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Shared Services Partnership
Specialist Estates Services

Health Technical Memorandum 07-02

EnCO$_2$de – making energy work in healthcare.

Environment and sustainability.

Part A: Policy and management

2015

STATUS IN WALES

APPLIES

This is a Department of Health document that applies in Wales with the following note attached:

The policy sections in the document generally refer to English only policy and the document is based upon English specific data and statistics. These, as well as references to English-specific organisations, should be treated with caution when used in Wales.

All technical content in the document is applicable to Wales, and the document's general principles can be applied when followed in conjunction with relevant policy documents and regulatory requirements. However, the previous HTM 07-02:2006 EnCO$_2$de guidance remains available through the Specialist Estates Services document archive (and from the link below) and may be used to support the new 2015 documents as a source of useful technical information.

Link to HTM 07-02:2006 EnCO$_2$de

For specific queries about how to apply or interpret the EnCO$_2$de guidance documents, please contact Christopher Lewis, Environmental Management Advisor, Specialist Estates Services on: 029 2090 4096 or email: christopher.lewis4@wales.nhs.uk

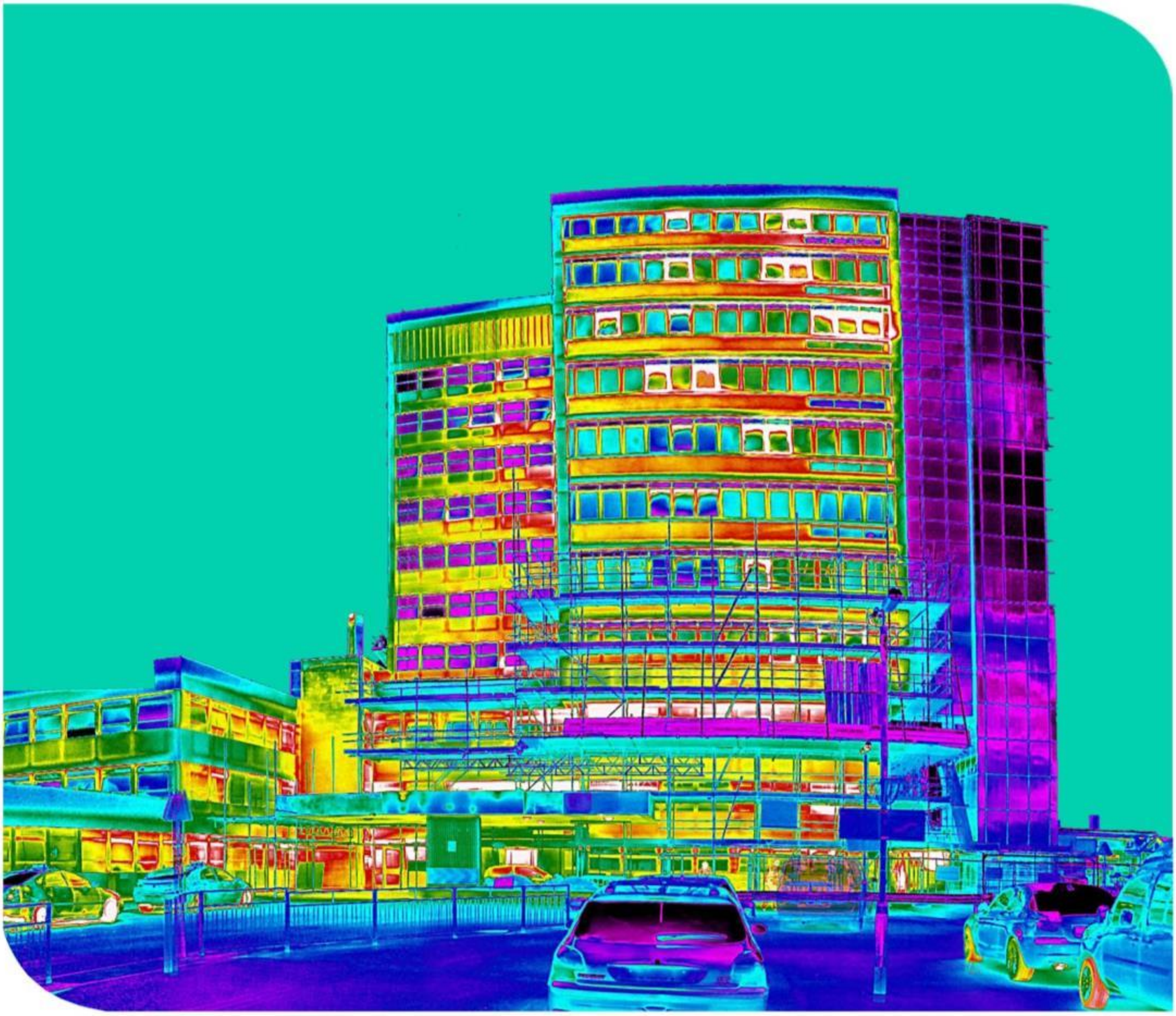
Status Note created April 2016

Department of Health

Health Technical Memorandum 07-02: EnCO$_2$de 2015 – making energy work in healthcare

Environment and sustainability

Part A: Policy and management



Published to gov.uk, in PDF format only.

www.gov.uk/dh

Health Technical Memorandum 07-02: EnCO$_2$de 2015 – making energy work in healthcare

Environment and sustainability

Part A: Policy and management

Prepared by

Professor C. Alan Short	Department of Architecture, University of Cambridge
Professor Peter Guthrie	Centre for Sustainable Development, Department of Engineering, University of Cambridge
Eleni Soulti	Centre for Sustainable Development, Department of Engineering, University of Cambridge
Dr Sebastian Macmillan	Department of Architecture, University of Cambridge

Preface

About Health Technical Memoranda

Health Technical Memoranda (HTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of Health Technical Memorandum guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle (see diagram below).

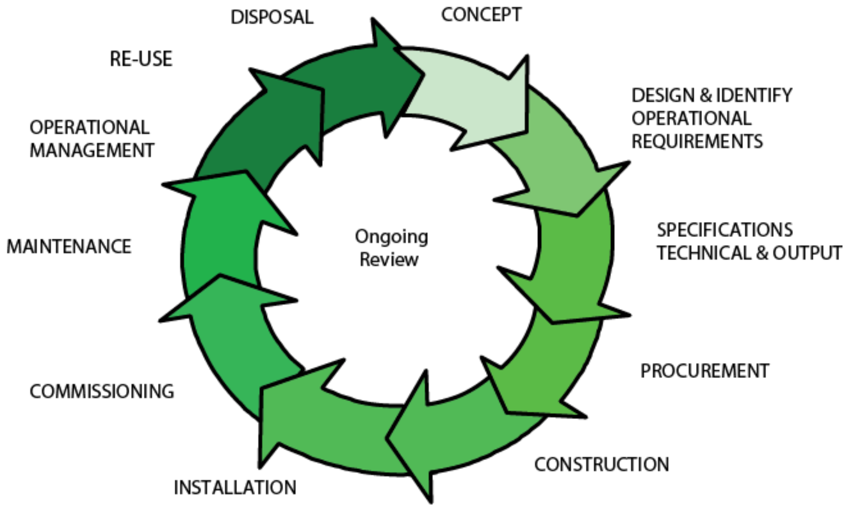
Healthcare providers have a duty of care to ensure that appropriate governance arrangements are in place and are managed effectively. The Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

It is not the intention within this suite of documents to unnecessarily repeat international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of nine subject areas provides access to guidance which:

- is more streamlined and accessible;
- encapsulates the latest standards and best practice in healthcare engineering, technology and sustainability;
- provides a structured reference for healthcare engineering.



Structure of the Health Technical Memorandum suite

The series contains a suite of nine core subjects:

Health Technical Memorandum 00
Policies and principles (applicable to all Health Technical Memoranda in this series)

Choice Framework for local Policy and Procedures 01
Decontamination

Health Technical Memorandum 02
Medical gases

Health Technical Memorandum 03
Heating and ventilation systems

Health Technical Memorandum 04
Water systems

Health Technical Memorandum 05
Fire safety

Health Technical Memorandum 06
Electrical services

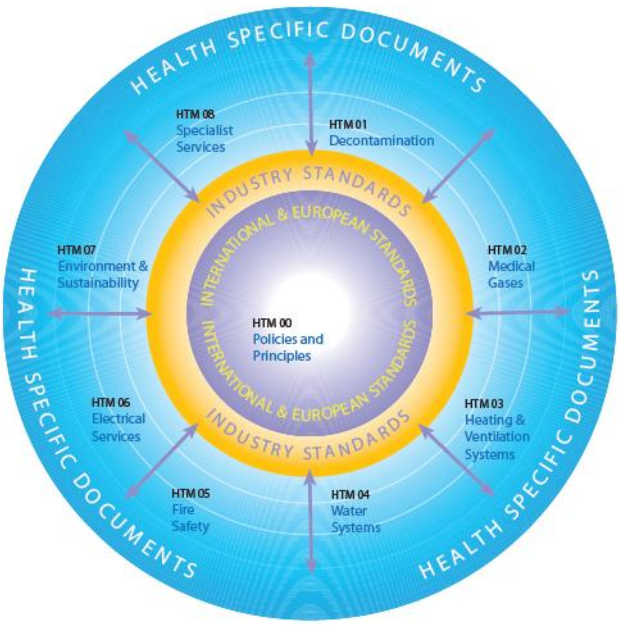
Health Technical Memorandum 07
Environment and sustainability

Health Technical Memorandum 08
Specialist services

All Health Technical Memoranda are supported by the initial document Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

DH Estates and Facilities Division wishes to acknowledge the contribution made by professional bodies, engineering consultants, healthcare specialists and NHS staff who have contributed to the production of this guidance.



Other resources in the DH Estates and Facilities knowledge series

Health Building Notes

Health Building Notes give best practice guidance on the design and planning of new healthcare buildings and on the adaptation/ extension of existing facilities.

They provide information to support the briefing and design processes for individual projects in the NHS building programme. All Health Technical Memoranda should be read in conjunction with the relevant parts of the Health Building Note series.

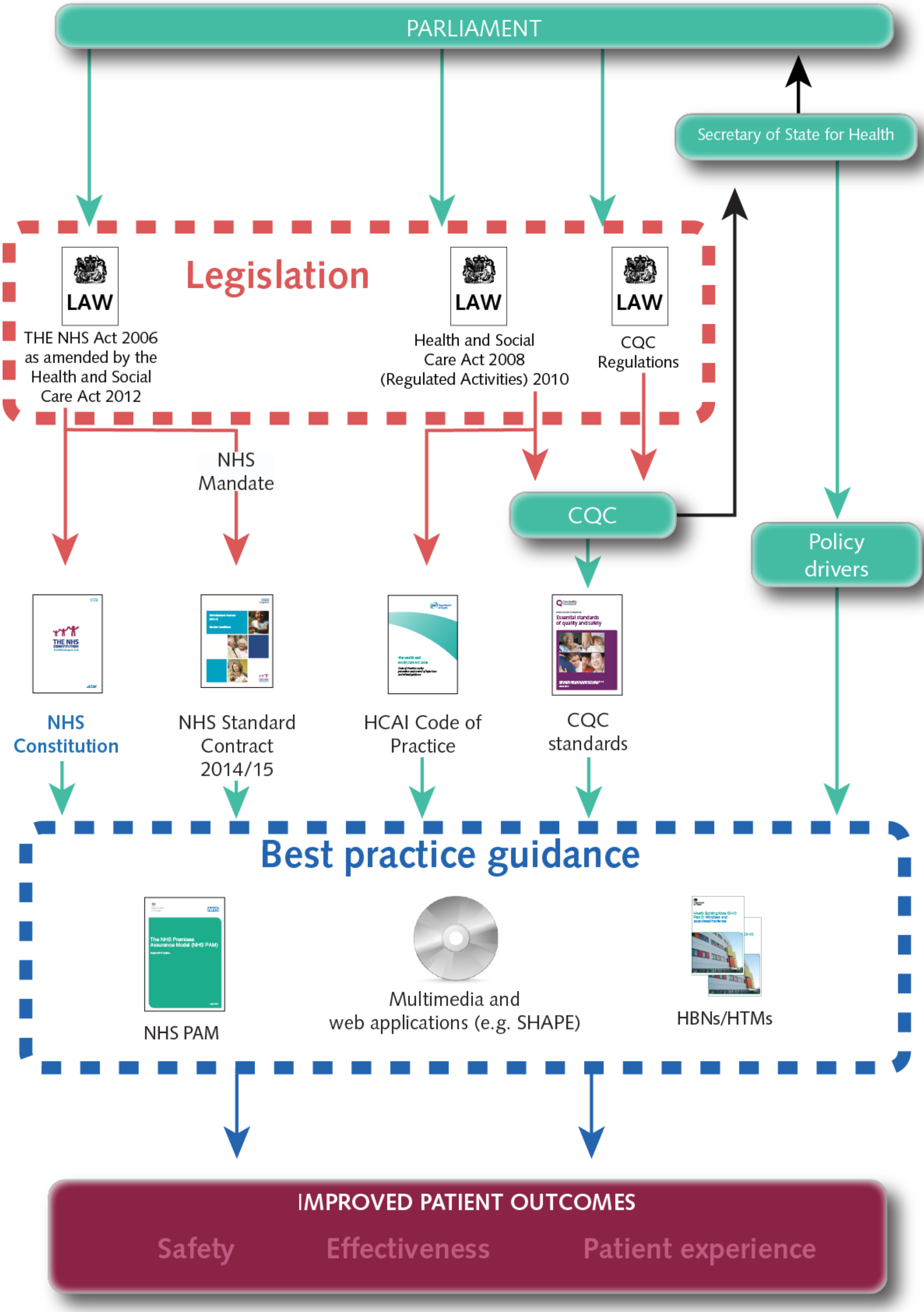
Activity DataBase (ADB)

The Activity DataBase (ADB) data and software assists project teams with the briefing and design of the healthcare environment. Data is based on guidance given in the Health Building Notes and Health Technical Memoranda.

For ADB technical queries only, contact the ADB Helpdesk. Telephone number: 01939 291684; email: support@talonsolutions.co.uk
For new ADB customers and licence renewals only, email: adblicencerenewals@dh.gsi.gov.uk

How to obtain publications

Health Technical Memoranda are available from the UK Government's website at: https://www.gov.uk/government/collections/ health-technical-memorandum-disinfection- and-sterilization
Health Building Notes are available from the same site at: https://www.gov.uk/government/collections/health-building-notes-core-elements


PARLIAMENT
Secretary of State for Health
Legislation
LAW
THE NHS Act 2006 as amended by the Health and Social Care Act 2012
LAW
Health and Social Care Act 2008 (Regulated Activities) 2010
LAW
CQC Regulations
NHS Mandate
CQC
Policy drivers
NHS Constitution
NHS Standard Contract 2014/15
HCAI Code of Practice
CQC standards
Best practice guidance
NHS PAM
Multimedia and web applications (e.g. SHAPE)
HBNs/HTMs
IMPROVED PATIENT OUTCOMES
Safety
Effectiveness
Patient experience

Foreword

The National Health Service (NHS) is responsible for the management of its publicly funded healthcare estate. This includes the provision of an efficient, safe and resilient estate that supports both clinical services and improves the experience that patients have of their care and treatment. It should be a public sector exemplar for the implementation of Climate Change adaptation and mitigation strategies.

The NHS estate has an important contribution to make in reducing running costs and delivering savings for investment in frontline patient care. These must be undertaken to meet the challenges of funding the NHS in the future and will form part of the government's drive to increase the efficiency of the public sector estate in parallel with the dual challenges of an ageing population and Climate Change. A significant step change in the way this estate is managed has to be achieved.

The opportunities for the NHS to achieve efficiency savings and reduced running costs in the estate are considerable. These efficiencies need to be driven by:

- more efficient plus effective running and use of the estate;
- improved efficiency, including value for money, in capital procurement and construction;
- improved energy efficiency and associated carbon reduction.

Building energy use (gas and electricity) is 18% of the NHS England carbon footprint[1] at a metered energy cost of £636 million[2].This cost equates to approximately 9% of the total estates budget of £7bn.

In 2013/14 the Department's NHS Energy Efficiency Fund (NHS EEF) of £49.3M was allocated to 117 energy efficiency projects across 48 NHS organisations in England. The Fund enabled the NHS to go further, faster in mitigating the effects of climate change, by improving energy efficiency, whilst retaining the resulting benefits within the NHS organisations for re-investment directly into frontline patient services. The lessons learnt from these energy efficiency projects are embedded in Encode 2015 as best practice guidance.

The current NHS Estates Efficiency programme has the challenge of reducing the current estates budget as part of the contribution to help ensure the continued delivery of a sustainable NHS. Improving energy efficiency of the NHS estate will deliver a contribution to this important initiative whilst also assisting the NHS to meet the necessary reductions in carbon emissions of 34% compared to 1990 levels by 2020.

Peter Sellars
Head of Profession for NHS Estates & Facilities Policy
Department of Health

[1] Sustainable Development Unit - Goods and services carbon hotspots (published 2012)

[2] ERIC 2013/14 returns from the NHS

Executive summary

Preamble

'Health Technical Memorandum 07-02: EnCO$_2$de 2015 - making energy work in healthcare' is the primary guidance on energy efficiency in healthcare facilities in England. It has been produced as a guide to all issues relating to the procurement and management of energy in the NHS and energy efficiency in new build and existing buildings.

Encode 2015 incorporates the learning from projects implemented under the NHS Energy Efficiency Fund (EEF) which was undertaken during 2013/2014. Encode 2015 has been written by the University of Cambridge Department of Architecture and the University of Cambridge Centre for Sustainable Development in the Department of Engineering. It incorporates their observations and examples of good practice following their role of monitoring the differing nationwide EEF projects.

Encode 2015 is not prescriptive. It draws together best practice guidance so that healthcare organisations can determine a way forward that best suits their situation.

Encode 2015 replaces all previous versions of Health Technical Memorandum 07-02: making energy work in healthcare.

Encode 2015 is published in two parts:

- Part A deals with the policy context, organisational carbon management, building energy management and behaviour change in healthcare environments.
- Part B covers energy efficiency in new build and the refurbishment of existing buildings, as well as energy efficient building services and low and zero carbon technologies.

Introduction

The Intergovernmental Panel on Climate Change highlights three major issues: that warming in the climate system is unequivocal, that the effect of humans on the climate is clear, and that climate change mitigation requires significant reduction of greenhouse gas emissions.

This poses a double challenge for healthcare facilities:

- to reduce their carbon emissions and contribute to the national and NHS targets for climate mitigation, identify opportunities for adapting to expected climate change and build resilience to extreme climate events;
- to support resilient communities including planning services for expected changes in health needs and providing high quality healthcare particularly focusing on needs during adverse climatic conditions.

Encode 2015 sets the foundations for meeting this challenge and for assisting in the delivery of a resilient healthcare estate as detailed in HBN 00-07: Planning for a resilient healthcare estate (published April 2014).

Aim of the guidance

The aim of Encode 2015 is to ensure that everyone involved in managing, procuring, designing and using buildings and equipment thinks about the implications of energy use and carbon reduction whilst putting patients first; today and in the future. In short, it puts climate change mitigation and adaptation at the heart of the health service.

Who should use this guidance?

The audience of this Encode 2015 includes those managers involved in the strategic, and day to day, management of energy consumption, energy efficiency and carbon reduction within their organisation. It is also includes those responsible for the procurement, design, construction and handover of all capital projects to confirm that the aims of the organisation’s energy and carbon management policy have been taken into consideration and correctly addressed.

Main changes from Encode 2006

This Health Technical Memorandum has been revised to reflect the latest carbon reduction targets set on a national and NHS level. It includes an update on the latest low and zero carbon technologies and lessons learnt from their use to date. Encode 2015 has a major contribution regarding the refurbishment of existing buildings and provides relevant information combined with the outcomes and lessons learnt from the NHS Energy Efficiency Fund, which financed 117 energy efficiency projects delivered through 2013 to 2014 in 48 NHS organisations.

Other key issues – Recommendations

- It emphasises the need for an organisation to have a Sustainable Development Management Plan including sections on energy and carbon management and environmental policy. This should be board approved with updates annually by an ‘energy champion’ who sits on the board.
- It highlights the importance of energy and carbon management at an organisation level and the significance of feedback mechanisms in this process.
- It highlights the significance of patients’ comfort in healthcare buildings, especially under adverse weather conditions affected by climate change.
- It provides information on the policies related to energy efficiency and carbon reduction in healthcare organisations.
- It provides a project design checklist that it recommends should be used during the design, construction and handover phases of all capital projects to confirm that the aims of the organisation’s energy and carbon management policy have been taken into consideration and correctly addressed.
- It provides information on the refurbishment of existing building facilities, the evaluation of different options and potential challenges faced during this process.

Chief executives should ensure that:

- Encode 2015 is distributed to board members and departmental leaders;
- Departmental leaders brief their colleagues and staff on the specific recommendations set out in Encode;
- Encode 2015 is given to suppliers and contractors - perhaps as an appendix to contractual requirements - so that they too can play their part in helping to cut energy usage and carbon emissions.

Acknowledgments

Sounding Panel Members:
Philip Ashcroft, Department of Health
Peter Barton-Wood, Department of Energy & Climate Change
Julie Braidwood - Crown Commercial Service
Robert Cohen, Verco Advisory Services
Kathryn Dapre, NHS Facilities Scotland
Paul Decort, Deaprtment for Communities and Local Government
Patricia Donnan, Department of Health, Social Services and Public Safety
Richard Egerton, Ashford & St Peter's NHS Foundation Trust
Christopher Lewis, NHS Wales Shared Services Partnership
Frank Mills, ASHRAE, CIBSE
David Reilly, Carbon Trust
Imogen Tennison, Sustainable Development Unit
Ollie Swan, Ashford & St Peter's NHS Foundation Trust
Gaynor Whyles, JERA Consulting

Additional contributors:
Michael Bellas, Department of Health
Dr Angie Bone, Public Health England
Nick Bundle, Public Health England
Katie Carmichael, Public Health England
Christopher Farrah, Department of Health
Richard Hales, Cambridge University Hospitals NHS Foundation Trust
Chris Hall, BRE
Charlotte Hardy, BRE
Dr Louise Newport, Department of Health
Eleni Pasdeki-Clewer, Sustainable Procurement Sustainable Development Unit
Carl Petrokofsky, Public Health England
John Prendergast, Department of Health
RIBA
Christian Richardson, Department of Health
Gerardo Sanchez, WHO European Centre for Environment and Health
Ray Stephenson, Department of Health
Paul Townsend, Department of Health
David Wilson, Department of Health, Social Services and Public Safety
David Whiteley, Department of Health

For giving us permission to use content from their publications, as referenced in the document:
British Standards Institution
Carbon Trust
CIBSE
Manoj Chohan, Southend University NHSFT (for the Encode 2015 cover)
Paul Davidson, DECC
Joseph Little of Building Life Consultancy
Philip Steadman, UCL
Malcolm Thomas, Consulting Engineer

Contents

1 Management and policy context

1.1 Introduction

1.1.1 This chapter presents essential background information, and it should be read by anyone who is involved in managing resources and services – not just energy management. In addition, it should be read by suppliers of goods and services so that they also understand the need for energy efficiency.

1.1.2 It is important to be aware that Encode is intended as a guidance and signposting document. It is not and should not be used as, a comprehensive or definitive technical manual. Appropriate legal, financial, contractual and/or technical advice should be sought from the sources it signposts and/or from those with appropriate expertise and experience.

1.1.3 This chapter includes:

- NHS carbon reduction commitments;
- a summary of policies and legislation relevant to energy performance and carbon emissions reduction;
- a summary of why we need to take adaptive and mitigating actions as a response to the climate change;
- a summary of the benefits of energy efficiency and carbon emissions reduction;
- a brief explanation of energy efficiency and its connection to patients' well-being and staff behaviour with regards to energy use;
- a summary of how energy is measured and where it is used in the healthcare sector;
- a summary of the documentation determining energy and carbon management policy in the healthcare sector.

1.2 Energy and carbon savings

1.2.1 The Sustainable Development Strategy for the NHS, Public Health and Social Care system in England describes a vision for a sustainable health and care system by reducing carbon emissions, protecting natural resources, preparing communities for extreme weather events and promoting healthy lifestyles and environments. High quality care now and for future generations will mean working within available financial, social and environmental resources.

1.2.2 The sustainable approach suggested by the Sustainable Development Unit (SDU) in the Sustainable Development Strategy for the NHS, helps to create sustainable, resilient, healthy places and people. This needs to be approached both by enabling the positives and by reducing the negatives allowing virtuous cycles to constantly improve outcomes. Figure 1 presents this approach.

1.2.3 Carbon emission targets: Improving energy efficiency on an organisation level can contribute to the achievement of the organisation's carbon emissions targets and thus provide an example of leading energy efficiency for other public sector organisations. Carbon reduction also forms part of the Carbon Reduction Commitment (CRC) targets analysed in Chapter 1 and Appendix 4.

1.2.4 Positive feedback for organisations from the local community: Organisations that reinvest the finances freed up as a result of improved energy efficiency into local healthcare services are likely to receive positive feedback from their local community.

1.2.5 There is another reason why action should be considered. The global environment – and by implication, the health of nations – is being damaged by the burning of fossil fuels (coal, oil and gas) to supply an ever-increasing demand for energy. The UK, together with many of the world's governments, has pledged to curb its reliance on fossil fuels so that it can cut carbon emissions to a sustainable level (see Box 1).

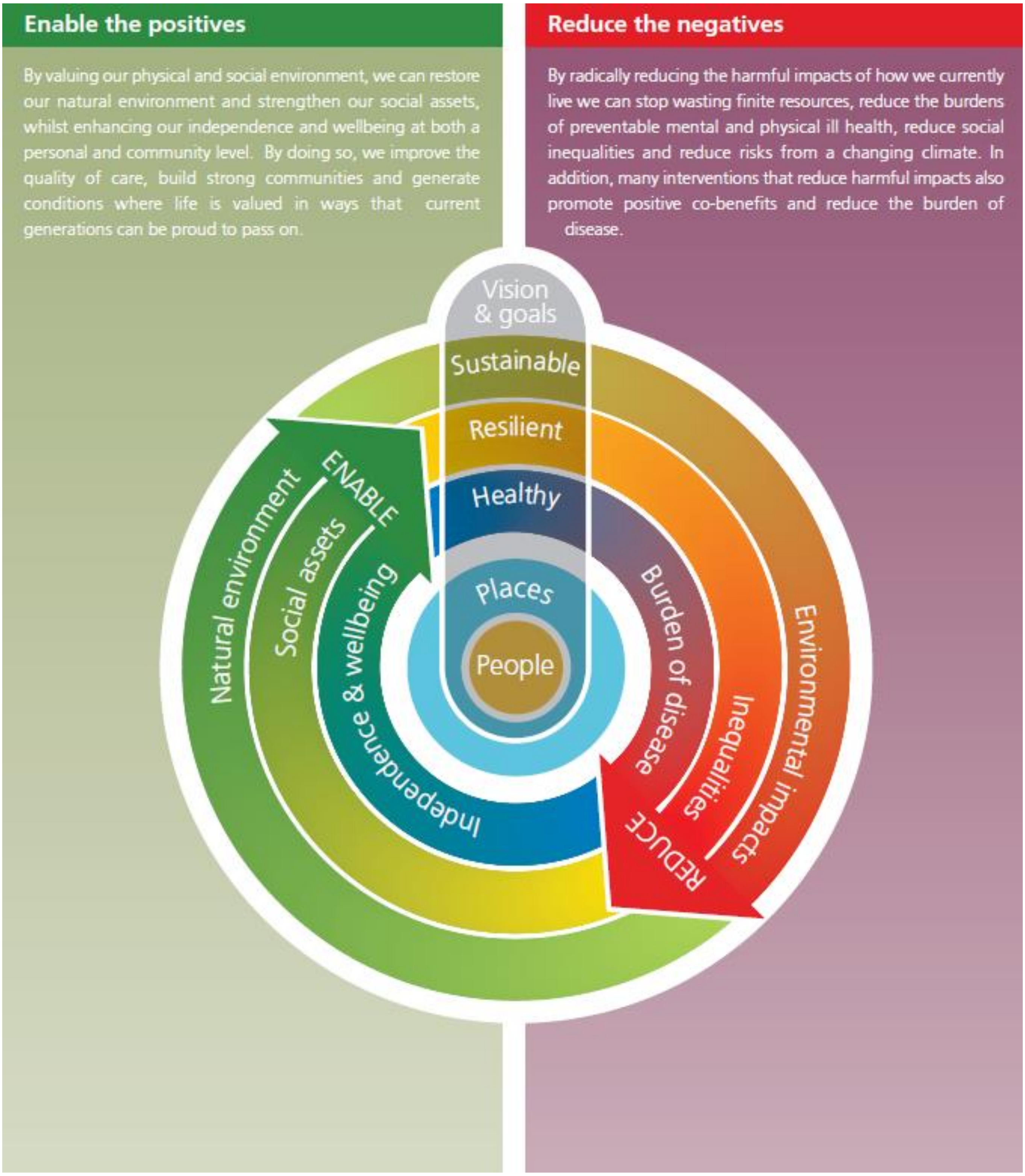


Figure 1 The Sustainable approach of the SDU. Source: Sustainable, Resilient, Healthy People & Places: A Sustainable Development Strategy for the NHS, Public Health and Social Care system

Box 1 Climate change and the carbon challenge

Burning fossil fuels releases carbon dioxide (CO_2) into the atmosphere. According to the UK Climate Change Risk Assessment: Government Report, there is strong scientific evidence that this could warm the Earth's climate by as much as 3ºC over the next 100 years, resulting in floods, droughts, storms and severe weather phenomena. At the same time, as a result of warming climate, periods of severe heat (heatwaves) are likely to increase in frequency, duration and intensity. Despite the overall warming climate, periods of severe cold weather are also likely to continue. The social, environmental and economic costs associated with this could be immense.

The Intergovernmental Panel on Climate Change (IPCC) in its report Climate Change 2013: The Physical Science Basis highlighted three major facts: that warming in the climate system is unequivocal, that the effect of humans on the climate is clear and that the climate change mitigation requires significant reduction of greenhouse gas emissions. The UK, through the Climate Change Act 2008, has set the legally binding target of decreasing its greenhouse gas emissions by 80%, compared to the 1990 levels, by 2050. The Energy White Paper 2007 describes the obligation of all public sector organisations to reduce their carbon emissions, leading energy efficiency. For the NHS, public health and social care system to be on track for the Climate Change Act target, a 34% reduction on 1990 levels would be needed by 2020. This translates to a reduction of 28%, compared to the 2013 levels by 2020.

The NHS Carbon Reduction Strategy Update suggests that the potential of carbon emissions reduction in the NHS through the energy use in buildings is in total 6% on the 2020 baseline, as shown in Table 1. The reduction appears to be the same, for the two options: refurbishing all NHS buildings with low or zero carbon technologies, or replacing all NHS buildings with highly efficient stock.

Proposed NHS intervention	Saving on 2020 baseline	
	Potential reduction in carbon emissions ($MtCO_2$)	Potential reduction in carbon emissions (%)
Refurbish all NHS buildings using Low or Zero Carbon Technologies - reduces NHS building energy use by 25%	1.4	6%
Replacing all NHS building s with super-efficient stock - reduces NHS building energy use by 25%	1.4	6%

Table 1 Description of CO_2e reduction measures on NHS buildings. Adapted from the NHS Carbon Reduction Strategy Update

The UK Climate Change Risk Assessment identified the health risks from increased summer temperatures and overheating in buildings as the most significant, along with the health impacts from floods. Nevertheless, cold related mortality is expected to decline only slightly, due to the ageing population. At the moment, 90% of the total stock involves types of hospital ward that are vulnerable to overheating.

The Health and Social Care Act 2012 and the Civil Contingencies Act 2004 require the NHS to ensure managing risks related to health and social care, including those resulting from severe weather events.

1.2.6 The SDU Saving carbon, improving health: NHS Carbon Reduction Strategy for England describing carbon footprint modelling for the NHS up to 2020, suggested that the NHS carbon footprint was projected to rise by 55% compared to 1990 levels. According to the Estates Return Information Collection (ERIC) data the building energy use emissions increased by 0.9% between 2007/2008 and 2012/2013, which is in the context of a 12.4% increase in inpatient activity. Nevertheless, 58 organisations have managed to decrease their building energy use by more than 10% compared to 2007/2008.

1.2.7 It is also likely that the ever-growing reliance on technology in the healthcare sector will continue. Most of the equipment utilised within healthcare services relies on electricity which is responsible for more than double carbon emissions compared to other fossil fuels (see DEFRA Greenhouse Gas Conversion Factor Repository). This means that energy efficiency measures and particularly behaviours that reduce energy use, are essential in contributing to the necessary reduction in carbon emissions to help prevent escalating damage to the global environment.

1.3 The need of mitigation and adaptation to climate change

1.3.1 Climate change is considered to be the biggest global health threat of our century. There are significant health implications that are likely to be generated from climate change and its characteristics. Addressing the health impacts themselves, but also preparing the healthcare sector buildings for climate change can protect lives, save costs and improve health conditions in the country.

1.3.2 Health Building Note 00-07: Planning for a resilient healthcare estate differentiates between adaptation and mitigation:

- Adaptation involves designing and planning in a way that projected healthcare demands are met and patients' well-being is protected within buildings.
- Mitigation refers to the reduction of carbon emissions in order to alleviate climate change.

1.3.3 However, there are significant benefits of combining adaptation and mitigation actions. Although both contribute to the reduction of the risks due to climate change on society and nature, they act at entirely different times and vary between different locations. Mitigation will have a global effect; nevertheless, due to the lag times in the climate and biophysical systems, this effect will not be realised before the middle of the 21st century (see IPCC Fourth Assessment Report: Climate Change 2007). Adaptation on the other hand, typically involves regional scales but its effects are more immediately identified. Therefore, it is not about making a choice between adaptation and mitigation on a policy level. For vulnerabilities to climate change to be addressed, adaptation is essential, because climate change effects are unavoidable in the next few decades, even under stringent mitigation efforts. Mitigation is also necessary because the reliance on adaptation alone, would lead to a level of climate change to which adaptation would only be effective under very high social, environmental and financial costs.

1.3.4 While buildings should have low carbon emissions and minimal effect on the environment, they should at the same point be designed to work efficiently, effectively and reliably, taking into account expected changes to their external environment and especially those related to the climate change. The SDU in collaboration with the Environment Agency, in their 2014 report describe heat, air quality and aeroallergens, as well as extreme weather among those signs of climate change that might have a significant impact on health. Those are also the signs of climate change to which healthcare buildings have to adapt to. The following paragraphs give a brief description of this evidence of climate change.

1.3.5 Temperatures have been constantly increasing by approximately 0.25˚C per decade since 1960s in the UK. UK Climate Projections suggest that annual mean temperatures will increase between 2.5˚C and 4.2˚C in 2080 compared to the 1961-1990 levels; the most significant increases are expected in parts of Southern England and the lowest ones in the Scottish Islands. Other than the gradual warming, heatwaves are a significant concern for the NHS. The Met Office on its website defines heatwaves as ‘extended periods of hot weather compared to the expected conditions of the area at that time of the year’.

1.3.6 According to the Climate Change Adaptation Sub-Committee, 90% of the UK hospital stock belongs to categories vulnerable to overheating, while temperatures in some wards can exceed 30˚C even at external temperatures of 22 ˚C. There is a direct impact on human health, with illnesses and poor health being attributed to high temperatures. Mortality due to heat is expected to increase dramatically during the 21st century, based on predictions of outdoor temperatures, with an increase of 70%, 260% and 540% in the 2020s, the 2050s and the 2080s respectively, compared to the 2000s (see Health Effects of Climate Change in the UK 2012).

1.3.7 Figures 2 and 3 present the locations of acute hospital sites in England and the 2030s scenario for heatwave hazard projected increase in incidence.

1.3.8 The Heatwave Plan for England provides recommendations for long-term planning and different levels of heatwave alerts, depending on the temperatures and associated risks. Preparing the built environment for these new conditions and adapting to climate change are significant challenges. They involve improved design of building envelope, including insulation, shading and the use high-albedo materials; they are also related to temperature monitoring aiming to ensure high thermal comfort levels, especially for patients, elder people and infants.

1.3.9 Research has demonstrated the potential of existing hospital buildings to show resilience in future climate characteristics, through the implementation of non-invasive refurbishment measures, which improve thermal comfort conditions while increasing hospitals’ energy savings.

1.3.10 Additionally, heatwave and droughts can result in increased levels of dust, reduction of water supplies and water quality, increased demand for water supplies and finally increased demand for emergency power and emergency services (see Health Building Note 00-08 Part A). For example, the use of cooling systems is expected to increase, as a response to increasing summertime temperatures and the need to maintain populations’ thermal comfort levels at acceptable ranges.

Climate change can also result into the deterioration of air quality and the increase of aeroallergens. Climate change has an impact on ground level ozone, which affects respiratory health. Potential changes in air quality and related adverse health effects will also depend on the exposure to particulate matter and to nitrogen dioxide. Those three are the most significant ambient pollutants in terms of their effect on human health. Moreover, high temperatures are connected to poor air quality, while the exposure to aeroallergens can also deteriorate health conditions. Ensuring good air quality in healthcare buildings is significant for the provision of high levels of patients' care and this requirement may become more crucial due to climate change. For example, adequate ventilation rates in buildings that are becoming increasingly airtight, is crucial for maintaining high levels of indoor air quality.

1.3.11 Finally, extreme weather conditions which are expected to become increasingly common due to climate change will put additional pressure on healthcare providers to keep services running under those conditions. It is their priority to ensure patients' comfort and safety, whilst staff productivity is also an issue. Appropriate building design and ensuring adequate thermal comfort levels are crucial in healthcare buildings, especially as extreme weather phenomena increase in frequency and severity. The Health Building Note 00-08 Part A suggests improving building design and building insulation properties, while of course maintaining appropriate temperature controls, to ensure low energy use and high thermal comfort during extreme cold weather phenomena. It is worth highlighting the requirement to retain thermal comfort conditions throughout the year, meaning appropriate warmth during winter and comfortably cool temperatures during summer; this is something that initial building design or potential interventions should take into consideration. Special care should be taken so that interventions and design options do not intensify one extreme condition in the attempt to diminish the other one.

1.4 Patients' and staff well-being: thermal comfort and health

1.4.1 CIBSE Guide A describes comfort as 'the condition of mind that expresses satisfaction with the environment'. The indoor environment should ensure the comfort and health of its occupants. Comfort may include among other characteristics, thermal and visual conditions, as well as indoor air quality.

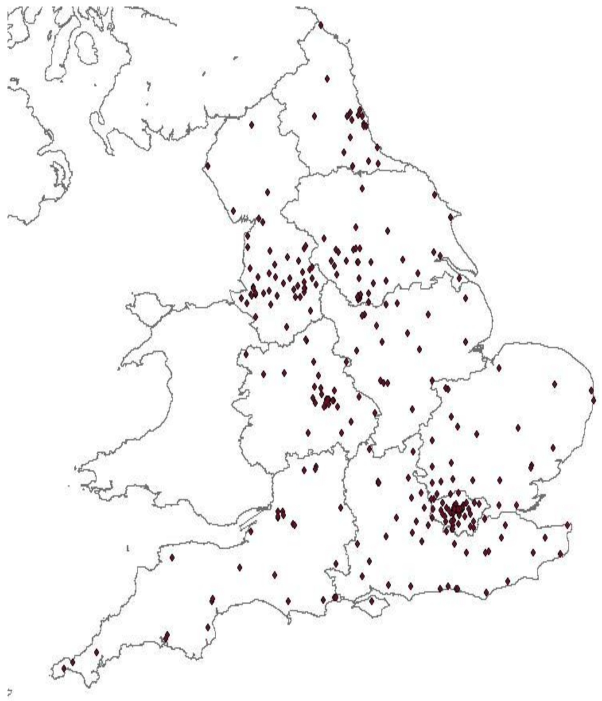


Figure 2 NHS Acute hospital sites in England (plotted by the EPSRC DeDeRHECC project team)

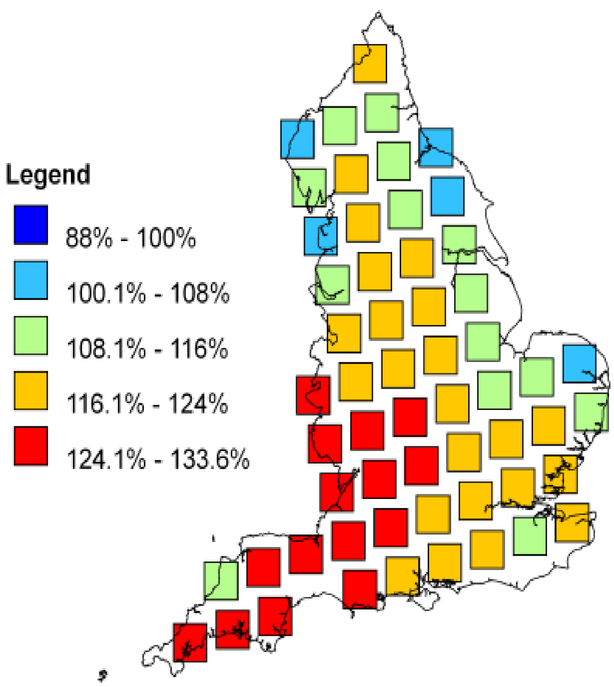


Figure 3 Scenario (2030s) Heatwave (T95) Hazard projected increase in incidence (plotted by the EPSRC BIOPICC project team)

1.4.2 Specifically for hospitals, there is extensive research demonstrating the impact of the healthcare environment on staff satisfaction and patients' health; an extensive literature review summarised physical factors of the indoor environment in healthcare buildings and their effect on staff, visitors and above all patients' health and well-being. These factors include ventilation and HVAC systems, thermal and acoustic environment, daylight and views, nature and gardens and lighting, which can all be influenced, positively or negatively, from attempts to improve energy efficiency in hospitals.

1.4.3 These factors formed the basis for 'A Staff and Patient Environment Calibration Tool' (ASPECT). This tool includes, among other parameters, light, ventilation, temperature and the level of control that the patients have over these conditions. All of these are crucial for patients' well-being and can often be influenced, positively or negatively, by attempts to improve energy efficiency in hospitals.

1.4.4 According to the 'Heatwave Plan for England: Making the Case', there is strong evidence on the risks to health associated with excessive heat. These are mostly respiratory and cardiovascular diseases, but are also heat syncope and more seriously heat exhaustion, heat stroke and death that can be caused from excess heat. Excess heat conditions are particularly risky for vulnerable population groups, such as older people and infants or those with chronic and severe illnesses. There is some evidence suggesting that between 1971 and 2003 the population became more tolerant to increasing summer heat (see Direct effects of rising temperatures on mortality in the UK) but there is uncertainty with regards to the levels of social and behavioural adaptation that will be achieved as summer temperatures continue to rise. Finally, there is a need to consider that the population ageing will increase the number susceptible to heat effects which may counteract adaptation effects.

1.4.5 Similarly, according to the 'Cold Weather Plan for England: Making the case', winter weather increases the incidence of heart attacks, strokes, respiratory diseases and influenza. A minimum of 18°C in winter poses minimal risk to the health of a sedentary person, wearing suitable clothing. Additional care should be taken for vulnerable groups. Groups susceptible to the health effects of cold include older people, children and those with chronic or severe illnesses.

1.4.6 Many patients in hospital will be in groups that are susceptible to health effects from room temperatures that are too hot or cold for them. This may be because their age, health condition or the medication that they are receiving makes them less able to regulate their body temperature, or because physiological changes to regulate body temperature exacerbate existing health problems, such as heart disease. There is also evidence that cold and heat perception can be impaired in older people, so that they may not take appropriate action to change their environment when it is too hot or cold. Furthermore, hospital patients may find it harder to adapt to the ambient temperature by opening windows, adjusting clothing or bedding, or increasing fluid intake.

1.4.7 It is worth mentioning here that many vulnerable people in the community are at risk of hospital admission, because their homes are too cold during the winter and/or too hot in summer. It is important that hospitals are prepared for additional demand on services at these times and able to ensure that the internal hospital environment doesn't place those who are admitted at additional risk.

1.4.8 It becomes therefore obvious, how important it is, especially in healthcare environments, to not only achieve and maintain thermal comfort conditions for different groups of people, including patients and staff, but also to set thresholds that are safe for their health. The differences in the perception of comfort make its determination a very challenging issue. In the same way it is challenging to identify indoor minimum and maximum temperature thresholds for health. Nevertheless, there are standards recommending specific conditions, regarding for example temperatures and lighting levels for various types of buildings and activities.

1.4.9 Health Technical Memorandum 03-01: Specialised ventilation for healthcare premises-Part A: Design and validation recommends temperatures from 18˚C to 28˚C in general wards, and 18˚C to 25˚C for more sensitive areas, such as birthing and recovery rooms. Calculations are also needed to ensure that internal temperatures do not exceed 28˚C dry bulb temperature for more than 50 hours per year. Specifically for hospitals, CIBSE Guide A: Environmental Design recommends ward temperatures from 22˚C to 24˚C during the winter and from 23˚C to 25˚C during the summer for air conditioned buildings, assuming specific clothing and activity levels. Finally, the Heatwave Plan for England recommends that hospitals provide cool areas below 26 ˚C for use during heatwaves. Maintaining these ranges of temperature ensures thermal comfort conditions for the majority of the staff and patients and protects their health and well-being.

1.4.10 Field studies in different countries with a variety of climatic conditions and temperatures, suggest that people have a natural tendency to adapt to changing conditions in their environment. This means that building designers can estimate internal temperatures at which occupants are likely to feel comfortable in free-running buildings. In these cases, the occupants should have the opportunity to adjust the conditions in a way that suits their specific requirements, given that the lack of control can increase discomfort.

1.4.11 The BS EN 15251 on indoor environmental parameters addressing buildings' indoor thermal environment, takes human adaptation into account and accepts different temperature ranges as thermally comfortable, allowing for a higher flexibility.

1.4.12 Criteria for the thermal environment should be based on the (BS EN ISO 7730: 2005), which takes into account PMV - PPD (predicted mean vote - predicted percentage of dissatisfied) and establish different categories of the indoor environment. The three categories (Table 2) refer to populations with different sensitivity levels and ability to adjust to their environment. The PMV-PPD index takes into consideration other thermal comfort parameters, such as clothing and activity levels, air and mean radiant temperature, air velocity and humidity. By assuming certain values for these parameters, a range of thermally comfortable temperatures can be established (see BS EN 15251: 2007).

1.4.13 Figure 4 presents those temperatures as a function of the outdoor running mean temperatures, as presented in the BS EN 15251. Box 2 describes a relevant example of applying BS EN 15251 to a hospital setting.

1.4.14 Category I is intended for spaces occupied by very sensitive and fragile persons. It has the narrowest acceptable temperature range as it is assumed that people are unable to change their clothing, be active and that air movement cannot be used (see Adaptive thermal comfort and sustainable thermal standards for buildings). This is broadly relevant to the many hospital patients who have limited ability to adjust their clothing, hydrate themselves or open the windows. However, even within the strict criteria of Category I it is still possible to reach internal temperatures that are harmful to patients' health. Heatwave conditions would normally be required for this to occur, but high internal temperatures have also been observed in NHS hospital wards outside of heatwave periods (see Building resilience to overheating into 1960's UK hospital buildings within the constraint of the national carbon reduction target: Adaptive strategies).

1.4.15 Adaptive thermal comfort guidance is recommended for non-clinical areas.

1.4.16 For each clinical area, decisions about setting environmental conditions should only be made after careful judgements as to the vulnerability and duration of stay of the intended patients. In all clinical areas, year round internal temperature monitoring is recommended. At any time of the year where temperatures are found to exceed 26˚C, a risk assessment should be carried out and appropriate action taken to ensure the safety of vulnerable patients.

The running mean of the outdoor temperature is the exponentially weighted running mean of the daily mean external air temperature Θ_{ed} is such a series and is calculated by the formula: $\Theta_{rm} = (1- \alpha) \times \{\Theta_{ed\ -1} + \alpha\Theta_{ed\ -2} + \alpha^2\Theta_{ed\ -3}\ldots\}$
Where Θ_{rm} = Running mean temperature for today
Θ_{ed-1} is the daily mean external temperature for the previous day
$\Theta_{ed\ -2}$ is the daily mean external temperature for the day before and so on.
α is a constant between 0 and 1. Recommended to use 0,8

1.4.17 The equations representing the lines in Figure 4 are described in Table 2, where Θ_i is the limit value of the indoor operative temperature in ˚C.

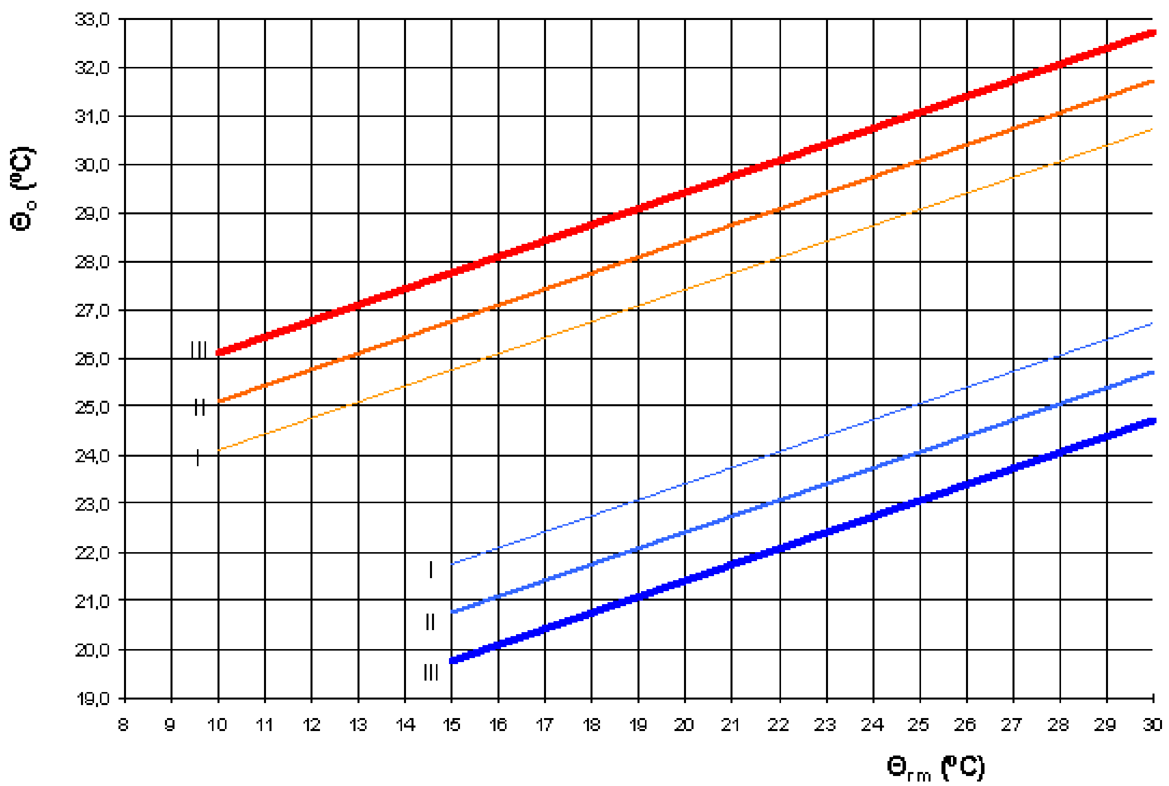


Figure 4 Acceptable 'summer' indoor temperatures (cooling season) for buildings without mechanical cooling systems as a function of the exponentially-weighted running mean of the outdoor temperature. The operative temperatures in this figure are valid for office buildings and other buildings of similar type used for human occupancy with mainly sedentary activities and dwellings, where there is easy access to operable windows and occupants may freely adapt their clothing to the indoor and/or outdoor thermal conditions. Θ_{rm} = outdoor running mean temperature ˚C and Θ_o = operative temperature ˚C. These limits apply when 10˚C < Θ_{rm} < 30˚C for upper limit and 15˚C < Θ_{rm} < 30˚C for lower limit. Above 25˚C the graphs are based on a limited database. © British Standards Institution (BSI – www.bsigroup.com). Extract reproduced with permission. Source: BS EN 15251:2007 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.

Category I (spaces occupied by very sensitive and fragile persons)	upper limit: $\Theta_{i\ max} = 0.33\Theta_{rm} + 18.8 + 2$ lower limit: $\Theta_{i\ min} = 0.33\Theta_{rm} + 18.8 - 2$
Category II (new buildings and renovations)	upper limit: $\Theta_{i\ max} = 0.33\Theta_{rm} + 18.8 + 3$ lower limit: $\Theta_{i\ min} = 0.33\Theta_{rm} + 18.8 - 3$
Category III (existing buildings)	upper limit: $\Theta_{i\ max} = 0.33\Theta_{rm} + 18.8 + 4$ lower limit: $\Theta_{i\ min} = 0.33\Theta_{rm} + 18.8 - 4$

Table 2 Equations representing the lines in Figure 4 for three different categories.

Box 2 Resilience in Addenbrooke's Hospitals' Tower, using the BS EN 15251

For Addenbrooke's Hospital's Tower, the use of BS EN 15251 provides a more favourable aspect regarding the resilience of spaces with natural ventilation and operable windows. The tower has been built between 1967 and 1972 as a ten-storey slab block and the existing wards provide satisfactory thermal comfort levels, although at a high monetary and carbon cost. This is largely due to the heat losses and the currently uncontrolled high air leakage.

Refurbishment of the ward tower with a focus on minimising heat leakage can reduce energy demand while maintaining thermal comfort levels in the current climatic conditions. Figure 5 depicts the original condition of a section through a typical ward floor. Five refurbishment options have been analysed and indicate that modest interventions can save energy and increase the building's resilience in future warmer summers. Mechanical ventilation is inevitable after 2030 and provision will need to be made for this in the future.

The options tested on the tower are described below. All of the options assume the external envelope is overclad to improve U-values and air tightness. The relatively recent high-performing thermal break aluminium-framed double glazing is retained. Table 3 presents a summary of the predicted internal air and dry resultant temperatures for Cambridge future climate conditions reaching up to 2080.

- *Option 1: Sealed building, mechanical ventilation with heating and cooling;*
- *Option 2: Sealed mechanically ventilated environment, radiant ceilings active in winter (heating) and summer (cold water for cooling) heat recovery;*
- *Option 3: Hybrid option with natural ventilation and concurrent mechanical ventilation supply, heat recovery, opening windows and perimeter heating;*
- *Option 4: Natural cross-ventilation, perimeter heating;*
- *Option 5: Natural stack ventilation with perimeter heating.*

The existing building would be deemed too hot by 2030s, as indicated by the HTM03-01 criterion, especially in an extreme year. However, using the BSEN15251 method the overheating in 2030s appears less serious in both typical and extreme years, especially in the spaces intended for normal, non-clinical, occupancy; this is based on the number of hours above BSEN15251 Cat II limits compared to using the HTM03 criterion limiting hours above 28˚C to less than 50 annually.

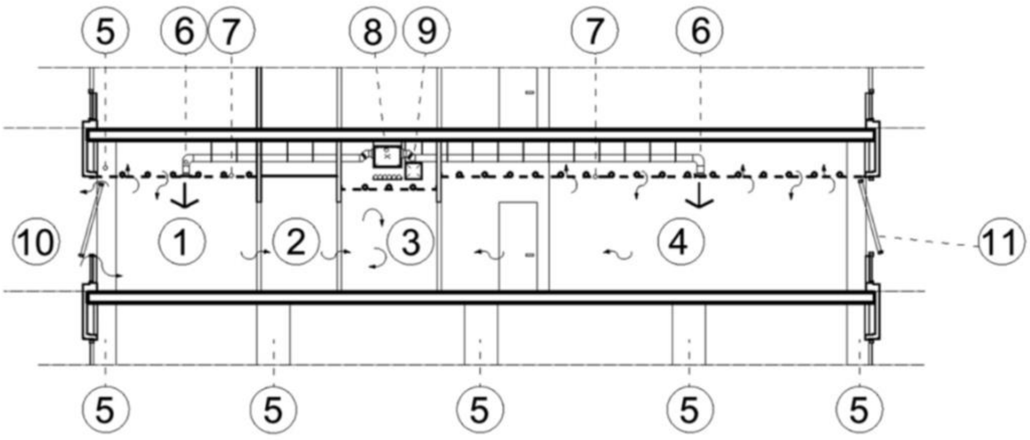


Figure 5 Section through Level 8, as built, a typical ward floor, showing mechanical services and intended ventilation strategy (left-hand window: as built; right-hand, as existing). Key: 1 Single bedroom with centrally controlled mechanical supply and room user operated natural ventilation; 2 Internal store room: extract only with grille in doorway to draw in air from wards; 3 Corridor: no extract, warm air from wards dwells; 4 Six bed ward: centrally controlled mechanical supply and room user operated natural ventilation; 5 Concrete structure: piers enable flat slabs with no downstands; 6 Mechanical air supply; 7 Radiant ceiling: perforated metal trays with attached low pressure hot water heating pipes; 8 Main air supply duct; 9 Main services spine; 10 As built window arrangement; 11 Current window arrangement. Source: ‘Building resilience to overheating into 1960's UK hospital buildings within the constraint of the national carbon reduction target: Adaptive strategies

Refurbishment option	TRY							DSY						
	Max. temp. (°C)	Min. temp. (°C)	Mean night time[a] temp. (°C)	Total hours[b] over 28 °C	Night time[a] hours over 26 °C	Total hours above Cat I Upper limit	Total hours above Cat II Upper limit	Max. temp. (°C)	Min. temp. (°C)	Mean night time[a] temp. (°C)	Total hours[b] over 28°C	Night time[a] hours over 26 °C	Total hours above Cat I Upper limit	Total hours above Cat II Upper limit
2005														
Existing	28.6	21.3	24.2	10	10	1041	399	30.1	21.3	24.3	115	60	1198	497
1 SMVHC	27.2	21.8	23.2	0	5	na	na	28.8	21.9	23.5	13	78	na	na
2 SMVRHC	24.9	21.6	23.0	0	0	na	na	25.8	21.6	23.0	0	0	na	na
3 NVMVPH	24.9	20.8	21.4	0	0	0	0	27.8	20.7	21.7	0	30	0	0
4 CVPH	24.9	19.7	21.5	0	0	0	0	28.2	20.0	21.7	5	17	16	2
5 SVPH	24.9	20.8	21.7	0	0	0	0	27.6	22.3	22.0	0	20	0	0
2030s														
Existing	30.6	21.6	24.3	93	59	859	395	33.0	21.2	24.7	383	231	711	341
1 SMVHC	28.3	22.0	23.7	0	36	na	na	29.2	22.4	24.4	14	210	na	na
2 SMVRHC	26.1	21.8	23.1	0	0	na	na	27.1	22.2	23.5	0	5	na	na
3 NVMVPH	27.2	20.8	22.1	0	6	4	0	30.4	20.9	23.4	98	185	58	18
4 CVPH	28.2	20.3	22.3	3	32	21	3	32.3	20.6	23.4	199	208	166	70
5 SVPH	26.7	21.0	22.3	0	13	0	0	30.1	20.9	23.3	102	141	60	22
2050s														
Existing	31.0	21.2	24.3	163	87	866	351	34.8	21.8	25.2	620	388	938	445
1 SMVHC	28.6	22.0	24.0	0	64	na	na	29.5	22.5	24.9	59	396	na	na
2 SMVRHC	26.2	21.9	23.2	0	0	na	na	27.8	22.3	23.8	2	23	na	na
3 NVMVPH	27.3	20.9	22.4	0	11	2	0	31.9	21.0	24.4	395	451	240	72
4 CVPH	28.9	20.3	22.5	18	41	22	4	33.9	20.8	24.5	582	435	462	203
5 SVPH	27.9	20.9	22.5	2	12	4	0	31.6	21.2	24.5	491	416	345	117
2080s														
Existing	31.7	20.7	24.5	232	152	806	396	36.5	20.9	26.0	1035	609	1132	645
1 SMVHC	28.6	22.3	24.2	0	151	na	na	29.7	22.6	25.5	145	610	na	na
2 SMVRHC	26.5	22.1	23.4	0	1	na	na	28.4	22.3	24.2	20	84	na	na
3 NVMVPH	28.1	21.0	23.0	15	110	23	0	33.8	21.0	25.8	990	654	693	324
4 CVPH	29.7	23.3	23.0	96	136	136	46	35.7	20.8	25.9	1060	638	870	577
5 SVPH	28.3	21.1	23.0	11	87	10	0	34.1	21.3	25.7	1014	636	758	418

Table 3 Summary of predicted internal air and dry resultant temperatures for May to September, future Cambridge climate. TRY refers to ‘Test Reference Years’ and DSY to ‘Design Summer Years’. The DSY is a year such that summers are only one summer in 20 is warmer. Source: ‘Building resilience to overheating into 1960's UK hospital buildings within the constraint of the national carbon reduction target: Adaptive strategies’

1.5 Understanding energy use in the healthcare sector

1.5.1 According to the SDU Sustainable Development Strategy 2014, the carbon footprint of the NHS in England in 2012 was 32 million tCO_2e, representing 40% of public sector emissions in England. According to the Sustainable Development Strategy 2014, the NHS aims to contribute to the Climate Change Act target with a 34% carbon emissions reduction compared to 1990 levels by 2020. This percentage involves building energy use, travel and procurement of goods and services.

1.5.2 It is relatively easy for an organisation to find out how much energy it has purchased – the delivered energy – by looking at data from the energy supplier, or from on-site meters. But a headline figure for delivered energy hides the true cost to the environment in respect of carbon emissions. Due to the inherent inefficiencies of electricity generation, and the subsequent distribution losses, associated with thermal power stations, the resulting carbon emissions are in the range of two or three times more than direct use of fossil fuels per delivered unit of energy. Figure 6 and Table 4 illustrate this point, based on Estates Return Information Collection (ERIC) data from 2014.

1.5.3 The amount of carbon released during the process of electricity generation is a very significant issue for the healthcare sector, where electricity consumption is rising rapidly because of the growth in the use of IT, medical equipment and air conditioning (AC). This is a greater issue for new buildings, where space heating demand is expected to decrease as a result of improved thermal performance, while electricity requirements remain the same or even increase. This is illustrated in Figure 7, where a decrease of fossil fuels (kWh/m^2) is observed, as opposed to the almost stable electricity use.

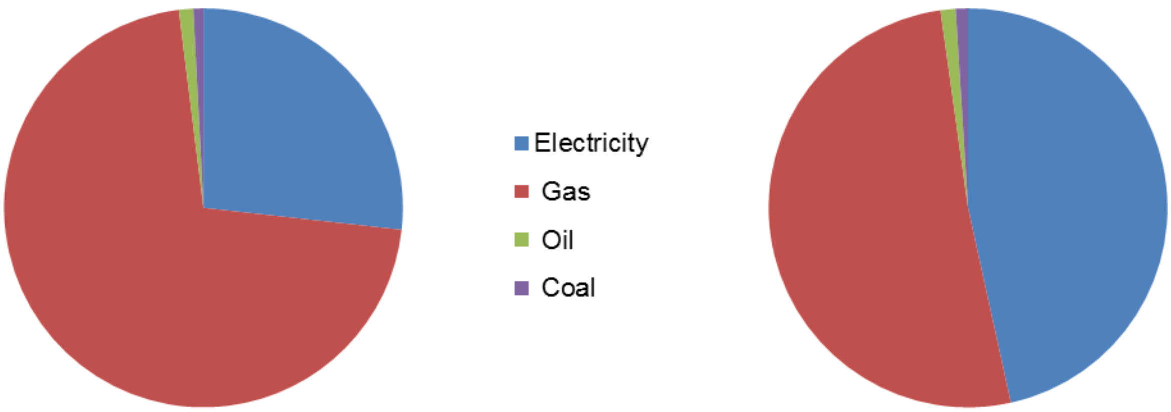


Figure 6 The pie chart on the left presents the total energy consumption for healthcare facilities in England in 2012/13, by fuel type, based on utility bills; the pie chart on the right presents the total carbon emissions from healthcare facilities in England in 2012/13, by fuel type. The 2013 conversion factors for carbon emission are taken from the Carbon Trust.

	Energy (kWh)	CO_2e (tonnes)	$kgCO_2e$ per kWh
Electricity	3,139,987,936	1,398,802	0.44548 + transmissions losses
Gas	8,363,283,726	1,539,179	0.18404
Oil	136,176,158	36,599	0.26876
Coal	95,659,994	29,945	0.31304

Table 4 Annual energy consumption and related carbon emissions in the healthcare sector for 2012/13 in England. The data information is taken from the ERIC data based on utility bills and the carbon conversion factors from the Carbon Trust for 2013.

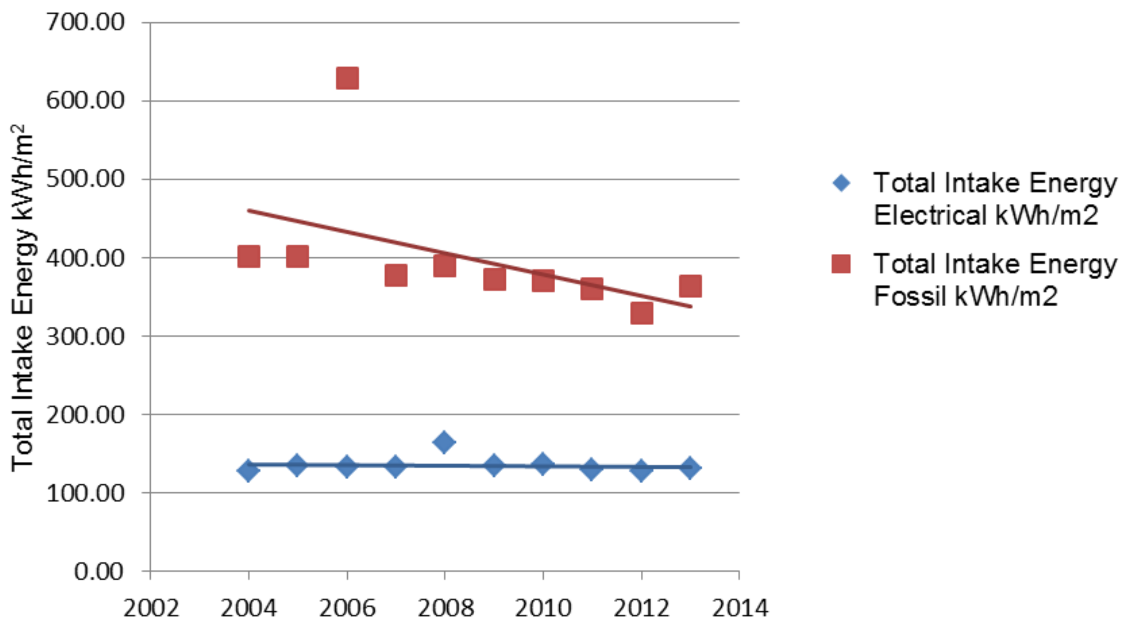


Figure 7 Current trend in electricity growth compared to fossil fuel usage in healthcare buildings (kWh/m^2), based on the ERIC data. This is based on delivered energy, normalised for on-site generation and it excludes Primary Care Trusts (PCTs) and other NHS Trusts.

1.5.4 Government's headline targets look at 'primary energy consumption' instead of focusing on the amount of energy purchased. Primary energy consumption is a measure that includes the power station losses incurred in generating electricity, as well as the metered consumption of fossil fuel and electricity delivered to the site. One major advantage of using primary energy consumption or carbon emissions as the measurement is that the benefits of on-site generation are accounted for easily. This opens the door to a range of new technologies and techniques, such as CHP or PVs. Such technologies may not diminish the actual amount of energy purchased, but they will have a positive effect on carbon emissions.

1.6 Evaluating energy efficiency in hospitals

1.6.1 The SDU defines the following sustainability indicators used for the energy and carbon management in its Sustainability Reporting Framework: energy cost, energy use, renewable energy, emissions from electricity, emissions from gas, emissions from business travel and emissions from other activities including procurement.

1.6.2 The evaluation of energy efficiency is a challenging process, perhaps even more so for NHS organisations, because of the numerous parameters involved.

1.6.3 The SDU Module: An integrated approach to metrics proposes some indicators to use in the NHS system, across different levels of the organisation and for a variety of purposes. Regarding carbon and environmental impact, the following indicators are suggested for NHS Trusts, NHS Foundation Trusts, as well as for large social care providers:

- Organisation carbon footprint: building energy use, procurement and travel per patient contact (Local indicator);
- Organisation water use per patient contact (ERIC) (National indicator);
- Organisation waste to landfill per patient contact (ERIC) (National indicator).

1.6.4 Regarding the energy use in buildings in the healthcare sector, the NHS Technical briefing for Measuring

Sustainable Development describes the following core areas of measurement:

- Building energy use and carbon footprint;
- Site/building carbon footprint provided by Display Energy Certificates (DECs) and Energy Performance Certificates (EPCs);
- Performance against BREEAM (Building Research Establishment Environmental Assessment Methodology).

1.6.5 However, these metrics are all related to energy efficiency and environmental credentials of buildings and it is often confusing to identify what information is needed for different purposes. This section summarises different metrics and clarifies their uses.

1.6.6 BREEAM is the leading and most widely used environmental assessment method for buildings in the UK. It provides a methodology which delivers better environmental outcomes and sets standard for best practice sustainable design against which the performance of buildings can be measured and independently certified. BREEAM includes criteria which are healthcare-specific. The current version of BREEAM New Construction was revised in July 2014. A new non-domestic refurbishment scheme in four parts which covers, Fabric and Structure, Core Services, Local Services, and Interior Design was launched in November 2014. A health specific In-Use scheme for the existing estate was launched with Bart's Healthcare in May 2014. The BRE website provides background BREEAM information and information on the BREEAM schemes. All new healthcare buildings are expected to achieve a BREEAM Excellent rating and all refurbishments a BREEAM Very Good. Detailed information on BREEAM requirements with regards to healthcare buildings are found throughout this guidance document.

1.6.7 There are other building and project certification schemes, focusing on energy and environmental aspects, such as LEED (Leadership in Energy and Environmental Design) by the US Green Building Council, Green Star by the Green Building Council of Australia, Estidama in Abu Dhabi and the Middle East, DGNB in Germany and HQE in France. LEED for healthcare, which is also used on a worldwide level focuses on key areas such as sustainable sites, water efficiency, energy and atmosphere, materials and resources, as well as indoor environmental quality.

1.6.8 It is worth highlighting that these are tools and as such, they do have limitations. Therefore, they should be used intelligently for decision making, rather than blindly. Achieving points in a specific tool is not always the best or the only way to achieve sustainability and energy efficiency. As Richard Egerton, Project Manager at Ashford and St Peter's Hospitals comments, 'You have to be cautious when using BREEAM; for example, you are encouraged to add a heat pump to provide heat to an AHU; however the majority of the heat to the unit is provided from the steam distribution system. The benefits to be gained from a heat pump are marginal when counter balanced by having two systems delivering heat. One needs to be mindful of how the extant local systems should modify the approach. A holistic overview is needed'.

1.7 Energy Performance Certificates and Display Energy Certificates

1.7.1 In the attempt to reduce carbon emission from buildings on a European level, the EU has implemented the Energy Performance of Buildings Directive 2002/91/EC (EPBD), introducing energy certification for buildings. In the UK, the Department for Communities and Local Governments (DCLG) specifies the following mandatory steps in order to comply with this European legislation:

- All properties (domestic and non-domestic) must have an Energy

Performance Certificate (EPC) when sold, built or rented;

- Public buildings of floor area larger than 500m² must display a Display Energy Certificate (DEC);
- All AC systems over 12kW must be regularly inspected by an Energy Assessor. In the UK, the principle guidance for air conditioning systems' inspection is the CIBSE Technical Manual 44: Inspection of air conditioning systems. More details on ventilation systems' inspection in healthcare buildings can be found in HTM 03-01 Part B.

1.7.2 It is important to highlight the difference between EPCs and DECs. EPCs are not always compulsory, while DECs are needed for any public building with a floor area larger than 500m². Most importantly, EPCs refer to the estimated energy use of a building based on modelling, while DECs refer to actual energy use. An EPC contains information on a property's energy use and typical energy costs and is based on general building characteristics and assumptions. DECs refer to the actual energy use of the building based on its meter readings including equipment use, while an EPC does not, only covering regulated emissions. The main differences between EPCs and DECs are summarised in Table 5.

1.7.3 The DECs produced for individual organisations are a good place to start in order to identify potential methods of reducing energy use. Each DEC is accompanied by an advisory report, which highlights recommendations for the building's energy performance improvement, for example fabric upgrades, heating, ventilation and lighting improvements, as well as the installation of low and zero carbon technologies.

Box 3 Possible changes in the use of DECs

According to the Defence Infrastructure Organisation and the 'Information Note: Energy performance of buildings directive', it is expected that the requirement for a DEC in public buildings will be extended to those with a floor area of between 250m² and less than 500m² in July 2015.

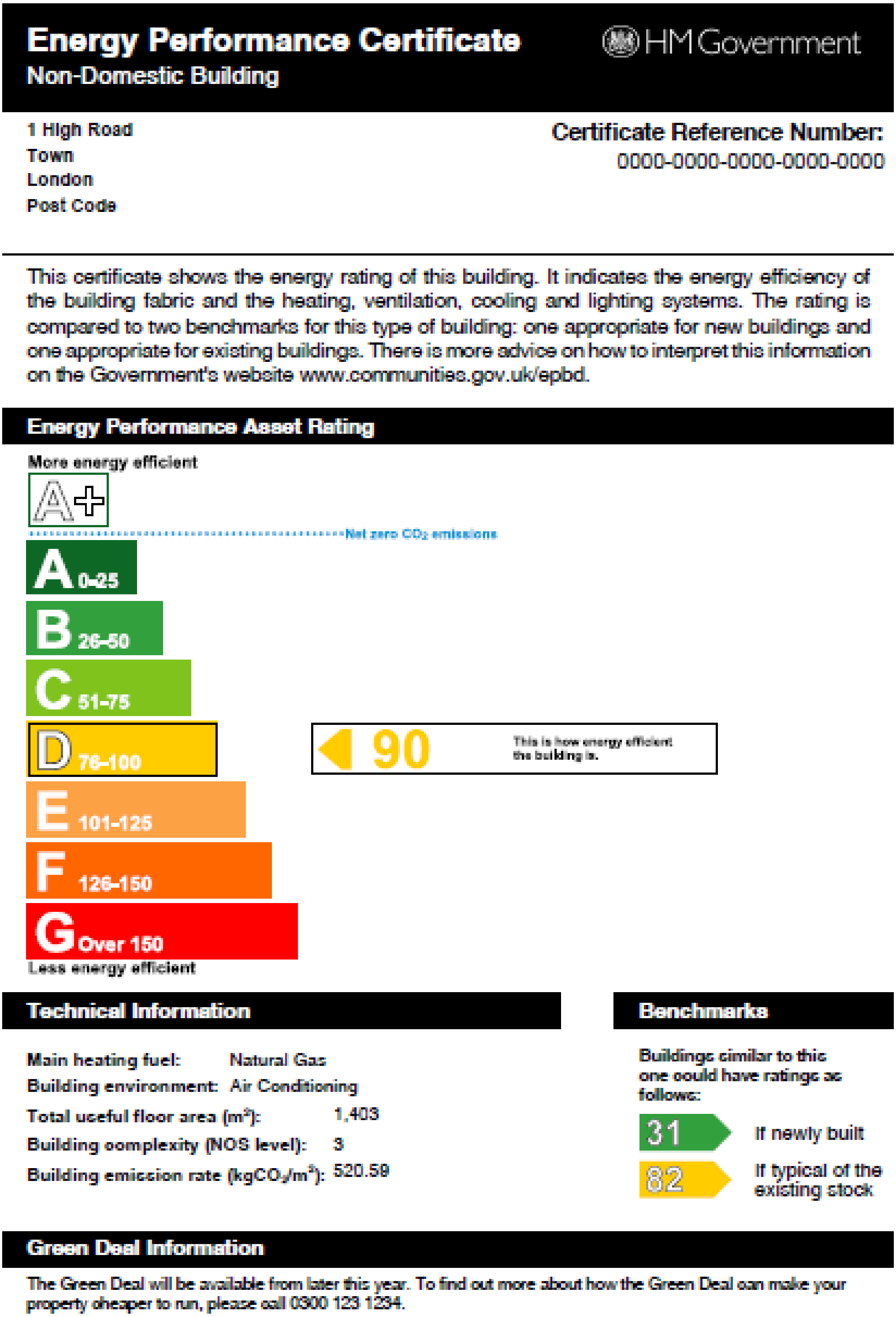
1.7.4 The advisory report categorises these recommendations by the length of the associated payback period, into short (up to three years), medium (three to seven years) and long term payback (more than seven years). The advice provided is intended to be only for information and the decision-makers are advised to use further professional advice before deciding on the implementation of any of those measures. It should be noted, that it is not compulsory to follow the advisory report's recommendations, although taking action on the recommendations is likely to improve energy efficiency (and hence the building's DEC rating in future years), reduce fuel bills and carbon emissions.

1.7.5 Figures 8 and 9 present samples of a non-domestic EPC and a DEC respectively. As described on the certificates in the figures, an EPC indicates the level of building energy efficiency and a DEC shows how efficiently the building is managed.

	EPC	DEC
Is it compulsory?	Yes, when a building is sold, built or rented	Yes, for building floor areas larger than $500m^2$
Actual or estimated energy use?	Estimated	Actual
Does it include energy use for equipment?	No	Yes
Does it give recommendations on energy savings?	No	Yes (Advisory report)
How long are they valid for?	10 years[1]	10 years for <1000 m^2, 1 year for >1000 m^2

[1] 'Where the building has a total useful floor area of more than $1{,}000m^2$, the DEC is valid for 12 months. The accompanying advisory report is valid for seven years. Where the building has a total useful floor area of between $500m^2$ and $1000m^2$, the DEC and advisory report are valid for 10 years'.

Table 5 Comparison between EPCs and DECs



Energy Performance Certificate
Non-Domestic Building

HM Government

1 High Road
Town
London
Post Code

Certificate Reference Number:
0000-0000-0000-0000-0000

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Asset Rating

Technical Information

Main heating fuel: Natural Gas
Building environment: Air Conditioning
Total useful floor area (m^2): 1,403
Building complexity (NOS level): 3
Building emission rate ($kgCO_2/m^2$): 520.59

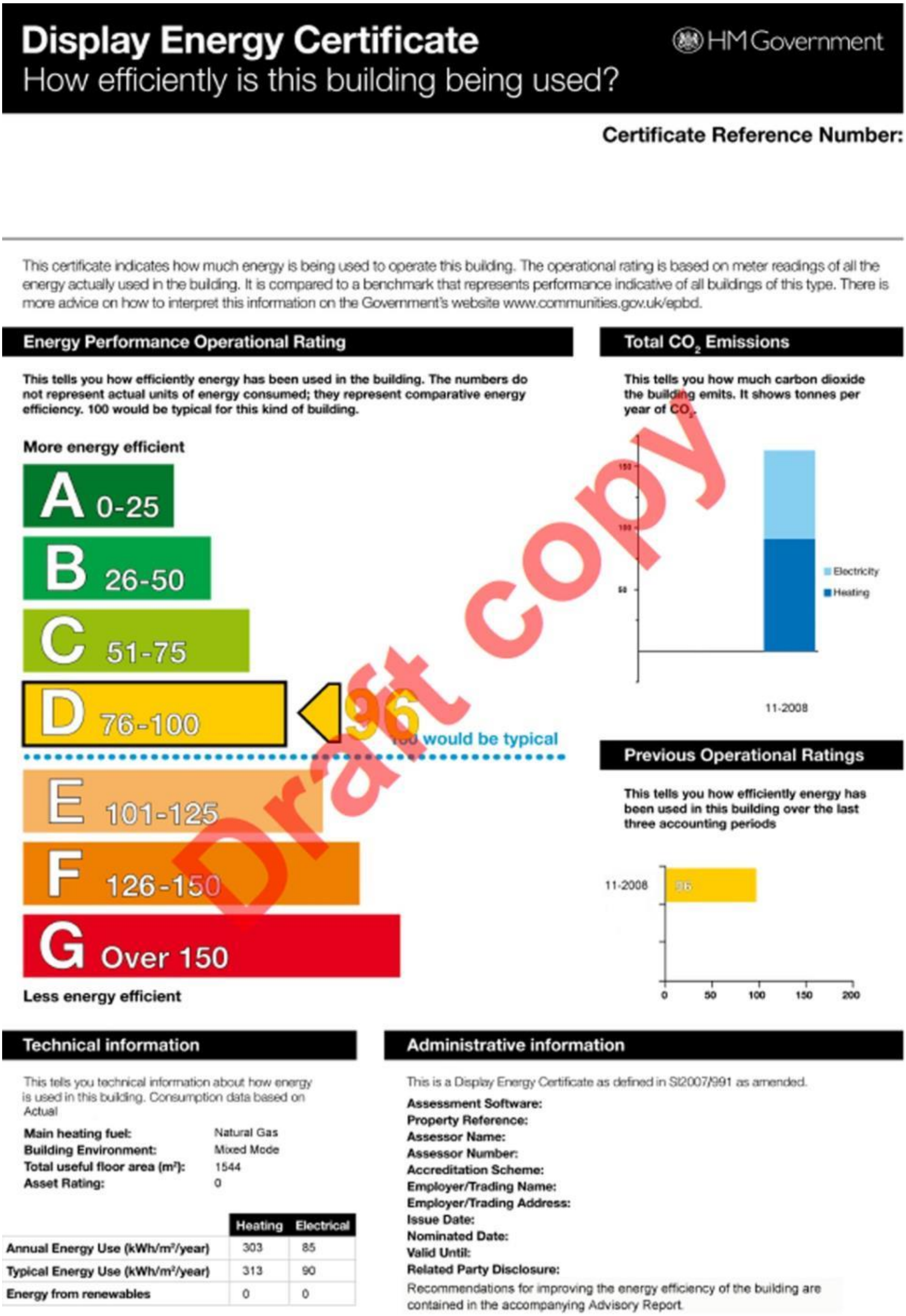
Benchmarks

Buildings similar to this one could have ratings as follows:

Green Deal Information

The Green Deal will be available from later this year. To find out more about how the Green Deal can make your property cheaper to run, please call 0300 123 1234.

Figure 8 EPC sample.



Display Energy Certificate

How efficiently is this building being used?

HM Government

Certificate Reference Number:

This certificate indicates how much energy is being used to operate this building. The operational rating is based on meter readings of all the energy actually used in the building. It is compared to a benchmark that represents performance indicative of all buildings of this type. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Operational Rating

This tells you how efficiently energy has been used in the building. The numbers do not represent actual units of energy consumed; they represent comparative energy efficiency. 100 would be typical for this kind of building.

Total CO_2 Emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO_2.

Previous Operational Ratings

This tells you how efficiently energy has been used in this building over the last three accounting periods

Technical information

This tells you technical information about how energy is used in this building. Consumption data based on Actual

Main heating fuel:	Natural Gas
Building Environment:	Mixed Mode
Total useful floor area (m²):	1544
Asset Rating:	0

	Heating	Electrical
Annual Energy Use (kWh/m²/year)	303	85
Typical Energy Use (kWh/m²/year)	313	90
Energy from renewables	0	0

Administrative information

This is a Display Energy Certificate as defined in SI2007/991 as amended.

Assessment Software:
Property Reference:
Assessor Name:
Assessor Number:
Accreditation Scheme:
Employer/Trading Name:
Employer/Trading Address:
Issue Date:
Nominated Date:
Valid Until:
Related Party Disclosure:

Recommendations for improving the energy efficiency of the building are contained in the accompanying Advisory Report.

Figure 9 DEC sample.

1.8 Benchmarking

1.8.1 Benchmarking is a management technique for assessing performance. The idea is to see how local data compares with the published benchmarks and then take steps to improve local performance. Priority should be given to those buildings or areas that are performing worst against the benchmarks.

1.8.2 Figure 10 illustrates this variety and presents the carbon emissions per floor area according to the ERIC data 2013/14 on actual energy consumption for different categories of healthcare buildings.

1.8.3 CIBSE TM46 provides benchmarking for a variety of buildings across different sectors, including healthcare. CIBSE suggested benchmarking values, based on CIBSE Guide F and the Energy Consumption Guide ECG19: Energy efficiency in offices. Those initial suggestions have been revised after a consultation with organisations with an interest in DECs. The benchmarking values suggested in CIBSE TM46 are the result of this process. TM46 includes the following five categories regarding the healthcare sector:

- **Clinic** (provision of primary healthcare): electricity typical benchmark 70 kWh/ m^2, fossil thermal typical benchmark 200 kWh/ m^2.
- **Hospital - clinical and research** (mainly space for medical care with 24-hour accommodation for patients, with associated operating theatres, laboratories, offices and workshops): electricity typical benchmark 90 kWh/m^2, fossil thermal typical benchmark 420 kWh/m^2.
- **Laboratory or operating theatre** (special equipment and conditions in at least 30% of floor area): electricity typical benchmark 160 kWh/m^2, fossil thermal typical benchmark 160 kWh/m^2.
- **Long term residential** (full accommodation, including sleeping space, day time space, all domestic facilities, some office facilities): electricity typical benchmark 65 kWh/m^2, fossil thermal typical benchmark 420 kWh/m^2.
- **General office** (general office and commercial working areas): electricity typical benchmark 95 kWh/m^2, fossil thermal typical benchmark 120 kWh/m^2.

1.8.4 The health sector includes a variety of buildings, from GP practices to hospitals with operating theatres. Therefore, a single energy benchmark cannot be implemented across the whole sector. The needs, specific services and equipment and therefore the carbon emissions can highly vary even within the same category of healthcare buildings.

1.8.5 The characteristics for each one of these categories are described in detail in Appendix 2.

1.8.6 Many healthcare organisations will have properties and services that are not covered by healthcare related benchmarks. Therefore it will be necessary to use benchmarks that apply to other building and function types.

1.8.7 Mixed use buildings, for example including administration spaces, teaching activities or hydrotherapy pools and gymnasia need to be treated differently in terms of benchmarking. They can be split into their component uses and separately assess the different types of uses. According to CIBSE TM46, 'a composite benchmark based on the relative percentage of total usable floor area allocated to each use may be calculated'. For example, for a building having 1200 m^2 of clinic and 1800 m^2 of administration areas, the clinic element comprises 40% of the total floor area and the administration 60%. A composite benchmark will be calculated by adding 40% of the clinic benchmark to 60% of the offices benchmark.

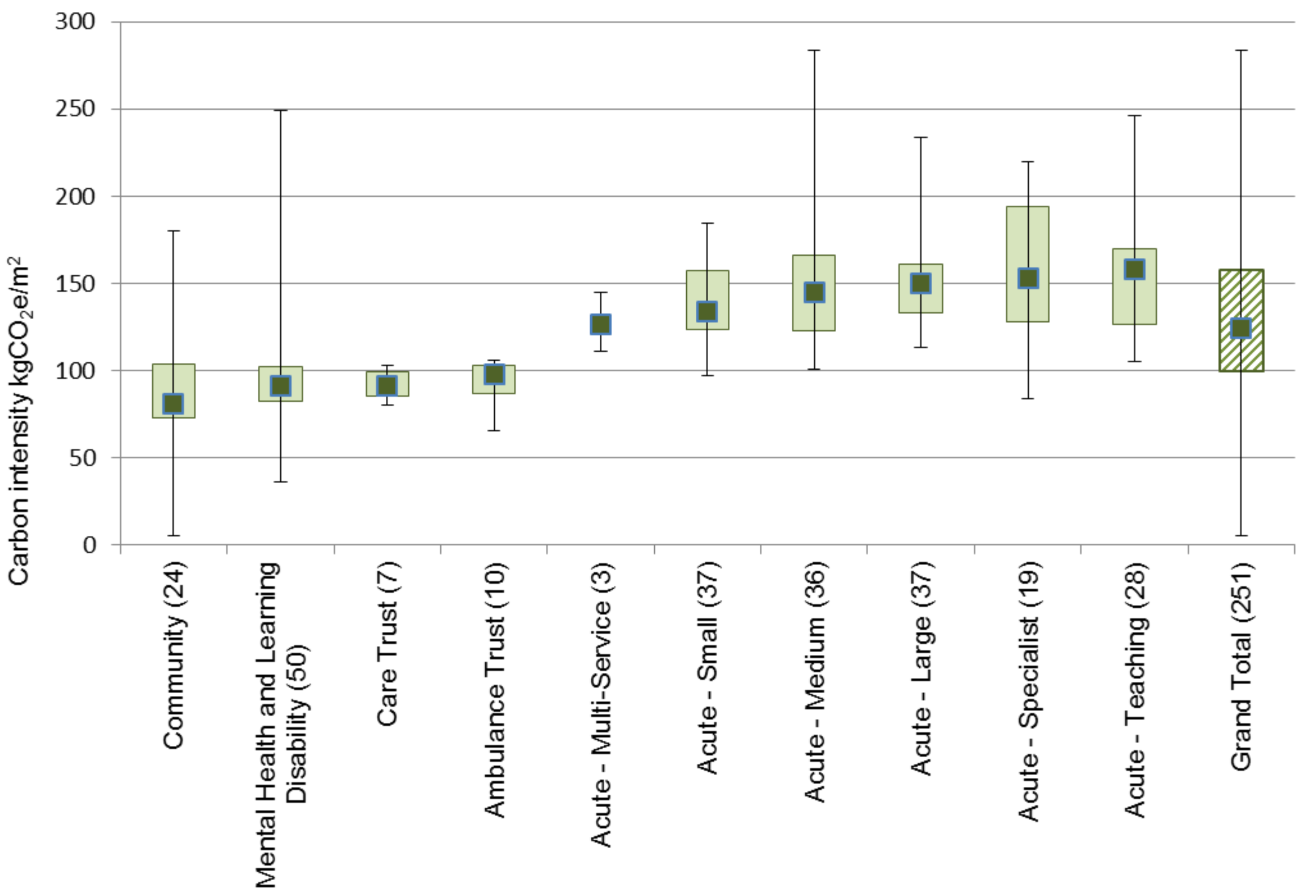


Figure 10 Carbon intensity ($kgCO_2e/m^2$) per type of healthcare building during 2013/14. Source: ERIC data 2013/14. The square marker in each one of the bars represents the mean value; the upper and lower whiskers present the highest and lowest values in each building category. The upper and lower ends of the bars refer to the lowest 25% and the highest 25% of the data. For the acute-multi service buildings, there is no bar, because there are only 3 buildings in this category. The numbers in brackets next to the building types refer to the numbers of buildings in the ERIC data. Finally, the striped bar on the far right of the figure refers to the total of the sample.

1.8.8 The Energy Institute of the University College London (UCL) has conducted a study of public buildings' DECs, from 2008 to 2012 (see An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012). The results were published in 2013 and present benchmarking for different types of healthcare buildings, based on actual energy use according to buildings' DECs. The report compares its findings, which are based on large building samples, to the CIBSE TM46 and demonstrates that some of the benchmarking figures are significantly different, suggesting revisions may be justified.

1.8.9 Figures 11 and 12 present the CIBSE TM46 benchmarking for electricity and heating for the five categories of buildings (clinic, hospital – clinical and research, laboratory or operating theatre, long term residential, general office), in comparison to the average of the medians from the UCL study. Those averages have been calculated from the medians of sub-categories belonging to these five types of buildings. Each one of the CIBSE TM46 categories is broken down into small sub-categories in the UCL report. The median value of annual electricity and heating fuel are provided for each one of these sub-categories. The values in the graphs are the result of the weighted average of these medians; therefore this comparison should be treated with caution.

1.8.10 In many cases there is higher electricity use and lower fossil thermal energy use than the benchmark values, which tend to cancel each other out as the report describes. More details on this analysis conducted by the University College London can be found in Appendix 2.

1.8.11 It should be noted that comparing the organisation's data with nationally-based benchmarks does not fully take account of the differences between the wide range of healthcare facilities that can be grouped under generic headings such as 'Hospital - clinical and research' or 'clinic'. Even if the building is better than the 'good practice' benchmark, there is usually some further improvement that can be made. Therefore, it is crucial to also set targets at an organisation level, aiming to improve performance year on year. The DECs and the advisory reports can contribute to this process, although additional professional advice may be beneficial.

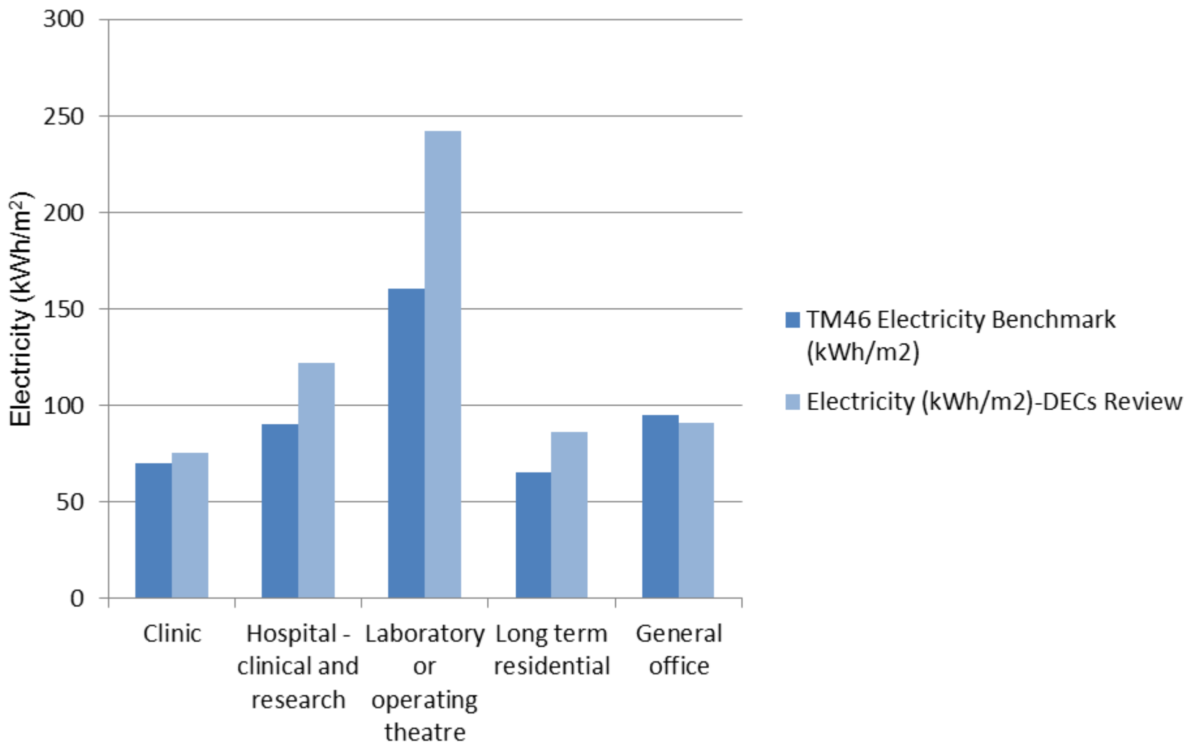


Figure 11 Comparison between theTM46 electricity benchmarks and the average of the medians for buildings in the healthcare sector according to DECs review. Figures based on CIBSE TM46 and An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

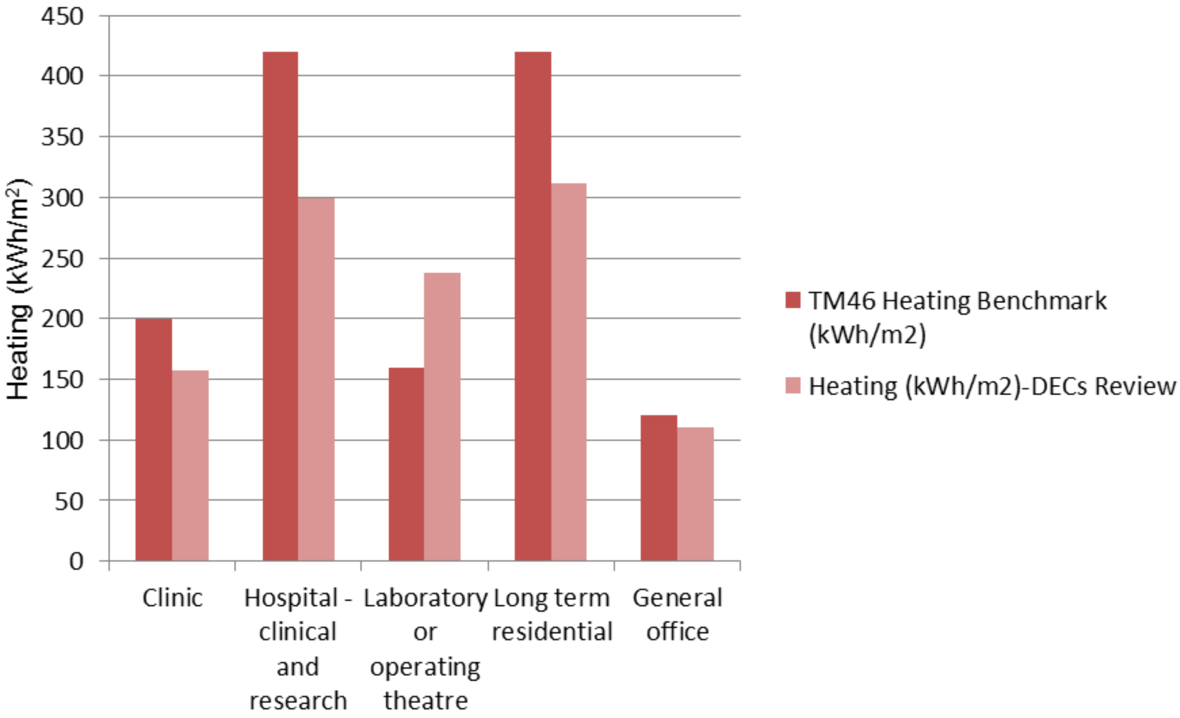


Figure 12 Comparison between theTM46 heating benchmarks and the average of the medians for buildings in the healthcare sector according to DECs review. Figures based on CIBSE TM46 and An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

2 Organisational carbon management

2.1 Organisational and carbon management

2.1.1 Chapter 1 has explained energy use in healthcare buildings and the importance of reducing energy consumption and carbon emissions. It has talked about benchmarking and relevant legislative requirements.

2.1.2 This chapter explains how healthcare organisations can control energy use by introducing a structured management technique. It summarises the steps and explains the resources and actions that are likely to be needed when adopting this approach.

2.2 The energy and carbon management policy

2.2.1 There are certain policies, schemes and requirements which are very significant for an organisation's energy and carbon management policy on a strategic level. These include government-wide policies, business schemes, planning and building requirements, as well as healthcare sector incentives. These are listed below:

2.2.2 Government-wide policies

- Climate Change Act 2008;
- Climate Change Plan 2010;
- Energy White Paper;
- The UK Low Carbon Transition Plan;
- Policies for 'Increasing the use of low-carbon technologies' in the UK, which include initiatives and schemes such as the Renewable Heat Incentive (RHI), the Feed-in Tariffs (FITs) and the Renewables Obligation (RO).

2.2.3 Green taxes, reliefs and schemes for businesses

- EU Emissions Trading Scheme (ETS);
- CRC Energy Efficiency Scheme (formerly known as Carbon Reduction Commitment);
- Climate Change Levy (CCL).

These are described in the following paragraphs.

2.2.4 EU Emissions Trading Scheme As of 1st January 2005, companies from sectors covered by the ETS, including qualifying healthcare organisations, must limit their CO_2 emissions. This is a mandatory requirement for those who are covered by the scheme. The ETS aims to the reduction of CO_2 emissions on an EU level and it operates in 28 EU countries, plus Liechtenstein and Norway. This system sets a limit for CO_2 emissions for carbon intensive sectors and this is reduced annually. In total, around 45% of total EU emissions are limited by the EU ETS. The ETS is based on the idea that there is a cap on the carbon emissions allowance for power plants, factories and other companies covered by the system on an EU level. Within this cap, companies receive or buy emission allowances which they can potentially trade. At the moment we are in the 3rd trading period (Phase III), which runs from 2013 to 2020. The most significant change compared to the previous period, is related to the cap on the EU emissions as a whole, reduced by at least 1.74% annually. More details on the EU ETS can be found in Appendix 3.

2.2.5 The Carbon Reduction Commitment Energy Efficiency Scheme (CRC) is a mandatory energy efficiency scheme. Organisations qualifying for the scheme are obliged to participate in CRC. If the participation requirements are not met, penalties apply regardless of the level of energy use. Participants are obliged to measure the carbon emissions from energy supplies for which they are responsible according to specified conversion factors. CRC operates in phases. Phase 1 ended in March 2014. We are currently in Phase 2, running between 1st April 2014 and 31st March 2019. The registration deadline was

31st January 2014. More details on the CRC can be found in Appendix 4.

2.2.6 The Climate Change Levy is an environmental tax on energy supply to industry, agriculture, local administration and other services. It intends to encourage energy efficiency and the reduction of carbon emissions. The CCL is charged at the time of supply and it covers electricity, gas, liquid petroleum gas and solid fuel. The final recipient of supplies of electricity generated from certain renewable sources and CHP enjoy tax exemptions. More details on the CCL can be found in Appendix 5.

2.2.7 Planning and building requirements:

- Building Regulations Part L: Regarding non-domestic buildings, the DCLG has published two documents. At the time of writing the most up to date version is the one which came into effect on 6th April 2014, for existing and new buildings:
    - new 2013 editions of Approved Documents L2A (New buildings other than dwellings);
    - further amendments to the 2010 editions of Approved Documents L2B (Existing buildings other than dwellings);
- The Health and Safety at Work etc. Act 1974;
- Local authority renewable energy policies.

2.2.8 The requirements for renewable energy sources in new buildings vary between different councils; however, the government has encouraged the promotion of renewable energy sources, with some of the councils implementing a requirement for 10% of the new developments' energy use being provided by renewable sources. The first Council to apply these requirements was Merton, which in 2003 implemented a policy requiring that 'all new non-residential developments above a threshold of 1,000 m^2 will be expected to incorporate renewable energy production equipment to provide at least 10% of predicted energy requirements'. The 'Merton Rule' is now widely applied by other councils. These requirements are additional to the obligation to comply with the Building Regulations.

2.2.9 Healthcare sector incentives

- Health and Social Care Act 2012;
- Department of Health policies on sustainability and environmental management;
- environmental assessment tools.

Box 4 Emerging issues

According to the IPCC, warming in the climate system is indisputable and so are the effects of human actions on it. Adaptation and mitigation towards climate change are both necessary to deal with the current conditions, particularly in the healthcare sector. The NHS, including healthcare buildings has a significant contribution to the UK's carbon emissions; therefore, mitigation is necessary. At the same time, the NHS has a significant responsibility towards its patients to ensure their well-being and to provide them a high quality of healthcare. Adaptation to climatic conditions and ensuring healthcare provision is uninterrupted by hot or cold weather, are among the priorities of the organisation (see Heatwave Plan for England and Cold Weather Plan for England). The National Adaptation Programme sets among its objectives 'To promote climate resilience within the NHS, public health and social care system to ensure continuity of services and resilient assets/estates including the ability to deal with the increased demand for services associated with severe weather events.'

Moreover, the NHS has set the aim to reduce its carbon emissions (including building energy use, travel and procurement of goods and services) by 34% by 2020 compared to the 1990 baseline. As part of this target, healthcare organisations have an obligation to assess their energy performance and to make efforts to decrease their carbon emissions. The current legislation, in accordance with the EPBD, requires display certificates presenting the operational energy use in public buildings over 500 m^2, as well as AC inspections and a series of actions relevant to the assessment of buildings' energy performance. More details on the evaluation of energy efficiency in hospitals can be found in Chapter 1. The government provides financial initiatives for the installation of low or zero carbon technologies, which enable organisations to reduce their carbon emissions (see Encode 2015 Part B). At the same time, there are pre-set limits for carbon emissions for organisations through the EU ETS; this also allows them to sell their 'unused carbon emissions' to other organisations in need. Therefore, there are systems and initiatives at place which provide the financial motivation for organisations to reduce their carbon emissions in a variety of ways.

2.2.10 Further details of these policies and documents can be found on the websites of the relevant government departments:

- HM Treasury;
- Department of Health;
- Department for Communities and Local Government;
- The Scottish Government;
- Scottish Government Health and Social Care Directorates;
- NHS Scotland;
- The Welsh Government;
- NHS Wales;
- Department of Enterprise, Trade and Investment;
- Department of Finance and Personnel;
- Department of the Environment (Northern Ireland).

2.2.11 These various recommendations should be reviewed when drawing up or revising an energy and carbon management policy. There are also emerging issues to be taken into consideration (see Box 4).

2.3 Drafting a policy

2.3.1 Senior managers are responsible for ensuring that the organisational structure, operational processes, staff and facilities are in place to deliver a high standard of healthcare. This includes ensuring that

appropriate organisation-level policies are in place and communicated to stakeholders. The energy and carbon management policy (or the environmental policy) may come under the remit of the organisation's estates department (or equivalent), even though various departments may have responsibility for its day-to-day implementation.

2.3.2 The fundamental objective of the policy is to ensure that energy is considered at every opportunity, from the purchasing of new office equipment to changing the set-point on local radiator thermostats. The real value of a strong energy and carbon management policy is that it sets a firm foundation without being prescriptive about the route to achieving the goals. The Carbon Trust's CTV022: Energy Management Strategy explains the basic principles of writing an energy policy and presents relevant examples. Moreover, the ISO 50001 provides information on developing an energy policy, as well as on setting targets and objectives to meet the policy requirements.

2.3.3 Once written, the energy and carbon management policy should be signed off by the chief executive to signal commitment at the highest level, and by the board member who has taken on the role of the 'energy champion', ensuring that energy is always on the organisation's agenda.

2.3.4 In the healthcare sector, the overall policy and its supporting strategy should have a maximum lifespan of around five years, so any existing policy should be given an annual health check. In particular, policies should be reviewed when NHS-specific guidance is issued by the Department of Health or the SDU.

2.3.5 The interest generated by the development of the policy statement provides an excellent opportunity for raising management awareness generally and consolidating senior management commitment. The signing and distribution of the policy statement itself are also key events that can be publicised to stakeholders, help to raise awareness of energy, which is fundamental of a successful policy.

2.4 From policy to practice

2.4.1 With the policy statement as a starting point, the next step is to draw up a detailed strategy to deliver the policy commitments. Guidance on developing the strategy can be found in the Carbon Trust's CTV022: Energy Management Strategy and FB44: Energy management in the built environment.

2.4.2 The strategy sets out the detailed actions that are needed to deliver the policy commitments. To be effective, the strategy should be accompanied by a management system, and together the management system and the strategy should:

- relate actions to individual objectives and goals which in turn can be traced to specific policy commitments;
- assign actions to individuals, with clear deadlines for reporting progress and completion;
- indicate the person responsible for approving or signing off the action when it has been successfully discharged;
- describe the resources that may be required;
- be used to inform budget negotiations and confirm that adequate budget provisions have been made.

2.4.3 Strong leadership by the chief executive and an 'energy champion' at board level is crucial in the process of achieving carbon reduction at the NHS organisation level. Strong leadership will involve:

- publicly endorsing the organisation's Sustainable Development Management Plan;
- empowering staff to take the necessary actions;
- encouraging a willingness to explore opportunities.

Example
Mission statement
The [organisation name] recognises that energy consumption is necessary for the provision of healthcare services, but it has a responsibility to be energy and resource efficient by minimising unnecessary energy costs and the thereby associated environmental impacts.
As far as is practical and consistent with the operational needs of our healthcare organisation, the [organisation name] shall commit to:

- Operating in an energy efficient way (to reduce consumption and costs etc.);
- Producing a local energy/carbon strategy and action plan (providing the effective use of staff and financial resources);
- Establishing an energy/carbon management structure (with clearly defined roles and responsibilities);
- Achieving local energy efficiency measures (in line with the SDU's carbon reduction programme);
- Minimising environmental impacts (arising from our energy consumption, finite fossil fuel use, CO_2 emissions, waste etc.);
- Investing in energy/carbon efficiency opportunities (such as new, clean energy efficient technologies where they are cost- effective and deliver value

for money);

- Including energy in the procurement evaluation process (that is services, fuel, equipment and capital projects etc., taking into account whole life costs);
- Informing and motivating staff (raise awareness at all levels starting with the induction process so that energy/carbon management is communicated and integrated throughout the organisation);
- Continual improvement (of performance through regular reviews of policies, procedures and working practices);
- Demonstrating that energy/carbon policy is being implemented (raise the profile by open reporting and being auditable so that stakeholders can confirm that the organisation is achieving all it claims);
- The policy shall be implemented by undertaking the following provisions:
- Monitor, audit and review efficiency measures in order to prevent pollution and contribute to the Government's national Climate Change Programme;
- Provide a resilient healthcare environment, adapted to a changing climate;
- Actively seek to promote good energy/carbon management practice through good working relationships with the relevant agencies; local authorities and the community;
- Promote energy/carbon efficiency awareness among staff, patients and visitors through the distribution of this policy;
- Maintain an open line of communication for employees and members of the public.

Signed: ....
Chief Executive
Date: ....

2.5 The six-step approach

2.5.1 The six-step approach to energy management[3], which is described in this chapter, is summarised in Figure 13 and is recommended for the following reasons:

- cost savings can be easily identified and reported to stakeholders. Money saved through energy efficiency can then be redirected to delivering healthcare;
- having tangible evidence of the benefits creates the right climate for developing the programme;
- the six-step approach fits in with the strategies of other management programmes, such as quality, energy and environmental management (relevant standards ISO 14001 and ISO 50001 are analysed in Section 2.14).

2.6 Step one: Getting commitment

2.6.1 A clear and simple energy and carbon management policy sets the foundations for good energy management. It is recommended that the Board gives consideration to providing the resources that will be needed to implement an energy management strategy. The main resource is likely to be staff time, which will be needed for:

- preparing and implementing the management strategy;
- communicating it to others;
- training and raising awareness.

[3] Throughout this chapter the term "energy management" is used – for conciseness only – instead of "energy and carbon and/or environmental management"

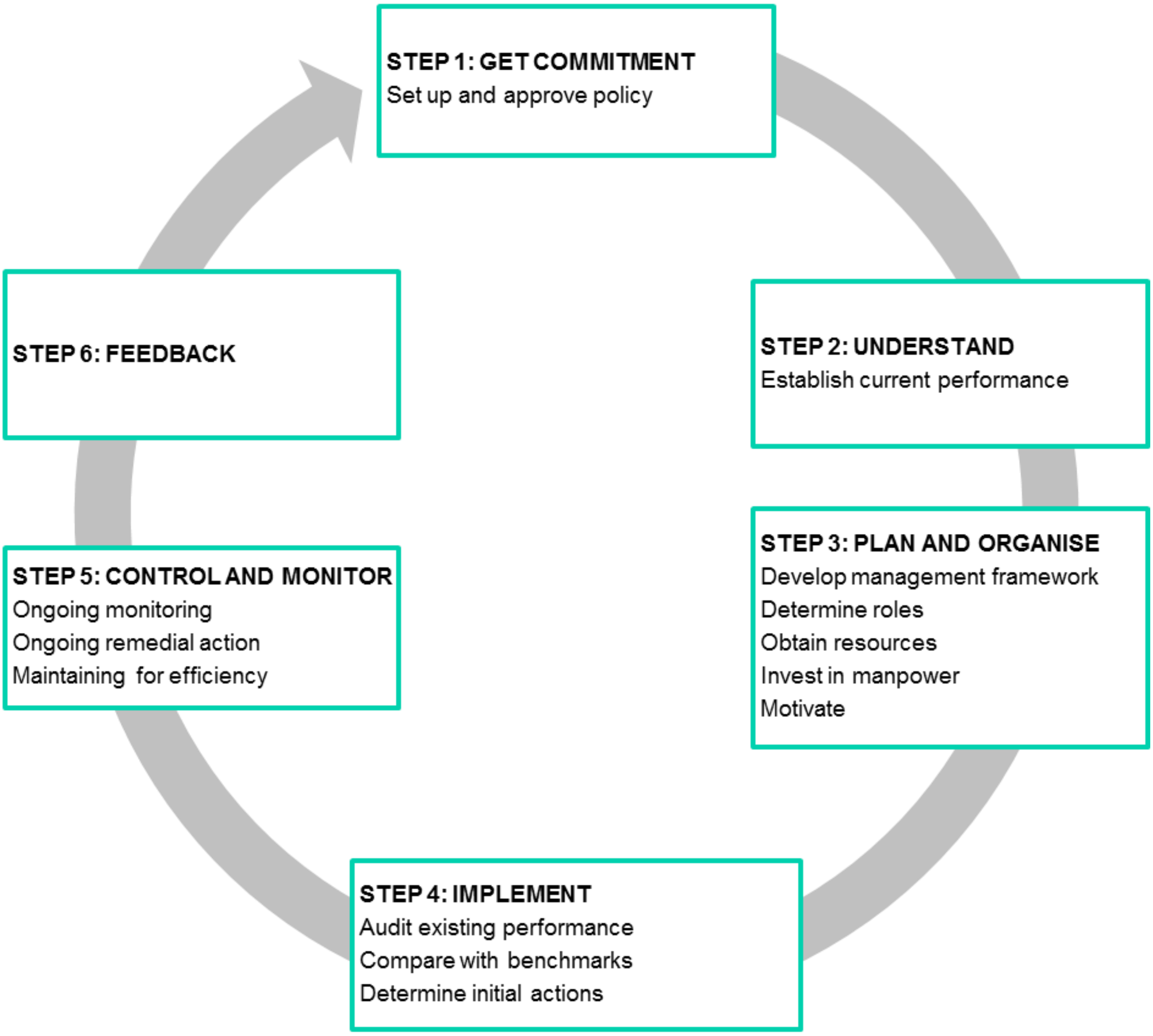


Figure 13 The 6-step approach to energy management

2.6.2 Commitment from people at the high level of the organisations, demonstrates the importance of saving energy. In many cases, building the business case, translating energy savings into financial savings is the key to getting this commitment. Incentives relevant to EU ETS, CRC and CCL can motivate towards the implementation of energy management strategies.

2.7 Step two: Understand

2.7.1 To develop an effective energy management strategy, it is important to gain a basic understanding of the status quo. For example, some organisations may have run energy saving campaigns in the past, but let them dwindle; others may have decided to gain control of their energy use for the first time. The energy management matrix in Table 6 provides sufficient information upon which to base an energy management strategy, because it answers the simple questions:

- Where are we now?
- Where do we want to get to?
- How much further do we need to go?

How to use the matrix

2.7.2 The energy management matrix shows five levels of performance, ranging from level 0 where there is no provision for energy management to level 4 representing best practice. For each column, decide which phrase best describes the organisation and mark that box. Then assess the scores by looking at the level attained for each of the six columns. Join the marks across the columns to produce a graph line.

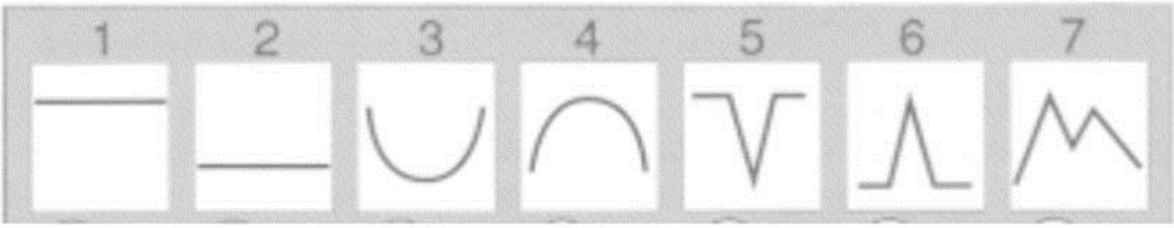
2.7.3 For example, scoring mostly level 2 would be typical of an organisation that is watching its expenditure on energy and may be reducing costs through prudent purchasing of gas and electricity, but which is not necessarily reducing energy consumption. It is not necessary to reach level 4 in each column; that will depend on the needs and nature of the organisation.

2.7.4 Now that you have drawn your organisation's profile, observe the shape: different shapes imply problems and potential solutions in different areas. For example a straight line demonstrates the organisation has excellent performance.

2.7.5 Figure 14 presents some typical examples and explains what each one of those shapes suggests.

Level	Energy Policy	Organising	Motivation	Information Systems	Marketing	Investment
4	Active commitment of top management	Fully integrated into general management	All staff accept responsibility for saving energy	Comprehensive system with effective management reporting	Extensive marketing within and outside organisation	Positive discrimination in favour of 'green' schemes
3	Formal policy but no commitment from top	Clear delegation and accountability	Most major users motivated to save energy	Monthly monitoring and targeting for individual premises	Regular publicity campaigns	Same appraisal criteria used as for all other investment
2	Unadopted policy	Delegation but line management and authority unclear	Motivation patchy or sporadic	Monthly monitoring and targeting by fuel type	Some adhoc staff awareness training	Investment with short term payback only
1	Unwritten set of guidelines	Informal part-time responsibility	Some staff awareness of importance of energy saving	Invoice checking	Informal contacts used to promote energy efficiency	Only low cost measures taken
0	No explicit policy	No delegation of energy management	No awareness of the need to save energy	No information system or accounting for consumption	No marketing or promotion	No investment in energy efficiency

Table 6 The energy management matrix. Source: Best Practice Programme: Good Practice Guide 167: Organisational Aspects of energy management: a self-assessment manual for managers



SHAPE	Description	Diagnosis
1 High balanced	score 3 or more on all columns	excellent performance; the problem is to maintain this high standard
2 Low balanced	balanced score of less than 3 on all columns	is this balance a symptom of orderly progress or stagnation?
3 U-shaped	the two outside columns are significantly lower	expectations have been raised and you are vulnerable
4 N-shaped	the two outside columns are significantly lower	achievement in the centre is likely to be wasted
5 Trough	a single column is significantly lower than the rest	underachievement on this column may hold back success elsewhere
6 Peak	a single column is significantly higher than the rest	effort in this area could be wasted by lack of progress elsewhere
7 Unbalanced	two or more columns 2 points above or below the average	the more imbalance the harder it is to perform well

Figure 14 Typical examples of profile shapes and key explaining each one of them. Source: Best Practice Programme: Good Practice Guide 167: Organisational Aspects of energy management: a self-assessment manual for managers

2.8 Step three: Plan and organise

2.8.1 This step is about deciding what resources will be needed to manage energy usage across the organisation. Specific targets should be related to actions and responsibilities, as well as to resource requirements and various timescales. Assigning actions to individuals, with the responsibility to report their progress and achieve timelines, is significant for organisation purposes. More information on planning and organising can be found in the Carbon Trust's CTV023: Practical Energy Management.

2.9 Step four: Implementation

2.9.1 This step involves undertaking a detailed analysis of the organisation's energy usage so that actions can be prioritised. It starts with the diagnosis of the actual energy performance of the organisation and the collection of data and sets energy and carbon savings targets on a hospital level. Savings and projects' costs should be estimated as accurately as possible and projects should be differentiated between low cost and high cost. A differentiation is also required between short term and long term planning; they are both essential for the successful implementation of energy management. CIBSE Guide F recommends not only establishing the financial aspects, but also identifying potential tax incentives, and any additional benefits, including environmental, carbon reduction, improved performance, comfort etc. More details regarding the diagnosis of actual energy performance can be found in 'Chapter 3'.

2.9.2 The information gathered during this implementation step will contribute to an ongoing energy saving campaign. It should be fed back to senior managers in the form of a 'paper to the board'. The information can also be given to staff, patients and other stakeholders in the form of 'performance league tables' to encourage further savings. It could also be used to launch an in-house competition between departments or services. As further data comes on-stream (for example from Step 5: monitoring and targeting), that can also be used to report back on progress.

2.9.3 The investigations carried out so far will invariably point to some areas where energy can be saved. But at this point the energy management team should think very carefully about the practicalities of their proposals and discuss options with various stakeholders.

- good housekeeping measures should be at the top of the list of actions, because these are generally no-cost or low-cost actions that will bring tangible savings or comfort improvements straight away;
- introducing or revising any maintenance strategy will likewise result in early success;
- fabric improvements and changes to plant and equipment – which have financial implications – should then be addressed.

2.10 Step five: Monitoring and Targeting

2.10.1 Monitoring and targeting (M&T) is a way of using energy related data to drive continuous improvement. M&T can flag improvements, but also weaknesses in energy use. The objective is to keep a close eye on ongoing fuel consumption so that unexpected consumption can be investigated and avoided as quickly as possible. There should be a plan for regular, detailed M&T assessments and a relevant reporting system must be developed. As part of an ongoing management plan, using an environmental management system can be very useful. For example, the ISO 14001 is primarily concerned with environmental management. It can be implemented without certification, so that the NHS organisation can make use of the relevant benefits; its main targets are for organisations to minimise harmful effects on the environment due to their activities; moreover, it helps organisations achieve continuous improvement regarding tis environmental performance. A step forward is achieved through the ISO 50001, where the improvement of the resulting energy performance is also required.

2.11 Step six: Feedback

2.11.1 The six-step approach described in this chapter can only succeed if the information gathered and the behaviours observed are linked back to specific energy saving actions. For example, if benchmarking shows that one building consistently uses more power for AC than another comparable building, the information should trigger an investigation, which may involve the energy management team, front-line staff and financial decision-makers (who may need to approve an investment in new plant or equipment).

2.11.2 Managing energy use is an ongoing task, and there is a potential danger that the energy management team could spend too much time focusing on technical detail. That is why providing feedback is so important. It gives energy users an incentive to keep up with the good housekeeping; but it also gives senior managers the information they need to be able to offer praise where it is due – to the energy management team. The importance of ongoing feedback mechanisms that ensure continuous updates and assessment of energy use and strategies should be emphasised, as an integral part of successful energy management.

2.12 Resources

2.12.1 It is recommended that all organisations should have an 'energy champion' (this role may be fulfilled by the 'sustainability lead' in some organisations). This person will be the 'public face' of the policy, and their role is to keep energy on senior managers' agenda. In addition, it is recommended that all organisations should have:

- someone to take on the role of energy manager;
- an energy information system that is designed to aid the reporting process;
- a budget.

2.12.2 It is advisable for each organisation to have their own trusted documents and information available to external consultants and designers, so that they have a solid basis to work with. Once an organisation has specific policy documents and verifiable historic energy information, that they accept as representative for the organisation in place, then calculations and tenders can be accepted only if based specifically on those documents.

2.13 Roles and responsibilities

The energy manager

2.13.1 The role of the energy manager is a crucial part of the efficient running of the estate budget. Although energy efficiency and carbon reduction is a team effort, it is important not to underestimate the significance of the energy management function. An energy manager provides a focal point for the energy efficiency programme, even though specialist support may be necessary.

2.13.2 Most healthcare organisations have someone who is responsible for energy, even if they are only responsible for checking the energy bills. However the introduction of various carbon related charges, energy tariffs, renewable energy incentives and opportunities to participate in demand response frameworks has resulted in the need for the person, or team, responsible for the management of the organisation's energy consumption to have specialist knowledge and training to enable them to fulfil their duties appropriately and for the organisation to benefit fully.

2.13.3 Designating a dedicated member of staff is a good example of 'invest to save'; some organisations designate an energy manager on the basis that the post should be self-financing through energy cost savings. Alternatively, for smaller organisations, it may be more appropriate for the role to be:

- shared with another NHS organisation;
- part-time;
- shared among several members of a team with a broader remit.

2.13.4 For more information on designating members of staff to energy management, see CIBSE Guide F, the Carbon Trust CTV023: Practical energy management and the BRE FB44 Energy management in the built environment.

2.13.5 Regardless of the staffing route chosen, the responsibilities of the person (or people) who take on the energy manager role are wide-ranging. Responsibilities are likely to include:

- checking fuel bills and local tariffs against meter readings and investigating anomalies;

- raising awareness of energy wastage and promoting good housekeeping throughout the organisation;
- measuring performance and reporting achievements to senior decision-makers in a simple and clear way;
- maintaining control by keeping up everyone's enthusiasm for conserving energy;
- ensuring that people receive due praise and credit for making savings and reducing carbon emissions.

2.13.6 Although the specific tasks will change over time the energy manager role will incorporate:

- provision of financial reports related to energy consumption, energy costs, carbon emissions related to energy use and associated carbon emissions charges for the Financial Director, or their designate;
- working closely with the estates director (or equivalent) or the energy champion during the formulation of the energy and carbon management policy;
- maintenance of procedures that enable the financial value of energy management activities to be continually reviewed so that their outcomes can be communicated appropriately to senior managers and other relevant staff;
- overseeing of day-to-day energy management activities;
- appointment of suitably qualified and accredited energy assessors to enable the organisation to meet its requirements under the EPBD. This should include the provision of EPCs, DECs and their associated energy reports, as well as AC inspections. The energy assessors should ideally have knowledge of healthcare buildings to ensure reports produced for the NHS organisations are robust and that recommendations contained within the reports are well considered to aid their implementation. For example, healthcare sector knowledge is beneficial for DEC assessors implementing CIBSE TM46 and the assignment of different building uses for different zones of the building. More details on this are provided in Chapter 1.
- cost-effective ways of providing management information about energy consumption, carbon emissions and other environmental impacts that may be associated with energy use or its export;
- ensuring the effective good housekeeping and plant-operating practices throughout the organisation;
- identifying the organisation's training needs for energy related skills and awareness;
- participating in the design team during the design and commissioning of projects related to the refurbishment and construction of buildings within the healthcare organisations estate to ensure appropriate decisions are taken with respect to energy efficiency, integration of renewable energy technologies, potential export of surplus energy and energy related income streams (see HBN 00-08 Part A: Strategic framework for the efficient management of healthcare estates and facilities);
- participating in key procurement decisions, including identifying cost-effective opportunities for increasing energy efficiency – whether in new or existing premises;
- considering formulating an investment programme for reducing energy consumption and environmental impact;
- providing guidance on energy efficiency to non-technical staff;
- making sure monitoring and targeting processes are followed as described in Section 2.102.10 (the Energy Manager will normally work alongside the person(s) responsible for waste and environmental management to fulfil these requirements, particularly as part of ensuring ongoing ISO accreditations are to be met);
- ensuring the organisation complies with the requirements for CRC or EU ETS and that it follows all the required processes;

- collating accurate energy data for the ERIC return as and when required.

2.14 Environmental and energy management systems

2.14.1 An energy management system can provide a framework to manage and drive improvements in environmental and energy efficiency on an organisation level. For example, NHS Wales has targets for all Health Boards and Trusts to achieve ISO 14001 certification as it is seen as a key environmental management tool.

2.14.2 The ISO 14001 standard specifies criteria for an environmental management system and it provides a framework for organisations to ensure their environmental impact is measured and improved. Nevertheless, it does not state requirements for environmental performance for the organisation. Benefits of using this standard can involve reduced cost of waste management, reduced energy and material use, reduced distribution costs and improved corporate image among regulators, customers and the public.

2.14.3 Since 2011, ISO 50001 has been introduced and provided a step forward in management. It is highly compatible with ISO 14001 and involves energy management. The aim is to enable organisations to integrate energy management with their efforts to improve quality and environmental management. ISO 50001 provides a framework enabling organisations to do the following:

- develop a policy for more efficient use of energy;
- fix targets and objectives to meet the policy;
- use data to better understand and make decisions concerning energy use and consumption;
- measure the results;
- review the effectiveness of the policy;
- continually improve energy management.

2.15 The energy information system

2.15.1 As the saying goes 'you can't manage what you can't measure'. An effective energy information system (EIS), ideally as part of a larger information system (environmental or otherwise), is recommended to enable an integrated approach for energy and carbon management. The EIS should help the energy manager to:

- track and report on progress easily (that is, the system should use widely understood terms and performance indicators);
- provide management information for budgeting and financial control purposes;
- verify and demonstrate ongoing benefits of completed energy improvement projects;
- provide alerts and exception reports that indicate when energy usage exceeds expectations;
- provide reliable records from which business cases for new projects can be developed;
- deliver better healthcare outcomes.

2.16 Budget

2.16.1 As well as the need for an energy manager and an energy information system, a budget should also be considered. Planned capital investment can produce rapid revenue savings, and healthcare organisations can take advantage of this by introducing a degree of flexibility over accounting practices. For example, allowing slightly longer pay-back periods for some energy efficient equipment can enhance the viability of such schemes. Another option is to look at energy efficiency proposals in terms of their potential to reduce carbon emissions, because such proposals may help the organisation to avoid incurring a financial penalty for excessive emissions.

2.16.2 To ensure continuous improvement an appropriate level of annual investment should ideally be set for energy management, this could be up to 10% of the annual expenditure on energy. To ensure the appropriate targeting of this investment the utilisation of MAC curves (http://www.sduhealth.org.uk/delivery/measure/finance/macc.aspx) will assist in identifying the interventions that are most cost effective at improving energy efficiency and reducing carbon emissions.

2.16.3 This percentage figure could be exceeded in the early stages of an energy management strategy, when there are more opportunities for investment. A lower figure may be considered adequate in a well-developed programme until new opportunities arise. Other options include:

- reinvesting some of the revenue savings made by energy management;
- allowing a share of the energy cost savings to be used for other purposes by those who achieve the savings (for example, the staff working in a particular building or department);
- treating some energy management costs as an overhead that contributes to staff comfort and productivity;
- allowing use of revenue for capital expenditure when it can be recovered by revenue savings within the accounting period.

2.17 Using Encode 2015 to drive the change process

2.17.1 Developing an energy and carbon management policy and strategy will involve much inter-departmental communication, with representatives from the estates department (or equivalent) guiding discussions and advising on suitable actions. There are four main issues to discuss:

- day-to-day management of energy use;
- energy considerations for new building facilities;
- energy considerations for the refurbishment of existing building facilities;
- procurement of energy, equipment and services.

2.17.2 Day-to-day building management and behaviour change are discussed in Chapter 3. The other three issues are analysed in Encode 2015 Part B. Day-to-day energy management should ideally be led by a dedicated Energy Manager (whose expertise may be shared between NHS organisations) but could also be led by the estates department or its equivalent. To ensure success it is important that staff across the organisation are engaged and involved in its implementation. Therefore all staff should buy in to the idea of saving energy; they are the key to achieving considerable daily savings and improving indoor comfort.

3 Building energy management and behaviour change

3.1 Building energy management

3.1.1 The previous chapter has analysed energy management on an organisation level; it described energy policies and strategies but did not go into detail regarding building energy management or behavioural aspects of energy efficiency in organisations. This chapter focuses on analysing energy use on a building level and diagnosing problems and potential areas of energy performance improvements. Moreover, it reviews the occupants' perspective and methods used to explore and analyse their satisfaction regarding the building performance.

3.1.2 The main aspects of analysing building energy use are described in the paragraphs that follow. However, it is important to remember that any analysis is not, in itself, a solution to energy wastage. The techniques are very useful to identify priorities – but unless specific actions follow, wastage will continue. In addition, the pattern of energy usage in healthcare organisations is constantly changing – under the influence of the weather, demand for services, wider development plans and so on. This means that priorities for actions to save energy also change. Therefore it is recommended that an organisation's energy team regularly reviews energy consumption and reassesses the actions required for its reduction.

3.2 Benchmarking

3.2.1 Chapter 1 explained the purpose of benchmarking and has described different tools used specifically for the healthcare sector. It focused on energy use and target setting on organisation level. Nevertheless, benchmarking can also be used in a set of buildings. For example, for organisations having several similar buildings, it is possible to benchmark these against the best performer of the group. Moreover, comparing the performance of the same building year on year with the national benchmarks will show whether performance is improving or deteriorating; again attention can be directed towards those buildings that most need it. This will help to prioritise action, even where the whole stock of a particular health sector organisation is consistently worse than 'typical', perhaps because the buildings are old. Finally, this will enable the identification of unexpected energy use, for example one piece of plant or equipment that is in need of maintenance.

3.2.2 The raw data for a benchmarking exercise can be obtained from the organisation's energy consumption data, a building management system (BMS), or a purpose-built automated metering software dedicated to collecting and comparing energy data. Provided there are sufficient energy meters around the site, BMS data usually gives sufficient information to derive detailed benchmarks; and the software associated with some BMS tools can perform the calculations automatically.

3.2.3 The 'headline' benchmarks are appropriate for presenting an overall assessment of performance to prioritise action. A subsequent step is to understand which of the services within a building are causing energy consumption to go over the benchmarks. This can be achieved by monitoring local performance closely for a set period or by gathering automatic meter readings (AMR) or energy usage data from sub-meters (or via the BMS), then comparing performance year on year or comparing with benchmarks that are published for other sectors (for example, IT equipment benchmarks are available for offices).

3.3 Energy audit

3.3.1 Energy audits are compulsory for all organisations and the public sector. Audits should take into account standards such as the ISO 50001: 2011 and the BS EN 16247-1: 2012. In practical terms, the audits defined in BS EN 16247, Parts 1-4, more than meet the requirements of ISO 50001, which refers to 'energy reviews' being underpinned by energy audits.

3.3.2 An energy audit comprises a detailed review of an organisation's energy performance and is usually based on measurements and observations of actual energy use. For smaller healthcare organisations, or facilities housed in a single building, the energy manager can do a quick and effective audit simply by looking at the organisation's fuel bills or meter readings – the type of information that forms part of the ERIC data – and ranking the organisation's buildings in order of their energy consumption. This gives a rough guide to prioritising subsequent activities. For example, the building with the highest electricity consumption should be the one that is visited first when the energy manager begins an energy walk-around.

3.3.3 However, the scale of the exercise depends on the size and complexity of the organisation. If the organisation has multiple sites and monthly bills, or if the energy management team is inexperienced, it may be necessary to engage the assistance of specialist energy consultants. If this is the case, it will be more cost-effective to ask the energy consultants to perform the audit as the preliminary stage. More detailed information can be found in CIBSE Guide F: Energy efficiency in buildings. The DEC assessor can also compliment this service through his advisory report. Audits are part of the process of identifying issues and improving an organisation's energy performance and they might be accompanied by a series of relevant recommendations.

3.3.4 Detailed information on conducting an energy audit is provided in the BRE's Information Paper IP 7/13: Energy surveys and audits: A guide to best practice. See also Appendix 6 for an example of standard stationery forms that can be used in a site energy audit.

3.4 Energy surveys

3.4.1 An energy survey is an on-site technical investigation of the supply, use and management of energy to identify specific energy saving measures. Typically, a survey will consider:

- the building: levels of insulation, ventilation, air infiltration etc. Figures 15 and 16 present an example of diagnosing potential inefficiencies and identifying building characteristics, focusing on building fabric heat losses and infiltration;
- the pattern of use: periods of occupancy; types of control; temperature and humidity levels maintained; the use of electric lighting; the activities and processes being undertaken, including their operating temperatures; insulation etc.;
- energy supply and distribution arrangements: fans and pumps, insulation of hot water and steam pipes and air ducts, evidence of leakage etc.;
- the main building services: primary heating, cooling and air handling plant, and the condition of plant;
- lighting: quality, efficiency and control of electric lighting, and the use of daylight.

3.4.2 Many consultants provide DECs free of charge on the basis that they will pick up the energy improvement contracts when opportunities are identified. In this case, it is important to make sure there are no conflicts of interest and that the energy efficiency measures recommended by the consultant are actually the optimum ones to implement. Ideally energy assessors/consultants should not have any pecuniary interest in firms employed to carry out energy efficiency work unless it is all open, transparent and auditable.

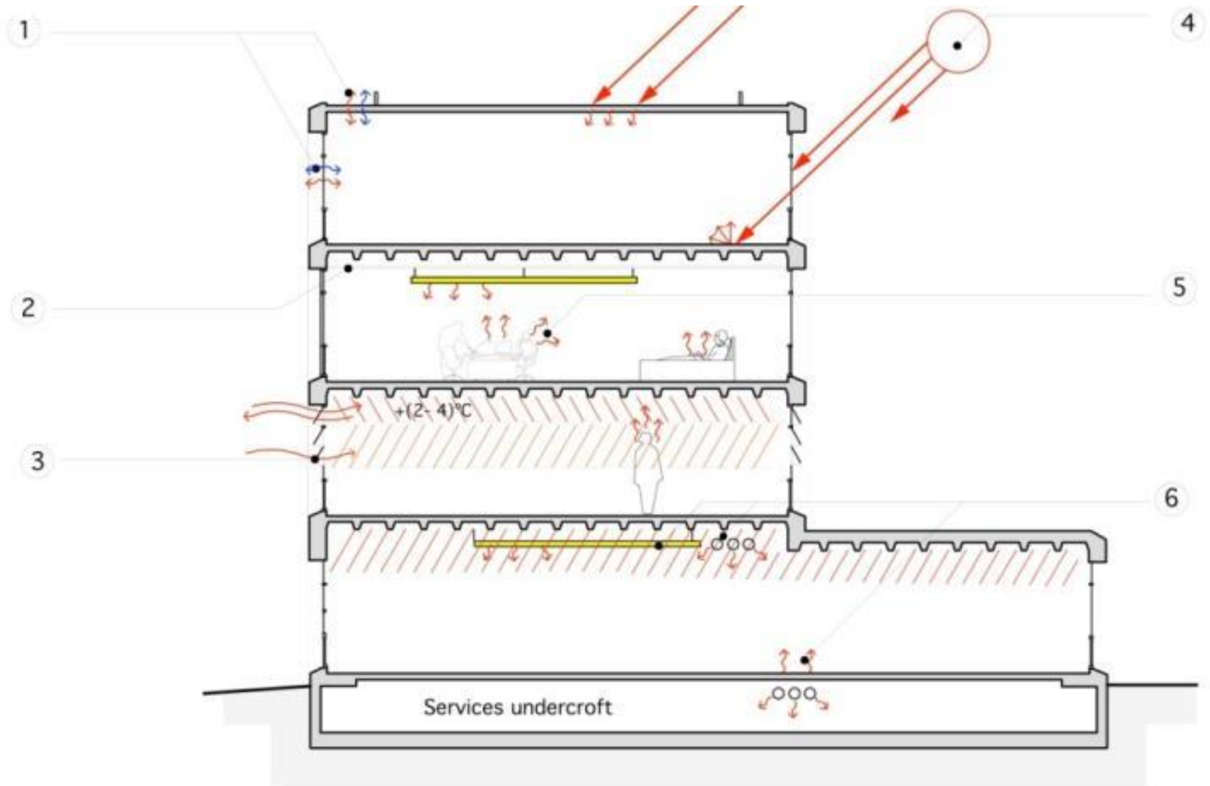


Figure 15 Section through maternity wing (as built) showing environmental characteristics during summer time operation. (1) Fabric heat losses/gains; (2) lightweight surfaces; (3) uncontrolled infiltration; (4) direct solar gain through large areas of unshaded glazing; (5) and (6) internal heat gains from patients, staff, equipment and lighting. Courtesy of Professor C. Alan Short

3.4.3 Surveys can be time consuming and expensive. The cost of the survey, if done by in-house staff, depends on internal accounting procedures (for example, savings identified may cover the cost of the time spent doing the survey.) If consultants are called in, the cost will typically be a fixed sum or a function of a shared savings scheme. Whichever route is followed, the total cost should be no more than a small percentage of the annual cost of energy under investigation (for example, 3% or 5%)[4] and is usually recovered during the first year if recommendations are implemented fully.

3.4.4 For an estate with small energy demands, the other techniques described in this chapter should suffice, unless there is a major change in circumstances (for instance, revised working practices or occupancy patterns). It may also be appropriate to perform a survey before a major redevelopment to provide up-to-date information.

3.4.5 More detailed guidance can be found in CIBSE Guide F: Energy efficiency in buildings. In addition, CIBSE's energy assessment and reporting methodology (EARM) could be used. This is described in CIBSE TM22: Energy assessment and reporting method.

[4] The percentage may well be higher for an organisation with many small sites, even though the total energy bill may be several million pounds

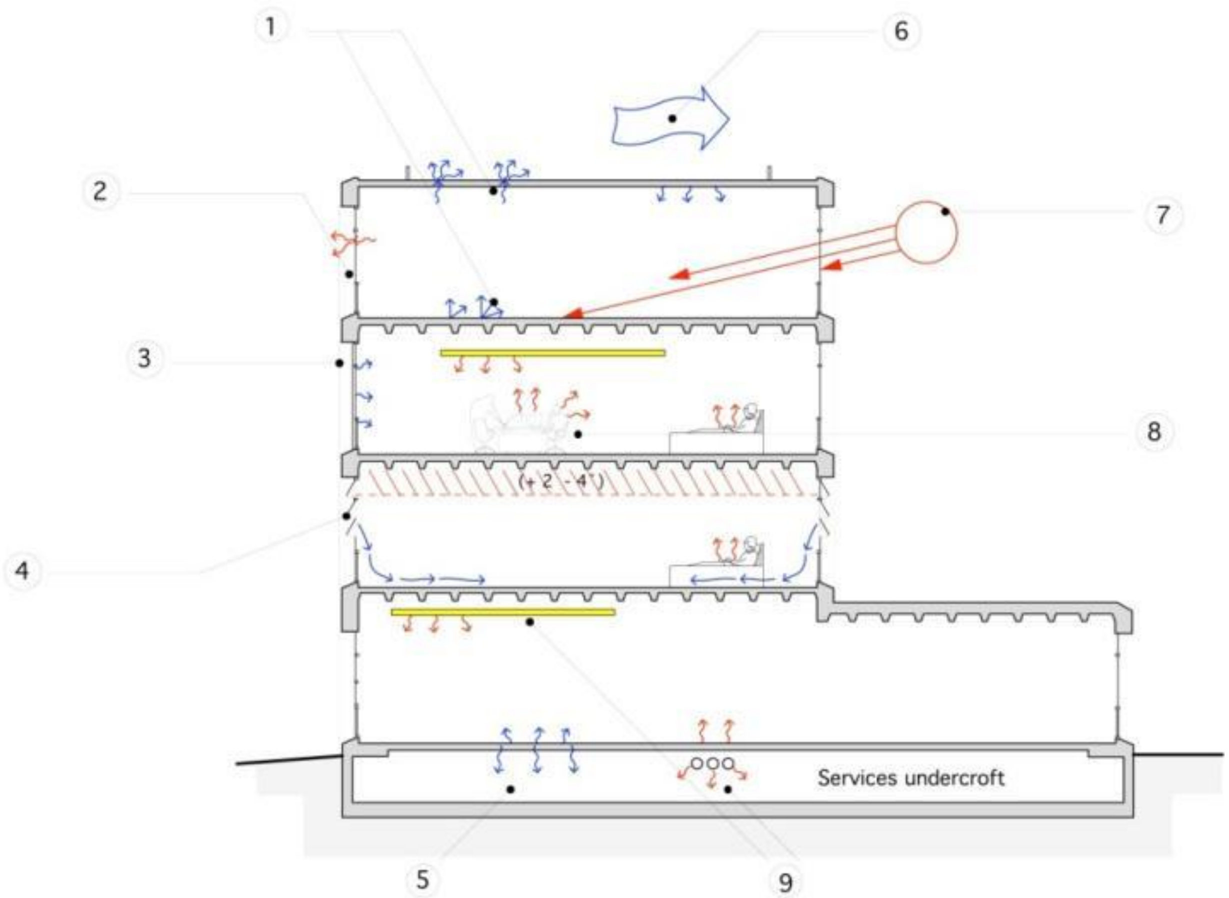


Figure 16 Section through maternity wing (as built) showing environmental characteristics during winter time operation. (1) Poorly insulated roof slab radiates heat to night sky; (2) heat loss through poorly insulated solid envelope, glazing and non-airtight construction; (3) dry resultant temperature (operative temperature) is lower than air temperature due to cold surfaces; (4) ill-fitting single glazing causes uncontrollable infiltration and cold downdraughts for patients; (5) conductive heat losses through uninsulated ground floor slab; (6) wind effects increase heat loss from building; (7) glare from low-level sun results in use of blinds which reduces daylight resulting in greater use of artificial lighting; (8) and (9) internal heat gains from patients, staff, equipment and lighting. Courtesy of Professor C. Alan Short

3.5 Energy walk-around

3.5.1 At least once per year and certainly at the start of an energy saving campaign, the energy manager should conduct an energy walk-around. It is worth perhaps doing this energy walk-around during both winter and summer seasons, because different issues are likely to be identified, such as overheating of certain spaces during the summer, or cold and draughts during the winter season. The energy walk-around is a user-friendly survey aiming to identify where energy is being used around a building or estate using simple checklists. It can be a great opportunity for raising awareness of energy use, particularly if the organisation's 'energy champion' is invited to join in. It is also likely that obvious wastage will be spotted and can be corrected immediately, for example lights left on in unoccupied areas. The walk-around includes aspects such as heating and relevant controls, lighting, electrical equipment, hot water and building fabric. A health sector walk-around checklist is provided by the Carbon Trust CTL069. Further information on walk-arounds and energy management in the built environment are provided in the Carbon Trust's FB44: Energy management in the built environment.

3.5.2 The best time to perform the walk-around is when people are least expecting it. (If they are aware that a walk-around is planned, people will make a special effort to switch off unused equipment.) However, patient care and confidentiality should not be compromised:

- alert the appropriate person before visiting patient care areas (for example, suggest to staff that the walk-around is comparable to a health and safety spot-check, in that staff should not take actions in advance of the visit);
- if a member of the energy management team spots obvious energy waste during the walk- around, they should not take action themselves; discuss it with clinical staff first (after all, this is an awareness-raising exercise).

3.5.3 The information gathered during a walk-around can form the basis of a good-housekeeping system. For example, once particular areas of wastage have been identified during a walk-around, these could be added to a daily checklist to be used by the person who has agreed to monitor the energy use for that area. The information can also be used to:

- develop a more detailed energy management campaign;
- highlight areas where maintenance procedures should be tightened;
- provide evidence that remedial action such as renovation or investment in equipment is needed.

3.5.4 For example, if during an energy walk-around it became clear that there were many electric kettles for staff and patient use, the energy manager might consider the benefits of providing hot water dispensers for drinks. There would be an initial capital outlay, but these devices would save energy and would also have long-term safety benefits.

3.6 Monitoring

3.6.1 Ongoing monitoring of energy use will identify a wide range of issues – from plant that is not working at its optimum to areas where housekeeping (for example routine maintenance) is being neglected. Monitoring individual departments or specific usages can even be used as a basis for re-charging departments; an excellent way to encourage people to take control of their energy use.

3.6.2 An M&T system will be based on the information from the energy audit, combined with the energy management strategy that assigns various actions to specific people. In addition, the energy management team will need a reliable stream of short, medium and long term energy performance indicators for the whole estate and key elements within the estate. This may be obtained from simple meter readings or, more likely, sub-meter readings that record half-hourly energy usage.

3.6.3 Installing new meters can be expensive, but this measure should not be ruled out on the grounds of cost alone, because metering can bring additional advantages. Before consumption is analysed, meter data should always be checked against invoices, just as delivery notes for consumables are checked when goods are delivered. The validated data can then be analysed (using basic statistical techniques, off-the-peg or custom-built software packages) to obtain energy use profiles, including graphs or charts showing the energy use in a particular building or by one specific service.

3.6.4 The profiles should show:

- base load;
- night/weekend differences;
- the hours when the main consumption tends to occur ('shoulder hours').

3.6.5 The profiles will have a particular shape, so unusual consumption will show up because the graph will contain a spike, peak or trough. The energy management team should then check back with the people working in the department at the time to try to explain why this change in consumption has occurred. M&T

techniques are described in the Carbon Trust's CTG054 Energy Management.

3.6.6 M&T is a highly iterative process, with successive measurements being compared with historical data. Clearly, the amount of time devoted to M&T should be proportional to the savings that can be achieved. Crucially, any M&T system will not deliver the benefits if the management does not react to the feedback it provides.

3.6.7 As well as identifying potential energy savings, the M&T system should be coordinated with the organisation's maintenance strategy. The two will then reinforce each other to everyone's benefit. For example, M&T data can highlight that a plant has begun to operate at lower than optimum performance and alert the maintenance team that a service is required. This prolongs the life of the plant and improves its energy efficiency. M&T information may suggest that measures involving capital expenditure are necessary. This will involve both design and procurement issues (discussed in Encode 2015 Part B).

3.6.8 Moreover, it is important to collect information regarding organisations' indoor temperatures and occupants' comfort conditions. An energy manager should be reviewing the site's energy consumption (fuel and electricity) in combination with the available heating degree days and cooling degree days data and the internal temperatures to ensure efficient use of energy supplies. Consequently, any internal temperature issues that may affect patient comfort can also be identified and shared with estates and clinical staff. Information on cooling and heating degree days is provided in Appendix 1.

3.7 Smart metering

3.7.1 Smart meters are described by the Energy Saving Trust as the 'next generation of gas and electricity meters'. They transmit customer's 'real time' energy consumption data to the energy supplier (and hence network operator) enabling them to manage the supply network more effectively. They are accompanied by display devices that enable building owners and occupants to be informed about their energy use. All homes and businesses in the UK will have smart meters by the end of 2020.

3.7.2 The installation of smart meters does not reduce energy use by itself; it is the correct use of the information provided that can contribute to this purpose. Smart metering enables the following:

- better knowledge of building energy consumption;
- disaggregation of energy use into separate end uses;
- identification of patterns in energy use
- identification of areas and components of low performance;
- identification of areas and components in need of maintenance.

3.7.3 Smart meters provide an opportunity to make 'real time' energy consumption visible to staff, patients and visitors via appropriately located Visual Display Units (VDUs). They contribute to the success of behaviour change programmes when not only the energy managers, but also the building users themselves, can view the effect of their efforts and behaviour.

3.8 Air conditioning inspection

3.8.1 As it has been mentioned in Chapter 1, it is a requirement of the EPBD, for all AC systems over 12kW to be regularly inspected by an Energy Assessor. CIBSE Technical Manual 44: Inspection of air conditioning systems provides guidance on good practice for inspection procedures. The aim of these inspections is to identify potential ways of reducing energy consumption in a non-invasive and site-based manner. Experience demonstrates substantial energy and running cost savings can be achieved through small or zero capital cost. The requirement on AC inspections is supported by regulatory structures, such as the accreditation of the professionals carrying out those inspections, as well as the quality assessment of inspections and inspection reports. The CIBSE TM44 assesses 'how well a system is maintained, controlled and operated and whether it is fit for purpose'. CIBSE TM44 focuses on energy use. For health aspects of AC, such as Legionella, CIBSE TM13: Minimising the risk of Legionnaires' disease should be referenced. The AC inspector must provide a report containing the current efficiency of the equipment and making suggestions for its improvement, including where appropriate its replacement. The report should also include a list of identified faults, such as malfunctions and poor conditions of air filters, as well as comments on the equipment's maintenance and installed controls. Figure 17 presents examples of AC inspection findings.

3.9 Predicting performance

3.9.1 The previous paragraphs analysed different methods used to establish building energy performance. The next requirement is to be able to predict what the expected benefits can be due to the implementation of specific energy efficient measures.

3.9.2 Energy modelling or building simulation is a method used to estimate the energy performance of a building, based on a building model built in a simulation tool, with specific assumptions regarding the building fabric, building services, occupancy patterns and climate conditions for a given site or building. The software and the expertise required vary, with different levels of detail involved in the relevant calculations.

3.9.3 Simplified Building Energy Model (SBEM), as the name explains, is one of the simplest building energy modelling tools; it is adopted for the generation of EPCs for non-domestic buildings and it is used in support of the National Calculation Methodology and the Energy Performance of Buildings Directive. The input to this tool is general building characteristics and default weather data used for the assessment.

3.9.4 Nevertheless, there is more detailed and complicated software, which requires different levels of expertise and can use detailed information on the building analysed. For example, specific building energy patterns, detailed building services components and fabric elements can be modelled in a way that is closer to the actual built condition. This service comes at a cost, although it is likely that companies providing different energy efficient refurbishment upgrades would perform a simulation for the specific NHS organisation if needed.

3.9.5 An additional benefit of using building energy modelling, is the possibility to use predicted weather data for the future in order to estimate the response of a specific building to future climatic conditions, such as higher summer temperatures.

3.9.6 At the moment there are Test Reference Years (TRYs), which consist of hourly data for 12 months, produced based on data between 1983 and 2004 and smoothed to provide a one-year sequence of data. They enable building simulation after what is considered to be 'typical' weather conditions for different areas in the UK. Moreover, there are Design Summer Years (DSYs), produced from the same data to represent a year with a hot summer. Finally, CIBSE provides future weather data base on TRYs and DSYs and incorporating the UKCIP02 climate change scenarios, for the 2020s, the 2050s and the 2080s, assuming four different levels of scenarios for carbon emissions.

Figure 17 These pictures present examples of AC inspection findings, such as poor access for maintenance (a), incorrect use and unsuitable material of flexible ducting (b), use of wrong component parts (c) and lack of maintenance (d). Picture e presents chiller units placed directly in front of an air intake so that the heat they reject is drawn straight back into the building. Courtesy of Malcolm Thomas, Consulting Engineer.

3.10 Post occupancy evaluation

3.10.1 As mentioned in Chapter 1, occupant satisfaction is another criterion used to evaluate a building's performance. Collecting information on occupant satisfaction means that energy managers learn more about the building, how it operates and they avoid potential mistakes, especially after maintenance or refurbishment changes. Post Occupancy Evaluation (POE) is the process of obtaining feedback on a building's in-use performance. According to the BRE, POE can do the following:

- identify teething problems;
- identify communication gaps that influence building operation and efficiency;
- teach lessons that can be useful for future projects and changes;
- act as a benchmarking tool across projects and over time.

3.10.2 BREEAM includes POE in the issues it addresses, although it is not a compulsory requirement for certification. It includes feedback from all building users, including the facilities managers. It focuses on internal conditions of the building such as light, noise temperature and air quality, as well as on control, operation and maintenance aspects. In addition, it involves criteria regarding layout and access, as well as facilities and amenities. Finally, POE addresses sustainability, through criteria such as energy and water consumption, as well as the performance of low and zero carbon technologies.

3.10.3 POE often includes an occupant survey, aiming to identify occupants' perception of building features and internal conditions as mentioned in the previous paragraph. The occupants are invited to comment on their satisfaction regarding specific building features, such as the following:

- temperature (in winter and summer);
- air (in winter and summer);
- lighting;
- noise;
- comfort;
- design;
- needs;
- perceived health;
- image to visitors;
- perceived productivity.

3.11 Motivating stakeholders

3.11.1 Everyone involved in a healthcare organisation, including staff, patients, suppliers, visitors and contractors, has an impact on energy usage. There is no one-size-fits-all solution which works across all types of organisations. However, behaviour change is considered as a low cost option reducing energy use in organisations.

3.11.2 The NHS Confederation document Taking the temperature: Towards an NHS response to global warming, regarding the organisation's response to global warming, highlights the role of the staff in reducing the sector's carbon emissions. According to the same document, the NHS employs more than 1.3 million people, who have a significant potential of reducing carbon emissions in their workplace. Education and training encouraging energy efficient behaviours can have a significant benefit towards carbon emissions' reduction.

3.11.3 The following characteristics are important for the success of the campaign:

- the campaign is endorsed at the very highest level - usually by the organisation's chief executive;
- the campaign is supported at board level by an 'energy champion';
- the campaign is underpinned by a strong energy and carbon management policy (or environmental policy), which succinctly states the organisation's intentions.

3.11.4 Carbon Trust in its CTC827: Low Carbon Behaviour Change suggests that there are seven steps to follow for behaviour change. These steps, presented

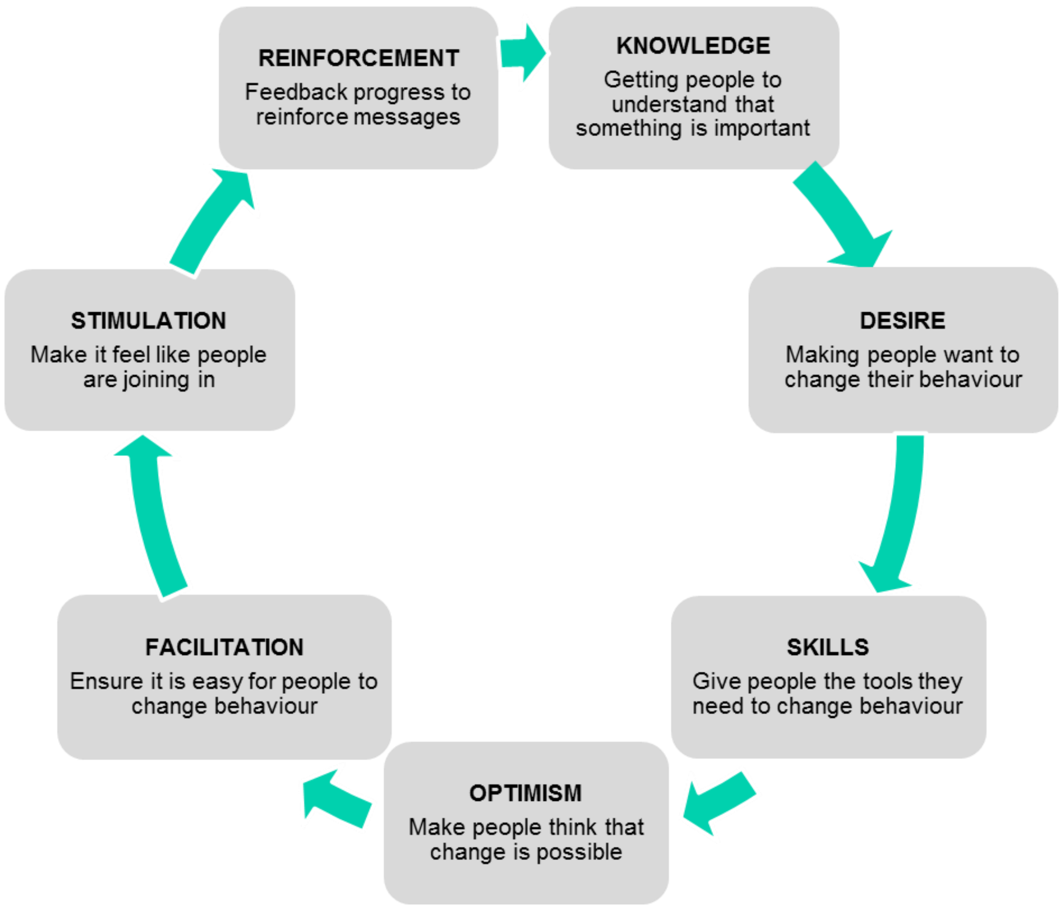


Figure 18 The seven steps of behaviour change. Reproduced from CTC827: Low Carbon Behaviour Change: The £300 million opportunity by permission of the Carbon Trust

in Figure 18 are worth considering when designing the organisations behaviour change campaign, as they involve the stages a person goes through when changing their behaviour.

3.11.5 An effective campaign involves the following:

- understanding the organisation's energy use;
- identifying which behaviours are realistically easier to change and also expected to achieve the highest energy savings. This will allow the organisation to prioritise the behaviours they want to change;
- setting targets, so that progress can be monitored;
- identifying what values the organisation's staff shares and how they interact with the building technologies and features;
- ensuring there is senior support, which will allow the use of resources.

3.11.6 Some organisations have found that it helps to nominate someone to take on the role of 'energy monitor'. This person has a list of good housekeeping actions and is responsible for checking that they are achieved each day; for example, as part of a security check at the end of the shift or a theatre nurse alters the theatre ventilation to 'set-back' mode.

3.11.7 It is also helpful to remember that the audience for energy awareness raising campaigns is not static. There is a constant stream of new patients, visitors, staff and suppliers who will not be aware of the energy and carbon management policy. For this reason many organisations require

Box 5 Behaviour change in Barts Health NHS Trust

Barts Health NHS Trust has managed to reduce its energy use while improving the interior conditions for staff and patients. This campaign has been designed with the collaboration of the staff. They identified problems in interior conditions, as well as opportunities to improve them, while saving energy. The Operation TLC (T for turning off equipment when not in use, L for switching off lights when possible and C for closing doors and windows) was designed with the staff input, ensured safety, rewarded staff for their success and identified the relevant benefits, including financial and intangibles.

energy, carbon emissions and wider environmental issues to be discussed as part of the standard induction procedure for all staff. The message to staff on such occasions is not just about their own behaviour, but that they should spread the word to other people using the healthcare facilities.

3.11.8 Box 5 describes a campaign where the staff's input was significant for its success, while ensuring improved healthcare conditions.

3.11.9 Communication with staff often identifies problems quickly and generally improves good housekeeping achievements. When changes to building plant or systems are necessary, good communications help staff to accept new services or controls rather than raising objections to the innovation.

3.11.10 Although there may be initial enthusiasm for an energy management exercise, it is important to keep up the momentum. This can be achieved, in part, by regularly reporting back on progress. If savings can be quantified in cash terms, or patient and staff benefits, so much the better; and that is one of the positive reasons for having a well- developed energy information system.

3.11.11 Motivating stakeholders is not a question of dictating actions from above; if the action required does not fit with their values, then they are unlikely to do it just because they are encouraged. Changing values takes time and is very challenging especially when people do not necessarily share the same values. The most effective way to convince people to save energy is to identify their values and build an energy saving campaign around those values. An example by the Carbon Trust (Box 6) describes how different values have been used in practice to motivate building occupants who were not interested in saving energy.

3.11.12 Table 7 presents different methods of motivating staff to save energy. Not all of them will apply on each organisation. However, the person in charge of the energy saving campaign should be able to identify the most important motivators and use them to save energy through staff behaviour changes.

Box 6 Motivating building occupants when saving energy is not their priority

The Carbon Trust worked with a police service where very dedicated staff were focused on their jobs and not conscious of saving energy at work, but were motivated by the need for data security. The solution was to build a switch-off campaign around the fact that computers are less vulnerable to cyberattack if shut down overnight, which immediately resonated with staff.

Motivation	Explanation
Increased productivity	More efficient equipment allows people to do their jobs better.
Marketing	Energy efficiency is a positive step towards greater environmental responsibility. Corporate responsibility is important in many boardrooms. Being seen as 'green' enhances an organisation's reputation.
Improved reliability	Equipment used efficiently and correctly works better and longer, resulting in cost savings, less equipment downtime and fewer demands on maintenance staff.
Financial	Energy awareness leads to cost savings. This money can be reinvested to patient care and contribute to the improvement of healthcare provision by the NHS organisation.
Environmental	Make people aware of the positive effect their actions can have on their global and local environments. Saving energy is one of the simplest green actions. For some, environmental issues are significant. By making the link between energy use, CO_2 emissions and the environment, people can appreciate that they can make a difference.
Improved comfort	Better control of heating and lighting leads to a more comfortable environment for staff and patients and to potential health benefits.
Morale	Having better working conditions as a direct result of being energy efficient has a positive effect on the attitude of most people.
Saving in the home	Although staff may not always respond to energy awareness at work, most will be interested in saving energy at home and on the road. People are motivated by self-interest; persuade them that methods used to save energy at work can apply to their home and save them money.
Charitable giving	Some people are motivated by helping others. Appeal to them by agreeing to donate a percentage of the energy cost savings to charities nominated by staff.
Competition	Some people respond to the challenge of competition. Set up ongoing competitions to see which sites, buildings or departments can make the greatest energy savings. Publicise the results regularly and if possible award a prize to the best every year.
Recognition	Recognise the actions and successes which staff make with energy savings. This will encourage them to make further suggestions.

Table 7 Ways of motivating staff to save energy. Adapted from CTG056: Creating an awareness campaign

3.11.13 The use of the right language and appropriate communication routes is also a significant factor in the success of an energy saving campaign. The following ideas from the Carbon Trust's CTG056: Creating an awareness campaign provide alternatives for communicating the campaign messages: emails, presentations and training, posters, staff newsletters, meetings, walk-arounds, stickers, word of mouth, displays, competition, internal communications, payslips, energy literature, suggestion schemes and external input.

3.11.14 Further guidance on motivation can be found in the Carbon Trust's CTC827: Low Carbon Behaviour Change and in the CTG056: Creating an awareness campaign.

3.11.15 A list of guidance regarding energy and carbon management by the Carbon Trust is provided in Box 7).

Box 7 Energy and carbon management guidance by the Carbon Trust

CTV045: An introduction to energy management

Energy management guide

Better business guide to energy saving

Making the business case for a carbon reduction project

CTG039: Green your business for growth

Energy surveys - a practical guide

Monitoring and targeting - In depth management guide

CTV061: Metering - Introducing the techniques and technology for energy data management

Degree days for energy management

CTG045: Voltage management

CTG076: Power factor correction

CTL172: Conducting a walk around energy survey

The following guidance documents focus specifically on the healthcare sector:

CTV025: Primary healthcare: Caring for budgets through energy efficiency

Guy's and St Thomas' NHS Foundation Trust - Carbon management

South West Yorkshire Partnership NHS Foundation Trust - Carbon management

Appendix 1: Analysis of metrics in relation to energy

Gross internal floor area

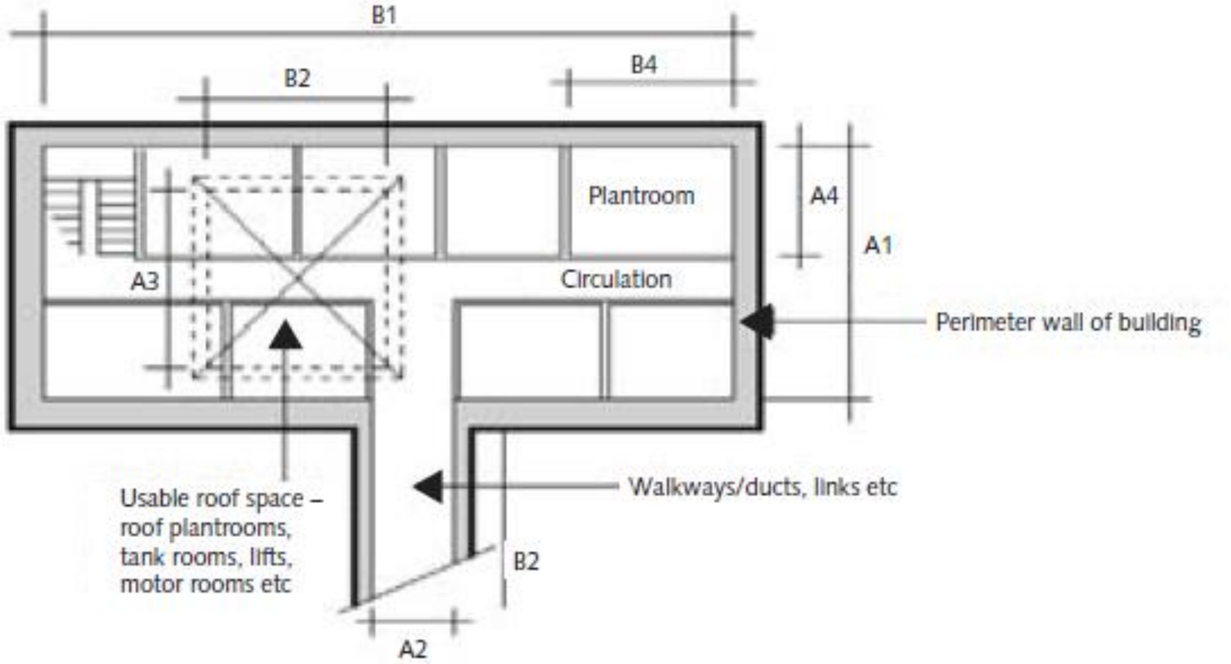


Figure 19 Gross internal floor area

The gross internal floor area (GIA) is calculated as follows:
Gross internal floor area (m^2) should be the overall internal floor area within the perimeter of the external walls (for example measuring the building or premises externally and by deducting from the overall length and width the thickness of the external walls, and then multiplying the resultant length by the resultant width (Figure 19).

Allowances should be made for projections, indentations, insets, voids and courtyards. This is repeated for each storey of the building and added together to obtain the total gross internal floor area. The floor areas of plant rooms, circulation spaces and internal walkways are included.
Gross internal floor area = [(A1 x B1) + (A2 x B2) + (A3 x B3)] + GIA of other floors.

Taking account of degree-day data

The energy use of a building can be predicted by reference to changes in outside temperature. Some energy use is largely independent of outside temperature, for example lighting and energy used in catering. Energy use which does not vary with outside temperature changes comprises the base load energy consumption. Energy use for heating depends on the outdoor temperature. According to CIBSE TM41, 'Heating degree-days (HDD) are a measure of the amount of time when the outside temperature falls below the base temperature. They are the sum of the differences between outside and base temperature whenever the outside temperature falls below the base temperature.' The Department of Health's Estates and Facilities Division publishes degree-day data on a monthly basis for several different geographic areas of the country. Similarly to HDD, cooling degree-days (CDD) are calculated from temperatures above a base temperature; the equations to calculate them simply subtract the base from the outdoor temperature using similar principles as for the heating case.

For heating, hospital degree-days are based on a temperature of 18.5˚C; if the average outside temperature, taken over any particular month, was 18.5 degrees or higher, the degree-day figure for that month would be zero. At this outside temperature, no heating energy load would be needed. If the average temperature was, for example, 8.5 degrees and the month had 30 days, the degree-day figure would be:

(18.5 – 8.5) x 30 = 300 degree-days

Therefore, the higher the month's degree-day figure, the colder the month's average temperature.

It is possible to construct a simple straight-line graph from measured energy consumption plotted against published degree-day data. An example is shown in Figure 20. Each month's energy consumption is plotted against that month's degree-day figure.

Once the points are plotted on a graph of energy (vertical axis) against degree-days (horizontal axis), the best fit straight line is drawn through the 12 plotted points. The best straight line can be calculated using linear regression analysis – a simple tool available in, for example, Microsoft Excel® software. In the example above, the best-fit straight line is represented by the formula:

y = 3.3258x + 53.505

The R^2 number (in this example, 0.9682) is a measure of how well the plotted points correlate. R^2 (the correlation coefficient) ranges from 1, where all the points fall exactly on the straight line, to zero, where the points are scattered so randomly that there is no one best-fit straight line that can be implied or derived.

After the formula of the straight line is derived by linear regression analysis, this can now be used to predict annual energy consumption.

y is the predicted energy consumption in gigajoules for an annual degree-day value of x. The slope of the straight line (measured in kWh per degree-day) in this example is 3.3258 kWh/DD. The base load, in this example in kWh, is the point on the energy axis where the straight line passes through that axis. The derived slope and base load can be calculated from at least one complete year's data, or more accurately from at least two years' data. Once the base load and slope are calculated, these numbers can be fed into the formula using (readily available) 20-year-average degree-day figures. In this way the annual energy target can be predicted. An operator's performance against the 20-year average can then be used to calculate volume variances (up or down).

The main advantage of this method over simply using the total energy consumption averaged for two years as the target is that the annual energy target will change each year as new 20-year-average degree-day figures become available. Further information on this topic can be found in the Carbon Trust CTG075: Degree days for energy management, the CIBSE TM41: Degree days: Theory and application or from the Department of Health's Estates and Facilities Division.

A note on $kgCO_2$ and $kgCO_2e$

When referring to an organisation's carbon emissions we often use kilograms or tonnes of CO_2 and kilograms or tonnes of CO_2 equivalent (tCO_2e) per gross internal floor area. CO_2 is not the only greenhouse gas, therefore using the term CO_2e instead of CO_2, takes into account other greenhouse gases and their relative importance in terms of global warming potential. The Kyoto Protocol greenhouse gases are the following: Carbon dioxide (CO_2), Methane

(CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) and the term CO_2e includes all six of them.

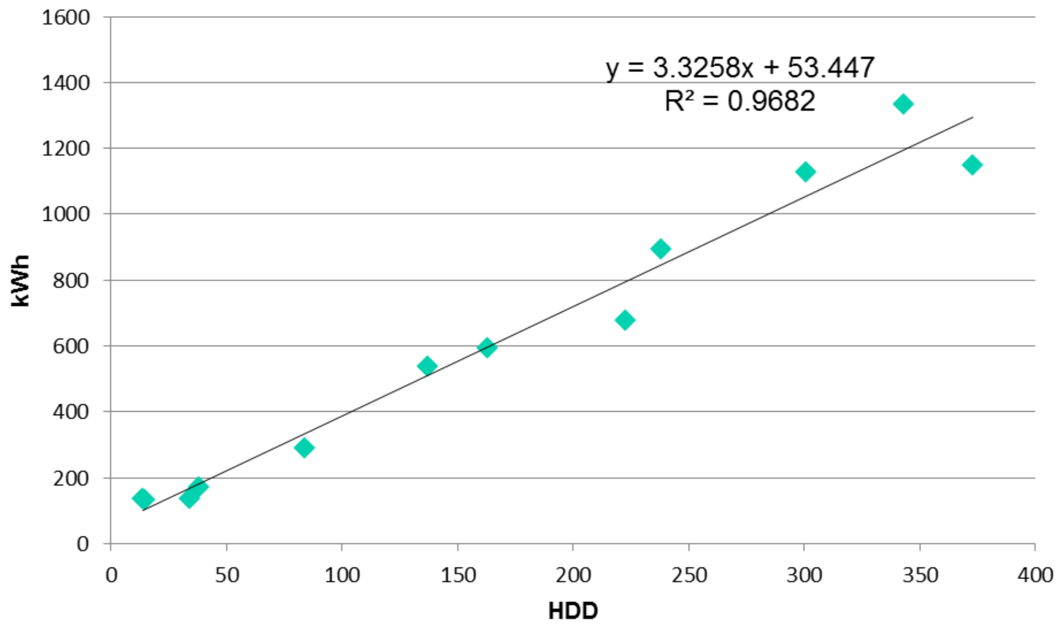


Figure 20 Energy consumption plotted against heating degree days.

Appendix 2: Benchmarks for energy performance and carbon emissions in healthcare buildings

Benchmarking according to CIBSE TM46

The categories related to healthcare buildings in CIBSE TM46 include smaller sub-categories of building types. Therefore the benchmarking compares a building's performance to a broad group of buildings. At the time when CIBSE TM46 was written, the intention was to retain these categories under review as statistical data from DECs is collected.

Table 8 presents the details and assumptions involving each one of the five categories of interest: clinic, hospital (clinical and research), laboratory or operating theatre, long term residential and general office. It should be noted that some of these categories also include buildings that are not related to the healthcare sector; for example detention centres are also included under the 'long term residential' category. Table 8 shows the allocation of building types to benchmarking categories.

Name	**Clinic**	**Hospital - clinical and research**	**Laboratory or operating theatre**	**Long term residential**	**General office**
Brief description	Health centres, clinics and surgeries	Clinical and research hospital	Laboratory or operating theatre	Long term residential accommodation	General office and commercial working areas
Space usage	Provision of primary healthcare	Mainly space for medical care with 24-hour accommodation for patients, with associated operating theatres, laboratories, offices and workshops	Special equipment and conditions in at least 30% of floor area	Full accommodation, including sleeping space, day time space, all domestic facilities, some office facilities	Mainly by employees, for sedentary desk based activities. Includes meeting and conference facilities.
Operational schedule	Usually week days and early evenings	Continuous for the majority of the facility	Either weekday or 24-hour multi-shift	Continuous	Weekdays and early evenings
Distinguishing features	Daytime use, essentially office hours, but needs to provide for high public use, generally by appointment	24-hour accommodation with stringent environmental conditions, ventilation control, quarantine, and high occupant servicing needs	Spaces requiring controlled ventilation and conditions	24-hour fully conditioned and serviced accommodation	Relative uniformity of occupancy, density, conditions, schedule and appliances

Name	Clinic	Hospital - clinical and research	Laboratory or operating theatre	Long term residential	General office
Services included	Heating, lighting, cooling, hot water services	All services	Heating lighting, ventilation	Heating, lighting, cooling, appliances, food and hot water services, entertainment, laundry	Heating, lighting, cooling, employee appliances, standard IT, basic tea room
May be part of mixed use with areas on the right		Laboratory or operating theatre, restaurant		Restaurant (dining hall)	Covered car park, staff restaurant
Summary of allowable special energy uses		Furnace or forming process	Furnace or forming process		Regional server room, trading floor
Representative buildings	Doctors surgeries, health clinics, veterinary surgeries, dentist	Acute hospital, specialist hospital, teaching hospital and maternity hospital	Research chemical laboratory, hospital operating theatre	Residential home, homeless unit, cottage hospital and long stay hospital, detention centres and prisons	General office benchmark category for all offices whether air conditioned or not, Town Halls, architects, various business services that do not include retail functions
Electricity typical benchmark (kWh/m^2)	70	90	160	65	95
Fossil-thermal typical benchmark (kWh/m^2)	200	420	160	420	120
Illustrative electricity typical benchmark (kgCO_2/m^2)	38.5	49.5	88	35.8	52.3
Illustrative fossil-thermal typical benchmark (kgCO_2/m^2)	38	79.8	30.4	79.8	22.8

Name	Clinic	Hospital - clinical and research	Laboratory or operating theatre	Long term residential	General office
Illustrative total typical benchmark ($kgCO_2/m^2$)	76.5	129.3	118.4	115.6	75.1
Separable energy uses		Furnace, heat treatment or forming process	Furnace, heat treatment or forming process		Regional server room, trading floor
Definition of annual occupancy hours in this sector	Number of hours when the premises are fully open to customers according to published hours		Number of hours when the recorded number of occupants exceeds 25% of the nominal maximum number		Number of hours when the recorded number of occupants exceeds 25% of the nominal maximum number
Reference hours per year	2,040	-	2,040 (see operational schedule)	-	2,040
Maximum allowed hours per year	4,284	-	8,568	-	8,760
Percentage increase in electricity benchmark at maximum allowed hours per year	45%	0%	105%	0%	107%
Percentage increase in fossil-thermal benchmark at maximum allowed hours per year	20%	0%	43%	0%	44%

Table 8 Characteristics of NHS related buildings, adapted from CIBSE TM46. It has been assumed that a kWh of electricity and a kWh of fossil-thermal are responsible for 0.55 $kgCO_2$ and 0.19 $kgCO_2$ respectively. For the heating degree days, the temperature base is 18.5˚C. Finally, the floor area is measured as gross internal area.

Clinic	Hospital (clinical and research)	Long term residential	Laboratory or operating theatre	General office
Clinic or health centre	General acute hospital	Community and mental health hospitals	Laboratory	Offices
Dentist's surgery	Teaching/Specialist Hospital	Detention		Offices - cellular, naturally ventilated
Doctor's surgery		Detention centre		Offices - mechanically ventilated and/or air conditioned
Health Centres and Clinics		Home		Offices - open plan, naturally ventilated
Medical and dental centre (combined)		Hospital		Public sector offices
Medical centre		Hostel		
Mortuary		Nursing home		
Occupational health centre		Nursing residential homes and hostels		
Outpatient treatment area		Prison		
Primary health care buildings		Remand centre		
Surgery or clinic		Young offenders institution		
Veterinary surgery				

Table 9 Allocation of building types to benchmark categories (adapted from CIBSE TM46).

DECs Review

This section describes the study conducted by the Energy Institute of UCL (An Analysis of Display Energy Certificates for Public Buildings) based on DECs for public buildings, produced between 2008 and 2012. The analysis involved significant numbers of buildings, including 728 buildings belonging in the ‘clinic’ category, 573 in ‘hospital – clinical and research’, 990 in ‘long term residential’ and 74 in ‘laboratory or operating theatre’. It also involved 1163 office buildings, in the sub-categories most relevant to this guidance, as described in Table 9. The years included in the study are 2009, 2010 and 2011 for which complete data was available.

Hospital buildings are the second in carbon emissions within the study, partly due to their large size, but also because they are very energy intensive, due to equipment, long occupancy hours and internal conditions requirements. Figure 21 presents the distribution of DEC grades per benchmark category analysed. Hospitals, clinics and long term residential buildings, have a large number of their sample in grade D, while laboratories have a significant percentage in G range, which is more than any other category, probably due to the energy intensive equipment.

It should be highlighted that this study is based on DECs for three consecutive years, for a sample of buildings equal to approximately 25% of the total number of buildings with DECs, therefore some bias is inevitable.

Healthcare buildings

Chapter 1 has described the differences in benchmarking between TM46 and the UCL Energy Institute benchmarking in terms of electricity and heating fuel for healthcare buildings. It has been mentioned that the comparison is conducted between the averages of the median values for the sub-categories belonging to the five types of healthcare buildings. The full details of the median values per sub-category of building are presented in Table 10.

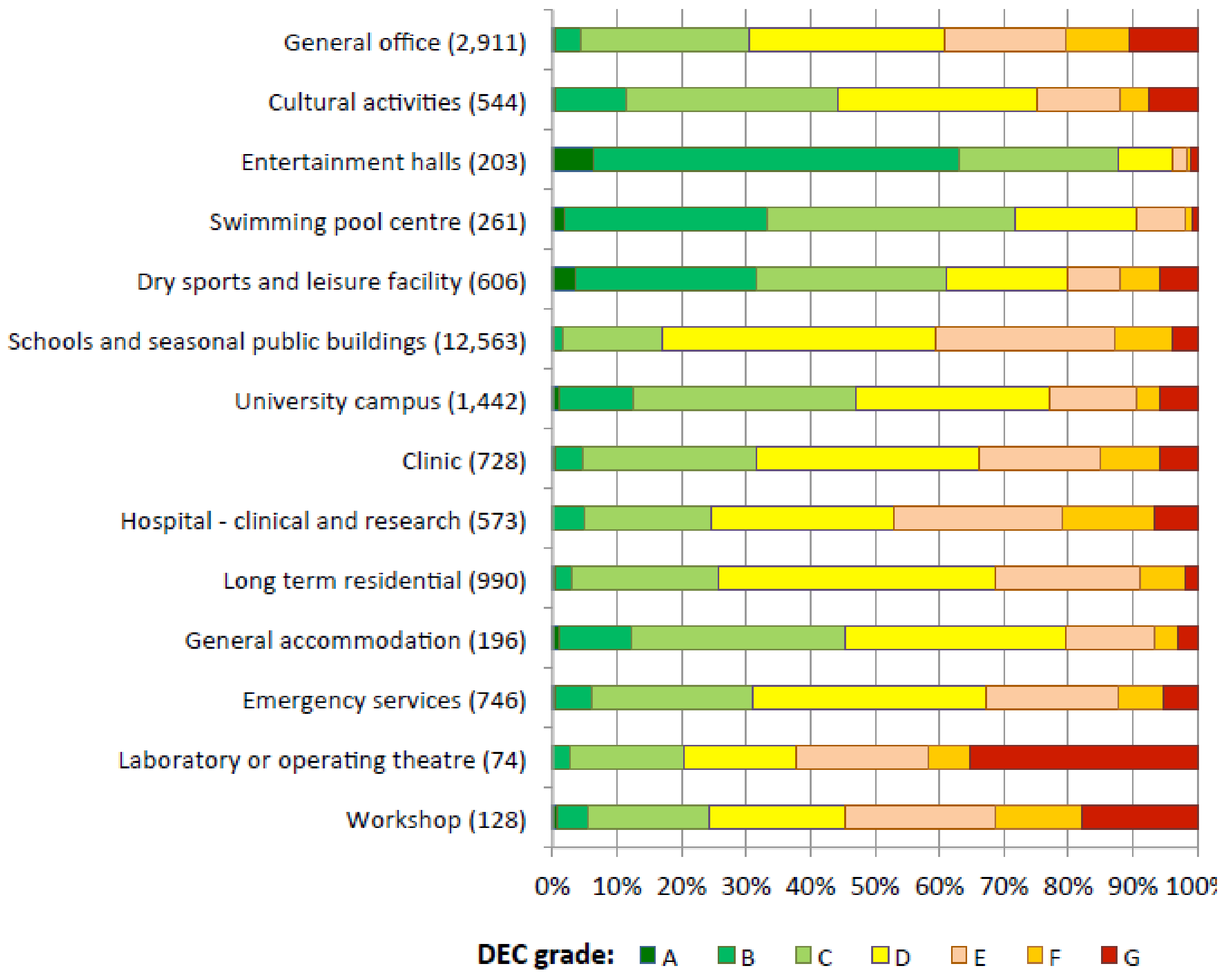


Figure 21 Distribution of DEC grades in each benchmark category. Source: An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

Benchmark category	Building type	Number	Electricity (kWh/m^2) Median	Heating (kWh/m^2) Median	DEC Rating Median	Floor Area Median
Clinic	Clinic or health centre	232	75	157	89	1,317
	Dentist's surgery	4	122	155	122	2,107
	Doctor's surgery	16	77	120	78	1,037
	Health Centres and Clinics	229	77	145	86	1,472
	Medical and dental centre combined	16	72	180	85	1,483
	Medical centre	28	63	117	65	2,080
	Occupational health centre	17	51	213	91	1,482
	Outpatient treatment establishments	48	66	169	90	1,711
	Primary health care buildings	131	82	174	95	1,565
	Surgery or clinic	7	68	156	88	684
Hospital – clinical and research	General Acute Hospital	423	118	311	97	5,038
	Teaching/Specialist Hospital	150	132	265	101	3,244
Laboratory or operating theatre	Laboratory	74	242	238	115	3,050
Long term residential	Community and Mental Health Hospitals	257	91	287	90	2,530
	Hospital	35	86	308	93	2,412
	Nursing home – Nursing residential homes and hostels	372	83	329	91	1,504
General office	Offices	274	86	123	91	1,830
	Offices - cellular, naturally ventilated	91	72	127	85	1,609
	Offices - mechanically ventilated and/or air conditioned	234	128	113	116	2,653
	Offices - open plan, naturally ventilated	111	84	103	88	1,669
	Public sector offices	453	80	100	83	2,374

Table 10 Energy and floor area statistics by building type category. The table is adapted by An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012 conducted by the Energy Institute of the University College London.

Clinic

The most diverse category of buildings in the healthcare sector is that of clinics, including from dentists' surgeries to primary healthcare buildings. The median values for electricity and energy use for heating vary considerably across the sub-categories of clinics. Figures 22 and 23 present this variation for electricity and heating respectively. Dentists' surgeries have considerably higher electricity consumption as shown in Figure 22, with occupational health centres being at the lower end of the range. Most median values are between 60 and 80 kWh/m^2, thus not that far from the 70 kWh/m^2 suggested as a benchmark by TM46 for the specific category of buildings. Heating seems to present higher variations (Figure 23), with occupational health centres being at the higher end of this range, with a median value of 213 kWh/m^2.

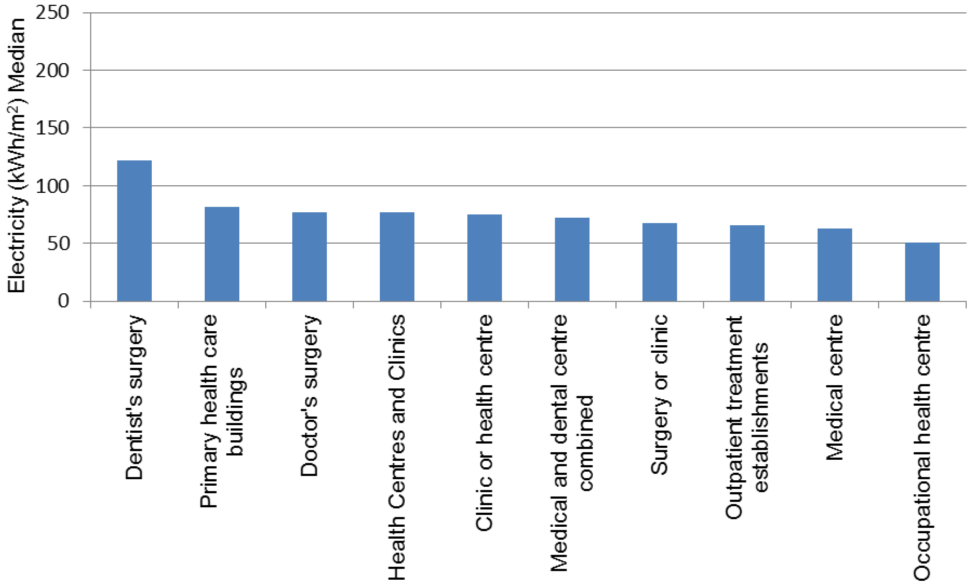


Figure 22 Electricity use per sub-category of clinic buildings. Data taken from An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

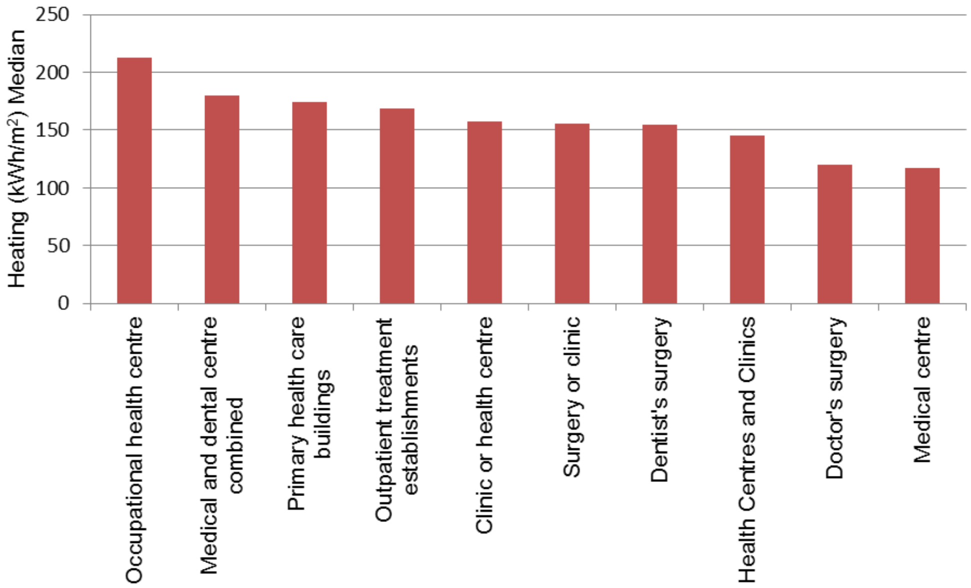


Figure 23 Heating use per sub-category of clinic buildings. Data taken from An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

Hospital – clinical and research

In the category of hospitals, including clinical and research, there are only two sub-categories of buildings, namely general acute hospitals and teaching/specialist hospitals.

The results of the UCL Energy Institute study (An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012) show small variation in terms of electricity use between these two types, based on samples of 423 and 150 buildings respectively. Nevertheless, general acute hospitals appear to consume 15% more energy on heating in kWh/m^2 of floor area.

Figures 24 and 25 present those differentiations.

The comparison between the DECs of the analysed sample between the years 2009 and 2011 in the category of hospitals (including clinical and research) provides some interesting insight. 3% more buildings achieved a grade B in 2011 compared to 2009, while none of them achieved grade A during these three years analysed. 53% of buildings performed better than the benchmarks buildings with grade G accounted for 6% of the buildings, with minor changes within those years. Finally, there was a 6% decrease of buildings with grade E, accompanied by an increase of those with grade F by 2%. Figure 26 presents the relevant details.

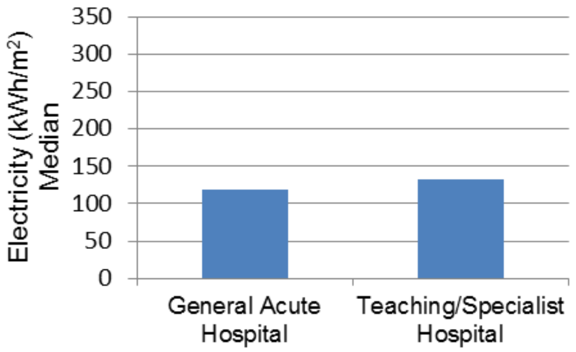


Figure 24 Electricity use per sub-category of hospital (clinical and research) buildings. Data from An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012.

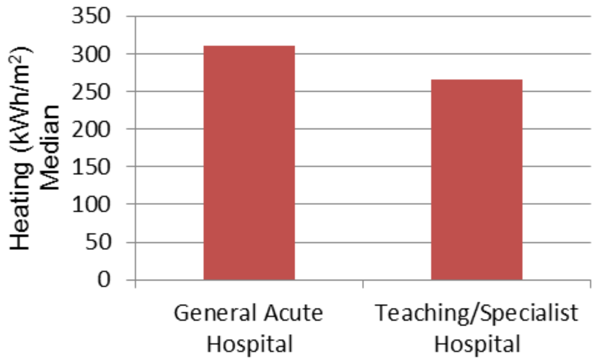


Figure 25 Heating use per sub-category of hospital (clinical and research) buildings. Data from An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012.

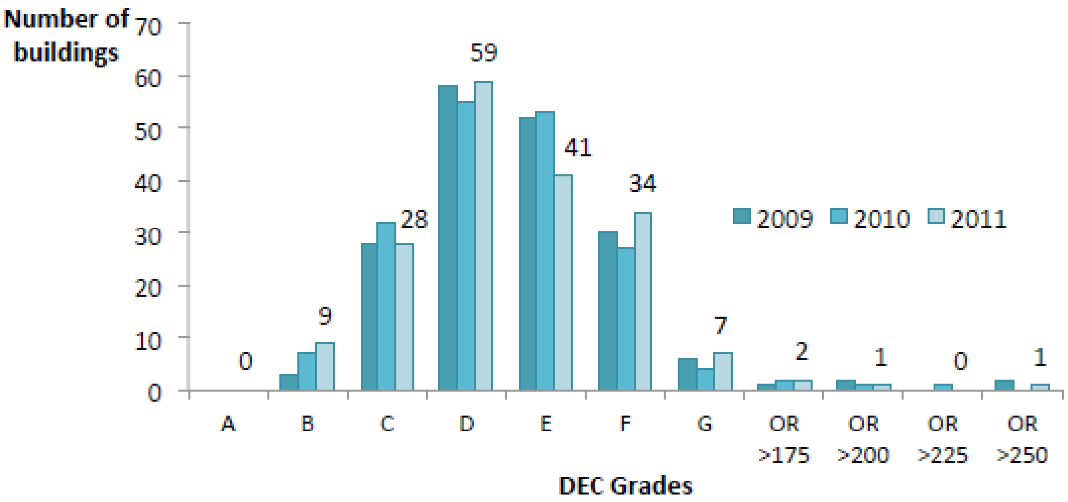


Figure 26 Changes in the distribution of DEC grades between 2009 and 2011 in hospital (clinical and research) buildings (the numbers on the bars refer to 2011, OR: operational rating). Source: An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

Long term residential buildings

In the category of long term residential buildings, there are three sub-categories, according to the UCL Energy Institute report (An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012): community and mental health hospitals, hospitals and nursing homes, combined with nursing residential homes and hostels. The last two categories were combined together due to the median values being almost identical. Figures 27 and 28 present the variations between those three categories of long term residential buildings. The UCL report has used more sub-categories, in accordance with TM46, but this Appendix only refers to the ones relevant to the healthcare sector. It appears that both, electricity and heating use present very small variations among the three distinct categories of buildings. Electricity is higher for community and mental health hospitals, while this sub-category has lower heating energy use. The opposite happens with nursing homes, nursing residential homes and hostels. The sub-category of hospitals is in between the other two sub-categories, in both types of energy use.

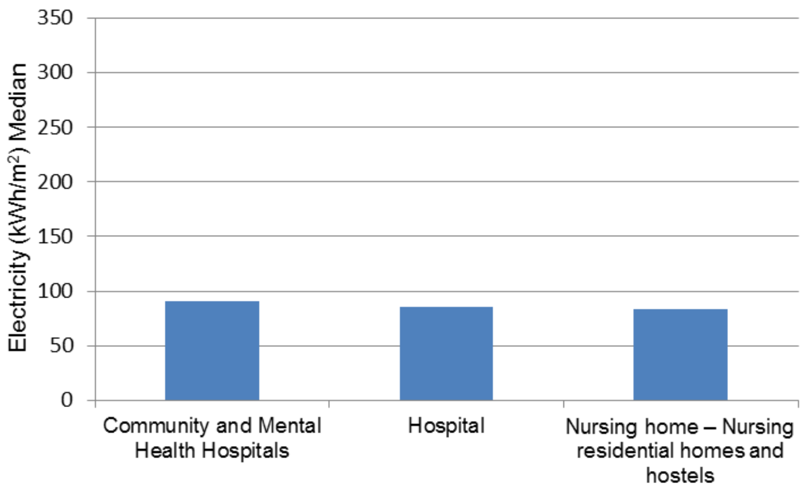


Figure 27 Electricity use per sub-category of long term residential buildings. Data from An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

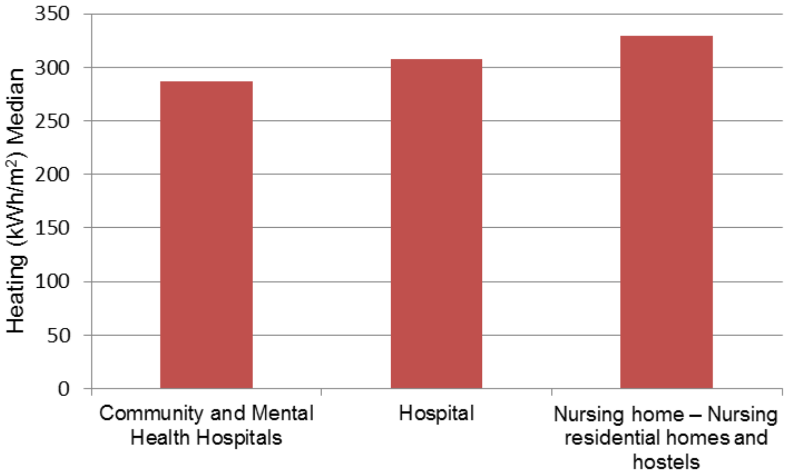


Figure 28 Heating use per sub-category of long term residential buildings. Data from An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

The UCL energy institute report provides specific information on the DEC grades for long term residential buildings and the relevant changes between 2009 and 2011. It is observed that no buildings achieved grade A during those years, while 3% of the buildings in this category had a grade B in their DEC. Around 20% of this type of buildings had grade C by 2011, with an increase of 39%. Finally, more than 66% of the buildings performed better than the benchmarks and 42% were in grade D in 2011. Figure 29 presents the relevant details.

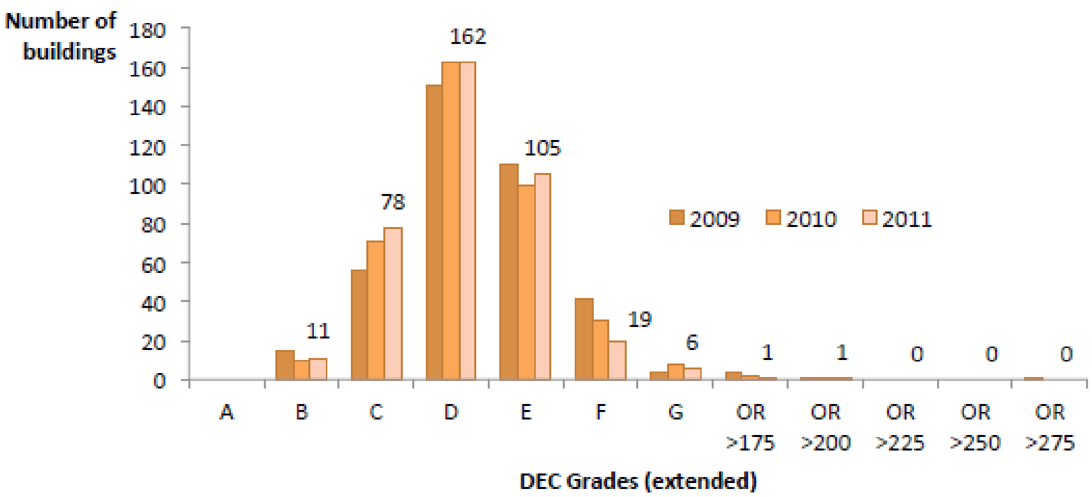


Figure 29 Changes in the distribution of DEC grades between 2009 and 2011 in long term residential buildings (the numbers on the bars refer to 2011, OR: operational rating). Source: An Analysis of Display Energy Certificates for Public Buildings, 2008 to 2012

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Appendix 3: EU Emissions Trading Scheme requirements

How will I know whether I will be part of the scheme?

Phases I and II set the basis for the ETS, making it mandatory for all stationary installations with combustion capacities exceeding 20MW thermal rated input to participate in the scheme. The EU ETS scheme rules also specify that where one operator carries out several activities falling under the same sub-heading, in the same installation or on the same site, the capacities of such activities should be added together. Special conditions may apply if there is contract energy management on the site. Any healthcare organisation that is in the process of a major extension or PFI (Private Finance Initiative) should ensure that the proposed carbon emissions for the development are known. If the development is likely to increase the site-wide carbon emissions to a level above the threshold of 20 MW, registration should be considered in advance of the development being completed.

Nevertheless, from the beginning of Phase III, DECC has introduced a provision for small emitters and hospitals in accordance with the EU legislation on ETS, allowing them to opt-out from the ETS (EU ETS Small Emitter and Hospital Phase III Opt-out). The aim is to reduce their administrative costs, through simplified monitoring and verification processes and simpler rules for target adjustments in case of increasing installation capacity. However, those emitters eligible for opting out will still have to deliver an equivalent carbon reduction.

How does the EU ETS work?

All installations must hold a greenhouse gas emissions permit or risk incurring financial penalties. Although the scheme may be expanded in the future to accommodate other greenhouse gases, at least for the initial phase it only covers carbon dioxide.

The allowance allocations for each installation for any given period (the number of tradable allowances each installation will receive) will be set down in a document called the National Allocation Plan. The overall allowances for the period will then be broken down into annual amounts.

Installations that reduce their annual emissions to below their allocation of allowances can trade their surplus allowances on the market or bank them (storing them for use in future years). Installations that need additional allowances to cover their annual emissions will be able to buy them from the market.

What do I need to do next?

The EU ETS scheme rules make it clear that the responsibility lies with the operator of the installation to apply to the competent authority for a permit. If any installation covered by the EU Scheme operates without a permit, it will be liable to financial penalties. Due to the ‘Small Emitter and Hospital Phase III Opt-out’, hospitals had the opportunity to apply for an exclusion in 2012. If a hospital applied and excluded installation emissions permit was granted or converted on 1st January 2013, then it is no longer obliged to participate in the ETS scheme, although it still has obligations regarding its carbon emissions. No new excluded installations will be considered during the remainder of Phase III.

Further information is available by the respective ETS regulators: The Environment Agency, Northern Ireland Environment Agency (NIEA), The Scottish

Environment Protection Agency (SEPA) and Natural Resources Wales (NWA).

Further details on the scheme, are contained in the following documents:
The UK's Small Emitter and Hospital Opt-out Scheme
EU Emissions Trading Scheme by the Carbon Trust
EU Emissions Trading Scheme: Guidance Note 1
European Union Emissions Trading System Phase III: Guidance for installations – How to comply with the EU ETS and Small Emitter and Hospital Opt-out Scheme

Can I re-enter the EU ETS?

Once an organisation has opted-out of the EU ETS, they cannot re-enter the EU ETS during 2013-2020. However, under certain circumstances, the excluded installations might be required to re-enter the EU ETS. This happens in the following cases:

- A small emitter installation no longer meets the definition of a small emitter as annual emissions have risen to exceed 25,000 tCO_2;
- An installation has ceased to primarily provide services to a hospital and therefore no longer meets the definition of a hospital installation;
- The operator fails to pay the excess emission penalty by the date specified in the penalty notice;
- The operator of the installation commits a sufficiently serious breach of the excluded installations emissions permit.

Appendix 4: CRC Energy Efficiency Scheme

How will I know if I need to register?

According to the Environment Agency, an organisation qualifies for CRC Phase 2 if, between 1st April 2012 and 31st March 2013, it met both of the following criteria:

- having at least one settled half hourly electricity meter;
- using 6,000 MWh or more of qualifying electricity supplied through settled half hourly meters.

How does the CRC Energy Efficiency Scheme work?

In each compliance year, an organisation that has registered for CRC needs to collate information and submit a report regarding its energy supplies, as well as to buy and surrender allowances equal to the CO_2 emissions it generated. Energy already covered under climate change agreements and the ETS is not included in CRC. Trading allowances is also possible. This refers to buying from or selling to another account holder in the CRC Registry.

What do I need to do next?

Organisations qualifying for the CRC must register using the CRC Registry. The following requirement is the monitoring and reporting of their energy use annually. Based on this information on emissions factors for gas and electricity, carbon emissions are calculated for each organisation. Organisations then have to purchase and surrender allowances to offset these emissions.

Organisations need to report the total amount of CRC gas and electricity supplies. The supply data can be actual or estimated, but this has to be clarified and there is a 10% added on top of the supply data if the figure is an estimate. For each compliance year, you need to order, pay for, and surrender allowances for your annual carbon emissions. Participants have the option to buy allowances at the start of the compliance year for a lower 'forecast' price or for a higher 'compliance' price after the end of the compliance year. The first annual reports for phase 2 of CRC need to be submitted by 31st July 2015.

The diagram in Figure 30 presents the steps an organisation needs to undertake if it qualifies for CRC.

Information on CRC

Further information is available by the following sources
Reducing demand for energy from industry, businesses and the public sector
CRC Energy Efficiency Scheme: qualification and registration
CRC Energy Efficiency Scheme: Allowances
CRC Energy Efficiency Scheme: Annual reporting
and the respective regulators:
The Environment Agency
Northern Ireland Environment Agency (NIEA)
The Scottish Environment Protection Agency (SEPA)
Natural Resources Wales (NRA).

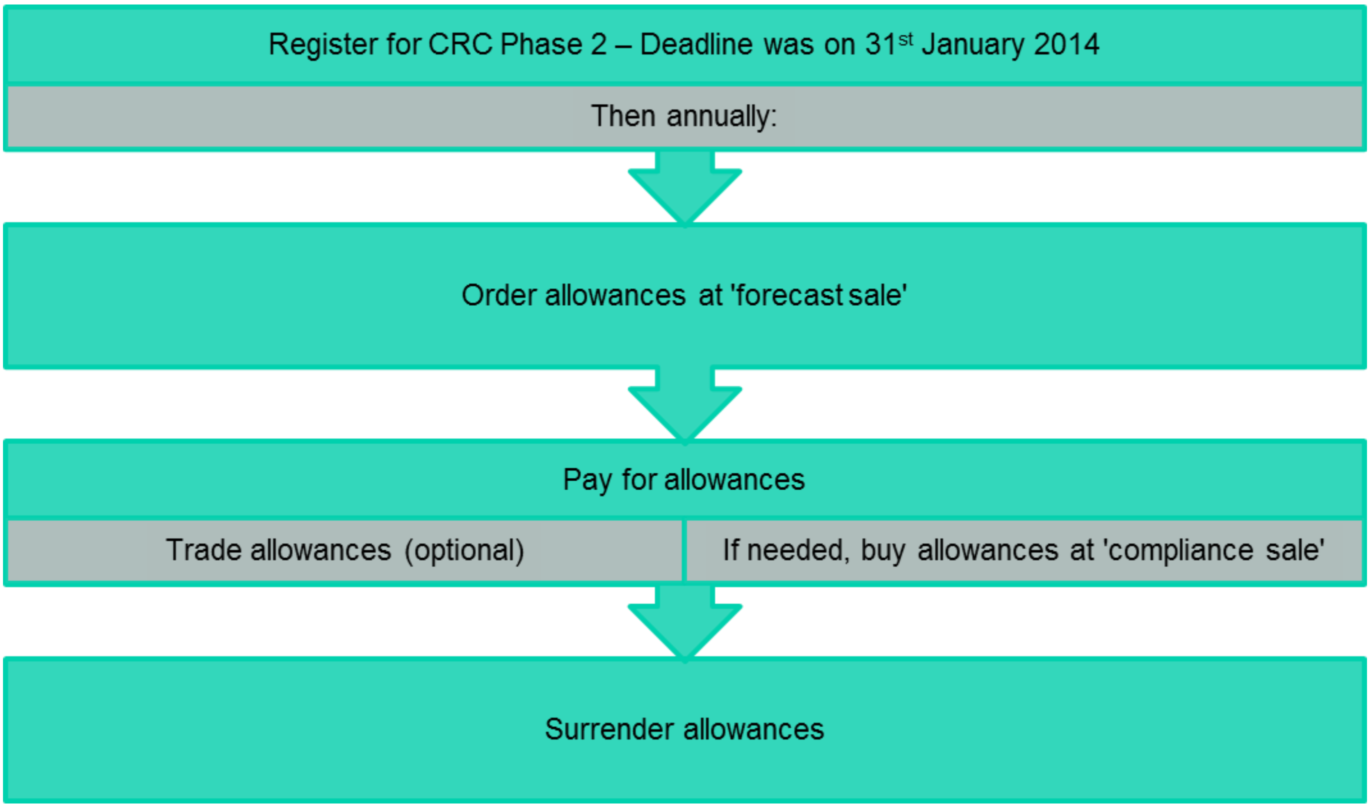


Figure 30 Diagram presenting actions to be taken by organisations included in CRC

Appendix 5: Climate Change Levy

The CCL applies to industrial, commercial, agricultural and public services sectors, obliged to pay the main rates of CCL.

The CCL is made up of two rates:

- main rates;
- carbon price support rates (CPS).

The main rate of the CCL is paid on electricity, gas and solid fuels, such as coal, lignite, coke and petroleum coke. The CCL main rates are listed in your energy bills.

The CPS rates of CCL encourage the use of low carbon technologies for electricity production. For example, the owners of electricity generating stations and the operators of CHP stations pay the CPS rates of CCL.

There are exceptions for electricity, gas and solid fuels, when electricity is produced by renewable sources, or if they are supplied by CHP schemes registered under the CHP quality assurance (CHPQA) programme. More exceptions apply.

Information on the CCL can be found on the UK Government's website, in Climate Change Levy: application, rates and exemptions.

Appendix 6: Standard stationery

This appendix provides a list of questions to answer regarding the building's condition, as well as examples for a set of standard stationery forms that can be used in a site energy audit.

ENERGY MANAGEMENT
Phase 2 Energy Saving
Schedule of Hospital Site Buildings

Form 1A

Hospital: ………

Type: …………………………………… No. Beds: ……………………… Exposure (1): ………………………………

Notes

(1) i.e. Sheltered, Normal and Severe (ref CIBSE Guide).

(2) The heated volume should exclude all unheated spaces, e.g. roof spaces, basements, subways, plantrooms etc.

(3) The gross volume should be the total internal floor area within the perimeter of external walls to the height of each storey from the floor surface to the underside of structural floor or roof, including roof spaces, plantrooms and subways etc.

(4) Indicate approximate age of building.

(5) Identify basic form of construction, e.g. Traditional brick/pitched tile roof, System built/flat roof, Prefab asbestos/pitched roof etc.

Bldg Group Ref	Title and function	Volume m^3		No. of floors	Age Years (4)	Type of construction (5)
		Heated (2)	Gross (3)			
Totals				Continued over →		

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**							Form 1B
Bldg Group Ref	Title and function	Volume m^3		No. of floors	Age Years (4)	Type of construction (5)	
		Heated (2)	Gross (3)				

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**			Form 2A
Hospital: …… Building (Form 1A) Ref: ……………………………………………………… Title/function: ………………………………			
Occupation requirements		**Notes**	
Type of occupancy		Note 1	
Period of occupancy			
Continuous	Yes/No		
If No: Number of days/week			
From (time):			
To (time):			
Total hours/day			
Building parameters			
Heated volume m^3		Note 2	
Gross volume m^3		Note 3	
Floor/roof area m^2			
Number of floors		Note 4	
Floor to ceiling height m			
External wall area m^2			

Construction details		**Notes**
Walls Type		
Thickness		
Materials		
Cavity size		
Insulation		
Glazing Single/Double		
% Glaze/wall area		
Roof type	Flat/pitched	
Plan area m^2		
Materials/thickness		
Other information		
Floor type	Solid/ventilated	
Materials/thickness		
Other information		

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**	Form 2B
Form of heating (5)	Note 5
Circulation mains (6)	Note 6
Heating plant: Type	
Age	
Heating controls (7): Building	Note 7
Age	
Plant	
Age	

Notes

(1) Where there is mixed occupancy to a significant extent, identify as such with the forms of occupancy, e.g. Mixed occupancy: Admin (2000 m^3 approximately), Dining rooms (600 m^3) etc. For large buildings of 'continuous' construction containing a number of departments, complete a separate sheet for each department and/or each discrete part of the building, e.g. male and female wings
(2) Heated volume as Form 1
(3) Gross volume as Form 1
(4) To include any heated basement but exclude plantrooms and service ducts or voids.
(5) Identify type(s) of heating surface and forms of circulation, e.g. single or two-pipe.
(6) For buildings with mixed occupancy and departments or areas with intermittent occupation, do/could circulation mains serve these separately from adjacent areas?
(7) Identify type and age (if necessary age range) of heating system controls on heating, plant and in the building(s).

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**	Form 3A
Hospital: ……	
Building (Form 1A) Ref: ………………………………………………………. Title/function: ……………………………	

Diagrammatic sketch of heating system and controls

Identify with a simple single line diagrammatic sketch, heating system layout, indicating position and type of existing controls, time switches and sensors. Indicate control manufacturer.

ENERGY MANAGEMENT

Phase 2 Energy Saving

Schedule of Hospital Site Buildings

Form 3B

Hospital: ………

Building (Form 1A) Ref: ………………………………………………………… Title/function: ………………………………

Describe items of energy consuming equipment.

For each item, identify the consumption rating and any practical energy saving modifications.

Item	Energy consumed kWh	Notes

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**			Form 4A
Hospital: ……			
	Yes	No	Don't know
Background Information			
Has a walk around audit been carried out in accordance with the approved method?			
Is there an advisory report?			
Is the building listed or of special architectural or historic interest?			
Has any proportion of the site energy consumption been discounted for special energy uses?			
Conventional Heating Boilers			
Ventilation			
Lighting and Lighting Controls			
Hot water			
Small Power			
Lifts and Escalators			
Swimming Pool			
Commercial Catering Facilities			
Steam Boiler Systems			
Other Services			
HVAC Controls			
Have the HVAC control settings been checked by suitably qualified persons to match current occupancy levels?			
Have the HVAC time and temperature settings been checked by suitably qualified persons in the past 12 months?			
Are the HVAC controls (including Building Energy Management Systems) operated by suitably qualified staff?			

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**			Form 4B
Hospital: ………			
	Yes	No	Don't know
Conventional Heating Boilers			
Has a boiler plant energy performance been carried out in the past 12 months?			
Is there a system in place that ensures regular (annual) expert checks are made on the heating system for operating efficiency?			
Is the heating plant in good condition, i.e. free from any leaking, fouling, corrosion and is it suitably maintained?			
Is the seasonal efficiency of the boiler plant less than 65%?			
Is the heating system more than 15 years old?			
Ventilation			
Are any obstructions or partitions preventing free cross flow of air?			
Are there areas of the building where stratification can occur, for example atria and high ceilings?			
Is the building adequately cooled?			
Mixed mode – Are the mixed mode changeover controls appropriately set and are adjustments delegated to a suitably qualified person?			
Do the building occupiers understand the various modes of ventilation and cooling operation?			
Have the mechanical ventilation systems been assessed against current needs?			
Is the building humidity controlled?			
Is there a servicing and maintenance plan in place that addresses ventilation energy efficiency?			
Do the mechanical ventilation systems have variable volume controls?			
Cooling			
Is there a servicing and maintenance plan in place that addresses air conditioning energy efficiency?			
Are the air conditioning systems in good condition, i.e. free from any leaking, fouling, corrosion, blockages and suitably insulated?			
Are the air conditioning systems more than 10 years old?			
Are the air conditioning systems' heat rejection equipment (condensers) clean and positioned in an unobstructed surroundings away from other heat sources?			

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**			Form 4C
Hospital: ……			
	Yes	No	Don't know
Lighting & Lighting Controls			
Is lighting maintenance, cleaning and lamp replacement planned and carried out regularly?			
Are windows and skylights cleaned regularly and kept free of obstruction to maximise us of natural lighting?			
Has the building lighting strategy been reviewed by experts which shows it matches current needs using minimum energy?			
Lifts and Escalators			
Are lift and escalator systems fitted with energy meters?			
Have lift and escalator systems been reviewed by experts for match with current occupiers' needs?			
Are stairs open and an attractive alternative to lifts and stairs?			
Notes			

ENERGY MANAGEMENT
Phase 2 Energy Saving
Schedule of Hospital Site Buildings

Form 5A

Hospital: ……

Building (Form 1A) Ref: …………………………………………………….. Title/function: ………………………………

1. Heat loss on existing building structure

Element	Heat loss A kWh/year/m^2 (m^3)	Intermittent heating factor B	Area/volume C m^2 (m^3)	Heat loss D = A x B x C kWh/year	Notes
Wall					
Roof					
Floor					
Ventilation					
			Totals		
Degree day correction =					

2. Heat saving through modified building structure

Element	Structural change	Heat loss factor kWh/year/m^2 (m^3)	Intermittent heating factor	Area/volume m^2 (m^3)	New heat loss kWh/year	Heat saving kWh/year	Cost per kWh (£)	Annual cost saving (£)
Wall								
Roof								
Floor								
Ventilation								
				Totals				
Degree day correction =								

3. Heat saving through modification to control system

Description of modification	% improvement	Existing heat loss kWh/year	Heat saving kWh/year	Cost per kWh (£)	Annual cost saving (£)

Degree day correction = $\frac{\text{Heat Loss x 20 year District Av. DD}}{\text{Base DD 20 year National Average}}$

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**				Form 5B
Item or modification	Energy consumption prior to change kWh/year	Energy/carbon saving due to change kWh/year (tCO_2/year)	Cost per kWh or tCO_2 (£)	Annual cost saving (£)

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**	Form 6A
Hospital: ………	
Boilers	
Type	
Rating	
Age	
Condition	
Feed pumps	
Fuel storage and handling	
Log sheet records	
Blowdown	
Water treatment	
Other equipment	

Instrumentation and metering

Location and parameter	Manufacturer	Reading

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**	Form 6B

Summary of performance	
Measured commissioned efficiency	
Assessed annual efficiency	
Potential annual efficiency	
Annual consumption	
Potential saving	

Summary of boiler house energy saving measures

Energy/carbon saving measure	Saving kWh/year (tCO_2/year)	Cost per useful kWh or tCO_2 (£)	Annual cost saving (£)

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**	Form 7A

Hospital: ……

Introductory notes

1. Building heating requirements (details from Form 4A series)

Bldg ref	Title/function		Energy/carbon requirement kWh/year (tCO_2/year)	Bldg ref	Title/function		Energy/carbon requirement kWh/year (tCO_2/year)

2. Other energy requirements

Use	Consumption norm kWh/ m^2	Heated volume m^3	Energy/carbon requirement kWh/year (tCO_2/year)	Form of energy and its % (steam, HPHW, gas, electricity)
DHWS				
Cooking/Incin.				
Light &power				

3. Boiler efficiencies and site utilisation

Efficiency	%	Source of assessment and comments
Assessed annual operation		
Assessed potential operation		
Assessed utilisation		

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**	Form 7B

Introductory notes

Energy source	Indirect energy assessment kWh/year A	Potential annual efficiency B	Potential utilisation efficiency C	Indirect energy assessment total D = A/BC	Direct energy total kWh/year E	Site total energy assessment kWh/year F = D + E	Site actual energy consumption kWh/year G
Oil (Sec/CV)							
Oil (Sec/CV)							
Coal (Sec/CV)							
Gas (CV)							
Electricity							

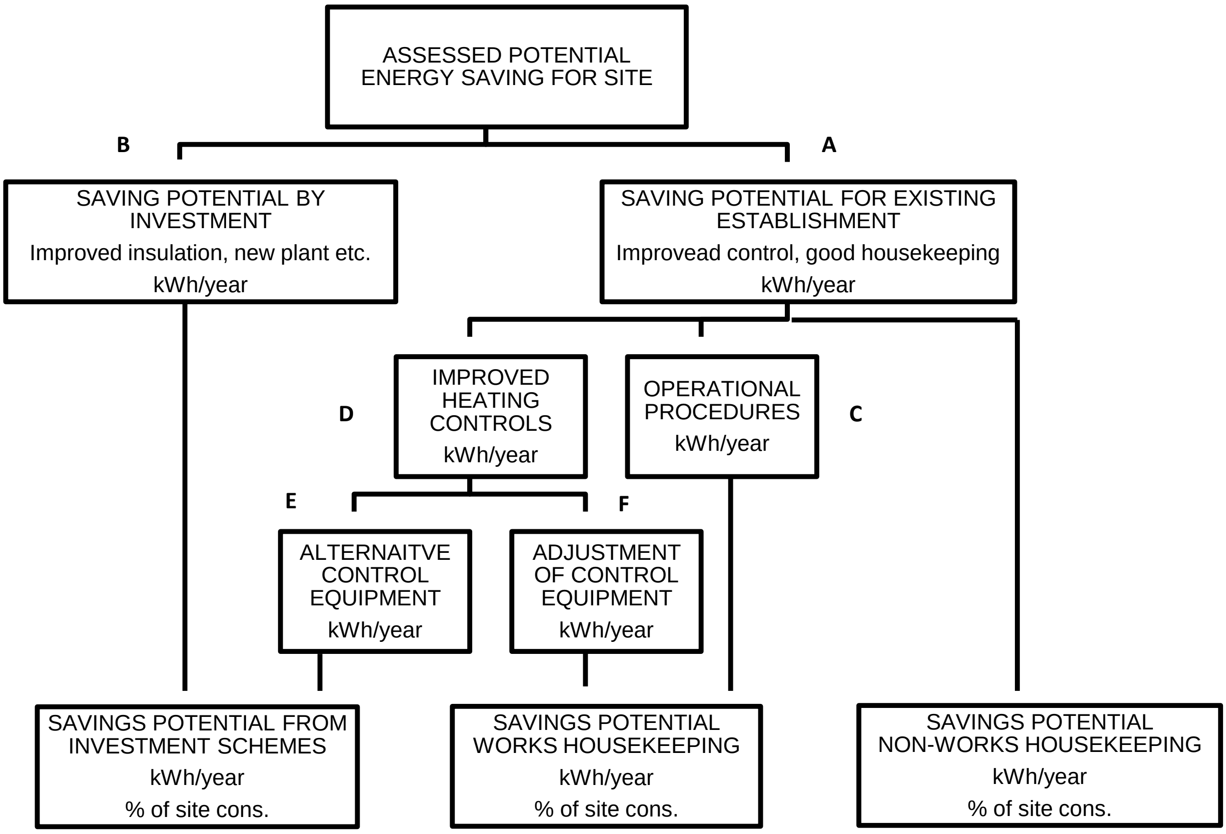
Resulting characteristic norms for the site:			
Space heating (kWh/D.day)	Assessment total		
Base load (kWh/month)	Assessment margin		
(This includes mains loss of kWh/month)	Sub-total		
	Potential saving = G – F		
	Balance		

ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**	Form 8A

Hospital: ……

A Energy/carbon saving potential (balance sheet 7B)
B Investment schemes excluding heating controls (sheets 5B and 6B)
C on-investment schemes with Works responsibility (sheets 5B and 6B)
D improved space heating controls; **E** by investment; **F** by improved housekeeping (sheet 5A)

Note: All savings in the following diagram are expressed in kWh/year. However, carbon emissions (tCO_2) year or carbon emissions equivalent (tCO_2e) can also be used and provide information on cost savings related to carbon tax as explained in Chapter 1.



ENERGY MANAGEMENT Phase 2 Energy Saving **Schedule of Hospital Site Buildings**					Form 8B
Building group ref	Description of proposal	Capital cost (£)	Saving kWh/year (tCO_2/year)	Saving £	Payback (years)

Abbreviations

AC	Air conditioning
ASPECT	A Staff and Patient Environment Calibration Tool
BIOPICC	Built Infrastructure for Older People in Conditions of Climate Change
BREEAM	Building Research Establishment Environmental Assessment Methodology
CCL	Climate Change Levy
CDD	Cooling degree-days
CHP	Combined heat and power
CHPQA	CHP quality assurance
CIBSE	Chartered Institution of Building Services Engineers
CPS	Carbon price support
CRC	Carbon Reduction Commitment
DEC	Display Energy Certificate
DCLG	Department for Communities and Local Governments
DeDeRHECC	Design and Delivery of Robust Hospital Environments in a Changing Climate
DH	Department of Health
EEF	Energy Efficiency Fund
EIS	Energy Information System
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EPSRC	Engineering and Physical Sciences Research Council
ETS	Emissions Trading Scheme
ERIC	Estates Return Information Collection
EUI	Energy Use Index
FITs	Feed-in Tariffs
GIA	Gross internal area
HDD	Heating degree-days
HTMs	Health Technical Memoranda
IPCC	Intergovernmental Panel on Climate Change
LEED	Leadership in Energy and Environmental Design
M&T	Monitoring & targeting
OBC	Outline Business Case
OR	Operational rating
PCTs	Primary Care Trusts
PMV	Predicted mean vote
PPD	Predicted percentage of dissatisfied
RHI	Renewable Heat Incentive
RO	Renewables Obligation

SBEM	Simplified Building Energy Model
SDU	Sustainable Development Unit
UCL	University College London
VDU	Visual Display Unit

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