green museums

a step by step guide

GROUNDWORK
DERBY & DERBYSHIRE

This step by step guide has been 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.

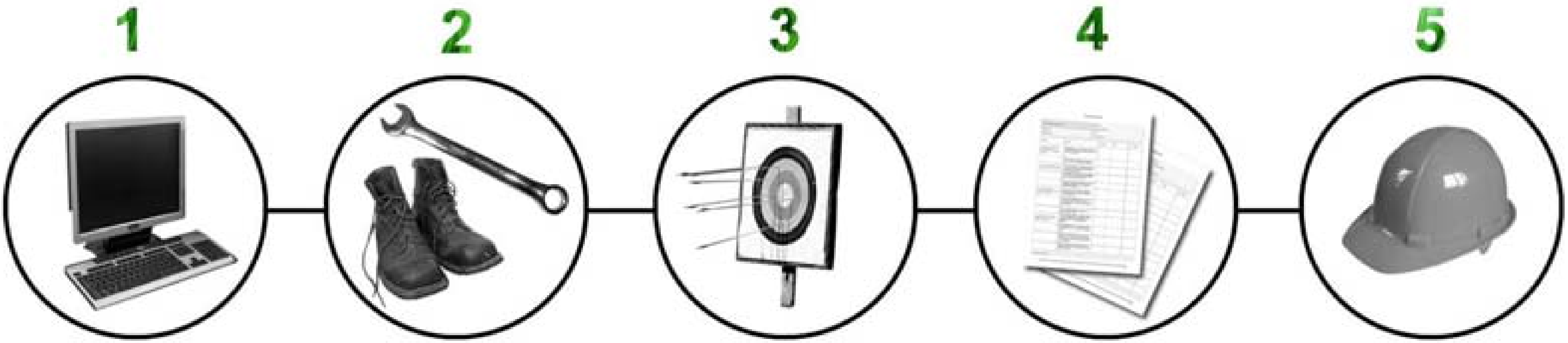
MUSEUMS LIBRARIES ARCHIVES EAST MIDLANDS

RENAISSANCE EAST MIDLANDS
museums for changing lives

And in partnership with:

T4 Sustainability Ltd

GROUNDWORK DERBY & DERBYSHIRE



I n t r o d u c t i o n

0.1 Introduction by MLA:

Whoever said “it’s not easy being green” (and I think it was Kermit the Frog) was not entirely right. Being green is not that difficult in itself. Actually, it can be surprisingly easy to make a difference (and surprisingly cheap), but sometimes we just need a helping hand to work out where to begin, or where to go next.

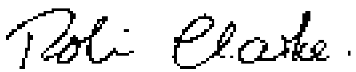
That’s where this guide comes in. It aims to help museums take a close look at their operation and work out the most practical way to become a little (or a lot) greener.

Not being green is no longer an option. The dangers to the planet are well documented, and there is considerable political pressure to reduce our individual and collective carbon footprint.

But aside from that, museums have a particular responsibility in this field. They are, after all, primarily about sustainability, and are unique in having responsibilities to people of the past, present, and future to ensure that collections remain in good shape and accessible for years to come.

Museums shape our view of the world. They help us understand who we are and the world in which we live. They influence how we think and the way in which we behave. They are, therefore, uniquely placed to help change attitudes towards all sorts of contemporary issues. Museums are ideally placed *to make a difference.*

So take this guide, use it and remember that a greener society really can begin with Green Museums.



Robin Clarke,
Leicestershire County Council.

Caroline Pick,
MLA East Midlands

0.2 Why Green Museums:

Green Museums is an initiative to enable the region's museums to reduce their environmental impact. It has been commissioned in 2 parts, both funded and coordinated by Renaissance East Midlands and MLA East Midlands.

Part one, a survey carried out by De Montfort University found that 80% of museums in the East Midlands are already taking important steps to improve their environmental performance.

- 35% of museums are actively aware of their environmental footprint and are already taking action to reduce their environmental impact.
- 80% have systems in place for recycling and 60% regularly buy recycled goods.
- Nearly three quarters of sites recognise they have a role in environmental education of visitors and 42% have organised environmentally themed events or activities.

Part two, delivered by Groundwork Derby & Derbyshire, provided one-to-one support for six museums and the development of this guide ,a step-by-step guide, available to all museums in the East Midlands and the UK.

The project board which steered the project was:

Ruth Stockdale, Renaissance East Midlands

Caroline Pick, MLA East Midlands

Rob Clarke, Leicestershire County Council

Vicky Martin, Nottingham City Museums

Isabel Churcher, Renaissance East Midlands

Gillian Crawley, Nottingham City Museums

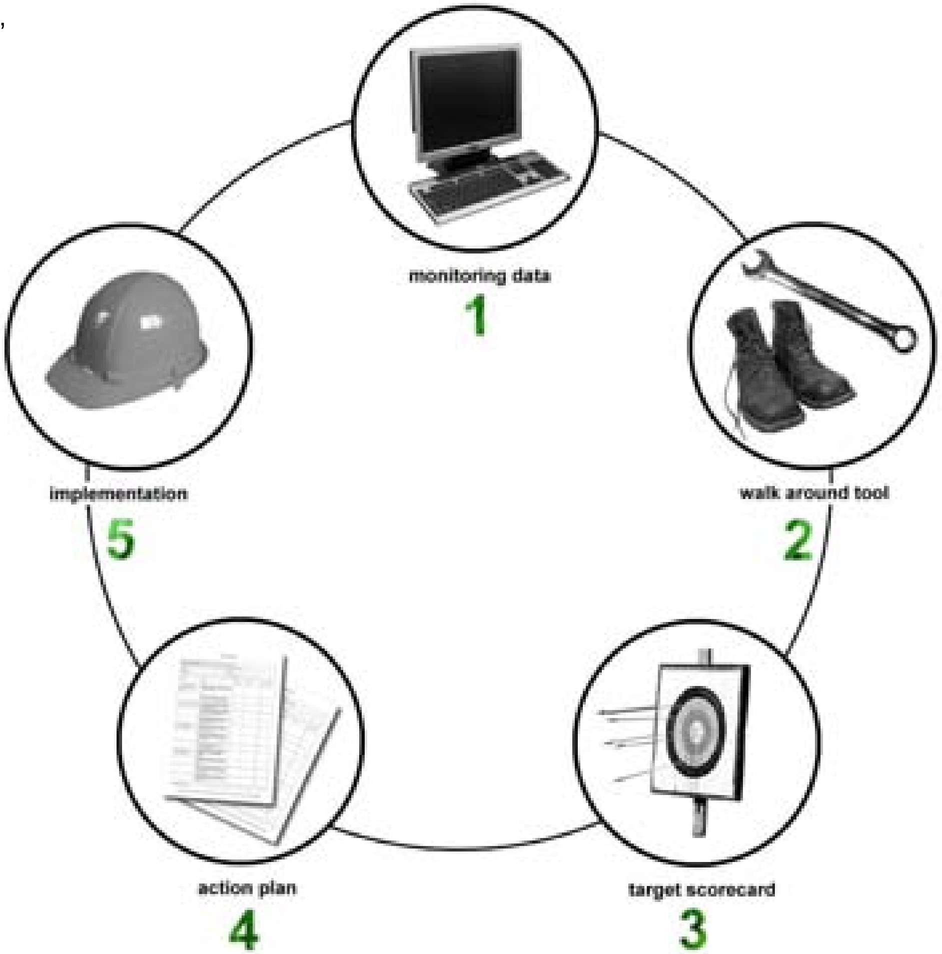
The 6 pilot museums were:

- Church Farm Museum , Lincolnshire
- Derby Silk Museum, Derbyshire
- Greens Mill Museum, Nottinghamshire
- Irchester Narrow Gauge Railway Museum, Northamptonshire
- Papplewick Pumping Station, Nottinghamshire
- Wigston Framework Knitters Museum, Leicestershire

0.3 Flow Diagram of the Process

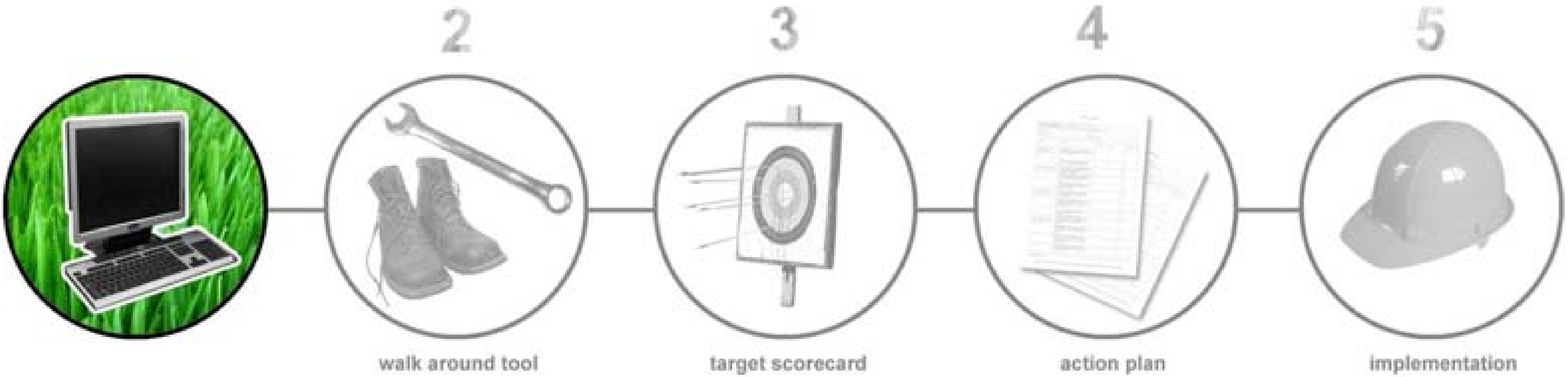
Below are the 5 recommended steps to start the journey of making your museum more environmentally friendly whilst also helping to reduce your running costs.
Once you have carried out all 5 steps, start the process again to see whether you need to update or amend the results of each step. Doing this keeps the process up to date and means you are continuously trying to improve your environmental sustainability.

"We do not inherit the earth from our ancestors; we borrow it from our children."
(Native American Proverb. www.quotegarden.com)



monitoring data

1



Monitoring Data

Getting started…… “If you can’t measure it you can’t manage it” attributed to Peter Ducker, management consultant.

Data collection is important as it will help your museum to understand the use of resources, generation of waste and overall environmental impact.

Using the Data Monitoring Sheet will give you the following benefits:

Guidance for Data Monitoring

The information required in the Data Monitoring Sheet can be taken from your metered supply either from reading the meter directly, obtaining information from your landlord/owner, if relevant, or drawn from your bills and invoices. Please note that the bills & invoices can be estimates, if so it is worth reading your meters, to obtain the most accurate information. Use the guide below to help you fill in the data and find out what your carbon emissions are, from your energy use. Section C provides information on the different types of meters.

This guidance note should provide your museum with the necessary information to fill in the Data Monitoring Sheet (DMS). The DMS has 6 main sections to be filled in. The notes below, explain the different parameters, their units and the conversion methods required for entering the data onto the DMS. The hyperlink attached to the DMS takes you to an Excel version that has all the standard formulae so that your CO^2 emissions from direct energy use are automatically calculated and shown in the Environmental Impacts Summary box on the DMS. Please try and collect the data for the last 12 months.

1st SECTION:

Please indicate the museum's turnover which can be very helpful to assess the cost of energy/waste/resources for your museum.

2nd SECTION:

Please indicate, ideally for every month, the number of visitors your museum had, as well as the number of volunteers (if applicable) and the monitoring of temperatures (if applicable and available).

3RD SECTION: UTILITIES

TOTAL ELECTRICITY USED

Description:	Required unit:	Source of data:	Conversion factors:
Total electricity used on site.	kWh	Data drawn from electricity bill.	Not applicable.

TOTAL GAS USE

Description:	Required unit:	Source of data:	Conversion factors:
Total gas used according to metered devices	kWh	Data drawn from gas bill.	Not applicable.

TOTAL WATER USE

Description:	Required unit:	Source of data:	Conversion factors:
The total water used on site. Water sources include mains water and any other sources such as borehole abstraction	m^3/year	Data can be drawn for water bills and/or meter readings.	Not applicable unless meter readings are in litres. $\Rightarrow$ 1 m^3 = 1,000 litres

TOTAL BURNING OIL USE

Description:	Required unit:	Source of data:	Conversion factors:
Total oil used as fuel or energy source, excluding oil as lubricant or raw material.	L or kWh	Data drawn from supplier bill.	Not applicable

4TH SECTION: TRANSPORT FUEL

Please indicate the types of fuel used for using vehicles as part of the museum's activities.

Description:	Required unit:	Source of data:	Conversion factors:
Total fuel used by the museum for motor vehicles. It may include the use of specific vehicles such as a forklift truck, which may be using gas bottles for its operation	Litres (L)	fuel records	Not applicable

5th SECTION: WASTE

WASTE SENT TO LANDFILL

Description:	Required unit:	Source of data:	Conversion factors:
Total waste generated on site and sent for disposal to landfill. This is usually general waste collected for instance by the Council.	Preferably as a weight (in kilogramme or tonnes if applicable). If the weight is not known, it can be specified as a volume (in cubic metres or cubic yards), or by the number of lifts and size of bins/skips.	Data can be drawn from the waste disposal bills and the collection agreement made with the waste contractor. However, it is important to take into consideration the fact that bins/skips may not be collected completely full.	Not applicable

TOTAL WASTE SENT FOR RECYCLING

Description:	Required unit:	Source of data:	Conversion factors:
Waste collected and specifically sent for recycling.	Preferably as a weight (in kilogramme or tonnes if applicable). If the weight is not known, it can be specified as a volume (in cubic metres or cubic yards), or by the number of lifts and size of bins/skips/bags.	Data drawn from waste collection bill and in-house records.	Not applicable

HAZARDOUS WASTE SENT FOR DISPOSAL

Description:	Required unit:	Source of data:	Conversion factors:
Hazardous waste (previously called special waste) and listed in the European Waste Catalogue. Museums that generate hazardous waste must be registered as a producer of hazardous waste and must use specified consignment notes for removal off-site. The waste contractor is not allowed to collect and take the waste off site if the	Ideally as a weight (in tonnes or kg as appropriate). If the weight is not known, it can be specified as a volume (cubic metres or litres), or by the number of lifts and size of bins/skips/containers, together with an indication of materials	Data from the consignment note.	Not applicable

waste producer is not registered as such. Hazardous waste include chemicals, fluorescent tubes, certain types of paint, oil, etc			

6th SECTION: USED RESOURCES

Description:	Required unit:	Source of data:	Conversion factors:
Please indicate the main types of resources/materials used as part of your organisation, for instance paper for administration/marketing, ink cartridges for printing/photocopying; food and drinks if you have a café/restaurant within the museum; packaging to preserve artefacts/goods; etc	All materials should be listed and specified by the unit measured on site and would normally be in number of units, meters, cubic metres, tonnes, litres, etc.	Data can be drawn from suppliers invoices and purchasing records	Not applicable

7th SECTION: ENVIRONMENTAL IMPACTS SUMMARY

This section does **not** need to be filled in by the participants. It is used to summarise, on an annual basis, some of the environmental impacts of your museum. This is done automatically using formulae to translate the use of direct energy in emissions of CO_2.

Data Monitoring Sheet: (Download active excel spreadsheet)

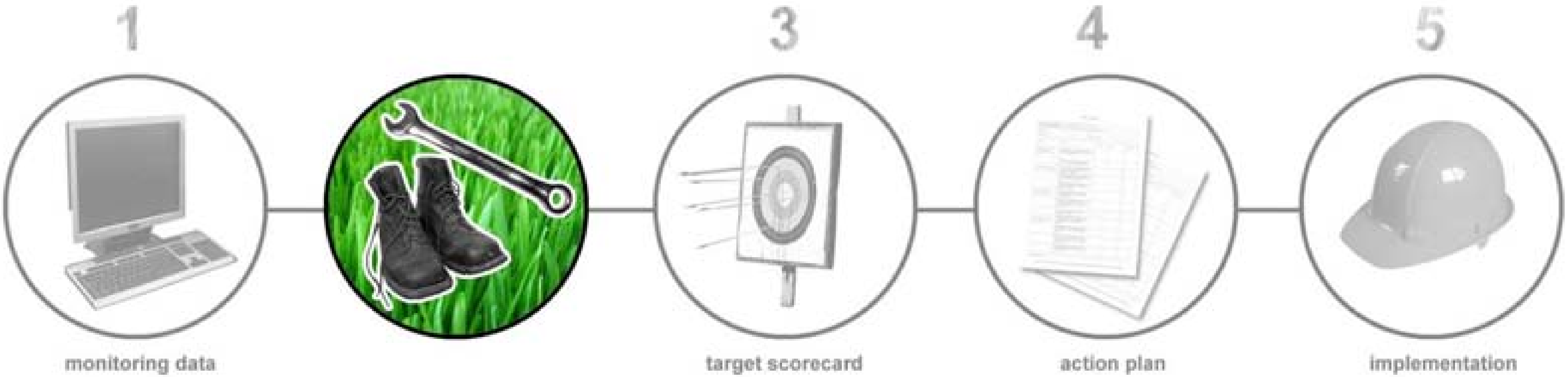
Museum Name	
Museum Contact	
Telephone number	
Email	
Museum's main activity	
Number of employees	
Floor area (m2)	
Turnover (£)	
Period of information	

Environmental impacts summary	Year			
Grid electricity CO2 emissions	0.00	kg	0.00	tonnes
Natural gas CO2 emissions	0.00	kg	0.00	tonnes
Oil CO2 emissions	0.00	kg	0.00	tonnes
Petrol CO2 emissions	0.00	kg	0.00	tonnes
Diesel CO2 emissions	0.00	kg	0.00	tonnes
Gas bottles CO2 emissions	0.00	kg	0.00	tonnes
Total CO2 emissions	0.00	kg	0.00	tonnes
Water litres per employee	#DIV/0!			
Recycling rate	#DIV/0!			

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Equivalent CO2 emissions (kg CO2)
	Number of visitors													0	
	Number of volunteers													0	
	Temperature monitoring (°C)														
	Environmental Aspects														
Utilities	Electricity (kWh)													0	0
	Electricity (£)													0	
	Gas (kWh)													0	0
	Gas (£)													0	
	Water (m3)													0	
	Water (£)													0	
	Burning Oil (Litres)													0	0
	Burning Oil (£)													0	
Transport Fuel	Petrol (Litres)													0	0
	Petrol (£)													0	
	Diesel (Litres)													0	0
	Diesel (£)													0	
	Gas bottles (Litres)													0	0
	Gas bottles (£)													0	
Waste	Waste to landfill (tonnes)													0	
	Waste to landfill (£)													0	
	Waste to recycling (tonnes)													0	
	Waste to recycling (£)													0	
	Hazardous Waste (tonnes)													0	
	Hazardous Waste (£)													0	
Used resources	Paper (quantity)														
	Cartridges (quantity)														
	Cleaning products (quantity)														
	Food (quantity)														
	Drinks (quantity)														
	Packaging (quantity)														

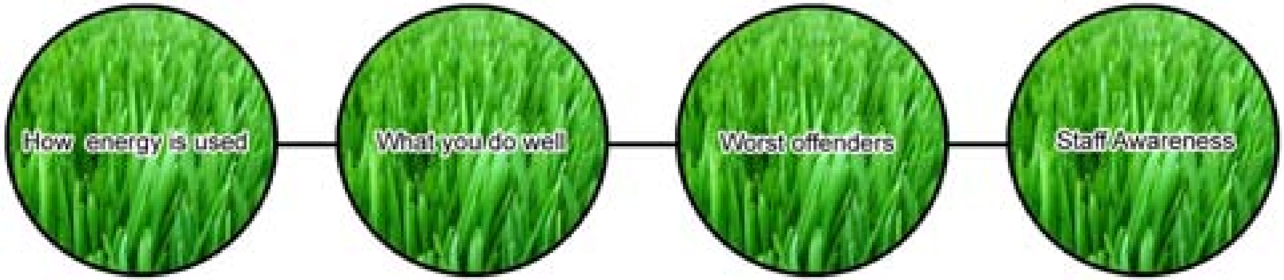
walk around tool

2



Walk Around Tool

Now you have collected your data you should undertake a physical walk around your site to identify:



It is recommended that you cover the entire site and conduct your walk around at several different times as energy use will differ. Varying the times produces a better idea of when and where energy may be wasted. Suggested times could be:

- At lunchtime
- After 5.00 p. m
- At a weekend

The Green Museum Walk around Tool is a fairly detailed walk around tool but is also fairly flexible and covers more than just energy usage.
It is divided into 9 sections and it is up to you if you want to mix and match the various pages.

CONTENTS

Section 1 deals with the property details i.e. is your museum listed or in a conservation area

Section 2 deals with your management of Waste

Section 3 deals with the Boiler Room or where the boiler is located

Section 4 deals with the Toilets

Section 5 deals with the External Grounds

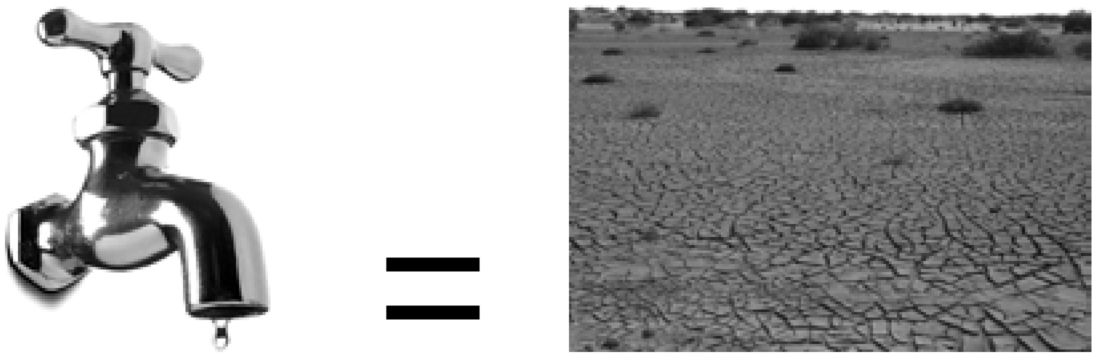
Sections 6 -8 are meant to be used for each room, excluding the rooms already covered above. The topics covered are lighting, energy and insulation/ventilation. You can change the room number as appropriate.

Section 9 deals with office equipment and this may be used for several rooms if equipment is dispersed. If so, it is worth making a note what is located where.

The Walk around Tool provides a Comments section which we have used to provide statistical evidence or information that may be useful if you want to take further action or are unsure what the benefits are.

For example with water. Water consumption in England and Wales is estimated to be about 150 litres a day per head of population - this is the highest in Europe. This means that water will be viewed increasingly as an economic resource and its supply will be restricted. While water is a renewable resource, it is delivered at a variable and finite rate, and so has the potential to become scarce, not least due to climate change. More infrastructure will be needed to meet new demand, the cost of which is likely to be passed on to end users.

This is one very important reason why we should be careful with water consumption. Envirowise advise a tap dripping just 2 drops per second will lose nearly 10,000 litres (more than 2,200 gallons a year)



There is also a Yes/No response at the end of most of the questions and if you answer **Yes** then those items can be written on the Target Scorecard. This is a tool designed to help museums identify which items they should tackle first.

Once you have decided on these they can form part of your action plan and become key areas for your environmental policy.

Green Museums: Walk around Tool

Name of Museum:	
Date of Inspection:	
Name of Reviewer:	

1. GENERAL PREMISES DETAILS:

Question	Comments	Answer
1.1 Are you aware if the premises is listed or in a conservation area or are the trees protected?	Comments: English Heritage has recently produced a number of publications on how historic properties can be adapted to make them more energy efficient. For further details see Section E in Supporting Information of the guide. Information on tree protection and to see if your building is listed, contact your local council.	Y/N
1.2 Who Owns the Premises?	Comment: If you do not own the premises make sure you are aware of what you can do under the terms of the lease	
1.3 Are there other tenants?	Comments: Make a note of the area covered by the walk around, below. If there are other tenants try and encourage them to participate in this process.	Y/N
1.4 Who pays the bills?	Comments: If you are not responsible for your bills we recommend you make your landlord aware of this work and request copies of the bills as you will paying for them, even if you are not monitoring them yet.	
1.5 Would you be interested in moving onto a Green Tariff?	Comments: This is not straightforward. Although green tariffs are frequently represented as supporting the environment, no credit for their use is given by DEFRA or the Carbon Trust when calculating Carbon Footprints. For further details see Section C of Supporting Information of the guide.	Y/N
1.6 Could you improve travel directions to your museum?	Comments: By making visitors aware of more sustainable forms of transport on leaflets, your website and on directional signage should encourage the use of these forms of transport. To find the nearest forms of transport to your site visit www.transportdirect.info	Y/N

2. WASTE:

2.1 What happens to Waste?

Comments: The definition, of what is waste can be confusing. It is something for which you have no use, which is not going to be used for its original purpose and requires work on it to make it useful! (Envirowise Waste Fact Sheet 10) See Section E for website.

2.2 Could Waste be reduced?

Comments: Try the Reduce, Reuse, Recycle approach to your waste. The very best approach to reducing waste is to generate less in the first place. See Section C of Supporting Information of the guide for more help.

Y/N

2.3 Could you develop recycling facilities?

Comments: Waste that isn't recycled often goes to landfill. The main environmental problem from landfill, apart from the visual impact and noxious smells, is the production of methane a greenhouse gas which is twenty times as potent as CO^2.See www.recyclenow.com

Y/N

2.4 Would you like to improve your awareness of your responsibility in relation to waste?

Comments: There is a Duty of Care that covers anyone who makes, stores, transports, treats, recycles or disposes of waste. All reasonable steps must be taken to keep and dispose of the waste safely. For further information see Section A of the Supporting Information of the guide.

Y/N

3. BOILER ROOM:

3.1 What type of boiler & is it older than 10 years?	Comments: As a rule of thumb boilers older than 10 years would benefit from replacement. The most efficient type of boiler is the condensing boiler that can provide saving costs between 10-30%. Alternatively you may wish to consider biomass, heat pump or Combined Heat and Power options. See Section C for details.	Y/N
3.2 Check that the boiler is serviced annually?	Comments: Check with the manufacturer about service schedules. Any gas or oil fired appliance will need servicing regularly to ensure the flue is clear and your boiler is running safely and efficiently. Ask for boiler efficiency data from a flue gas analysis from your supplier.	
3.3 Check that timers and programmers are working and on the correct setting.	Comments: Turning down the thermostat by just 1 degree can reduce heating costs by 10%. By installing a programmer and checking that you heat your museum and hot water when needed will save your museum energy and money.	
3.4 Do you want to improve hot water pipe and boiler insulation?	Comments: A hot water jacket can provide a payback within 6 months. Fit a BS Kite marked insulating jacket 75mm thick. The Energy Saving Trust advise that in it will save you £40 a year and only costs £12 to buy. (Based on a gas heated semi detached 3 bedroomed property)	Y/N

4. TOILET FACILITIES:

Question	Comments	Answer
4.1 How is hot water supplied?	Comments: If your hot water consumption is high and is heated by electricity consider gas or renewable options .Electricity produces about three times as much CO^2 per unit of heat .(Defra) See Section C for alternatives such as solar water heating or biomass with a back boiler.	
4.2 Are there any dripping taps?	Comments: Envirowise estimate that a dripping tap at just 2 drops per second can lose 10,000 litres .Either adjust or replace the washer or disc. See Section C in the Supporting Information of the guide for more information on water stress.	Y/N
4.3 Could the hot water temperature be reduced?	Comments: Ensure your hot water cylinder thermostat is not set above 65c/140f as anything above will waste energy. Also settings lower than this can increase the risks of legionella.	Y/N
4.4 Could you fit any spray taps to limit water usage?	Comments: Fitting with spray taps can save up to 50% of water when compared with conventional taps. (Green Building Bible) A spray tap reduces the flow of water. The alternative is self closing taps that switch off after a certain time.	Y/N
4.5 Can you reduce flushing either in the cistern or urinals?	Comments: New dual flush (3 and 6 litres) can save up to half the water used by the old 9 litre WC units. If this is not an option for your 9 litre WC unit try a retrofit Interflush kit to save 47% water use per person on flushing or a HIPPO bag. Automatic flush controls on urinals should be installed as a minimum.	Y/N
4.6 Do you want to identify the foul drain and surface drain?	Comments: The Environment Agency recommends having a drainage plan of your site to avoid unauthorised discharges. Ensure you also have a procedure that all staff are aware of, in case of spills.	Y/N

5. EXTERNAL AREA & GROUNDS:

Question	Comments	Answer
5.1 Are there opportunities for renewable power?	Comments: If your roof faces south to easterly and is not shaded you may want to consider solar panels. A large open area of space may offer options for a wind turbine or if you have space for a fridge sized box a ground source heat pump. The ability to store wood in a dry area would be important for biomass heating. See Section C.	Y/N
5.2 Could recycling facilities be developed for visitors?	Comments: You should consider encouraging not only your staff but also your visitors to recycle. People are now used to recycling at home (U.K's recycling efforts have doubled over the last 4 years) To find out more visit www.recyclenow.com or www.recycle-more.co.uk	Y/N
5.3 Is there an opportunity for composting facilities?	Comments: EU legislation aims to reduce the amount of organic waste land filled to 75% of 1995 levels by 2010.For further information on composting see www.communitycompost.org	Y/N
5.4 Could rainwater harvesting be developed?	Comments: Fit a water butt to your drainpipe and use the water for watering the plants. Grey water from baths and sinks can be stored and recycled for toilet flushing. A rainwater harvesting system basically captures rainwater and stores it for later use. For further details see Section C of the Supporting Information of the guide.	Y/N
5.5 Are there opportunities to promote biodiversity?	Comments: The Wildlife Trust has an accredited biodiversity benchmark to minimise negative impacts on biodiversity and promote good practice. Perhaps you have objects in your collection that could support this. For further details see Section E of Supporting Information.	Y/N
5.6 Do any external exhibits have power requirements?	Comments: Look at renewables for alternative sources of power if this does not detract from the main point of the display. See Section C of Supporting Information of the guide.	Y/N

6 LIGHTING: Room: 1

Question	Comments	
6.1 Are there any special lighting requirements?	Comments: Some objects and collections are very vulnerable to light and exposure to light should be kept to a minimum. Any light is damaging, but UV radiation found in daylight and given off by some types of artificial light is particularly damaging. Look at Collections Link for the specific lighting requirements for certain collections. You need to bear this in mind when changing lighting in your museums. See Section C for further details.	Y/N
6.2 Do you have old tungsten bulbs?	Comments: The Carbon Trust estimate that replacing with energy saving compact fluorescent bulbs with the same fitting can produce a 75% energy saving plus longer lamp life. Old tungsten light bulbs will be phased out over the next few years.	Y/N
6.3 Are there old, large diameter fluorescent tubes?	Comments: Replace T12 and T8 fluorescent lighting with lower wattage T5 to achieve between 8% - 30% savings. You can buy kits that will allow you to fit new T5's into your existing older tubes. Use diffusers to eliminate UV radiation which can damage collections. See Section C for more information on types of lighting.	Y/N
6.4 Are halogen lights used?	Comments: Consider replacing with retro fit LED's for spotlights. High pressure sodium or metal halide with T5's to achieve between 30-80% energy saving for equivalent lighting performance. LEDs give off less heat and ultraviolet radiation and so are good news for your collections (but remember that visible light is also damaging in too great a quantity). See Section C for more info.	Y/N
6.5 Would movement sensors help to reduce lighting requirements?	Comments: Automatic proximity switches can sense whether a room is occupied or not and come on accordingly, saving energy. See the Kind Seed Centre in Liverpool where photoelectric sensors are used on taps, lights and hand driers. Daylight level sensors can be used when there is not sufficient light. It also reduces time collections are exposed to light.	Y/N
6.6 Is the lighting switched on when not required?	Comments: The Carbon Trust estimate that lighting a typical office overnight wastes enough energy to heat water for 1,000 cups of tea!	Y/N
6.7 Would zoning and alternative switches assist in reducing lighting instead?	Comments: Groundwork Derby & Derbyshire have found on their museum audits that many groups of lights are often controlled by a single switch. Consider zoning of lighting so lights can be switched off independently when not required.	Y/N
6.8 Are there any opportunities for natural light?	Comments: Remember that natural light can be damaging to your collections, though. Exposure to any light should be minimised and ultra violet light should be eliminated as far as possible – and UV is found in natural light in significant quantities. It can be eliminated using certain types of UV-absorbing clear film that you can put on your windows, though. See Collections Link / your MDO for advice!	Y/N

7. HEATING: Room: 1

Question	Comments	Answer
7.1 Do you use electricity for heating?	Comments: If heating is provided by electricity you may wish to consider gas or renewable options as electricity produces about three times as much CO^2 per unit of heat when compared to gas. See Section C for alternatives.	
7.2 Have staff complained of varying temperatures?	Comments: Staff can assist in detecting areas that need better insulation or that overheat. Look out for windows that are open whilst the heating is on. Remember this could also affect your collections too!	Y/N
7.3 Are radiators/heaters located on external walls?	Comments: When radiators are fitted to an outside wall you may be able to turn down your heating and improve heat retention by fitting reflective insulation panels behind your radiators. Also avoid placing furniture or long curtains in front of radiators. For radiators under a window closing curtains may help to keep heat in the room	Y/N
7.4 Could the heaters benefit from thermostats? If present, check they are set to the correct temperature.	Comments: You could save up to 30% on your heating bills by having the correct heating controls. For further details visit www.energysavingtrust.org.uk/Home-improvements/Heating-and-hot-water/Heating-controls	Y/N
7.5 Check that heaters and air conditioning are not on at the same time.	Comments: Cooling by air conditioning is expensive you may want to consider variable speed fans as an alternative and pumps to save energy by increasing your ability to control. If heaters and air conditioning are on at the same time this is a waste of energy as they are working against each other. Relative humidity alert.	
7.6 Could you do more to monitor temperature levels?	Comments: Museum accreditation requires museums to monitor environmental conditions. It is important to remember that RH is directly related to temperature. Both should be monitored and kept as stable as possible. Collections can be at greater risk from mould and pests at high temperatures too.	Y/N
7.7 How is hot water provided?	Comments: Lagging with a hot water cylinder jacket that is 75mm thick and insulating the hot water pipe can keep water hotter by reducing the amount of heat lost. For a given temperature of cylinder, less heat will be lost if it is insulated better, therefore less energy will be needed to keep it at that temperature.	

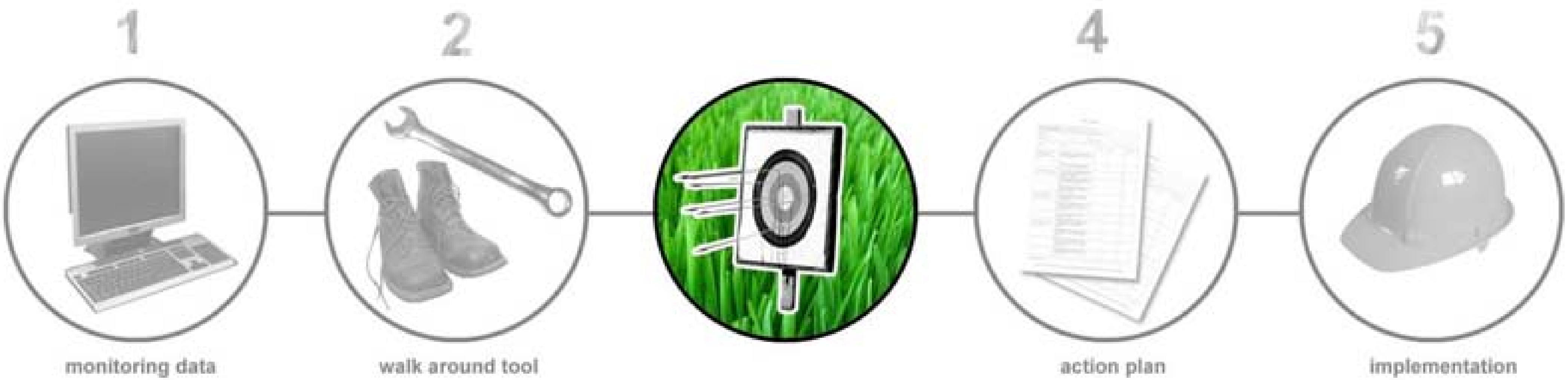
8. INSULATION & VENTILATION: Room: 1

8.1 Is secondary glazing required?	Comments: Energy saving glazing can save £140 per year on energy bills and 720 kilograms of CO^2 according to the Energy Saving Trust. (Based on a 3 bedroomed gas heated semi detached house) For less expensive option energy reduction film can reduce winter heating and aid summer cooling.	Y/N
8.2 Do the doors require draught excluders?	Comments: Greenspec have identified that leakiness is responsible for 20% of heat loss with your space heating. Draught strip existing windows and doors. Use synthetic rubber or elastomeric tubular seals. Use brush seals with sash windows.	Y/N
8.3 Does the humidity level need checking /monitoring for the quality of displays?	Comments: Museum accreditation requires museums to monitor the environmental conditions, including the relative humidity. A stable RH is best for your collections. Look at collections Link or talk to your MDO for advice on RH and collections.	Y/N
8.4 Is insulation required in the roof?	Comments: Energy Saving Trust state that £205 p.a can be saved if an un-insulated roof is insulated. (3 bed roomed gas heated semi detached house) Renewable materials (cellulose, sheep's wool, flax or hemp) have lower embedded carbon and generally suit older breathing constructions but check for pest treatments. See Collections Link.	Y/N
8.5 If the walls are of cavity construction do you want information on cavity insulation?	Comments: Energy Saving Trust advise that a third of all heat is lost through un-insulated walls. (Based on a 3 bedroomed gas heated semi detached house) Cavity wall insulation can save you around £160 a year on fuel bills as less heat is required to heat your museum.	Y/N
8.6 Check that windows/ doors are closed when the heating is on?	Comments: Close curtains at dusk to keep the heat in. Remember that a well insulated building will not be subject to the same sort of fluctuations in temperature and relative humidity that are damaging to collections! An investment in your building is also an investment in the care of your collections.	
8.7 Ensure filters/grilles are free from obstructed and cleaned as recommended by the supplier.	Comments: Regular housekeeping will assist to make the systems more efficient helping you to reduce costs and benefit the environment.	

9. EQUIPMENT: Room: 1

Question	Comments	Y/N
9.1 Do staff need reminding to power down equipment when not required?	Comments: Switching off equipment at night and weekends can reduce their energy consumption by 75%. Switching off laptops during the day too frequently can reduce their life expectancy.	Y/N
9.2 Check that you take frequent back ups of the work on your computer.	Comments: If you are regularly switching on and off your computer to save energy, it is worth doing more frequent backups.	
9.3 Do staff need reminding to turn off printers/ photocopiers overnight/at weekends?	Comments: A photocopier left on overnight uses enough energy to make over 5,000 copies. Where possible place photocopiers in naturally ventilated locations and away from air conditioning units. Try and run copies in batches to allow the copier to be in power save for longer.	Y/N
9.4 Check that vending machines/water coolers/fridges are turned off when not in use	Comments: If you only have stock in the fridge, which you rarely use, it may well be worth giving it away and saving energy and costs by switching off the fridge. Remember that good housekeeping will not only help the environment by the use of less energy but will also save you money!	

target scorecard



Target Score Card

If you have answered YES to any of the questions, these are the items you may want to address to save money and reduce your museums environmental impact.

Try and group these around the headings of Energy, Waste, Water and Other. Attached is an illustration of one carried out at Greens Mill, Nottingham. Keep hold of your checklist so you have the specific details in each room.

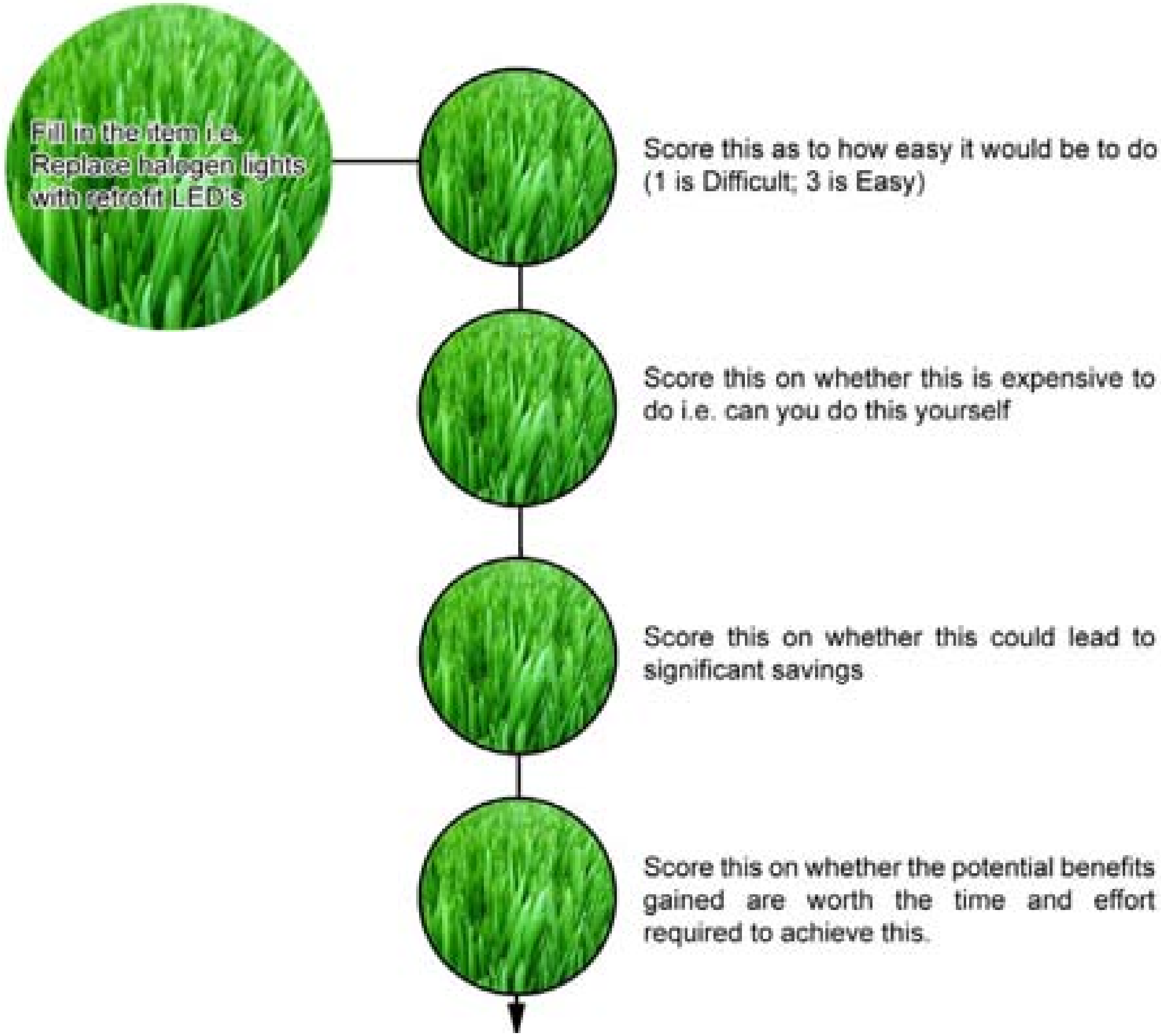
Now write down the items in the Target Scorecard and try to score each item for Ease/Affordability/Benefits and Magnitude of Benefits. 3 is a high score and 1 is low. The scoring is a guide to assist in deciding what to tackle first.

By way of example, one of Green's Mill targets within their Target Scorecard is "assess lighting needs". A final score of 81 was calculated by multiplying together the individual score given for each aspect. A score of 3 for "ease" as it will be very easy to list the types of lighting used in the museum; a score of 3 for "affordability" as it will only require someone's time to do this assessment; a score of 3 for "benefits" as this assessment could lead to the achievement of significant savings or educational benefit, and a score of 3 for "magnitude of benefits" as the potential benefits gained are worth the time and effort to achieve this. The 4 scores are multiplied together to give an overall rating.

On the Target Scorecard for Greens Mill the biggest area seems to be the lighting requirements with a score of 81 and the lowest is segregated waste for visitors with a score of 4.

Target Scorecard Process:

Follow the steps below to start filling in your own:



Example of Target Score Card:

GREEN MUSEUM - Target Scoring Matrix - Template Green's Mill Museum

	Nb	Targets	EASE (*)	AFFORDABILITY (*)	BENEFITS (*)	MAGNITUDE OF BENEFITS (*)	SCORE (**)	Deadline	Potential savings (£)
Energy	1	Assess lighting needs	3	3	3	3	81	Mar-09	
	2	Thermal imaging of roof/ceiling for insulation *	2	3	2	2	24		
Waste	3	Measure use of electrical appliances	3	3	3	1	27	Mar-09	
	4						0		
Water	5						0		
	6						0		
Other	7	Draft exclusion on doors and radiator reflectors.	3	3	3	2	54	31-Jan	
	8	Insulate pipes for boiler	3	3	2	2	36	Jan-08	
	9	Segregated waste for visitors	2	2	1	1	4	Mar-09	
	10	Investigate feasibility of bio fuel engine *	0	0	2	3	0	?	

* Would need support

(*) score 0, 1, 2, or 3, with 0 low score and 3 high score

(**) results comprised between 0 (not at all feasible) and 81 (highly recommended)

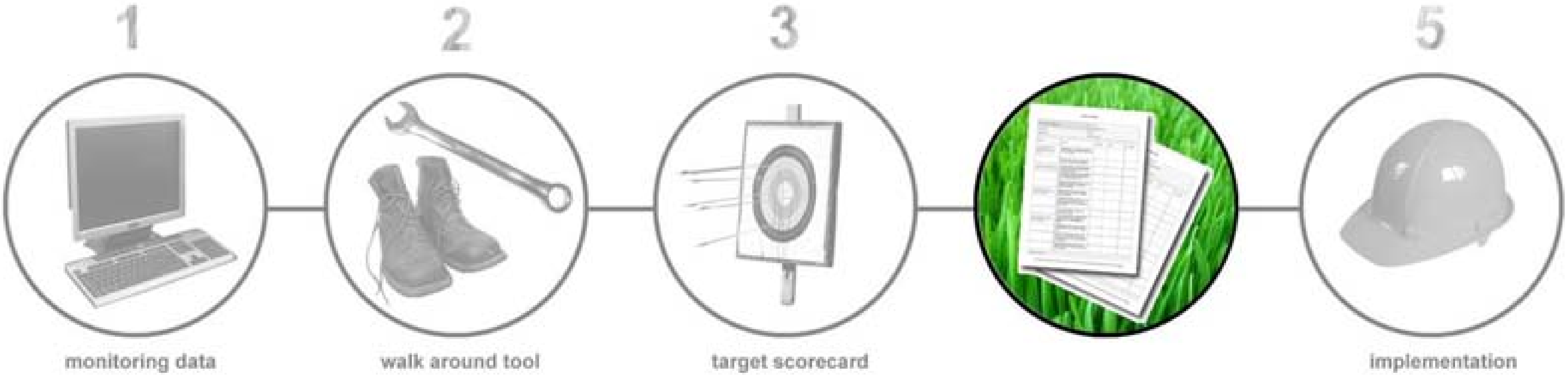
Target Score Card: (Download active excel spreadsheet)

GREEN MUSEUM - Target Scoring Matrix - Template

	Nb	Targets	EASE (*)	AFFORDABILITY (*)	BENEFITS (*)	MAGNITUDE OF BENEFITS (*)	SCORE (**)	Deadline	Potential savings (£)
Energy	1		3	3	3	3	81		
	2						0		
Waste	3						0		
	4						0		
Water	5						0		
	6						0		
Other	7						0		
	8						0		
	9						0		
	10						0		

action plan


4


1
monitoring data
2
walk around tool
3
target scorecard
5
implementation

Action Plan

What's next?

Now you can enter the items with the highest score in your Action Plan. Below is an example of an Action Plan that provides information on what the targets are, how and when these will be achieved and by whom.

↓

Remember this is a working document and should be reviewed regularly at staff meetings and also at least yearly at Board meetings.

↓

Pick a few off your list to action and don't overburden yourself. You will probably not be able to tackle all the items at once so make sure you allow for sufficient time to implement these. Good sources of free advice are the Energy Saving Trust and the Carbon Trust. See Section E for details.

↓

There will be a number of items that are not part of your environmental action plan for this year. Do still note these but on a separate sheet for the following year/s.

↓

Remember it is not just one person's responsibility that targets are actioned. Make sure you allocate tasks out fairly and realistically!

Environmental Action Plan:

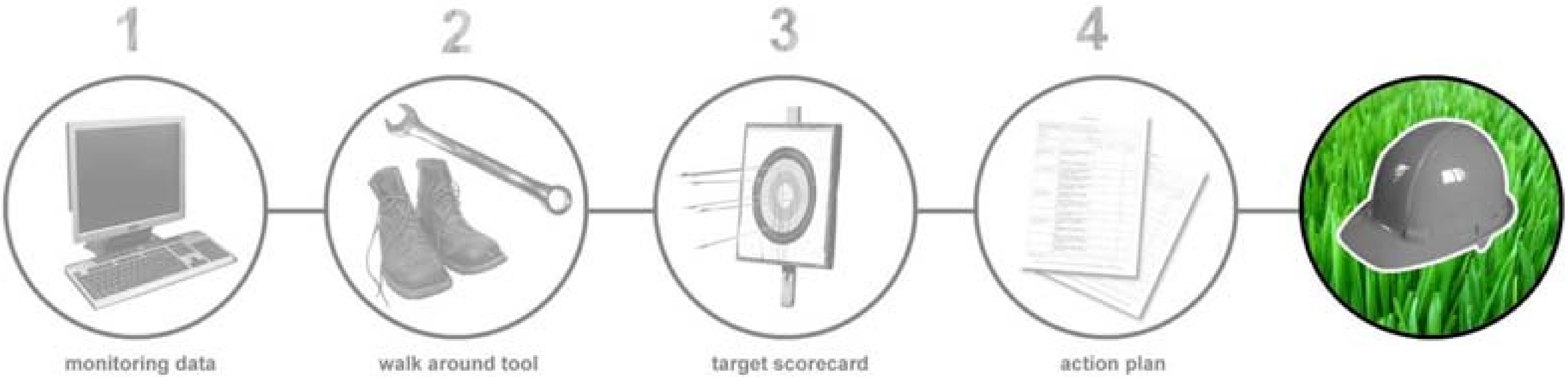
Environmental Action Plan	Reference:
	Page:
Written by:	Issue:
Approved by:	Revision Date:

Targets	Actions	Deadline	Name	% Complete
1. to ensure procurement of office stationary in a responsible and sustainable manner	**Establish a list of sustainable suppliers of office stationery and products used as part of xxxxx activities**			
	Induct all current and new staff on the way to procure sustainable stationary			
2. To induct all staff on how to reduce and recycle office waste	**Set each computer's printing preferences in black & white and duplex (if printers allow duplex printing)**			
	Investigate whether the council building has its own recycling collection scheme, which could be joined by xxxxx			
	Ensure any electrical and electronic waste (WEEE) is disposed of in a legal and appropriate manner			
3. to reduce the Museum's environmental impact through the use of transport	**Display clearly bus/trains timetables to encourage staff to use public transport when appropriate**			
	Look at the possibility to sign-up to Cycle Scheme (www.cyclescheme.co.uk) to encourage staff to cycle to work and/or as part of work			
	Look at the possibility to organise car-sharing between staff			

Targets	Actions	Deadline	Name	% Complete
4. to ensure the Museum uses energy efficiency measures as part of its activities	**Contact the head office's landlord to look at the possibility of changing the current lighting system for energy efficient lighting**			
	Investigate if the Museum is charged under the appropriate energy (gas & electricity) tariff			
	Order free Carbon Trust's posters and stickers (www.carbontrust.co.uk) to raise the awareness of staff on energy efficiency in the building			
	When purchasing new IT and electrical equipment, ensure that high-energy rating ones are chosen			

Completed & Signed Off	

implementation 5



I m p l e m e n t a t i o n:

Now you have an Action Plan for improvement you can develop your own environmental policy.

So what is an Environmental Policy?

- ❑ It is a written statement which is available to the employees & public
- ❑ It details the Company's aims & targets in relation to the environment
- ❑ It provides a commitment to comply with environmental legislation
- ❑ It provides a basis for review of environmental performance & management

Environmental Policies are often now required by funders and suppliers. Also visitors to museums will often expect museums to show a lead in the environmental arena and having an environmental policy is a public expression of this commitment.

But writing a policy without an action plan or formal review process can mean the document is worthless.

To ensure your environmental policy is effective follow the actions below:

- Make certain it is adopted and signed by the Board of Trustees
- Communicate the policy to all staff; display it on your website and in a prominent public place in the museum
- Make sure that there is an action plan attached to the policy detailing what measures are to be taken, when and by whom
- Review and update the environmental policy and action plan yearly and ensure it is signed off at the Board Meeting.
- Make environmental improvements a regular item at staff meetings so it is taken seriously by all.

The next page shows an example of a draft environmental policy which you can use if you wish to develop your museum's policy.

<u>Top Tip:</u>
Try and keep the policy to 1 page and prioritise 3 or 4 targets as the main ones you plan to achieve over the year. You don't need to go into detail as this is in the action plan. Just summarise the main points in your Environmental Policy.

You will need to amend the policy yearly and this must be raised at a Board Meeting and the policy should be signed off by the relevant Board Member. This is important to show what your museum does and what it wants to achieve, as identified by all the stages of Data Collection, Walkaround, Target Scorecard and Action Plan.

You could then produce graphical evidence to visitors either at the end of the year or during the year to show how much you have achieved.

It may be, if you are part of a local authority, you will need to look at their policy to ensure there are no contradictions. You may decide to adopt their policy instead of having your own.

DRAFT Environmental Policy

Xxxxxxxxxxxx is a registered charity/local authority museum/independent museum that works to xxxxxxxxxx and is located within xxxxx area. The museum aims to educate and enhance the local community through for example, the operation of xxxx, newsletters, maintenance of archives and through the operation of xxxxxxx. In all spheres of operation the xxxxx Museum and trustees/board are committed to reduce the impact on the environment and to comply with all applicable legislation and other organisational requirements.

As part of xxxx's commitment to reduce its impact on the environment, the following targets have been agreed for the period April 2009 to March 2010:

1. **to ensure procurement of office stationary in a responsible and sustainable manner**
2. **to induct all staff on how to reduce and recycle office waste**
3. **to reduce the Trust's environmental impact through the use of transport**
4. **to ensure the Trust's uses energy efficiency measures as part of its activities**

This policy is subject to annual review to ensure the completion of the Targets, and to promote continual improvements throughout the Museum's operations.

xxxxxx's Environmental Policy has the support of the Charity/Museum's Board. It has been communicated to all members of staff and interested partners/ voluntary organisations and is publicly available. The Chair is responsible for implementing this policy and in communicating it.

This policy has been ratified and signed in hard copy by

Name & position

Name & position

Date

supporting information

A. Environmental Legislation

Main Items of Environmental Legislations for Museums

The list below provides a brief summary of the main pieces of environmental legislation that museums need to consider and comply with.

Your waste responsibility:

The Duty of Care affects any organisations and businesses, including museums. You must make sure that:

- ✓ Your waste is stored, handled, recycled or disposed of safely and legally;
- ✓ Your waste is stored, handled, recycled or disposed of only by businesses which hold the correct, current permit or licence to undertake the work;
- ✓ You record all transfers of waste between your business and another business, using a Waste Transfer Note (WTN);
- ✓ You keep all WTNs, signed by both businesses, for a minimum of 2 years;
- ✓ You record any transfer of hazardous waste between your business and another business, using a consignment note. Typical types of hazardous waste include, amongst others, chemicals, oils, etc;
- ✓ You keep all consignment notes, signed by both businesses, for a minimum of 3 years.

In addition, your business must store, collect, treat, recycle and dispose of waste electrical and electronic equipment (WEEE) separately from your other waste. You must obtain and keep proof that your WEEE was given to a waste management company, and was treated and disposed of in an environmentally sound way.

Common types of WEEE include:

- computers and other office equipment
- fluorescent light tubes
- fridges
- washing machines
- TVs
- automatic dispensers.

If your organisation produces, distributes or sells electrical or electronic equipment you may have to comply with additional requirements under the WEEE Regulations.

If you have a catering facility and use cooking oil, you must not dispose of it with the rest of your catering waste.

If you produce waste cooking oil, you must:

- store it properly using oil containers that are strong enough and that are unlikely to burst or leak during ordinary use
- store containers within a secondary containment system (SCS), such as a drip tray, bund, or any other suitable system, which will contain any oil that escapes from its container
- ensure that only an authorised waste carrier collects your waste and takes it to an authorised site for recovery or disposal.

Energy efficiency:
Display Energy Certificates (DECs) are required for buildings with a total useful area of over 1,000 m^2 that are occupied by a public authority and institution providing a public service to a number of persons on a frequent basis. DECs are valid for 1 year and the accompanying Advisory Report is valid for 7 years. The requirement for DECs came into effect on 1 October 2008. It is aimed at informing people on how efficiently energy is used in a building. DECs should therefore be clearly displayed at all times and clearly visible to the public.

Carbon footprint:
The Carbon Reduction Commitment (CRC) is a legally binding UK-wide scheme designed to encourage organisations to reduce their carbon emissions. The CRC will affect mainly large private and public energy organisations, bearing in mind that an organisation can be made up of many different smaller organisations. Typically, a business using more than 6,000 megawatt-hour (MWh) of electricity annually will be covered by the CRC. It is however important to note that local authorities will have to register under this legislation and, even though you may be a small public museum, you may have to comply as part of your local authority.

Discharges to water and sewer:
Only drain clean, uncontaminated water to the surface water drainage system.
You must have an authorisation, such as a licence, permit or consent, from your environmental regulator before you release any sewage, effluent or contaminated run-off to water.

You must get permission from your water company or water authority before connecting to their drainage system.

You are allowed to connect sewage from domestic facilities, ie toilets and basins, to a public foul sewer (pipe which collects foul water only) or to a public combined sewer (pipe which collects both foul and surface water drainage). However, if the drainage facilities include a separate surface water sewer (pipe which collects surface water drainage only), you must never discharge sewage into it.

Fuel and chemicals storage:
Store all fuels and other chemical substances where any spills will be contained. This should be within an impermeable bund, or secondary containment system (SCS).

The SCS should be able to hold:

- at least 110% of the container's capacity, or
- if there is more than one container within the bund at least 110% of the volume of the largest tank, or
- 25% of the total volume of fuel likely to be stored, whichever is the greater.

Inspect bunds regularly and remove any rainwater. If the water is contaminated you may need to deal with it as hazardous/special waste.

Spillage of chemicals, oils, and other hazardous substances:
If you store, handle and use any chemicals, oils, and other substances in significant quantities, you should consider implementing a pollution incident response procedure and ensure that all staff are aware of it. To deal with a spillage, you should:

- ensure that you have **absorbent materials** and other **containment equipment** suitable for the type and quantity of fuel you store and use on-site;
- **train** all staff in what to do in the event of a spill, and how to use any spill equipment, and
- report pollution incidents as soon as they happen to the **Environment Agency**.

Car parking:
If your business causes a **nuisance** to your neighbours your local council can require you to take steps to stop the nuisance. Your local council can also impose restrictions on or stop your operations.

Nuisance from parking areas could be caused by a number of sources including:

- **noise** and **fumes** from vehicle engines, or noise from vehicle alarms
- **dust** from vehicle wheels
- excessive artificial **lighting**
- surface water **run-off** causing erosion or localised flooding
- **vermin**, windblown rubbish and accumulations of **refuse** and **other material**.

You should take measures to control these potential sources of nuisance.

Surface **run-off** from car parks may contain pollutants such as:

- oil and fuel
- hydraulic or other fluids
- suspended solids
- grease
- antifreeze.

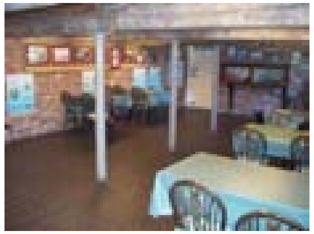
You must not allow contaminated run-off to enter surface water drains, watercourses or groundwater. This will cause pollution and could lead to you being prosecuted.

For further information and advice, please visit the Environment Agency's website Netregs (www.netregs.gov.uk). This website provides free guidance on how to comply with environmental law. You can undertake your research by sector, environmental topics, or environmental legislations. If you choose to browse the website by sector, you should consider to pay particular attention to the sectors hospitality, leisure and tourism, and offices.

B. Case Studies

CASE STUDY 1 -Church Farm, Church Road, Skegness



Church Farm is Lincolnshire's only open air museum and provides an insight into agricultural farming and living in the 18th and 19th century. The site is a Grade 2 listed building and is held on a lease by Lincolnshire County Council.
Estimated visitors are between 12,000 and 15,000 and admission is free.
The museum is open every day in the summer season and closes from November onwards.

Church Farm had previously collected energy data using a Rural Museums Carbon Calculator which provided an indication, on their quick calculator that Church Farm produced 8.27 kg of CO^2 emissions per visitor.
During the walk around and using the Target Scorecard the museum scored the items below as the ones requiring action first:

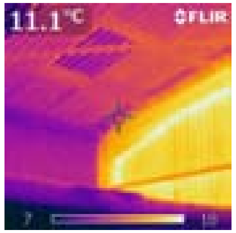
- Assessment of lighting requirements
- Insulation of the roof over the office space
- Assessment of heating controls and draught proofing of doors
- Installation of self closing taps on the wash hand basins

Church Farm are now in the process of insulating their roof ; contacting suppliers on the self closing taps and lighting ;draught proofing the main reception door and undertaking a thermal camera experiment to ascertain heat loss in one of the main buildings.

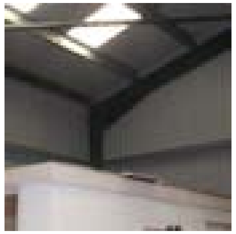
CASE STUDY 2 - Irchester Narrow Gauge Railway Museum, Irchester Country Park, Wellingborough

Irchester Narrow Gauge Railway has the only public Metre gauge collection in the U.K. The museum is run by a board of trustees and volunteers. The museum is open every Sunday, Bank Holidays and hold regular steam days. Admission is free. There is no published data on visitor figures.

During the walk around a thermal camera was used in the main building as shown in the photographs below:



Thermal image of the North East corner of the building, back wall heated by the morning sun.



The same part of the building showing the office and skylights

The walk around identified 3 key areas elements to focus on:

- Office heating and prevention of carbon monoxide
- The use of a composting toilet
- Evaluation of renewable energy on site.

Following on from the results Irchester are currently working on the following areas :

- A wood burning stove is being constructed in the office to replace the current propane gas heater.
- A composting toilet is being investigated to replace the existing chemical toilet
- A carbon monoxide detector has been fitted in the office
- The use of photovoltaic panels are being considered for lighting
- The use of a Stirling Engine to generate electricity.

C. Walk around Tool (Support)

Whilst using your Walk around Tool you may have identified the following sections where you would like more information. The points below may assist you with this. The item numbers below relate to the item numbers in the Walk around Tool.

Item 1.5 - Green Tariffs

Although green tariffs are frequently represented as supporting the environment, and the production of renewable energy indisputably helps to reduce carbon dioxide emissions, no credit for its use is given by DEFRA or the Carbon Trust when calculating Carbon Footprints.

This is because the apparently simple process of buying renewable electricity is compromised by a legal and financial instrument, the Renewables Obligation.

The Renewables Obligation places an obligation on all UK electricity suppliers to provide an increasing proportion of electricity from renewable sources. Generators of renewable energy that register with the Office of the Gas and Electricity Markets (OFGEM), are issued with one 'Renewable Obligation Certificate', (a ROC), per megawatt hour of energy they produce.

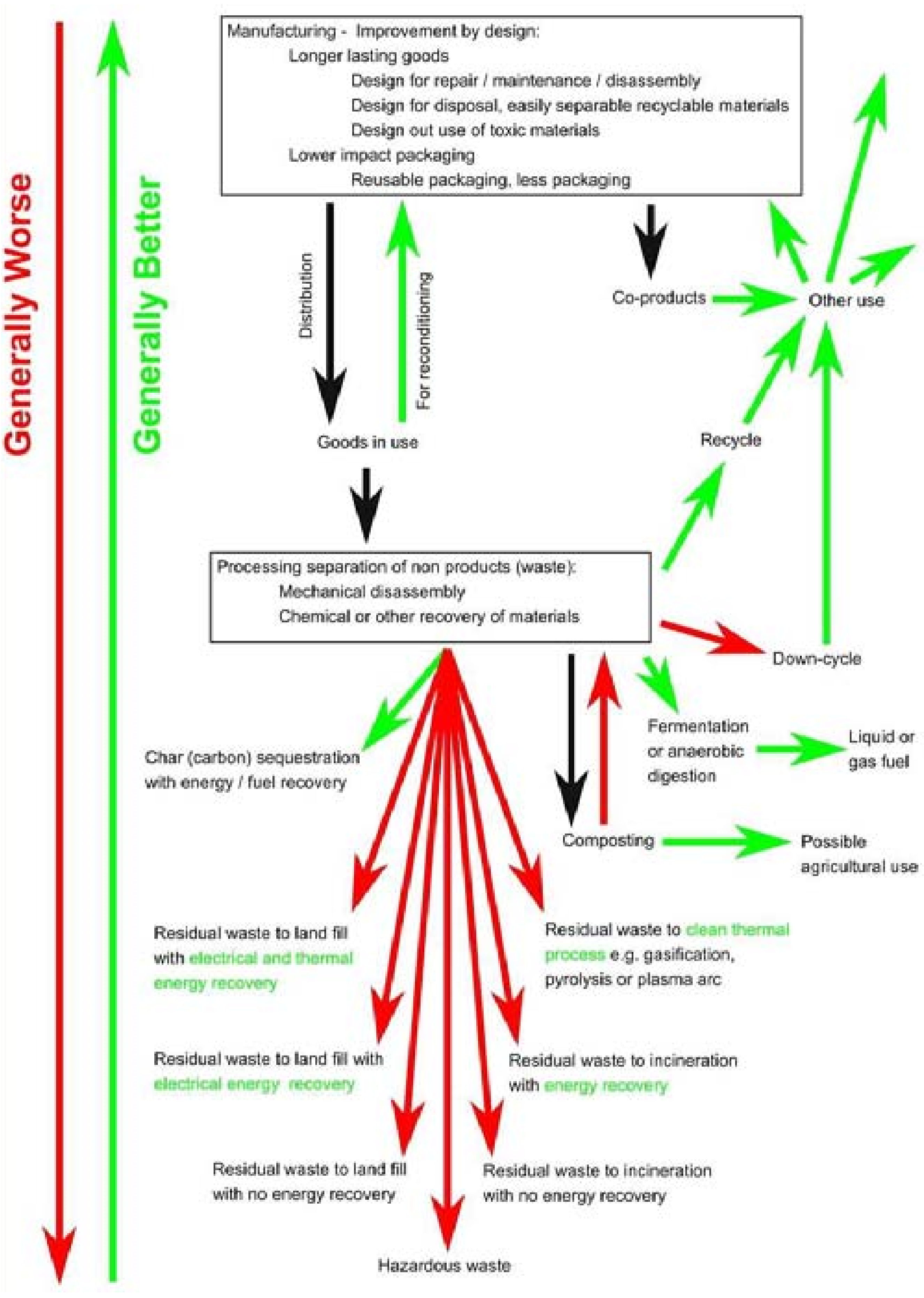
To demonstrate that the obligation is met, all electricity suppliers must be able to present sufficient Renewables Obligation Certificates (ROCs). Where suppliers do not have sufficient ROCs to meet their obligation, they must pay an equivalent amount into a fund, the proceeds of which are paid back on a pro-rated basis to those suppliers that have presented ROCs, effectively a fine. To avoid this charge, suppliers may buy ROCs from renewable energy generators. A ROC then, is a traded commodity with a financial value.

As the production and sale of 'green electricity' to end users is generally associated with the sale of ROCs to other electricity suppliers, the view is frequently taken that renewable electricity generation is also facilitating the 'business as usual' production of electricity from fossil fuels, so the carbon savings that arise from renewable electricity production are aggregated into an average figure for all electricity production. This average figure was 0.43kg per kWh last year, but has now risen to 0.54kg per kWh, at least in part because of the rise in coal fired electricity production, in part to reduce the dependency on imported fuel, and in part to exploit cheap coal mined in the UK as the natural gas price has risen.

Item 2.2 Waste Hierarchy

The diagram below identifies the many options available and tries to identify which of those options have the least environmental impact. However may museums will have limited options of what happens to their waste when it leaves their site.For the areas that museums do have more control over the hierarchy below may be useful.

reduce,
reuse,
remanufacture,
refurbish,
repair,
recycle,
recover,


Generally Worse
Generally Better
Manufacturing - Improvement by design:
Longer lasting goods
Design for repair / maintenance / disassembly
Design for disposal, easily separable recyclable materials
Design out use of toxic materials
Lower impact packaging
Reusable packaging, less packaging
Distribution
For reconditioning
Goods in use
Co-products
Other use
Recycle
Processing separation of non products (waste):
Mechanical disassembly
Chemical or other recovery of materials
Down-cycle
Fermentation or anaerobic digestion
Liquid or gas fuel
Composting
Possible agricultural use
Char (carbon) sequestration with energy / fuel recovery
Residual waste to clean thermal process e.g. gasification, pyrolysis or plasma arc
Residual waste to land fill with electrical and thermal energy recovery
Residual waste to land fill with electrical energy recovery
Residual waste to incineration with energy recovery
Residual waste to land fill with no energy recovery
Residual waste to incineration with no energy recovery
Hazardous waste

Items 3.1/4.1/5.1/5.6/7.1 Electrical Power and Alternatives - Renewables

Kilowatts and Kilowatt Hours

kW (kilowatt) - This is the standard measure of power – the rate at which a device can convert energy from one type to another. A 2kW heater will thus warm a room twice as fast as a 1kW heater.
kWh (kilowatt hour) - Kilowatt hours are units of energy. These are what you are charged for. You can measure how much energy you use by multiplying the power rating of your device by the time it is switched on. A 1kW heater run for 2 hours will consume 2kWh of energy. So will a 2kW heater run for one hour. Your bill will be the same.

Kilowatt hours can be used to measure any type of energy that you use, so although gas meters may indicate cubic meters, (m^3) used, gas bills are now also expressed in kilowatt hours.

Electricity or Gas?
If you compare gas and electricity bills you will see that the cost per kilowatt hour of energy purchased as gas is typically about a third of the price of energy purchased as electricity.
If you are using electric fires or storage heaters to heat your building or to heat significant amounts of hot water, and you plan to stay at the same site for a number of years, it is likely to be worth finding out what it would cost to install gas heating or a heat pump, especially if the building has long opening hours.

Utility Bills
Utilities companies, (gas and electricity suppliers), both typically bill customers quarterly. Ideally meters should be read, and changes made to reflect the amount of energy used. In reality this does not usually happen.

Bills may be estimated for a number of reasons. Your meter may be in an inaccessible location for example, or you may be out when the utility company tries to read it.

If the utility company over estimates your bill, this is bad for cash flow and is a cost to your organisation, especially if you are paying interest on what is in effect, a loan to the utility company. If bills are over estimated significantly it will be worth calling the utility company to give them a true reading so that a lower bill can be issued. While utility companies may issue a number of consecutive estimated bills, they may require you to provide them with an accurate reading so that a correct bill may be issued and the estimating process adjusted.

If you are free to choose your own electricity supplier it will probably be worth comparing the unit charges for electricity from a number of suppliers. Find out if other suppliers are cheaper and switch if appropriate, but if your consumption is small, remember to take account of the standing charge.

Measuring Energy Used

Because so many utility meter readings are estimated, utility data is a very poor source of information for understanding your energy consumption and bills. It is thus a good idea to read all your utility meters, including water, for example, at least every month. Fortunately it is fairly easy to read most meters. Generally electricity meters have a simple display of kilowatt hours consumed to date. Modern meters generally use mechanical or electronic numeric displays, but a few sites will still have meters that display using mechanical dials. The second example below comes from Papplewick Pumping Station.

It is good practice to read electricity, and water meters at least every month to check trends in energy use, and to check these readings against invoices for energy and water.

Meters are usually located in a cupboard that is set into an outside wall in a sheltered spot. To minimise the number of estimated bills, make sure this is accessible at all times.

Note however that to open the door of the meter cupboard to read your own meter, a ‘key’ is required to turn the triangular head of the catch. These can be obtained for a small cost from plumbers and electrical merchants.

In the examples shown overleaf, electricity meters and measuring devices have all had a single ‘live’ or ‘phase’ and neutral supplied to the building and equipment. In such systems, meters are connected to four wires. Larger sites generally have three phase supplies to allow more power to be delivered. In these systems the meter will be connected to eight wires as in the example below.

Large items of equipment, usually built in to the building, may also use three phase supplies including electric heaters, lift motors, and the motors of some workshop tools such as lathes and milling machines. It is worth making a mental note if you have a three phase supply.

Although reading your meter can give an idea of how energy use varies from day to day, it is frequently interesting to know the energy consumption at a particular point in time, how it has varied over the course of a day, or to be able to check the power consumption remotely.

As time goes by, products are being released onto the market at moderate prices to carry out some or all of these functions. See for example the Electrisave, sensor pictured above. The top part of the unit, (white clip on a grey wire), is a 'current transformer' sensor. This clips over an incoming cable and senses the current in the wire magnetically without requiring an electrical connection to be made.

The other white box in that picture, processes the data from the current clamp, and transmits it to a remote LCD display pictured below. Three phase equivalents of this equipment are available.

Although monitoring the power consumed by a whole building is useful, it is also important to be aware of the power used by individual appliances, so that when trying to save energy, you can work out where it is best to invest your efforts.

One way to do this is to read the manufacturers documentation or rating labels, but this may indicate the peak power that may be consumed rather than indicating the amount of energy that will be used over time, and many items such as fridges, freezers and heaters may be controlled thermostatically, with an average power consumption much less than the peak power they can use.

To find out how much energy an appliance uses in your circumstances, meter plugs may be used between the wall socket and an appliance power cord to check electricity consumption at any given moment, and also to record the number kilowatt hours of energy consumed during a measured period of operation. These are relatively low cost items which can be purchased from about £15 each. These are now widely available from a number of suppliers. CPC is generally the cheapest.

It is also possible to undertake such measurements on three phase supplies using a three phase electrical data logger. Again this uses current transformers to measure current, and is usually connected to the electrical supply directly to sense voltage. This connection to sense current and voltage on all three phases must be undertaken by a competent person.

Advanced data loggers such as these can connect to a PC to provide a great deal of information including graphs of supply voltage, supply current, power factor and power consumed against time, and information about supply failures. They can also be used to make more sophisticated checks on single phase sites, and can be used to 'sanity check' the readings from utility meters.

Buying Energy

If the rates charged by your current suppliers appear to be excessive, it may be possible to get cheaper energy by switching supplier. Electricity and gas prices of around £0.06 and £0.02 per kWh should be available. (February 2009)

It is important to obtain impartial advice to find the best price. Using the following web sites may assist in identifying cheaper suppliers.

Energyhelpline, ukpower and commercial-power offer free impartial price comparisons.

www.energyhelpline.com (phone: 0800 970 2626)

www.ukpower.co.uk

www.commercial-power.co.uk (phone: 0800 195 3647)

Bizzenergy supplies gas & electricity to small and medium sized businesses, apparently at very competitive prices.

www.bizzenergy.com (phone:08703000633)

A typical user may achieve savings of around 15 to 25 percent by changing supplier, though occasionally better results may be obtained.

Cogeneration, Heat Pumps or Renewables

Beyond insulation and ventilation improvements, there are two ways to get better value for money out of conventional fuels.
The first, termed cogeneration, burns a fuel, but in addition to a thermal output, generates some electricity. The main benefit to this is not the overall efficiency of combustion, but the higher financial value of the electrical component of the output.

The second, the heat pump, typically uses a relatively modest electrical or mechanical energy input to extract low grade heat energy from the environment at a low temperature, introducing it to the building at a higher temperature where its use displaces expensive fossil fuels, and reduces the associated carbon releases to well below those of electric or gas heating.
From an environmental perspective the above options are an improvement over simple fossil fuel boilers and resistive electrical heaters, but generally make some use of primary fossil fuels.

The best environmental option where it is affordable and aesthetically acceptable, is to make increasing use of renewable energy, which while it has a significant capital cost, has little or no ongoing fuel cost or adverse global environmental impact.

Within most non industrial buildings, space heating consumes the bulk of purchased energy.

Renewable space heating is best accomplished by designing high thermal mass buildings to exploit opportunities for passive solar gain. This allows the building to store and release a significant amount of heat without significant change of temperature, but unless you have the luxury of designing a building from scratch, you will need to consider a limited retrofit options. New build design is outside the scope of this work, but please contact T4 if you wish to discuss new build projects.

Refurbishment also offers scope to make buildings much more sustainable, but there is always a conflict between the conservation of a building and the way it is used and maintained, and adaptation to make it more sustainable by changing fuels and architectural features. None the less, passive solar techniques, active solar water heating and photovoltaic electricity production, and possibly wind power and hydro where appropriate should also be considered along with biomass heating.

Few if any planning restrictions are anticipated with respect to solar energy, heat pump or cogeneration technologies, though if biomass heating is used, an external boiler house and fuel store may be required, extending the footprint of the building, and issues will inevitably arise with listed buildings and those in conservation areas.

Aesthetic issues that complicate wind schemes may also be an issue, especially in National Parks. Even if no wind related health and safety or noise nuisance issues arise, even small turbines may require bat surveys to demonstrate that there is no threat to endangered species. This said, if the wind available justifies it, it may be appropriate to install a moderate and appropriate wind turbine in the interests of developing sustainable energy supplies.

District heating

Where appropriate, integration with District heating systems should be considered. These have been common practice in many parts of Europe for some decades. While the perception persists that such systems are rare in the UK, it should be kept in mind that a number of cities do use them, including Lerwick, Sheffield, Nottingham, Leicester, London and Southampton. There is no reason however why these schemes need be on such a large scale, and in many parts of Europe, village schemes are common.

While some of these systems such as Lerwick and Nottingham have been based on environmentally contentious ‘energy from waste’ schemes, Southampton uses a geothermal heat source, and the ‘tri-generation’ system emerging in London with the participation of EDF Energy, provides both cooling and heating in addition to electricity generation. Where these schemes generate electricity, they may improve utilisation of primary fossil fuels by as much as a factor of three compared to conventional power generation, and should be considered where ever possible.

Because the ‘rejected heat’ from conventional electricity generation is generally wasted on an incredible scale, the combination of local medium scale power generation and district heating should perhaps be considered a strategic national priority, though there is no reason why other technologies with thermal outputs should not contribute to such a scheme, nor any reason why such a scheme should only use a single source of heat from a single site. Indeed there is no technical reason why any connected building should not be able to export as well as import heat.

The implementation of district heating schemes require the cooperation of a large number of parties, but the energy and cost savings, and reduction of environmental footprint make this an outcome worth striving for.

From the point of view of an end user of the heat, one major benefit is the outsourcing of heat production, and a reduction in the amount of plant required within their own building. All that need be installed is a simple heat meter to integrate thermal energy consumption over time, and a contraflow plate heat exchanger. For a house, in its entirety, this equipment need be no bigger than a shoe box.

We will assume for now however, that despite the broader benefits, museums will not generally lead on the development of district heating projects, but museums in cities that such schemes should consider connection to them.

Heat Pump Options

A heat pump is a machine which uses mechanical energy and low grade heat (thermal energy at a low temperature) to produce higher grade heat (thermal energy at a higher temperature). Generally these systems are driven by an electric motor, so they are widely perceived as electrical machines.
An indication of the efficiency of these systems is given by the Coefficient Of Performance (COP), which is the ratio of electrical or mechanical energy input, to thermal energy output.

In heating applications, the COPs of heat pump systems improve as the heat source temperature rises and as the heat load temperature falls. They are thus at their most efficient when used to draw heat from a large volume of high thermal capacity material that cools as little as possible during operation, while providing a minimal temperature increase to maintain comfortable conditions in the heated building.

Because COP values are typically in the range 3 to 5, well designed heat pump systems, (ones with bigger COP values), may deliver more thermal energy per unit of primary fuel, (gas or oil used to run a power station or boiler), than a domestic gas or oil boiler, even though the heat pump is typically run from a mains electrical supply which typically only makes about 40% efficient use of its primary fossil fuel.

Heat pumps can draw heat from a number of media, but common varieties include ‘air source’, ‘ground source’ and ‘water source’.
Air source heat pumps use high surface area air to fluid heat exchangers with fans to cause air movement to bring heat into the system. These can be noisy, and as the atmosphere tends to be coolest when the demand for heat is greatest, COP figures are not typically as high for these as other types of heat pump system, but the cost are lowest as they are the simplest and quickest to install.

Hilton Scouts and Guides building, 20kW air source heat pump which provides all space heating and contributes to domestic hot water heating (Picture by David Higgs MBE)

Ground source heat pumps typically draw heat from a large volume of earth. Heat is slowly transferred to this from inside the planet, and from above the ground, but the high thermal capacity of the soil limits the rate of temperature change as heat is drawn out of it, so if the system is sized correctly, COP values can be significantly better than air source systems. Generally, ground source heat is ether collected from closed loops of pipe buried one to two and a half meters deep, or from boreholes which may be hundreds of meters deep and are expensive to drill.

17kW Steibel Eltron ground source heat pump

Water source heat pumps have the advantage that even in a still pond, changes of temperature cause water to move by convection, and this ‘mass flow’ of water, (which has a high thermal capacity), transfers heat more quickly than conduction through a solid medium. Moving water in a stream or river offers an even better heat source, as flows are often large, and cooling this bulk of moving water, even by a fraction of a degree, yields a significant energy output. If your site has a large body of still water, or a stream that runs reliably during the heating season, this option might be considered.

Although it is desirable to let heat collection loops run at as high a temperature as possible, more lower grade heat may be extracted if necessary by letting the heat pump input temperature fall with some efficiency penalty. If the input loop temperature can fall below 0°C, antifreeze must be used to prevent the formation of ice damaging the system. Although ethylene glycol has been used for this purpose, this is quite a toxic material to many species including man. Should antifreeze be required, we prefer the use of a propylene glycol based product. MSDS hazard identification for this material states “No particular hazards known“.
Various hybrids of the above systems are also possible, and ‘open loop’ systems may be constructed which draw water from one location, extract heat via a heat exchanger, and returning it to the same body of water. Where there is no open water on site, an alternative is to draw ground water from one borehole, and return it to another one nearby. As water flows back from the second borehole to the first, it draws heat from the ground in between, giving it access to large reserves of low grade heat.

Problems With Heat Pumps

Hilton Scouts and Guides building, underfloor heating pipe laid on insulating base prior to pouring concrete floor. Pipes at optimal spacing for low temperature heat pump operation.

In practice the requirement to keep the heat pump output temperature as low as possible means that the best COP values will be obtained when using underfloor heating rather than radiators, as underfloor heating, having a much larger surface area, need only run at a much lower temperature. In historic buildings there may be little possibility of installing underfloor heating. As a rule of thumb the use of radiators reduces the COP by about 1. This can be mitigated by fitting more and larger radiators, and possibly using fan assisted radiators where space is limited. Fan assisted radiators also have the benefits of transferring heat directly to the air around users of the building, and help to avoid temperature stratification, i.e. the warming of the air at the top of the high rooms or galleries, leaving the lower parts of these spaces relatively cold.

One of the biggest issues with electric heat pumps is the supply current required to start them. With little or no 'soft start' provision, a heat pump with a thermal output as low as 1.2kW can have a start up surge current of over 90 amps. Many modern units use 'soft start' electronics to mitigate this problem. This makes the switch on surge current smaller, but of longer duration. It is thus always important to check that the power supply to a building can deliver the necessary switch on surge current.

A heat pump with a COP of 4 and a thermal output of 10kW would require a 2.5kW electrical input. In a single phase electrical 250VAC system, this would require a 10 amp supply current to run.

In practice, heat pumps above 10 to 15kW tend to require three phase power supplies which reduce the current required per phase, cutting power losses from the supply cables by a factor of nine. The difficulty of three phase provision may be overcome in single phase buildings by using a number of small single phase machines, though these may have a higher capital cost. See the section on electrical energy measurement which gives guidance on identifying single and three phase supplies.

Ground source heat needs to be collected from outside of the buildings to be heated. MDPE pipe work is normally used for near surface heat collection (pipes at a depth of 1 to 2.2 metres).
As a rule of thumb, 10 metres of linear trench is required per kilowatt of installed heating capacity, with each 10 meters of trench containing about 60 meters of looped MDPE 'slinky' pipe. It may be unwise to put heat collection pipe work under roads and pavements in case this contributes to ice formation in winter.

The main practical heat collecting alternative is the drilling of boreholes. These are generally regarded as relatively expensive, but a significant part of the cost may be getting drilling equipment to site. This overhead becomes less significant as the size of the system increases, and the cost of drilling bore holes has reduced significantly over the last few years.

Biomass Heating

Where sources of wood can be found within less than twenty miles it is worth considering wood burning as a means of heating.

Wood is generally burned either in the form of logs (cordwood), chips or pellets. Cordwood burners require the manual handling of significant amounts of fuel and tend not to be very efficient though the efficiency has improved in recent years.While pellets can be handled automatically and some are now manufactured in the UK, considerable amounts of energy are required to form the pellets, which may be shipped considerable distances prior to use. As the use of wood fuels is only environmentally virtuous if the wood is consumed within a few tens of miles of the point where it is grown, the use of pellets can be hard to justify environmentally.

Wood chip offers a compromise between the amount of processing required prior to burning the wood and combustion efficiency. Unless pellets made from locally grown and processed wood can be sourced, wood chip may well be the most environmentally satisfactory way to burn wood.

Wood chip boiler

Wood burning boilers are fairly large items of equipment compared to other space heating plant, and the energy density of wood fuel is considerably lower than oil, so it should be kept in mind that stores of wood based fuel stores are comparatively bulky.

Assuming that cordwood is eliminated because of inefficiency, the choice of chipped and pelleted fuels remains. It is worth noting that pellets are the more expensive fuel per unit energy delivered, and while both present some risk of dust explosion, which has implications for fire insurance, this is particularly acute with pellet handling equipment, which requires careful design. A benefit to the use of pellets however, is that their uniform physical characteristics make automatic handling of the fuel simpler and more reliable, especially on a small scale. If pellets are used, it is likely that they will be purchased, stored until required, then transferred to a small hopper above to boiler.

Wood chip may be purchased on the same basis, but it may also be possible for the immediate community to participate by growing fuel and managing the process of processing it for use. If locally produced wood chip is to be used, it must first be dried and chipped. Correct moisture content is critical to good performance from a wood burner, and it should also be kept in mind that if woodchip is stored in a damp condition, it is inclined to compost, producing material which if it will burn at all, will offer much less heat than the original wood chip.

While it is possible to chip green wood and burn the chips immediately, the efficiency of this process is compromised by the high water content of the chip. A more common practice is thus to dry the cut cord wood out of doors for a year, or ideally two, to bring the water content down to about 35%.
High quality wood chipping equipment that can handle large logs is expensive, and the volumes of material that must be handled to justify such investment are large. For equipment which can chip twelve inch cordwood, we have seen prices quoted of over £100,000. It should be noted however that such a machine is likely to be able to chip enough wood to run a system at a moderately sized museum for a year in less than half a day, and can be hired for around £450 per day. Wood chipping costs thus need not be prohibitive, nor need the community take the risk of owning such expensive equipment and having it stand idle most of the time.

While there are many trees in the area which might be used as fuel, their sustainable use requires that if cut down, they be replaced with species that are appropriate for periodic coppicing. These might include poplar (populus), alder (alnus glutinosa), eucalyptus (eucalyptus) and willow (salix spp.), and will take some time to become established. Short rotation coppice (SRC) fuel crops are likely to be harvested every three or four years, and long rotation coppice (LRC) crops every five to ten. If land is available to grow it, myscanthus might also be used initially, until SRC harvests can begin.

Although it is tempting to select SRC crops because the first crop becomes available sooner, a mixture of SRC and LRC crops will contribute to biodiversity and the aesthetic amenity of the site. Any local biodiversity action plan should be consulted.
A survey of the existing trees available for fuel use should be undertaken, taking aesthetic, habitat, and wider ecological and environmental needs into account, as well as the condition and age of the trees, their potential as fuel, and their ease of access and handling.
Once cut, dried and chipped, the dry chip will need to be stored which will require dedicated dry space.

The boiler will consume a significant volume of fuel each day, and provision must be made to handle this material, either manually or using a screw feed.

Wood on site chip bulk storage

The use of a woodchip burner invites a number of strategies, but it should be kept in mind throughout, that as with any heating plant, if the insulation of the building can be upgraded, it may be possible to reduce the size, space requirement and capital cost of the required plant.
Modern wood chip boilers may be able to modulate their output from full to about a quarter of full power.

Another strategy, is to fit a smaller wood burner to be used to meet the bulk of the heat demand, but on the coldest days, to make up any short fall by the use of a second wood fired boiler or other heating equipment. This option combines low cost of operation on typical days with high peak power availability on the coldest of days and reduced infrastructure cost. It also offers more fault tolerance than any single boiler solution can, and if the second boiler uses another fuel, reduces any risk of shortage of fuel supply.

A final approach might be to use two wood chip boilers, each offering half the peak load requirement. Acting together, these boilers would offer a range of output powers from about an eighth of full power to full power. - a very flexible range of output powers, coupled with a measure of fault tolerance.
Given the size of the equipment, the use of a plant room and fuel store seems inevitable, but one alternative remains. Some manufacturers will also supply wood chip boiler systems in ISO containers. Such preassembled installations are delivered preinstalled, and plumbed back to the building where the heat will be used.

Although wood is excellent as a fuel with net near zero carbon dioxide emissions (excluding transport), it is worth making one or two comments that might help to further reduce the environmental impact if its use. Wood is not a perfect fuel in terms of polluting emissions, especially if it is not burned in a dry enough state. Like fossil fuels it may contribute to environmental problems such as visible smoke, acid rain and reduced air quality, and of the commonly used fuels, it has the highest dioxin emissions.
Poor quality wood chip containing green waste and unlignified material with a high water content may burn with significant NOx emissions, though some processes press the moisture content out of such plant material, and this nitrate rich extract can be recycled as a fertiliser.
The best emissions come from winter harvested deciduous wood which tends to emit less NO_x on combustion, due to nitrates and other nutrient resources being drawn into the rootstock of the plant at the time of harvest.

Cogeneration - Combined Heat and Power
Combined heat and power systems may operate on a wide range of scales. Large scale units may be linked to district heating systems, but domestic scale systems are emerging which may replace ordinary gas boilers.

Cogeneration systems may use a number of technologies to generate electricity. Depending on scale, Stirling engines, internal combustion engines, steam or even gas turbines may be used to generate shaft power for electrical generators, but the thermodynamics of the process dictate that about two thirds of the applied heat from the primary fuel will typically be rejected as low grade heat, and it is this, collected from engine water jackets, oil coolers, exhaust gasses and the condensation of used steam and combustion gasses, that can be used to operate a district heating system or provide heat to a single building.

Small scale domestic CHP systems have been relatively common in Europe for some time. Historically, internal combustion engines have been used, but these have required significant maintenance, and local experience calls the reliability and viability of small scale internal combustion engine CHP into question, especially in situations where noise may disturb residents and viability depends on generating electricity all year, but where heat is only required in the winter months.

Small scale free piston Stirling engine and generator systems are now coming on sale. Such systems are still very new, and typically natural gas or oil fuelled. These systems may herald the direction the boiler industry is taking. These can deliver a higher cash value energy output because in addition to heat, the electrical energy output has a high cost per kWh value, and the electrical energy may be ‘reused’ if heat is dissipated by appliances within the building.

As a general point, the use of more than one boiler offers a degree of fault tolerance which may be felt desirable given the degree of disruption that failure of the heating system might cause.

As heat from internal combustion engines in CHP plant may be available at quiet high temperatures, especially if energy is extracted from the exhaust gases, it is possible to use this to operate absorption chilling plant to provide air conditioning in summer. In conjunction with the demand for winter heat, this can give rise to a nearly year round demand for heat which can enhance the utilisation and viability of CHP equipment.

Wind Electricity Production

Site Issues

Because there is a cube law between wind speed and the amount of energy that can be extracted from that wind, the viability of sites for wind energy production depends far more on wind speed than is immediately obvious.

Sites for commercial wind production are generally held to be viable at annual average winds speeds of 6.5 metres per second or more at the turbine hub height. Large commercial grid connected systems will generally seek to optimise output by mounting the turbine nacelle between 30 and 100 metres from ground level, but planning guidance suggests that dwellings be excluded within a 400 metre radius of machines of this size.

On many sites, if conventional wind turbines are used at all, mast heights must be much lower, and the equipment designed and selected, as far as possible, to blend into the landscape

Range of Turbines Available

An ever wider range of small wind turbines is available. On the smallest scale these are intended to be mounted directly on to buildings, though we have grave reservations about this, as vibration levels during high winds might loosen fastenings or crack masonry, potentially causing structural damage and injury. We advise any prospective users of building mounted turbines to obtain a structural engineers report before installing such a system, and concerns may also be encountered with respect to the aesthetic consequences of the use of these turbines on traditional buildings. On new build, the use of such a turbine should be considered as part of the structural design.

Larger turbines are generally installed as stand-alone structures, mounted on concrete ‘pads’. Either a simple mast standing on a single concrete pad may be installed, or the mast may be guyed, with each guy line attached to its own pad, pile or ground anchor, the mast itself standing on a possibly smaller central pad. Unguyed masts tend to be thicker, but the consequent loss of visual amenity is traded for much smaller footprint on the ground.

Most ‘off the shelf’ wind products intended for grid connection are ‘bundled’ with inverters operating to the G59 or G77 specification for grid connected generating equipment, which meets the necessary safety and statutory requirements.

Manufactured in the East Midlands, Iskra Wind Turbines AT5-1 5kW wind turbine on guyed mast.

When assessing wind turbines, it is important to look, not just at the manufacturers rated output figures which may be specified under poorly defined or extreme conditions, but also at the output under the range of wind conditions that typically prevail where the machine is to be installed.
It is interesting to note for example, that the Windsave machine quotes a 1kW rated output at a 12.5 ms-1 wind speed, yet applying the ratio of cubes method to estimate the output available at a location with a wind speed of 6 ms-1, it appears that only about 125 watts might typically be produced. Although the UK has world class wind resources, sites with an average wind speed of 12.5 ms-1 are very rare ! It is highly unlikely that any East Midlands museum site would come close to this figure.

Manufacturers should produce a 'power curve' graph for each model of turbine they sell, showing the relationship between average wind speed and energy output in kWh per unit of time. If the manufacturers are reluctant to give this information, consider other options.
While wind turbine power output generally improves as a function of wind speed as the mast height increases. Another factor which improves both power output and the life of the equipment is the avoidance of turbulence.

To avoid turbulence, horizontal axis wind turbines are generally installed as far away as possible from buildings, trees and other obstructions, but many vertical axis machines are far less affected, and may be installed closer to buildings and other structures. Although a horizontal axis turbine might be appear to be mounted well clear of a roof top, it is hard to prove that wind blowing over a complex roof shape will not be turbulent under any given set of wind conditions. This may make vertical axis machines a better choice in many built up environments.

Without long blades that sweep out a large disk, a vertical axis machine may look more like an architectural feature or mobile phone mast from a distance, especially if it can be painted in a neutral colour and mounted on a building in such as way as to appear consistent with the local vernacular from a distance.
Much more work could be done to blend all types of wind turbine into landscapes, and noise may also be a significant concern, as well as the proximity of dwellings. Manufacturers noise data should be consulted, and visits should be made to see and listen to any turbine which is to be considered for purchase.

It has been our experience, that especially when moving, the blades of small turbines are generally hard to see from any significant distance. Even machines as small as 1kW can raise significant planning issues, though some have been installed over areas accessed by the public, though risks to the public must be assessed with great care to ensure that proposals should not be rejected on health and safety grounds.

Unguyed turbine masts are thicker than guyed masts which tend to make them more visible.
Micro wind technology is evolving at a significant pace, so if no appropriate product can be identified now, it may be worth checking again in a year or two. 'Ridge turbines' which are mounted over the apex of a roof are a particularly interesting new technology that may come to dominate wind power in the urban environment, and might also find applications where a tall mast might not be aesthetically acceptable.
As well as being mounted on the apex of pitched roofs as the name implies, similar machines might also be installed vertically on the corners of tall buildings, especially where the gap between buildings funnels the prevailing wind, increasing its velocity, and the power available in proportion to the cube of the velocity.

Building Orientation and Solar Opportunities
For effective solar energy production a site must face the south half of the sky. Facing east of south will deliver peak energy output in the morning, where as west of south will provide peak production on the afternoon. Photovoltaic systems are generally best oriented facing south to deliver the greatest possible number of kWh per year, but the ideal orientation of panels for water heating depends on the time of day the water will be used. The earlier or later the hot water is needed, the further east or west it is useful for the panels to deviate from facing south, should there be any choice of orientation.
Because of the level investment required and the time taken to recover the installation costs, the best sites on any roof should be reserved for PV panels if these are to be used. In ideal circumstances these might be mounted on 'tracking arrays' on the ground, but these are expensive, may not be aesthetically acceptable, and may be at more risk of vandalism than panels on a roof.

Where traditional PV panels are not aesthetically acceptable, roof integrated PV tiles might be considered. On buildings with valleys between pitched roofs, these may allow some collectors to be hidden.

Mounting on flat roofs is possible, but care should be taken to ensure that the peak wind loading due to a 'hundred year gust' cannot blow them off the roof, and that the roof is strong enough to withstand the wind loading and or weight of ballast required to weigh the panels and frames down.
Mounting on standing seem roofs is possible but these are frequently of shallow pitch.
Collectors mounted on shallow pitch roofs may benefit from being inclined more steeply using a small frame. This may be essential for heat pipe evacuated tube solar collectors which must be mounted at a steeper angle than thirty degrees to operate correctly. A steeper angle optimises performance for winter use.

If access, orientation or planning issues make the mounting of panels on a building problematic, they may be mounted on frames on the ground. As these may be seen as a non permanent installation, they may fall outside the scope of planning regulations.

Photovoltaic Electricity Production
Photovoltaic (PV) panels may be installed to generate part of the electricity used in buildings. These are most effective in cold bright conditions, but performance may be badly compromised if even a small part of the panel area is in shadow, or covered with leaves etc.When considering the power available from PVs, it is important to remember that the maximum rated power is seldom delivered in UK conditions, and no power is given at night, so a significant area of panel is required to make a useful contribution to the needs of a building.

Common PV panel technologies fall into three broad classes, all based on silicon semiconductor materials. Monocrystalline panels typically offer the most power per area, affordable models having efficiencies up to 16%. Polycrystalline panels are a little less efficient with efficiencies up to about 14%. Both these technologies are long lived and well tested. Products from reputable manufacturers such as Kyocera, Sharp and BP are likely to have design lives of about 25 years, but may last well beyond that, their outputs diminishing very slowly over time. A third technology, 'amorphous silicon' has a much lower efficiency, typically in the range 4% to 6%, and early devices degraded rapidly, their outputs sometimes falling by as much as 10% per year, though the derived 'triple junction' PV technology claims to be more efficient and long lived than amorphous silicon. While we do not generally recommend the use of this third family of products, it is claimed that they perform better than other technologies in low light conditions, panels can be fabricated as flexible sheet materials which can be cut to form roof tiles and other shapes.

As far as possible, access to PV panels should be easy to allow occasional maintenance, but it must be appreciated that this might make them accessible to vandals. At a cost of about £250 per 75W panel, theft and vandalism are a significant threat to the viability of this technology.
Like wind power, a G77 or other approved specification of inverter is required for grid connection, and the solar version might incorporate Optimal Power point Tracking (OPT) regulation, which optimises the power transfer between the panels and their load by drawing the maximum possible current from the panels at their optimum operating voltage.

It is interesting to note that monocrystalline panels can be quite a good colour match with 'slate grey' roofing materials, but even where the colours match well, the differences in texture and reflectivity may contrast significantly when viewed from some angles, particularly compared to old roofs that are weathered, and may have growths of mosses and lichens.

This may raise planning issues, but allowing the growth of mosses and lichens on PV tiles, such that they blend into the roof better, will inevitably compromise the limited performance of an already costly asset, and ideally periodic cleaning of any PVs should be part of the scheduled maintenance of the building.

Solar Thermal

Of the commonly installed renewable energy technologies, solar water heating generally offers one of the quickest rates of return on investment, and the more hot water is used, the greater the benefit it offers.

For details of the theory, design and implementation of solar water heating systems, please see T4's solar water heating publications including "Solar Power for Dairy Farms", available from the download page of the T4 web site. Although these are aimed at dairy systems, most of the content applies to all medium and larger solar water heating systems. It is available as a free download.

One rule of thumb from the solar industry suggests a panel area for domestic systems of $1m^2$ plus $1m^2$ per user of the system. Some European guidelines would suggest the installation of larger collectors than this. There is no single correct rule that can be applied to system sizing, and ideally, a careful analysis must be made of the distribution of hot water demands throughout the week so that the system can be appropriately sized. Some hot water surplus on good days in summer is inevitable, and in winter virtually no solar heat may be delivered, but the greater the collector area used, the more solar energy can contribute to user requirements in spring and autumn.

The length of pipe work between the solar collectors and the hot water cylinder or calorifier should be kept to a minimum, and this must be insulated to a high standard, being able to withstand high stagnation temperatures, all weather conditions, and remaining undamaged by years of UV radiation.

A considerable choice of panels is now available. The best performing collectors at higher temperatures are generally held to be evacuated tube designs, but these are also among the most fragile. As the tubes are evacuated, they implode on breaking and can scatter glass fragments. They also fail with a bang which vandals may find attractive, and may have toxic coatings inside the glass which could be hazardous to anybody involved in clearing up after a tube has fractured.

Hilton Scouts and Guides building, evacuated tube solar collector which heats hot water. (Picture by David Higgs MBE)

The alternative is to use good quality flat plate collectors. These come in a variety of forms, but again risk assessment may dictate the selection made. If vandalism is a significant issue, glass panels might be rejected because of risk of injury in the event of the glass being broken, but fortunately there are a variety of plastic fronted panels available.

Flat plate solar collector for water heating installed by T4 Sustainability," in roof mounting" (flashed into roof)

Flexible sheet plastic front covers are perhaps best avoided because they are easy to puncture and not easy to repair. Triple wall polycarbonate designs might be avoided because experience with conservatory roofs suggests that this material is likely to become brittle and crack as it ages. This leaves panels with acrylic and Lexan (sheet polycarbonate) fronts which should be quite adequate in normal use. Of these, one is a fairly conventional design using a 240 volt AC power supply for its controller and pump (Filsol), and the other uses a small PV panel and requires no external power (Imagination Solar), providing a minor energy saving over the provision and long term use of mains power for the pump, see picture over.
The T4 publication "Solar Power for Dairy Farms"can be downloaded from:
http://www.T4sLtd.co.uk/ by following the "T4 Downloads" link.

Items 3.4 Pipe Insulation

A hot uninsulated pipe at 75 centigrade in a warm office at 20 centigrade will lose 45 watts per meter from a 15mm pipe, 60 watts per meter from a 22mm pipe, and 76 watts per meter from a 28mm pipe. That covers the 'domestic' pipe sizes, but on the other hand, a 108mm pipe in a larger building could loose 232 watts per meter, so 4 meters of old uninsulated four inch pipe could emit a little more heat than a 1 bar electric fire!

Items 4.2 Water Stress

Water consumption in England and Wales is estimated to be about 150 litres a day per head of population - this is the highest in Europe. It is estimated that water demand in Great Britain will rise 13% by the year 2025 (Herrington 1996). Water stress, (consumption divided by availability), is currently 0.15 in Europe; this figure is set to rise 30% by 2025 (Memon & Butler 2001). This means that water will be viewed increasingly as an economic resource and its supply will be restricted. While water is a renewable resource, it is delivered at a variable and finite rate, and so has the potential to become scarce, not least due to climate change. More infrastructure will be needed to meet new demand, the cost of which is likely to be passed on to end users.

The pressure on existing water resources, plus the shifting emphasis on sustainability are drivers behind the increasing use of harvested rain water and grey water, and water efficient appliances in both the domestic and commercial sectors. As water stress increases, the use of these appliances is being increasingly mandated.

Given these facts, and the finite nature of our water resources, it makes sense that every effort should be made to utilise 'harvested water' and low water use (LWU) appliances and technologies. This not only makes sense from a practical perspective - it also serves to demonstrate that these measures can be used in a wider context, and has an educational value in the community.

Items 5.4 Rainwater

Use of waste water or rain water reduces water stress, but precautions must be taken to ensure that health and the environment are not put at risk.

Potential sources of water include

black water (foul water) from toilets and urinals,

grey water (waste water from the washing of hands, showers, baths, or the washing of dishes or washing machines),

and rain water.

Any available water can be processed for any use, but in general it is not economically sensible to process biohazard materials such as black water, though on large remote rural sites it may be appropriate to consider setting up reed beds as part of a scheme to process and dispose of the black water element of sewage. This is beyond the scope of this guide however. Please contact T4 for further details.

Grey water varies greatly in its degree of contamination by dissolved chemicals and detergents, and also the amount of suspended solid material. Grey water may be used with relatively little treatment for watering plants or washing mud off vehicles, but unnecessary human contact should be avoided, and droplets should not be inhaled as a result of spraying this water. Too high a concentration of detergents in grey water may be harmful to some plants, and some dilution with rain water may be desirable. Because grey water contains high levels of substances which may feed the growth of bacteria and fungi, it is not recommended that large volumes of grey water be stored for long periods.
Should the growth of micro organisms take hold, these may pose a threat to health, and odour problems may arise which make the use of this water inappropriate in applications such as toilet flushing, even if there is no direct contact with users of the water. Where Grey water is to distributed via pour taps for applications such as washing down equipment, clear concise warnings should be posted at each tap.

The use of rain water is generally the simplest and most cost effective option. Potential rain water uses include

- toilet and urinal flushing,
- the washing of clothes,
- and the provision of drinking water.

For toilet flushing and the washing of clothes with rain water, little more processing than filtration may be needed. It should be noted that rain water is soft so minimal amounts of detergent are required, but due to the decomposition of organic material on roofs, it may contain high levels of nutrients that bacteria and fungi might exploit. Further, if it is collected from plastic pipes, it may contain plasticisers, some of which are classed as 'endocrine disrupters'. It is recommended then, that if water is to be drunk, copper rain water goods be used, as these are free of plasticisers, and copper is toxic to many fungi and bacteria.

Rainwater is generally stored in a central location. This main storage tank, because of its weight, is usually at ground level or underground, in or out of doors, though can be located at a high level within a building.

Hilton Scouts and Guides building, installing the submersible tank in the underground storage tank.

Water usually passes though a fairly course filter as it enters the main tank. Excess water is diverted to a drain or soak-away. There are various ways water can be delivered from the underground tank. One of the preferred methods is to use a submersible pump in the main tank to raise water via a finer filter to a smaller 'header tank' in the top of the building. All filters should be cleaned or changed periodically.

From the top tank, water can run by gravity to the point of use, for example, toilets or urinals on the levels below.

Hilton Scouts and Guides building, pumping water to the top tank via the blue filter (right of picture) Picture by David Higgs MBE

To minimise energy use, water should only be pumped when necessary. Should it not be possible to supply rain water from the main tank because of drought, water must be available to the top tank from the rising main or some other source.

The controller shown below uses three sensors on the top tank in such a system to pump water from the outdoor tank as required, but will also draw on supplies of tap water automatically if rain water is not delivered for any reason.

Hilton Scouts and Guides building, low cost automated controls operate the submersible pump in the underground storage tank, and allow the use of mains water as backup .Picture by David Higgs MBE

Although rainwater is free, you must use energy and consumables such as filters to move it and process it, so it is still in everyone's interest that water use is minimised, and low water use appliances should be used where possible to minimise the risk of having to use tap water during dry periods.

Potable, or drinking water should be clean enough to drink, wash in, and prepare food. The standards for Potable water are strictly controlled; the parameters for maximum permissible levels of certain minerals, pollutants and microbes are established by the Water Supply (Water Quality) Regulations. The quality of water is verified by testing, this is generally carried out by the local authority responsible for the area in which the water is collected and used; it is not the responsibility of the water authority.

Micro-organisms and other contaminants may be controlled by a range of physical and chemical processing techniques, including heating, reverse osmosis, ultraviolet light (UV) irradiation, and chemical disinfection. A UV water steriliser is shown below.

Howsham Mill UV-C unit treats rain water for human consumption

The details of potable water processing are outside the scope of this guide. Please contact T4 for further details.

Items 6.1/6.3/6.4 Lighting

The quality of display lighting will typically depend on the efficiency of the lights (light output per watt of electrical input) and the quality of the light.
The quality of the light is frequently indicated by the colour temperature and the Colour Rendition Index (CRI).

Colour temperature typically gives an indication of the absolute filament temperature in an incandescent lamp, and is normally expressed in degrees Kelvin. The higher the colour temperature, the more blue the light. Conventional tungsten lighting typically offers colour temperature values between 2700 and 3300K while daylight is between 5500 and 6000K.

Colour temperature has also been used to describe the colour of fluorescent lighting, though as the phosphors in fluorescent tubes are far from simple black body emitters, the colour of the emitted light is matched to the light of a thermal emitter to determine a ‘correlated colour temperature’.
White light offers a full spectrum - all the colours of the rainbow. Humans can perceive a good range of colours by mixing red, green and blue light, and if these colours have broad spectral bands, the resulting mixed ‘white’ light will offer a complete spectrum.

Light with a full spectrum has a good CRI and will allow the colour of any objects to be perceived in a similar way to that which would be experienced in daylight.

Note that the higher the colour temperature of light, the more blue it contains, and at very high colour temperatures, increasing amounts of invisible ultraviolet (UV) light may be present. As light at the blue end of the spectrum conveys more energy than that at the red end, there is some hazard associated with light sources which give of significant of UV light. UV light in sunlight or artificial sources can cause the fading of paints and coloured materials including dyed fabrics and artworks, and is also linked to human skin cancers.

Taking account of the above, the common types of lighting can be described as follows. The least efficient are listed first, though there is some overlap in efficiency between some of the discharge and fluorescent lighting technologies. Note that in general only tungsten, tungsten halogen and LED lighting can be dimmed. Fluorescent lighting can be dimmed under limited circumstances. Also note that if the power supply to discharge and high intensity discharge lighting is briefly interrupted, it may be more than ten minutes before it will restart. This has obvious health and safety implications.

Tungsten lighting has set the benchmark against which other lights are judged, though it is now widely regarded as obsolete, as it is inefficient, and with a mean time between failures (MTBF) of around 1000 hours, it is unreliable, especially if switched on and off frequently.

Tungsten halogen lighting has come to replace standard tungsten lighting in many situations. It offers a more compact source of light which is easier to focus in display lighting applications, has a higher colour temperature, and is around 20% more efficient. As it has more blue light it will typically have a better CRI value than standard tungsten lighting, but may give off amounts of UV that could compromise delicate exhibits.

LED lighting as a rule of thumb, is about twice as efficient as standard tungsten lighting, though this depends on the colour and type of LED light, and the technology is improving all the time. MTBF figures can reach hundreds of thousands of hours. The physical properties of LEDs dictate that light of a given colour is emitted in very narrow bands. These bands are said to be monochromatic (of a single colour). Light from red, green, and blue LEDs can be blended to make something that is perceived as white. The perceived colour temperature can be adjusted by varying the intensity of the constituent colours, but the CRI will always be poor as without the intermediate colours in the light from the LEDs, many hues may not be well displayed in illuminated objects.
LED lighting comes from very small devices and may be extremely intense, and very bright LEDs are available with optics that enable beam width as small as six degrees to be achieved which can give rise to very dramatic lighting effects. Further, the DMX digital control protocol allows digital LED lighting to be controlled remotely by a range of automated or manually operated systems, and these allow very dramatic lighting effects to be achieved. Such systems have been expensive in the past, but are getting cheaper all the time. Automated and possibly interactive control, from low cost PCs is now possible, but the details of this are outside the scope of this document. Please contact T4 for details.
Some ‘white LEDs’ are also sold. Strictly these are a blue or UV LED, which while monochromatic, illuminates a phosphor which glows white. While these devices are less efficient, they do provide a much wider range of colours in the light giving a far superior CRI. These are available in a range of colour temperatures, but where UV light is used to excite the phosphor, care should be taken as some UV might be emitted which might pose a risk to exhibits.

Discharge and High Intensity Discharge (HID) lighting is more efficient, but generally suffers from poor CRI and colour temperature values. Low pressure sodium lighting is efficient but virtually monochromatic. High pressure sodium is less efficient, but has a better colour temperature and CRI, the light having a pink to orange hue which makes it quite inappropriate in all but workshop or warehouse applications.
Metal halide HID lighting has better CRI and colour temperature values again, and while the light has a pale blue hue, it is frequently used in shop display lighting. Unfortunately the light emitted contains significant amounts of UV radiation so these should not be used with delicate exhibits, and at close range,

the UV light can cause skin burns and affect the eyes.

Fluorescent lighting offers the most efficient lighting solutions at the moment, though it is important to select the correct kind of light. Older fluorescent lights used wider less efficient tubes and phosphors. A common size was the T12, 1.5 inches in diameter which was operated at 50Hz with an inductive ballast.
In new installations the newer T8 fittings, 1 inch in diameter have now supplanted T12 fittings. Many T8 units use high frequency electronic ballasts which along with the narrower tubes offer significant energy consumption and MTBF benefits.

T5 fittings are now coming into use with a tube diameter of five eighths of an inch. These all use electronic control gear and in turn offer increased efficiency. Some fittings are available to allow the retrofit of T5 tubes to equipment designed for T8 tubes. This can deliver a useful energy saving.
Compact fluorescent lamps are also available with bayonet or Edison Screw fittings to replace standard incandescent lighting, though in general these lights cannot be dimmed. These can however reduce energy consumption by about a factor of five. Compact fluorescent lamps are also available to work from low voltage DC supplies. These may have a number of educational uses.

When upgrading lights it is important to consider how quickly the financial cost and environmental impact of manufacture will be recovered. If a light is seldom used, the building might be rewired before the investment in an upgrade is recouped, but if lights are on for several hours per day, upgrade costs and environmental impacts of manufacture might be recovered in a small number of years.

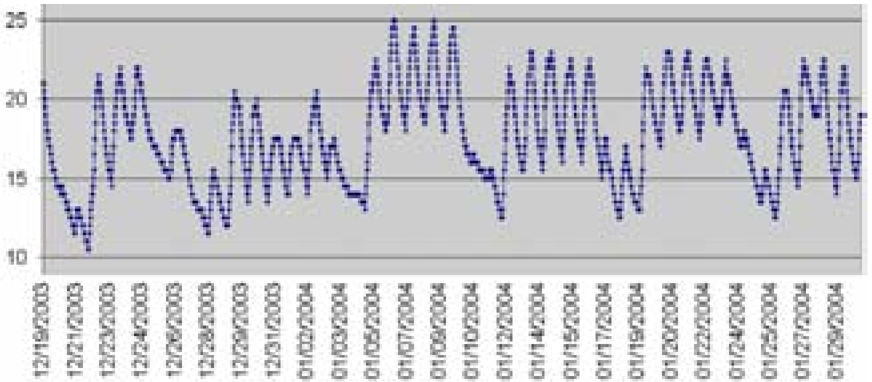
Items 7.6/8.3 Measuring to manage

Following the adage that ‘if you don’t measure it, you can’t manage it’, we should now look at some measurement techniques.
Measurements broadly divide into those made at an instant in time, and those made over a period of time. Those made over time require the use of a data logger, which in addition to having the ability to make a measurement, has the ability to record periodic readings automatically.
In the context of a museum we might be interested in measuring things like temperature, humidity, power use and energy consumption.

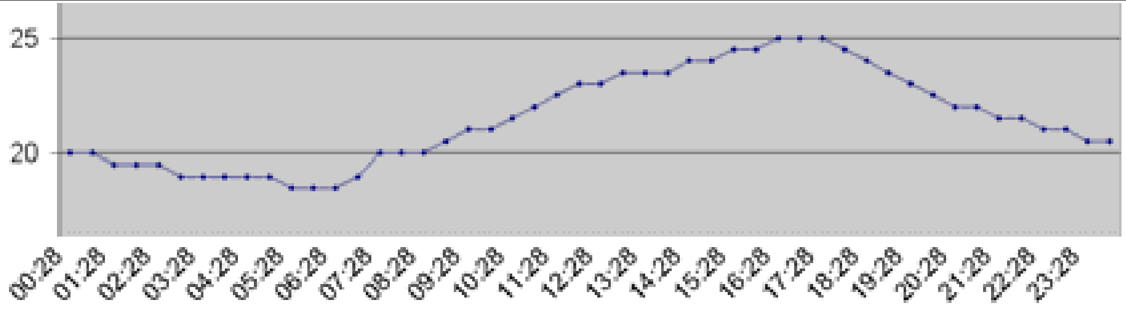
Temperature and humidity
There are many devices that can measure temperature. We will all be familiar with common thermometers that display the current temperature, and many of us will have used maximum minimum thermometers which additionally indicate the maximum and minimum temperatures since it was last reset. These however give little idea about how much time has been spent at any given temperature and how temperature has varied over time.
One of the cheapest devices that offers time based measurement is the Dallas Semiconductor iButton Thermochron product range. These have an internal battery and a range of accuracies and memory sizes. They are a sealed unit that measures the temperature of their external surfaces which will normally be the temperature of the air or water around them, though they can be attached to pipes, surfaces or equipment to monitor usage as most equipment warms up slightly when in use.

As an example, the DS1921 Thermochon stores 2048 temperatures, and can be programmed to record temperature readings at any interval between 1 and 255 minutes. If the device is set to record temperatures every 10 minutes, it can record temperatures for a little over two weeks, with good enough resolution to allow the details of any particular day to be explored. The devices cover an operating temperature range of -50°C to +100°C, and can be obtained for £5 to £10 each.

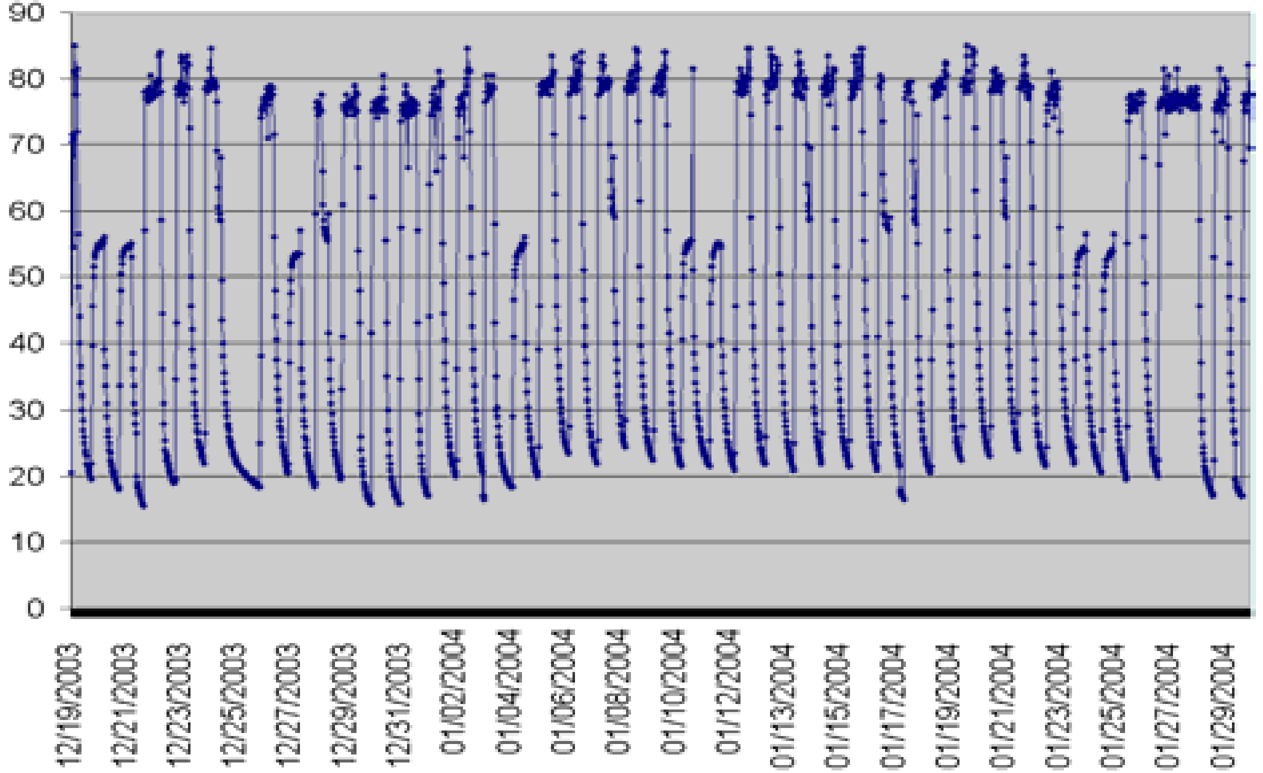
Thermochrons may be programmed and read with free software, and if you have basic text editing and spreadsheet skills it is possible to convert the output data into a .CSV file for import into for example Excel or the Open Office Calc spreadsheet which is free. Once the data is in a spreadsheet, it can be graphed or analysed in any way you choose. The graph below shows three weeks of temperatures with half hourly readings from an office with a large amount of south facing glazing over the Christmas and New Year period.



Note that while the heating was correctly turned off on days when the office was closed, it was routinely overheated on many working days. The following graph uses an extract of the same data to show half hourly temperatures for the 8th of January only.



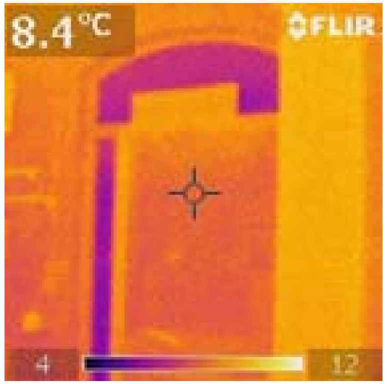
Looking at the heating pipes from the boiler in the same building, the following graph was obtained which shows when the heating was used at full and part power over the holiday period. Note that operating temperatures as high as this would make efficient operation of modern condensing boilers difficult. Efficient operation would be more likely at lower temperatures where the flue gasses could be cooled more and more of the water in the flue gasses condensed.



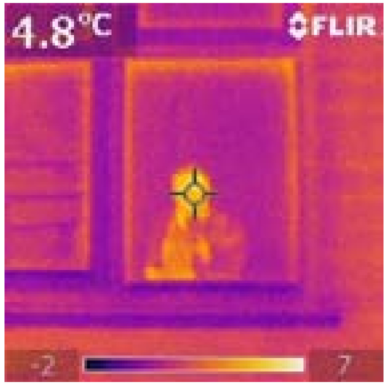
Other iButton products are able to measure temperature to higher relative and absolute precision, have more memory, and others are able to measure temperature as well as humidity. Because all these devices are compact, they can easily be placed on, in or amongst museum exhibits, either on display, in storage or in transit. As they are intended for use in the food industry, they can also be used to check the operation of fridges, freezers, cold stores and air conditioning plant. At typical room temperature, the batteries in iButton devices can last up to ten years.

In addition to measuring the temperature of a medium within which a sensor is in contact, it is possible to measure the temperature of a surface by the heat it radiates. Hand held non contact thermal infrared temperature sensors start at prices of a few tens of pounds. Note however that the further away you stand from the object whose temperature is being measured, the larger the area sensed, so care must be taken to ensure that the object of interest filled the entire area sensed. Although these are a useful tool for looking for hot or cold spots in inaccessible areas, they are not useful for sensing small areas at great distances.

Detailed studies are better accomplished with thermal infrared cameras. Although these provide poor resolution by comparison with modern visible light digital cameras, they often provide an 'at a glance view' that makes it immediately clear what's going on. These show the location of hot and cold areas quite precisely, and the software supplied with them usually allows images to be analysed pixel by pixel where appropriate to make considerable detail available. In the example below, a fire door at Derby Silk Mill museum, it is clear that the door to the outside of the building is reasonably thermally insulating, but the glass over the doors is of low thermal performance, as is the panel to its left.



Temperatures in thermal infrared images are frequently represented in artificially generated colours to enhance the visual contrast arising from small temperature differences, but as an alternative, most cameras can be set to display a black and white image where the hotter objects are shown as brighter white.
One complication with thermal infrared sensing is the reflection of infrared by some surfaces. Even dirty copper pipes for example can reflect the temperature of the rest of the room which can make it difficult to sense pipe temperatures. It is better to sense temperatures at brass fittings than copper pipes. Reflection can be useful tool however, in that in some circumstances it makes it possible to see if thermal infrared reflective 'low emissivity' glass has been installed in a building - in the above example it has not, the blue colour above the door represents the temperature of objects out-doors seen through the glass. By contrast, 'low emissivity' glass will reflect a thermal image. The picture below shows a thermal image of the photographer reflected in the glass.



Item 9.3 Staff Behaviour

The Carbon Trust has good literature on how to change staff awareness and behaviour with posters and stickers. For example publications such as Creating an Awareness Campaign can be ordered on www.carbontrust.co.uk or 0800 085 2005.

D. Funding Opportunities

Funding Sources for Environmental Sustainability:

Environmental sustainability, energy efficiency and waste reduction are increasingly seen as important factors in the awarding of grant funding. Many Lottery, European and Charitable Trust funders now ask the question: "How does your project ensure environmental sustainability?" and will require applicants to have considered these issues, regardless of the theme of the grant application.

All projects can impact on environmental sustainability even in a basic way, such as committing to using recycled materials and / or public transport. However, there are more and more opportunities for organisations to think more deeply about environmental sustainability and funding available to invest in this significantly.

What follows is an overview of some of the major funds available for environmental sustainability, including renewable energy. As these are often time limited and subject to change it is also worth registering on funding websites to keep up to date with changes to the funding available. A good one for government funding is:

www.governmentfunding.org.uk

whilst:

www.lotteryfunding.org.uk/uk/funding-internet-search.htm

will allow you to search all the lottery funders for a suitable scheme.

The "4 Community" family of websites are funded through the Government's Change Up! programme and offer a comprehensive range of Lottery, Trust and Government funding targeted at geographical areas, at no cost, for example:

http://www.derbyshire4funding.info/

http://www.open4community.info/leicestershire/default.aspx

http://www.open4community.info/southlincscvs/

http://www.open4community.info/northnorthants/

And, of course, your local CVS will also have details of funders and may also produce its own funding newsletter.

Funding for energy efficiency and renewable technologies:

1.0 BERR - Low Carbon Buildings Programme - Phase 2 - http://www.lowcarbonbuildingsphase2.org.uk
Phase 2 is due to end in June 2009.
Grants for the installation of micro-generation technologies are available to public sector buildings (including schools, hospitals, housing associations and local authorities) and charitable bodies.
50% Funding is available for:

- Solar photovoltaic
- Solar thermal hot water
- Wind turbines 0.5kWp –50kWp
- Ground source heat pumps
- Automated wood pellet stoves
- Wood fuelled boilers up to 45kWh

Work must be undertaken by framework suppliers and their subcontractors. See website for eligible organisations.

2.0 Big Lottery – Community Sustainable Energy Programme -
http://www.communitysustainable.org.uk

Dates for 2009:

Friday 1 May 2009, Friday 7 August 2009, Friday 30 October 2009

Grants are available for renewable energy and energy efficiency measures.

Open to:
- community groups governed by a written constitution
- registered charities and trusts
- parish councils
- schools and colleges
- companies with a charitable purpose and community focus
- mutual societies
- church based and other faith organizations

The maximum Capital Grant available is £50,000 or 50% of the project cost whichever is lower.

3.0 Scottish Power - Green Energy Trust -
http://www.scottishpowergreentrust.co.uk/content/

Scottish Power operates the Green Energy Trust which awards grant funding to small scale community based renewable energy projects within the UK. The Trust can provide up to 50% of the project cost up to a maximum of £25,000 with the average successful project receiving around £10,000 (the full £25,000 will be provided only to exceptional proposals).

The Trust meets three times a year to consider applications – usually during the first week of April, September and December. Applications should be submitted seven weeks prior to the Trustees' meetings, with the final deadline being four weeks before the meeting.

The application form and further details are available by accessing 'Guidelines for the Scottish Power Green Energy Trust' from the website.

4.0 EON - Source Fund -
http://www.eon-uk.com/about/2654.aspx
The closing dates for applications in 2009 are:

May 15th 2009 and October 16th 2009

The Fund offers grants of up to £30,000 for Renewable Energy and Energy Efficiency.

The Fund is available to community groups, charities and not-for-profit organisations across England, Scotland and Wales. Projects must demonstrate community benefits.

5.0 EDF - Green Plan fund
http://www.edfenergy.com/greenpages/edf-energy/showPage.do?name=greenpages.greenfund.til

http://www.edfenergy.com/products-services/for-your-home/our-green-products/green-energy-fund.shtml

Deadlines 28th Feb 2009, 31st August 2009

- Non profit or charitable organisations and or organisations involved in education and or work at community level.
- Funding will be provided to cover the costs associated with the installation of small-scale renewable energy technology and a proportion of the funding requested may be used for educational purposes (Up to 20%).
- Funding may also be requested for feasibility studies into the installation of small-scale renewable energy technology.
- There will be a maximum grant value of £30,000 for installations.
- Interested in projects which demonstrate a community benefit
- Match funding must be applied for where available.

6.0 Other Miscellaneous Funders

Local Authorities often provide small grants for environmental projects e.g.

Derbyshire County Council – Greenwatch action grants
http://www.derbyshire.gov.uk/environment/green_issues/green_grants/default.asp

Up to £500 for environmental projects including waste and energy efficiency.

E. Other Supporting Links

MUSEUM CONTACTS
MLA – www.mla.gov.uk Tel: 0121345 7300
Renaissance East Midlands – www.renaissanceeastmidlands.org.uk
Collections Link – www.collectionslink.org.uk
East Midlands Museum Service – www.emms.org.uk
Museum Association – www.museumassociation.org Tel: 0207 4266910

STEP BY STEP AUTHORS
Groundwork Derby & Derbyshire – www.gdd.org.uk/business. Tel: 01773 535232
T4 Sustainability – www.T4sLtd.co.uk Tel: 0845 4561332

FREE ENVIRONMENTAL ADVICE
Carbon Trust – www.carbontrust.co.uk.Tel: 0800 085 2005
Energy Saving Trust – www.energysavingtrust.org.uk Tel: 0800 512012
Envirowise – www.envirowise.gov.uk Tel: 0800 585794
English Heritage – www.english-heritage.org.uk
English Heritage Energy Conservation Guide – www.helm.org.uk/upload/pdf/89410-energy
Wildlife Trust – www.wildlifetrusts.org Tel: 01636 677711

GREEN BUILDINGS/ENVIRONMENTAL ADVICE
Green Spec – www.greenspec.co.uk
Green Building Bible – www.greenbuilding.bible.co.uk
Kind Seed Environment Centre, Liverpool – wwwgreenspec.co.uk/html/imagebank/kind.html
Groundwork Derby & Derbyshire – www.gdd.org.uk/business Tel: 01773 535232
Groundwork UK – www.groundwork.org.uk
Groundwork Environmental Business Services – www.groundworkebs.co.uk

FREE SUPPORT LINKS
Derbyshire Business against Crime- www.saferderbyshire.gov.uk
Business Link – www.businesslink.gov.uk Tel: 0845 6009006