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Facilities management added value in closing the energy performance gap

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Abstract

Existing non-domestic buildings tend to use more energy than expected. This paper investigates how the operational strategies of facilities management can contribute to reducing building energy use. A longitudinal case study of a higher education (HE) campus which was conceptualised with the objective of being environmentally friendly and energy efficient is presented. The paper reflects on the energy performance of the campus since its operation in 2001, based on 14 years of energy data and a detailed record of all initiatives undertaken by the campus's facilities management (FM) team in order to optimise energy performance. The integrated FM strategy composed of low- and no-cost strategies, continuous improvements, ongoing commissioning and retrofits succeeded in reducing campus energy intensity from 174 to 87 kWh/(m^2*yr), now outperforming most relevant benchmarks. This finding highlights the importance of operations and maintenance in reducing the energy usage of existing buildings. This presented findings draw on a single case only, which excels through a very detailed longitudinal dataset. Going forwards, the analysis of further cases is recommended to corroborate the findings. The presented results suggest that proactive operations and maintenance strategies in existing buildings can contribute towards significantly improving energy performance. The profile and competency level of facilities management personnel should consequently be raised strategically at the organisational and national/industrial policy level, whilst integrated design processes should be further expanded to include FM's operational control and management in a holistically fashion.

Keywords: Facilities management; Building energy performance; Performance gap; Higher education campus; Operation and maintenance

1. Introduction

Reducing greenhouse gas emissions to avoid dangerous climate change has increasingly become the focus of environmental legislation as well as corporate business and social responsibility agendas (Ernst and Young, 2013; United Nations Global Compact, 2013). Buildings and activities they host are responsible for a significant share of greenhouse gas (GHG) emissions: In 2010, buildings accounted for 35% of total global final energy use (OECD/IEA, 2013), 19% of energy-related GHG emissions, approximately one-third of black carbon emissions, and an eighth to a third of F-gases (IPCC, 2014). Globally, building energy use and related emissions may double or

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potentially even triple by mid-century due to several key trends such as population growth, migration to cities, and increasing levels of wealth and lifestyle changes globally (IPCC, 2014).

Addressing GHG emissions from buildings can, however, also be one of the key mitigation mechanisms since their reduction potentials may be large compared to other major emitting sectors (UNEP-SBCI, 2009). As opposed to other sectors, such as transportation where major low carbon innovations are yet to be expected, many technologies to realise the mitigation potential in buildings are already in existence and well documented (IPCC, 2014). If today's cost-effective best practices and technologies were broadly diffused and implemented, significant carbon savings are possible. The IPCC (2014) further argues that mitigation opportunities in the built environment are often associated with significant co-benefits (such as energy security, health and environmental benefits, improved comfort and services, productivity and net employment gains, increased value for building, etc.), that may exceed the direct benefits by orders of magnitude.

Retrofitting the existing building stock is key to carbon mitigation in built environment because buildings are very long-lived and a large proportion of the total building stock today will still exist in 2050 in developed countries (IPCC, 2014). But initiatives which encourage retrofits at sub-optimal level may "lock in" much of the mitigation potential of buildings, thereby failing to achieve the required level of emission reductions (UNEP-SBCI, 2009). GEA (2012), OECD/IEA (2013) and IPCC (2014) extensively highlight and warn of lock-in effects and risks in both new and existing buildings because of the inability to apply urgent and aggressive state-of-the-art standards on efficiency performance.

At the same time there is overwhelming evidence that many green buildings perform poorly and emit much more CO_2 during actual operation than expected. OECD/IEA (2013) report highlights that many buildings have been designed and built with very efficient technologies and systems and have been recognised with distinction awards such as LEED Platinum and showcased as model buildings, however, their energy consumption is often much higher than expected. Studies of the energy performance of LEED buildings show more mixed results but equally some building perform poorly (Turner and Owens, 2008) – and it was suggested that LEED building certification is not moving towards its goal of climate neutrality (Scofield, 2013; Newsham et al., 2009). Innovate UK's 2014 study on BREEAM rated buildings found that overlooking unregulated energy uses and outdated assumptions on operating hours contributed to the performance gap at the design stage, whilst tick boxing to comply or score more in rating systems instead of taking appropriate design decision for proper use and control during operation was widespread. In particular, it is often cautioned against building controls and systems that are overly complex (CIBSE, 2012). Further, poor construction details as well as the failure to deliver the design intent on-site during construction are problematic (Carbon Trust, 2012).

Whilst aggressive building regulations and standards for new buildings and existing building retrofits are important, there is hence a dire need to addresses these substantial energy performance gaps for buildings in use. Integrated Design Processes (IDP) for the delivery of new buildings and retrofits together with Post-Occupancy Evaluation (POE) may offer ways forwards (Preiser and Vischer, 2005; GEA, 2012; WBCSD, 2009; Harvey, 2009; Lewis et al., 2010), whilst challenges have been reported to effectively applying these two approaches in practice (de Wilde, 2014; Riley et al., 2010; NRF, 2014; National Audit Office, 2007; Carbon Trust, 2012; Harvey, 2013).

Facilities management (FM) may offer important contributions in the face of these challenges. Commercial buildings undergo a major renovation on average every 20–30 years – mostly based on the need for HVAC equipment changes (NEEA, 2014). In the meantime, however, further opportunities to reduce energy costs and carbon emissions should not be overlooked. FM can achieve continuous improvements in building performance through low- and/or no-cost maintenance strategies, retrofits and commissioning, together with proactive operational control and maintenance (O&M) (Aune et al., 2009; Hignite, 2009; Lewis et al., 2010; Hodges, 2012; Finch and Zhang, 2013).

Facilities management is, however, disjointed and the potential contributions of operations and maintenance (O&M) to addressing poor building performance are often overlooked or taken for granted. This paper argues that the holistic inclusion of O&M, i.e., is the domain of facility management, into the integrated design process as part of the building life cycle can make major contributions to reducing the energy use of non-domestic buildings. Such integration will at the same time support FM in focusing on the long term sustainability performance rather than mainly respond to short-term issues arising from either occasional emerging opportunities or opportunistic availability of funds.

Two hypotheses are here proposed:

1. Proactive FM practicing a continuous improvement strategy can majorly reduce the energy performance of a higher education campus.
2. A diligent retrofit based on suitable green rating systems requirements and applied to an existing HE building which has been practicing proactive FM's O&M can further improve energy performance.

They are tested against a longitudinal case study of the long-term FM strategy for an aspirational green HE campus in Singapore. O&M measures and their impact on building energy performance over the course of 15 years are documented.

Implications of the findings for facilities management of HE campuses in tropical climates, building design

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