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The Impact of Controls on the Energy Efficiency of Buildings

Introduction

The British and European standard, BS EN 15232-1:2017, assesses the cumulative impact of building automation and controls – commonly referred to as BACS - on the energy efficiency of buildings. Its official title is *"Energy performance of buildings. Impact of Building Automation, Controls and Building Management"*.

It is a well-documented fact that buildings account for over 40% of global energy consumption, with commercial (i.e., non-domestic) buildings accounting for more than half of this figure. Buildings rarely perform as well as their designers calculated with energy consumption and costs being as much as double what was expected.

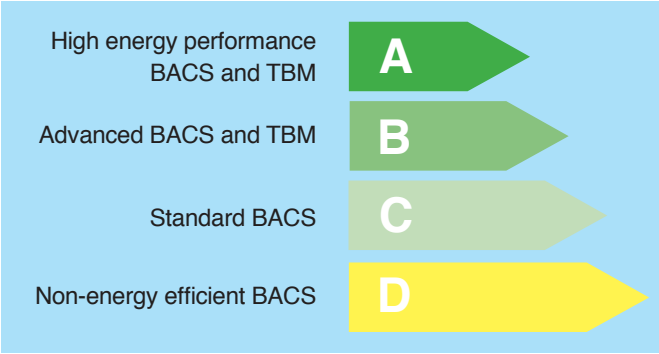
In a white paper by the BRE (Building Research Establishment) it was established that lack of, or poorly implemented, controls accounted for seven of the top 10 reasons for this energy performance gap.

The BS EN 15232 standard prescribes methodologies for control that will result in significant energy savings in both domestic and commercial buildings.

Existing buildings can be operated at significantly lower energy use after updating building automation and system functions that are optimally implemented, properly commissioned, monitored and maintained.

Four levels of BACS efficiency

The Standard defines four levels of BACS efficiency, from A to D



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Class	Energy efficiency
A	Corresponds to high energy performance BACS and Technical Building Management (TBM) • Networked room automation with automatic demand control • Scheduled maintenance • Energy monitoring • Sustainable energy optimization
B	Corresponds to advanced BACS and some specific TBM functions • Networked room automation without automatic demand control • Energy monitoring
C	Corresponds to standard BACS • Networked building automation of primary plants • No electronic room automation, thermostatic valves for radiators • No energy monitoring
D	Corresponds to non-energy efficient BACS. Buildings with such systems shall be retrofitted. New buildings shall not be equipped with such systems • Without networked building automation functions • No electronic room automation • No energy monitoring

The Standard defines the control functions that are required to meet the requisite performance classes. These cover heating control, domestic hot water supply control, cooling control, ventilation and air conditioning control, lighting control, blind control, and technical home and building management (TBM). The Standard does not, however, define how these control functions should be achieved.

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In the extract below for lighting control it can be seen that to achieve Class A compliance in a non-residential building, lighting must be turned on and off based on fully-automatic occupancy detection, using automatic daylight control (i.e., Lux level measurement) to adjust the intensity of the artificial light. This ensures that lighting should never be on if a space is unoccupied and/or if there is sufficient ambient daylight.

		Definition of classes							
		Residential				Non-residential			
		D	C	B	A	D	C	B	A
5	**Lighting Control**								
5.1	**Occupancy control**								
	0 Manual on/off switch	■	■			■			
	1 Manual on/off switch + additional sweeping extinction signal	■	■	■		■	■		
	2 Automatic detection	■	■	■	■	■	■	■	■
5.2	**Daylight control**								
	0 Manual	■	■	■		■	■		
	1 Automatic	■	■	■	■	■	■	■	■

The Standard contains these matrix charts for all of the above-mentioned control categories.

To achieve the highest level of efficiency, the amount of energy delivered into a room or space should be based solely on the demand of the consumer(s), i.e., those occupying the space, effectively creating an accurate closed loop system. The energy demand signals could be derived by the interaction of the consumers themselves (e.g., adjustment of thermostats) or, more effectively – as defined within Class A system requirements - by automated measurement systems (e.g. occupancy sensors, temperature and CO2 measurement, light level sensors, etc.) which reduce or eliminate human interaction and, therefore, the potential to waste energy.

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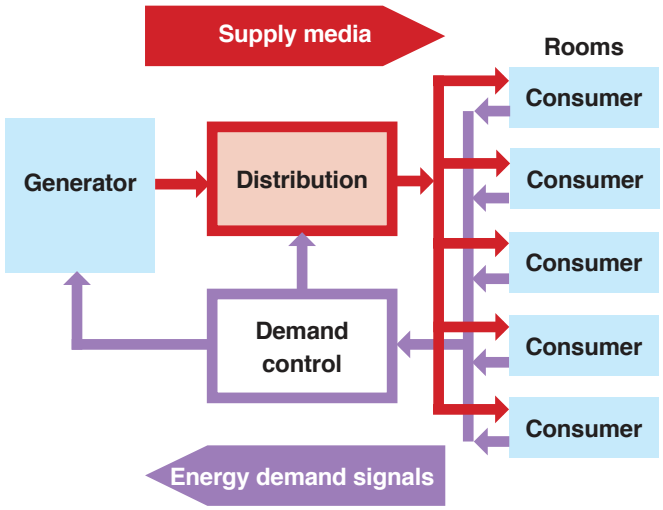
Who should use the Standard?

The Standard is designed to allow designers and end users to estimate the expected energy performance efficiency of a building when controls and automation are implemented to a specific Class. It also provides an excellent checklist of required control functionality (e.g., for software engineers) to avoid the wastage of energy. For example, to achieve Class A, there must be a total interlock between heating and cooling control to ensure that they can never be 'on' at the same time in the same space. This may seem like an obvious statement, but it is one that is very often overlooked. This could be caused by poor software implementation, an overlapping of setpoints or, more commonly, due to the fact that the heating and cooling systems were installed by two different contractors and no thought was given to the 'hand-shaking' between the two.



		Definition of classes							
		Residential				Non-residential			
		D	C	B	A	D	C	B	A
3.6	**Interlock between heating and cooling control emission and/or distribution**								
	0 No interlock	■				■			
	1 Partial interlock (dependant of the HVAC system)	■	■	■		■	■	■	
	2 Total interlock	■	■	■	■	■	■	■	■

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The Standard provides the calculations from which the efficiency factors are derived. In the table below you can see that an office with a Class D system (i.e., little or no control) will consume more than twice the thermal energy of one having a Class A system (0.7 vs 1.51, where the baseline of 1 is the Class C reference standard):

Overall BACS efficiency factors $f_{BACS, th,}$ - Non-residential buildings

Non residential building types	Overall BACS efficiency factors $f_{BACS,th}$			
	D Non energy efficient	**C** **(Referance) Standard**	**B** Advanced	**A** High energy Performance
Offices	1,51	1	0,80	0,70
Lecture hall	1,24	1	0,75	0,5*
Education buildings (schools)	1,20	1	0,88	0,80
Hospitals	1,31	1	0,91	0,86
Hotels	1,31	1	0,85	0,68
Restaurants	1,23	1	0,77	0,68
Wholesale and retails trade service buildings	1,56	1	0,73	0,6*
Other types: sport facilities, storage, industrial buildings		1		

* These values highly depend on heating / cooling demand for ventilation

BCIA member companies (manufacturers and systems integrators alike) use the BS EN 15232 Standard as a guiding light for control system design and operation. As an Association, the BCIA recommends that all modern building control systems should meet at least Class B performance rather than the baseline Class C which, it is felt, leaves too many gaps for inefficient energy performance. The BS EN 15232 Standard is available to purchase from the BSI online store. https://shop.bsigroup.com/ProductDetail/?pid=000000000030331529

The BRE's report, "Bridging the performance gap: Understanding predicted and actual energy use of buildings" is available to purchase here. https://www.brebookshop.com/details.jsp?id=327495

The IET Code of Practice for Building Automation and Control Systems is available to purchase here: https://shop.theiet.org/code-of-practice-for-building-automation-and-control-systems