THE LEARNING NETWORK FOR SUSTAINABLE HEALTHCARE BUILDINGS

Research Project for the National Institute for Healthcare Research

MAKING EXISTING HEALTHCARE BUILDINGS SUSTAINABLE: Final Report

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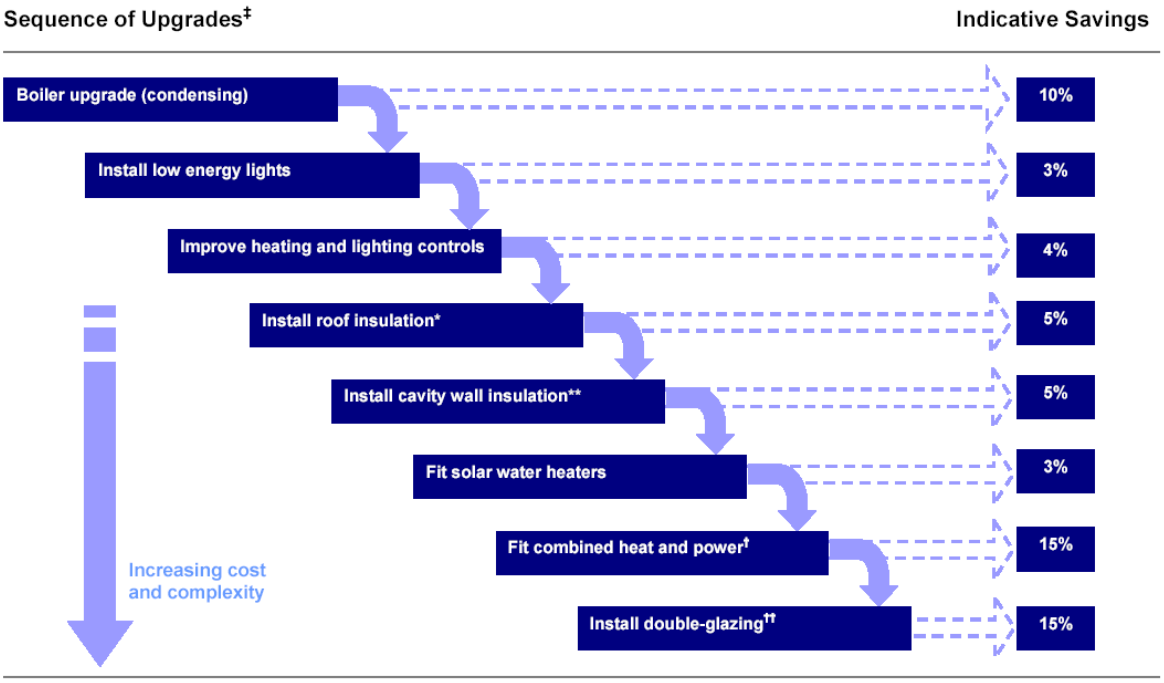

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Northampton General Hospital Trust
South London Hospitals Trust
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MESH – Making Existing Healthcare Buildings Sustainable

Introduction

This research project aimed to find out more about improving the sustainability performance of existing healthcare buildings. It acknowledged that the vast majority of healthcare buildings have already been built, and that the context for public spending means that few new healthcare facilities will be built over the coming years. Instead, the focus of attention will switch to how we can improve the existing estate.

The research covered all aspects of sustainability, but energy use and CO_2 emissions were the principal focus points. We were encouraged by the Estates and Facilities Division of the Department of Health to include climate change adaptation in the research, which we did. Other aspects of sustainability that we included in the work were:

- Water use
- Travel and transport
- Green space and landscaping
- Waste and recycling
- Providing a high quality internal environment
- Whole life costs and investment appraisal
- Low impact materials
- Improving historic/listed buildings, and
- Providing facilities for local people.

There were three basic objectives of the work. First, to understand how to improve existing buildings on sustainability issues. Second, to make recommendations to the Trusts we studied – and to a wider audience – about how to improve. And third, to write guidance on meeting climate change targets, adaptation and other climate change issues.

CIRIA, The Sustainable Development Foundation and Forum for the Future worked in partnership to carry out the work, with CIRIA coordinating. We were supported by the Department of Health and funded by the National Institute for Healthcare Research.

This report is divided into four sections:

Section 1 – Methodology
Describes how we carried out the research.

Section 2 – Overview
Summarises our findings, including a short description of each Trust or building in the study, and the main findings from each of them.

Section 3 – The case studies
Provides detailed descriptions of all six case studies, including energy and climate change emissions for all of them, and focusing on the other aspects of sustainability for Trusts that felt they were important.

Section 4 – Recommendations
Draws out the key recommendations from all of the case studies, and includes two tools for other Trusts. The first tool helps Trusts to assess themselves and work out their own priorities in terms of sustainability, while the second allows them to see where they are in the sequence of upgrades aimed at improving carbon dioxide emissions from their buildings, and plan what to do next.

Section 1: Methodology

We started the research with a clear five-step plan of action, summarised here.

- Step 1 – Collate relevant data
  We carried out a comprehensive literature review, using Internet searching and specialist libraries. We identified 150 publications related to existing buildings and/or sustainability, and summarised each of them. Almost none of them focused specifically on existing healthcare buildings, and very little of the literature review could be used to inform later stages of the research.

- Step 2 – Examine six case study Trusts
  We identified around 30 Trusts that were known to have existing buildings, and who had either improved these buildings with regards to sustainability in the past two years, or who planned to do so imminently. We contacted the Trusts, but many of them declined or were unable to be involved in the study. Of those who were willing to be studied, we selected Trusts in different parts of the country, representing each of a) Acute Trusts, b) Primary Care Trusts, c) Mental Health Trusts, and d) other Specialist Trusts, see table next page.
  We drew up a standardised interview schedule to use for all Trusts, included here as Appendix 1. These are all open questions, and the standardised approach helped to ensure consistency though three different people actually carried out the interviews. (Follow-up questions were also needed in every case, but these were left at the discretion of interviewers.)
  We developed a standardised approach to collecting and recording energy data, and a consistent structure for writing up the case studies. All of the case studies deal with energy use and CO_2 emissions (including heating and lighting), the quality of the internal environment (notably thermal comfort), daylighting, recycling and waste, and investment appraisal. The other aspects of sustainability, listed above, are only included where there is useful information to report – where the Trust has either taken action to improve or where the SHINE team has identified potential for making improvements.

- Step 3 – Analyse data
  We compared findings from these case studies to SHINE's collective experience of what can be achieved to improve sustainability (notably our 12 case studies of recently-completed healthcare buildings, and buildings in other sectors – in particular education, and what we found in the literature search).
  We also compared figures collected for energy and (where available) water use to published benchmarks for healthcare buildings. The energy analysis relied first on converting whatever figures were available from the Trusts (sometimes in $MJ/100m^3$, other times kWh/m^2, and other times simply the meter readings from utilities bills) into $kgCO_2/m^2$, in line with current Department of Health thinking on energy benchmarking.
  For one of the case studies, we were also able to convert information about staff travel into CO_2 emissions, so this could be compared to CO_2 from the buildings.

- Step 4 – Make recommendations
  We used the findings from Step 3 to draft unambiguous recommendations to each of the case study Trusts explaining what they can do to improve, included at the end of each case study report (and collated together in Section 4 of this report).

- Step 5 – Write up results
  This report draws together the results of this work.

Section 2: Overview

We had more difficulty than expected in recruiting Trusts to be involved in the research. It proved very time-consuming to persuade Trusts to allow us to visit and provide the information necessary to assess their sustainability and make recommendations for improvements.

However, in spite of this difficulty, with support from the Department of Health and the North East Strategic Health authority, as well as SHINE's existing contacts in Trusts, we managed to negotiate access to six Trusts representing all of the main types of facility in the NHS, and a good geographical spread. The Trusts involved are shown in the table below.

Name	Type of facility	Region	Notes
Alder Hey Children's Hospital	Specialist acute hospital	North West	Modest improvements planned, but replacement hospital due 2014
Kensington and Chelsea PCT	Primary care	South	Major refurbishment underway
Mental Health Trust	Mental Health and Training	South	Comprehensive refurbishment planned
Northampton General Hospital	Acute hospital	Midlands	Ongoing refurbishment projects
South London Hospitals	Acute hospital	South	2002 building, but scope to refurbish
Washington Galleries, Sunderland	Primary care	North East	Extensive refurbishment complete

The diversity in types of facility was matched by diversity in the Trusts' sustainability objectives, and how much progress they had made in addressing sustainability. They also had diverse sites – from a single building up to a large, complex site with around 50 buildings. The smallest (Washington Galleries) was 3,774m2, while the largest (Northampton General Hospital) was nearly 25 times bigger, at 94,000m2. The largest spent over £2.5m annually on energy alone – so the incentive for acting on sustainability is economic as well as environmental.

Predictably, the services and facilities offered also differed hugely – from predominantly consulting rooms and research facilities (similar to a university building) at the Mental Health Trust, to operating theatres and neurosciences wards at Alder Hey Children's Hospital. Naturally, this diversity of use has a major impact on nearly all aspects of sustainability.

There was also a huge diversity of building types – from Victorian buildings dating to the 1880s, designed to meet 'Florence Nightingale' ward standards, at St Charles' Community Hospital, to the Princess Royal University Hospital, which was completed only in 2002 on a new site. (Our working hypothesis was that even modern buildings, built to superseded

versions of the Building Regulations, present significant opportunities for improving their sustainability. This was borne out by the work.)

Climate change emissions
Unsurprisingly, all of the Trusts in the study had climate change emissions and energy use as their main priority in relation to sustainability. (In line with DH's emphasis on climate change in its sustainability work.) All of them had begun thinking about how to reduce energy consumption in buildings, and two had already undertaken major capital investments to reduce CO_2 emissions from their buildings. Some had also begun to set targets for CO_2 emissions reductions.

More surprisingly, though, only one of the Trusts had collated robust energy consumption data and compared it to benchmarks for similar buildings. None of them had been able to break down energy consumption or CO_2 emissions by final use (heating, lighting, catering, equipment, etc.).

Other aspects of sustainability
Regarding other parts of the sustainability agenda, and specifically the other points in SHINE's list of principles for sustainable healthcare buildings (see www.shine-network.org.uk), the information available and Trust priorities were very different. Some Trusts, like St Charles' and the Mental Health Trust, are keen to make progress on travel and transport. Whereas other Trusts are more focused on reducing water use (Northampton), or patient comfort (Washington Galleries and Princess Royal), or providing facilities for local people (Alder Hey).

Some of the Trusts have more green space on their sites than others, and some view green space and ecology as very important while others put much less weight on this.

To summarise the most important themes to emerge in each case study, the tables below shows the three main issues we identified at each building or group of buildings.

Case Study	**Main issues**
Alder Hey Children's Hospital	High electrical consumption Short payback improvements: lighting, inverter drive ventilation, heating controls Travel and waste identified as priorities
Kensington and Chelsea PCT - St Charles	Grade II* listed building vs. desire to achieve NEAT 'Excellent' through refurbishment Holistic, strategic approach Developed protocol for sustainable development
Mental Health Trust	Climate change emissions from buildings and transport Thermal comfort Green space and landscaping
Northampton General Hospital	Climate change emissions from buildings Water use for dialysis and rinsing Longstanding travel plan
Princess Royal University Hospital	Summer overheating High electrical consumption Adapting to hotter summers
Washington Galleries, Sunderland	High electricity use – cooling? Education and awareness-raising for staff Adapting to hotter summers

Section 3: Case Studies

Section 4: Analysis

This section looks across all six case studies, tabulating data and making comparisons between them. It also tries to identify patterns that emerge from the data – links between, for example, size and action on different aspects of sustainability. The conclusions drawn here are necessarily tentative – because we have looked at relatively few case studies – but they are intended for other work researching sustainability in existing healthcare buildings to add to.

What have they done?

All of the Trusts and buildings in this study have taken some concrete action on sustainability. Using the list of issues from the Introduction section as a way to categorise what they have done, they have all made measurable progress on at least three of the 11 issues we identified (see table, below).

The Trusts are most likely to have taken action on CO_2 emissions or, surprisingly, some form of whole life costing. (Some of the Trusts were encouraged in this direction by support provided by the Carbon Trust, who prepared their recommendation in terms of whole life costs. Others were driven by the opportunities they saw to cut costs through better energy efficiency.)

The issues they were least likely to have tackled were choosing low impact materials, water use and providing facilities for local people. (These issues have probably received less attention from the Department of Health and other government agencies than climate change and some of the other aspects of sustainability.)

There are very few obvious patterns or correlations between different aspects of sustainability. There may be a link between addressing climate change emissions and whole life costing, but the link would not pass tests of statistical validity with such a small sample. (This apart, it would be easy to explain such a link: focusing on whole life costs makes Trusts more likely to spot opportunities to reduce running costs, and energy is one of the more controllable aspects of a Trust's operating costs. In addition, whole life cost calculations make it easier to justify investment in energy efficiency and low carbon upgrades.)

Size and action

Building floor area is a reasonable proxy for the size of a healthcare Trust – although community-based healthcare services typically have less floor-space per patient (because services are often provided in people's homes). We have sorted the Trusts below by size, with the largest at the top of the table.

However, there is no clear link between the size of Trusts and their progress on different aspects of sustainability. (This is the 'breadth' measure; the 'depth' measure of how much they have achieved is more difficult to evaluate, and again there is no obvious link between scale and how much Trusts have done.) It is true that the largest Trust, Northampton Hospital, has taken more measurable action than any of the others, but the second-largest, Alder Hey, seems to have achieved much less – partly because they are building a new hospital, due for completion in 2014.

At the small end of the scale, Washington Galleries does not show evidence of acting across the whole range of sustainability issues (although it has done more than any of them on the specific issue of climate change emissions). But the second-smallest Trust, St

Charles Hospital, appears to have tackled many more issues – suggesting that small scale does not act as a particular impediment to action.

MESH Case Studies: **Past Action**	Size (m2)	Energy and CO_2	Climate change adaptation	Water use	Travel and transport	Green space and landscaping	Waste and recycling	Providing a high quality internal environment	Whole life costs and investment appraisal	Low impact materials	Improving historic/listed buildings	Providing facilities for local people
Northampton General Hospital	94,000	✓	✓	✓	✓	?	✓	✓	✓	✘	✓	?
Alder Hey	58,256	✓	?	✘	✓	?	✓	✓	✓	✘	✓	✓
Princess Royal Hospital	45,000	✓	✓	✘	✓	?	✓	✓	✓	✘	✘	✘
Mental Health Trust	7,390	✓	✘	✘	✘	✓	✓	✓	✓	✘	✘	✘
St Charles Hospital	5,400	✓	✘	✘	✓	✓	✓	✓	✓	✓	✓	✓
Washington Galleries	3,774	✓	✓	✘	?	✘	?	✓	✓	✘	✘	✘
Total known to have acted		**5**	**3**	**1**	**4**	**2**	**4**	**4**	**6**	**1**	**3**	**2**

Key: ✓ = has made measurable progress on this issue
✘ = has not made measurable progress
? = no evidence available

Planned future action

A similarly complex pattern emerged for the Trusts' plans for addressing sustainability in the future, see the table on the next page. All of them intend to improve the internal environment in one way or another. Virtually all of them also intend to do something to reduce energy use and CO_2 as well. Travel and transport and whole life costing are the next most likely targets for future attention, and four Trusts intend to address these.

However, only one of the Trusts appears to have documented plans for using materials with a low environmental impact (Alder Hey, in its ambitious plans for the new hospital), and only two of them have plans to reduce water use or to provide facilities for local people. This is remarkably consistent with past action by the Trusts, above, and underscores how, currently, Trusts put less emphasis on these aspects of sustainability.

There appears to be some correlation between planned action on energy and CO_2, climate change adaptation, and providing a high quality internal environment. However, there are too few case studies in this sample to draw any definitive conclusions about this correlation.

As before, the Trusts are sorted by size in the table, with the largest by floor area at the top. There appears to be a somewhat stronger correlation between size and planned future action than there was with past action, but again the link is inconclusive. It is likely, based on our interviews, that some larger trusts have more staff time to devote to

sustainability issues. However, some small buildings (such as NHS Tyne & Wear/Washington Galleries) have access to more staff time from the parent trust and can therefore be more ambitious in their future sustainability work.

There is no obvious relationship between past or future sustainability work and the type of the trust: primary healthcare trusts do not appear to have accomplished more or less than acute trusts or the mental health trust. However, again the small sample size makes it harder to identify such patterns.

Overall, having a corporate commitment to sustainability and a sustainability 'champion' appear to be more significant in what trusts can achieve than their size or the type of trust.

MESH Case Studies: **Planned Action**	Size (m2)	Energy and CO_2	Climate change adaptation	Water use	Travel and transport	Green space and landscaping	Waste and recycling	Providing a high quality internal environment	Whole life costs and investment appraisal	Low impact materials	Improving historic/listed buildings	Providing facilities for local people
Northampton General Hospital	94,000	✓	✓	✓	✓	?	✓	✓	✓	?	✓	?
Alder Hey	58,256	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Princess Royal Hospital	45,000	✓	✓	✘	?	?	✘	✓	✘	✘	✘	✘
Mental Health Trust	7,390	✓	?	?	✓	✓	✓	✓	✓	?	✘	?
St Charles Hospital	5,400	?	?	✘	✓	✓	?	✓	✓	?	✓	?
Washington Galleries	3,774	✓	✓	?	?	?	?	✓	✓	?	✘	?
Total that plan to act		**5**	**4**	**2**	**4**	**3**	**3**	**6**	**5**	**1**	**3**	**1**

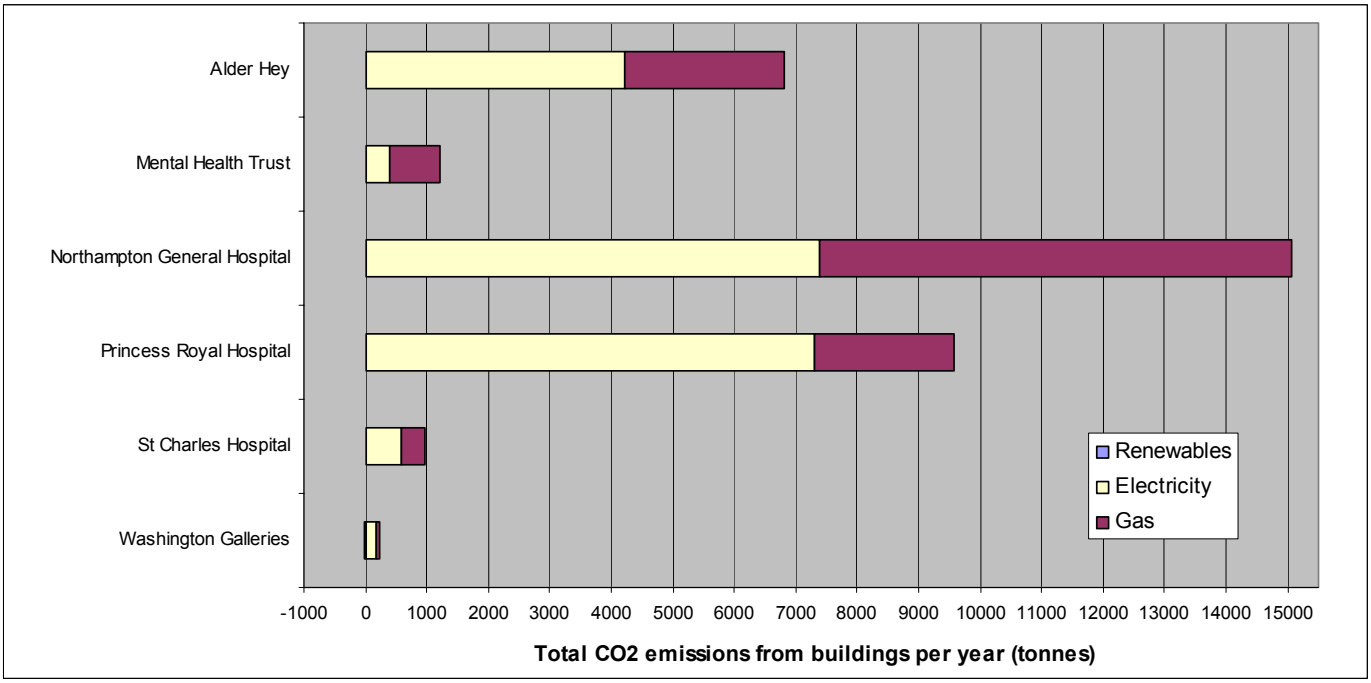
Key: ✓ = have documented plans to address this issue
✘ = do not have documented plans to address this
? = no evidence available

Energy Analysis

We have energy data describing gas and electricity use from all of the Trusts in the study. In most cases this is based on actual energy use data from utilities bills that reflect a full year's consumption. This is broadly robust evidence. However, in two cases bills data was not available. For the first, St Charles Hospital, currently being refurbished, utilities bills are not available for the period before refurbishment. Consequently, we estimated gas and electricity use based on design estimates – so the data should be treated with caution. Such design estimates typically under-estimate actual energy use, and CO_2 emissions per m^2 are probably higher than those reported here.

For the second case study, Princess Royal Hospital, no bills data was available, so we inferred gas and electricity use from calculations by the Carbon Trust. It was not possible to check the robustness of the Carbon Trust figures.

Total CO_2 emissions per year in all of the Trusts are shown in the graph below, with CO_2 from electricity shown separate from CO_2 from gas – following good practice in reporting CO_2 emissions. There is a large range of emissions between the trusts – from 197 tonnes for Washington Galleries to more than 15,000 tonnes for Northampton General Hospital. Unsurprisingly, much of the variation is linked to floor area, and we present CO_2 emissions per m^2 of floor area below. Unfortunately, tonnes of CO_2 are meaningless to most people. Even knowing that the UK's total annual emissions of CO_2 are 577 million tonnes of CO_2 doesn't help people to make sense of these figures.



To make it easier for readers to digest the emissions data, we have converted emissions into equivalent number of homes – based on an average UK home emitting six tonnes of CO_2 per year. The results are shown in the table below, along with floor areas converted into number of homes (assuming an average UK house is $85m^2$).

	CO_2 (equivalent number of homes)	Floor area (equivalent number of homes)	Ratio compared to an average UK home*
Alder Hey	1,135	685	1.7
Mental Health Trust	200	87	2.3
Northampton General Hospital	2,509	1,106	2.3
Princess Royal Hospital	1,594	529	3.0
St Charles Hospital	163	64	2.6
Washington Galleries	33	44	0.7
Mean values	939	419	2.1

*CO_2 emissions represented in home-equivalents divided by floor area in home-equivalents.

The table shows that these trusts have CO_2 emissions equivalent to between 33 and 2,509 times an average UK home – typically but not always higher than the ratio of their floor size to an average home. On average, the trusts' CO_2 emissions per m^2 are more than double those for an average dwelling. This is not surprising because, unlike most homes, they tend to be used intensively and consequently are heated and lit all of the time, and most of the buildings also have lots of medical and other equipment that uses energy.

The lowest ratio of CO_2 emissions to floor area is Washington Galleries, a primary healthcare facility in Sunderland. This building underwent a major refurbishment where energy efficiency was one of the primary drivers. It is a testament to that project's success that CO_2 emissions are even lower, per m^2, than those for a typical UK home. However, CO_2 emissions from primary healthcare buildings are nearly always lower than those from acute hospitals, because the latter are used continuously (notably at night), and they have more medical and other electrical equipment.

It is surprising that Princess Royal Hospital has the highest emissions of CO_2 relative to an average home, given that it is the most recently-built hospital of all case studies. This appears to be entirely due to its high electricity consumption from lights, equipment and air conditioning. Without the exceptional electricity consumption, it would be around the average for hospitals. We return to the issue of electricity consumption in more detail below.

There are published benchmarks for energy use in healthcare buildings, and these can be converted into CO_2 emissions per m^2, as we did for the case studies. All of the case study emissions data are compared to these benchmarks in the graph on the next page. There are three benchmarks – one from CIBSE (the Chartered Institute for Building Services Engineers) for "clinics", and two from the Carbon Trust for "hospitals". All three have limitaions, for different reasons.

There is no widely-accepted benchmark for existing healthcare buildings apart from the Department of Health's figure of 55-65 GJ/100m^3, which lacks meaning for most people, and cannot easily be compared with buildings in other sectors. The DH benchmarks are intended as a minimum for refurbishments of existing buildings, but actual energy consumption goes unmeasured in most healthcare buildings.

The DH benchmarks cannot be converted directly into kgCO_2/m^2, and DH itself is working on new benchmarks. However, 55-65 GJ/100m^3 converts to roughly 95-110 kgCO_2/m^2 (depending on the mix of electricity and heating fuel). As the graphs show, only one of the case studies – Washington Galleries – achieves this.

We have used benchmarks from CIBSE and the Carbon Trust because they distinguish between electricity and heating fuel, which is important in energy and CO_2 analysis because UK electricity has CO_2 emissions per kWh of energy two-and-a-half times those of gas.

However, even these benchmarks are flawed. The Carbon Trust's benchmarks are weak because they were based on assessments of energy use in hospitals in the 1980s-1990s, when electricity use was lower than it is today. CIBSE's benchmark for clinics is the closest benchmark available to apply to GP's surgeries like Washington Galleries, but GP's surgeries are not exactly 'clinics', and some of the accommodation in a surgery is more like office accommodation than a clinic. Finally, there is no publicly-available benchmark against which to assess mental health facilities – which aren't either hospitals or clinics.

Nevertheless, comparing our case studies' CO_2 emissions per m^2 with these benchmarks indicates that all of them except Washington Galleries and Alder Hey have high CO_2 emissions. This suggests, quite rightly, that at least four of the six have significant potential to reduce emissions.

The second point emerging from the analysis is that electricity consumption is consistently higher – in almost every case – than the published benchmarks. (Even at Alder Hey, where there has been a conscious effort to reduce electricity consumption.) As we noted above, this is partly because the benchmarks themselves are based on historic data – from a period when electricity use was lower. This raises two questions:

1. Should we re-assess electricity benchmarks for hospitals and other healthcare buildings to reflect higher electricity use? (Yes)

2. (More fundamentally) Should we reassess the way patient services are delivered in ways that return the healthcare estate to much lower electricity use from the 1980s and 90s? (I.e. with fewer, or better-controlled, patient entertainment systems, and less comfort cooling.)

Even accepting that all case studies exhibit high electricity consumption, there remain very large variations in use between trusts. Surprisingly, the most modern building of them all – Princess Royal Hospital – has electricity use nearly three times the benchmark for a 'typical' building. Given advances in lighting efficiencies, greater concern about avoiding overheating, and much stricter control of energy efficiency in the Building Regulations, you might expect a modern building to use *less* electricity than an older one. Why is it that a modern building actually has higher CO_2 emissions per m^2 than older ones?

The reasons for over-consumption are complex and building-specific, but it is likely that the trend towards larger windows, married to better standards of insulation and lightweight construction, increases the risk of summer overheating. When mechanical ventilation and cooling are used (to combat the overheating) this leads to significantly higher electricity use.

The structure of the procurement route also seems to have made it more difficult to implement known, tried-and-tested design ideas that would have helped to improve sustainability. At Princess Royal, there was intense pressure to minimise capital costs initially, and it is now difficult and expensive to alter the building in any way. The way energy costs (specifically heating costs) are paid also mitigates against low-carbon strategies. (Heat is supplied through a separate PFI agreement, and there is an incentive for the PFI operator to use the cheapest form of heating, not the form emitting least carbon.)

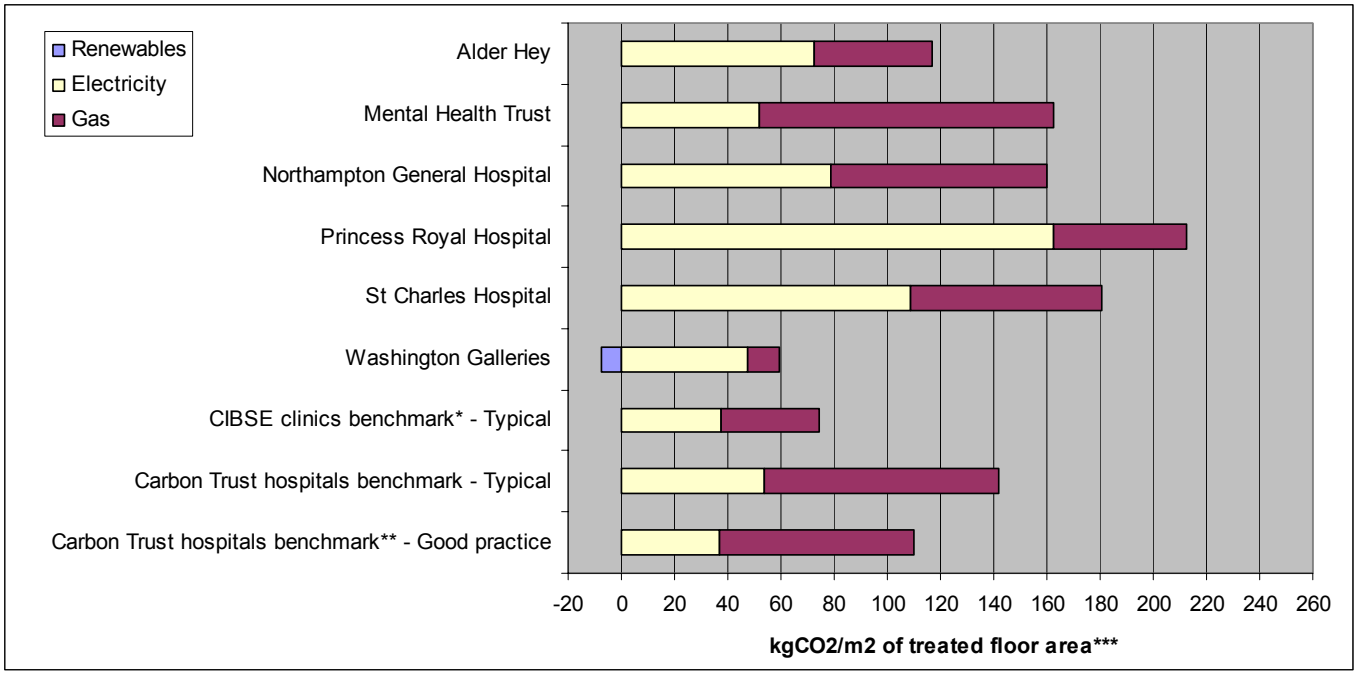
Another trend revealed in the data is that buildings with high electricity consumption (like Princess Royal, St Charles, Northampton General and Alder Hey) have relatively low heating fuel consumption. High electricity use results in high internal gains, which is likely to compensate for gas or oil-fired heating in winter.

There appears to be some correlation between floor area and energy consumption per m^2, with larger buildings emitting more CO_2 per m^2. However, how much attention the Trusts have given to energy efficiency and CO_2 reductions appears to be more significant in determining CO_2 emissions.

Perhaps surprisingly, the date of construction does not appear to be a significant determinant of energy use or CO_2.

The final observation is that the contribution from renewable energy systems in all of these buildings is tiny. Only one of them – Washington Galleries – has any renewable energy so far. It is a coincidence that Washington Galleries happens also to be the facility with lowest CO_2 emissions, and the contribution its solar water heaters make to reducing its CO_2 emissions is modest.

Collated CO_2 emissions from all case studies



*CIBSE (2008) TM46: Energy Benchmarks, CIBSE, London. **Energy Efficiency Best Practice Programme (1998) ECON72: Energy Consumption in Hospitals, Carbon Trust, London. *** CO_2 conversion factors: electricity 0.537, gas 0.185. Treated floor area is the area that is heated or cooled and lit by electric lights.

Section 5: Recommendations

This section starts by bringing together the recommendations from all six case studies. It goes on to develop a self-assessment tool allowing Trusts in different circumstances to prioritise action on sustainability for themselves.

Alder Hey Children's Hospital

- Assess and focus on areas with high energy consumption.
- Consider 'quick wins': improvements with short pay-back periods that are practical and cost effective.
- Seek funding from external sources and use maintenance budget as much as possible to improve sustainability.
- Do not neglect other sustainability issues unrelated to refurbishment, that can be improved to everyone's benefit: transport, improved performance strategies.

Northampton General Hospital

- Connect new Combined Care building to the CHP – there is currently insufficient demand for heat to absorb all of the heat from the existing CHP system. By connecting Combined Care to the CHP, more of the heat generated could be used, saving energy and CO_2 for heating this new building.
- Install an absorption chiller connected to the CHP to provide chilled water for comfort cooling in the Main Theatres. Also install a chilled water ring main to deliver the cooling water to where it is needed.
- Connect the unused heat recovery circuit for the Main Theatres to a thermal wheel or similar device so that heat from outgoing air can be used to warm incoming air. This will also reduce the cost and CO_2 for heating the operating theatres.
- Lighting – investigate possibility of replacing older T8 and T12 luminaires with modern, more efficient T5s, and modern controls with daylight or movement sensors.
- Cooling – investigate how to reduce unnecessary cooling below 24ºC, which would cut the number of hours comfort cooling is used, and how intensively the chillers need to run when cooling is on.
- Investigate passive and night cooling for areas currently served by comfort cooling – to reduce electricity use for cooling.

Princess Royal University Hospital

- Introduce photocell and movement sensors and dimmable luminaires.
- Remove the automatic turn on of patient entertainment systems.
- Ensure that HVAC controls adjust between day and night environments, and for occupancy levels.
- Set a 2ºC difference between the Return Air Temperature set point and the cooling 'on' set point where there is a tempered ventilation air supply in the same room or a

2ºC difference between the space temperature set point and the cooling 'on' set point where there are heat emitters.

- Introduce an awareness raising campaign, equating the effects of leaving lights and fans on or mis-use of the setback functionality to the effects of use of everyday items.
- Plant the planned trees to help shade the building and reduce solar gain.
- Where possible, use planting boxes under windows to prevent heat rising into floors from concrete or tarmac.
- Assess potential for tri-generation (using CHP for cooling).

St Charles' Community Hospital

- Do not use listed status as a reason not to consider sustainability and not achieve 'Excellent' NEAT or BREEAM ratings.
- Incorporate sustainability from the start of the project.
- Adopt a holistic approach to sustainability, including issues not directly related to the refurbishment.
- Develop a generic sustainability protocol that can be tailored to individual projects.

Mental Health Trust

- Draw up a phased strategy for improving the multi-storey building's thermal performance. This needs to tackle wall insulation, glazing and air tightness. It will be expensive and complicated, but also essential if the Trust is to meet long-term targets for reducing climate change emissions. The strategy needs to consider both financial implications and how to create decant space so the upgrades can take place.
- Explore and cost the options for charging electric vehicles in the Trust's car park.
- Explore how the flat roof of the multi-storey building could be used as a roof garden offering therapeutic and recreational activities.
- Lighting – continue the replacement of older T8 and T12 luminaires with modern, more efficient T5s, and modern controls with daylight or movement sensors.

Washington Galleries

- Most of the easy wins for energy efficiency have already been taken on this building, and there are no opportunities to make low cost upgrades to the building. (There is evidence of this in the EPC Recommendation Report, which has no short- or medium-term payback recommendations.)
- The Trust should focus on ensuring that staff understand how to operate the building – that they need to open windows early in the morning, and perhaps close them at lunchtime when it's hotter outside than inside.
- The Trust should also discourage using mechanical cooling at the same time as heating (or perhaps improve the controls of cooling equipment to stop this).

- It should also consider limiting mechanical cooling so the minimum summer temperature is 24^{o}C, so avoiding wasteful use of air conditioning.

Commentary

Some of these recommendations are specific to the building or Trust they apply to, while others are generic, and would apply to most Trusts seeking to refurbish their building(s) to improve sustainability. Most of them relate to buildings, but a few are aimed at broader aspects of sustainability, sometimes extending beyond the built estate, and/or to management issues.

All of the recommendations require some resources to implement – even those that do not need capital investments do require some investment of staff time to plan and carry out. We understand that Trusts have limited resources, and we would not wish to dictate to trusts what they need to do to address sustainability. These decisions lie with the trusts themselves, and any successful initiatives do in any case need to align with their own motivations and aspirations. Ownership and buy-in are important factors in making progress on sustainability, and not all trusts will wish to achieve the same thing.

However, based on this study we have selected recommendations that apply to most trusts. These serve as a framework for others to adapt as they see fit. We have divided them into two parts (Energy and CO_2, and 'Other issues'), see next section.

Some points arising from this research lie outside the control of individual trusts – they are policy questions in the hands of government agencies including the Department of Health, the NHS Sustainable Development Unit, the Treasury and others. These are dealt with in the final section, "Policy recommendations".

Recommendations for all trusts

Energy and CO_2

Adopt a strategic, long-term plan for reducing energy use, which may include:

- Assessing energy use and identifying areas with high consumption
- Implementing 'quick wins': improvements with short payback periods that are straightforward to carry out
- Raising awareness of energy issues – especially unnecessary lighting, ventilation, cooling and heating

Then carry out other upgrades where appropriate (see also *Sequence of upgrades*, p71*),* for example:

- Considering combined heat and power and 'trigeneration' (heat, cooling and power) if you have mechanical cooling
- Considering heat recovery if you have mechanical ventilation
- Adjusting controls to avoid unnecessary cooling and prevent cooling and heating at the same time
- Exploring passive and night cooling
- Investigating automatic lighting controls and more efficient lights
- Improving controls on patient entertainment systems

- Improving insulation and airtightness
- Exploring the cooling and other benefits of green space/ landscaping

Raise awareness of energy issues – especially unnecessary lighting, ventilation, cooling and heating

Other issues

Recognise that sustainability is not just about energy and CO_2, and adopt an holistic strategy, including:

- Water management – avoiding unnecessary water use
- Outdoor spaces – for use as therapeutic and recreation areas for patients and the public, to support passive cooling, and to promote biodiversity and ecology
- Waste minimisation – including recycling
- Travel and transport – for staff, patients and visitors. Draft a Travel Plan if you don't already have one.

Although waste and travel are not directly related to refurbishment, many Trusts find it helpful to consider different aspects of sustainability together.

Self-assessment tools

Tool 1: Choosing priorities

There are many different aspects of sustainability, and all are important. However, we are all working under scarce resources, and it is counter-productive to try to improve every aspect of your Trust's sustainability all at once. Instead, it is better to prioritise the aspects that are most important to you now and make progress on those.

The chart below summarises the key aspects of sustainability, identified by SHINE's past work on sustainability and NHS Trusts. Try to pick just three or four of them to concentrate on in the early stages of work on sustainability in your Trust. You may find it helps to put one or more ticks on those that are most important, and crosses on the aspects that are less of a priority for you now – to return to in the future. (This could be based on you assessment of the most significant environmental or social impact of each aspect, or how well they fit with your Trust's strategic priorities.)

You may like to work on this with a group of your colleagues to try to build consensus about the most important issues for the Trust. This is a good way to engage people in your work on sustainability, and inevitably different people have different views about what is important.

1. Reducing car travel and encouraging sustainable forms of transport	6. Integration with the local environment and local regeneration
2. Using resources (energy & water) efficiently, so cutting climate change emissions	7. Providing facilities for local people
3. Delivering cleaner, greener, public spaces that are rich in biodiversity	8. Using materials that reduce environmental and health impacts
4. Cutting pollution and waste	9. Providing a high quality internal environment
5. Considering whole life performance, including long-term asset value	10. Building flexibility and adaptability into facilities

Now that you have worked out your priorities, you can assess how much progress you have already made, and work out what tasks follow from your priorities. For example, if you decided that “Cutting pollution and waste” is something you want to address in the short-term (say, in the next year), you might think you need to do a waste audit to see exactly where the Trust stands in its waste. (See below.) The audit would assess the volume and type of waste that is generated, and how it is currently disposed of. This might identify opportunities for recycling more waste, or give you ideas for how to reduce waste at source.

Alternatively, if you have already completed a waste audit, you’ll probably already know quite a lot about waste and recycling. You might decide that you need to improve collection facilities for recycling and run awareness-raising for staff and patients about avoiding waste.

4. Cutting pollution and waste	→ Carry out a waste audit – what, how much and where?
	→ Improve recycling facilities and raise awareness

Below is a complete set of suggested tasks for different priorities. Please note that these tasks are not exhaustive and do not apply to all Trusts or all buildings. They are intended as suggestions to help kick-start your own discussions about what to do first – it is not possible to provide a blueprint that applies in all circumstances.

1. Reducing car travel and encouraging sustainable forms of transport	→ Develop a Travel Plan – what do you want to achieve on transport?
	→ Plan how you can encourage walking, cycling and bus transport
2. Using resources (energy & water) efficiently, so cutting climate change emissions	→ Work out your current CO2 emissions
	→ Work out a strategy for cutting CO2 emissions
3. Delivering cleaner, greener, public spaces that are rich in biodiversity	→ Assess the Trust’s current provision of public space and biodiversity
	→ Identify improvements you could make over time
4. Cutting pollution and waste	→ Carry out a waste audit – what, how much and where?
	→ Improve recycling facilities and raise awareness

5. Considering whole life performance, including long-term asset value	Draw up a site-wide strategy for maintenance and refurbishment
	Use cost-benefit analysis to compare between refurb. options
6. Integration with the local environment and local regeneration	Assess how the Trust can support recreation space & green transport
	Work with local stakeholders to tie development plans to local priorities
7. Providing facilities for local people	Assess what facilities could be opened to the local community
	Work with local schools and the local authority to see what's needed
8. Using materials that reduce environmental and health impacts	Identify products, like PVC and MDF, known to harm human health
	Specify preferred materials in your Tenant's Requirements
9. Providing a high quality internal environment	Examine staff and patient areas to spot interiors needing improvement
	Survey staff and patients to see what they think needs improving
10. Building flexibility and adaptability into facilities	Include the need for flexibility in your Tenant's Requirements
	Ask how government policy on healthcare will affect your Trust

Tool 2: Energy and CO_2 Emissions from Buildings

Most of the Trusts involved in the MESH study had energy use and carbon dioxide emissions at the top of their list of priorities. Most of them were also working to reduce CO_2 emissions from their buildings. The actions they were undertaking were quite varied - they depended partly on their buildings, and partly on what they had done already.

We inferred from the diversity that there is a logical sequence of 'upgrades' Trusts can make to their buildings. The sequence is linked to cost-benefit analysis. Broadly, Trusts should aim to save as much CO_2 as possible within the resources (time and money) they have available. It usually makes sense to implement "quick wins" first (if only to show that it is possible to reduce CO_2 emissions, and to gather support for more work).

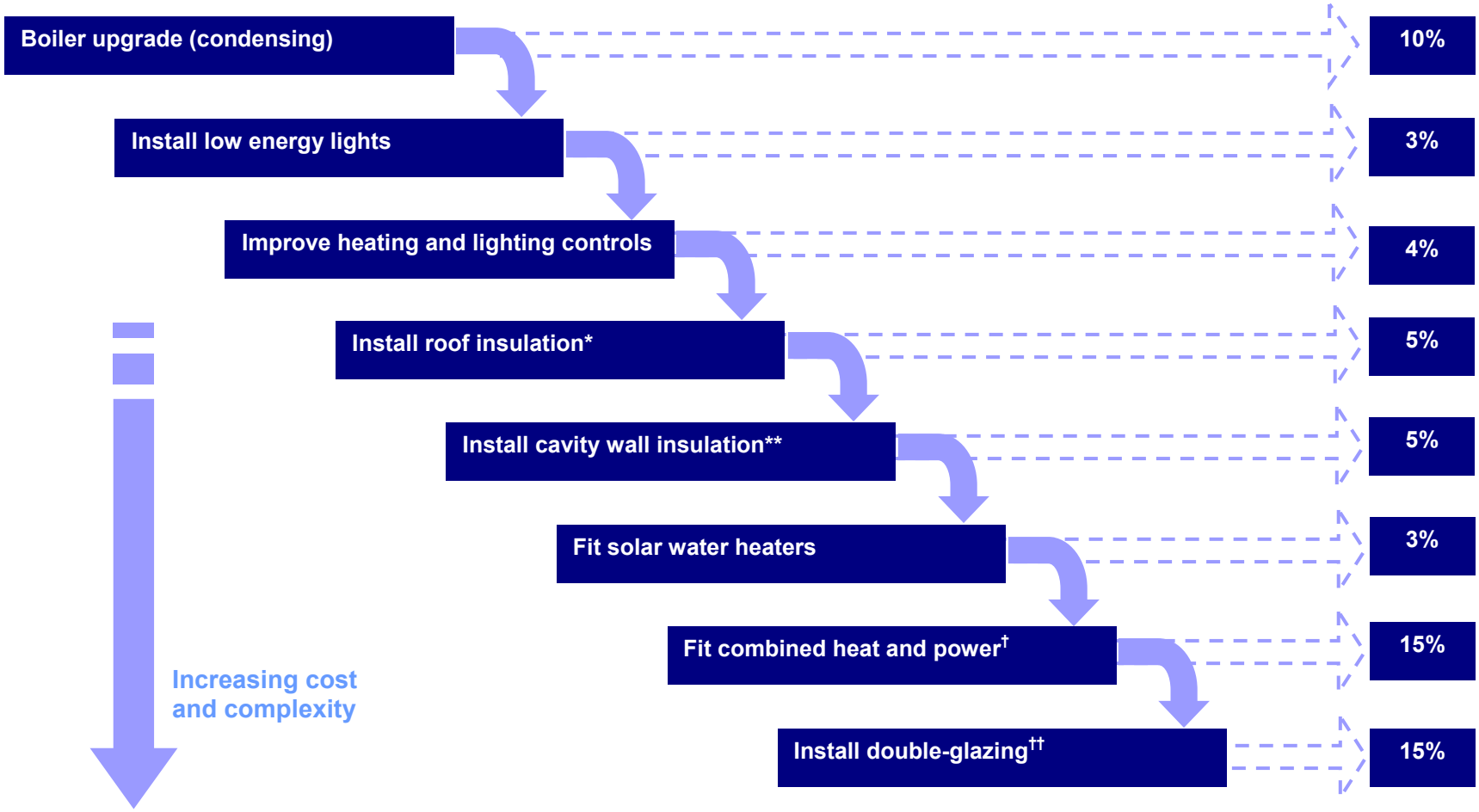
Some upgrades, while very desirable, are very disruptive, and in many cases it would not be possible to continue offering services to patients without decanting to another building while the work is carried out. (An example is installing dry-lining insulation on solid-wall Victorian buildings.) Few Trusts have the luxury of empty buildings they aren't using to decant services into, so this sort of work requires careful planning and is only realistic as part of a long-term refurbishment strategy.

The chart below gives a suggested sequence for a 'typical' existing healthcare building that has not been significantly refurbished. It may not apply directly to every building, or to every Trusts, but it is a good place to start when thinking about how to improve your buildings. It may also help guide a site-wide CO_2 reduction strategy.

If your Trust has not looked in detail at the potential for cutting CO_2 from its buildings, and is concerned about the Carbon Reduction Commitment and the NHS Carbon Reduction Strategy, this will help you to understand the possible steps involved in bringing an existing building up to modern standards of energy-efficiency.

Alternatively, if you have already carried out some upgrades to your building(s), the chart will help to clarify what you should think about next. Most renewable energy systems have been left off because they are either very site-specific (like wind turbines and ground-source heat pumps) or very expensive (like photovoltaics).

The 'Indicative CO_2 Savings' shown at the right of the chart show approximately what proportion of building CO_2 could be saved from implementing each of the upgrades on its own. These percentages cannot simply be added together because multiple upgrades work together in complex ways.



‡The sequence is generic, and the exact order may change depending on your circumstances. *Assuming there's a poorly insulated pitched roof. **If there are unfilled wall cavities. †Especially if there is a use for heat generated in summer, like a pool. ††If windows are currently single-glazed.

Section 6: Policy findings and recommendations

The number of Trusts who had engaged proactively with sustainability improvements for their existing estates was very limited. From a database of over 500 individuals, we could identify only around 30 Trusts who had either made sustainability improvements to their buildings in the past two years, or who planned to do so imminently. This does not mean that other Trusts have not developed a carbon management or sustainability improvement plan for their estate, but we did not find them. Similarly, the Carbon Trust lists only 15 healthcare organizations that have taken part in their Carbon Management Programme.

Policy recommendation 1: *All NHS Trusts, PCTs and Mental Health Trusts should be required to prepare a sustainability improvement plan for their estate, or at least a carbon management and reduction plan, irrespective of their size.*

More surprisingly, only one of the Trusts that participated in the SHINE study (i.e. one of those that had already made the most progress on sustainability or energy improvements) had collated robust energy consumption data and compared it to benchmarks for similar buildings. None of the Trusts had been able to break down energy consumption or CO_2 emissions by final use (heating, lighting, catering, equipment, etc.).

Policy recommendation 2: *All NHS Trusts, PCTs and Mental Health Trusts should be required to collect energy consumption data for their estate, ideally broken down at least into heating, building-related electricity, and medical equipment.*

Given the above points, it is worth asking why so few Trusts had developed a proactive approach to address the energy or sustainability performance of their estate. During this project, the research team organized two workshops that served both a consultative and a dissemination purpose. At the second workshop, which ran in March 2010, near the end of the project, we asked the 35 delegates:

1. If you [the attendee] are already making energy efficiency/ carbon reduction or sustainability improvements to your estate, what is the driver for doing so?

The main responses to this question are listed in the table below:

	current drivers
NHS Regulations and Controls	
Mandatory Requirements (e.g. BREEAM rating linked to funding approval, CIAMS)	5
Behaviour change	
Leadership	7
Financial	
Cost savings	6
Other Regulations and Controls	
Other requirements (eg CRC or Display Energy Certificates)	4

Note: the numbers shown simply represent the number of responses at the event.

These results have no statistical significance, but it is interesting that Leadership was cited as a key driver more often than NHS Regulations and Controls. The finding that

Leadership was one of the important drivers chimes with our findings from analysis of the six case studies, where we found that "having a corporate commitment to sustainability appears to be more significant in what Trusts can achieve than their size or the type of Trust". This could be developed and exploited further.

Policy recommendation 3: *Leadership programmes should be developed to encourage, train and support Trust Board Members, Non-Executive Directors and/or other senior staff to take a leadership role in improving the sustainability performance of their estate.*

It is also worth reflecting on why "Regulations and Controls", both within the NHS and elsewhere, weren't identified as a major driver by more of the attendees. Again, the MESH research team undertook a brief literature review to identify existing Regulations and Controls, which resulted in the following list:

a) CRC Energy Efficiency Scheme
b) Capital charges
c) Commissioners Investment and Asset Management Strategy (CIAMS)
d) Premises Assurance Model (PAM)
e) Estatecode (now part of CIAMS)

Of these, the Premises Assurance Model did not come into effect until April 2010 and CIAMS does not yet seem to include any sustainability requirements. Furthermore, feedback from the second MESH workshop suggested that Capital Charges may actually discourage the adoption of sustainability or energy efficiency/ carbon reduction measures. It therefore appears that the only effective Regulations and Controls that are driving performance improvement for existing estates is the CRC Energy Efficiency Scheme; BREEAM Healthcare also has a significant impact (as with new-build), but only on significant refurbishments, not on smaller improvement schemes.

Policy recommendation 4: *Energy efficiency/ carbon reduction measures should be incorporated into existing Regulations and Controls, particularly CIAMS and PAM. These or similar controls should be extended to cover smaller improvement/ refurbishment projects, as well as major refurbishments covered by BREEAM.*

The second question asked at the final workshop was:

2. "What do you [the attendee] need to improve your performance further?"

	Needs
NHS Regulations and Controls	
Formal requirement on the Board (eg. Tier 1 and Tier 2 Targets)	6
Behaviour change	
Leadership	3
Financial	
Incentives	4

Again, these results have no statistical significance, but it is interesting to note that Leadership was again cited as a key driver and the Regulations and Controls suggested would require more leadership from the Trust Board. This therefore **reinforces Policy Recommendation 3.**

And finally, a number of knowledge requirements were specifically identified during the second workshop:

	Needs
Knowledge	
Introductory sustainability briefings	4
Details of costs and benefits	4
Tools and support services	3
Information about links between service design and estates strategy	3

Of these requirements, all except "Tools and support services" could reasonably be interpreted as methods to engage the senior personnel (Board, Non-Exec Directors and senior management) within a Trust. Again, this chimes strongly with the previously expressed need to encourage greater leadership from senior management, and again **reinforces Policy Recommendation 3**.

However, there is further work required to provide this knowledge for senior Trust personnel, which leads to Policy Recommendation 5.

Policy recommendation 5: *Information and guidance should be developed to provide senior Trust personnel with introductory briefings and details of the costs and benefits of improving the energy efficiency/ carbon reduction and sustainability performance of their existing estate. Such guidance should also explore the links between service design/ delivery and the estate strategy, and consider how changes to the estate can help with service efficiency and quality improvements.*

And finally, the suggestion that "Tools and support services" are needed, although only a small part of the remaining picture, is also worth addressing. The MESH research identified a number of decision-making tools or processes that Trusts could use to prioritise their energy/ carbon and sustainability improvement actions. Tool 2, relating to energy/ carbon improvements, has very similar recommendations to the Marginal Abatement Costs table in *Saving Carbon, Improving Health – NHS Carbon Reduction Strategy Update* (NHS Sustainable Development Unit, 2009), and the Carbon Trust also use a similar framework or guidelines. These could usefully be drawn together into one combined/ authoritative piece of guidance that all Trusts could use.

Policy recommendation 6: *Authoritative guidance (possibly a Health Building Note or Health Technical Memorandum) should be developed to provide all Trusts with a framework or guidelines for identifying and prioritizing the energy efficiency/ carbon reduction improvements they could make to their existing estate. This could usefully be linked to the requirement to prepare a carbon reduction strategy (Policy Recommendation 1), as it would effectively give guidance about how to prepare such a plan.*

Policy recommendation 7: *The guidance proposed in Policy recommendation 6 should gradually be extended to provide a framework or guidelines for identifying and prioritizing the broader sustainability improvements that Trusts could make to their existing estate.*

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Appendix 1: Interview schedule

SHINE – Sustainable Healthcare Learning Network

Sustainable Healthcare Buildings

MESH Case Study Questions

[Start by telling them about the research project, and how we will use the case studies]

1. What is your role in the Trust?

2. How do you feel about your building(s)?

3. Who uses the building(s) and how?

4. To what extent does the building satisfy their needs?

5. What is the building's history? (when and how has it been refurbished?)

6. What were the overall aims of the building a) when constructed, and b) in its refurbishment? [try to draw out aims relating to sustainability]

7. Were there specific aspects of the [refurb or construction] work intended to reduce the building's environmental impact?

8. What are the main achievements of the building in terms of sustainability? Can you quantify any of the benefits (e.g. energy or CO_2 savings, or amount of public space provided, or number of trees planted, etc.)

9. What were the costs - overall costs of the project (total and £/m2), and individual costs of specific sustainability features where appropriate; capital and whole life costs where possible, including payback periods and comparison with standard where possible (e.g. costs of renewable energy provision, better insulation, more efficient heating or cooling, improvements to public space, etc)

10. What other benefits are there? Did the Trust get extra funding, stakeholder buy-in, better patient recovery/ satisfaction, or staff retention/satisfaction? Can you quantify these benefits?

11. What factors made the project successful? (e.g. a sustainability champion, partnerships, stakeholder engagement)

12. What are the energy and water costs per year? What is the energy consumption per sq m?

13. What carbon dioxide emission does this imply? [they might not know the answers to these two questions, but their response could be revealing]

12. What are the building's major successes and what recommendations would you make in hindsight?

Other details

Try to get professionally taken photo's as well as your own - ideally one frontage of the building, on its own or in the local context, one or more interior photo's, and photo's of sustainability aspects e.g. stakeholder engagement sessions or low energy design features.

Ask for quotes from the project team side (e.g. Chief Exec or Project Director or Sustainability Champion) about the benefits of the sustainability approach. Also one from the stakeholders (e.g. users, local community, staff) - this can be a wider quote about how wonderful the building is, rather than needing to focus on the sustainability aspects.

Finally, ask for agreed contact details for the appropriate contact from Trust, design team and/or contractor. Also list of necessary acknowledgements (funders, perhaps?).