SHINE

THE LEARNING NETWORK FOR SUSTAINABLE HEALTHCARE BUILDINGS

Sustainability Budgeting

A guide to using whole life costing in sustainable procurement

London, 2009

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Sustainability budgeting. A guide to using whole life costing in sustainable procurement

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SHINE learning network

Shine is a learning network for sustainable healthcare buildings. It has been developed as a partnership programme between leading healthcare, sustainability and built environment organisations, and is supported by the Department for Health Estates & Facilities, Community Health Partnerships and the Sustainable Development Commission, as well as several charities and other organisations.

SHINE helps NHS Trusts and PCTs to improve the sustainability of their buildings by providing a learning network that offers guidance, case studies, events and training. The network covers all aspects of sustainable building projects and how they can be delivered through NHS procurement processes.

CIRIA

CIRIA presents a way by which the many different stakeholders in the modern built environment can work together to identify, codify, publish and promote the emerging best practice in the industry. In this way, CIRIA continually seeks to raise the standard of excellence in the broad construction sector beyond the lowest admissible acceptability for designers and constructors set by the framework of legislation, statutory regulations and codes of practice.

Forum for the Future

Forum for the Future is the UK's leading sustainable development charity and aims to show that a sustainable future is both possible and desirable. The charity works with forward looking organisations in business and the public sector to find practical ways to build a future that is environmentally viable, socially just and economically prosperous.

The Sustainable Development Foundation

The Sustainable Development Foundation works to create a healthy, environmentally sound and productive built environment, which will support sustainable lifestyles and communities by challenging clients and investors to deliver a radical step-change in their sustainability performance.

ciria forum for the future Sustainable Development Foundation

Purpose of this document

This document aims to explore how whole life costing can be used in procuring construction projects and the effect that early decision making can have on both sustainability and the whole life costs of the project. The document is intended to be complementary to the Health Technical Memorandum HTM 07-07 *Sustainable health and social care buildings: planning, design, construction and refurbishment* (Department of Health, 2009).

This guide provides practical guidance for individuals in the NHS who are involved in procuring and managing construction projects.

Acknowledgements

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Project sponsors

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Review panel

In addition to the technical working group, the following experts were consulted in producing this guide: Andrew Green (Faithful+Gould, lead author of SMLCC), Roger Pulham (head of healthcare, Faithful+Gould), Lorraine Holme and colleagues (DH Estates & Facilities).

Notes

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Glossary

Life cycle cost (LCC)	Cost of an asset or its parts throughout its life cycle, while fulfilling the performance requirements (BS ISO 15686-5:2008)
Life cycle costing	Methodology for the systematic economic evaluation of life cycle costs over a period of analysis, as defined in the agreed scope (BS ISO 15686-5:2008)
Whole life cost (WLC)	All significant and relevant initial and future costs and benefits of an asset, throughout its life cycle, while fulfilling the service requirements (BS ISO 15686-5:2008)
Real cost	Cost expressed as a value as at the base date, including estimated changes in price due to forecast changes in efficiency and technology, but excluding general price inflation or deflation (BS ISO 15686-5:2008)
Net present value (NPV)	The sum of the discounted future cash flows (based on BS ISO 15686-5:2008)
Period of analysis	Period of time over which LCCs or WLCs are analysed (BCIS, 2008)
Sustainable procurement	Process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis (National Sustainable Procurement Task Force)
Sustainability budgeting	Budgeting that takes account of the whole life objectives and purpose of the project in accordance with the guidance in OGC (2007b)
Value for money	The optimum combination of whole-of-life costs and quality (or fitness for purpose) of the good or service to meet the user's requirement (HM Treasury, 2006)

1 Overview of sustainability budgeting

1.1 Introduction

This chapter summarises work already done in the health sector, and covers the following topics:

- why is sustainability budgeting important in healthcare?
- what is sustainability budgeting?
- what are the key issues for sustainability budgeting?
- what are the big opportunities for improving value?
- what are the barriers, and how can they be overcome?

Sustainability is treated throughout as “triple bottom line” sustainability, ie the optimum balance between the three pillars of social, economic and environmental sustainability. This guide is largely focused on the environmental aspects of the triple bottom line, with a particular emphasis on carbon in the worked example, but it does not cover all aspects of sustainability due to space and time constraints.

The guidance on whole life costing throughout is in accordance with the recently published BS ISO 15686-5:2008 and the associated Standardized method for the UK (BCIS, 2008), which have been developed to resolve some of the barriers to adopting whole life costs as the basis for budgeting.

1.2 Why is sustainability budgeting important in healthcare?

The NHS is one of the largest employers in Europe (employing 1.1m people), so has a huge effect on sustainability. In 2006 the health care sector had an annual energy bill of £400m and emissions of 3.3MtCO_2/yr (Carbon Trust, 2007)

The health estate represents about four per cent of the total government estate by area (HM Treasury, 2006), but there is a disproportionate effect because:

1. Health facilities have high energy use and operational costs.
2. There is a significant ongoing construction programme.

The NHS plan led to a construction programme worth about £5.5bn (capital costs only) in 2007 to 2008 alone (Department of Health, 2007b). It envisaged:

- 7000 extra beds in hospitals and intermediate care
- over 100 new hospitals by 2010 and 500 new one-stop primary care centres
- modernisation of 3000 GP premises
- major hospitals – 111 schemes worth £8.5bn by end of 2010 with another £7bn in the pipeline
- ProCure 21 – about £2bn
- LIFT – about £1.1bn on 200 facilities.

The Department of Health (DH) policy also encourages NHS Trusts and primary care trusts (PCTs) to deliver more sustainable buildings that have significantly lower CO_2 emissions, particularly through:

- energy targets[1]
- financial incentives for low carbon buildings[2]
- the independently audited BREEAM Standard with an expectation that all new builds will achieve BREEAM Excellent and refurbishments BREEAM Very Good
- policy guidance such as HTM 07-07 Sustainable health and social care buildings (Department of Health, 2009).

It is essential to understand how and where to invest money to gain the maximum sustainability improvement and CO_2 reductions. The NHS can also expect to live with and own these facilities for at least another 60 years, so it's important to look at the longer term cost implications over the whole life of the project. All of this takes place in the context of efficiency reviews and targets for value improvement.

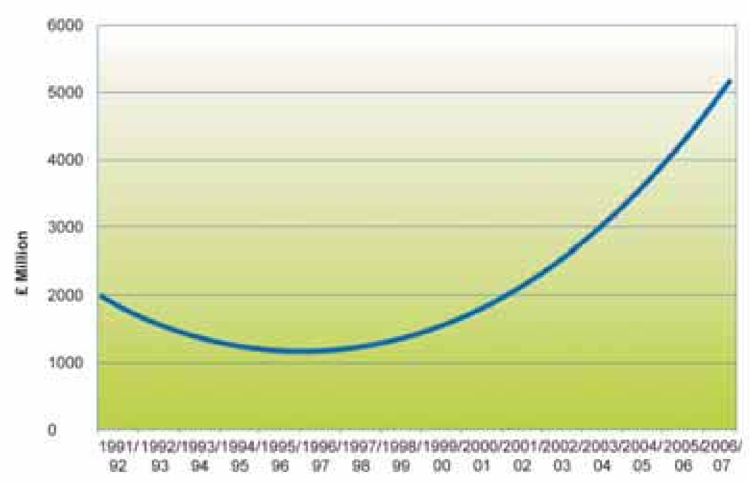
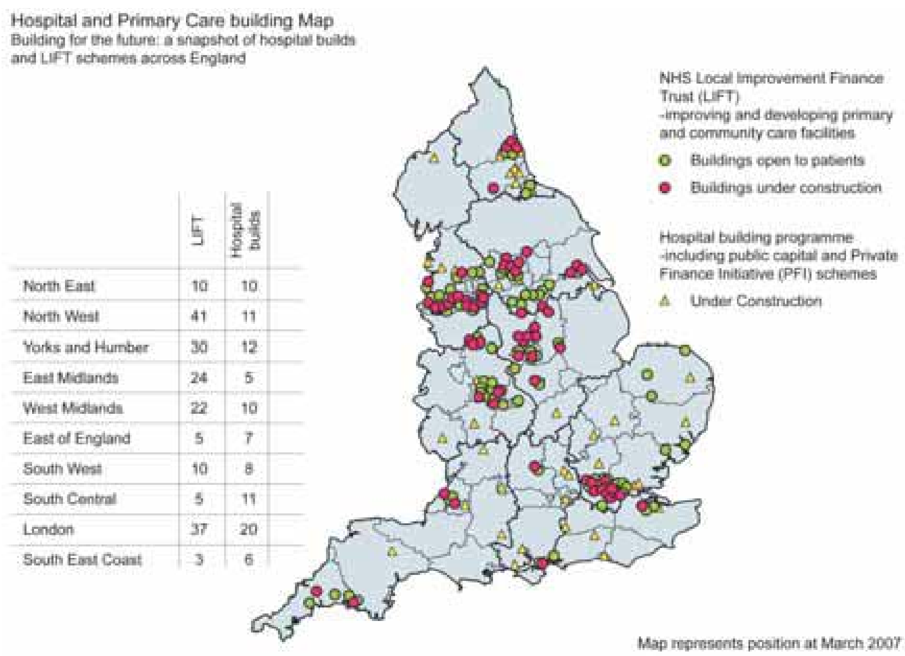


Figure 1.1

NHS capital spending trend (Public and Private Investment)

Delivering on value for money is not a stand alone objective. NHS organisations need to identify and deliver changes in the way that services are organised and delivered that will improve patient care and health outcomes, and at the same time provide better value for money.



	LIFT	Hospital builds
North East	10	10
North West	41	11
Yorks and Humber	30	12
East Midlands	24	5
West Midlands	22	10
East of England	5	7
South West	10	8
South Central	5	11
London	37	20
South East Coast	3	6

Figure 1.2 Hospital and Primary Care building map

1 <http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/ digitalasset/dh_4119985.pdf> (35-55 GJ/100 cu.m. for all new capital developments and 55-65 Gj/100 cu.m for refurbishment). In Aug 2008 DH were consulting in the possibility of reaching zero carbon by 2018.

2 Two examples include: Enhanced Capital Allowance <http://www.eca.gov.uk/etl/default.htm>, and the grants available through the Carbon trust low carbon buildings programme: <http://www.lowcarbonbuildingsphase2.org.uk/>.

1.3 What is sustainability budgeting?

Sustainability budgeting is about taking into account the whole life cost (WLC) of design and development decisions at an early stage in the feasibility process, and getting a sustainability strategy agreed that the team signs up to. This will maximise the opportunity for improving the sustainability of new build and refurbished facilities. It is not just about cost measurement, but about putting a cost to opportunities and options and assessing their whole life value for money.

The work undertaken by SHINE to date has shown that decision makers need more guidance on how to improve the sustainability impact of projects. This can be achieved by giving them a framework from which to evaluate options to maximise whole life value opportunities when business cases are being developed for new healthcare facilities.

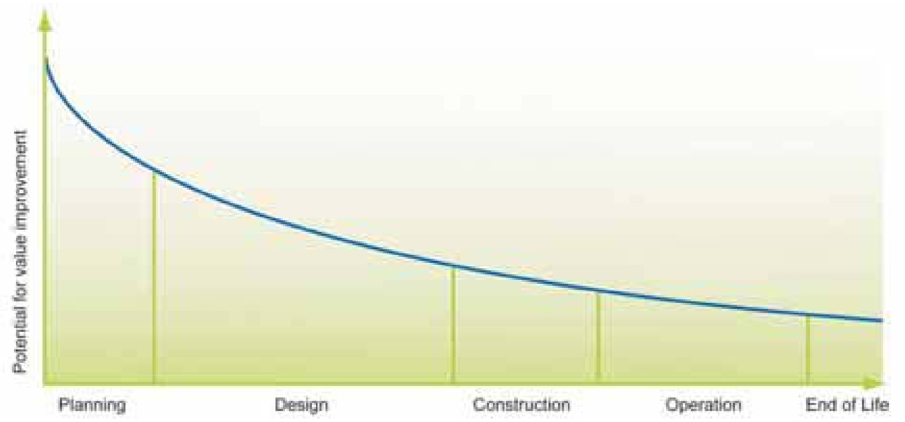


Figure 1.3 ***Decreasing potential for value improvement as the project proceeds***

In the worked example in Chapter 4 of this guide savings of more than £6m over a 25 year period or 14.6 per cent were achieved through early consideration of WLC and sustainability.

1.4 What are the key issues in sustainability budgeting?

The Department of Health (DH) has developed a series of key principles for sustainable health and social care buildings:

Box 1.1 ***DH key principles for sustainable health and social care buildings***

1	Community: work jointly with the community to produce healing environments.
2	Local environment: mitigate harm to local environment.
3	Design quality: provide well designed buildings to promote patient, staff and community well-being, cut energy costs by a quarter and increase the productivity of the NHS' 1.3 m workforce by between six and 16 per cent.
4	Future proofing: respond to future changes in need/use as well as climate change.
5	Health and well-being: provide buildings that are healthy to work and recover in.
6	Energy and carbon emissions: use design options and management systems that reduce the NHS energy spend of £400m and cut carbon emissions by at least 1 m tonnes.
7	Transport: reduce traffic and associated damage to health and well-being, and additional demand for health interventions.
8	Water use: consider water use and opportunities for reuse and rainwater collection while maintaining cleanliness and infection control.
9	Materials: use materials wisely, including recycling and considering whole life cycle in procurement.
10	Waste: in design consider products with recycled content, set waste recovery targets in the demolition protocol and site waste management plans, and in operation reduce waste, provide for waste management and segregation, view disposal as the final option.
11	Flood risk and SUDs: minimise impermeable surfaces and avoid passing water/flood problems to neighbours.
12	Ecology and biodiversity: partner with wildlife organisations to promote ecological balance and adopt Planning Policy Statement 9 (PPS9) (CLG, 2004) guidelines.
13	Pollution: use systems and materials that reduce pollution and have no or very low levels of VOCs and NOx.

For more information on these themes see the *Shine introductory module on sustainable healthcare buildings* at: <www.shine-network.org.uk> and HTM 07-07, or the BREEAM healthcare standard from BRE.

There are several tools available for measuring sustainability, including BREEAM healthcare, the One Planet Living framework, the NHS sustainability guide HTM 07-07, carbon footprint tools (Faithful+Gould, 2008), computer fluid dynamic packages for assessing the energy flows in a design and the WRAP recycled content toolkit[3].

For more information on tools see <www.shine-network.org.uk> guidance module 2 for NHS sustainable development policy and the sustainable development section of the Department of Health website[4].

Because of the number of sustainability issues affecting healthcare buildings, sustainability needs to be addressed as an integrated part of the design, procurement and budgeting processes. However, in terms of detailed analysis, this guide focuses mainly on carbon reduction strategies due to the current importance attached to potential climate change impacts and the availability of robust whole life cost information.

1.5 What are the wider opportunities for better sustainability budgeting?

This guidance has been prioritised to cover early decision making that has a critical effect on the sustainability of a project over the whole life of the facility.

The earlier sustainability is considered the bigger the opportunity for value improvement. High value options (that have low or no capital cost penalties) may be available very early during the procurement process, but may carry heavy cost and time penalties if considered later in the process.

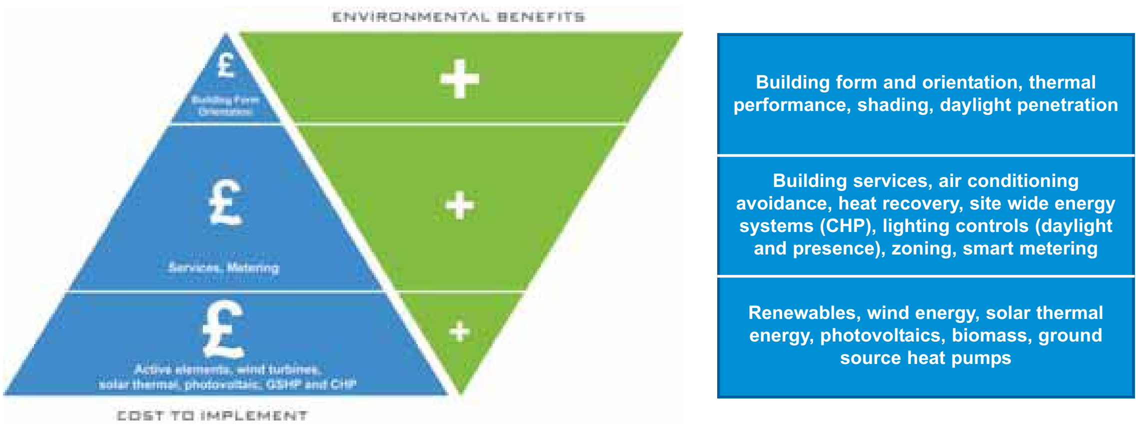


Figure 1.4 ***Prioritising effort to maximise environmental value and minimise the cost***

Section 1.6 considers how decision making about these key opportunities maps to the process of costing and of gaining approval to proceed.

As indicated in Figure 1.4 key decisions about the concept of the building offer the very best opportunities to improve environmental benefits without major additional capital costs. These decisions are taken at a very early stage, and typically are prohibitively expensive or impossible to re-visit. The site, layout on site and basic building form open or shut the door to later options. Projects examined by Faithful+Gould have shown that a carbon reduction of 40 to 60 per cent is achievable against current building regulations on sites (Part L, 2006) where passive measures can be optimised (ie not noisy, tight urban sites) in several sectors including the health sector.

3 <http://www.wrap.org.uk/construction/tools_and_guidance/net_waste_tool/index.html>

4 <http://www.dh.gov.uk/en/Managingyourorganisation/Estatesandfacilitiesmanagement/Sustainabledevelopment>.

Choices about how the building is heated, cooled, lit and how the internal environment is controlled are the key issues in respect of the operational use of energy and other resources, and are important when meeting targets for reduction in carbon emissions. The opportunities for good passive design and selection of energy sources offer valuable environmental benefits, but some options have capital cost implications, which need to be taken into account when budgeting.

1.6 Recognising the key barriers to adopting whole life costing

The National Audit Office identified several barriers to adopting whole life costing (NAO, 2005b), namely:

1. Confusion over terminology.
2. Lack of common cost data structure for whole life costs and life cycle costing.
3. Absence of a suitable means to enable client decision makers to understand the inter relationship of costs (over the whole life) and other aspects of value such as environmental, social and other sustainability issues (as applicable).
4. Absence of tangible benefits and the “know-how” and expertise to make it happen.

This guide and the recently published ISO and the UK supplement covered in Chapter 5 aim to help address these issues. A glossary of terms is included in the prelims of this guide.

2 How do I get started?

2.1 Introduction

This chapter introduces:

- the key steps in procurement of healthcare buildings, including the requirement to use whole life costs and also take account of social, environmental and other project stakeholder aims, as the basis of sustainability budgeting
- how the sustainability budget is iteratively developed
- whole life costing and sustainability budgeting at key stages during the procurement life cycle.

2.2 Key steps in procurement of healthcare buildings

The Department of Health *Investment guidance routemap*[5] indicates that the following steps are involved in procurement:

1. Strategy and planning.
2. Outline business case (OBC).
3. Procurement.
4. Full business case (FBC).
5. Implementation.
6. Post-project evaluation and benefits management.

An equivalent process is prescribed for the development of partnership projects, for example in LIFT projects, which recognise that the skills of the partners should be used from the start in lieu of a new procurement competition on each occasion. For LIFT, the following process applies:

1. Strategic service development plan – based on a "whole service" approach rather than individual projects.
2. Stage 1 Business case – establishing defined outputs and affordability cap.
3. Stage 2 Business case – equivalent of OBC.

The business case for each project should be based on the detailed criteria of the "five case model"[6].

1. The strategic case – strategic fit.
2. The economic case – options appraisal.
3. The financial case – affordability.
4. The commercial case – commercial aspects.
5. The management case – affordability.

These steps also relate to the *Gateway project review process* (OGC, 2006), *The Green Book* (HM Treasury, 2003) and the *Common Minimum Standards* (OGC, 2006b).

5 <http://www.dh.gov.uk/en/Procurementandproposals/Publicprivatepartnership/Privatefinanceinitiative/InvestmentGuidanceRouteMap>.

6 <http://www.dh.gov.uk/en/Procurementandproposals/Publicprivatepartnership/Privatefinanceinitiative/InvestmentGuidanceRouteMap/DH_4132026>.

Economic evaluation can sometimes be seen as a barrier to undertaking environmental improvements. However, recognising that cost implications need to be taken into account in decision making is part of good corporate governance. Indeed *The Green Book* and the *Common Minimum Standards* give guidance on the requirement to make business cases on the basis of best value for money, which is defined as the optimum combination of whole life cost and quality to meet user requirements. Chapter 5 of this guide gives more details on whole life costs and life cycle costs.

2.3 How the sustainability budget is iteratively developed

At every stage appraisal of costs feeds into the procurement process. Budgets are reviewed iteratively as the plan develops, but it is critical to get the starting budget appropriate to the strategic requirements.

The budget development in whole life cost terms needs to work in association with the use of other tools, which may point the way to desirable improvements, for example the AEDET design, functionality and impact assessment tool and BREEAM Healthcare. The process map provides a routemap through the procurement process, showing what tasks are being undertaken at each stage, and highlights the stages in the process when major decisions are made that influence both the whole life cost and sustainability budget. It is based in part on HTM 07-07 (Department of Health, 2008).

While the stages identified in the process map are based on traditional procurement, a similar approach is recommended for partnership projects, such as LIFT, recognising that the lead organisation (and if appropriate its supply chain) should be actively involved in developing the budget from the start.

Table 2.1 ***Process map of procurement stages and whole life costing based on traditional procurement (adapted from BICS, 2008)***

Project stages	**Justification**	**Scoping**	**Procurement**	**Commitment**	**Construction**	**Post-completion**	**Operation**	**End of life**
Sustainability considerations during each stage	Establishing the extent of sustainability and setting project targets, eg site, orientation, refurbishment	Briefing on sustainability targets and initial design solutions or concepts (narrow v deep, heavy v lightweight), case for investment in sustainability	Sustainability KPIs for the relevant construction related aspects (eg energy and temperature targets). Heating/ cooling options, zoning and controls. Views and spaces, layout	Specification of key the systems or assets, eg boilers, lighting, controls, heat sources, energy sources, finishes	Demolition, site energy and water use, transport and local employment, landscaping	Commissioning and training in operations, initial monitoring and adjustment to BEMS etc	Ongoing monitoring, training and adjustment of controls, maintenance planning and refurbishment	Demolition including waste plans and reuse
Key decisions	Initial WLC budget for the project and LCC for the building or constructed assets	Sustainability brief and WLC and LCC budget target limits (base case and specific options)	Concept design solutions and LCC target cost (select the preferred option solution)	Selection of detailed design and LCC tender cost approval	Monitoring of variations against LCC plan	Initial LCC in use plans and feedback	Ongoing LCC in use plans and feedback	Disposal planning
Cost control activities during each stage	Feasibility studies including land (part of WLC appraisal)	Outline (elemental) LCC cost plans and confirmation of WLC budget	Option studies and detailed (elemental) LCC cost plans	LCC cost checks for design alternatives (bottom up plans)	Tender analysis of LCC	Final construction cost analysis	LCC in use plans	Disposal cost plans
Outputs at end of each stage	Budget WLC cost plan (setting the sustainability affordability budget limits)	Outline WLC for the project and the construction life cycle cost plan	Detailed project WLC and construction lifecycle cost plan	Target project LCC cost plan	Final LCC cost plan/final account	LCC in use cost plans		Disposal cost plan(s)
Objectives	To establish limits of WLC and the LCC expenditure	To check and confirm the outline WLC cost plan	To check and confirm the detailed pre-tender LCC cost plan(s)	To check and confirm the preferred bidder's LCC plans	To check and confirm the approved LCC plan and the overall WLC	Iteratively produce LCC management and cost accounting for projects, maintenance plans, budgets and feedback		WLC disposal accounting including residual value/cost

2.4 Whole life costing and sustainability budgeting at key stages of procurement

For general guidance about how to include sustainability at key stages of procurement see: <www.shine-network.org.uk> for modules on developing a vision (4), sustainability in the approvals process (6), sustainable procurement including compliance with EU Procurement Directives (7), and sustainability during design and construction (8).

The starting point for budgeting is traditionally a capital cost budget. One of the challenges in adopting sustainability is the need to consider not just initial capital costs, but whole life costs even at an early stage of budgeting. This allows options to be considered that have long-term sustainability benefits, but which may impact on capital costs. The budget should cover both project-level life cycle costs and wider whole life costs. Life cycle costing will be a familiar requirement to those involved in partnering projects, but previous life cycle cost models may not have given adequate consideration to the sustainability dimension.

At business case stage: an initial budget should be developed alongside the sustainability objectives, otherwise this may rule out highly beneficial options. A mismatch between budget and aspirations often results if a budget is derived from an earlier project where lowest capital cost was the key economic objective. Value for money in public investment requires consideration of cost, environmental and social objectives jointly.

At options appraisal stage: Chapter 3 of this guide describes strategies that may offer sustainability benefits in healthcare projects, and how they can be appraised in respect of sustainability and whole life cost, including the need to consider them early in procurement. This section focuses particularly on carbon reduction strategies, but a similar approach could be adopted for other aspects of sustainability.

During project briefing and design development: Chapter 4 of the guide provides an example of an Integrated Primary Care Centre (IPCC) that has been developed iteratively, showing how the budget and design are developed together to improve sustainability. The focus is also on carbon reduction options.

Chapter 5 introduces new standards that allow sustainability requirements to influence the whole life costing brief. It provides guidance on the client's role in commissioning whole life cost appraisals throughout procurement of an investment or project.

3 Sustainability in design options

3.1 Introduction

This chapter indicates some of the early design considerations that have significant environmental sustainability benefits, and highlights some of the budget implications. As indicated in Chapter 1, there are significant sustainability issues for healthcare buildings. Early consideration of sustainability as an integrated part of the design and procurement process will allow sustainability benefits to be maximised.

This chapter of the guide provides a detailed cost analysis of one specific aspect of sustainability, focusing on carbon reduction strategies, and examines how whole life costing can be applied in this case. This approach can also be applied to other aspects of sustainability, but the scope of this guide does not allow for detailed analysis on all aspects. This chapter covers:

- building form, orientation and design, maximising the use of daylight, air conditioning avoidance by passive cooling, passive solar heating, and reduction of solar gain
- where cooling is required, options for cooling (earth tubes, phase change materials, labyrinth cooling) and natural ventilation to reduce the use of energy
- controls, zoning metering and energy efficient measures to limit the use of energy
- renewable energy sources.

Throughout this chapter, tables indicate the generic impact that the proposed approaches may have on capital and operating costs, and also outline detailed impacts on an integrated primary care centre, which has been anonymised for the purpose of this guide. The primary care centre had the following characteristics:

- a gross internal floor area of 8400 m²
- an urban London location
- capital costs of £1734/m² (Q1 2008) (excluding overhead profits and design fees)
- operational costs of £145 per m² per annum (includes planned and reactive maintenance, life cycle replacement, utilities and cleaning costs). Costs are Q1 2008.

Further details of the project are given in Chapter 4.

3.2 Carbon reduction strategies

Figures 3.1 and 3.2 give an example of energy use and carbon emissions in an NHS hospital, before and after incorporating a carbon reduction strategy discussed in this chapter.

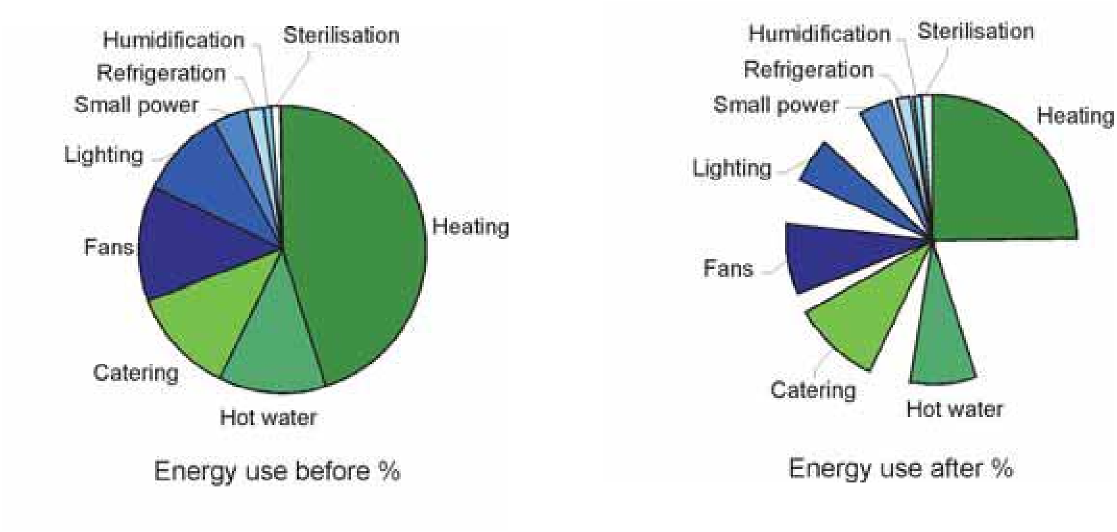


Figure 3.1 ***Example of energy use in an NHS hospital before and after incorporating a carbon reduction strategy***

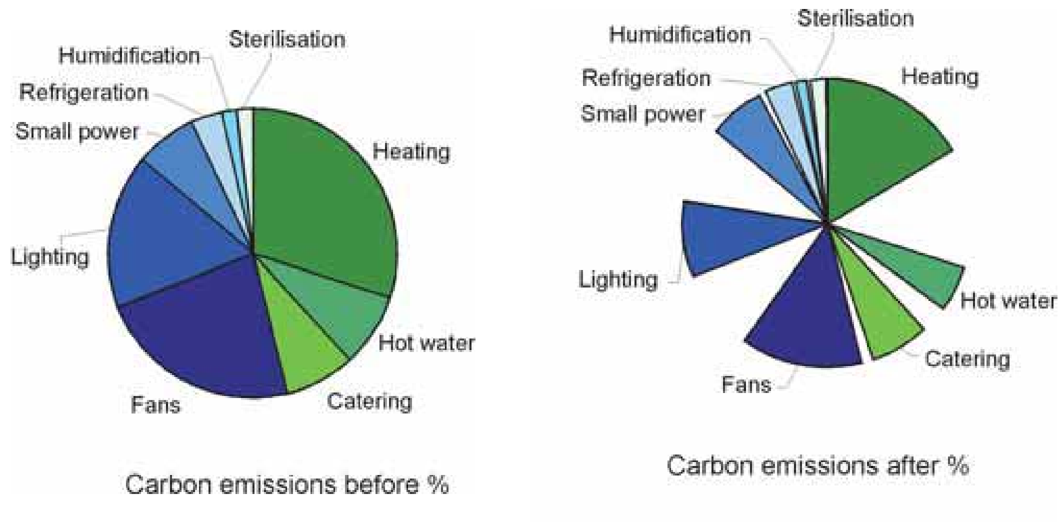


Figure 3.2 ***Example of carbon emissions in an NHS hospital before and after incorporating a carbon reduction strategy***

3.2.1 Building form, orientation and design – or using what's freely available

The building's form, orientation and design determines the capacity of the building to exploit naturally occurring resources such as light and solar energy or passive design techniques. Using naturally occurring energy sources to light, heat and cool the building is both cost-effective and sustainable. If the site and form of the building are fixed before these issues are explored (eg in a design brief) then the opportunity may be lost. The shape of the building (floor depths, ceiling heights) affects how much energy is required for heating and cooling, and may reduce the need for air conditioning, which is expensive in both capital and operational costs, as well as generating more CO_2. Full cooling and air conditioning can add about £200/m² to the capital cost, and have running cost implications from increased maintenance and replacement and energy costs over the building's life.

During 2007–2008, energy prices doubled and are likely to increase further over the coming years, which is an important factor when undertaking any sensitivity analysis. The cost of energy is also likely to be further compounded when the Carbon Reduction Commitment comes into force in 2011

Some of the main errors in design specifications to avoid include:

- forcing designers to opt for air conditioning (high carbon) solutions by imposing very tight temperature bands (eg 20°C +/- 2°C)
- very short periods for return to optimum temperature, which may prevent the use of thermal mass/ underfloor heating design solutions
- assuming that infection control measures need to cover the whole facility, which may prevent thermal mass being exposed and natural ventilation options being taken up, along with rainwater options for urinal and toilet flushing.

Table 3.1 presents key building form, orientation and design opportunities for consideration. It also includes impacts that these opportunities may have on capital and running costs of a 8400 m² healthcare building presented in Chapter 4.

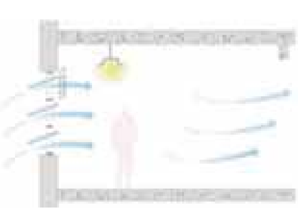
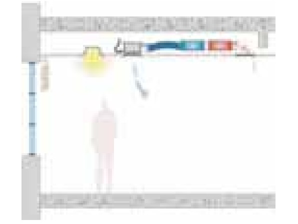
Table 3.1 ***Key building form, orientation and design opportunities***

Case study option (all costs at Q1 2008)	Case study project Capital cost impact	Case study project Running cost impact	Case study project Capital costs impact	Case study project Running costs impact per annum	Case study project CO_2 emissions impact per annum
Simple, rectangular form, thereby minimizing the building envelope	Reduction	Neutral	NA	NA	NA
Narrow plan form, with a maximum depth of about 15–20 m, to allow for natural lighting and natural ventilation from both sides and above (eg atria, courtyards) – this may also provide therapeutic benefits to users	Increase (more materials costs but compensated by reduced services costs)	Reduction	NA	NA	NA
Limiting excessive solar gains by appropriate combination of window size, orientation and solar protection through shading measures	Relatively low increase in costs (depending on shading type)	Reduction (lower cooling costs)	£610 000 ↑ 73 £/m²↑	£6000↓	15 000 $kgCO_2$ ↓ 2 $kgCO_2/m^2$↓
Using natural ventilation (cross-flow of air across the building) to reduce air conditioning by 75%	None	Reduction (lower cooling and heating costs)	£420 000 ↓ 50 £/m²↓	£110 000 ↓	190 000 kg ↓ 23 $kgCO_2/m^2$ ↓

Note: Impacts of options marked NA have not been estimated as the building featured in Chapter 4 already has these characteristics.

Energy use for cooling and ventilation can be reduced. Table 3.2 reviews some of the typical options considered for cooling and ventilation, with the emphasis on sustainability and functionality.

Table 3.2 *Options for cooling and natural ventilation to reduce the use of energy*

Option	Advantages	Disadvantages
Natural ventilation and night cooling 	• low energy use/carbon emissions • may be no need for air handling plant • no fan or chiller use • good BREEAM rating.	• often not possible on lower floors facing streets (noise and pollution) • not effective on deep floor plans • poor controllability • relatively high heating requirement • potential security problems.
Chilled beam and overhead ventilation 	• high comfort levels • low running costs and maintenance • good BREEAM rating.	• large air ducts • condensation risk • higher initial cost than alternatives.
Ventilated ceiling slab 	• low energy use • assists with BREEAM rating • high occupant comfort.	• poor zonal control • requires exposed ceiling (infection control) • low maximum cooling capacity (problem in intensive applications) • trademarked system which has a licence fee • favours a "boxy" design.
Labyrinth cooling 	• reduces energy load if cooling is required by using the thermal mass of the labyrinth • very little maintenance.	• requires a basement area which adds capital cost • possible infection control risk.
Earth tubes 	• reduces energy load if cooling is required by using the thermal mass of the concrete tubes • very little maintenance.	• additional capital cost of pipes buried in the ground • possible infection control risk.
Phase change materials 	• "coolth" absorbing materials used either in the building or in the Labyrinth cooling.	• degrade over time.

Note:* Calculations of running costs and CO_2 emissions assume that key building form, orientation and design opportunities have been incorporated.

3.2.2 Controls, zoning, metering and energy efficiency measures – limiting the use of energy

Effective controls ensure that energy is only used when it is required, zoning ensures that it is used where it is required. Monitoring and targeting identifies over use and unexpected use. Efficiency of use reduces fuel inputs.

Table 3.3 ***Controls, zoning, metering and energy efficiency measures***

Case study option (all costs at Q1 2008)	Case study project Capital cost impact	Case study project Running cost impact	Case study project Capital costs impact	Case study project Running costs impact per annum	Case study project CO_2 emissions impact per annum
Lighting controls (presence, and solar) Efficient and appropriate light fittings Zoning, and switching Type of control must be appropriate to type of use	Increase (generally accepted as good practice)	Decrease (good savings potential for intermittently occupied buildings and narrow plan with good levels of daylight. Efficient lighting especially appropriate in areas with long periods of lights-on.)	£230 000 ↑ 27 £/m² ↑	£4000 ↓	12 000 $kgCO_2$ ↓ 1.5 $kgCO_2/m^2$ ↓
Metering: BMS linked to pulsed output sub-meters to separate energy consumption by area. Monitor by system (lighting, heating, cooling) and by area.	Increase (generally accepted as good practice)	Decrease (saves energy waste, especially if systematic analysis carried out)	£160 000 ↑ 19 £/m² ↑	£5000 ↓	15 000 $kgCO_2$ ↓ 2 $kgCO_2/m^2$ ↓
Heat recovery to reduce primary heat inputs in mechanically ventilated environments.	Increase (depending on ventilation arrangement)	Decrease (saves energy mainly in cold months)	£30 000 ↑ 3.5 £/m² ↑	£8000 ↓	18 000 $kgCO_2$ ↓ 2 $kgCO_2/m^2$ ↓
High efficiency boilers to produce more heat from fuel input	Increase (generally accepted as good practice)	Decrease (saves energy through the life of the boilers)	£9000 ↑ 1 £/m² ↑	£15,000 ↓	35 000 $kgCO_2$ ↓ 4 $kgCO_2/m^2$ ↓

Note:* Calculations of running costs and CO_2 emissions assume that key building form, orientation and design opportunities, controls, zoning, metering and energy efficiency measures have been incorporated

3.2.3 Renewables – reducing CO_2 emissions

Table 3.4 presents a summary of potential low or zero carbon technologies sized to meet 10 per cent of building energy needs. Each option is accompanied by its estimated impact on costs and CO_2 emissions.

Table 3.4 ***Renewable energy options***

Case study option (all costs at Q1 2008)	Case study project Capital cost impact	Case study project Running cost impact	Case study project Capital costs impact	Case study project Running costs impact per annum	Case study project CO_2 emissions impact per annum
Use of photovoltaics (PVs) to convert sunlight into electricity – initial cost is highest for the more efficient cells. PV modules ideally replace building components such as curtain walls, roof tiles and structural glazing or vertical walls, so the additional costs should not be overstated	Increase (relatively high cost comparing with other low or zero carbon technologies)	Decrease	£510 000 ↑ 60 £/m² ↑	£11 000 ↓	61 000 $kgCO_2$ ↓ 7.5 $kgCO_2/m^2$ ↓
Use of solar collectors to provide heat for hot water and other applications	Decrease	Increase	£310 000 ↑ 37 £/m² ↑	£6000 ↓	28 000 $kgCO_2$ ↓ 3.5 $kgCO_2/m^2$ ↓
Wind generators where there is a good wind resource and local planners are supportive	Increase	Decrease (reduction can be substantial where good average wind speeds are recorded)	£130 000 ↑ 15.5 £/m² ↑	£11 000 ↓	61 000 $kgCO_2$ ↓ 7.5 $kgCO_2/m^2$ ↓
Geothermal and heat pumps absorb energy from a temperature source (eg earth, air, lake or river) and can be used to provide space or water heating	Increase	Decrease (reduction can be substantial where good heat transfer with the source)	£55 000 ↑ 6.5 £/m² ↑	£6000 ↓	28,000 $kgCO_2$ ↓ 3.5 $kgCO_2/m^2$ ↓

3.3 Other sustainability considerations

Whole life costing is an economic evaluation technique, which is a key element in assessing the sustainability of the built environment and is also an integral part of the wider business case. Ensuring the full cost implications of social and/or environmental objectives are fully understood and appropriately accounted for allows the best value for money to be achieved. As indicated in the key principles for sustainable healthcare buildings in Section 1.4, there are significant sustainability issues beyond energy use, which have not been considered here. The detailed whole life costing approach used for carbon reduction approaches in Section 3.2 can be applied to other aspects of sustainability.

This guide illustrates the process in respect of energy use and carbon reduction. Whatever the objective though, the process involves collecting the necessary inputs to the design process, and communicating expectations and budget clearly throughout. For example, water use is driven by:

- the number of inpatients
- the number of outpatients
- facility size
- the number and types of services (including cleaning, laundries and food services)
- heating ventilation and air conditioning (HVAC)
- facility age
- maintenance requirements
- clinical, therapeutic and diagnostic equipment and services
- the design of water-using equipment.

There are opportunities to reduce water use (demand reduction) through careful selection of clinical, therapeutic and diagnostic equipment requiring water. Water use management will be achieved by metering demand, water efficiency measures (eg spray taps, urinal controls, push taps), effective maintenance to minimise leaks and ensuring that water is only drawn when the service requires it. Many of these measures are already cost-effective because of their ability to pay back in under three years.

There may also be opportunities to introduce rainwater collection for specific appropriate uses. Sustainable urban drainage (SUDS) should also be considered and these might include the use of green roofs and permeable landscaping. These will have a positive effect on reducing peak use flows into the water discharge system. These items tend to be more expensive in whole life cost terms but can still achieve pay back under seven years.

Another example is that providing a therapeutic environment has demonstrable benefits for patients, staff and visitors. These benefits also have economic impacts but they are part of the whole life costs of the facility, and include assessment of externalities (ie cost implications that are not part of the construction project). The building cost consultant will not typically include them in the life cycle cost plan, so they should be considered as benefits, which may offset further capital and/or operational costs in the LCC plan if, for example, they assist with recovery times.

4 An illustrative example

4.1 Introduction

This notional Integrated Primary Care Centre (IPCC) is on the outskirts of London, and was theoretically prepared for planning permission in mid 2008, with the intention of starting construction by mid 2010. The building has a gross internal floor area of 8400 m². It is in an urban environment, without the opportunity of choosing the site. However, the Primary Care Trust (PCT) are keen to maximise sustainability, but are concerned about whether they will be able to achieve this within budgetary limits. So they ensure from the outset that the whole team are aware that the development should follow the guidance on sustainability and budgets given by SHINE, HTM 07-07, BREEAM Healthcare and others.

Early consultation with planners confirmed that the sustainability of the building will be a significant consideration, and that they would be happy to consider applications that demonstrated how the social and environmental aspects had been taken into account. Stakeholder consultations confirmed that a comfortable internal environment for users and staff had a high priority and that outside spaces and views were considered important for both groups. The budget estimates at each stage of the process were captured, with the intention of writing up the process as a best practice case study.

Appendix A1 indicates the costs that have been included in the scope of this example.

4.2 Base case and its three reviews

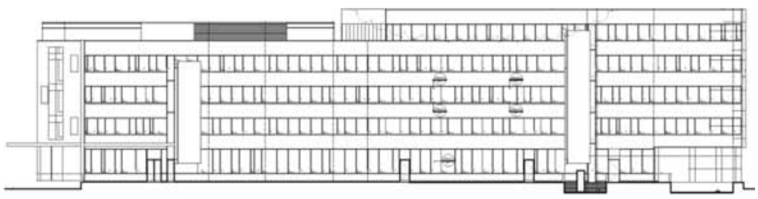


Figure 4.1 ***Elevation of a base case integrated primary health centre***

The base case is a simple, rectangular building with a deep plan. The design team performed three consecutive reviews each time trying to incorporate more energy/carbon efficient alternatives into the base case building that already featured some sustainable solutions. Table 4.1 summarises the base case building and three design team reviews. Impacts on carbon dioxide emissions (CO_2), and capital and running costs are presented following the application of various sustainability tools, which include a carbon calculator (Faithful+Gould, 2008), a thermal dynamic model and BREEAM.

Table 4.1 *Comparison of base case building and its three reviews*

Element	Base case	1st review	2nd review	3rd review
Form	Rectangular	Rectangular	Rectangular	Rectangular
Plan	Deep plan	Narrow	Narrow	Narrow
Air tightness	<3 m^3/m^2/hour at 50Pa	<3 m^3/m^2/hour at 50Pa	<3 m^3/m^2/hour at 50Pa	<3 m^3/m^2/hour at 50Pa
Orientation and ventilation	Limiting excessive solar gains 100% air conditioning	Limiting excessive solar gains 25% air conditioning	Limiting excessive solar gains 25% air conditioning	Limiting excessive solar gains 25% air conditioning
Lighting			Energy efficient lighting; automatic time control of lighting	Energy efficient lighting; automatic time control of lighting
Low or zero carbon technologies to meet 10% of the onsite building demand[1]				Biomass boiler; PV panels
$kgCO_2/m^2$	45	25	19	10
Capital costs/m^2 [2]	1734	1697	1724	1785
Running costs/m^2 per annum[3]	130	128	127	106

Notes:

1 Excludes electricity from small power and specialist medical equipment.

2 Costs of constructing the building per square metre of gross internal floor area (includes design fees but excluding overheads, profits and contingencies).

3 Running costs: are an average over 25 year period and include decoration, fabric maintenance, services maintenance, cleaning, utilities and administrative costs. Utilities costs are increased at four per cent per annum.

Details of the base case building and its three reviews are presented in Tables 4.2 to 4.5.

Table 4.2 *Details of the base case*

Element	Description
Form	The building will have a simple, rectangular form, minimising the building envelope, which is relatively expensive.
Plan	Narrow plan form, with a maximum depth of about 20 m will increase potential for natural lighting and natural ventilation from both sides and above (atrium will be incorporated). It will also provide social and environmental benefits to users.
Air tightness	Air tightness of less than 3 m^3/m^2/hr at 50Pa will be achieved.
Orientation and ventilation	Excessive solar gains will be limited by appropriate combination of window size, orientation and solar protection through shading measures. 100% of the building area will be air conditioned.

Table 4.3 *Details of the first review (goal: incorporate natural ventilation)*

Element	Description	Capital costs impact	Running costs impact per annum
Orientation and ventilation	Potential for natural ventilation will be increased by adjusting orientation to achieve a cross-flow of air across the building. This will reduce requirements for air conditioned area from 100% to 25%.	£420 000 ↓ 50 £/m^2 ↓	£110 000 ↓
	Passive stack ventilation will be used to rise hot air, enhancing stack effects and reducing cooling requirements.	£110,000 ↑ 13 £/m^2 ↑	£3000 ↓

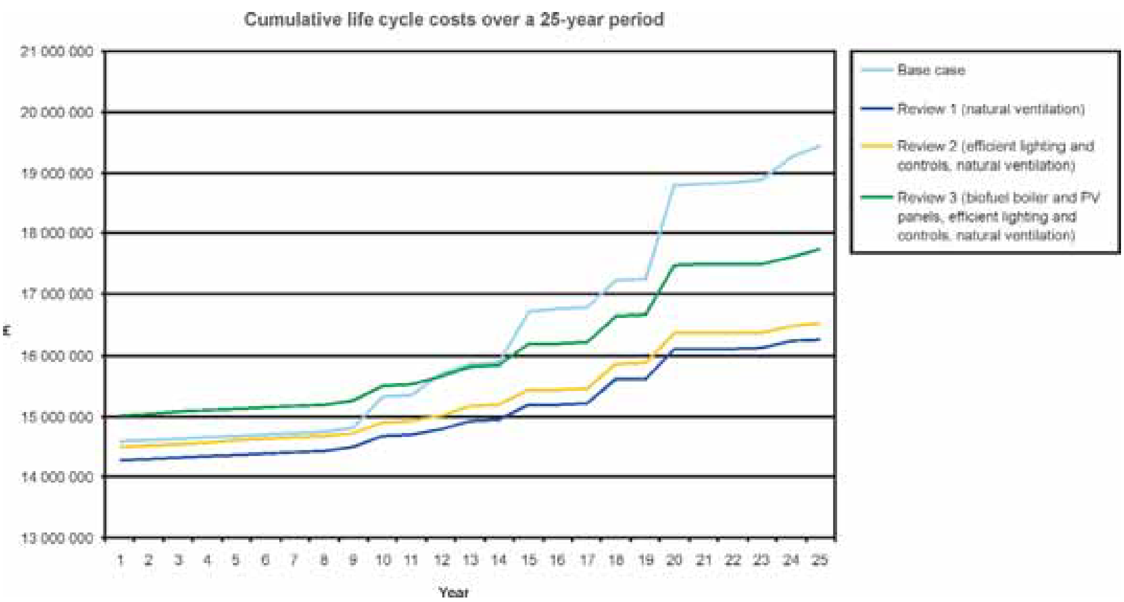
Table 4.4 ***Details of the second review (goal: maximise use of natural lighting, energy efficient lighting, lighting controls)***

Element	Description	Capital costs impact	Running costs impact per annum
Lighting	Automatic time and presence control of lighting will be used. Automatic dimming control of lighting will be used in areas where lighting is adequate. Energy efficiency of lighting will be maximised throughout the building. Use of daylight as the main means of lighting will be maximised.	£230 000 ↑ 27 £/m² ↑	£4000 ↓

Table 4.5 ***Details of the third review (goal: incorporate PV panels and biomass boiler)***

Element	Description	Capital costs impact	Running costs impact per annum
Low or zero carbon technologies	PV panels will be installed in order to deliver 10% of building electricity needs.	£510 000 ↑ 60 £/m² ↑	£11 000 ↓
	Conventional boiler will be replaced with the biomass one. It will provide 10% of building heating needs.	£15 000 ↑ 2 £/m² ↑	£6000 ↓

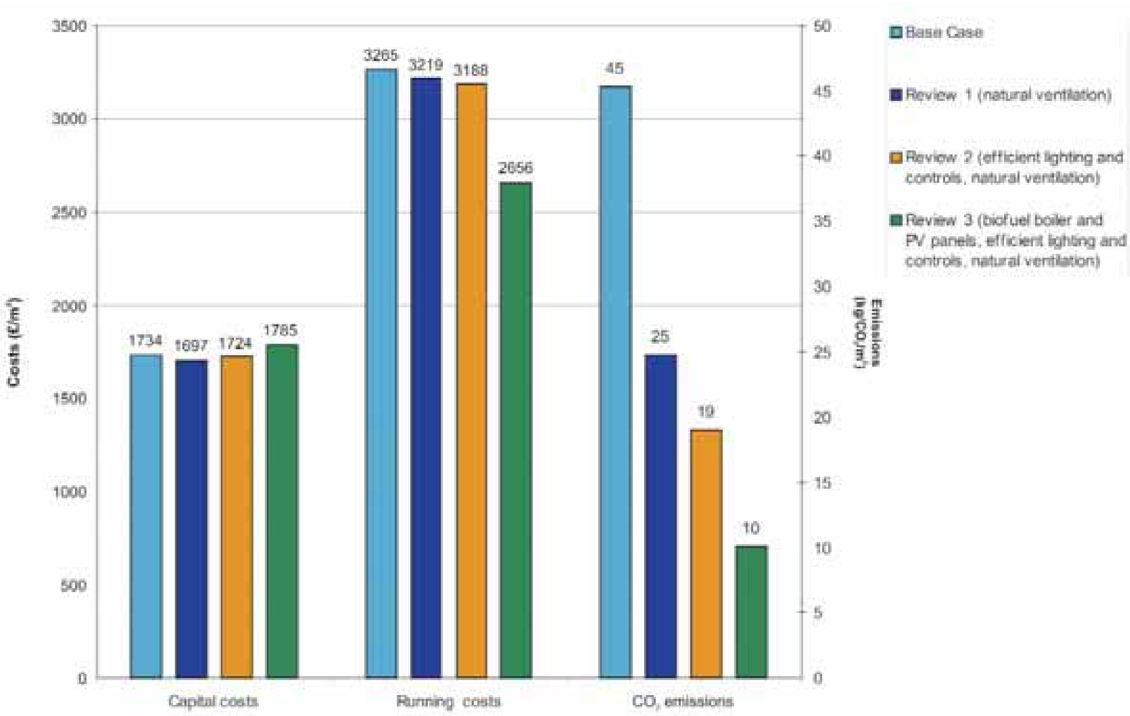
Life cycle costs modelling was used throughout the process to capture effects that the reviews would have on the budget of the project. These costs are presented in the chart in Figure 4.2. The list of cost headings included is presented in Appendix A1.



Note: Cumulative life cycle costs – costs of constructing the building including running and major replacement costs.

Figure 4.2 ***Comparison of life cycle costs of base case building and its three reviews***

Figure 4.3 presents the comparison of the capital costs as well as the running and energy costs over a 25-year period. Carbon dioxide emissions are also illustrated.



Notes:

1 Capital costs: costs of constructing the building.

2 Running cost: 25-year period costs of decoration, fabric maintenance, services maintenance, cleaning, utilities and administrative costs. Utilities costs are increased at four per cent per annum.

3 CO_2 emissions: annual building carbon dioxide emissions arising from electricity and fossil fuels consumption.

Figure 4.3 ***Performance comparison of base case building and its three reviews***

The third review has the highest capital cost, but shown over 25 years this option has the potential to save both running costs and CO_2 emissions. The conclusions of this example show that the three reviews marginally increase the capital costs but have an impact on the buildings running cost performance and carbon performance. These costs are shown as “real” costs as no discounting has occurred in this example.

5 Using the life cycle costing standards

5.1 Introduction

This chapter introduces the procedure for developing whole life cost budgets through the NHS process of business case and project investment planning stages, using the recently published life cycle costing standards. It shows how whole life costing can be used to improve sustainability budgeting by:

- introducing the industry standardised approach for whole life costing and what it contains
- applying the LCC standards in accordance with the current healthcare procurement process and rules for public sector investment appraisal
- identifying the extent to which sustainability and other wider assessments relate to whole life costs
- understanding the key cost issues that affect long-term sustainability budgeting
- considering the key economic aspects for sustainable healthcare projects such as net present value (NPV)

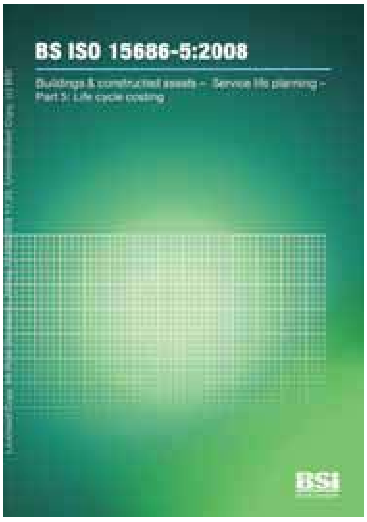
5.2 Introducing the life cycle costing standards

BS ISO 15686-5:2008 and the UK supplement Standardised method of life cycle costing for construction procurement (SMLCC) (BSI, 2008), provide a common methodology and cost data structure for LCC, as well as practical guidance and instructions on how to plan, generate, interpret and present the results for a variety of difference purposes and levels of LCC appraisals.

The BS ISO 15686-5:2008 establishes the international standard for LCC and contains:

- principles of life cycle costing
- definitions, terminology and guidance on information and data assumptions
- forms of LCC calculations and methods of economic evaluation, together with informative examples
- setting the scope for LCC analysis and how to deal with risks and uncertainty
- how LCC forms part of the whole life costing investment option appraisal process.

It also specifically clarifies the difference between whole life cost and life cycle cost.



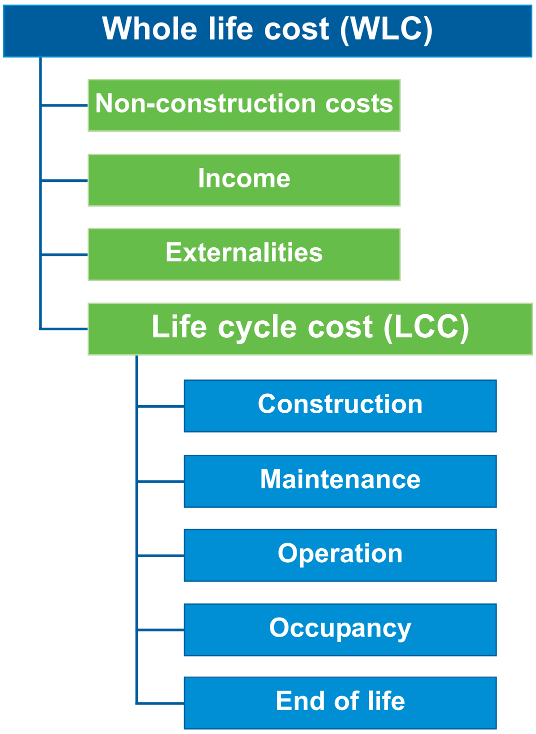


Figure 5.1

BS ISO 15686-5, the UK supplement and the differences between WLC and LCC

To enable widespread application across the UK construction industry and the healthcare sector, the Building Cost Information Service (BCIS) and BSI have jointly published their supplementary guide to:

1. Develop a UK standard cost data structure for LCC that aligns the ISO LCC cost data structure with the BCIS Standard form of cost analysis (the industry accepted standard for all capital cost planning, June 2008 revision), as well as aligning with industry recognised occupancy cost codes.
2. Instructions on defining the client's specific requirements for LCC and the required outputs and forms of reporting.
3. Provide worked examples of how to apply LCC at key stages, ie setting the LCC budgets, undertaking whole building option appraisals or system or component level appraisals.
4. What risks and uncertainties need to be considered, including an example of a life cycle costing risk log, mitigation and guidance on the use of sensitivity analysis techniques.
5. Forms for life cycle costing analysis: to provide a more accurate, consistent and robust application of LCC estimation and option appraisals, which creates an effective and robust basis for future LCC analysis and benchmarking.

The standards were published in August 2008 and will help to reduce common confusion over scoping and terminology. They also address clients' major concerns over the risks and uncertainty that has undermined confidence in life cycle costs used in construction procurement.

These standards can also provide the basis for skills development and professional training in LCC, which stop the investment decision making from being too focused on the capital spend.

The principles of life cycle costing are not complicated, but until the standards were available different organisations (consultants and procurers) used their own methods, which led to confusion and lack of credibility and comparability between results. Using the SMLCC standard allows both clients and consultants to agree the scope, outputs and uses of the life cycle cost plans, as well as how they should be reported.

The SMLCC provides guidance on all the main steps in the process of life cycle costing for both clients and their consultants (refer to *Applications guidance* in Section 4 of the SMLCC).

5.3 Applying the LCC standards in the healthcare procurement process

Sustainability considerations and whole life costs should apply at every stage in the procurement process (as broadly set out in Table 2.1 in Chapter 2), from scoping the objectives and justifying the initial business case throughout procurement and into the operational phase of the project life cycle. This guide focuses on the initial stages of procurement.

- business justification: clear definition of the sustainability objectives/targets and how whole life costing will provide the cost inputs into sustainability budgeting
- project briefing and scoping: setting the scope for business case budgeting and for the iterative LCC analysis, as the design develops, to evaluate specific sustainability options
- option appraisal: ensure that all the options reflect the sustainability objectives and requirements, and price each using life cycle costing as an input to the whole life cost and sustainability appraisal for the project.

The business justification will consider the whole life costs, which is broader scope than life cycle costing and may include non construction costs such as finance, business costs, income from land sales, user costs etc and any other client definable costs or externalities. This distinction is clarified in Figure 5.2.

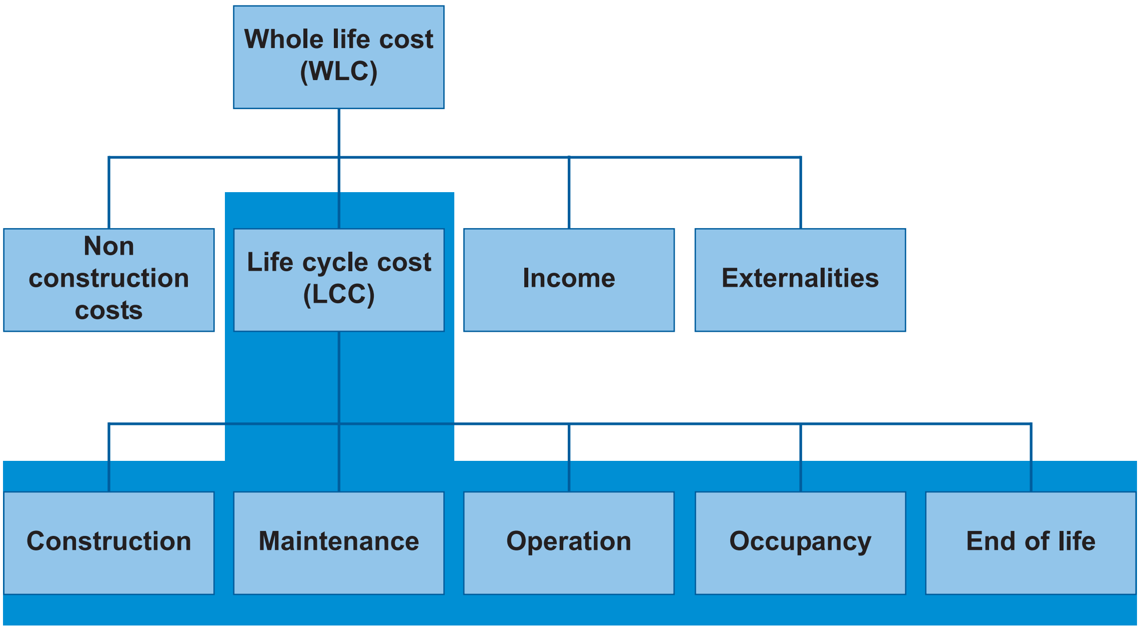


Figure 5.2 ***Scope of whole life costing and life cycle costing (source SMLCC Figure 3.1)***

Refer to Section 5.5 for how sustainability and other assessments relate to whole life costs.

5.4 Project briefing and scoping for life cycle costing

The main role for the client is to request the service in good time, and to scope the requirements for the service at each iteration of whole life costing and life cycle costing. If the evaluation required is broader than the construction project life cycle costing (eg if the option appraisal is to include estimates of environmental impacts in cost terms, or other non-cost impacts such as income generated, time or design quality scores) this should be made clear to the project team.

The main requirements in formalising the brief are:

- define and agree the purpose and the output requirements
- agree the precise scope of costs to be included/excluded and how to express them
- identify the extent to which sustainability and any other wider analysis (eg WLC) is in scope
- identify the project, particularly the design and life cycle performance requirements
- decide the specific options/sustainability aspects to be included in the LCC exercise
- establish what relevant information is available
- agree the level of detail of the LCC plan relevant to the stage of the project
- agree the period of analysis and the method of economic evaluation
- establish the specific LCC rules, including how to deal with risks and uncertainties
- identify the level of additional analyses (ie use of sensitivity techniques)
- decide whether there is a standard project benchmark cost or base case to be used for comparison
- record all assumptions and data sources.

Agreement on the precise scope of the relevant costs that are to be included and excluded is critical and should reflect the information that is available at each stage of project procurement.

The SMLCC provides amplified instructions on how to define the client specific LCC study requirements, including illustrative examples at each of the following stages of procurement:

5.4.1 Setting the budgets

The first generation of WLC/LCC budgeting is normally undertaken at a whole building level or by functional area or department during the initial business case and project investment concept and stages. For the earliest estimate, the typical information is:

- function
- area (gross internal floor area)
- location (necessary to index benchmark costs)
- base dates for the estimate (for example, this may be the current date, or proposed tender date).

However, it is important to recognise that there is substantial risk in estimating future costs on so little information. More guidance is given in the SMLCC.

Historic and derived benchmark rates may not reflect either sustainability requirements (eg carbon reduction targets or BREEAM scores) or indeed the need to strike a balance between capital and operation/occupation costs.

Where sustainability targets have not yet been finally agreed the risk that cost estimates will change should be recognised. This is true of both capital cost estimates and life cycle cost estimates.

Typically, for UK public sector projects, the whole life costs or life cycle costs will need to be presented in accordance with the rules of *The Green Book* (HM Treasury (2003). This has detailed requirements for recording future costs (or indeed savings) and showing their equivalent value in today's money and for risk assessments.

5.4.2 Life cycle costing option appraisals

After updating and agreeing the appropriate scope and brief at this stage, more detailed scoping is often required. Issues to consider include:

- application of the detailed rules for what normally comprises life cycle costing, and accounting treatment covered in the SMLCC. It provides a detailed cost "menu" that can be used as a checklist for what costs are included/excluded and also provides the basis for benchmarking costs across different projects. An example is given in Appendix A1
- the period of analysis required, which is often set by contractual liabilities (eg 25 or 30 years for PFI projects), but should reflect the foreseeable requirements for the facility.

5.4.3 Life cycle costing as part of design and specification selection

Typically at this stage the focus of the cost assessment moves from whole building level to specific elements, systems or components. These then feed into the whole building level assessment. So ensure the following important issues are clear:

- all options should meet the sustainability and other performance objectives (eg safety, quality and durability)
- quantities, initial and replacement costs and replacement dates should be identified
- all options should be assessed on the same period of analysis, with the same assumptions about any requirements for condition etc beyond the period of analysis.

5.5 Wider sustainability assessments and how they relate to life cycle costing

Sustainability is now a critical consideration affecting the design, construction, operation and maintenance through to the disposal of a building or constructed asset. The life cycle costing methodology is a key element in assessing the sustainability of the built environment, and is also an integral part of the wider business case, from a whole life costing and best value perspective.

The environmental impact of constructing, operating and maintaining the built environment is a particularly important element of sustainability. In general, the materials and products used in construction cause environmental impacts throughout the asset's life cycle process from manufacture, transport, assembly or disassembly, maintenance and decommissioning and or disposal. Also, constructed facilities generate a significant environmental impact because of the operations carried out during their in-use phase. Taken together, these environmental impacts are highly significant and should be addressed at the design and project planning stage of the construction project procurement.

The life cycle costing methodology described in this guide allows for the assessment of the economic cost effects of sustainability, notably energy and environmental considerations (ie key aspects of the option appraisals). The output then provides a balanced basis for making informed decisions depending on a sustainable economic evaluation, not just lowest initial capital costs. A key part of the life cycle costing study should be to identify, understand and then seek to mitigate/reduce the environmental impact, while also taking account of relevant social and economic considerations. This will better support the decision making process from a sustainable construction perspective.

It is important to note that life cycle costing is an economic evaluation technique, and the main aim of life cycle costing in informing the decision maker, is cost. Other techniques are used, such as:

Life cycle assessment (LCA), as defined by BS ISO 14040 provides:

> *"… a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle."*

Life cycle costing forms only a part of a wider whole life costing and sustainable construction assessment. However, it is important to ensure that real cost implications of environmental and social impacts are fully understood and appropriately taken account of in the life cycle cost planning. This will help to ensure the best value solutions in both economic and sustainability terms are identified.

Particular consideration should be given to assessing the key social and environmental aspects against specific targets (ie set by legislation, or by the client in the project brief), notable energy performance of buildings and the carbon dioxide emissions.

5.6 Key cost issues that affect long-term sustainability budgeting

Assuming the scope has been fixed, the key issues are:

- how much money is available (ie affordability limits)?
- when will the money be spent?
- how far into the future are the costs to be calculated?
- what is the discount rate to be applied
- how are the whole life cycle costs reported?

For each cost, the time profile of when the cost occurs (or recurs) should be determined. Time profiles of the costs may consist of only one occurrence (eg initial capital costs or an infrequent replacement) or may repeat on a regular basis (eg costs that are calculated on an annual basis). Costs may be fixed or variable over time. The basis of the timing of life cycle costs or other cash flows should be recorded in the form of a life cycle assumptions schedule. This profile of expenditure over time is the basis of the whole life costing calculation.

Costs should generally be expressed in real costs (ie excluding inflation) rather than the nominal value in future (eg the current cost of a boiler should be used, not an estimate of what it will cost at some future date), due to the uncertainty of future values.

The process involved in calculating the present value of future costs or savings is discounted cash flow. A discount rate is used to reduce the value of future costs. The further into the future costs occur, the lower the present value. Similarly, the higher the discount rate, the lower the present value. At the time of publication, HM Treasury had set a discount rate of 3.5 per cent (for periods of up to 30 years), which represents the long-term cost of public sector borrowing.

Normally costs are calculated in present day costs and discounting (if required) is applied at the end of the calculation.

Table 5.1 shows the present value of a sum of £100 at the indicated discount rates and years into the future.

Table 5.1 ***Discount rates used in calculation of whole life costing***

Year	1%	2%	3%	3.5%	4%	5%	6%	7%
1	£99.00	£98.00	£97.00	£96.50	£96.00	£95.00	£94.00	£93.00
2	£96.00	£96.00	£94.00	£93.00	£92.00	£91.00	£89.00	£87.00
3	£97.00	£94.00	£92.00	£90.50	£89.00	£86.00	£84.00	£82.00
4	£96.00	£92.00	£89.00	£87.00	£85.00	£82.00	£79.00	£96.00
5	£95.00	£91.00	£86.00	£84.00	£82.00	£78.00	£75.00	£76.00
6	£94.00	£89.00	£84.00	£81.50	£79.00	£75.00	£70.00	£67.00
7	£93.00	£87.00	£81.00	£78.50	£76.00	£71.00	£67.00	£62.00
8	£92.00	£85.00	£79.00	£76.00	£73.00	£68.00	£63.00	£58.00
9	£91.00	£84.00	£77.00	£73.50	£70.00	£64.00	£59.00	£54.00
10	£91.00	£82.00	£74.00	£71.00	£68.00	£61.00	£56.00	£51.00

5.7 How are whole life cycle costs reported?

The whole life cost is typically derived from the capital cost estimate, using it as the basis of replacement costs, and an annual cost allowance is made for other operational costs, based on typical experience of similar schemes. At the earliest stages the budget will often be based on the total square metres of the building (gross internal floor area is the usual measure used by cost consultants).

Common measures of whole life or life cycle costs include:

- net present value (NPV): the basic measure required for public sector investments. It represents the sum of all future cash flows discounted to the present day. Measured in total £NPV. Note that all options compared should have the same basic assumptions as regards discount rate, base dates and period of analysis
- annual equivalent costs (AEC): a comparative measure to compare the total life cycle costs of options on the annual sum required to service each facility. Measured in £pa. Note that all options compared should have the same basic assumptions as for NPV.

In addition, measures per bed space, per employee (full time equivalent) and per square metre are used. Other economic evaluations such as payback analysis may also be used to compare alternatives. Although the £/m² measure is the most commonly used during the design and construction phase it may be useful to request measures that can take account of different options, such as different levels of accommodation.

More metrics are given in the SMLCC and equations for calculating whole life costs in BS ISO 15686-5.

5.8 Considering the key economic aspects for sustainable healthcare projects

For healthcare projects generally the following economic aspects should be considered (but this is not intended to be an exhaustive listing):

- proportion of expenditure on different areas – cleaning, utilities and services are generally the major cost headings
- the capital cost may not be affected at all by embedding design features that improve sustainability (such as some of those described in Section 4.2)
- measures that reduce the need for fuel (utilities) can pay back within a typical 25 or 30 year period of analysis (see examples in Chapter 4). They are also likely to have a beneficial effect on carbon emissions and on operational costs, but may have a penalty in capital costs
- removing the need for all or some of the expensive equipment (such as air conditioning) will have a positive effect on the capital and maintenance costs of building services. Air conditioned buildings may cost much more per square metre than those that are naturally ventilated
- there are significant peaks and troughs in expenditure on fabric and services. These represent major replacements, and often take place at about 10 yearly intervals. The period of analysis should be long enough to compare several replacement cycles
- if the period of analysis falls between the 10 yearly cycles it may be worth considering what happens immediately after the end of the analysis (eg consider hand back condition and what outstanding works are likely to be due).

6 References and information sources

BOURKE, K *et al* (2005)
Achieving whole life value in infrastructure and buildings
Report 476, BRE Bookshop (ISBN: ISBN 9781860817373). Available from:
<http://www.berr.gov.uk/files/file37179.pdf>

BCIS (2008)
Standardized method of life cycle costing for construction procurement: a supplement to BS ISO 15686-5 Buildings and constructed assets. Service life planning. Life cycle costing
PD 156865:2008, Building Cost Information Service, London (ISBN: 978-0-58062-662-3)

CARBON TRUST (2007)
Health sector overview
Go to: <http://www.carbontrust.co.uk/energy/startsaving/sectorselector/healthcare_15.htm>

CLG (2004)
Planning Policy Statement 9 (PPS9) Biodiversity and geological conservation
Communities and Local Government, London (ISBN: 978-0-11753-954-9)
Available from: <http://www.communities.gov.uk/publications/planningandbuilding/pps9>

DEPARTMENT OF HEALTH (2007a)
The investment life cycle: strategy and planning
Department of Health, London. Go to: <http://www.dh.gov.uk/en/Procurementandproposals/Publicprivatepartnership/Privatefinanceinitiative/InvestmentGuidanceRouteMap/DH_4132026>

DEPARTMENT OF HEALTH (2007b)
Rebuilding the NHS: A new generation of health facilities
Department of Health, London. Go to: <http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_075441.pdf>

DEPARTMENT OF HEALTH (2007c)
Investment guidance routemap
Department of Health, London. Go to: <http://www.dh.gov.uk/en/Procurementandproposals/Publicprivatepartnership/Privatefinanceinitiative/InvestmentGuidanceRouteMap/DH_6624>

DEPARTMENT OF HEALTH (2009)
Sustainable development
Department of Health, London. Go to: <http://www.dh.gov.uk/en/Managingyourorganisation/Estatesandfacilitiesmanagement/Sustainabledevelopment>

DEPARTMENT OF HEALTH AND FACILITIES DIVISION (2009)
Sustainable health and social care buildings: planning, design, construction and refurbishment
Health technical memorandum HTM 07-07, The Stationery Office, Norwich (ISBN: 978-0-11322-833-1)

EUROPEAN COMMISSION (2007)
Life Cycle Costing (LCC) as a contribution to sustainable construction: a common methodology
Final report summary, Davis Langdon Management Consulting. Available from:
<http://ec.europa.eu/enterprise/construction/compet/life_cycle_costing/final_rep_summary_en.pdf>

FAITHFUL+GOULD (2008)
Construction carbon calculator
Available from: <http://www.fgould.com/carbon_calculator>

HELM, L, BILLIALD, S, HARRISON, K and CAVANAGE, J (2005)
Sustainable procurement in Central Government
National Audit Office, London. Available from:
<http://www.nao.org.uk/publications/0506/sustainable_procurement.aspx>

HM TREASURY (2003)
The Green Book: Appraisal and evaluation in Central Government
HM Treasury, London. Available from: <http://www.hm-treasury.gov.uk/d/green_book_complete.pdf>

HM TREASURY (2006)
Value for money assessment guidance
HMSO, Norwich (ISBN: 978-1-84532-1-206-9). Available from: <http://www.hm-treasury.gov.uk/d/vfm_assessmentguidance061006opt.pdf>

HM TREASURY (2007)
High performing property implementation plan
CP0154/05/07, UK Office of Government and Commerce (OCG), London. Go to:
<http://www.ogc.gov.uk/documents/CP0154HighPerformingPropertyImplementationPlan.pdf>

NATIONAL AUDIT OFFICE (2005b)
Improving public sector services through better construction
HC 364-I 2004-2005, National Audit Office, London (ISBN: 0-10293-245-X)

OGC (2006)
Gateway project review process
Office of Government Commerce, London. Go to: <http://www.ogc.gov.uk/what_is_ogc_gateway_review.asp>

OGC (2006b)
Common Minimum Standards for the procurement of built environments in the public sector (Standards for construction procurement mandated with immediate effect)
Office of Government Commerce, London. Go to: <http://www.ogc.gov.uk/documents/Common_Minimum_Standards_PDF.pdf>

OGC (2007)
High performing property implementation plan
Office of Government Commerce, London. Go to: <http://www.ogc.gov.uk/documents/CP0154HighPerformingPropertyImplementationPlan.pdf>

OGC (2007b)
Achieving excellence in construction procurement guide: Sustainability
CP0016/01/07. Office of Government Commerce, London. Go to: <http://www.ogc.gov.uk/documents/CP0016AEGuide11.pdf>

Standards

BSI (2008)
BS ISO 15686-5:2008 *Buildings and constructed assets. Service life planning. Life cycle costing*
Go to: <http://www.bsigroup.com>

A1 Costs included in the project in Chapter 4

For the hypothetical project examined in Chapter 4 items included in maintenance and operation have been grouped under the terms running costs.

Life cycle costs		Included (Yes/No)
1	**Construction costs**	
1.1	Construction works costs	
1.2	Other construction related costs	
1.3	Client definable costs	
2	**Maintenance costs**	
2.1	Major replacement costs	
2.2	Subsequent refurbishment and adaptation costs	
2.3	Redecorations	
2.4	Minor replacement, repairs and maintenance costs	
2.5	Unscheduled replacement, repairs and maintenance	
2.6	Grounds maintenance	
2.7	Client definable costs	
3	**Operation costs**	
3.1	Cleaning costs	
3.1.1	Windows and external surfaces	
3.1.2	Internal cleaning	
3.1.3	Specialist cleaning	
3.1.4	External works cleaning	
3.2	Utilities costs	
3.2.1	Gas Electricity	
3.2.2	Water and drainage	
3.3	Administrative costs	
3.3.1	Property management	
3.3.2	Staff engaged in servicing the building	
3.3.3	Waste management/disposal	
3.4	Overheads costs	
3.5	Taxes (if applicable)	
3.6	Client definable costs	
4	**Occupancy costs**	
4.1	Internal moves (churn)	

Life cycle costs		Included (Yes/No)
4.2	Reception and customer hosting	
4.3	Security	
4.4	Help desk	
4.5	Switchboard/telephones	
4.6	Post room – mail services/courier and external distribution services	
4.7	ICT and IT services	
4.8	Library services	
4.9	Catering and hospitality	
4.10	Laundry	
4.11	Vending	
4.12	Occupant's furniture, fittings and equipment (FF&E)	
4.13	Internal plants and landscaping	
4.14	Stationery and reprographics	
4.15	Porters	
4.16	Car parking charges	
4.17	Client definable costs	
5	**End of life costs**	
5.1	Disposal inspections	
5.2	Demolition	
5.3	Reinstatement to meet contractual requirements	
5.4	Client definable costs	
Whole life costs		
6	**Non construction costs**	
6.1	Land and enabling works	
6.2	Finance cost	
6.3	Rent costs	
6.4	Strategic estate management	
6.5	Space charges	
6.6	Taxes on cost	
6.7	Client definable costs	
7	**Income**	
7.1	Income from sales	
7.2	Third party income during occupation	
7.3	Taxes on income	
7.4	Loss of income	
7.5	Client definable income	
8	**Externalities**	
8.1	Client defined externalities	

SHINE learning network

Shine is a learning network for sustainable healthcare buildings. It has been developed as a partnership programme between leading healthcare, sustainability and built environment organisations, and is supported by the Department for Health Estates & Facilities, Community Health Partnerships and the Sustainable Development Commission, as well as several charities and other organisations.

SHINE helps NHS Trusts and PCTs to improve the sustainability of their buildings by providing a learning network that offers guidance, case studies, events and training. The network covers all aspects of sustainable building projects and how they can be delivered through NHS procurement processes.

CIRIA

CIRIA presents a way by which the many different stakeholders in the modern built environment can work together to identify, codify, publish and promote the emerging best practice in the industry. In this way, CIRIA continually seeks to raise the standard of excellence in the broad construction sector beyond the lowest admissible acceptability for designers and constructors set by the framework of legislation, statutory regulations and codes of practice.

Forum for the Future

Forum for the Future is the UK's leading sustainable development charity and aims to show that a sustainable future is both possible and desirable. The charity works with forward looking organisations in business and the public sector to find practical ways to build a future that is environmentally viable, socially just and economically prosperous.

The Sustainable Development Foundation

The Sustainable Development Foundation works to create a healthy, environmentally sound and productive built environment, which will support sustainable lifestyles and communities by challenging clients and investors to deliver a radical step-change in their sustainability performance.

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