. • Demand control can be linked in to CO_2 sensors or footfall sensors. • Allows the building to be separated into zones it which services are supplied and controlled as required.
Sequencing	• Sequencing can be a stand-alone control or via the BMS/BEMS. • Controlling the number of boilers required to meet the current heating load of the building.
Weather compensation	• Controlling the indoor temperature of the building independently of increases or decrease in outdoor temperature. • Enables energy savings to be achieved by reducing the heating system's operating (flow) temperature.
Boiler load optimisation	• Stand-alone control which prevents boilers from dry cycling and reduces energy costs. • Boiler optimisation can be programmed as part of the BEMS and some have a standard strategy package to do this.
Optimum start/stop	• A time schedule should be set up to control plant and equipment to fit in with the occupancy of times of a building. This time schedule will also be used to provide optimum start (and stop) of the HVAC plant to ensure comfort conditions are achieved for the start and finish of occupancy.
Occupancy controls	• Mainly used in lighting systems, though they can also be used for fast-response extract fan systems in bathroom areas. • There are typically four types of sensors: passive infrared (PIR) sensors, ultrasonic sensors, microwave sensors and audio sensors.
Variable controls	• Controlling the speed of drives and fans when full speed is not required will deliver cost savings.
Interlock controls	• Prevents unnecessary energy use and plant operation. • For example, if doors or windows are opened, sensors detect this and the interlock controls prevent the boiler(s) or air conditioning from operating.

Building Controls – Q & A

Solutions

Which technologies should I use?

There are a range of technologies available but you need to consider what functionality is required of the control systems, the first step is to consider which services need to be controlled and what level of control is required – a servicing strategy.

For example, Demand control adapts the standard assumption on occupancy and follows actual occupancy patterns. All building services can be controlled to meet peak loads and occupancy levels – in normal operation these conditions rarely occur.

Which service strategy?

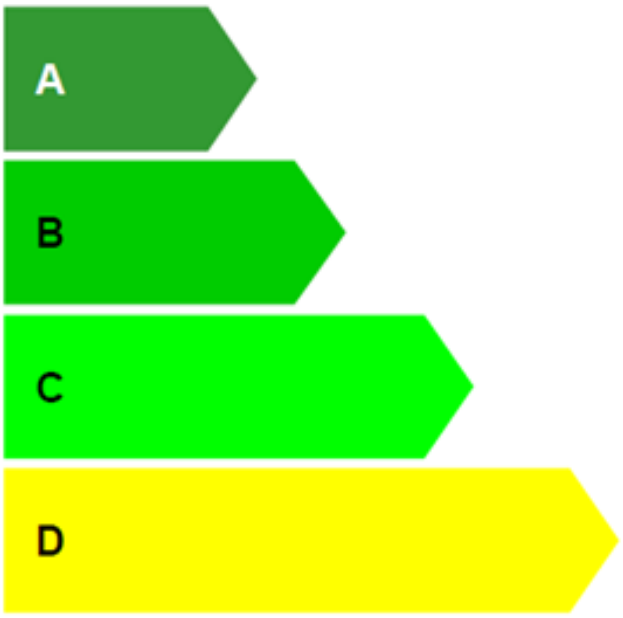
The first point in establishing your Servicing and Controls Strategy is to determine your business's objectives over the next 3 to 5 years. This will be driven by issues such as: Is your business expanding in size? Will more space be required? What is the plan with your business's estate? How long is left on the lease? Does your business have the skill set or expertise to manage and control the building controls? Is senior management committed to reducing energy costs or/and carbon emissions?

What is the first step?

To understand what existing controls you have in your building(s) and across your estate. An asset log of your plant should exist; if not, it is recommended that this is created, maintained and updated. An audit may be required to highlight areas where controls are lacking and enable you to identify areas where controls are urgently required.

How can the performance of controls be assessed?

This can be done by considering the classes of BS EN 15232:2012:



Class A:
- High energy performance BACS and TBM

Class B:
- Advanced BACS and TBM

Class C:
- Standard BACS (is normally used as reference)

Class D:
- Non energy efficient BACS

BACS (building automation and controls systems) and TBM (technical building management systems) are European terms for what is known in the UK as Building Management Systems (BMS) and Building Energy Management systems (BEMS) respectively.

What is a Class C control?

These are typically Building environment zone controls are used to control the environmental conditions (i.e. temperature, ventilation rate etc.) in individual zones (i.e. rooms or areas) within a building and the supply of services to them.

Building Controls – Q & A

Solutions

What is best practice?

This is typically a Class B control which can be programmed to maintain environmental conditions within pre-set limits in a manner that reflects occupation schedules, occupation status and/or level of activity in the zone, whilst also taking account of environmental conditions, and the specific operating requirements of the zone.

How do I specify a Class B control?

Use the Building Environment Zone Controls criteria in the UK Energy Technology List (ETL) - https://www.gov.uk/guidance/energy-technology-list plus add the summer/winter change-over functionality and a requirement for 365 day programming, as defined in BS EN 15500. This will cover the Heating, Ventilation and Air Conditioning (HVAC) requirements but extra requirements will have to be added when other types of equipment are controlled - see below.

What extra requirements will I need to consider?

Extra requirements will have to be added when other types of equipment are controlled, for example: Lighting control; Automatic monitoring and targeting equipment; Commercial refrigeration equipment system controls and Air compressor master controllers.

How do I control lighting?

Lighting controls are technology specific; and are products that are specifically designed to switch electric lighting on or off, and/or to dim its output. In addition to the functionality covered by the building environment zone controls described above, lighting controls cover presence detection and daylight detection – with and without dimming.

How do I specify lighting controls?

Again use the UK Energy Technology List (ETL) - https://www.gov.uk/guidance/energy-technology-list criteria when specifying **lighting controls**; heating management controllers and Variable Speed Drives (VSDs). This should be added to the Class B control requirements where appropriate.

What is a Pre-programmed Building Energy Management system (BEMS)?

These are stand-alone products using a fixed set of functions. They are normally expandable, so the size of the building is not a limiting factor. If installed with sensors, fan speed inverters and dampers they can perform functions such as Demand Control Ventilation (DCV) functions and realise significant savings. DCV is the control of ventilation rate to maintain the required level of indoor air quality while avoiding unnecessary ventilation.

However, they are only suited to small installations as the complexity of many HVAC systems and the desire to add extra services, such as renewable technologies, makes use of fixed control functions very limited. BEMs also offer the ability to control all building systems, e.g. lighting, shading, etc, which gives them the ability to maximise the overall energy saving potential.

What is a Programmable Building Energy Management system (BEMS)?

As the title says, these are fully programmable and offer greater flexibility in that that they can perform a wide range of control strategies as well as demand control ventilation (DCV); for example, using free cooling in order to reduce the chiller load may require ventilation rates to be increased, i.e. the BEMS considers the whole building energy picture. Ease of programming and recent reductions in cost have expanded applications into the market served by local pre-programmed controllers (e.g. small plant rooms), so these programmable BEMS can be applied to all applications regardless of size.

Are there any BEMS issues I should be aware of?

The BEMS is only as good as the person who writes the code; as a result the programmer needs to have full knowledge of the system and the hardware/software protocols.

Building Controls – Q & A

Solutions

Who can help?

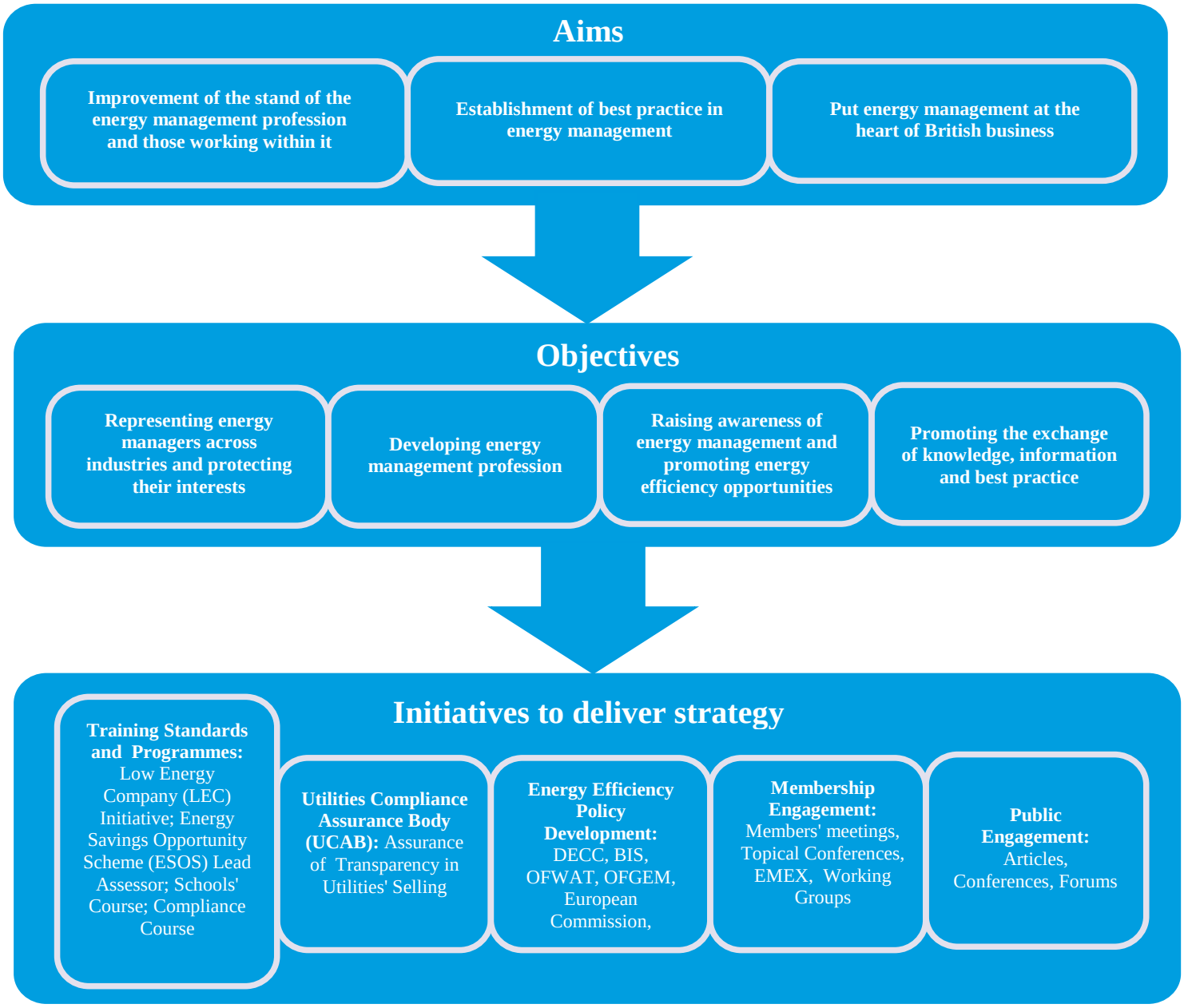
If you have a Facilities Management (FM) provider, Mechanical and Electrical (M&E) contractor or BMS/BEMS service provider they will be able to help you understand what you have and what is possible within your estate. Use their experience and knowledge to your advantage. Alternatively if you do not have such partnerships or service providers; consultants can provide a valuable service by carrying out an in-depth Energy/Building audit.

What are the key issues?

There **are Ten** key issues to address:

- **Specification breaking – procurement routes and 'value engineering'**
  This is normally a cost-cutting exercise with the temptation to cut capital costs. Stand-alone controls are cheap, in the order of £250 installed, but several will be required. Pre-programmed BEMS have an installed price of around £1000. But to fully realise the potential savings from energy efficiency, you probably need a programmable BEMS which costs in the range of £3,500 and £5,000 installed.
- **Occupancy patterns – schedules and density**
  As we have seen above, insight into how the building is used improves the estimation of potential savings and, following installation, allows commissioning of the controls to fully realise the potential energy savings.
- **Future proofing – flexibility and upgrades**
  Technology soon becomes dated and to ensure that your system does not become redundant it needs to be programmable. A programmable system is likely to be flexible enough to take into account changes in usage and can be upgraded to take on board technological and software advances.
- **Links to monitoring and targeting (M&T) – optimisation systems**
  Energy management relies on the old adage 'if you cannot measure it, you cannot manage it'. This means that the control system (i.e. the BEMS) needs to be linked to the metering, then all the monitoring and targeting M&T functions can be carried out in the same place, thus allowing management to be instantaneous.
- **Verification/certification**
  To justify business cases it is increasingly important for the performance of new assets, including control systems, to be verified. A fully integrated system can allow collection and analysis of this data, thus allowing this step to be simple and relatively painless.
- **Commissioning – initial set-up and an on-going process**
  As we have seen above it is essential to understand your business and building(s) in producing a Servicing and Controls Strategy. Once this has been achieved the next step is to ensure that the controls are installed and commissioned to achieve this strategy. However, it is an unceasing process to resolve operating problems, improve comfort, optimize optimise energy use and identify retrofits for existing buildings and central plant facilities.
- **Training**
  Training is only as current as the last person trained, so, like commissioning, should be an on-going process to ensure that Facilities staff, the Facilities Management (FM) contractor (if you have one) and other users know how to optimise the use of the system. If knowledge is lost, the temptation is to use default systems which leads to inefficiencies and defeats the object of having a customisable programmable system.
- **Maintenance requirements – planned upgrades**
  This runs alongside ongoing commissioning, requiring the hardware to be monitored and upgraded where appropriate. This is especially true of sensors where the system will still run if they are damaged or have drifted due to old age, but not at optimal performance. The result is normally far higher running costs.
- **Management reporting**
  For energy management to be effective, the data has to be presented in a concise manner and in a form appropriate to the audience. What is required for management of the system will be far more detailed than that required for the financial department to reconcile the bills on a monthly basis and Board reports need to be concise and to highlight any issues.
- **Additional functionality – critical services/alarms**
  When managing services you need to ensure that they are delivering the right amount at the right time. Modern systems can be set up to alert key staff by email when services fail to switch off when expected, use more energy than expected or when communications go down. This minimises risk to the business in terms of uncontrolled usage and possible damage to the asset.

The Energy Managers Association



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