museums & art galleries survival strategies

A guide for reducing operating costs and improving sustainability

MLA Renaissance
Museums for changing lives

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museums & art galleries survival strategies

A guide for reducing operating costs and improving sustainability

including

A five-step plan for institutions plus 205 initiatives to help get you started

Sustainability makes good sense for museums.
A sustainable business is one that will survive and continue to benefit society.

Vanessa Trevelyan, 2010 President of Museums Association
Head of Norfolk Museums & Archaeology Service

Survival Strategies
Contents

Foreword

The UK sustainable development strategy "aims to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations".

Museums and galleries are striving for organisational, social, economic and environmental sustainability in a challenging economic climate, to develop and provide relevant and inspirational services to users. As a result of pressures to become more sustainable, our sector is becoming increasingly aware and focused on the reduction of energy use, costs and carbon emissions.

The Green Museums programme in the North West is part of a nationwide fabric of initiatives and projects developed and supported through Renaissance in the Regions. They have been inspired and guided by the work of the Museums' Association and other agencies on sustainability, and will provide a significant resource for museums and galleries. This work also supports and complements work undertaken by the Heritage Lottery Fund to minimise the environmental impact of capital developments.

Many museums and galleries are located within local authorities and universities that have their own climate change action plans. For example, a groundbreaking initiative to help protect against the impacts of global warming will provide a blueprint for Greater Manchester to adapt to what are now accepted as the inevitable effects of climate change. By 2015 Manchester will be a "Green City" with improved local and global environmental performance and with sustainable transport, which contributes to economic growth.

Our Green Museums programme has focussed on empowering members of staff at all levels to bring about organisational change. We have recognised that in addition to developing technical expertise and confidence, there is a need to strengthen individual responsibility and capacity to influence. An important part of this has been working together as a network of green champions to test ideas, develop transferable findings and to share learning and best practice. We hope that the Survival Strategy is a crucial tool for everyone working in museums to use to make immediate and long-term change in the way we work.

Sustainability remains one of the key challenges for our sector; as a contributor to the Museums Association's consultation stated, 'It's pointless showcasing history to the world if it costs the earth'.

Virginia Tandy OBE
Director of Culture,
Manchester City Council, and
Hub Lead Renaissance North West

Image credit: Ben Blackall

Introduction

Museums, Galleries and Energy

Museums and Galleries consume significant amounts of energy to maintain internal environments to protect and preserve their collections. By targeting this energy demand, significant energy savings can be made.

The Survival Strategy has been developed to build on the Green Museum Step-by-step Guide, delivered as part of Groundwork Derby & Derbyshire's Green Museums programme initiated and funded by Museums, Libraries and Archives East Midlands and Renaissance East Midlands. http://www.mla.gov.uk/what/programmes/renaissance/regions/east_midlands/info_for_sector/collections_buildings/buildings_projects

Together these documents will help your organisation to benchmark current energy and water use as well as waste production, develop a strategy with reduction targets and choose the best options for implementing new practices and initiatives to meet your goals.

The Survival Strategy comprises 5 steps which will guide your institution through the process with a selection of case studies to demonstrate how the survival strategies have been implemented. The 205 upgrade initiatives listed in Step 4 of the Survival Strategy range from low cost, quick win solutions to longer-term schemes across a range of operational activities.

Other environmental sustainability initiatives supported by the Renaissance in the Regions programme are listed on page 58.

Benefits of Change

Improving energy efficiency and acting sustainably now will avoid the increasing costs of acting later and avoid the penalties being introduced by legislation. This is in addition to the immediate benefits of operating more sustainably.

Museums and Galleries are strongly linked to the community, and so have a choice as to how they promote sustainability. Institutions can directly educate the public through newsletters, displays, events etc. Alternatively sustainability can be promoted indirectly through sustainable practices carried out by an institution. Both methods have advantages and disadvantages; however each is a big step towards more sustainable behaviour in the institution and the wider community.

Meet the needs of users, reduce consumption, improve environmental performance and protect your balance sheet

Make do with the current performance of your existing buildings, or plan your survival strategy and reap the rewards - the choice is yours

"Now, it makes more sense than ever for museums to reduce their use of energy and other natural resources; **it's not just good for the planet, but it reduces running costs too.**"

Maurice Davies, Head of Policy and Communication, Museums Association

Survival strategies for museums and art galleries

Legislation

The tightening of the regulatory environment over the last decade is scheduled to increase steadily to meet the overarching Government objective of reducing carbon emissions by 80% by 2050. Below is a list of the relevant legislation and other considerations that are applicable to Museums and Galleries. Additional details about the legislation can be found in the Further Information section on page 53.

- Energy Performance of Buildings Directive (EPBD)
- UK Building Regulations
- BS5454
- Government Indemnity Scheme
- The Carbon Reduction Commitment Energy Efficiency Scheme (CRC)
- Feed in Tariffs (FITs)
- BREEAM
- The EU Emission Trading System (ETS)

Environmental Control and Collections Care Standards

BS 5454
Work is underway for a new Published Document (PD 5454), Guide for the Storage and Exhibition of Archival Material, which will merge BS 5454 with its accompanying guidance, PD 0024. It will still include guidance relating to building construction, security, fire and flood protection but will take into account current thinking around environmental sustainability. It is directed to archive and library collections only, but is often used as a reference by museums and galleries.

PAS 198
A Publically Available Specification, PAS 198 Specification for environmental conditions for cultural collections, is due to be available in May 2011. PAS 198 will provide a set of requirements for the environmental conditions in which archive, library and museum collections should be stored and displayed, including requirements for temperature, relative humidity, light and pollution. It will provide a framework for risk-based decision making that allows organisations to identify and implement tailored controls to meet the needs of particular collections and buildings whilst looking at responsible use of energy.

A PAS is a sponsored fast-track standard that is reviewed after two years to become a formal British Standard. This work follows on from the growing need to meet environmental conditions whilst being responsible with the use of energy. There is potential for significant energy saving measures to be adopted if the environmental conditions can be relaxed.

New European standard being developed by CEN/TC 346
The development of a new European standard dealing with the protection of objects in all types of collections is currently under way by CEN, the European Committee for Standardisation. It will take the latest thinking on environmental criteria into consideration and update advice on building construction and protection, fire precautions, storage and packing requirements, modern media and exhibitions. This work should be completed by 2013/14.

For updated news on the changing standards visit http://www.bsigroup.com/

Government Indemnity Scheme
The Government Indemnity Scheme (GIS) provides compensation cover for objects being loaned by the institution. The scheme covers loss and damage for the objects; however, the institution must meet certain requirements to qualify for the scheme.

The Environmental Assessor is responsible for approving the environmental conditions set for the object. The GIS guidelines state that conditions should be constantly maintained during the loan, and that environmental readings are provided for one year prior to the display period. During a full week the relative humidity is required to be kept within the band of 40-65%, with a maximum cycle of 10% within 24 hours. The temperature must also be kept in the band of 16-24°C, with a maximum cycle of 4°C within 24 hours.

The GIS allows institutions to loan objects for which it would not otherwise be able to provide sufficient insurance and therefore it will be a priority for institutions to meet the GIS requirements. However, there is still potential for the institutions to meet these requirements and provide energy savings. For example, by providing climate control using display cases, instead of conditioning the entire gallery space.

Case study

Updating Lighting Manchester Museum

Manchester Museum houses over 4.25 million specimens and objects. Its collections range widely from Ancient Egypt to Plants and the Changing Planet. In 2008 The Carbon Trust surveyed Manchester Museum to identify the ways in which it could reduce its carbon footprint. The objective was to highlight the most productive activities that would reduce the museum's carbon footprint.

Benefits

The Carbon Trust survey highlighted three main areas where savings could be made. These comprised lighting, local hot water supply and space heating. The museum identified updating lighting as having the most significant potential to save energy. Lighting previously accounted for 50% of the total electricity consumption.

Matrix Initiatives

Energy/Lighting
- LED Lighting
- Occupancy sensors for lighting
- Provide programmable lighting control system

The lighting project is split into two phases. The first phase replaced the luminaires in The Fossils Gallery.

Phase one replaced the fluorescent tubes and dichroic lamps with LED lamps. This upgrade cost £15,500. In total 576 35W halogen lamps were changed to 5W LED lamps.

The second phase will improve the lighting control system. It is predicted that by re-zoning the lighting and adding occupancy sensing, energy consumption will be reduced by a further 5%.

As a result of the change to LED lamps with their lower light output and greater efficiency, the energy consumption reduced by 89% with a 1.5 year payback period. This will save 60 tonnes of CO_2 per year.

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Survival strategies for museums and art galleries

BREEAM
BREEAM was first launched in 1990 and is updated annually to keep ahead of UK Building Regulations and to stay in line with current best practice. The first version of BREEAM was developed to assess the environmental performance of offices. Since then schemes have been developed to cover 16 types of buildings. Museums and Galleries will come under a bespoke classification as they are not covered by a standard scheme.

To assess a building's performance, BREEAM uses nine categories:

- Management
- Health and wellbeing
- Energy use
- Transport
- Water
- Materials
- Waste management
- Land use and ecology
- Pollution

The rating tools award points for performance against criteria that are added together for an overall score and then awarded a "Pass", "Good", "Very Good", "Excellent", or "Outstanding" grade, based on the overall building performance. It provides assessment opportunities for pre-design, design completion, and occupied buildings. Overall BREEAM provides a recognised means of demonstrating a building's environmental performance.

> **We need to reduce the energy load in caring for, displaying and lending our collections,** and consider fresh options for how we design and operate our buildings. This is an opportunity for all of us - Directors, Curators, Conservators, Registrars, Architects and Engineers - to share our expertise and research. **The growing momentum for revised professional practices reflects the urgency and priority of this issue.**
>
> Judith Nesbitt, Chief Curator, Tate Britain

Case study

Voltage Power Optimisation
World Museum Liverpool
National Museums Liverpool

World Museum Liverpool combines a collection of historic treasures with interactive exhibitions and has been an institution since 1851. It is the largest consumer of energy on the NML estate, with approximately 5 million kWh electricity usage per annum. Previous strategies have included low energy lighting, power factor correction and switch off campaigns. NML identified the opportunity for meaningful savings by installing voltage power optimisation.

Key Initiatives

The supply voltage for the institution is likely to be higher than the voltage required by the equipment. The excess voltage is usually discharged in the form of heat. NML uses a transformer and a regulator to match the supply voltage to the voltage required by the equipment, and thus reduces the losses due to inefficiencies. SALIX funding was available which provided an interest free, Government- backed loan to finance 100% of the costs of energy saving products.

Matrix Initiatives

Energy/Electrical

- Voltage Power Optimisation

Outcomes

- Potential savings of £43,300 - a saving of 12% on electricity consumption
- Savings of 332 tonnes of CO_2 per annum
- Reduction in maintenance costs because of matching supply and demand voltage
- Benefit in reduction to CRC claims
- Any future electricity tariff increases will reduce the project payback period

Overall the project will provide both economic and maintenance benefits. The payback period is estimated to be 4 years.

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Reducing our carbon footprint not only saves money but also helps sustain the quality of the environment for future generations. **Museums are not just about the past and must show they can help safeguard the future.**

Vanessa Trevelyan, 2010 President of Museums Association
Head of Norfolk Museums & Archaeology Service

Abbot Hall Art Gallery ©Tony West

Five simple steps
A survival strategy for your building

“Our research has shown that electricity usage contributes to **over 60%** of the typical museum **carbon footprint**.”

Rachel Madan, Executive Director, Greener Museums

Step #1
Determine your baseline and appropriate level of refurbishment

What is the baseline?

To plan a route to where you want to be requires that you know where you are starting from by defining the baseline. For buildings, the key baselines are energy consumption, lighting, the facilities management operation, and the condition of the building. Other baselines might include water consumption, waste generation, and Indoor Environment Quality (IEQ).

A baseline can be established by conducting an audit. This should be carried out as a systematic examination and measurement of key aspects of the building's performance or condition. The results of audits can be compared against benchmarks to determine opportunities for improvement. Knowing what to measure and how to measure it against key benchmark parameters are key to defining a reliable starting position.

Occupant satisfaction audit

Occupant surveys can be highly effective in judging a building's current performance. A well conducted survey will highlight any aspect of building condition, facilities, or day-to-day performance that falls below occupants' expectations.

Surveys of staff and visitor satisfaction allow institutions to gauge how well a building is performing. However, for conditioned display areas the maintenance of appropriate conditions for exhibits overrides the comfort conditions for staff and visitors. Issues that affect occupant satisfaction include thermal comfort, acoustics (including speech privacy), floor planning, ventilation, amenities and management regimes. To be effective the audit has to be carried out in a highly structured manner so that the results are capable of comparison with a well-established benchmarked database of criteria.

Energy audit

An energy audit is intended to find out which areas or services within a building are responsible for contributing significantly to the energy bill. Only when these are established can you target savings. Energy audits often contain surprising results and uncover great potential for 'quick wins'. They identify the sources of energy use and help to prioritise reduction strategies and establish the most cost effective opportunities for energy savings.

The term energy audit describes a broad range of energy studies. These range from a quick walk through of a facility to identify major problem areas, to comprehensive measurement and analysis of the energy flows.

Security audit

A significant facilities cost for many institutions is the cost of appropriately qualified static guarding. If this manpower can be reduced to a twelve hours per day, five days per week basis then potentially significant savings are realisable, often for a modest capital outlay on physical and electronic systems.

Outsourcing security monitoring to a qualified alarm receiving centre without reducing security or flexibility is possible but must be planned and backed up by good physical security as well as electronic systems. The most important requirement is that the galleries can be closed, locked and alarmed separately from other operations such as café's and offices which may have different operational hours. Where indemnified works are involved the MLA National Security Advisor should be involved in the planning. In addition to manning, key holding and opening and closing services can be outsourced easily, either to remove manning or reduce risks associated with lone-working.

Top 10 "quick win" initiatives

In no particular order, these are easy to achieve, yet yield substantial benefits:

1. **Conduct an energy audit and act upon it**
2. **Replace existing luminaires with ones using T5 fluorescents and provide clear light switch labelling**
3. **Modify relative humidity and temperature set points to provide wider control bands focusing on preservation of collections over human comfort**
4. **Switch off equipment not in use**
5. **Use low irritant or non-chemical cleaning products**
6. **Implement a comprehensive building preventative maintenance programme**
7. **Maintain up-to-date, comprehensive, accessible building users' guide and Operations & Maintenance (O&M) manuals**
8. **Provide sub-metering of electricity, gas and water**
9. **Ensure control systems in the building are working correctly**
10. **Provide water-efficient appliances**

Case study

Reducing Energy Consumpton
Abbot Hall Art Gallery, Kendal

Abbot Hall Art Gallery owned by Lakeland Arts Trust (LAT) is located within a Grade I listed Georgian house built in 1759, which was saved from dereliction in the 1950s and opened as the gallery in 1962. Abbot Hall was refurbished in the late 1950s and again in the 1980s, but since then has remained unchanged with a very limited maintenance programme. This has resulted in the building operating in an extremely inefficient way; heating and hot water are both run on electricity, with the main rooms fitted with old and expensive underfloor heating and typical high consumption gallery lighting fitted throughout the building.

Key Initiatives

A recent mechanical and electrical survey has shown that all of the electrical systems, including heating and lighting, are in need of a major refurbishment. Currently the underfloor heating accounts for 60% of the annual electricity usage and fails to produce a comfortable environment for the occupants. With this in mind the following initiatives have been selected for implementation as resources become available:

Matrix Initiatives

Legislative and code compliance

- Feed in Tariff (FIT)

Energy/Lighting

- LED lighting
- Occupancy sensors for lighting

Energy/Building fabric

- Draught excluders
- Add secondary glazing to existing single glazing to improve insulation value
- Upgrade wall and roof insulation.

Outcomes

Through installing a more effective and efficient heating system, the LAT will save a significant amount of energy and money, whilst also providing a more comfortable environment for visitors and staff. Installing a renewable energy source would reduce costs further and also significantly reduce the carbon footprint of the building.

Abbot Hall has an electrical consumption of 145kWh/m²/yr. By implementing the above initiatives this figure will reduce significantly.

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Step #1
Determine your baseline and appropriate level of refurbishment

Benchmarks
Museums and Galleries

Benchmarks provide a direct means of estimating how a particular institution is performing. Below are benchmarks specific for Museums and Galleries referenced from Chartered Institution of Building Services Engineers (CIBSE) Guide F (CIBSE, 2004). However, by their nature museums and galleries are very varied with differing levels of environmental contol.

The benchmarks listed below relate to non-humidity controlled museums and galleries.

Calculating the benchmarks involves taking the total kWh energy consumption (fossil fuel or electrical) and dividing it by the gross internal floor area.

Energy Consumption benchmarks for museums and galleries kWh/m² of gross internal area per year:

Good Practice

Fossil fuels	96
Electricity	57

Typical Practice

Fossil fuels	142
Electricity	70

Condition audit

A condition audit is intended to determine the current condition and expected remaining economic life of a building's components. It is a vehicle for producing a complete inventory of a building, including equipment, that identifies deficiencies. Typical areas to be examined will include structure, external walls and roof, mechanical, electrical and IT systems, hazardous materials (asbestos, lead, etc), security and life safety. The condition of the finishes in the public areas of buildings will be one determinant of occupant satisfaction.

Other audits

Water audit
A water audit should be performed to establish the areas of the building that are consuming large amounts of water and target them for improvement. The audit should include a review of water bills to determine any seasonal variations in consumption that may be abnormal.

Waste audit
Undertake a waste audit to find out the total amount the building generates, the types and amount produced, how much is being recycled, and how much is sent to landfill.

Indoor environment quality audit
Many existing buildings have poor indoor environmental/air quality (IEQ/IAQ). These encompass thermal comfort, air quality, air tightness, lighting and noise levels. At their worst, buildings may suffer signs of a "sick building syndrome" with occupants suffering with symptoms such as nasal stuffiness, eye irritation, wheezing, skin irritation, or asthma. An on-site audit will involve physical inspection, sampling and testing, and the assembly of an inventory of all cleaning chemicals currently in use.

For additional information see page 54.

Did you know?

Government policy on CO_2 emissions reduction targets - The Climate Change Act 2008 calls for a 26% reduction in the "net UK carbon account" by 2020, against a 1990 baseline; and for an 80% reduction by 2050. Manchester, has set itself the more ambitious target of a 41% reduction by 2020 against a 2005 baseline.

Refurbishment

Table 1 provides a quick guide to determining what level of refurbishment your building may require, based on its condition and its performance, in order to bring it up to optimal standard. Table 2 provides examples of the degree of intervention for each level of refurbishment.

Did you know?

Water consumption in the UK has been rising by 1% a year since 1930. This level is not sustainable in the long term without measures to reduce leakage and waste, to recycle and to collect rainwater.

Table 1 – What level of refurbishment is required?

Building performance \ Building condition	Excellent	Good	Poor	Very Poor
Excellent	Maintain	**Level 1**	**Level 2**	**Level 3**
Good	**Level 1**	**Level 2**	**Level 3**	**Level 3**
Poor	**Level 2**	**Level 3**	**Level 3**	**Level 4**
Very Poor	**Level 3**	**Level 3**	**Level 4**	**Level 5**

Table 2 – Examples of the degree of intervention for each level of refurbishment (based on BSRIA, 1998, and BRE, 2000).

Level of refurbishment	Examples of degree of intervention
Level 1 Tune up and minor refurbishment	Carry out health checks on Building Management System (BMS) and controls, revise layout to improve daylight and flexibility, low energy ICT option on replacement. Recommissioning of building services.
Level 2 Intermediate refurbishment	All level 1 works plus: renew lighting and control system, remove false ceilings to expose thermal mass.
Level 3 Major refurbishment	Replacement of major plant and services, floor finishes, raised floors, and internal walls. Installation of external solar control.
Level 4 Complete refurbishment	Only substructure, superstructure and floor structure retained. Structural and façade alterations. Possible relocation of cores and risers.
Level 5 Demolition	Consider demolition and rebuild.

Step #2
Review your building maintenance, housekeeping and energy purchasing

Do you know what's going on?

Effective property maintenance and housekeeping is essential to the efficient operation of buildings. In many instances facilities management (FM) contracts are well executed, but all too often they are not reviewed for many years. In doing so opportunities to maximise savings and optimise performance are overlooked. Most contracts deal with the 'oil change' elements of maintenance very effectively, but do less well on maintaining system efficiencies to cut energy costs or seek continual performance improvement.

A modest investment to review your FM strategies will either confirm that they are protecting your investment, or need updating to provide effective standards and provide assurance that you are achieving value for money.

Out of control

From the day new buildings are handed over, the building services systems require constant tuning to match the use of the building with the output of the building's systems. This has only recently been fully acknowledged, with the introduction of the 'soft landings' programme for new buildings. It involves continued input from the system's designers for a period that extends past construction completion. This allows the designer to tune the building in the light of operational experience. Where buildings have undergone long periods of well intentioned but uninformed tweaking, Retro-Commissioning (RCx) should be considered. RCx is a process that attempts to resolve operating problems, improve comfort, optimise energy use and identify retrofits for existing buildings.

RCx can directly benefit:
- Electricity demand
- Fuel use
- Water use
- System performance
- Carbon emissions
- Operations & Maintenance costs
- Plant lifespan
- Occupant satisfaction/wellbeing

Housekeeping and Facilities Management (FM) – are they combined?

Often housekeeping and FM activities are undertaken separately with little linkage between the two activities. Whilst this is a reasonable approach, these activities must be coordinated if cost savings are to be maximised. The drudgery of continuously monitoring energy and utility costs can, to a large degree, be automated using smart meters and setting performance envelopes. In setting these parameters, opportunities to reset control values to save energy whilst maintaining comfort levels need to be explored. Temperature standards for comfort vary over time and with the seasons. Therefore by adopting adaptive behavioural control strategies to climatic conditions, savings in the energy used for heating and cooling can be achieved.

These measures, together with a regular health check of consumption trends, will help predict when the performance of the building systems has strayed outside anticipated performance boundaries, enabling prompt corrective action.

Energy purchasing – maybe you have the best deal

With the transformation of the energy marketplace a majority of domestic customers now take the opportunity to switch suppliers to save money. A review of your supplier could instantly save money. This has probably already been covered in most building strategies, but have these strategies included an examination of potential technical modifications such as intelligent peak lopping or the reduction of reactive energy charges?

If you are undertaking a significant upgrade in the building's systems resulting in an increase in the required supply capacity, you may have to negotiate a new connection contract with the incumbent utility or network operator. Be sure to understand your demand requirements, and the impact in terms of the network tariffs. If the network operator demands a customer contribution, make sure their request conforms to the regulatory authority's criteria for developer contributions.

> We are looking forward 100 years and changing the way in which we approach everything.
>
> Maria Balshaw, Director, Whitworth Art Gallery

Case study

Auxiliary lighting retrofit
Whitworth Art Gallery, Manchester

The Whitworth Art Gallery is part of The University of Manchester. It is home to internationally renowned collections of modern art, textiles, watercolours, prints, drawings and sculpture. Created in 1908, with a refurbished Scandinavian modern interior dating from the 1960s, the Whitworth is today developing a new vision for the role of a university gallery through a Heritage Lottery Fund application for a park-facing second entrance and extension.

Until recently the gallery used a variety of high wattage tungsten and halogen lamps (50-100W). These would typically run for between 10-24 hours per day, were expensive to run and needed to be replaced frequently. With a pending extension and refurbishment it didn't make financial sense to invest heavily in new fittings and transformers, and therefore it was decided to concentrate on direct replacements for existing bulbs.

Several lamp types were sampled and suitable products for all areas were identified. It became apparent that the better known branded manufacturers' lamps produced a superior colour rendering and had a shorter warm up time compared to the cheaper brands.

The high cost of LED replacements for Par 38 and R80 fittings were less viable and often their energy consumption was comparable to the Compact Fluorescent Lamps (CFL). In non-gallery areas tungsten lamps were replaced with retrofit CFLs. A mixture of tungsten and CFLs were also used in areas of the gallery where colour rendering properties were not a priority. 50W halogen lamps in areas such as the foyer, reception areas, shop and general gallery lighting were replaced with 7W LEDs.

Matrix Initiatives

Energy/Lighting
- LED lighting
- Formal/out-of-hours lighting
- Energy efficient lamps, luminaires, ballasts

Outcomes

After an initial outlay of around £1,600 electricity usage has been reduced by a total of 53,373 kWh per year which in 2010 equates to a saving of £5,200; this is a 10% reduction in electricity usage.

The project has highlighted how different areas require different light properties and grades of product. It is important to prioritise the areas which have the greatest usage as these will deliver the shortest payback.

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Case study

The cost of the new lighting scheme has been estimated at £98k, giving a payback of just under 2.5 years.

Low Energy Lighting
Manchester Art Gallery

Manchester Art Gallery (MAG) is a local authority service; part of Manchester City Council, the gallery houses many of the city's most important fine and decorative art works, which are designated as being of national importance. It has an international reputation for high profile, high quality exhibitions.

The gallery comprises two 19th century buildings brought together in a £35m expansion and refurbishment of the City Art Gallery, a Grade I Listed Building, and The Athenaeum. The gallery reopened in 2002 and attracts 400,000 visitors per year.

The gallery consumes 4.8 million kWh of energy per annum, affording it a G energy rating and placing it in the bottom 5% of UK museums and galleries. Cutting the building's existing £800k+ bill for utilities and plant maintenance is a key priority.

MAG are working to identify priority initiatives to tackle demand reduction. Replacing the existing tungsten-halogen gallery lighting with energy-efficient LED lamps has been identified as a priority for MAG for three reasons:

1. Existing tungsten-halogen lamps have now been phased out and are no longer available. MAG has secured a stock of lamps but, once this stock is exhausted around March 2011, it will no longer be able to light its temporary exhibition spaces, or replace lamps in permanent gallery displays.
2. The existing lighting consumes a significant amount of electricity. This could be reduced by up to 60% by converting to LED light sources. Factoring in the additional savings in lamp costs and maintenance, this scheme is estimated to have a payback of 2.5 years.
3. Existing lamps generate a significant heat load that places additional pressure on the air conditioning equipment, increasing energy consumption due to the additional cooling requirement and reducing longevity of plant components. If heat load from lighting can be reduced, we can explore modifications to the operation of the Building Management System and the relaxing of environmental performance parameters. This has the potential to further reduce energy use and maintenance costs.

©David Millington Photography

The current review of lighting density, energy consumption and an options appraisal by Arup has shown that existing gallery lamps consume 780,000 kWh of electricity at a cost of £59k. LED lighting will save around £26k in electricity costs and deliver additional savings in maintenance/re-lamping costs of c. £15k per annum - saving over £40k per annum.

Until recently, LED lighting was not an appropriate low energy solution for lighting museum and gallery collections due to problems with colour-rendering and spectral composition. However recent innovations have resulted in the production of a cold phosphor LED that has excellent colour rendering, no significant contribution in the UV area of the spectrum and an extremely long lamp life with no degradation in the appearance or quality of light.

Matrix Initiatives

Energy/Lighting

- LED lighting
- Formal/out of hours maintenance lighting

Legislative and code compliance

- Display Energy Certificate (DEC)
- Compliance with current environmental requirements
- Carbon Reduction Commitment Energy Efficiency Scheme (CRC)

Energy/HVAC

- Review of standards for storage and display

Outcomes

The cost of the new lighting scheme has been estimated at £98k, giving a payback of just under 2.5 years. The heat load contribution of the current lights has not yet been factored but the additional energy savings due to the reduced cooling would reduce the payback further and deliver even greater efficiencies. Additional savings can be made through introducing a robust strategy for the maintenance/display lighting regime, whereby full gallery lighting is only in use when spaces are open to visitors. This could potentially save a further 10%, £5.9k in electricity costs and a further reduction in electrical consumption and cooling requirement.

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Step #3
Establish your targets and goals

Understanding your aims

To survive in today's climate you need to develop a strategy, work out a plan, act on it and review it regularly.

As an institution you will have aims and goals. You will have an understanding of the service you provide and the methods you use to achieve it. It is important to decide what you want from your Survival Strategy. These aims could be to reduce energy bills, improve sustainability or to promote the profile of the institution. There are many possible approaches to achieving these aims, such as:

- Energy saving focus – Prioritise the energy efficiency of your institution, taking the sustainability benefits as an additional benefit.
- Sustainability focus – Selecting initiatives that have the greatest sustainability benefit.
- Intangible benefits – The greater the influence the institution wishes to have on the public, the more obvious the initiatives will need to be.

Energy Performance Certificates (EPCs) and Display Energy Certificates (DECs)

Energy will be an increasingly important consideration for institutions because of rising bills and ever fiercer legislation.

Since October 2008 all domestic and commercial buildings must have an EPC whenever the building is sold, built or rented. The certificate records how energy efficient a building is and provides A to G ratings. These are similar to the labels now provided with domestic appliances such as refrigerators and washing machines. DECs, required for public sector buildings, show the actual energy usage of a building, and make this information publicly available.

These certificates make it possible for the energy efficiency of one building to be easily compared with another building of the same type. This allows prospective buyers, tenants, owners, occupiers and purchasers to include energy efficiency in their investment decisions.

Improving the EPC and DEC ratings of an existing building will have a positive effect on the institution. Any changes or interventions should be carefully evaluated to ensure EPC and DEC ratings are improved.

For many institutions, improving the energy rating will be an important part of their upgrade strategy.

Factors to bear in mind ...

- **Staff education is essential for the initiatives to be implementated successfully.**
- **Museum and gallery buildings are very varied, resulting in unique strategies for each.**
- **Often the building is not owned by the Gallery/ Museum itself and this may limit the extent of the changes that can be made. It is essential that the institution has strong communication links with the governing body in order to allow a successful strategy to be employed.**
- **Some of the strategies will be more obvious and so if the institution wishes to promote sustainability as a priority, this will influence their choices.**

Case study

Passive Humidity Control
Victoria and Albert Museum, London

The Victoria and Albert Museum (V&A) is an art and design museum in London. The new Medieval & Renaissance Galleries have adopted a passive approach to environmental control which allows less energy to be used to control the gallery environment.

Key Initiatives

During the design process the V&A decided to revise its environmental guidelines so that a wider band of Relative Humidity (RH) is allowable. The updated guidelines specify a RH of 45±10% with less than 10% variation within a 24hr period. This replaces a much stricter range of 50±5% RH with a temperature control of 22±1ºC. By prioritising object conservation over occupant comfort the perimeter heating and ventilation system can be used to provide adequate environmental control.

Matrix Initiatives

Energy/HVAC

- Modify set-points
- Optimise free cooling
- Passive environmental control

Outcomes

- No humidification or refrigeration equipment required
- Environmental control achievable through ventilation and heating systems
- Up to 30% energy saving possible compared to a traditional close controlled mechanical air conditioning system
- Less capital required for mechanical equipment and reduced running costs
- Reduced carbon dioxide emissions due to less mechanical equipment

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Case study

Staff Awareness
Harris Museum & Art Gallery, Preston

Electricity consumption has gone down by over 9,000kWh, or 10%, on the same period last year, which represents a reduction in carbon dioxide emissions of 4 tonnes.

The Harris building was opened in 1893 in the heart of Preston as a free Museum, Library & Art Gallery. Today, the Museum & Art Gallery are run by Preston City Council and the Library services are run by Lancashire County Council. The Museum houses displays of fine and contemporary art, decorative art and social history.

Details and benefits of actions

The building is Grade I listed and still retains most of its original features including grand, but inefficient and uncontrollable, Victorian radiators. The building has a central rotunda through the middle which acts as a chimney stack drawing up heat, making conditions on the top floors extremely warm, even in winter.

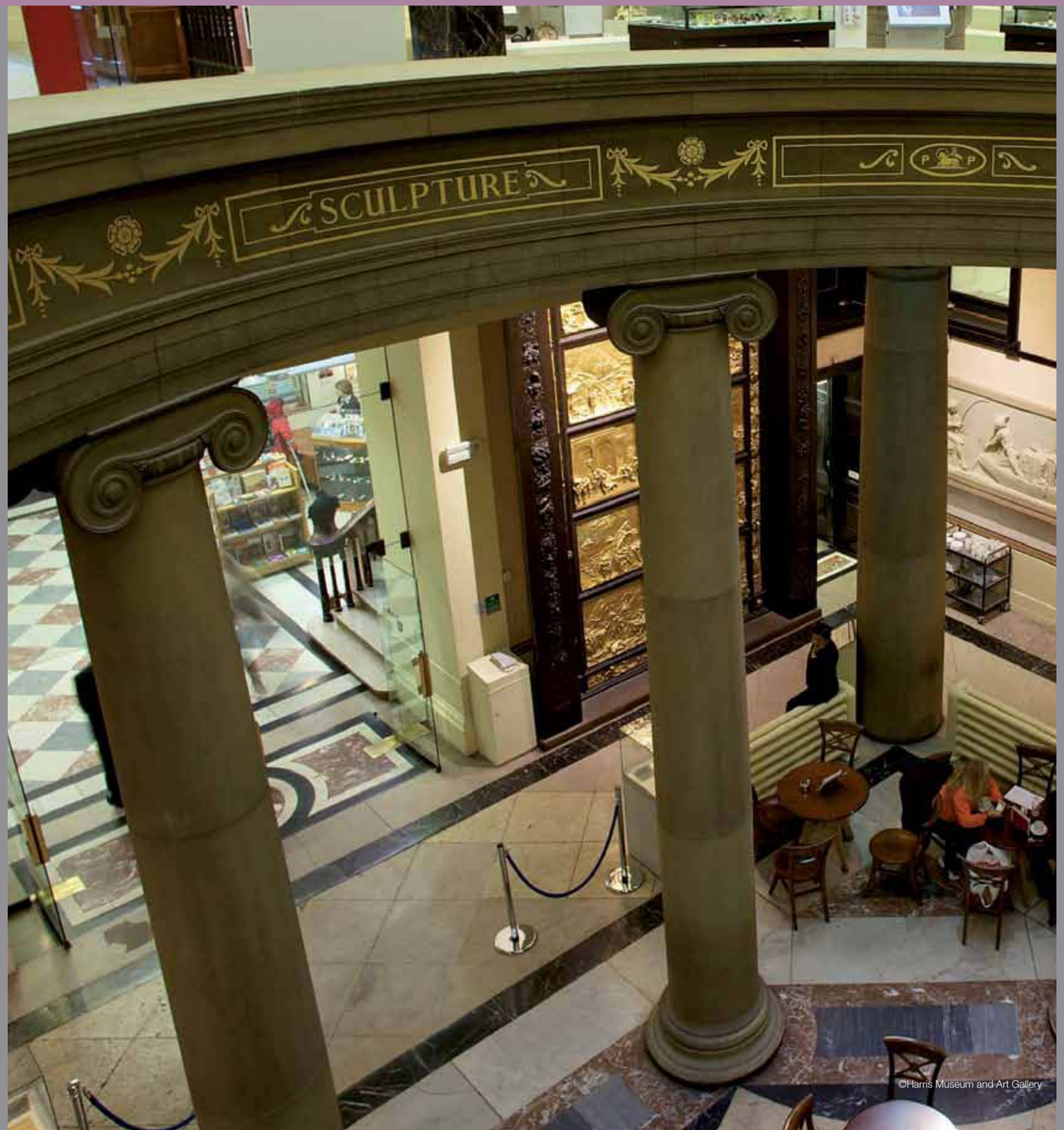
A major contributory factor to the heat and energy bills is the amount of electricity used by lighting and computers. Therefore we decided to concentrate our efforts on reducing our electricity consumption.

In May 2010 staff attended a briefing introducing them to the sustainability work we were going to be doing and we recruited a volunteer from each section, including the library, to form a Green Champions group. The Green Champions are advocates for sustainability; they are providing a lead for others to follow in incorporating small changes to everyday working practices that are already starting to make a big difference.

Each Green Champion went back to their team and worked with the rest of the staff to come up with 3 lists:

1) what we currently do that's green
2) the "quick wins" we could start to implement straight away
3) "in an ideal world" thoughts / longer term ideas / ideas with a financial cost

We put these ideas together to produce definitive lists and we are now concentrating on the "quick wins". Most of these are based around reducing the amount of electricity we use.



To keep the momentum going we are making sure that the work we are doing on sustainability remains visible to staff. Monthly electricity consumption figures have been turned into a graph which is pinned up in all the staff kitchens. Greening the museum is a fixed item on meeting agendas so we can regularly update on what's happening. Signs have been put on light switches as a reminder to switch them off; staff have been given plans of the basement, marking the location of light switches including which ones to leave on to light corridors and which are optional for when needed.

We have already achieved a substantial reduction in a short time and from such small measures, but with Preston City Council supporting us we are now aiming higher. Our next steps are in two directions. Firstly, to talk to our visitors, explaining what we're doing and why, and to get ideas from them on how we can make their museum more sustainable. Secondly, using a recent detailed survey of the condition of the building as a basis, to tackle the larger issues requiring substantial investment, such as replacing inefficient heating and lighting systems, which will ensure the sustainability of the building well into the future.

Matrix Initiatives

Management

- Formal staff feedback mechanisms
- Raise tenant and staff awareness on sustainability

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- Easily understood light switch labelling

Outcomes

In the three months since the staff briefing and formation of the Green Champions Group, our electricity consumption has gone down by over 9,000kWh, or 10%, on the same period last year, which represents a reduction in carbon dioxide emissions of 4 tonnes. This is purely through being more diligent about switching off lights and computers. We are also experimenting with different light levels on stairwells, galleries and the libraries.

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Step #4
Select your optimal upgrade initiatives

205 initiatives to improve your buildings

On the following pages are 205 initiatives to help you choose those that are right for your building and your institution. To make selection easier, the initiatives are grouped into the following categories:

- Management
- Legislative and code compliance
- Economic
- Business continuity
- Energy/Lighting
- Energy/Electrical
- Energy/HVAC
- Energy/Fitout
- Energy/Building fabric
- Building modifications and alterations
- Emissions
- Indoor environmental quality
- Materials
- Water
- Site
- Transport
- Social
- Additional

Each initiative is ranked according to the level of intervention required, its cost, and its benefits to the environment, the occupants and the institution. Within each category, initiatives are listed in ascending cost order, i.e. cheapest first. Some initiatives require only a light touch, while others represent a major intervention. Some offer immediate paybacks, while others will take longer to recoup costs. A list of 10 “quick win” initiatives is provided in Step 1.

How to use the initiatives summary

By following Steps 1-3 in this guide you have determined your baseline and appropriate level of refurbishment, you have reviewed your maintenance, housekeeping and energy purchase strategy and you have established your targets and goals. These will have given you a good indication as to what categories of upgrades may be appropriate.

Next, read through the initiatives listed in the indicated categories and select those that address your particular objectives, at the appropriate level of refurbishment. For example, if you want to reduce your building’s electrical consumption, then consider the initiatives listed in the Energy/Lighting, Energy/Electrical and Energy/Fitout categories. Step 1 has told you what level of refurbishment (1, 2, 3 or 4) is appropriate for your building’s condition and performance. Use this to help narrow down your choice to the initiatives most appropriate for your refurbishment level, e.g. for a level 3 refurbishment, consider initiatives rated at level 3 and below. Then use the cost and benefit indicators to help you further narrow down your selection.

Repeat this process for all your objectives. When you have a list of possible initiatives, move to Step 5, which will help you decide which combination and sequence of initiatives are best for your institution.

Remember

- Use the energy hierarchy – reduce demand first, then maximise efficiency before installing renewable energy systems
- Use the water hierarchy – reduce demand first, then maximise efficiency before installing water recycling features
- Simple solutions are often the best.
- If complex initiatives are not easily understood by the building’s users they may not make much difference
- Consider the system efficiency, not just the individual component efficiency
- Some initiatives may not complement each other directly, e.g. increasing outside air rates may improve IAQ but increase energy consumption. A balance must be found.

Factors to bear in mind ...

- **Listed buildings will have more restrictions on new interventions than new builds – This will be a major consideration when developing a strategy.**
- **Continuity of Staff – Many of the initiatives rely on staff involvement and so it is essential that a sufficient number of staff are involved, so that the initiatives continue independently of staff turnover.**
- **Time to implement the adopted initiatives – many of the initiatives will require staff time. Although this will prove a challenge, for the strategy to be worthwhile it is important that this provision is put in place.**

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Case study

Gallery Refurbishment
Bolton Museum

Bolton Museum was opened to the public in 1947 and forms part of the Le Mans Crescent Civic Centre. Bolton Museum is a local authority service run by Bolton Council. The Museum houses an art gallery, Egyptology gallery, history centre and a local history gallery. The local history gallery, telling the story of Bolton, has undergone a significant refurbishment in 2010.

Key Initiatives

As part of the local history gallery refurbishment various energy savings opportunities were identified and integrated into the project. These included zone control of the heating system, upgraded thermal insulation to walls and ceilings, improved air tightness, replacement of lighting systems and refurbishment of Edmonds cases.

Matrix Initiatives

Energy/HVAC

- HVAC zone control

Energy/Building fabric

- Improve air tightness to reduce unwanted infiltration
- Upgrade wall and roof insulation

Outcomes

Benefits of the refurbishment will include lower energy use, improved gallery temperature control and improved microclimates within display cabinets.

Future work identified includes improvement to summertime ventilation using passive techniques where possible. Monitoring of the refurbished display cases will be undertaken to identify the improvements in the microclimate of the cases.

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Case study

The Gallery has to save £50k per annum to meet efficiency savings targets.

Smart Metering
Manchester Art Gallery

Manchester Art Gallery is in the process of installing a comprehensive telemetric utility monitoring system with reporting software for gas, electricity and water consumption. This is a major step in identifying areas of high energy/utility consumption and engaging staff in individual and collective responsibility for reducing energy consumption. The project has been supported by funding from Manchester City Council Carbon Innovation Fund.

We currently consume almost £400k in electricity, gas and water. The City Council has signed up to a Low Carbon Policy to reduce CO_2 emissions by 41% by 2020 and the gallery has a business plan commitment to save £50k per annum to meet efficiency savings targets; therefore all staff must engage with our environmental and financial sustainability plans to address operational wastage.

Matrix Initiatives

Energy/Electrical

- Electrical sub-metering- lighting small power, machinery and plant
- Time switches on small equipment and electrical sockets

Energy/HVAC

- Gas sub-metering

Water

- Water sub-meters for all major users

Outcomes

Utility monitoring (and reporting software) will allow us to monitor consumption and inform our planning in the following areas:

- Full cost recovery for commercial activities such as weddings, corporate and private hire out of hours events, where the daily occupancy hours of the building are extended to accommodate the event. With an average of 90 events per year, this equates to approximately 440 hours per year (approx 10% of annual average opening hours).

©David Millington Photography

- To log current usage by catering partners to inform the tender process for renewing the catering contract. Under the terms of the current contract the catering partner pays a set fee and all utility costs are included. Consumption data will inform us whether current fees are set at an appropriate level and will allow us to identify areas of waste or inefficiency and set targets for improvement and demand reduction.
- Identify areas of wastage due to inefficient operation of the building and log the impact this has on the operation of the environmental plant (e.g. external delivery doors left open for long periods); inform good practice in running the building efficiently.
- Provide baseline data on current consumption on a variety of plant and equipment such as chillers, boiler burners, humidifiers, pumps and fans on air handling units to support a longer term strategy to secure continued investment in the mechanical and electrical infrastructure of the building.
- The software will interpret the data from the smart metering and present it in a user friendly format via the website to encourage collective responsibility and understanding of consumption and also enable us to inform and engage with our visitors.

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Level 1 refurbishment, consider initiatives categorised under refurbishment level 1
Level 2 refurbishment, consider initiatives categorised under refurbishment level 1 & 2
Level 3 refurbishment, consider initiatives categorised under refurbishment level 1, 2 & 3
Level 4 refurbishment, consider initiatives categorised under refurbishment level 1, 2, 3 & 4

Key to initiatives chart

Heading	Brief Description	Symbols	Key to Symbols
Refurbishment level	Describes the degree of intervention typically required for the initiative.	**1**	Tune Up/Minor refurbishment.
		2	Intermediate refurbishment.
		3	Major refurbishment.
		4	Complete refurbishment.
Capital Cost	Quantitative measure of capital cost requirement for the initiative.	**Nil**	No cost.
		£	Minor cost financed under maintenance budget.
		££	Considerable cost financed under an annual project budget.
		£££	Substantial cost financed over a number of years.
Environment	The benefit of the initiative with respect to the environment.		No benefit.
			Minor benefit.
			Considerable benefit.
			Substantial benefit.
Occupant	The benefit of the initiative to the occupants. Some initiatives will help save costs. Others will have a less measurable qualitative benefit.		No benefit.
			Minor benefit.
			Considerable benefit.
			Substantial benefit.
Institution	The benefit of the initiative to the institution/ building owner. Some initiatives will directly improve or preserve value once completed.		No benefit.
			Minor benefit.
			Considerable benefit.
			Substantial benefit.

For some galleries/museums the occupant and institution/building owner will be the same

Management

	Refurbishment Level	Cost	Environment	Occupant	Institution
Responsive Facilities Management (FM) team A FM team that responds quickly and effectively to the occupants' concerns will help ensure that the occupants report problems and do not let them fester	0	£			
Temperature of server rooms Some ICT equipment can tolerate higher than the recommended temperatures, though meantime between failures (MTBF) may reduce	1	0			
Supply chain management Suppliers can be selected on the basis of environmental performance	1	£			
Energy consumption targets and monitoring/metering Setting consumption targets allows the performance of the building to be objectively measured	1	£			
Water consumption targets and monitoring Setting consumption targets allows the performance of the building to be objectively measured	1	£			
Waste generation targets and monitoring Setting consumption targets allows the performance of the building to be objectively measured	1	£			
Formal staff feedback mechanisms Staff feedback can identify under-performing areas of the institution, as well as any indoor environmental quality issues	1	£			
BMS (Building Management System) trend logging of museum/ gallery areas Monitoring review and graphing of museum/gallery conditions. Clear understanding of condition and monitoring will enable plant use to be optimised	1	£			
Representative location for BMS Sensors Sensor position should be where the control is needed to give precise feedback	1	£			
BMS (Building Management System) Sensor Calibration Correct calibration will ensure precise feedback is given	1	£			
Communication Plan Museums/Galleries are often publically owned or part of a larger organisation. Therefore actions can only be taken once the relevant group has been consulted	1	£			

Management

	Refurbishment Level	Cost	Environment	Occupant	Institution
Raise Tenant and Staff Awareness on Sustainability A sustainability brief for tenants and staff gives tenants and staff guidance on sustainable features, both in general, and in relation to the building they occupy	1	£	3	2	2
Clean Grilles/Diffusers Remove build up of dust/dirt to maintain efficient operation	1	£	2	2	2
Develop a building user training program A training program can be used to facilitate energy, waste and water management	1	£	3	2	2
Daytime cleaning service Cleaning during the day means that lights do not have to be used at night, when the building would be otherwise unoccupied. Additional benefit of added security	1	£	2	1	2
Building users' guides A building users' guide provides details of the everyday operations of the base building to staff and tenants. This includes information of energy efficient features and strategies	1	£	3	3	3
Up to date, comprehensive, accessible O&M manuals Effective operations and maintenance manuals will help ensure that equipment is maintained at optimal working conditions	1	£	3	2	3
Building management and operation team employed on site For large and/or multi-tenanted buildings and for estates, an onsite building management and operations team ensures that equipment is maintained, and any issues can be tended to quickly	1	££	3	3	3
Environmental management system An environmental management system can be used to track the usage of energy, water, materials and waste generation. This provides a feedback mechanism	1	££	2	1	2
Ongoing training of building management staff Staff that undergo ongoing training will be able to work efficiently and respond quickly to any problems. They will also stay up to date with the latest technological advances and legislative requirements, helping to ensure high quality maintenance and up to date building management practices	1	££	2	1	3
Electric, water and gas sub-metering Sub-metering ensures that all tenants are charged only for what they use. This allows institutions to pass on accurate costs to tenants	2	££	3	2	3

Legislative and code compliance

	Refurbishment Level	Cost	Environment	Occupant	Institution
Display Energy Certificate, DEC Required for public institutions with a total useful floor area over 1,000m². Valid for one year. The accompanying Advisory Report is valid for seven years	1	£	1	2	2
WEEE (Waste of Electrical and Electronic Equipment) The WEEE Directive aims to reduce the amount of electrical and electronic equipment being produced and to encourage everyone to reuse, recycle and recover it	1	£	2	1	1
Sustainable Timber Policy Requirement to comply with the Sustainable Timber Policy set out by Government	1	£	3	1	1
Carbon Reduction Commitment Energy Efficiency Scheme (CRC) The CRC is designed to improve energy efficiency in large organisations. It will operate as a 'cap and trade' mechanism, providing a financial incentive to reduce energy use by putting a price on carbon emissions from energy use. Museums/Galleries may need to comply if part of a local authority	1	££	2	1	1
RHI (Renewable Heat Incentive) The Renewable Heat Incentive (RHI) will provide financial support for those who install renewable heating, which qualifies for support under the scheme	2	£££	3	2	3
FIT (Feed in Tariffs) Government backed financial incentive to produce renewable electricity	2	£££	3	2	3
Compliance with current health & safety and disability requirements Ensure building facilities and operations comply with current H&S safety and disability regulations. This may require prioritisation	3	££	1	3	2
Consequential improvements Under Part L of the Building Regulations, when carrying out works on an existing building, there is a requirement in certain situations to undertake consequential improvements	3	££	2	3	3
Compliance with current environmental requirements Ensure building operations comply with current environmental requirements. This may require prioritisation	3	££	3	3	2
BS 5454 for archives Ensure archives meet the required temperature, humidity and air-borne pollutant requirements	3	££	3	3	2

Economic

	Refurbishment Level	Cost	Environment	Occupant	Institution
Review tariff structure	1	0			
Reviewing the tariff structure ensures you are only paying for the capacity that you need, reducing utility costs					

Business continuity

	Refurbishment Level	Cost	Environment	Occupant	Institution
Risers with security access	2	£			
Security access controls who can access risers					
Standby power supply for security measures	2	££			
Maintain protection of valuable exhibits during a power cut. Includes CCTV, secure access controls, and security centre					
Remove single points of failure with critical systems	3	££			
In critical systems redundancy should be provided so that in case of a system failure the institution's operations can continue. Important for exhibit security					
Provide greater than 60% cooling plant redundancy	3	££			
Identifies the minimum amount of plant cooling capacity available if one chiller, cooling tower or pump fails, expressed as a percentage of estimated peak building cooling load					
Provide standby power to 50% of lifts	3	££			
Identifies the minimum base building stand-by power provision required for lifts					
Provide standby power to 100% of emergency services	3	££			
Identifies the minimum base building stand-by power provision required for all essential services and base building ventilation systems					
Provide standby power to 50% of chillers	3	££			
Identifies the minimum base building standby power required to achieve the specified percentage chilled water operation. Potentially required for archives and areas with climate control					

Energy/Lighting

	Refurbishment Level	Cost	Environment	Occupant	Institution
Easily understood light switch labelling	1	£			
Easily understood light switch labelling is an effective way to reduce energy consumption, by ensuring that staff know which switches control which lighting zones. This is especially relevant for out of hours and weekend use, and will reduce operating costs					
Track Lighting zone control and dimming	1	££			
Provide for each lamp on a lighting track to have individual control and dimming by having multiple units or individual addressable lighting					
Display Case Lighting	1	££			
Lighting strategy tailored for display cases. Meeting display requirements and improving efficiency					
Lighting Optimisation	1	£			
Re-assess the lighting currently used. Identify where lighting levels can be reduced, or the ambience changed to use the lighting more efficiently. Confirm light is efficiently aimed onto exhibits and not spilt beyond. Are spaces or exhibits overlit? Identify redundant luminaires and omit					
LED lighting	2	££			
LED lighting can offer significant energy savings and excellent longevity when compared with halogen light sources. Care needs to be taken with equipment selection to avoid issues with colour rendering and consistent colour temperature. Negligible UV and IR are possible with some LED sources. Equipment can be retrofit lamps for reception areas etc, or replacement spotlights for gallery spaces where highest quality lighting is required					
Daylight pipes	2	£££			
A daylight pipe is a tube used for transmitting daylight to an internal space. These can be used as an alternative to electric lighting, and offer better heat insulation properties than skylights and windows with reduced running costs					
Daylighting Lighting Control	2	££			
In a space with natural and electrical lighting, lighting control only turns on electrical lighting when there isn't sufficient natural daylighting					
Formal/Out of hours Lighting	2	££			
The lighting requirements will be reduced during out of hours. Therefore by having separate lighting strategies for formal/out of hours times, energy can be saved					
Lighting Zoning in storage rooms	2	££			
Useful for large storage rooms where only small sections will be accessed at any given time. Lighting triggers will ensure only necessary spaces are lit					

Energy/Lighting

	Refurbishment Level	Cost	Environment	Occupant	Institution
Occupancy sensors for lighting Occupancy sensors can be installed stand-alone (lower cost option) or as part of a lighting control system. These control lighting based on occupant detection and should be installed as a minimum in intermittently occupied areas such as meeting rooms, toilets and print rooms	2	££			
Provide programmable lighting control system Lighting control systems can switch off lights automatically or step down lighting levels for night-time security or reduced occupancies. This lowers operating costs	2	££			
Individual light switches for individual enclosed spaces Enclosed spaces should have individual lighting switches to ensure they are not unnecessarily lit. These switches can be used in conjunction with room occupancy sensors	2	££			
Switching/dimming according to available daylight Daylight sensors can be used to dim or even switch off lights to respond to room daylight levels, reducing operating and energy costs	2	£££			
Office lighting zones <100m². Reducing office lighting zones below 100m² ensures that areas of the office that do not need the same level of lighting are not used unnecessarily	2	£££			
Energy efficient lamps, luminaires, ballasts Cost reductions can be achieved by renewing old, inefficient equipment with more modern light sources and electronic lamp controllers. Modern equipment typically offers lower heat gains, more controllability and greater efficiency	2	£££			
Create an atrium within the building to improve daylight An atrium produces daylight and is a social space for staff/visitors to gather	4	£££			

Energy/Electrical

	Refurbishment Level	Cost	Environment	Occupant	Institution
Electrical sub-metering - lighting, small power, machinery, plant Electrical sub-metering allows tenants to be charged only for the energy they use. This allows institutions to pass on accurate costs to tenants, and highlight any areas operating inefficiently. It also provides the tenant with financial incentives to reduce energy use	1	£			
Last Man Out Switch By powering down all non essential equipment with one switch the staff are more likely to save energy	1	£			

Energy/Electrical

	Refurbishment Level	Cost	Environment	Occupant	Institution
Green energy procurement Green energy procurement involves the procurement of energy from a supplier who has sourced it from verified renewable generators	1	£			
Assess efficiency of Freezers/low temperature storage By reducing the size and use of the freezers energy can be saved. Efficiency will also reduced with appliance age. Alternative methods such as using nitrogen may be possible	2	££			
Time switches or similar on small equipment Time switches ensure that equipment is switched off automatically after a period of time when they are not used, reducing unnecessary energy usage	2	£			
Upgrade all motors to high efficiency High efficiency motors improve the performance of equipment wherever a motor is used. They also tend to be quieter and cooler then regular motors	2	££			
Occupant controlled master isolation switch A staff controlled master isolation switch can be used to switch off appliances after hours automatically after all occupants have left	2	££			
Power factor correction Power factor correction units can be installed to keep the power factor of the system as close to 1 as possible; this increases energy efficiency and reduces operating costs	2	£££			
Building integrated wind turbines Wind turbines can be integrated as part of the building façade. Effective aerodynamic design can funnel wind so that the turbines are more efficient. Possible limitations with listed buildings and not generally effective in urban areas	3	£££			
Photovoltaics (PV) Electricity generating PV solar panels can be installed on building roofs or incorporated into their façades and shading elements. As production costs continue to fall, lengthy payback periods will reduce. PV is not effective in every solution. Possible limitations with listed buildings	3	£££			
Combined heat and power Combined heat and power plants produce heating as a by-product of electricity production. Best for mixed used buildings with different load profiles. Institutions with climate control air conditioning have the potential to use CHP for reheat to provide humidity control. Overall reduces energy costs and occupancy costs but has heavy capital cost	3	£££			
Voltage power optimisation The supply voltage for the institution is likely to be higher than the voltage required by the equipment. The excess voltage is usually discharged in the form of heat. VPO uses a transformer and a regulator to match the supply voltage to the voltage required by the equipment, and thus reduces the losses due to inefficiencies	3	£££			

Energy/HVAC

	Refurbishment Level	Cost	Environment	Occupant	Institution
Modify setpoints Modify setpoints to the upper and lower limits of acceptable thermal comfort boundaries	1	0			
Ensure controls are working correctly Incorrectly set or functioning controls can significantly increase energy consumption, and reduce stability of control for exhibits and thermal comfort for staff/visitors	1	£			
Implement a comprehensive preventative maintenance program A comprehensive preventative maintenance program ensures equipment efficiency does not decrease over time	1	£			
Comprehensive cooling tower maintenance program A comprehensive cooling tower maintenance program ensures chiller efficiency does not decrease by ensuring condenser temperature is maintained at an appropriate level	1	£			
Outside Plant Setpoints Air conditioning systems with outside air plants often have fixed supply setpoints. These need to be reviewed to ensure that maximum energy savings are realised	1	£			
Review of standards for storage and display Relaxed temperature and humidity setpoints can save considerable energy	1	£			
Implement seasonal setpoint adjustments Adjustment of temperature and humidity setpoints throughout the year will save energy	1	£			
Rebalance and recommission all plant Rebalancing and recommissioning all plant ensures that systems are operated as efficiently as possible, reducing running costs	1	££			
Categorise archives depending on level of condition needed Tailor HVAC to exhibit needs. Potential cost saving by having the provision for, say, one highly serviced exhibit space. Therefore infrastructure is only needed for one highly serviced archive, saving costs and energy	1	£			
Modify Flow and Return Temperatures of Heating Water Set to give maximum system efficiency by changing temperatures to optimise energy saving	1	£			
Air Conditioning Control Ensure systems are not cooling, heating and humidifying simultaneously	1	£			

Energy/HVAC

	Refurbishment Level	Cost	Environment	Occupant	Institution
Investigate original Natural Ventilation Strategy for older buildings For older buildings the likelihood is that the ventilation strategy was natural ventilation. Therefore, with possible relaxed ventilation standards, it might be possible to return to the original strategy	2	££			
Optimise free cooling Air handling unit economiser cycles replace treated air with untreated outdoor air when outdoor ambient conditions are similar to those the air handling system would typically produce Up to 100% outside air can be supplied to the system in this way, resulting in significant energy savings. This method is suited to museums/galleries, however there needs to be an awareness of quality of air supplied to rooms containing sensitive items. Carbon filters will be required in city centre locations to clean the outside air	2	£			
Check and repair any major ductwork leakage Ductwork leakage increases the amount of energy needed to meet indoor air conditions, and reduces indoor air quality	2	£			
Chilled water temperature reset Reset CHW temperatures higher when conditions permit, thereby improving system efficiency	2	£			
Gas sub-metering Gas sub-metering ensures that tenants are charged only for the gas they use. This allows building owners to pass on accurate costs to tenants, identify leaks, and gives tenants a financial incentive to reduce energy use	2	£			
Occupancy sensor/switch controlled air conditioning Occupancy or switch control ensures that air conditioning systems do not operate needlessly, which saves energy costs and reduces greenhouse emissions	2	£			
Active Display Case Microclimates rather than Climate Control of building Climate control strategy tailored for display cases. Meeting display requirements and improving efficiency by conditioning smaller air volumes	2	££			
Passive Display Case Microclimates rather than Climate Control of building Climate control strategy tailored for display cases. Meeting display requirements using passive means if possible. Passive microclimates have preference over active methods	2	££			
Positioning of exhibits within museum Depending on the orientation and layout of the museum, gallery exhibits can be arranged to reduce the amount of zone control required. For example, positioning a sensitive exhibit away from an area of high solar gains	2	££			

Energy/HVAC

	Refurbishment Level	Cost	Environment	Occupant	Institution
HVAC (Heating, Ventilation and Air Conditioning) Zone Control Specifically for display areas that require a high level of climate control, such as humidity control in archives and gallery areas. Broadly, the areas could be split into climate control and non-climate control areas as they will have different requirements	2	££			
Conditioned wall mounted display cabinet Separate conditioning for art mounted on walls, provided from behind the art work. This will meet display requirements at improved efficiency by conditioning smaller air volumes	2	££			
Heat recovery ventilation Heat recovery systems transfer heat between inbound and outgoing air flow streams, reducing the heating (or cooling) demands of the inbound air	2	££			
Introduce night cooling in conjunction with exposed thermal mass Night cooling can be used to lower the temperature of the thermal mass of the building when the outside temperature is below the internal daytime design temperature	2	££			
Use heating hot water for zone reheat Inefficient electric reheat should be replaced with hot water reheat wherever possible	2	££			
Introduce variable speed pumps and fans Variable speed works by decreasing power to pumps and fans to decrease flow rates to match decreased loads	2	££			
Introduce demand ventilation control Demand control ventilation involves monitoring carbon dioxide levels in the air and varying ventilation rates proportionally In this way, outside air rates are matched to actual occupancy densities, rather than on assumed occupancy patterns	2	££			
Zone controls Zoning existing air conditioning systems can improve their energy consumption by ensuring that only relevant parts of the building are cooled. This improves thermal comfort for staff/visitors	2	££			
Provide digital control system to monitor and control all major plant Digital control systems can control and modify flow rates, compressors, pumps, fans, valves, etc. A digital system will ensure accurate and efficient use of equipment	2	££			
Review ductwork and pipework insulation Insulation reduces the amount of energy lost in duct and piping systems	3	££			

Energy/HVAC

	Refurbishment Level	Cost	Environment	Occupant	Institution
Solar boosted domestic hot water Solar boosted domestic hot water can be used to reduce fossil fuel energy consumption in heating hot water	3	££			
Biogas Biogas is gas produced by anaerobic digestion of organic matter, and can then be used as a fuel	3	£££			
Ground source heat pumps With the aid of a heat pump, the ground can be used to reject heat or gain heat. High efficiencies can be realised compared to air cooled systems, as the ground temperature is relatively stable throughout the year	3	£££			
Mixed mode ventilation Natural ventilation is used when ambient conditions are suitable, with A/C operated only during peak conditions, thereby reducing energy consumption	3	£££			
Efficient chiller selection Modern chillers have increased efficiency (more cooling can be provided with less electrical power consumed), which can reduce the energy demand on the building	3	£££			
Natural ventilation If a fully naturally ventilated system is provided, significant energy savings can be realised. Older institutions will have been naturally ventilated. It is worthwhile investigating the possibility of reinstating the ventilation strategy. This also improves indoor air quality	3	£££			
Replace existing air conditioning Antiquated systems can be replaced with modern more efficient types to significantly reduce energy consumption and improve thermal comfort This may be a tax deductible improvement	3	£££			
Biomass heating Biomass refers to living and recently dead biological matter, including biodegradable waste, which can be used as a fuel	3	£££			
Chilled beams or underfloor supply Chilled beams or underfloor supply systems can provide a more energy efficient means of cooling spaces	3	£££			
Passive environmental control Mechanical refrigeration and humidification equipment can be replaced by passive systems to provide environmental control. The relative humidity is controlled by exploiting the external air conditions along with the heating and ventilation of the space. This design strategy requires a suitable building and a relaxed range of temperature and humidity conditions. Significant energy savings are possible	3	£££			

Energy/Fitout

	Refurbishment Level	Cost	Environment	Occupant	Institution
Internal blinds Internal blinds can be used to reduce the solar gain to a building, decreasing the cooling loads	1	£			
Use LCD/LED Screens LCD/LED screens use significantly less energy then CRT screens, as well as taking up less space, and emitting no harmful radiation and reducing the cooling required	1	£			
Next generation thin client technology Thin client technology is where the client computer is used for input and output to the user, while the actual processing is done on a central server. Thin client technology uses much less energy then traditional systems, as well as decreasing the heating load within the office space. It can also produce a quieter environment because the noise from computer fans is removed	1	£			
Energy efficient appliance selection Selecting energy efficient appliances can reduce energy consumption significantly	1	££			

Energy/Building fabric

	Refurbishment Level	Cost	Environment	Occupant	Institution
Internal shading Internal solar shading can be used to reduce unwanted solar gains to a building, increasing the thermal and visual comfort of staff/visitors	1	£			
Paint roof with reflective paint Reflective paint can be used to reduce the amount of solar heat transmitted to the building	1	£			
Draught Excluders Reduce infiltration in transient spaces	1	£			
Improve air tightness to reduce unwanted infiltration Unwanted infiltration can increase the amount of unconditioned air into a space, increasing the heating or cooling requirements. Infiltration can also decrease thermal comfort and introduce unwanted particulates, such as dust, into the environment	1	££			
Automatic blinds Automatic blinds can be programmed to close as solar radiation or glare increases	1	££			
Review of daylighting for exhibits Maximising the potential daylighting in place of electrical lighting saves energy. Suitability depends on exhibit sensitivity and location. Light shelves etc. can be used to maximise potential daylighting	2	£			
Sealing of galleries / air tightness between spaces Depending on the time of year this improves the effectiveness of the HVAC systems by reducing unwanted losses/gains. Particularly important where conditioned and non-conditioned spaces are adjacent to each other	2	££			
UV protection Reduces the potential for UV damage from daylighting	2	££			
Blackout unused areas Minimise solar gains when a space is unused by using blackout blinds	2	££			

Energy/Building fabric

	Refurbishment Level	Cost	Environment	Occupant	Institution
Add solar control film to existing glazing Solar control film can reduce heat gains to a building, as well as reduce UV transmission, which reduces fading. This results in cost savings for institutions	2	££			
Mid pane blinds Mid pane blinds can be installed in the air cavity of double glazed systems. They are particularly effective at reducing solar gain and controlling glare	2	££			
Add secondary glazing to existing single glazing to improve insulation value Secondary glazing can be installed with an existing single glazed system to improve insulation, without the need to completely remove the framing	2	££			
Upgrade wall and roof insulation Upgrading wall and roof insulation can significantly reduce conduction through walls and roofs, with a corresponding decrease in the amount of heating and cooling required	3	££			
External light shelves Light shelves can be used to reflect incoming sunlight upwards to illuminate the ceiling. The reflected light will have little solar heat content, and can reduce the need for indoor lighting. It is also useful for reducing glare	3	££			
External solar shading External solar shading can be used to reduce unwanted solar gains and glare to a building	3	££			
Optimise window area Reducing the window area decreases transmitted solar gains, reducing the cooling load on the space	3	£££			
Double skin façade A double skin façade usually consists of an inner double glazed unit, a cavity and a second outer pane of glass. The cavity is usually around 1 metre wide, and can contain solar control devices and walkways for maintenance	3	£££			

Building modifications and alterations

	Refurbishment Level	Cost	Environment	Occupant	Institution
Review entrance area lobbies Relaxed temperature and humidity setpoints will save considerable energy. Lobbies themselves have potential to save energy	1	£			
Link adjacent buildings Bridges can enable adjacent buildings to work together	2	££			
Locate buildings together Avoid having stores and exhibit spaces in separate locations. Having the store near the exhibition space will reduce the transportation demands	3	££			
Roof over courtyard This can provide additional useful floor space and reduce envelope heat losses	3	£££			
Infill small gaps between buildings This can provide additional floor space, such as toilets or meeting rooms or break-out rooms, which frees up the planning of the existing floors	3	£££			
New floors in light wells and atria These can provide additional floor space, such as toilets or meeting rooms or break-out rooms, which frees up the planning of the existing floors	3	£££			
New floors in double height spaces These can provide additional floor space for storage or general office use	3	£££			

Emissions

	Refurbishment Level	Cost	Environment	Occupant	Institution
Boiler emissions A regular boiler maintenance programme can minimise NOx, CO and CO_2 emissions from boilers	1	£			
Zero Ozone Depletion Potential (ODP) refrigerants Use Zero ODP refrigerants refer to those refrigerants that have no ozone depletion potential (for example HFC or HCs)	2	£			
Refrigerant leak detection Where practicable, refrigerant leak detection tied into the BMS ensures that dangerous refrigerants leaks are detected quickly. This reduces a safety and environmental hazard, while saving money	2	£			
Automatic refrigerant pump down Where practicable, automatic refrigerant pump down captures and stores refrigerant during maintenance of refrigeration systems	2	£			

Indoor environmental quality

	Refurbishment Level	Cost	Environment	Occupant	Institution
Internal plants Plants improve indoor air quality	1	£			
Increasing outdoor air supply above Part L2 requirements Increases in the level of outside air supplied to a building has been shown to improve air quality, but may also increase energy demand costs	1	££			
Printers located near dedicated exhausts Printers can release harmful chemicals, such as ozone. Where possible, placing printers near dedicated exhausts helps ensure that these particulates do not effect occupants' health	2	£			
Low VOC products Volatile Organic Compounds (VOC) arise from the use of solvents which end up in formaldehyde paints, carpets, adhesives & wood products. VOCs can cause adverse health effects commonly known as 'sick building syndrome'	3	£			
Top level skylights Skylights can be used to introduce natural daylight into a building	3	£££			

Indoor environmental quality

	Refurbishment Level	Cost	Environment	Occupant	Institution
Personal control of thermal conditions Personal control of thermal conditions allows the differing comfort needs of individuals to be met. This is appropriate for non-exhibit areas	3	£££			
Replace existing glazing with high performance Low-E double glazing An appropriately selected double glazed, Low-E system with solar control performance reduces solar heat gain, radiant heat transfer, glare, noise and improves daylight	3	£££			
Natural ventilation to some parts of the building, where appropriate The use of natural ventilation increases the amount of outside air supplied to the building, which increases the indoor air quality	4	£££			

Materials

	Refurbishment Level	Cost	Environment	Occupant	Institution
Collections Rationalisation Removing surplus items from the collection will reduce the energy required to provide suitable storage	1	0			
Inter-gallery recycling Unwanted display materials can be reused by another institution	1	0			
Reuse packaging materials/cases/crates This saves costs and improves the sustainability of the supply chain	1	0			
Green waste compost Compost can be collected for use in landscaping	1	£			
Low maintenance, durable materials Low maintenance, durable materials last longer, use less consumable materials and take less time to maintain	1	£			
Avoid having a large number of temporary exhibits A sustainability benefit can be gained by recycling as much of the material from temporary exhibitions as possible	1	£			

Materials

	Refurbishment Level	Cost	Environment	Occupant	Institution
Preference of environmentally friendly suppliers Environmental impact can be reduced by selecting environmentally conscious suppliers	1	££			
Operational waste management plans A waste management plan details the expected levels of waste, and plans strategies to minimise the waste sent to landfill	1	££			
Reuse materials as much as possible Reusing materials reduces waste and saves money, specifically for exhibits	2	££			
Waste separation and recycling facilities Waste separation and recycling ensures that waste is diverted from landfill	2	££			
Carpet treated and reused in high use areas The reuse of carpet reduces wastage, consumption of materials and VOCs	2	££			
Centralised waste Centralised waste handling facilities can improve the effectiveness of collecting waste and can help to increase the lettable area of the building	2	££			
Minimise PVC in pipes, conduits, cables PVC production can produce harmful chemicals such as dioxins. They also are difficult to dispose of, and much PVC is either left in situ or sent to waste landfill at the end of its life	3	££			
Sustainable timber Sustainable timber refers to timber that is either reused, post-consumer recycled timber or Forest Stewardship Council (FSC) certified timber	3	££			
Waste compaction plant A waste compaction plant can be used to minimise refuse truck movements	3	£££			
Recycled concrete subgrade fill Recycled concrete can be used as an environmentally friendly substitute for new concrete. The reclaimed concrete is crushed and used as a substitute for crushed virgin rock	4	0			

Water

	Refurbishment Level	Cost	Environment	Occupant	Institution
Water audits Regular water audits can determine potential ways to reduce the use of water	1	£			
Low flow shower heads Low flow shower heads are an effective way to reduce water usage of showers	1	£			
Water efficient appliances Products should be chosen with reference to their efficiency rating	1	££			
Flow/pressure responsive flow regulators Flow regulators throttle the amount of flow through pipes to ensure water is not used unnecessarily	2	£			
Water sub-meters for all major end users Water sub-metering ensures that all tenants are charged only for the water they use. This allows the building owner to pass on accurate costs to tenants, and identify leaks	2	£			
Water leak detection A leak detection system as part of a BMS can pick up leaks quickly, meaning leaks can be repaired without significant water waste	2	£			
Urinal flush controls Urinal flush controls can be used to ensure that urinals flush only when used, rather than continuously	2	£			
Dual flush toilets Dual flush toilets provide the option of a full or half flush, reducing water consumption	2	££			
Waterless urinals Waterless urinals operate without the use of water	2	££			
Drought resistant landscape design Drought resistant landscaping design ensures the landscape does not require supplemental irrigation	2	££			
Non-potable water in cooling towers Non-potable water such as recycled water, rainwater, treated grey water, may be used in cooling towers instead of potable water	3	££			

Water

	Refurbishment Level	Cost	Environment	Occupant	Institution
Rainwater capture, treatment and reuse Rainwater capture treatment and reuse systems can be used to reduce reliance on potable water	3	££			
Grey water capture treatment and reuse Grey water can be captured from showers, basins and dishwashing, then treated and reused where non-potable water is required	3	£££			
Black water capture and reuse Black water can be treated and reused for non potable uses	3	£££			

Site

	Refurbishment Level	Cost	Environment	Occupant	Institution
Native planting Native plants, once established, require less maintenance, are more tolerant to the local environmental conditions and improve biodiversity	1	£			
Regular pest assessment and removal Regular pest assessment and removal ensures that disease carrying pests can be removed before causing adverse effects on staff or community	1	££			
Semi-permeable landscape Semi-permeable landscaping allows water to seep into the landscaping, providing plants and lawn with water, and reducing runoff to the sewer system	2	££			
Soft landscaping Soft landscaping allows water to seep into landscaping, providing plants and lawns with water, and attenuating runoff into the sewer system	2	££			
Stormwater detention Stormwater detention captures stormwater on site, and then releases it slowly to reduce impact on the stormwater system at discharge	3	££			

Transport

	Refurbishment Level	Cost	Environment	Occupant	Institution
Dedicated car parks for car pooling Encouraging car pooling reduces the number of cars on the road, and improves employee relations	1	0			
Sustainable travel plan for employees A sustainable travel plan encourages employees to travel via more sustainable methods	1	£			
Real time transport information The provision of real time transport information makes it easier for the building's visitors and staff to use public transport	1	£			
Bicycle maintenance An on-site bicycle maintenance scheme, operated by visiting bicycle mechanics, encourages staff to use bicycles and reduces transport emissions	1	£			
Park and ride A park and ride scheme, perhaps shared with neighbouring buildings, can reduce congestion and the need for on-site parking	2	££			
Bicycle storage, accessible showers, changing facilities, lockers Encouraging visitors and staff to ride to work helps reduce transport emissions	2	££			

Social

	Refurbishment Level	Cost	Environment	Occupant	Institution
Communication with other stakeholders, eg monitoring tenant/ investment satisfaction Good communication will help ensure that the needs of stakeholders are met	1	£			
Communication with community Increased communication improves relations between the institution and tenants with the local neighbourhood	1	£			
External lights on movement sensors Linking external lights to movement sensors improves the security of staff outside the building at night, and reduces energy consumption	2	£			

Social

	Refurbishment Level	Cost	Environment	Occupant	Institution
Public Sustainability Display Inform the public of the institution's intentions and actions. This will help engage the public and promote the institution	1	£			
Promote community related meetings This will engage the institution more with the community, and so indirectly promote the sustainability methods being adopted by the institution	1	£			
Organise sustainability themed public volunteering events This will promote sustainability within the community and benefit the institution	1	£			
Community involvement e.g. community events, open days Community involvement can help to establish a connection and engagement between the institution and tenants and the local community	1	££			
Improved accessibility and wayfinding Provision of appropriate footpaths, lifts, floor layouts and access ways to cater for all levels of physical ability	2	££			
Accessible open space Accessible office space promotes an environment that encourages interaction	2	££			
Provide a concierge desk A concierge facility can be a part of the base building	2	££			
Circulation and social spaces Circulation and social spaces foster informal and spontaneous interactions	2	££			
Acoustic attenuation for neighbours Acoustic attenuation minimises noise pollution into the surrounding areas	2	££			

Additional

	Refurbishment Level	Cost	Environment	Occupant	Institution
Gas Suppression System Fire fighting strategy for where sprinklers are not usable due to delicate exhibits	2	££			
Technology infrastructure that facilitates the use of various work settings This helps staff and visitors work in a range of locations and settings	2	££			
Outdoor breakout spaces such as roof gardens or courtyards These provide a change from the internal environment and promote social interaction	3	££			
Provide CCTV to main public areas, carparks and goods lifts Identify the minimum level of CCTV coverage provided by the base building	3	£			
Provide car parking Identify the minimum requirement for car parking available as part of the base building	3	£££			

Step #5
Make your survival strategy happen

Make your survival strategy happen

Once you have established a Survival Strategy it is essential that you set up a feedback mechanism to review the impacts of your actions. Certain initiatives will provide tangible benefits, such as reduced energy bills. Others will be more difficult to measure, such as public opinion. Nonetheless, it is important to determine the benefit of each.

Benchmark your building

The energy benchmarks for museums and galleries are a very useful method of measuring performance and improvement. Calculating a kWh/m^2 per year value will be a direct means of assessing the building performance.

Establish costs

Next, find out the cost of a proposed intervention. Likely cost ranges of many interventions can be established relatively easily, by reference to published cost data. These figures must then be "tuned" to fit the particular circumstances of your building. For example, must exhibits be moved to allow work to proceed? Could new plant be tax-deductible?

Larger scale or more intrusive interventions will need the involvement of a design team containing building services engineers, structural engineers, architects, cost consultants, and possibly specialists such as fire or façade engineers.

Assess returns

Interventions are designed to produce cost savings, but whether some do is another matter. The greenest building can be operated poorly if its systems are not well understood by those responsible for running it, or if they do not suit the needs and behaviours of the staff, visitors or exhibits. A realistic assessment of savings is therefore required, that takes account not only of the best possible outcome but also factors that may lessen the benefits.

Conversely, this assessment may highlight the need for further actions by management, such as the preparation of building users' guides or clear light switch labelling, to inform and educate the building's occupants and make it easier for them to do the right thing.

This concludes your five steps. Take a look at the case studies in this document for examples of people who are *"making it happen".*

Case Study

Sustainable Energy Review
Wordsworth Trust

The Wordsworth Trust owns a number of buildings in Grasmere, Cumbria including the Wordsworth Museum and Jerwood Centre which house much of the Trust's collection of work by William Wordsworth. The museum was partially refurbished in 2004 at the time that the new Jerwood Centre building was completed. The two interconnected buildings contain a number of galleries, reading room, archives, offices, workrooms and a shop.

The two buildings currently consume 129,000kWh gas per annum and 280,000kWh electricity per annum which means the buildings are considerable users of energy. The high usage is due to the plant that is installed to control the temperature and humidity in the galleries and archives.

An energy review was commissioned by the Wordsworth Trust (undertaken by Arup) which looked at museum and gallery setpoints, building management system, general review of systems and identification of potential interventions.

Matrix Initiatives

Management

- BMS Trend logging of gallery areas
- BMS sensor calibration

Energy/HVAC

- Ensure controls are working correctly
- Air conditioning control
- Review of standards for storage and display
- Passive environmental control

Energy/Building fabric

- Improve air tightness to reduce unwanted infiltration

Outcomes

Following the review various options are under discussion as to those that will be most cost effective to implement in the future. Options include radical changes such as using a system which does not rely on mechanical refrigeration, dehumidification and humidification to control humidity. Systems utilising heating to control humidity are being considered to potentially provide more stable control and reduced energy use.

Contact

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Case study

Changes have resulted in display lighting energy use being reduced by 18% saving 5.5 tonnes CO_2 per annum.

Sustainable Behaviour
The Beacon Museum, Whitehaven

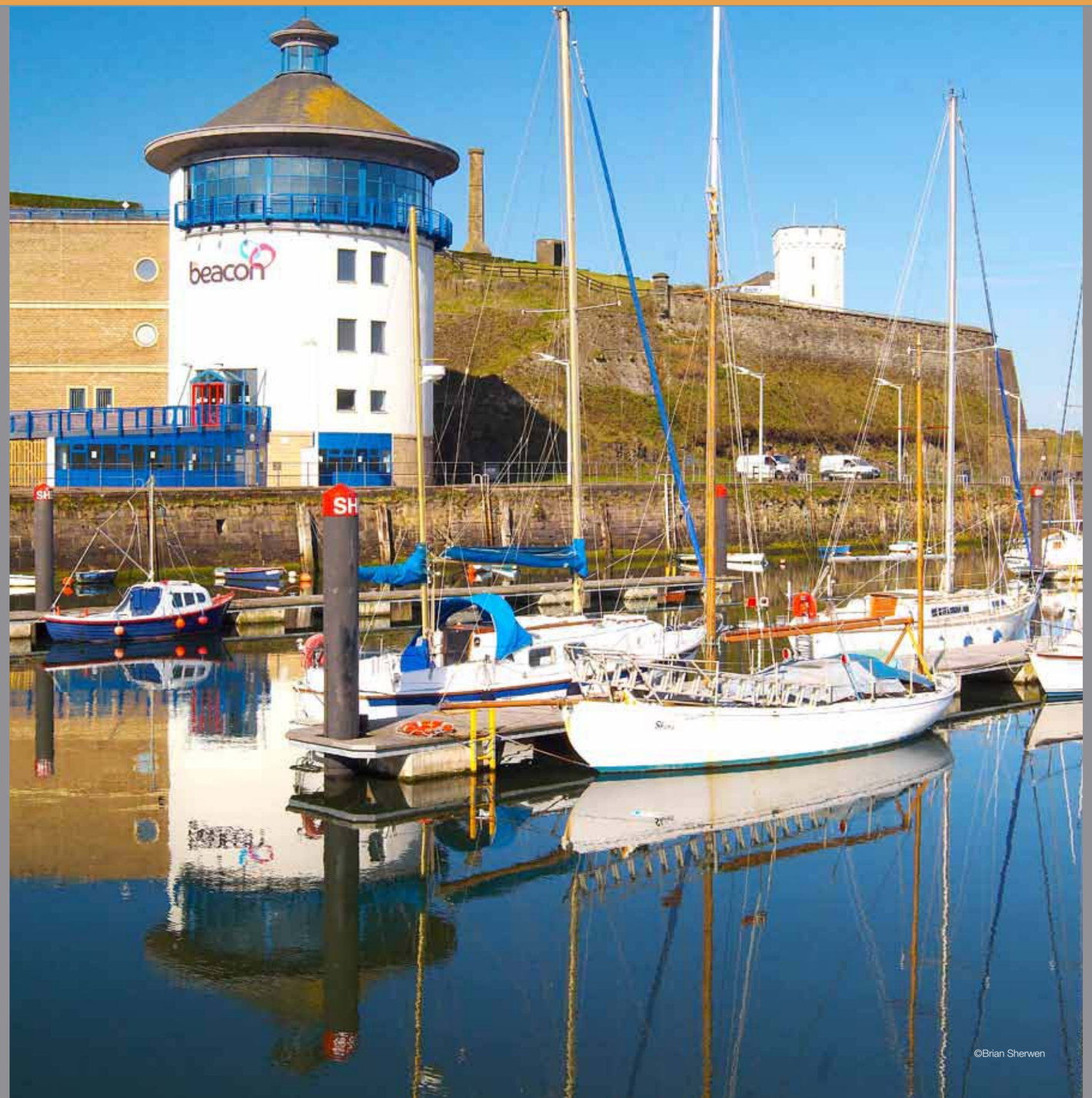
The Beacon is Copeland Borough Council's museum in Whitehaven, Cumbria. Opened in 1996 in a purpose built building on Whitehaven's harbourside, The Beacon supports the Council's aims to increase tourism spend, support area regeneration and economic development, as well as enabling lifelong learning and access to cultural heritage.

The 5-storey building contains approx 1500 sq metres and includes 3 floors of permanent galleries, 1 large temporary exhibition gallery, education space, offices, reference library, photographic darkroom, shop and café/bistro (tenanted). With the exception of the top floor or Viewing Gallery there are no windows to the other galleries.

The museum is open all year round and caters to evening room hire bookings or corporate events twice a week on average.

A lighting audit resulted in the following actions and results:

Gallery lights were left off until needed, cleaners were trained to operate lights, lights not required during daylight hours have been identified and not used during the day, gallery shop and reception lights are not operated until opening time, saving 2 hours usage per day.



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Matrix Initiatives

Management

- Energy consumption targets and monitoring / metering
- Develop a building user training programme
- Ongoing training of building management staff

Legislative and code compliance

- Carbon Reduction Commitment

Energy/Lighting

- Easily understood light switch labelling
- Occupancy sensors for lighting

Water

- Water efficient appliances

Transport

- Sustainable travel plan for employees

Social

- Organise sustainability themed public volunteering events

Outcomes

These changes have resulted in display lighting energy use being reduced by 18% saving 5.5 tonnes CO_2 per annum and £1,050 per year.

In addition water saving in toilets by reduced flush volumes, and a change from bottled to mains drinking water has realised considerable water savings.

The museum also encourages sustainable behaviour by a scheme of incentives and educational participation.

Contact

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Further information

Legislation

Energy Performance of Buildings Directive (EPBD)
Directive 2002/91/EC of the European Parliament and Council, on the energy performance of buildings, came into force on 4 January 2003. The principal objectives of the Directive are to promote improvement of the energy performance of buildings within the EU through cost effective measures, and to promote the convergence of building standards towards those member states that already have ambitious levels.

As part of the Directive, all EU member states must:

- Make "consequential improvements" to the energy efficiency of buildings over 1000m^2 undergoing refurbishment
- Arrange for all buildings to have an Energy Performance Certificate (EPC) available whenever they are offered for sale or rent. A small number of buildings are exempt (eg some heritage buildings). The EPC's of large buildings, to which the public has access, must be displayed
- Implement the inspection of air-conditioning systems

2008 saw the implementation of this Directive in the UK with the introduction of EPCs whenever a building is constructed, sold or rented. In addition, Display Energy Certificates (DECs) are required for public buildings. The rationale behind this legislation is to encourage the process of market transformation, by making the energy performance of a building clear to potential purchasers, tenants and users in the same way that the labelling of domestic appliances has led to the virtual elimination of poorly performing white goods.

The recently published EU document "An EU Energy Security and Solidarity Action Plan" indicates that it is intended to revise the EPBD in 2010 to require member states to penalise via the tax system the owners of buildings with a poor EPC. In the UK, business rates, Council Tax, Stamp Duty Land Tax would perhaps in the future apply at variable levels to reflect the energy performance of individual buildings.

UK Building Regulations
In response to the EPBD, the UK introduced building regulations in England and Wales in April 2006, in Northern Ireland in November 2006, and in Scotland in June 2008. The most significant change was the development and implementation of a National Calculation Methodology (NCM) that standardises the calculation of CO_2 emissions from energy use in non-domestic buildings.

Part L of the building regulations sets minimum standards for energy efficiency in new and some existing buildings.

The new Part L 2010 (introduced in October 2010) builds on the 2006 regulations, requiring carbon emissions to be reduced by 25% on an aggregate approach based on the building type. Each type of building will have a Target CO_2 Emission Rate (TER) based on the cost effectiveness of the carbon emission reductions for that building type.

The EU Emissions Trading System (ETS)
This scheme is intended to collectively reduce CO_2 emissions to combat the threat of climate change. At present the EU ETS has the greatest impact on big power companies; however, in time it is likely to affect all buildings.

The Carbon Reduction Commitment Energy Efficiency Scheme (CRC)
This scheme is a legally binding carbon emissions trading scheme that covers all businesses and large public sector organisations with a yearly consumption of more than 6,000MWh per year of electricity. This translates to approximately £500,000 of electricity/year.

The aim of the scheme is to reduce the carbon emissions from these sectors by 4 million tonnes of carbon dioxide per year, by 2020. Each year the organisations concerned will need to submit sufficient allowances to cover their annual emissions. The scheme starts in April 2010 and allowances will be available for purchase in April 2011. Initially the allowances will be sold at a fixed rate of £12 per tonne of carbon dioxide.

If in 2008 the institution's electricity bill was greater than £500,000 then it will be required to participate. Only very large institutions will need to be involved with the CRC. Each year the involved institution will need to purchase allowances. If the institution has reduced its carbon emissions below its allowable amount, then it will receive its contribution back, as well as a bonus. Essentially the institutions involved will pay into a pot, and at the end of the year the highly performing institutions will be rewarded, and the others will be penalised further.

Link
http://www.carbontrust.co.uk/policy-legislation/business-public-sector/pages/carbon-reduction-commitment.aspx

Further information

Feed in Tariffs (FITs)
This scheme rewards the production of electricity from renewable or low carbon sources. From April 2010 energy suppliers will make regular payments to an institution for all accredited renewable/low carbon electricity generated, and additional payments for electricity exported to the grid.

For the institution this provides a means of making renewable and low carbon technology more financially accessible. Once the technology is installed the institution will be able to generate a proportion of its electricity sustainably. The benefits will be threefold: a reduction in electricity bills, payment for producing electricity sustainably, and payment for exporting electricity. Often a loan is taken out to pay for the technology and so the repayments and the interest needs to be accounted for.

For museums and galleries the ability to install renewable or low carbon sources will vary considerably. An institution based in a Listed Building will find it more difficult to gain permission to install this technology, whereas a modern science museum for example, could install this technology and incorporate it as an exhibit. Overall the benefit of FITs will need to be decided on a case by case basis.

Renewable Heat Incentive (RHI)
The Renewable Heat Incentive (RHI) is a new scheme to support the generation of heat from renewable sources. The government was expected to introduce this scheme in April 2011 but the Department for Energy and Climate Change has announced that it will set out a detailed proposal for the RHI after the Spending Review in October 2010. If the scheme is introduced it should give a very significant boost to renewable heating technologies such as air source and ground source heat pumps, biomass heating and solar water heating.

Legislation
The following link lists UK energy legislation on the UK statute law database maintained by the Ministry of Justice http://www.statutelaw.gov.uk/SearchResults.aspx?TYPE=QS&Title=energy&Year=&Number=&LegType=All+Legislation

Health and safety and disability legislation that may be relevant to institutions:

- The Health and Safety at Work, etc, Act, 1974
- The Electricity at Work Regulations, 1981
- Health and Safety (First Aid) Regulations, 1981
- The Food Safety Act, 1990
- Workplace (Health, Safety and Welfare) Regulations, 1992
- Manual Handling Operations Regulations, 1992
- Health and Safety (Display Screen Equipment) Regulations, 1992
- Disability Discrimination Act (DDA), 1995
- Management of Health and Safety At Work Regulations, 1999
- Control of Substances Hazardous to Health Regulations, 2002
- The Fire Regulatory Reform Order, 2005
- The Reporting of Injuries Diseases and Dangerous Occurrences Regulations, 2005
- Construction (Design and Management) Regulations, 2007

Environmental legislation that may be relevant to building owners and managers
Environmental Protection Act 1990 as amended and associated regulations including:

- Environmental Protection (Duty of Care) Regulations, 1991, as amended
- Controlled Waste Regulations, 1992, as amended
- Waste Management Licensing Regulations, 1994, as amended
- Regulation 2037/2000 on substances that deplete the ozone layer
- Landfill (England and Wales) Regulations, 2002
- Water Resources Act, 1991
- Noise and Statutory Nuisances Act, 1993
- Clean Air Act, 1993
- Environment Act, 1995
- Anti-pollution Works Regulations, 1999
- The Environmental Protection (Controls on Ozone Depleting Substances) Regulations, 2002, including: Ozone depleting substances (Qualifications) regulations SI 2006/1510

FITs work by guaranteeing a long term premium payment for electricity generated from renewable sources and fed into the grid. The government fixes both the payment levels and the duration of the scheme, thus providing certainty for investors.

Further information

Web Resources

Carbon Trust - http://www.carbontrust.co.uk/default.ct

Global Action Plan - http://www.globalactionplan.org.uk/

Centre for Construction and Innovation- Salford University - http://www.ccinw.com/

Centre for Alternative Technology - http://www.cat.org.uk/

Building Research Establishment's Environmental Assessment Method - http://www.breeam.org/

Green Globes - http://www.greenglobes.com/

Green Building Initiative - http://www.thegbi.org/

UK Green Building Council - http://www.ukgbc.org/

International Council for Local Environmental Initiatives - http://www.iclei.org/

International Council for Local Environmental Initiatives - Europe - http://www.iclei-europe.org/
ICLEI—Local Governments for Sustainability is an international association of local governments and national and regional local government organisations that have made a commitment to sustainable development. Also provide training.

National Energy Foundation - http://www.nef.org.uk

Constructing Excellence - http://www.constructingexcellence.org.uk/

Energy Saving Trust - http://www.energysavingtrust.org.uk/

Groundwork - http://www.groundwork.org.uk

Historic Scotland - http://www.historic-scotland.gov.uk/index.htm
Publications on conservation and repair of historic buildings

10:10 - http://www.1010uk.org/

British Standards Institute - http://www.bsigroup.com
News on updated standards

Business Link - http://www.businesslink.gov.uk/bdotg/action/home
Environment and Efficiency resources

Department for Environment, Food and Rural Affairs - http://www.defra.gov.uk

The Green Tourism Business Scheme (GTBS) is the national sustainable tourism certification scheme for the UK - http://www.green-business.co.uk/index.asp

Further information

Glossary

A/C: Air-Conditioning
AHU: Air Handling Unit
BMS: Building Management System
BREEAM: Building Research Establishment Environmental Assessment Method
CCTV: Closed Circuit Television
CDP: Carbon Disclosure Project
CHP: Combined Heat and Power
CHW: Chilled Water
CLG: Department of Communities and Local Government
CO: Carbon Monoxide
CO_2: Carbon Dioxide
CRC: Carbon Reduction Commitment Energy Efficiency Scheme
CSR: Corporate Social Responsibility
DEC: Display Energy Certificate
EPBD: Energy Performance of Buildings Directive
EPC: Energy Performance Certificate
ETS: Emissions Trading System
FIT: Feed-in tariff
FM: Facilities Management
FSC: Forestry Stewardship Council
GHG: Green House Gas
HCs: Hydro Carbon
HFCs: Hydro Fluorocarbon
HVAC: Heating, Ventilating and Air Conditioning
IAQ/IEQ: Indoor Air Quality/Indoor Environment Quality
ICT: Information and communication technologies
IR: Infra Red
IRR: Internal Rate of Return
kWh: Kilo Watt Hour
LCD: Liquid crystal diode
LED: Light emitting diode
LEED: Leadership in Energy and Environmental Design
MATV: Master Antenna Television
MTBF: Mean Time Between Failures
MWh: Mega Watt Hour
NCM: National Calculation Methodology
NOX: Nitrogen Oxides
NPV: Net Present Value
O&M: Operations & Maintenance
ODP: Ozone depletion potential.
PROBE: Post-occupancy review of buildings and their engineering
PV: Photovoltaic
PVC: Polyvinyl chloride
RCx: Retro-commissioning
RHI: Renewable Heat Incentive
TER: Target CO_2 Emission Rate
UV: Ultra Violet
VOC: Volatile Organic Compound
VPO: Voltage Power Optimisation
WELS: Water Efficiency Labelling and Standards scheme
WRAP: Waste & Resources Action Programme.

References and Information

Stern, N. (2006) *The Economics of Climate Change: The Stern Review*, Cambridge University Press.

Thomson, G (2002), *The Museum Environment, Second Edition*, Butterworth-Heinemann

CIBSE (2004) CIBSE Guide F – Energy efficiency in buildings

BRE Building Research Establishment (2000), *Comfort without air conditioning in refurbished offices - an assessment of possibilities*.

BSRIA Building Services Research and Information Association (1998), *Refurbishment of air-conditioned buildings for natural ventilation TN8/98.*

Renaissance in the Regions Environmental Sustainability Initiatives

Renaissance Yorkshire

Programme: Yorkshire and Humber Museum Sustainability Project, in conjunction with Welcome to Yorkshire and CO2Sense Yorkshire, encourages museums to look at their operations from an environmentally sustainable point of view. Groundwork Sheffield is working with 12 museums to reduce costs and meet recognised environmental standards through evaluating the impact of four development methodologies; (1) direct support, (2) use of Green Museums, a self-help guide following the model developed by Groundwork and Renaissance East Midlands, (3) Green Start, an on-line toolkit administered through Visit England and (4) Green Tourism Business Scheme (GTBS), a certificated membership scheme administered by Green Business UK Ltd, a not-for-profit independent company.

Participating museums assess performance, develop a targeted action plan and implement improvements, with access to a small improvement fund as well as additional funding opportunities, in order to

- Reduce costs associated with energy use, water use and waste collection and disposal.
- Identify where new technologies and equipment could help make further savings
- Access expertise, grants and support
- Gain an environmental sustainability accreditation

Resources and Tools:
http://www.better-tourism.org
http://www.co2sense.org.uk
http://www.yorkshire.groundwork.org.uk

Contact:
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Renaissance North East

Programme: The programme has worked with the Green Tourism Business Scheme (GTBS), the national sustainable tourism certification scheme for the UK. Participating museums receive one year membership including an advisory visit and an assessment by a qualified grading advisor against a rigorous set of criteria, covering a range of areas, such as energy and water efficiency, waste management, biodiversity and more. Progress is being made beyond the initial audits with consultancy support to facilitate the development of an Environmental Sustainability Improvement Plan and monitoring system for each museum. Introductory training has also been delivered across the region through 'Green Advantage' training courses (Welcome to Excellence).

Resources and Tools: Green Business Tourism Scheme (GTBS)
http://www.green-business.co.uk

Green Advantage:
http://www.welcometoexcellence.co.uk/trainingprogrammes/greenadvantage.asp

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Renaissance East of England

Programme: An ambitious programme focusing on triple bottom line sustainability; in relation to environmental issues it has worked with the Rural Museums East partnership, and addressed retrofitting and the Green Gateway at Gressenhall Farm and Workhouse; the evaluation of modern green build with Stockwood Discovery Centre, Luton. It also encourages more museums across the region to become more sustainable; museums in East of England have had the opportunity to work through the Green Museums Step by Step Guide, with Green Action Grants to help put ideas into practice.

Resources and Tools: Sustainability Case studies publication, Social Sustainability toolkit are being developed.

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Renaissance in the Regions Environmental Sustainability Initiatives

Renaissance London

Programmes: Regional Green Museum Programme – participating museums receive one year membership of the Green Business Tourism Scheme (GTBS) including an advisory visit and evaluation from GTBS. Funding is available to tackle action points.

Green Museum Promotional Museum Programme – funding is available for museums to run activities that communicate green issues to local communities through partnerships with local authorities.

Resources and Tools: Further information available -
http://www.mla.gov.uk/what/programmes/renaissance/regions/london/regional_programme/Funding_sustainability

Green Business Tourism Scheme (GTBS)
http://www.green-business.co.uk

Sustainable Exhibitions for Museums Group uk.groups.yahoo.com/group/sustainable_exhibitions

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Renaissance East Midlands

Programme: A three year programme to gain a greater understanding of the sustainability issues faced by museums in the East Midlands. Support has been provided to help participant sites undertake effective environmental monitoring and develop action plans for future environmental improvements.

Resources and Tools: Green Museums Step by Step guide and the environmental performance monitoring spreadsheet, developed by Groundwork Derby & Derbyshire. It can be used by museums across the country for their own monitoring and environmental improvement programme.
http://www.mla.gov.uk/what/programmes/renaissance/regions/east_midlands/info_for_sector/collections_buildings/buildings_projects

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The Museums Libraries and Archives Council Sustainability Advisory Panel

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Laura Frampton, Victoria & Albert Museum
Ben Cowell, National Trust
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Alex Homfray, BOP
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Acknowledgements and contacts

Renaissance is the Museums, Libraries and Archives Council's (MLA) national investment programme to transform England's regional museums. Renaissance is helping to meet people's changing needs – and to change people's lives.

Renaissance North West is delivered through six hub museums and galleries with sustainability and innovation embedded throughout our work. It comes from new ways of working, new ways of thinking and new ways of sharing the learning. Innovation comes from working together, testing and disseminating ideas to achieve greater impact.

Working towards greater sustainability has been at the heart of Renaissance North West's work over the last two years and will inform future developments. In the initial stages we were inspired and informed by the Museums Association's extensive work led by Maurice Davies. We have also brought in a range of experts and critical friends to help us on this journey including Gaby Porter, Rachel Madan, Steve Connor and Helen Wilkinson.

We are particularly grateful to the Green Museums Steering Group that has been led so effectively by Kaye Tetlow, and includes Amanda Wallace, Nicola Walker, Dean Whiteside, Jeff Cowton, Ronald Mcgregor, Samantha Sportun, Rachel Hammond, Pierrette Squires, Heather Davis, Mary Robinson, and Anne Fahy.

This publication is one of the legacies of the Green Museums programme that has brought together museums and galleries across the North West to get to grips with practical and organisational changes required to reduce resource usage and increase energy efficiency. It has been produced through a powerful partnership with Arup.

Arup
Design, Consulting, Engineering
Arup is a multi-disciplinary firm of designers, planners, engineers, consultants and technical specialists. Arup has a reputation of producing landmark projects with a focus on sustainability. We have a diverse international portfolio and an extensive track record in the Arts and Culture sector. Our first iconic project was the Sydney Opera House. More recently in the Arts sector in the UK, our projects have included the Natural History Museum, Darwin Gallery and National Gallery, Sainsbury Wing in London, as well as the Manchester Art Gallery, Nottingham Contemporary and Pallant House Gallery, Chichester.

> Reducing our carbon footprint not only saves money but also helps sustain the quality of the environment for future generations. **Museums are not just about the past and must show they can help safeguard the future.**
>
> Vanessa Trevelyan, 2010 President of Museums Association
> Head of Norfolk Museums & Archaeology Service

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The Heritage Lottery Fund has a strong focus on environmental impact and sustainable use of resources. We encourage all of our applicants to explore a sustainable approach in their projects, including energy efficiency, renewable energy, water and sustainable building materials. **We are delighted that the Survival Strategy will assist museums and galleries in planning effectively for greater efficiency and to reduce their environmental impact.**

Sara Hilton, Head of Heritage Lottery Fund North West

museums & art galleries survival strategies

A guide for reducing operating costs and improving sustainability

MLA Renaissance Museums for changing lives

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