Building Energy Management System (BEMS) Design and Embodied Carbon

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Introduction

Worldwide, national governments have recognised the consequences of global warming and the dangers that climate change can bring about. The United Nations have agreed to limit global warming and of the 196 nations that have signed up to the Paris Climate Change Agreement (COP21), the UK Government is one. The UK government has put in place legislation to become a net zero carbon economy by 2050 with staged goals along the way. The net zero goals encompass all new and existing industrial, retail, commercial and residential buildings, and operations.

The vast majority of carbon emissions are in the in-use phase of a building for the day-to-day heating, lighting, ventilation, and control systems. At present the majority of this demand is met with fossil fuels, however the UK power generation sector is increasingly moving to cleaner renewable sources of power. This shift to greener sources of power along with the electrification of heat, and energy efficiency measures in building structure, lighting and ventilation will eventually phase out our current reliance on carbon intensive fossil fuels.

Non-residential buildings last for many years and when considering the whole life of the building or asset there is carbon consumption outside of the in-use phase. The materials that make up the shell of the building structure, the plant and controls installed within, all require processing from the extraction of raw materials to the delivery of a finished product or installation. Material processing, transport, installation, and disposal all consume energy. The carbon consumption can be calculated from the energy consumed during these processes and declared as the embodied carbon within the product.

Consideration for BEMS design to reduce Embodied Carbon

Embodied carbon is the equivalent carbon dioxide (CO_2) emissions associated with materials and construction processes throughout the whole lifecycle of a building. By reducing the materials used in the BEMS systems, the embodied carbon and the cost is also reduced. The durability and longevity of BEMS components also reduces embodied carbon. It is important to specify that the most up to date BEMS controls are installed to ensure they last the full life expectancy of that product. For example, using legacy controls on an existing BEMS installation that may need to be replaced during the operational period of the building will increase the embodied carbon during maintenance of the system.

With all new contracts, consideration for Embodied Carbon reduction must be included in the BEMS design.

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Control Panel design

The plant used to keep the building running, its location, its electrical installation and its interface with the BEMS are key factors to consider when designing and specifying the control panels.

Shown below, Fig.1 provides a visualisation of how a traditional Motor Control Centre (MCC) can now be reduced to a smaller Control Enclosure (CE) and Electrical Power Distribution Board (DB).

An MCC was needed when fan and pump motors did not have internal electrical fault protection and they required contactors, overloads, or motor inverters to be installed inside an MCC for operational safety. Electronically Commutated (EC) fans and pump motors with built-in fault protection are now widely available allowing control panel designs to use fewer components and facilitating smaller panel design.

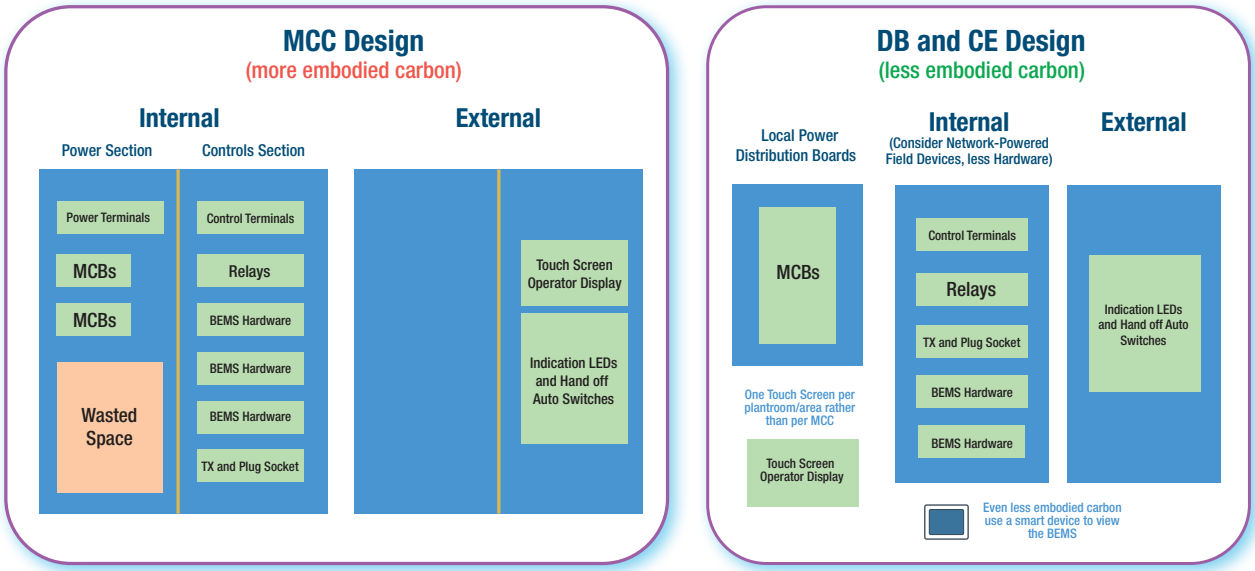

Fig.1 BEMS Panel design and reducing embodied carbon

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Electrical Installation Design – Mechanical Plant Rooms

Installing control panels using the smaller power DB and CE type of design into the mechanical plant room will reduce the size of BEMS electrical containment. Shown below, Fig.2 provides a visualisation of how using network-controlled field devices or locally controlled plant will reduce the containment size in the plant room. For a project with a large number of Air Handling Units (AHU's) or similar mechanical plant, it is considered to be best practice to send the BEMS Control Enclosure to the AHU manufacturer for installation at their factory. This will remove the need for remote site-based BEMS installation, use fewer materials in the equipment construction where the CE is installed in the AHU, and reduce the amount of cabling required due to shorter cable routes.

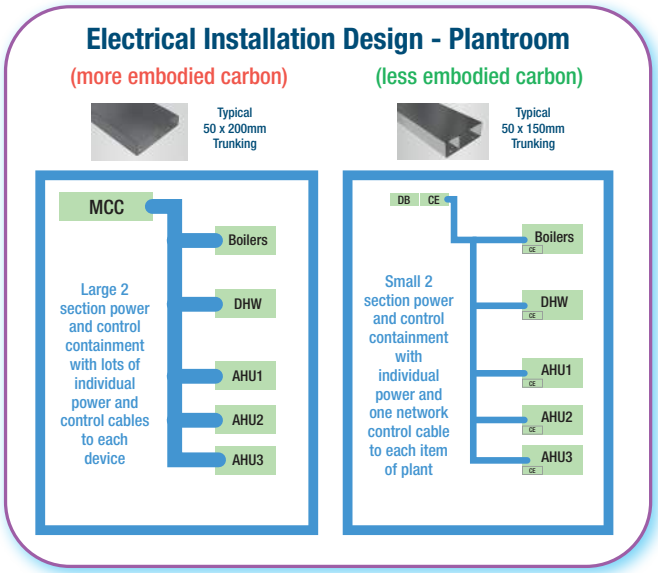

Fig.2 BEMS Electrical Installation design in plant rooms reducing embodied carbon

Electrical Installation Design – Building Floors

The use of network-powered field devices should always be considered to reduce the embodied carbon when designing BEMS electrical installation around individual building floors. Shown below, Fig.3 provides a visualisation of the reduced number of cables and containment size when installing network-powered field devices compared to wiring from a control enclosure to each space sensor. Wiring from a control enclosure to each space sensor requires the enclosure to be bigger to accommodate the necessary input and output hardware for each field device.

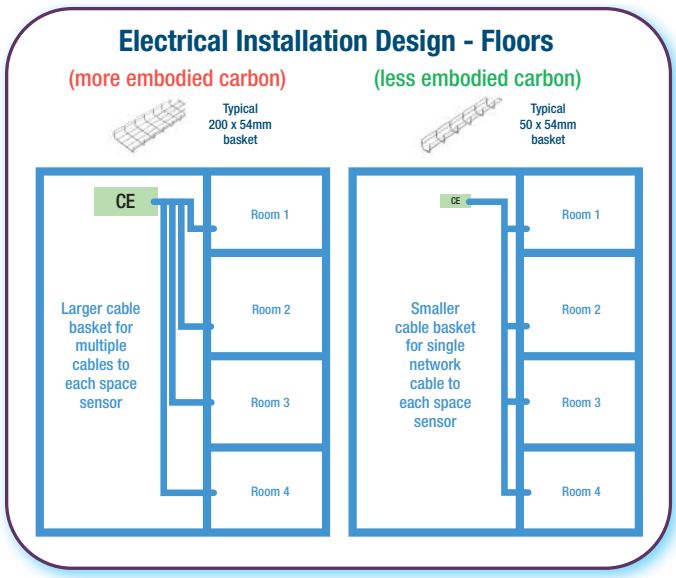

Fig.3 BEMS Electrical Installation design at floor level reducing embodied carbon

Consultants and Specifiers to reduce Embodied Carbon

We encourage consultants and specifiers to update specification templates using the content within this Technical Guide, to reduce the embodied carbon of the installed BEMS. Early engagement between the client and consultant to minimise the embodied carbon of the BEMS is essential. This does not only ensure a cleaner, greener and sustainable installation but also will reduce the cost of installing the system.

For refurbishment contracts, clients and consultants should consider the installation of wireless sensors to improve the energy performance of their building. Using wireless sensors, there is no need to install a large amount of containment and cabling in an existing building, which can be costly and increase the embodied carbon.

Guides and Products to reduce embodied carbon

At the time of publishing there is a lack of consistent information on the embodied carbon of BEMS products. There are several schemes being developed across Europe however, in the UK, embodied carbon can be reported in the products' Environmental Product Declaration (EPD). In the majority of cases, the EPD for the product will be created by the manufacturer.

Where EPD information is not available from the manufacturer of a control or sensing device, the Chartered Institute of Building Service Engineers (CIBSE) has created a Technical Memorandum - TM65 Embodied Carbon of Building Services Equipment. The document contains, guidance for engineers and consultants to calculate the embodied carbon emissions of MEP equipment. The guide is also supplied with a digital embodied carbon calculator tool. This spreadsheet-based tool enables manufacturers and engineers to estimate the embodied carbon associated with M&E services in buildings.

Note the TM65 Carbon calculator is for products rather than bespoke BEMS control panel and electrical installation design.

This document and declaration are a good source of information, but ultimately efficiently designing the BEMS to control the building environment in an energy-efficient manner while using the fewest materials, provides the optimal solution.

Other recommended reading

ISO 52120-1:2021 Energy performance of buildings — Contribution of building automation, controls and building management — Part 1: General framework and procedures

BS EN ISO 16484-2:2004 Building automation and control systems (BACS)

Hardware (British Standard) ISO 16484-2:2004 specifies the requirements for the hardware to perform the tasks within a building automation and control system (BACS).

BS EN 15232-1:2017 Energy Performance of Buildings. Impact of Building Automation, Controls and Building Management.

Note: BS15232 has since been superseded by BS EN ISO 52120-1:2022 Energy performance of buildings. Contribution of building automation, controls and building management. General framework and procedures

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