

# ARTS GREEN BOOK

**Sustainable Buildings**  
*(version 1)*



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*The Arts Green Book is a free resource for everyone in the cultural sector. It has been developed in partnership by the organisations whose logos are on this page, as well as many individual cultural organisations.*

*The Green Book is built on years of thinking, research and advocacy by pioneering organisations and individuals. You'll find their names in the acknowledgements and bibliography, and their ideas throughout.*

*We would like to thank everyone who has supported the Green Book with their time, their commitment and ideas. Their names are in the acknowledgements. And special thanks to the funders of the Green Book, Arts Council England and the Greater London Authority*

**Renew Culture**

**BURO HAPPOLD**

## Foreword

Culture is part of the climate emergency. Whether you work in theatre or run a library, operate a gallery, manage a venue, manufacture fashion, lead a museum, direct an archive or head a dance company, the climate emergency is changing what we do - and how we do it.

That affects how we operate, how we travel, and how we make work. But it also means making sure our buildings - one of our biggest energy users - are as sustainable as we can make them. The Arts Green Book : Sustainable Buildings helps tackle that challenge.

It shows how to make our cultural buildings more sustainable, even though many are ageing and starved of investment. Some may be planning a capital project. The Green Book will help identify the biggest impacts. Others may not have much control over their premises. The Green Book will spot the steps you can take, and advise on lobbying for more.

Cultural buildings include some of our most valued, most loved and most prominent public places. If we want the arts to point society towards a sustainable future, then we urgently need to regenerate them to suit a world of life-threatening temperature rise, over-exploited resources, and declining biodiversity.

That journey will never be easy - everyone in the arts knows how hard it is to raise funds for investment. But it is essential. Sustainable Buildings sets clear standards for assessing the challenge, selecting priorities - and setting out on the journey.

**Paddy Dillon, Green Book Co-ordinator**

# Contents

The Arts Green Book has brought together sustainability experts and people working in different cultural sectors to create a common standard for making progress in sustainability.

*In a hurry? Go to the sections shaded green*

## AT A GLANCE

4

Be Lean (use less)	6
Be Clean (services systems)	7
Be Green (renewables)	8
Biodiversity and water	9
Making a Plan	10

## THE PRINCIPLES

11

1 Introduction	12
2 Key Principles	13
3 Old and New Buildings	14
4 Lean: Building Fabric	15
5 Clean: Services Systems	17
6 Green: Renewables	19
7 Biodiversity and Water	21
8 Arts Building Types	23
9 Gathering information	37
10 Developing a Plan	39
11 Easy Wins	41
12 Maintenance	42
13 Capital Projects	43
14 Infrastructure and Resilience	45
15 Zero Carbon and Beyond	46

## THE GUIDANCE

The Sustainable Buildings 'Home Survey Tool' can be found online at:

<https://smartvizstatic.z33.web.core.windows.net/stage/ArtsGreenBookStaging/>

**Complete the Home Survey Tool to generate an initial Sustainability Plan, then turn to Section 10 for guidance on how to finalise it.**

## TOOLKIT

A toolkit of resources for sustainable cultural buildings can be found online at

<https://artsgreenbook.com/sustainablebuildings/toolkit/>

Acknowledgements and Thanks	49
Literature Review	50
Bibliography	52

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**sustainable buildings**

# **AT A GLANCE**

*"We have a once-in-a-generation opportunity to build a resilient recovery plan that is fair and tackles the climate and ecological crisis with urgency.*

*We cannot let this opportunity pass us by." Julie's Bicycle, 2020*

## **To become more sustainable any building must:**

- BE LEAN (upgrade walls, roofs etc so as to lose less energy)
- BE CLEAN (upgrade services systems to use less energy)
  - BE GREEN (draw energy from renewable sources)
    - Support biodiversity and reduce waste

## **To make that happen, cultural building owners and managers must:**

- Survey their building to identify what needs to be done
  - Make a Sustainability Plan
    - Start with the easy wins
  - Focus maintenance works on sustainability
    - Start planning for capital projects

**And operate the building with sustainability in mind!**

# Be Lean (leak less energy)

## 1 Roofs

1

Roofs are a major source of heat loss, particularly above auditoriums and large galleries.

## 3 Walls

3

Walls can be insulated to keep energy in.

## 2 Entrances

2

Entrances need lobbies. Thin, leaky doors waste heat.

## 4 Floors

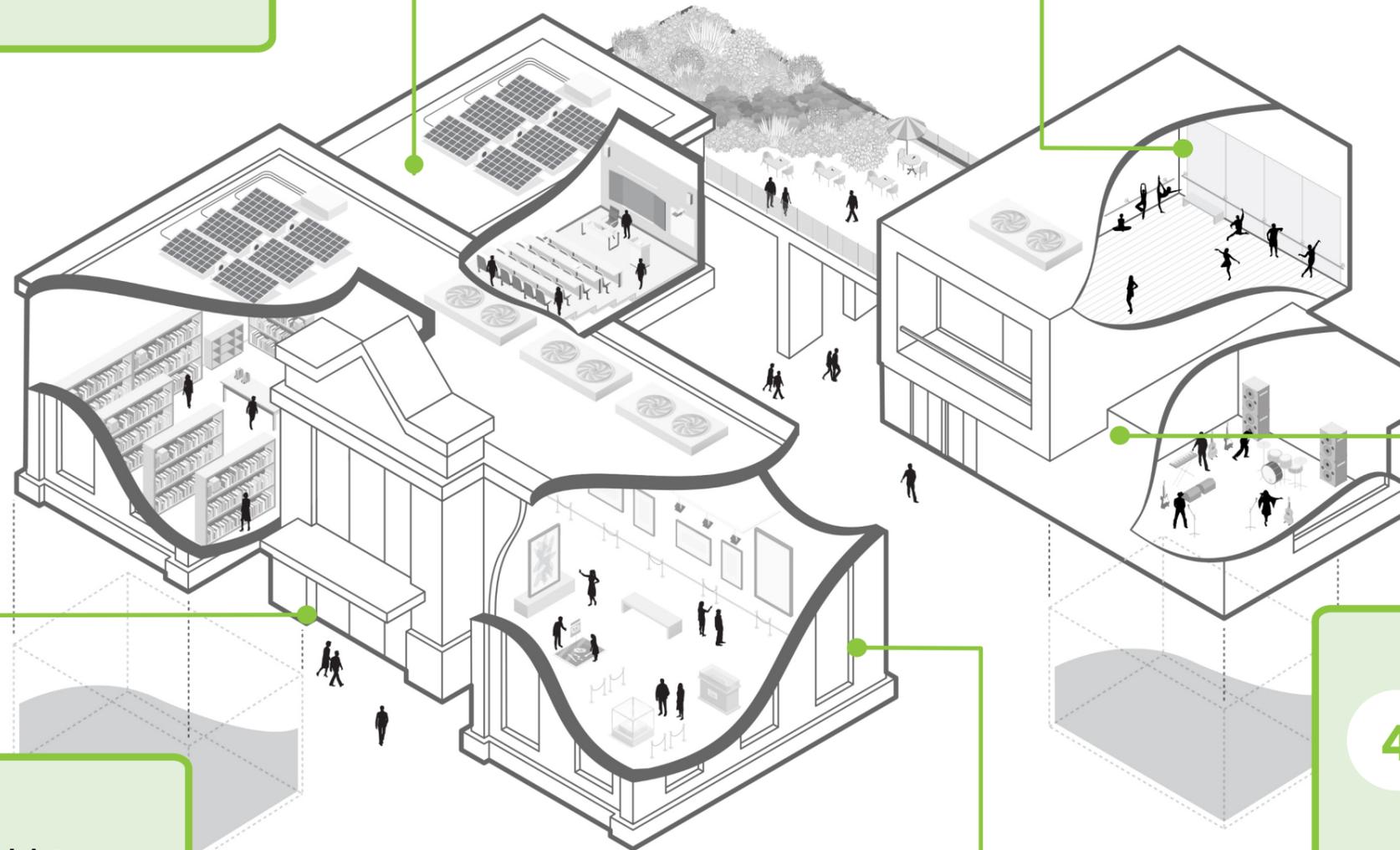
4

Uninsulated overhangs and balconies let energy escape.

## 5 Doors and windows

5

Double or secondary glazing stops heat going out of the windows. Triple glazing helps even more.



# Be Clean (improve services systems)

1

## Heating and cooling

Replace fossil fuels with low-carbon energy sources - or connect to a local heat network.

4

## Ventilation

Efficient fans and pumps prevent energy waste.

2

## Lighting

Switch to LED. Timers and movement / daylight sensors keep lights off unless they're needed.

5

## Other Systems

Lifts, servers, security systems and catering are all big energy users.

3

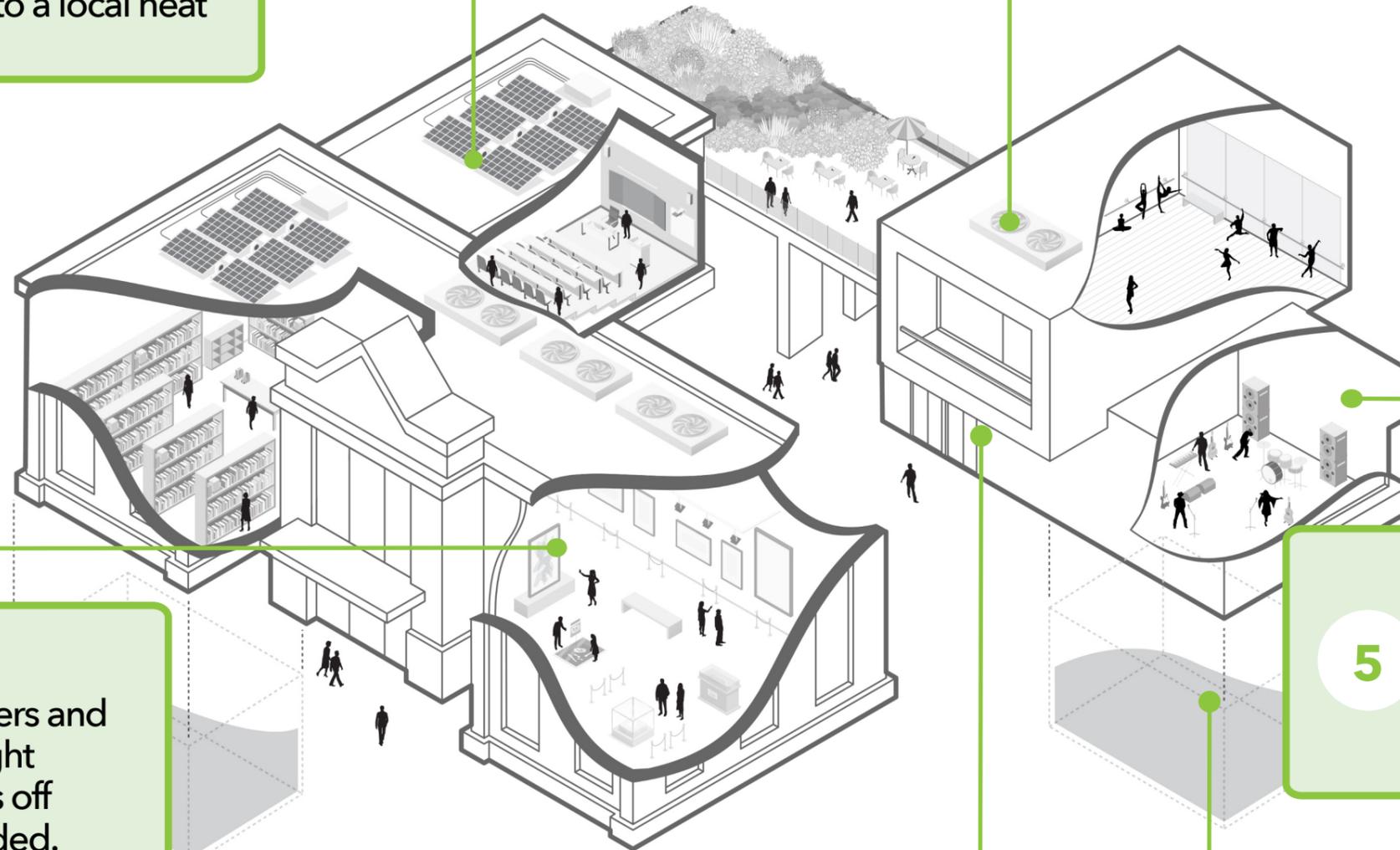
## Hot water

Hot water supply for taps and showers must be heated sustainably.

6

## Controls and 'BMS'

Good controls switch services on only when needed. A 'Building Management System' controls everything.



# Be Green (use renewable energy)

## 1 Solar panels

'PVs' and thermal panels work well on south-facing or flat roofs.

## 4 Turbines

Wind power rarely works in towns and cities, but may help rural buildings.

## 2 Air source heat pumps

Relatively easy to install, these can work well for some buildings.

## 5 The National Grid

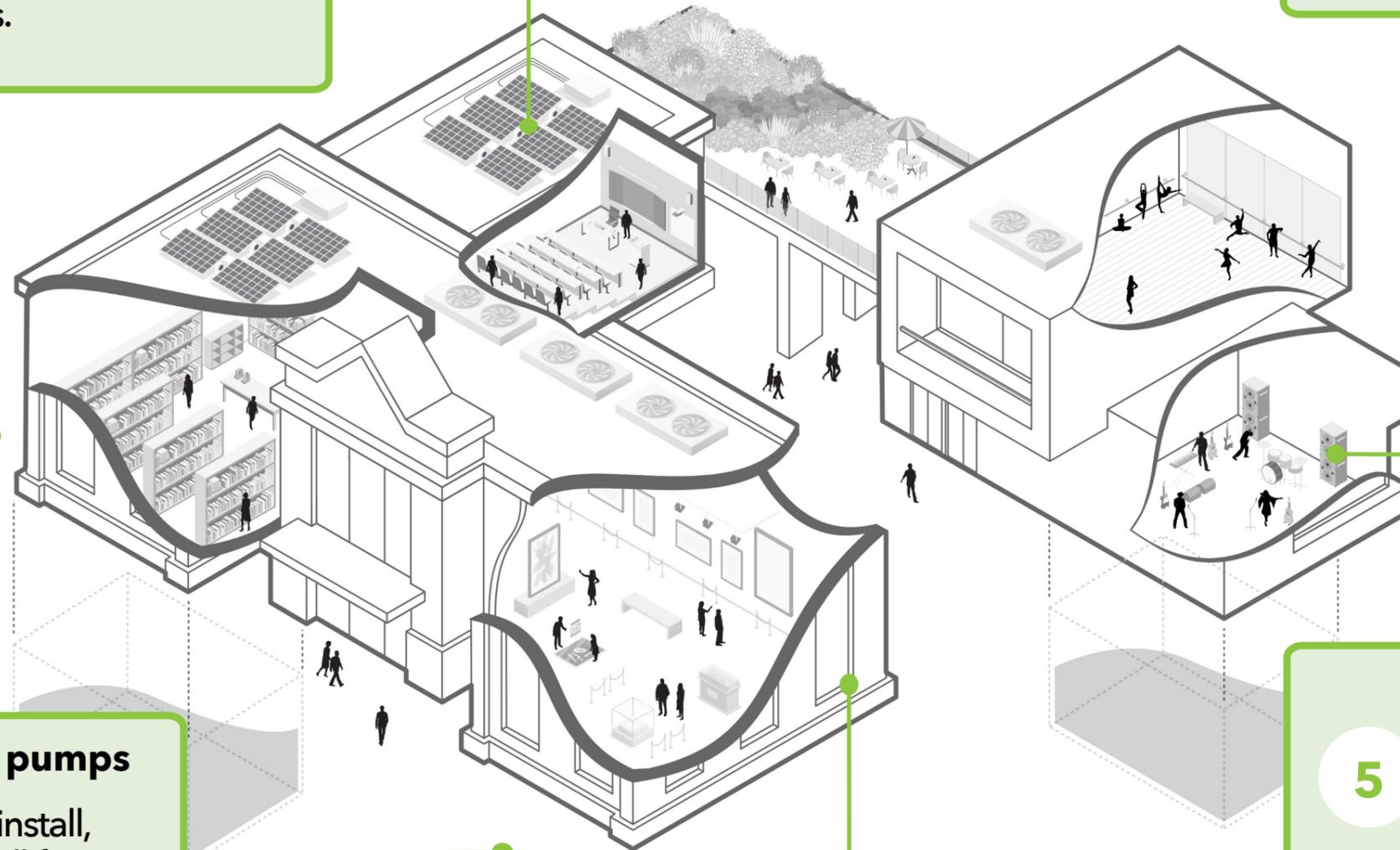
Greener every year, the Grid can offer renewable electricity through green tariffs.

## 3 Ground source heat pumps

Warmth in the ground is an energy source, though 'GSHPs' may require major works.

## 6 Working together

Local networks may offer efficient shared energy. Buying energy through a consortium reduces costs.



# Support biodiversity and use less water

## Green roofs

1

Planted roofs can support wellbeing as well as biodiversity.

## Rainwater

3

Rainwater can be captured to irrigate plants, but needs storage space.

## Landscape planting

2

Any building with outside space has a chance to support biodiversity.

## Grey water

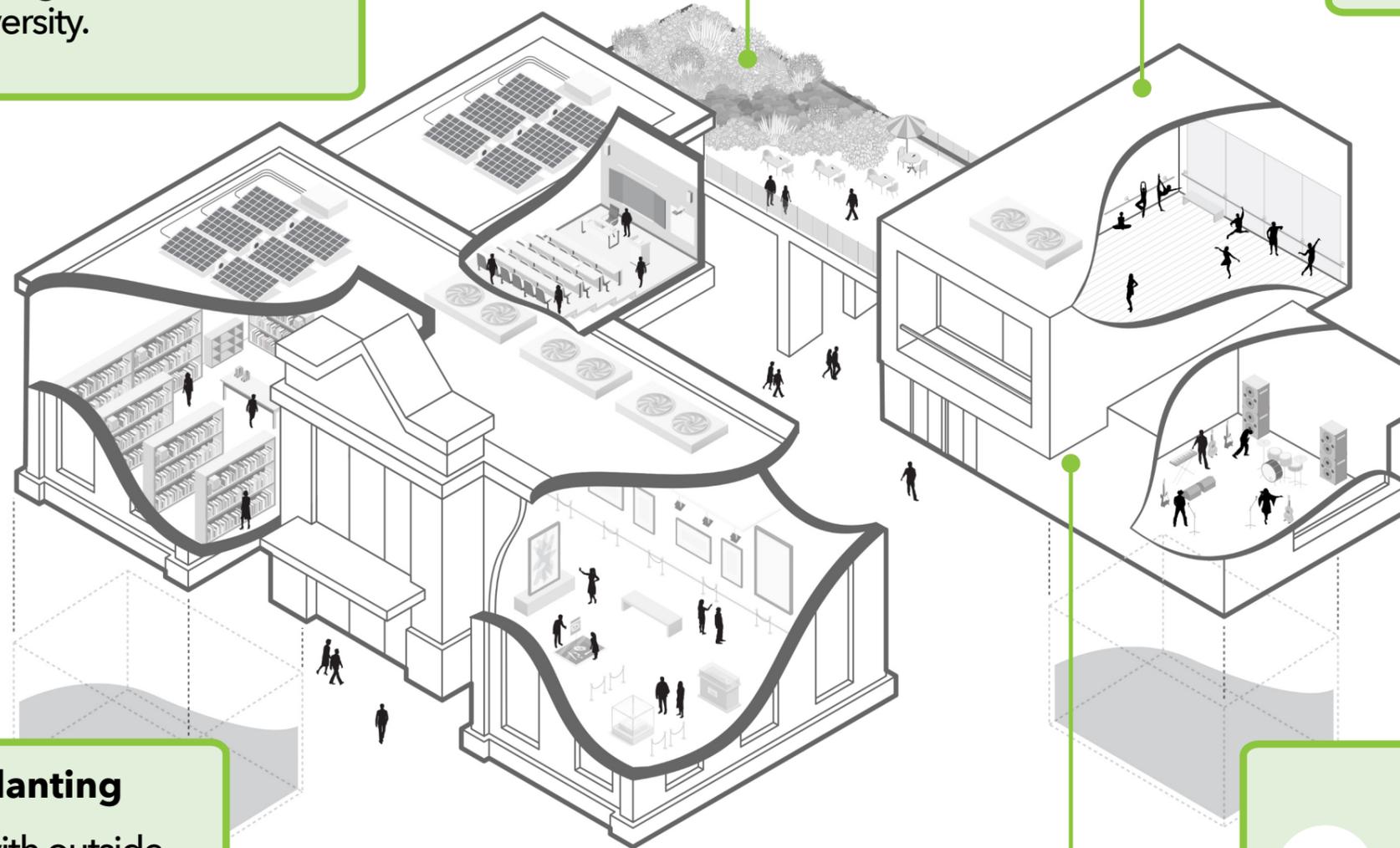
4

Water from showers can be reused in toilets, but needs extra pipework and storage.

## Sustainable drainage

5

Think of rainwater as a resource to support biodiversity.



# Making a Plan

## Carry out a Green Book 'Home Survey'

See Guidance Section: the Arts Green Book's Home Survey tool asks you questions about every aspect of your building



## Develop a Sustainable Building Plan

The tool automatically categorises actions and puts them in order of priority



## Put in hand the 'Easy Wins'

Actions which are low cost and easy to do



## Plan your maintenance strategy

Including green upgrades wherever possible



## Plan your capital projects

For larger interventions that will need fund-raising, closures or permissions



## Set a timetable

To achieve carbon zero

**sustainable buildings**

# **THE PRINCIPLES**

*“Without the cultural sector playing its part in helping current and future society to move towards a more sustainable way of life, this essential shift will not happen.” Creative Carbon Scotland, 2020*

# 1 Introduction

## 1 Why the Green Book?

The climate crisis is an immediate threat to our safety, equity and prosperity. We urgently need to limit carbon emissions, reduce biodiversity damage, and, in doing so, achieve a just transition where people, places and communities are supported and vulnerable groups protected.

The cultural sector cannot solve the climate crisis alone, but it can play an urgent role in addressing it. Performance buildings, studios, galleries and museums, archives, libraries, cinemas, and concert venues provide space to question and challenge, provoke, entertain, educate and surprise. One of culture's many roles is to reflect the preoccupations of generations facing a time of dizzying, frightening change.

To do that, the arts must themselves work sustainably. Part of that is making cultural buildings sustainable.

## 2 A Clear Path to Sustainability

The Arts Green Book : Sustainable Buildings tells building owners and operators what to do to make their buildings fit for purpose in the climate emergency.

It isn't about operations - how to manage waste, travel and so on. Nor is it about building new buildings. Our priority in the climate crisis must always be to make the most of the buildings we have. Instead, it focuses on the primary challenge of upgrading existing buildings - many of them old and some dilapidated - to make them sustainable. It's about insulating roofs, upgrading heating systems, fitting solar panels, supporting biodiversity and reducing water wastage.

Sustainable Buildings gives us a path towards sustainable cultural buildings. It maps a journey towards a net zero arts infrastructure, to contribute to a more sustainable society.

## 3 Sustainable Buildings

Cultural buildings are among our most high-profile public places. Some form part of our most important architectural heritage; others are among our most dynamic new buildings. They're the places we spend time together. It's all the more important, therefore, that our cultural buildings are fit for purpose in the context of the climate emergency.

The challenge is hard because many cultural buildings lack the investment needed to upgrade fabric and services. Few achieve anything like the environmental performance that we expect of new buildings in the climate crisis. Roofs are often uninsulated, services systems often old, inefficient, poorly-controlled - and powered by fossil fuels. Making our cultural buildings fit for purpose is an urgent task. The Arts Green Book : Sustainable Buildings provides a blueprint for the journey.

Its guidance has been developed by bringing together sustainability and building environments experts Buro Happold, design professionals, and - most importantly - professionals who own and manage buildings, to address the challenge of making arts and cultural buildings sustainable.

## 4 Scale and Type

Cultural buildings vary enormously in type and scale, but the principles of sustainability are the same. There is only a finite number of things you can do to make a building more sustainable, and that list applies to large buildings and small. So this guidance is designed for cultural buildings of all kinds and scales. Whether you operate a dance studio or a museum, a library or archive, a gallery, a fashion workshop or music venue, an opera house or a small community cinema, the process of assessing priorities, developing a Sustainability Plan and delivering improvements is the same.

Later (see section 8), you'll find guidance for different cultural sectors that picks up the challenges specific to each. First, the guidance will go through the principles of environmental sustainability that are common to all buildings.

## 5 Carbon

This guidance focuses on the practical steps you need take to improve your building's sustainability.

The ultimate aim is to reduce the carbon we put into the atmosphere, reduce the resources we consume, and support biodiversity. It's easy to track the impact of our carbon improvements. Calculators like Julie's Bicycle's Creative Green tools (<https://ig-tools.com/login>) include a calculator for buildings. By using it you can keep track of your carbon usage as it diminishes.

## 6 The Legislative Background

The UK is committed by law to decarbonisation. Building Regulations, Local Authority planning policies, and planning conditions all push buildings towards more sustainable operation. That legislative background will rightly become more demanding over time.

Now is the time for arts and cultural organisations to plan for a world in which sustainability is expected by the law - and also by their artists and audiences.

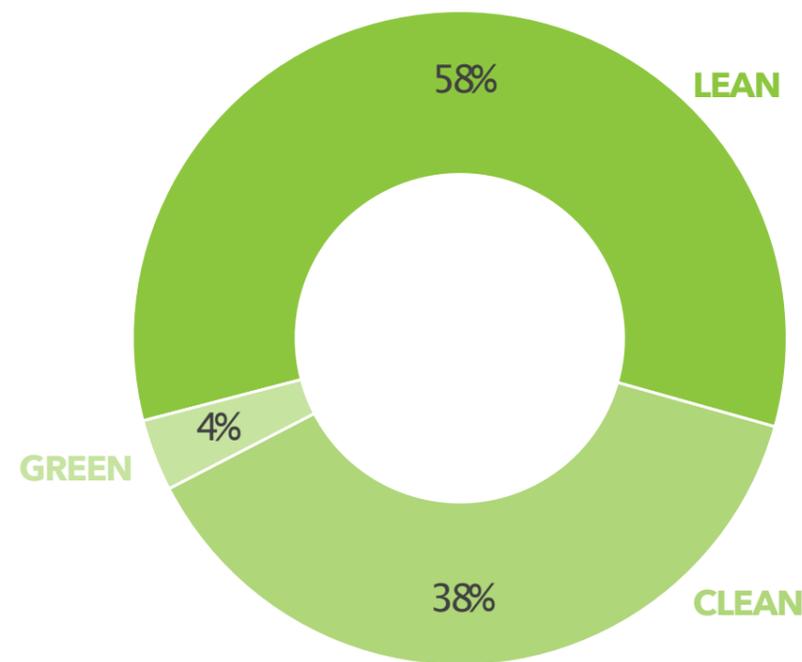
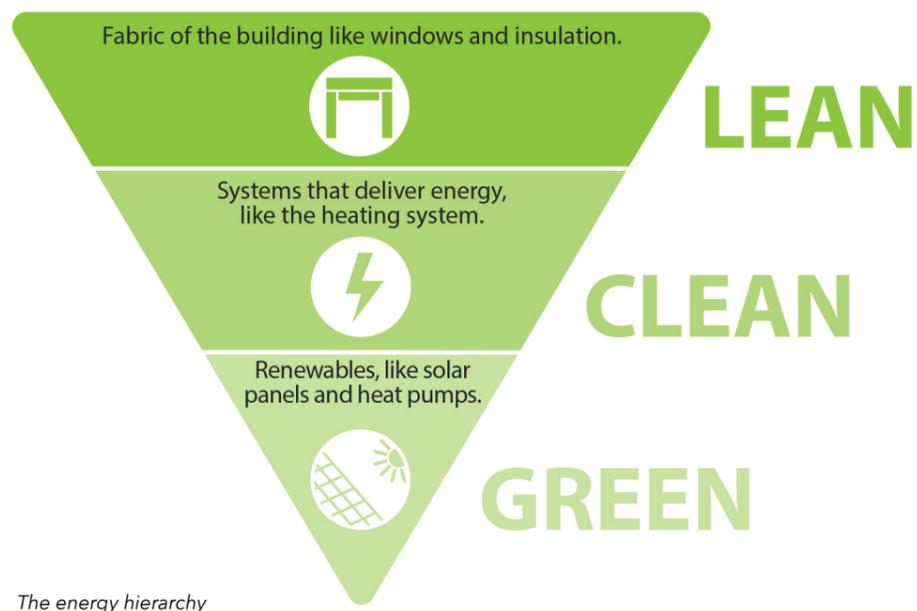
### Net Zero Carbon

Ideally, all buildings would be 'zero carbon', causing no carbon emissions in the course of an average year. The aim of Sustainable Buildings is to help building owners map the journey to zero carbon.

Most will still cause some carbon emissions, but might balance that, for example by generating surplus energy from renewable sources. They'll be 'net zero'.

For many existing buildings, achieving net zero on site will be very difficult. In that case, 'net zero' can only be achieved by 'offsetting' carbon use through schemes that (for example) generate green electricity or plant trees elsewhere.

# 2 Key Principles



The typical proportion of energy savings resulting from 'Lean', 'Clean' and 'Green' measures. 'Lean' measures have much the highest impact.

## 1 Lean - Clean - Green

To make arts and cultural buildings more sustainable, follow the 'energy hierarchy' illustrated above.

1) First, make your building **'Lean'** by improving its building fabric so it leaks less energy. That means insulating roofs and walls and improving windows and doors.

2) Second, make it **'Clean'** by replacing inefficient services systems, so as to minimise the energy they use and deliver the energy demand in the most efficient way possible.

3) Thirdly, go **'Green'**, switching that energy to renewable sources by generating energy on site wherever possible, with photovoltaic cells, heat pumps etc.

Typically, the greatest carbon impact is achieved at the beginning of the energy hierarchy. Lean energy savings account for 58% on average (66 kWh/m<sup>2</sup>/annum), Clean for 38% (43 kWh/m<sup>2</sup>/annum), and Green for 4% (5 kWh/m<sup>2</sup>/annum).

For an arts building of say 3,300m<sup>2</sup>, these savings could amount to approximately 80 tonnes of CO<sub>2</sub> – and save £50,000 per annum (at energy prices at the time of writing).

At the heart of Sustainable Buildings is an online 'Home Survey Tool', which will generate a Sustainability Plan for your building. It will automatically prioritise green measures according to the energy hierarchy.

## 2 Small Steps

There is no silver bullet for sustainability. No one intervention, from roof insulation to installing a wind turbine, will make an arts building 'green' overnight.

Achieving a sustainable building is a matter of aggregating marginal gains. Bit by bit, each improvement will take the building further down the road towards net zero carbon.

## 3 Sustainable Operation

Your building won't become green overnight. But even if significant building changes can't be achieved straightaway, it's still essential to operate as sustainably as possible with what you've got. Make sure everyone is trained and empowered to understand your systems, and operate them as efficiently as possible.

### Training and Learning

The shift towards sustainable working needs everyone to understand the principles on which green guidance is based.

More widespread Climate and Carbon Literacy training can help the whole arts sector move forwards. Meanwhile, active networks can help share the building owners' experiences and lessons learnt in working sustainably.

Go to the Toolkit for information on training.

## 4 Go Electric

Gradually, the UK has been shifting towards generating its electricity from renewable sources like offshore wind farms. That process is still continuing. It means that one of the main things a cultural building can do to become more sustainable, is to switch as much of its energy use as possible from fossil fuels (like oil and gas) to electricity.

By choosing your electricity supplier carefully, you can make sure the Grid uses renewable energy first. There's guidance in the Toolkit.

By including renewable generation in your Sustainability Plan, you can generate electricity in your building – and sell it back to the Grid.

### What do We Mean by Green?

The Green Book uses 'sustainability' and 'greener practices' as catch-alls to cover decarbonising buildings, reducing waste and eliminating environmentally harmful practices. That keeps it simple and readable.

For a more precise explanation of green terminology, the Future Materials Bank keeps an excellent lexicon of terms at [www.futurematerialsbank.com/lexicon](http://www.futurematerialsbank.com/lexicon).

# 3 Building Types



Historic



Mid-century



Recent

	Historic	Mid-century	Recent
<b>Description</b>	Likely to be Victorian or Edwardian. Likely to be listed under Historic England's register.	Built in the post-war boom of the 1960's and 1970's, as modernism first arrived.	Built during or after the 1990's.
<b>Likely Fabric</b>	Likely to have limited/no insulation, single glazing, draughty. Limited glazing. Limited scope for improvement given the visual aesthetic.	Limited insulation. Large amounts of single glazing.	Modest levels of insulation. Double glazed.
<b>Likely Systems</b>	Extensive "layering" of systems and patchwork fixes. No documentation.	A degree of layering and patchwork.	Relatively modern but coming to end of life. Likely to have some documentation.
<b>Likely potential for improvement</b>	Medium given the likely systems conditions and historic constraints.	High given the fabric potential and state of systems.	Medium given the recent standards of design.
<b>Most likely green interventions</b>	<ul style="list-style-type: none"> <li>• Glazing improvements</li> <li>• Roof insulation</li> <li>• Systems upgrades</li> </ul>	<ul style="list-style-type: none"> <li>• Facade upgrades</li> <li>• Lighting improvements</li> <li>• Renewable energy opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Lighting improvements</li> <li>• Ventilation enhancements</li> <li>• Renewable energy opportunities</li> </ul>

## 1 Different Times, Different Buildings

Cultural buildings may be very different. Some of those differences come with different art-forms and cultural sectors - they're covered in Section 8. But one of the main considerations in tackling sustainability depends on when a building was built - and how.

### Historic Buildings

Any building up until the early- to mid-twentieth century is likely to be built with solid brick or stone walls, and timber floors. Roofs are usually pitched and slated, often containing uninsulated lofts. This category includes many grand public buildings: theatres, galleries, museums, libraries and concert halls (as well as former pubs or schools which have been converted to cultural use). Ornate facades surround entrances, although elevations elsewhere are plain brick. Internally, public spaces are often decorated with elaborate mouldings.

Windows are often large, leaky, and single-glazed. Most spaces will be naturally ventilated, unless air-conditioning has been added later. Often, mechanical and electrical services will have been added piecemeal. Typically, they occupy inadequate plant spaces and voids, and will have been much altered (often with redundant services left in place), with limited records of how they work. Heating is often through radiators driven by an ageing oil or gas boiler. Mechanical ventilation and air conditioning may have been fitted later onto plant spaces on the roofs.

### Mid-Century Buildings

Numerous arts centres and other cultural facilities were built in the post-war boom of the 1960s and 1970s, as modernism first arrived.

Typically, these are much simpler buildings with plain walls and often flat roofs. Many are built of concrete. Like historic buildings, they are often uninsulated, or barely insulated. Foyers may have large areas of single glazing.

Services systems will typically be a combination of original systems at the very end of their lives, with a patchwork of subsequent upgrades and replacements. Air-conditioning may have been upgraded, with new plant on the roof.

### More Recent Buildings

The National Lottery initiated a boom in cultural infrastructure beginning in the early 1990s. These newer buildings, particularly those built in the last fifteen years, will have been designed and built to more modern standards, including much higher standards for insulation. Services systems will be newer. Some may have been built as exemplars of sustainability.

Many recent buildings, however, are less sustainable than you'd expect. Standards have moved on: many would not meet today's guidelines. And new buildings often fail to perform as well as their designers intended. They still need action to make them sustainable.

Some need substantial work. The earliest of these buildings now need to replace services systems, creating opportunities to improve sustainability. For others the challenge is to make their systems work as efficiently as the designers intended.

## 2 Using the Green Book

Most arts buildings will fall into one of the above age categories, even if they have subsequently been altered or extended.

Many, perhaps most, will have carried out upgrades of some kind - whether by insulating roofs, or replacing old boilers - often as part of a capital project. Sustainability Plans generated through the Home Survey Tool (see below) will take account of what's already been done in identifying next steps.

Although buildings are different in many ways, the principles of sustainability are the same: to reduce energy consumption and carbon emissions through more efficient building fabric ('Be Lean'), better services systems ('Be Clean') and - where possible - renewable energy sources ('Be Green'), while reducing water use and maximising biodiversity.

The following sections will look at each of these challenges in turn.

# 4 Be Lean : Building Fabric

## 1 Introduction

Design professionals talk about the 'building envelope', meaning everything - roof, walls, windows and doors - that separates the inside of a building from the rain, cold, heat and snow outside. In older buildings that 'envelope' does little to keep energy in. Roofs are often uninsulated (or poorly insulated), made of bare slate on rafters, or asphalt on concrete. Walls might be single thicknesses of brickwork. Windows are single-glazed. Energy pumped into the building to heat or cool it is quickly lost as heat bleeds out into the atmosphere.

The most important task in making any building more sustainable is to improve its 'envelope', so as to minimise how much energy is wasted. This section describes the main ways buildings can leak less energy. More detailed and bespoke suggestions for your building can be obtained from the Home Survey Tool (see below).

## 2 Insulation

Insulation keeps heat in in winter, and keeps rooms cool in summer. Ideally, it is fitted on the outside of a building, protected only by a final layer of render or roof membrane. This often isn't possible for existing buildings, since it changes the building's appearance (flat roofs are an exception), so it can be fitted as a lining on the inside face of roofs and walls. Or, if the wall is made of two 'skins' of brickwork, the cavity between them can be filled with insulation.

### Roofs

Flat roofs can usually be insulated on the outside when you replace roof coverings. It's sometimes possible to insulate pitched roofs on the outside (immediately under the slates or tiles), but only if you're carrying out a major re-roofing - and even then it can be challenging to modify eaves, ridges and gutters to accommodate the extra thickness. More often, pitched roofs will be insulated internally, by fixing insulation to the underside of rafters and covering it with plasterboard or timber linings. Where pitched roofs cover lofts, it's easiest of all to fit loft insulation directly to the loft floor.

There are some challenges to watch out for. You'll need to check that old roof structures can take the weight of extra insulation. And in historic buildings, decorative ceilings mustn't be sealed with loft insulation if you need to inspect fibrous plaster mouldings below.

### Walls

It may be possible to insulate walls from the outside, with systems that apply insulation to the wall and finish it with a coat of render. That's a major operation, though, and isn't possible if the facade has historic mouldings and cornices. This approach may be appropriate on back walls, or on plainer, modern buildings. Even then, windows, doors and eaves will need modifying to suit the extra thickness.

Unfortunately, internal cornices, dados and skirtings in historic buildings can make it challenging to line walls internally. Mouldings will need to be removed and replaced once the walls have been thickened by a layer of insulation and plaster. That can be awkward to achieve. It will disturb historic fabric. It will certainly be expensive.

With plainer walls - either in more modern buildings, or in non-public areas - internal wall lining is much more realistic, and can be achieved by linings of insulation bonded to plasterboard. Even so, windows and doors will need to be changed, and skirtings replaced. With corridors, you will need to check the insulation doesn't reduce the width of escape routes or limit access for wheelchairs.

## 3 Windows and Doors

Windows and doors are weak points in the building envelope. They are often thin and uninsulated. Many have gaps in the junction between window / door and wall.

### Where does your building leak?

A local engineer may be able to provide thermographic images of your façade. By highlighting warm areas in red and cold spots in blue, they can identify where heat is leaking out. That can help target priorities for sustainability works.

Windows are typically the key area for focus, followed by walls, then doors.

*Go to the Toolkit for more information.*

### Windows

Draughty, single-glazed windows can be replaced with modern windows that are double or triple-glazed. That's expensive and disruptive, but will improve comfort as well as reducing energy loss.

For historic windows, where double-glazed replacement isn't possible, an alternative is secondary glazing, where an inner window (usually with a thin aluminium frame) is added.

Large areas of glazing in the foyers of more modern buildings present a particular challenge, which can usually only be tackled by full replacement in a major building project.

## Doors

Doors are also a weak spot. Main entrance doors constantly open as the public comes in, allowing heat to leak out and causing energy loss and thermal discomfort internally.

Draught lobbies are much the best way to prevent heat loss. Revolving doors are next best, although they won't be appropriate everywhere, and alternative options will be needed for wheelchair-users.

'Air curtains' blast room temperature air down over the door to try and minimise incoming draughts or small gusts of wind. They need careful design to work efficiently. As a cheap and cheerful solution, a wintertime draught lobby can be created simply by hanging a heavy curtain inside the door, French café-style.

Loading doors can be a particular problem, since they are often open for extended periods. Where possible, design inner doors so that the loading bay acts as an airlock, preventing heat loss from the rest of the building. You'll also need operational systems to make sure heating is switched off in adjacent areas, and doors are closed before it comes on again.

## 4 Some Challenges

### Airtightness

Old buildings tend to be leaky. That means they have constant natural ventilation through ill-fitting windows and draughty doors. It wastes energy but does mean - for all the wrong reasons - a source of plentiful fresh air to replenish oxygen and prevent mould and condensation.

To reduce energy loss you have to make a building airtight. But that can create a problem: insufficient ventilation. You don't need to worry in areas with mechanical ventilation. Elsewhere you'll need to allow for controlled ventilation through 'trickle vents' (openable ventilation slots in new windows) or by 'hit- and miss' vents in walls. Seek professional advice if need be.

### Condensation

To prevent energy loss you need a building envelope that separates inside from outside to keep energy in. But in that case there's a risk that the warm, moist air inside the building will condense into water when it meets a cold surface. If that happens within the building fabric, it can cause rot and decay over time. Building professionals refer to this as 'interstitial condensation', and the point at which moisture in the air condenses into water as the 'dew point'.

To avoid problems, make sure you get professional help in designing new insulation and linings. Architects and surveyors can help; so can many contractors. A combination of good ventilation and 'vapour control layers' (to prevent moisture reaching the cold surfaces) can prevent insulation from causing problems.

In historic buildings it's important to use 'breathable' materials to prevent condensation within the structure (in the same way that 'breathable' waterproof clothes stop you sweating). Seek professional advice to make sure the works are appropriately designed.

### Cold Bridging

A third challenge is 'cold bridging'. Effective insulation needs a continuous layer of insulating material. Fixings and brackets which pierce it, or structural beams which run through it, act as 'cold bridges' to allow energy out and cold in.

Careful detailing is needed to eliminate or minimise cold bridging and make sure insulation works as effectively as possible.

## 5 Hazardous Materials

All works to older buildings may involve you in dealing with asbestos and other hazardous materials. Some asbestos was still being incorporated in UK buildings as late as 2001.

Guidance can be found from the Health and Safety Executive (HSE) <https://www.hse.gov.uk/asbestos/>

# 5 Be Clean : Building Services

## 1 Introduction

The energy consumption of arts buildings will fall into one of the following categories: heating and cooling systems, general plug-loads, operational loads (for example, stage lighting), lighting, ventilation, hot water, server rooms, and lifts.

Knowing there is a finite number of categories makes it easier to spot where energy's used and decide how best to target sustainability improvements.

## 2 Knowing Where You Are

Some organisations can afford professional facilities teams with a high degree of expertise, and good records of services systems, maintenance, and replacement.

Others necessarily work with tighter budgets, and may know far less about their building's systems, how old they are and how they work.

If there are gaps in knowledge, you may be able to fill them by talking with the companies that inspect and maintain your systems. You may be able to commission condition surveys from them, or ask them to provide a basic explanation. Utilities bills can tell you how much carbon you're using. If you sub-meter different areas, you'll learn more about how your carbon use is distributed.

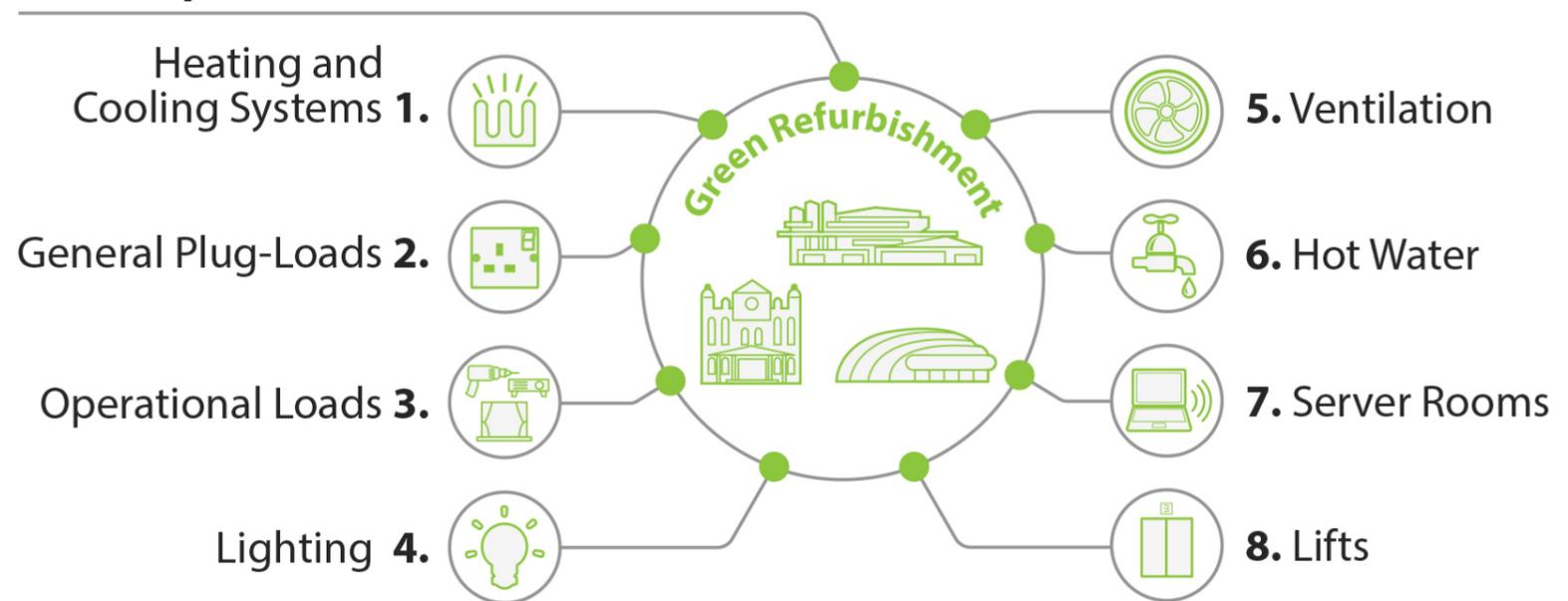
Section 9 gives more detail on gathering information.

## 2 Heating and cooling systems

Heating systems distribute heat from boilers, either through radiators filled with hot water, or by blowing warm air around the building. Most large spaces (like auditoriums) have air systems, while offices and smaller spaces often use radiators.

Heating and cooling are most efficient if they're targeted at people, not empty space. In large rooms like auditoriums, it's best to bring hot or cold air in at low level, where the people are (usually under seats).

## Consumption End-Uses



Systems are more sustainable when they can work at lower temperatures. Lower temperature systems waste less energy in distribution, and make it easier to work with sustainable heat sources. That means a shift to underfloor heating, larger radiators and fan-coil units in the ceiling (which draw in air from the room, heat or cool it, and blow it out again).

Some of those changes require disruptive building works. An easier way for cultural buildings to reduce the energy used for heating and cooling is to accept a wider band of temperatures: less cooling in summer and less heating in winter.

Visitors may become more tolerant of occasional hotter or cooler days, as we all accept the realities of the climate emergency.

## Heating

Boilers, fired either by oil or gas, are the usual heat source for both heating and hot water systems in arts buildings.

Old boilers should be replaced. However, modern 'condensing' boilers are more efficient and use less fuel. It isn't worth changing them until they reach the end of their lives.

Once it's time to replace them, the most common green alternative is a heat pump (see section 6), though biomass boilers may work in rural areas. A switch to heat pumps does have knock-on consequences, though (it might mean changing radiators and pipework, and certainly requires better insulation), so they won't be right for all buildings.

Sometimes, the only option is like-for-like replacement with a fossil fuel boiler. In that case, find a highly efficient model with a long warranty and good service and maintenance support.

For some, an alternative heating source might be via a local district heat network. Heat is provided from a centralised energy centre to a small community network. This is typically a more carbon-efficient way of delivering heat, but you'd need to check with your local authority to see if there's one close to your building.

### Cooling

Mechanical cooling, commonly referred to as 'air conditioning', is often provided in large spaces like auditoriums, galleries, reading rooms and foyers to keep temperatures down in the summer.

The first step towards sustainability is to reduce the need for mechanical cooling by improving insulation and shading windows. Air conditioning should be a last resort. When it really is needed, temperature sensors, timers and occupancy detection should be installed to minimise how often it's on.

To avoid air-conditioning, much can be achieved with natural cooling methods. Many organisations circulate cool night-time air in auditoriums or concert halls to bring temperatures down before a show.

### 3 Hot Water systems

Hot water systems are typically fed from a main boiler, but can also have their own local 'point of use' electric source (i.e. a water heater adjacent to the tap). That's usually a more sustainable option. 'Point of use' heaters remove peak demand from the main boiler, reduce reliance on fossil fuels, and all but eliminate the energy wasted as hot water is pumped around the building. They can be installed either during maintenance, or as part of larger refurbishment projects.

They may not be right for larger buildings which need more hot water, and might not have electrical capacity for multiple electric heaters. If you have to stick with a centralised hot water system, an easy win is to make sure all distribution pipes are lagged.

### 4 Ventilation

Mechanical ventilation is needed to give people enough air to breathe in windowless rooms. It's needed in most large spaces like auditoriums and galleries, and the law requires it in toilets and kitchens to remove smells. In newer buildings it's likely that most spaces, including foyers and offices, will be mechanically ventilated.

Mechanical ventilation typically needs two components: fresh air is pumped into the space, and exhaust air is pumped out of it. CO<sub>2</sub> sensors can be installed to ensure a minimal amount of fresh air is provided for current occupancy levels. To help reduce the spread of viruses like Covid-19, CO<sub>2</sub> levels shouldn't exceed 800 ppm (particles per million).

When outside air temperatures drop at night, mechanical ventilation can provide sustainable cooling by drawing chilly air into an overheated building to cool it down.

However, mechanical ventilation is often used as part of the heating and air conditioning systems, by heating or chilling the air before it's pumped into each room. In older buildings, the 'exhaust' air is simply thrown away, losing all the energy that's been used to heat or cool it. To avoid that energy loss, heat should be 'reclaimed' from the exhaust air and reused to warm up the fresh input air - as it is in newer systems.

### 5 Lighting

Lighting is often a high proportion of a cultural building's energy consumption. A move to LED lighting throughout is a relatively simple switch.

Improving lighting controls is just as important. Sensors for movement and daylight levels deliver significant energy savings, particularly in little-used areas.

### 6 General 'plug loads'

Anything that gets plugged in draws energy and contributes to the building's carbon footprint. That means computers, white goods, fridges, fan blowers and heaters, communication devices (radios and mobile phones), workshop tools, vending machines - and much else.

Replacing old white goods (for example) can contribute significant savings - but is only worth doing if they're reaching the end of their lives. Choose replacements to be as efficient as possible.

### 7 Controls

No matter how efficient your equipment, it will waste energy if it's on unnecessarily - for example, if lighting burns all night or radiators heat empty rooms. Good controls ensure things operate only when needed and to the degree required.

Installing good controls for heating, cooling and lighting is essential to sustainability, and can generate significant savings without much cost or disruption. If that's impossible, staff procedures should make sure systems are turned off at night and switched on only when needed.

For larger buildings, the most effective way to control services systems sustainably is through a Building Management System.

See the Toolkit for more on upgrading controls.

### Building Management Systems

Building Management Systems use computer software to control services across the building. A sophisticated 'BMS' will automatically control lighting, heating, cooling and ventilation, using sensors to manage output, and gathering data to ensure efficiency.

BMSs come in many shapes and sizes, depending on the complexity of the building and the number of systems that need controlling. A good system should be simple to use, with well documented user guides so that knowledge isn't lost when staff leave. Well-designed, and operated by well-trained managers, a good BMS can make sure the building runs as efficiently as it can.

By their nature, however, BMSs can be complicated, and require technical knowledge to run them efficiently. Training staff and simplifying controls can be an early step towards running your building sustainably. See the Toolkit for more information on Building Management Systems and how to make the most of them.

# 6 Be Green : Renewables

## 1 Introduction

Cultural buildings can generate their own electricity on site from renewable sources. Generating renewable electricity reduces the need to pull energy from the fossil fuel sources that still power much of the National Grid. At slack times, the buildings can put spare power back into the grid.

Solar Photovoltaics (PVs) create electricity from daylight. Turbines generate it from wind.

Rather than generate electricity, Heat Pumps take heat or coolth directly from the outside air or ground, and transfer it to the building's heating and cooling systems. The pumps themselves consume electricity, but are overall far more efficient than conventional heating or cooling systems.

This section describes all the ways buildings can turn to sources of renewable energy. The Home Survey Tool (see below) will make more specific suggestions for your building.

## 2 Solar PV Panels

Solar photovoltaic ('PV') panels are usually installed on roofs, and generate electricity which can both power systems within the buildings, and, at slack times, be fed back into the National Grid. PVs are installed in arrays either on pitched roofs, or on flat roofs, with frames to angle them towards the sun. They don't need direct sunlight, but operate most efficiently when facing as close to south as possible at an angle of about 30 to 40 degrees.

PVs are the most common and viable form of renewable energy. With energy costs rising, they may pay back their installation costs relatively quickly. However, they do need maintenance, and can only be installed in locations where you can reach them for servicing.

Like anything installed on a roof, they will make it hard to maintain or replace the roof afterwards, so make sure the roof is repaired or replaced before installing them (and that it's strong enough to carry their weight).

## 3 Solar Thermal Panels

Solar thermal panels use the sun's heat directly to heat up water either for showers and taps, or to pre-heat water for radiators.

They come in a couple of varieties: tubular or flat plated, with the latter looking similar to Solar PV panels. In most cases they work less well for cultural buildings than PVs - particularly if the building is quite small, and doesn't have a constant need for hot water.

## 4 Wind Turbines

Wind turbines use the wind's power to generate electricity. They're mostly viable at large scale in open areas - so only rarely apply to cultural buildings, though there are some high-profile exceptions in rural sites.

## 5 Heat Pumps

Heat pumps come in a few different guises: water-source, air-source or ground-source, depending on where they draw energy from. Air-source heat pumps are the most common option for refurbishing cultural buildings. But every building is different so it's important to get good advice and review all options.

Unfortunately, changing a gas boiler for a heat-pump isn't a straightforward like-for-like replacement, so professional advice is needed.

## Air-Source Heat Pumps

These are usually standalone, external units with fans that extract heat from the air and use it to warm up water that's pumped into the building. They are now quite commonly specified for new buildings, including cultural buildings. But they work best at low flow temperatures, so they need the building fabric to be well-insulated and sealed.

Air-source heat pumps are a great alternative to fossil fuels, but may require significant alterations to make them viable. Not only will building insulation need to be upgraded. Existing pipework and radiators may be too small for the low temperatures heat pumps work at. 'ASHPs' work best with underfloor heating.

## Ground-Source Heat Pumps

Instead of extracting heat from the air, Ground-Source Heat Pumps extract it from the ground, via underground arrays of pipework. The heat pump itself is typically a fridge-size unit that sits within the building.

Pipework extends outside the building, either snaking around a large area of ground, not far below the surface, or diving vertically into the ground as part of a building's structural piles.

'GSHPs' are more efficient than Air Source Heat Pumps. They are common in new buildings but less so in existing cultural buildings. Their installation depends on having a lot of outside space available, and suitable local geology.

### Water-Source Heat Pumps

Water-Source Heat Pumps require a local source of water to provide the heat. This might be a nearby river or canal, or an aquifer below ground. Liaison with the Environment Agency is required to ensure environmental harm is prevented or mitigated. These are the least common version of heat pump.

### 6 Biomass boilers

Biomass boilers are similar in size to gas or oil-fired boilers, and are considered to be renewable if the timber they burn (often in pellets) comes from a sustainable source.

However, they need a lot of fuel storage, with large vehicle access for deliveries, and can cause air quality issues in built-up urban areas, from particulate matter in the fumes.

They're almost never found in towns, and not often in cultural buildings.

#### Payback

Renewable energy sources save you buying energy from the National Grid. That means that over time, the savings you'll make from PVs (for example) will pay back the cost of installing them in the first place.

Grants can significantly help reduce payback periods. The Energy Saving Trust provides a source of information on the latest available grants. And rising energy costs of course make payback periods more tempting.

### 7 Storing energy

Energy demand isn't constant, particularly for performance buildings, which need a lot of power before and during shows, as well as hot water for changing rooms at specific times of the day. By contrast, most renewable energy systems generate energy continually (or during daylight in the case of solar panels). Storage systems can capture that energy for use during peak hours.

Storage systems typically take the form of batteries for electricity, or water tanks to store heat. They aren't commonly used. Unless you have a very large array of PVs, you're more likely to use the electricity yourself (or send it back to the grid). And batteries raise issues such as fire compartmentation, which need professional advice.

However, changing technology may make batteries more viable in future.

### 8 Challenges for renewables

Renewables are a high-profile way of demonstrating commitment to sustainability, and will likely be needed to reach zero carbon. In terms of actual impact, though, they come behind measures to make the building itself more efficient ('Be Lean'), and measures to improve services ('Be Clean').

Indeed, renewable energy will only have its full impact if it's operating on a building that's been upgraded to conserve heat efficiently.

When the time comes to move on to renewables, there will be a number of hurdles to face. These include:

- Planning and listed building permissions for solar panels, external plant and other changes.
- Finding plant space either internally or on roofs.
- Upgrading roofs before you place PVs or other plant on them.
- Upgrading services systems to suit the new energy source.

# 7 Biodiversity and Water

## 1 Introduction

The climate crisis is not only about carbon, but about biodiversity and scarce resources. Sustainable buildings have an important part to play in supporting biodiversity and ensuring efficient water use.

Supporting biodiversity through planting and outside space can also create more humane places to work and visit, raising staff wellbeing and creating better surroundings for everyone.

## 2 Biodiversity

Greening buildings and their surroundings, and installing features such as nest and bat boxes can help make space for wildlife. Planted landscapes designed with wildlife in mind, green roofs and living walls are all ways in which a theatre can provide new wildlife habitats.

The first step is to assess your area's ecology. Are there existing habitats for biodiversity or species present which need to be protected? What are the species most likely to colonise new planting and can your site help to link up other places for wildlife? Professional advice from an ecologist may be needed to answer some of these questions.

A sustainability plan should include holistic measures to deliver a positive impact on biodiversity for all of the buildings and land under its control. That may include removing invasive species such as Japanese knotweed.

If you're planning a capital project, be aware that national planning policy and many Local Authority planning departments will in any case require increased greening and net gains for biodiversity.

## Green Roofs

Green roofs can help to reduce localised flooding (by absorbing water) and provide wildlife habitats. They connect internal and external spaces through roof terraces and planting. They provide a calming setting for both staff and public areas.

There are many different types of green roofs, from rooftop gardens, sometimes with ponds, through roofs that mimic wildflower meadows, to brownfield habitats that require no irrigation and are typically designed for wildlife. New roofs should be designed following the GRO Green Roof Code to ensure they are successful. It is important to select plants that will support wildlife, require little irrigation, and survive the dryer, warmer climate that global warming is already producing.

Good water management means balancing irrigation needs and water demand as efficiently as possible.

Note that green roofs can be fitted beneath solar panels. But also beware the extra weight of green roofs: structural engineer's advice may well be needed. And think twice before you locate a green roof above a sensitive area such as an archive.

If you are interested in green walls or roofs, check with a specialist about fire risk: dried-out plants and plastics drainage membranes are both combustible.

### Sedum Roofs

These are living roofs, where vegetation is used as the top layer of the roof build-up. A sedum roof should be self-sufficient and will develop over time. These types of roofs absorb carbon dioxide, and attenuate rain fall and rainwater build-up. However, they increase a building's biodiversity less well than some planted roofs. All options should be explored in deciding how to proceed.

*See the Toolkit for more information.*

## Light Pollution

Light spill from your building can have a devastating impact on wildlife such as bats. Limiting the light levels of external signs and architectural lighting saves energy as well as protecting wildlife. Make sure any lighting is directed towards the item being lit. Warm colours are best. Install timers to switch lighting and signs off late evening, rather than leaving them on all night.

## 2 Water

Water is a valuable resource. Sustainable water use in cultural buildings and their surroundings focuses on reducing, recycling and reusing.

Water systems such as toilets and showers can minimise wastage. Not all water needs to be potable (drinking water). Rain and stormwater, treated on site without chemicals, works just as well for irrigating plants or green roofs, and serving water features.

### Reducing water use

Non-potable water is defined as water that does not meet drinking water standards for human consumption, but is suitable for other low risk uses, such as toilet flushing, irrigation or laundry.

Potable water is fit for human consumption and meets drinking water standards.

Cutting down the use of drinking water can be achieved by:

- Low-flow and waterless fixtures, such as waterless urinals.
- Leak prevention systems that flag unexpected water use.
- Reducing water demand for irrigation by careful selection of plants along with intelligent sub-soil irrigation systems that draw on harvested and treated rainwater.
- Using non-potable water for irrigation or toilet flushing.

### Greywater

Greywater is discharged from fixtures such as sinks, showers, laundry, or drinking fountains (it doesn't include water discharged from toilets and urinals). It can be reused for purposes like flushing toilets.

However, the retrofit to include a greywater system can be costly and disruptive. Two systems of pipework are needed, as well as storage tanks and filtration. The first step is a feasibility study to check how much greywater you might save, how much you could use, and whether you have space for greywater storage. For many buildings it won't be viable.

### Rainwater

Rainwater harvesting means collecting run-off from roofs and terraces to store for future use. Filtered rainwater can be used for toilet flushing, laundry, and cooling systems, or for irrigation of planting.

Rainwater harvesting can be applied to many buildings, although it does require a storage tank (which will be heavy) and associated filtration.

### 3 Other opportunities

It's worth thinking laterally about how an arts building can improve biodiversity and use water efficiently.

- Landscape, terraces and green roofs can create 'green corridors', linking between buildings and sites.
- Partnership with neighbours and local communities can connect sites and align strategies.
- Car parks offer opportunities for planting, rainwater capture, and below-ground storage and treatment.
- Sustainable Drainage Schemes (SUDs), which manage rainwater in the ground through planted areas and run-offs, can create habitats to support biodiversity.

# 8 Arts Building Types

## Museums and Galleries



### Introduction

Different cultural buildings will, of course, face different challenges. The principles might be the same, but there's a big difference between upgrading a historic county library for sustainability, and upgrading a fashion workshop in a rented warehouse.

This section looks at each of the following cultural sectors in turn. It highlights specific challenges and solutions for each, **in addition to** the general guidance contained in the rest of Sustainable Buildings.

Click on any of the links below to reach your sector.

- Museums and Galleries
- Libraries and Archives
- Studios and workspace
- Dance buildings
- Classical Music buildings
- Rock and Pop buildings
- Cinemas
- Multi-artform buildings

See the Theatre Green Book : Sustainable Buildings ([www.theatregreenbook.com](http://www.theatregreenbook.com)) for advice targeted specifically at theatres and similar performance buildings.

Museums and galleries vary widely in age and scale, ranging from national collections in historic monuments to community facilities and open-air attractions. They display renaissance paintings, space rockets, military hardware, dinosaur fossils, contemporary art, textiles, priceless manuscripts – and much else besides. Sometimes the building itself is what's on display. A good many museums and galleries are in historic buildings, limiting options for radical change (see Section 13).

Public display often involves large, open-plan spaces which require heating, cooling and (often) humidity and daylight control. Storage and archiving require careful control of temperature and humidity. Meanwhile, most museums and galleries will also include office space (often in separate buildings). Some will operate specialist departments for conservation and collection care. Alongside the buildings they own, many will rent ancillary space, often on short leases that make major building changes impossible.

As a result, larger museums and galleries often run complex estates of buildings of different ages in different conditions; and careful planning is needed to work out the best use of limited resources.

In terms of ownership and responsibility for buildings, the sector is very varied, but a significant number is connected with its Local Authority. Some museums and galleries have benefited from funding through the Public Sector Decarbonisation Scheme, and the Museums and Estates Development Fund.

Sector lead bodies such as the National Museum Directors' Council, the Museums Association, the Association of Independent Museums, the Archives and Records Association, and the Arts Councils actively promote sustainability within the sector, alongside focused initiatives like the Gallery Climate Coalition (<https://galleryclimatecoalition.org>). The Arts Green Book : Sustainable Buildings aims to support their work with a specific focus on the challenge of making Museum and Gallery buildings more sustainable.

### Specific Challenges

- Climate parameters for humidity and temperature, often dictated by lender requirements or insurance (and sometimes varying between different parts of a gallery). In many older buildings, energy is used to maintain a climate which neither the building nor the objects on display were designed for. Unfortunately, rising global temperatures will create further pressure on gallery and museum conditions.
- Very large (often open-plan) gallery spaces, with variable occupancy.
- A large storage need, often in buildings which were not purpose-built, therefore requiring high energy input to maintain stable temperatures and humidity levels.
- Complex and challenging estates. As well as including historic buildings, many larger museums and galleries pursue a fairly continuous programme of building works and upgrades, which bring their own challenges for sustainability.
- Ancillary spaces operated on short leases make investment difficult.

### Climate Parameters

- Check what's guiding your decision-making about climate parameters. You may be able to reduce temperatures for some objects. Most old objects existed in a broader band of internal temperatures than we now try to maintain – but equally, more careful stewardship may well have extended their lives. The primary aim should be to avoid sharp temperature changes and dew points (when temperature change causes moisture in the air to condense as water).
- There is already momentum within the sector to review the environmental requirements for collections. The NMDC has adopted the Bizot Green Protocol: <https://www.nationalmuseums.org.uk/what-we-do/contributing-sector/environmental-conditions/>. Arts Council England has committed to reviewing the environmental condition parameters for the Government Indemnity Scheme. The key is to achieve appropriate conditions for each specific material in view of its heritage value, and the risk to it.



- Gather accurate humidity and temperature data around your building (if you have no facilities team, a local building services engineer may be able to help with this, and data can be gathered through portable plug-in equipment). Plan the location of environmentally-controlled areas so that natural conditions need as little modification as possible.

- Plan services controls and airtight compartments - for storage and (where possible) for displays - to make sure you only maintain the controlled environment each group of objects needs. That way you avoid expending energy in creating controlled environments for objects which don't need it.

- Humidity control may be more critical for exhibits than temperature, but requires a lot of energy. If possible, store and display objects with onerous humidity requirements in separate, airtight spaces. Make sure you can separately control and measure the environment on both sides of the partition.

## Gallery Space

- Review 'set-points' for temperature (i.e. the temperatures that trigger heating or cooling to switch on). When people are moving around a gallery (rather than being seated in an auditorium, for example), they can generally cope with lower temperatures. They may still have coats on (or with them) on a winter's day. One gallery tested this by turning the heat right down and asking visitors about their day. No one complained about being cold. CIBSE Environmental Design Guide recommends a winter set-point as low as 13°C for circulation spaces and foyers in places of public assembly, and 19°C for museums.

- If the collection doesn't have specific environmental need, target heat (or coolth) at people, not spaces. In large spaces, focus heat at low level and on visitor paths. For example, underfloor heating can keep people comfortable without wasting energy on empty air.

- Don't run ventilation systems harder than you need. Carbon dioxide (CO2) sensors can optimise the amount of fresh air supplied to larger galleries. Aim to keep the fresh air supply to achieve no more than 800ppm CO2.

- In-flows of air through entrance doors make it hard to maintain internal conditions - which are consequently achieved only through intense input of energy. Set temperatures for lobbies and entrance halls to an interim level, midway between external and internal temperatures, so as to provide greater stability at lower energy cost.

## Storage Need

- Where possible, consolidate storage into fewer buildings.

- Where possible, locate storage in buildings which can naturally support the climate requirements of the objects stored there. Using energy to maintain climate parameters in inappropriate buildings can have a huge carbon impact. In the right building, even onerous requirements can be achieved with little energy. A new-build example is the Imperial War Museum's paper store at Duxford.

- Through much of the post-war period, it was common for museums and galleries to grow collections continually, with limited rationalisation or de-accessioning. This has created a significant storage challenge, which carries a high environmental price. Some museums and galleries may choose to review their policies for acquisition and disposal in light of the financial and environmental costs of storage.

## Managing Estates

- The Home Survey Tool will enable you to audit and provide a basic Sustainability Plan for all the buildings in your estate. It will identify where you need further professional advice, enabling you to target costs appropriately. With Sustainability Plans for all elements of the estate, it will be easier to assess the impact of different projects, and plan an estate-wide programme of refurbishment.

- Some museums and galleries have focused on consolidating estates, reducing the challenge of making multiple buildings sustainable.

- See Section 13 and the Toolkit for working with heritage buildings. The Home Survey Tool will automatically filter out suggestions unlikely to work in historic buildings.

- Improving historic building fabric can be challenging. Often poorly insulated, historic buildings have a high energy need, so it's important to concentrate on efficient services systems, and good controls.

- New construction has a high impact in 'embodied energy' (see Toolkit). In the context of the climate emergency, you may want to think twice before commissioning new building works. Challenges can often be solved by operational change, or by re-purposing existing areas.

- If you're sure new building is justified, make sure it's done as sustainably as possible, with lightweight, sustainable structures that don't require deep foundations. Consider using LETI embodied carbon guidance to set your design teams achievable targets: <https://www.leti.london/cedg>

- See Section 13 for more on capital projects.

- For short-lease spaces, focus on Easy Wins, and on energy reduction. Viable initiatives may include thermostatic radiator valves, movement detectors to replace light switches, sub-meters to control electricity, and timers to switch off boilers. Try to work with landlords to make the case for more major building upgrades.

## Other Opportunities

- Local Authority stakeholders and partners may offer good opportunities for sustainability, for example by giving access to Neighbourhood Heating Schemes.

- Local networks may create opportunities to increase buying power for services like renewable energy (see Toolkit), or for commissioning professional sustainability advice.

- If you lack knowledge about your building, maintenance and servicing contractors may be able to fill in gaps and offer suggestions as sustainability partners.

[Click here to go on to Section 9](#)



Libraries and Archives together cover a very wide range of different buildings, organisations and operations. The result is a broad spectrum of sustainability challenges, ranging from the specialist environments needed for the storage of rare books and other materials, to lack of control over decision-making.

Most public libraries are owned and operated by Local Authorities. There's a wide range of scale and age, however, from grand historic libraries, to small community libraries (and mobile vans). As with most cultural buildings, long-term maintenance issues - and funding - can be very challenging.

Academic libraries form another large category, from the British Library through universities, to school and colleges. Libraries are also operated by many large organisations.

Archives, meanwhile, may include secure and climate-controlled storage for books, papers and other objects; but public archives will also have reading rooms, public facilities, offices, and sometimes conservation studios. Their challenges overlap, therefore, not only with libraries, but with museums and galleries. Archives are often held by organisations of different kinds, including large cultural organisations, and managed within the context of large estates.

Being run by larger institutions creates both opportunities and challenges. Libraries and archives tend to be long-established, with a high degree of continuity. Some have regular condition surveys, and good knowledge of buildings and systems. On the other hand, significant improvements often depend on decision-making within a Local Authority or institutional owner. Library and archive staff and departments may not have control over maintenance.

The stability of public or institutional ownership is not enjoyed by community libraries operated by volunteers, sometimes in buildings with short leases. With a lease of limited duration, it can be hard to justify, or fund, significant works to the building fabric and services. Similar challenges face some smaller-scale archives.

Archive storage, of books and other objects, may require climate control of temperature and humidity. Poorly-insulated and unmodernised premises make this energy-intensive. By contrast, in a

sealed and insulated building with managed ventilation, efficient systems and good controls, low-energy archive storage is achievable.

Large reading rooms, sometimes sparsely occupied, can present challenges for sustainability. For many, equally, public reading rooms are a climate haven, offering warmth in winter and a daytime refuge during heat waves - which are likely to become increasingly common. This has already been seen in the Canadian heat wave of 2021.

Finally, historic buildings, where many libraries and archives are housed, represent a further significant challenge for sustainability.

## Specific Challenges

- Decision-making within public authorities or the larger institutions which operate libraries and archives. Staff and departments may have only partial control of their buildings. For Local Authority departments, meanwhile, there is an associated challenge of allocating scarce resource across complex estates of different buildings.
- Large reading rooms, sometimes sparsely populated.
- Archive and storage, often in energy-hungry buildings.

## Ownership and Estates

- The Green Book helps operators make the case for sustainability improvements to owners and funders within complex chains of governance. If you don't have, and can't afford, sustainability plans, use the free Home Survey Tool to create a basic Sustainability Plan for every building. By identifying easy wins and maintenance projects, and understanding sustainability priorities, you can argue for resources to be targeted for maximum impact.
- Departments running complex estates can develop a strategy for sustainability improvement across the estate. Use data to drive decision-making, for example by establishing a league table of sustainability across estates.

• Estate management creates opportunities for sustainability. For example, heat pumps can be installed in those better-insulated buildings where they're most appropriate, while serviceable boilers from those buildings replace inefficient plant elsewhere. Gather 'before and after' energy-use data from improvement projects to inform decision-making across the estate.

• Use accurate 'payback' data to make the case for sustainability improvements by showing how energy cost savings can quickly pay for capital investment. With rising energy costs, payback can be very quick.

• Operators may find it hard to initiate (or fund) improvements to building fabric (which may also be restricted by heritage issues). The best opportunities for sustainability may be through improving services systems like heating and lighting.

• If you operate on a short lease, with little control over the building, use the Home Survey Tool to identify easy wins you may be able to put in hand, and concentrate on lowering your energy use by reducing heating times and temperatures.

• Some libraries and archives are housed in multi-purpose buildings. See [here](#) for guidance on multi-artform buildings.

## Public Spaces

• Install better controls to reduce how much energy you use heating and cooling reading rooms and public spaces. Well-managed timers and thermostats can dramatically reduce energy. Establish zones to make sure you don't heat unused spaces.

• Switch to LED lighting for an immediate saving in reading rooms (and other spaces) which are artificially lit all day.

• Don't run ventilation systems harder than you need. Carbon dioxide (CO<sub>2</sub>) sensors can optimise the amount of fresh air supplied to suit current occupancy. Aim to keep the fresh air supply to achieve no more than 800ppm CO<sub>2</sub>.



## Storage and Archives

- Plan archive and book storage to provide appropriate environmental conditions for minimum energy. BS EN 16893:2018 covers the location, construction and modification of archive buildings, while BS 4971:2017 defines best practice for collection management. Their guidance will be hard to achieve sustainably in any location that requires high energy input to maintain a stable environment.
- If possible, locate storage in buildings able to achieve requirements sustainably, and environmentally-controlled archive areas in places where natural conditions need as little modification as possible. For example, a controlled store in the middle of the building will use less energy than one in an attic or by an outside wall.
- Try to ensure that the systems you rely on for temperature and humidity control are as energy-efficient as possible. Ensure that you have the sophisticated controls you need to switch those systems off when they're not needed.
- Review environmental requirements for the storage of books (and other materials), relaxing them where possible, and making sure energy is targeted at objects most in need of climate control. Humidity control requires a lot of energy, so store sensitive and rare objects in separate air-tight cases or rooms.

## Other Opportunities

- Public reading rooms may be needed as climate refuges as global conditions worsen. Over time, you may need to upgrade services systems for the changing climate (see Section 14).
- Use Librarians' and Archivists' networks to share best practice, case studies and lessons learnt.
- Libraries and archives have benefited from Public Sector Decarbonisation funding. The Arts Council England Green Libraries project also supports the journey to sustainability.
- Third party maintenance teams may have limited knowledge of sustainable systems (such as heat pumps). Consider future maintenance if you decide to install systems of that sort.
- Conservation studios in archives or libraries generally require high levels of controlled ventilation. Make sure your ventilation system includes heat recovery so that heat energy is recycled and reused efficiently.

[Click here](#) to go on to Section 9



For the arts to move towards sustainability, we need to transform not only the high-profile buildings the public visits, but the working spaces in which the arts are made: design and fashion workshops, artists' studios, and factories for theatre sets, scenery, costumes and so on.

These spaces can range from offices to industrial manufacturing facilities. They may be housed in purpose-built facilities, but just as often occupy industrial sheds, warehouses, former factories or even old garages and supermarkets, many of them dilapidated. Typically, the buildings are not owned by the end-users, and are often occupied on very short leases, making it hard to fund or justify significant investment. 'Meanwhile spaces' are often made available short-term by developers, but without any possibility for significant improvement.

Professional operators of arts, design and fashion workspace, some publicly-funded, are more likely to be able to balance commercial models with sustainability and social priorities. They may themselves be operating within tight lease restrictions, but can co-ordinate strategies for achieving sustainability gains. Some will be stakeholders in developments where the cultural workspace is part of a planning condition. They may be able to influence the developer's sustainability ambition.

For most users and operators of arts, design and fashion workspace, the challenge is to identify where realistic improvement can be identified, and make their workspace as sustainable as they can within those parameters.

## Specific Challenges

- Short leases. Lease restrictions that leave users and operators limited options for sustainability improvement.
- Old and dilapidated buildings, often with inadequate (if any) insulation. Services systems which are often controlled by others, and may be old and inefficient, with poor controls.
- Large manufacturing spaces with high ventilation requirements.

Some can be crowded, with machinery that itself produces heat, and a need for good light levels, resulting in a high energy requirement. Others may have a large volume of space with relatively few people, resulting in a different set of heating and cooling challenges.

## Short Leases

- Use the Home Survey Tool to identify 'easy wins' that you may be able to put in hand affordably, within the restrictions of a short-term lease. Bring longer-term works to the attention of landlords.
- Under short leases, it's usually impossible to carry out significant upgrades either to the building fabric or to major services systems (which are often shared, and run by landlords). Focus on reducing energy usage instead. If you are on a shared tariff, try to persuade landlords to meter your usage, so you benefit from any reductions.
- Easy wins to reduce energy usage (and cost), may include thermostatic radiator valves. 'TRVs' switch radiators individually rather than through larger zones, so you can avoid heating unoccupied spaces. Movement detectors to replace light switches, sub-meters to control electricity, and timers to switch off boilers are all relatively low-cost ways of cutting energy use. Heat loss through doors can be cheaply controlled through a draught lobby - or even a simple curtain.
- Try to negotiate shared responsibility for energy use between landlord and tenant. Ideally, the landlord would include heating within your rent (and therefore take responsibility for improvements to the building - which they control), while you pay the electricity bill (and therefore take responsibility for improvements to your operations - which you control).
- Use simple principles to reduce your energy consumption such as: turning the heating down and ensuring it's off when the building is unoccupied; making sure lighting is only on when and where needed; turning electrical equipment off instead of to standby; and avoiding or minimising the use of electric fan heaters.

- If you are a landlord, meter each workspace locally, so as to identify each tenant's energy use and incentivise improvements.

- Before signing a new short-term lease, ask some of the following questions to encourage the landlord to think about sustainability:

- Can I have an estimate for the typical cost of energy? Do you have any plans to improve the building to reduce these costs?
  - Are there any lighting sensors to automatically turn them off so we can save some energy?
  - Is the heating supply fossil fuel free? Do you have plans to move to a fossil fuel free supply?
  - Are you procuring electricity from a green supplier? Could this be possible?
- If you're fitting out a rented 'shell', the following fit-out system has been developed as sustainable, freely accessible and affordable: Space Form Space at <http://www.spaceform.space/>.

## Dilapidated Buildings

- Use the Home Survey Tool for an initial assessment of your premises. As well as easy wins, it will highlight other priorities for making the building sustainable. As noted above, lease conditions may make these impossible. But you may be able to lobby landlords / building owners to make improvements - and can try to ensure they include sustainability upgrades.
- Industrial buildings can be architecturally simple, and relatively free from planning or heritage controls. Insulating roofs and walls can be carried out quite cheaply with external or internal linings. Seek professional advice on how to achieve this.



## Manufacturing Space

- Manufacturing spaces sometimes mean rooms with high occupancy, and machines that emit heat. The result is high energy demand. Where possible (for example, in a new fit-out) focus on efficient plant with good controls. That won't be possible for short-lease tenants, who should focus on better controls that reduce energy wastage by making sure systems are only switched on when they're needed. Timers and thermostats may be affordable. If not, it's a matter of staff training and putting in place systems to make sure systems are switched off a night.
- Some workshops involve large volumes which contain only a small number of people. In those, the aim should be to heat or cool people locally, rather than trying to bring the whole space to the right temperature.
- Most workspaces require good light levels, which can draw a lot of energy. Changing to LED can save huge amounts of energy (and cost). Replacement bulbs are available for most lamp types. If your lamps are relatively efficient (eg fluorescent), wait until they fail. But tungsten and high-energy bulbs should be changed as soon as possible.
- If you run a high volume of mechanical ventilation to control fumes or dust, then try to make sure you reclaim the heat energy from exhaust air, and feed it back into the heating system.
- Review whether specialist extract can be achieved through local extraction systems (eg fume cupboards) rather than exhausting heated air from the whole space.

## Other Opportunities

- If you're working with a developer partner who's responsible for creating cultural workspace, make sure you state your environmental expectations clearly. Work closely with stakeholders to make sure spaces are insulated to a high standard, with a high level of control for services systems. Use the Green Book to develop a target list of proposals.
- Include the following checklist in fit-out requirements for a new workspace or studio (see the 'Be Clean' section of the Home Survey tool for more suggestions):
  - Low energy LED lighting
  - Daylight sensors to dim the lights (for spaces with windows)
  - Lighting presence detection to turn the lights off when not in use
  - Enhanced insulation to roof soffits (if the existing insulation is currently less than 200 mm)
  - Installation of electricity and heat meters, and sub-metering where appropriate
  - Zoning of heating and associated controls
  - Fully insulated hot and chilled water pipework
  - For smaller venues, point of use electric hot water is likely to be most carbon-efficient

- If cooling is required, request refrigerant leak detection
- Set a target of a minimum of EPC C rating
- Minimise the materials going into the fit-out
- Select natural materials with low embodied carbon (like wood from sustainable sources)
- Introduce natural light where possible.

[Click here](#) to go on to Section 9

# Dance Buildings



The Theatre Green Book ([www.theatregreenbook.com](http://www.theatregreenbook.com)) was prepared for the narrative performance sector as a whole, and included consultation with dance- and opera- as well as theatre-makers. Much of its guidance is relevant to dance companies.

The Dance sector occupies both performance buildings and rehearsal studios, which cover a wide range from repurposed spaces (in various states of repair), through to modern purpose-built facilities.

Dance companies often occupy their premises through complex stakeholder relationships, with many dance organisations lacking control over their spaces. There is a theme of relative powerlessness within the dance community which means it's imperative that a clear sustainability reference is developed which can survive the obstacle course of landlords, funders and authorities.

From a climate standpoint, it can be difficult to relax environmental conditions in dance spaces, which are set to preserve dancers' safety and well-being. Sustainability considerations always need to be reviewed in the context of health and safety.

Onerous environmental requirements can be especially challenging in older, uninsulated buildings which can only be kept up to temperature by pumping in energy.

## Specific Challenges

- Maintaining necessary environmental conditions in (often) poorly-insulated spaces.
- Buildings controlled by others.

## Dance Space

- Review environmental requirements with dancer partners. Dance Standards for the working environment states: 'Heating able to be maintained at a comfortable 21°C; not going below 18°C'. While following this guidance, try to expand the range of acceptable

temperature to avoid using energy as much as possible. Reducing set-points (the temperature at which heating comes on) to 19°C (with a +/-0.5°C variation) may save a huge amount of energy, while complying with the regulation. Set an upper limit to avoid triggering cooling unnecessarily. Consider installing 'smart' thermostats, and make sure temperatures are reduced when dance spaces aren't being used.

- Different activities require different environmental conditions. Install efficient controls so that heating and cooling systems can be managed sensitively. This will keep different areas of the building at the right temperatures to suit different needs - while reducing energy demand.
- Natural light aids dancers' well-being and cuts energy use. Where possible, choose naturally-lit spaces for dance use, or explore opportunities to introduce light. 'North lights' are good for constant, diffuse light, avoiding glare.

## Building Ownership

- The Green Book helps dance building operators make the case for sustainability improvements to owners and funders within complex chains of governance. Use the Home Survey Tool to create a basic Sustainability Plan for your building. By identifying easy wins and maintenance projects, and understanding sustainability priorities, you can argue for resources to be targeted for maximum impact.
- Dance building operators may find it hard to initiate (or fund) improvements to building fabric (which may also be restricted by heritage issues). The best opportunities for sustainability may be through improving services systems like heating and lighting - in particular by controlling them to use less energy.
- If you operate on a short lease, with little control over the building, use the Home Survey tool to identify easy wins you may be able to put in hand yourself, or concentrate on lowering your energy use by refining heating controls and times. Do what you can to bring longer-term projects to the attention of the building owner.

## Other Opportunities

- To reduce energy demand further as well as running costs, ensure that LED lighting is in place across the building, (especially in stage lighting which uses a lot of energy).
- Staff training, and well-placed control switches, can ensure studio lighting and sound systems (including amplifiers) are switched off at night.
- Easy wins to reduce energy usage (and cost), may include thermostatic radiator valves. 'TRVs' switch radiators individually rather than through larger zones, which may include unoccupied space. Movement detectors to replace light switches, sub-meters to control electricity, and timers to switch off boilers are all relatively low-cost ways of cutting energy use. Heat loss through doors can be cheaply controlled through a draught lobby - or even a simple curtain.
- See Section 13 and the Toolkit for working with heritage buildings. The Home Survey Tool will automatically filter out suggestions unlikely to work in historic buildings. Improving historic building fabric can be hard. With relatively poor insulation, historic buildings will have a high energy need, so it's important to concentrate on efficient services systems, and their controls.
- Local networks may create opportunities to increase buying power for services like renewable energy (see Toolkit), or for commissioning professional sustainability advice.
- If you lack knowledge about your building, maintenance and servicing contractors may be able to fill in gaps and offer suggestions as sustainability partners.

[Click here to go on to Section 9](#)

# Classical Music Buildings



Venues and rehearsal spaces for classical music range from renowned concert halls, purpose-designed for the best possible acoustic, to school and village halls, and repurposed churches. Relatively few concert venues are controlled by classical music organisations, who may, therefore, have only limited influence on their improvement. More typically, performance venues are run by Local Authorities, universities, or multi-arts organisations, with many, particularly outside big cities, used for multiple purposes. Many are listed.

While some large orchestras have their own rehearsal and storage space, the sector tends otherwise to depend on hired space. Again, this limits the sector's ability directly to drive improvement in the classical music infrastructure. Decision-making for major improvements is likely to run through complex governance structures. As with all cultural sectors, funding is hard to find, and most classical music buildings carry a heavy backlog of maintenance.

The sustainability challenge of classical music auditoriums has much in common with theatre auditoriums (however different they are architecturally and acoustically). Specialist guidance in the Theatre Green Book ([www.theatregreenbook.com](http://www.theatregreenbook.com)) is therefore likely to be relevant. The same is broadly true for entrance halls and 'front of house' areas.

Rehearsal space has a common challenge of large rooms irregularly filled with variable occupancy. Good controls are needed to avoid heating empty space unnecessarily.

An advantage for classical music is the strength of networking within the sector. Organisations like the British Association of Concert Halls, Scottish Classical Music Group, and the Association of British Orchestras allow best practice to be shared readily and quickly applied.

## Specific Challenges

- Achieving sustainability despite limited control of buildings.
- High energy usage of performance halls, many of which are inadequately insulated. Covid ventilation has increased energy use.
- Rehearsal spaces with high volume but limited occupancy.

## Achieving Sustainability

- If you operate a classical music venue or rehearsal space, use the Home Survey tool to develop a Sustainability Plan for the building(s).
- If you are a classical music organisation with limited control over the spaces you perform and rehearse in, do what you can to make the case for sustainability improvements to owners and funders within complex chains of governance. Use the Home Survey Tool to create a basic Plan for your building. By identifying easy wins and maintenance projects, and understanding sustainability priorities, you can argue for resources to be targeted for maximum impact.
- Classical music building operators may find it hard to initiate (or fund) improvements to building fabric (which may also be restricted by heritage issues). The best opportunities for sustainability may be through improving services systems like heating and lighting - in particular by controlling them to use less energy.
- If you operate on a short lease, with little control over the building, use the Home Survey tool to identify easy wins you may be able to put in hand yourself, or concentrate on lowering your energy use by refining heating controls and times. Do what you can to bring longer-term projects to the attention of the building owner.

## Listed Buildings

- See Section 13 and the Toolkit for working with heritage buildings.
- The Home Survey Tool will automatically filter out suggestions unlikely to work in historic buildings. Improving building fabric in historic buildings can be hard. With relatively poor insulation, historic buildings will have a high energy need, so it's important to concentrate on efficient services systems, and their controls.

## Auditoriums

- See the Theatre Green Book ([www.theatregreenbook.com](http://www.theatregreenbook.com)) for guidance on making performance buildings sustainable.
- Don't run ventilation systems harder than you need. Carbon dioxide

(CO<sub>2</sub>) sensors can optimise the amount of fresh air supplied to suit current occupancy. Aim to keep the fresh air supply to achieve no more than 800ppm CO<sub>2</sub>.

- Thermal imaging of some auditoria in the past has shown simultaneous heating and cooling, wasting energy. Check control settings to avoid this.
- When there's no audience in, set auditorium heating systems and controls to heat the stage (and sound desk) area only, rather than heating the whole auditorium.

## Rehearsal Spaces

- Rehearsal spaces may be large (for acoustics), but with a relatively low rate of occupancy. Where possible, provide heating where it's needed around musicians (for example by under-floor heating) rather than heating the whole space.
- Make sure your controls heat and ventilate rehearsal spaces only when they're in use.

## Other Opportunities

- To reduce energy demand further (as well as running costs), ensure that LED lighting is in place across the building, (especially in stage lighting which uses a lot of energy).
- Music buildings generally have low hot-water needs, which can be satisfied by combined PV / solar panels, which provide hot water as well as generating electricity (see Section 6).
- Use music networks to share best practice, case studies and lessons learnt.

[Click here to go on to Section 9](#)

# Rock and Pop Buildings



Existing initiatives in music are creating extensive momentum and awareness across the sector. The sector is supported by Julie's Bicycle (<https://juliesbicycle.com/our-work/music-programme/>), and by initiatives such as Live Green (<https://livemusic.biz/live-green/>) and Music Declares Emergency, which has over 6,000 signatories. Some venues are involved in the Europe Jazz Network which explores how the jazz sector can respond to the climate crisis. The Music Venue Trust (<https://musicvenuetrust.com>) supports a large membership with advice on many areas.

The pressure from sustainability initiatives is starting to shape the ways many venues work, with acts like Coldplay requesting sustainable initiatives in the buildings. For the most part, however, activity has focused on touring and performance models. By contrast, the current volume focuses on buildings – whether venues, or rehearsal and studio space.

Venues range from massive stadia down to rooms above pubs. Relatively few are purpose-built for music. The vast majority of smaller venues operate on very short leases, creating little opportunity for improving building fabric, even if funds were available. 93% of Music Venue Trust members are tenants, whose lease periods average no more than 18 months. Smaller organisations therefore face the challenge of restricted control, while larger ones have to address the huge scale of stadia and big concert venues.

A good many larger venues are converted cinemas or theatres. It's rare for insulation and sustainability to have been part of previous conversion works. With some exceptions, ancillary space for music (rehearsal and recording studios) is created ad hoc in spaces which may struggle acoustically as well as in sustainability.

At the other end of the industry, some larger commercial facilities are purpose-built, and operated by larger companies who may well have the resource to fund improvements, if they prioritise this. The sector's vocal engagement with the climate crisis will soon make this essential.

The carbon footprint of music's touring model has received widespread attention. Venues have a role in making it easier for bands to tour sustainably, for example by providing charging points for vehicles.

## Specific Challenges

- Short leases restrict opportunities for progress.
- Auditoriums can be energy-hungry.
- Helping the challenge of sustainable touring.

## Working with Short Leases

- The truth is that it can be very hard indeed for short-lease venues to carry out meaningful improvements to their building – unless they're lucky enough to have an unusually sympathetic landlord who is themselves focused on sustainability. It's usually impossible to carry out significant upgrades either to the building fabric or to major services systems. Even 'easy wins' may be unaffordable if you only have a year or so on your lease.
- If that's the case, focus on the things you can control. Use simple principles to reduce energy consumption. Switch-off routines make sure everything's switched off overnight. Turn the heating down and make sure it's off when the building is unoccupied. Only switch on lighting when and where needed. Turn electrical appliances off rather than to standby. Avoid or minimise the use of electric fan heaters. Beyond that, you can put your energy into making your operation more sustainable by looking at waste, staff travel, the bar etc.
- For some venues, there may be some 'easy wins' worth investing in. Use the Home Survey Tool to see if there are any you can put in hand affordably, within the restrictions of your lease.
- Easy wins to reduce energy usage (and cost), might include thermostatic radiator valves ('TRVs' switch radiators individually rather than through larger zones, which might include unoccupied space), movement detectors to replace light switches, and timers to switch off boilers. These are all relatively low-cost ways of cutting energy use, and some might be worth looking at if you have a few years on the lease. Heat loss through doors can be cheaply controlled through a draught lobby – or even a simple curtain.

- Landlords who care about sustainability may be few and far between – but are becoming more common. If you're lucky enough to have one, use the Home Survey Tool to bring sustainability works to their attention. It's unlikely to produce instant results but may help in the future.
- For a few venues, it may be possible to negotiate shared responsibility for energy use between landlord and tenant. In some new developments, the landlord might include the heating bill in the rent (and therefore take responsibility for improvements to the building – which they control), while you pay the electricity bill (and therefore take responsibility for improvements to your operations – which you control).
- Before signing a new short-term lease, try asking some of the following questions to encourage the landlord to think about sustainability:
  - Can I have an estimate for the typical cost of energy? Do you have any plans to improve the building to reduce these costs?
  - Are there any lighting sensors to automatically turn them off so we can save some energy?
  - Is the heating supply fossil fuel free? Do you have plans to move to a fossil fuel free supply?
  - Are you procuring electricity from a green supplier? Could this be possible?

# Rock and Pop Buildings cont'd



## Auditoriums

- See the Theatre Green Book ([www.theatregreenbook.com](http://www.theatregreenbook.com)) for guidance on making performance auditoriums sustainable.
- Don't run ventilation systems harder than you need. Carbon dioxide (CO2) sensors can optimise the amount of fresh air supplied to suit current occupancy. Aim to keep the fresh air supply to achieve no more than 800ppm CO2.
- Thermal imaging of some auditoriums in the past has shown simultaneous heating and cooling, wasting energy. Check control settings to avoid this.
- When there's no audience in, set auditorium heating systems and controls to heat the stage (and sound desk) area only, rather than heating the whole auditorium.
- Some concert venues are windowless boxes, invisible from the street. It may be relatively cheap to insulate them externally with wall and roof insulation.
- Instead of replacing seats, explore whether existing seats can be re-upholstered (perhaps in phases, to avoid operational impact). Specify new seats for long life and resilience.

## Sustainable Touring

- If venues provide energy efficient and high quality backline and kit, acts will be more likely to use it, reducing how much they transport from venue to venue, and making their tours more sustainable. Collaboration is key for this. If venues work together to provide consistent equipment across the UK and internationally, artists can tour with less and use smaller, more sustainable modes of transport.
- Venues with scene docks or parking spaces may be able to install EV charging points to support sustainable transport for tours.
- Green contract riders can ensure joined-up thinking between touring companies and venues.

[Click here](#) to go on to Section 9



This initiative concentrates mainly on cinemas, although the Home Survey tool and general guidance will also provide useful direction for studio and editing space.

As with some other sectors, dynamic sustainability initiatives are already under way within the screen and film world. We Are Albert (<https://wearealbert.org>) has widespread traction within the industry. Albert and Arup, their sustainability consultants, have recently launched a Studio Sustainability standard and scorecard to provide a framework for improvement in buildings and operations (<https://wearealbert.org/2022/03/08/studio-sustainability-standard/>). Sector lead bodies such as the BFI, Ffilm Cymru, Screen Scotland, Film London, the Film Audience Network, and the UK Cinema Association actively promote sustainability and share best practice. External pressure comes from the UN Entertainment net zero accord, which provides a framework for the screen industry, obliging cinema owners to take action. The British Film Commission is currently working on guidance for studio stages.

The Arts Green Book : Sustainable Buildings supports these initiatives, adding a specific focus on the challenge of making cinema and screen buildings more sustainable.

From large commercial multiplexes, operated by multinational corporations, cinemas range through arthouse chains and independents to screens within multi-use arts buildings and small community-run cinemas. Some cinemas were purpose-built in the early twentieth century (though many large halls have since been subdivided). Others occupy former theatres, or halls of different sorts.

As with many cultural buildings, cinemas are often occupied leasehold, even by the large corporate operators. This inevitably restricts options for improving the building.

Cinemas are typically open for long hours, often with limited occupancy. Auditoriums therefore need to maintain comfort (with corresponding input of energy), even with a small audience. Within cinemas, projectors demand high energy input, while server rooms have a high cooling need.

For those operating studio stages, these are characterised by massive spans and volumes, creating challenges for maintaining comfort without enormous input of energy. Editing and studio space is more manageable in scale, but typically involves sealed-box spaces wholly reliant on energy for their environment.

## Specific Challenges

- Leasehold arrangements make building improvements harder to achieve.
- Cinema auditoriums can be large spaces with occupancy ranging from full houses through to sparse attendance at some daytime screenings. Typically, heating is a large component of cinemas' energy use.
- Studio stages require environmental comfort within enormous volumes.

## Leasehold Arrangements

- Use the Home Survey Tool to identify 'easy wins' that you may be able to put in hand affordably, within the restrictions of a short-term lease. Bring longer-term works to the attention of landlords.
- Under short leases, it's usually impossible to carry out significant upgrades either to the building fabric or to major services systems. Focus on reducing energy usage instead, using simple principles to reduce your energy consumption. For example, turn the heating down and make sure it's off when the building is unoccupied. Only switch on lighting when and where needed. Turn electrical appliances off rather than to standby. Avoid or minimise the use of electric fan heaters.

- Easy wins to reduce energy usage (and cost), may include thermostatic radiator valves. 'TRVs' switch radiators individually rather than through larger zones, which may include unoccupied space. Movement detectors to replace light switches, sub-meters to control electricity, and timers to switch off boilers are all relatively low-cost ways of cutting energy use. Heat loss through doors can be cheaply controlled through a draught lobby - or even a simple curtain.
- Before signing a new short-term lease, ask some of the following questions to encourage the landlord to think about sustainability:
  - Can I have an estimate for the typical cost of energy? Do you have any plans to improve the building to reduce these costs?
  - Are there any lighting sensors to automatically turn them off so we can save some energy?
  - Is the heating supply fossil fuel free? Do you have plans to move to a fossil fuel free supply?
  - Are you procuring electricity from a green supplier? Could this be possible?

# Cinema and Screen Buildings cont'd



## Auditoriums

- See the Theatre Green Book ([www.theatregreenbook.com](http://www.theatregreenbook.com)) for guidance on making auditoriums sustainable.
- Don't run ventilation systems harder than you need. Carbon dioxide (CO<sub>2</sub>) sensors can optimise the amount of fresh air supplied to suit current occupancy. Aim to keep the fresh air supply to achieve no more than 800ppm CO<sub>2</sub>.
- Thermal imaging of some auditoriums in the past has shown simultaneous heating and cooling, wasting energy. Check control settings to avoid this.
- Some cinemas are windowless boxes, invisible from the street. It may be relatively cheap to insulate them externally with wall and roof linings. The large internal volumes of cinemas will likely mean that enhanced roof insulation will be significantly beneficial, where practical.
- Instead of replacing seats - a recurrent issue for heavily-used cinemas - explore whether existing seats can be re-upholstered (perhaps in phases, to avoid operational impact).

## Studio Stages

- Try to design heating systems to provide heat adjacent to people, rather than attempting to heat the whole stage.
- Don't run ventilation systems harder than you need. Carbon dioxide (CO<sub>2</sub>) sensors can optimise the amount of fresh air supplied to large spaces. Aim to keep the fresh air supply to achieve no more than 800ppm CO<sub>2</sub>.

## Other Opportunities

- Directly cut energy use by considering closing on a day (or days) which you know to be very quiet. Distributor agreements may demand 7-day showings, but some cinemas have managed to renegotiate this as a result of the pandemic.
- Multiplexes usually keep the whole building open even though some screens have low occupancy for daytime showings. It would be more sustainable to open the building only partially during the daytime. That may be possible - if rental agreements allow it - by reducing daytime screenings, or consolidating to make sure the screens in use are located together in one part of the building.
- Projectors require high energy input. If possible, select equipment for low energy demand (and running costs). Look for the 'Lumens per Watt' output: the higher, the better.
- If possible, choose a projector with a long lifespan, to avoid early replacement. Check warranties, guarantees, maintenance plans and the availability of key parts. The aim should be a projector with a lifespan beyond 10-12 years. Laser projectors (which seem likely to replace lamp-based systems) are considered to have longer lifetime savings, and better energy-efficiency, with instant on/off benefits.
- Ensure digital screens are switched off out of hours where they are unlikely to be seen by the public.

[Click here](#) to go on to Section 9

# Multi-Artform Buildings

Multi art form buildings are complicated. They contain multiple different types of space, often used in very different ways from one week to the next. Occupancy patterns vary. There's often no set pattern of use that allow services systems to be programmed in straightforward ways.

The mid-Twentieth Century saw the construction of numerous regional Arts Centres. Designed at a time of cheap fossil fuels (and little understanding of their consequences), these were barely insulated (see Section 3 Old and New Buildings). Half a century on, many have still not been upgraded, and run on increasingly elderly services systems. The challenge of making them fit for purpose in the climate emergency is steep, and funds hard to come by.

Other multi-artform buildings occupy historic buildings like former town halls, schools or libraries. A few are housed in newer purpose-built premises which were designed to higher standards - but may not always achieve those standards.

They share the characteristic of a high degree of flexibility and complex use, making services controls more than usually complicated. The trend of uniting art forms in one building, and working cultural premises harder, is likely to become more widespread, however, as economic models tighten, cultural organisations combine and diversify, and crossover spreads between some artforms. Meanwhile, Arts Centres will continue to offer an all-day welcome, requiring services systems to run even during quiet periods with limited occupancy. Like libraries, Arts Centres may become climate refuges for people unable to afford heating in winter or cooling in summer.

Some Arts Centre are owned or operated by Local Authorities. This creates many opportunities, but can reduce the control organisations have in improving their premises.

Multi-artform buildings share with other cultural sectors the challenges of heritage restrictions, dilapidated building fabric, ageing services, and a backlog of maintenance. The need is to make best use of limited resource in steering them towards sustainability. Owners and operators are likely to find useful guidance under each category of building type covered in this section.

## Specific Challenges

- Ownership and management challenges can restrict organisations' control over their estates.
- Complex and irregular patterns of use / occupancy within the building.
- Public facilities require long opening hours, sometimes with limited occupancy.
- Auditoriums bring specific challenges for sustainability.

## Building Management

- The Green Book helps building operators make the case for sustainability improvements to owners and funders within complex chains of governance. Use the Home Survey Tool to create a basic Plan for your building. By identifying easy wins and maintenance projects, and understanding sustainability priorities, you can argue for resources to be targeted for maximum impact.
- Building operators may find it hard to initiate (or fund) improvements to building fabric (which may also be restricted by heritage issues). The best opportunities for sustainability may be through improving services systems like heating and lighting - in particular by controlling them to use less energy.
- If you operate on a short lease, with little control over the building, use the Home Survey tool to identify easy wins you may be able to put in hand yourself, or concentrate on lowering your energy use by refining heating controls and times. Do what you can to bring longer-term projects to the attention of the building owner.

## Patterns of Use

- A 'Building Management System' is essential to control complex spaces with variations in use patterns. The BMS needs to be thoughtfully set up to suit the building, and fully understood by staff. Re-commission or simplify your BMS if necessary. Ask a local service engineer to review the BMS, diagnose issues and suggest upgrades.
- Data can help you control a complex building efficiently. Take regular meter readings, perhaps weekly (or at least monthly), to identify patterns of high and low use. Plan your controls to service the building's use with as little energy as possible.
- In complex buildings, the theoretical 'maximum occupancy' in different spaces may exceed the total maximum occupancy for the building. To avoid redundancy, ensure system capacity is designed for the latter, with switching controls and CO2 sensors to direct ventilation, heating, etc to the right place at the right time, and be off outside that period.

## Public Spaces

- Establish zones to make sure you don't heat unused spaces. Well-managed timers and thermostats can dramatically reduce energy.
- To reduce energy demand further as well as running costs, ensure that LED lighting is in place across the building, (especially in stage lighting which uses a lot of energy).
- In-flows of air through entrance doors make it hard to maintain internal conditions - which are consequently achieved through intense use of energy. Set lobbies and entrance halls to interim conditions, between external and internal, so as to provide greater stability at lower energy cost.

# Multi-Artform Buildings cont'd

## Auditoriums

- See the Theatre Green Book ([www.theatregreenbook.com](http://www.theatregreenbook.com)) for guidance on making performance buildings sustainable.
- Don't run ventilation systems harder than you need. Carbon dioxide (CO<sub>2</sub>) sensors can optimise the amount of fresh air supplied to suit current occupancy. Aim to keep the fresh air supply to achieve no more than 800ppm CO<sub>2</sub>.
- Thermal imaging of some auditoria in the past has shown simultaneous heating and cooling, wasting energy. Check control settings to avoid this.
- When there's no audience in, set auditorium heating systems and controls to heat the stage (and sound desk) area only, rather than heating the whole auditorium.
- Instead of replacing seats - a recurrent issue for heavily-used cinemas - explore whether existing seats can be re-upholstered (perhaps in phases, to reduce operational impact).

## Other Opportunities

- Local Authority stakeholders and partners may offer great opportunities for sustainability, for example by giving access to Neighbourhood Heating Schemes.
- Local networks may create opportunities to increase buying power for services like renewable energy (see Toolkit), or for commissioning professional sustainability advice.
- If you lack knowledge about your building, maintenance and servicing contractors may be able to fill in gaps and offer suggestions as sustainability partners.
- Arts Centres and other cultural buildings may be needed as climate refuges as global conditions worsen. Make sure new services systems are designed for the changing climate.

[Click here](#) to go on to Section 9

# 9 Gathering Information

## 1 Introduction

The Arts Green Book : Sustainable Buildings is built around a Home Survey Tool which asks you a series of questions about your buildings. They'll build up a picture of your current level of sustainability, and what's needed to move it forward. They'll cover:

- Its building fabric (roofs, walls, windows and doors).
- Its services systems (their condition, operation and the fuel they use)
- Any renewables you're already using - or opportunities for installing them.

Your answers will allow the tool to develop a Sustainability Plan that identifies actions to move your building towards sustainability. That process is covered in the next section.

Meanwhile, it's important to know how your building is performing now. That gives you a baseline. As improvements are made, you'll be able to track your progress towards zero carbon.

Measuring how your building operates allows you to:

- Compare yourself with similar buildings.
- Identify areas to focus on (helping you refine your Sustainability Plan)
- Set targets.

## 2 Measuring Energy Use

Electric and gas (or heat) meter readings are invaluable in the quest to reduce energy consumption. The famous business quote, 'what you can't measure, you can't improve' also applies to energy.

You should aim to improve your energy metering as a top priority and commit to recording and regularly checking the data. It's worth reviewing consumption at least once a year - and ideally every month.

Readings before and after performances, exhibitions, or times of intense working will help you understand the significance of specific loads in your operation. Each time you install new equipment or complete a green project, you can measure energy to assess its impact. The more you commit to metering and checking, the more you will understand how your building functions and what consumes the most energy.

### What to Measure - and How

The important information to look for is energy consumption in kilowatt-hours (kWh) rather than the power in kilowatts (kW). The number on your meter is usually in kWh. The difference between two readings records the amount you have used.

If you currently have only limited sub-metering, you could install sub-meters to monitor specific circuits at specific times of the day. Clamp-on electrical meters are a cheap alternative, and accurate enough (though they have a 20% margin of error) to identify the principal energy-consumers.

Air temperature and quality can also be measured, to help you focus heating and ventilation on the spaces and times which need it most. Monitors such as AirThings Wave are relatively inexpensive (circa £250).

If you have a Building Management System (BMS), it can identify problem areas. Professional consultants use tools to 'diagnose' more complex systems and potentially make significant savings. See the Toolkit for more information on Building Management Systems.

### Tracking Progress

Preparing an annual Display Energy Certificate (see sidebar) is a formal discipline for measuring your energy use.

For a more holistic record of your current position in sustainability, you can measure your carbon and other impacts with the Creative Green Tools, developed by Julie's Bicycle (JB) for the arts and culture industries (<https://juliesbicycle.com/reporting/>). Over 5,000 organisations, in 50 countries worldwide, use JB's free set of carbon and environmental calculators to record and measure their impacts.

### DECs (Display Energy Certificates)

Commit to undertaking an annual Display Energy Certificate (DEC). This not only gives you a formal reading of your annual consumption, it provides a reasonable benchmark to compare to, suggests simple improvements, and allows other buildings to compare to your building, which is a healthy way to improve energy transparency. For public buildings, it is a legal requirement.

Having a DEC, updated yearly, allows you to track improvements in your carbon reduction through improvement in your DEC rating. This helps ensure each intervention has a positive effect on performance. It allows you to communicate improvements as 'good news stories' to audiences, the general public, and funder.

Note: do not confuse DEC's with an 'Energy Performance Certificate' (EPC). EPCs predict energy consumption based on pre-assumed building usage. They aren't based on actual measurement).

You can find out more about Display Energy Certificates here: <https://www.gov.uk/government/publications/display-energy-certificates-and-advisory-reports-for-public-buildings>

To get a Display Energy Certificate, you need a qualified assessor. Local assessors can be found online.

### 3 Benchmarking

The aim of benchmarking is to track progress towards zero carbon, measuring how energy use reduces against the year you prepared your Sustainability Plan.

If you want to measure yourself against similar cultural buildings, you can search Display Energy Certificates on the DEC register. The key piece of information to look for is the "Annual Energy Use" in kWh/m<sup>2</sup>/year for both heating and cooling.

From their Creative Green data, Julie's Bicycle has developed a set of benchmarks to help organisations compare their environmental performance against the industry average. The benchmarks use 'relative' metrics - use of energy per square metre, per year - to help you measure your own organisation against the benchmark, whatever its size or scale.

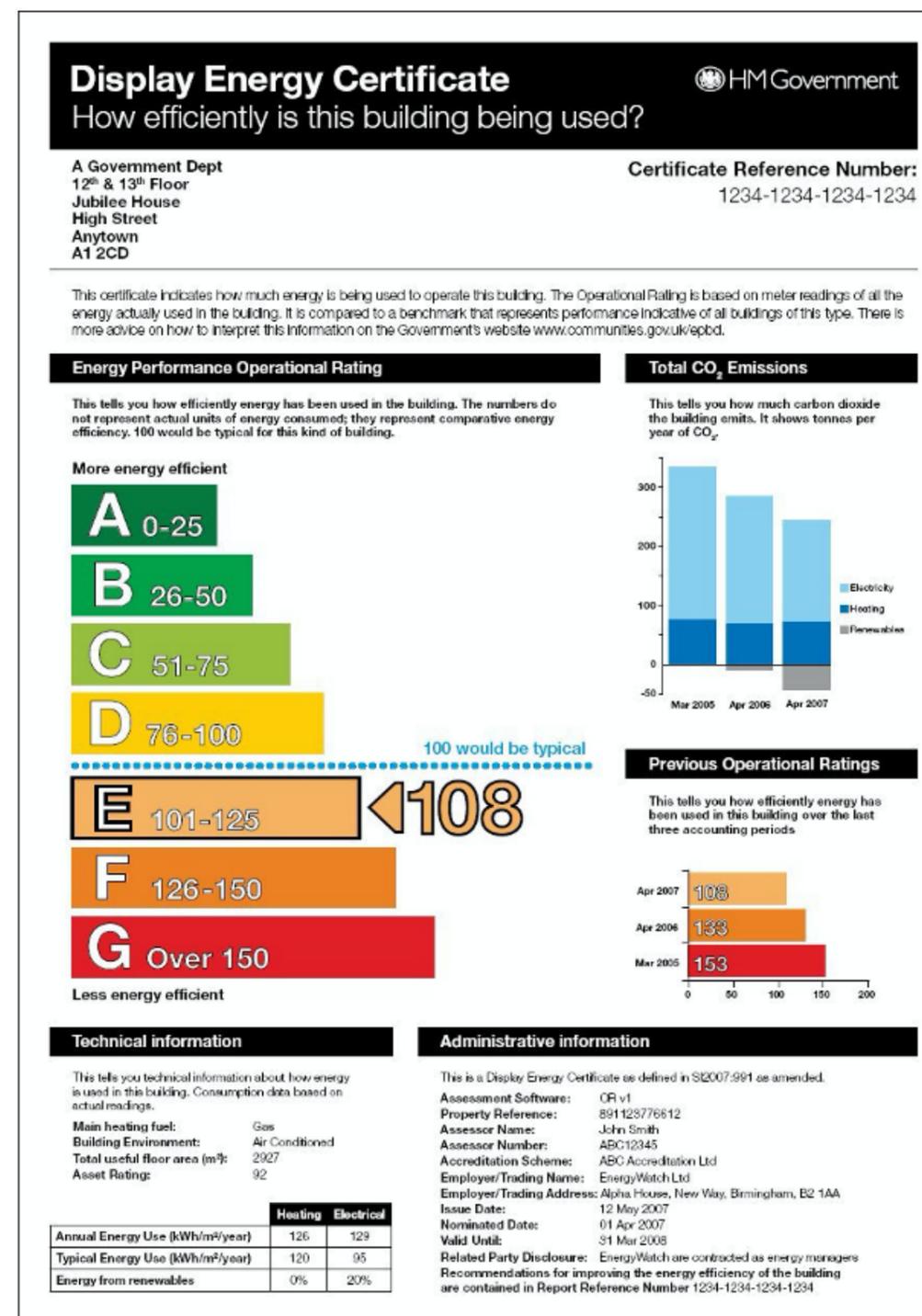
The Creative Green Tools will compare your impacts to the Julie's Bicycle benchmarks automatically.

### 4 Sharing

The journey towards sustainability depends on sharing knowledge, experience and data.

Once you've commissioned a DEC, share it on your webpages and display it in your foyer. Messaging to your audience and stakeholders can be powerful.

Use the networks in your cultural sector to share experience and contacts, support others and disseminate lessons learnt.



# 10 Developing a Sustainability Plan

## 1 Introduction

The Arts Green Book's Home Survey tool will take you through a series of questions about your building. They'll cover everything from roof insulation to entrance doors, from the state of your boilers to the possibility of fitting PVs on the roof.

The tool will output a provisional list of the actions needed to make your building sustainable, whether fitting secondary glazing or replacing lights. It will automatically list them in order of impact, to help you tackle the most beneficial actions first.

It will divide them into three categories:

- Easy Wins
- Maintenance Projects
- Capital Projects

Every building is different, however, and there's only so much that can be done automatically. The final step in making a Sustainability Plan is to go through the list yourself, and re-order it to reflect the specific needs and challenges of your building.

Your Sustainability Plan will answer the two key questions:

- What are the works our building needs?
- What order should we tackle them?

### The Home Survey tool

You'll find the Home Survey tool [here](#). It's been developed by Buro Happold to allow cultural building owners and managers to create a Sustainability Plan for their building. This section explains how. You'll still need professional advice, but the Home Survey tool will put you in a position to seek the right advice at the right time.

## 2 What Are the Works Our Building Needs?

The tool is based around a long list of the possible interventions that will make a building sustainable.

As you go through the Home Survey, it will rule out actions you've already taken.

It will also identify works which aren't possible. For example, it may not be possible to fit a draught lobby to the entrance of a historic foyer. In that case, it will suggest alternatives: a revolving door, or failing that, a heat curtain.

This is also the moment to spot realistic compromises. Secondary glazing may be less effective than complete window replacement - but it will still be a lot better than leaving old windows as they are because there's no money to replace them.

Through the Home Survey, the tool will identify the works your building needs. It can then help define the order in which you deliver them.

## 3 What Order Should We Tackle Them?

The right Sustainability Plan needs to balance two different factors:

- What has the most impact?
- What's easiest to achieve?

### What has the most impact?

In general, buildings can best move towards sustainability by tackling building fabric first (Be Lean), then services systems (Be Clean), and then adding renewables (Be Green).

That's a good starting-point. The Home Survey tool will automatically prioritise interventions according to this list, and to the impact they're likely to have on your buildings.

But the other driver needs to be taken into account as well.

### What's easiest to achieve?

Some high-impact works will involve cost (requiring a lengthy fundraising process), getting planning or listed building permissions, or closing the building for disruptive works. In the meantime, progress can still be made by addressing works that may have less impact, but are easier to get on with.

That's why your overall list of works needs to be triaged into three categories:

- Easy Wins
- Maintenance Projects
- Capital Projects

The Home Survey tool will do this automatically (though further triage will be required to make the list bespoke to your buildings - see next page).

**Easy Wins** are those works which can be carried out straightaway, with little or no cost or disruption. An example would be adding timing controls to lights and heating systems, or switching to a green energy provider. It's essential to get on with these while you're planning your capital projects. That way you can be sure you're moving towards sustainability as quickly as possible.

**Maintenance Projects** are works which don't involve closure or planning permissions, and can be carried out as part of annual maintenance works. An example might be fitting secondary glazing to dressing room windows, or replacing water heaters in toilets.

**Capital Projects** are those major works which require exceptional spending, disruption or permissions. They might include re-roofing, replacing windows, putting in new services systems, or replacing boilers with heat pumps.

The Green Book will automatically assign each intervention to one of those categories. But every building is different. In the next phase of making a Sustainability Plan, building owners and managers must juggle interventions to suit their judgement of what's achievable, and to fit sustainability works in with everything else the building does.

#### 4 Finalising the Plan

First, you can shift interventions between the three categories of Easy Win, Maintenance and Capital Project, depending on your own intimate knowledge of the building and organisation.

Next, you can re-order them to suit your general maintenance programme. For example, you may have put roof insulation high on the list - but the right time to do it is when your roof coverings need replacement anyway. The table in Section 12 identifies some of the typical refurbishment works buildings regularly undertake. It may cost significantly less to integrate a Green Intervention when you're carrying out these works anyway. Use this table to help re-order your list of Green Interventions.

Finally, you may find specific reasons to defer some works or prioritise others. For example, you may have gas boilers which are only a few years old. It makes no sense to replace them until they've given a few more years of life. If they're relatively efficient, then leaving them as they are is fine. Push boiler replacement down the list and make a plan to remove them later on.

#### 5 Internal Stakeholders

A good Sustainability Plan needs support across the organisation, from the board and funders through to end users in each department. In a large organisation, fundraisers, marketing heads, facilities managers, the property or estates department, caretakers, general managers, the green team, department heads, specialists such as conservators will all have important input to make.

Consulting, informing and sharing expertise are essential to arrive at a plan that has the whole organisation behind it.

See the Toolkit for more information on building a sustainability culture.

#### 6 Setting a Timeline

The process outlined above will create a Sustainability Plan that:

- Identifies the works your building needs to make it sustainable
- Places them in order of priority under three headings: Easy Wins, Maintenance Works and Capital Projects

The next task is to set a timetable for achieving each of those columns.

The final step is to check that your timeline delivers improvements that move you towards sustainability at the speed your organisation needs.

##### Professional Advice

The Arts Green Book aims to empower building owners and managers to develop Sustainability Plans quickly and without undue expense. But some of the decision-making can be complex, and you won't always be sure that everything in the plan is feasible, or what other complexities it might involve.

Once you have an initial Sustainability Plan, therefore, you'll probably need to involve professional sustainability consultants, engineers, architects, building surveyors and others to help confirm feasibility, refine costings, and hone the Sustainability Plan into a final working document. The Home Survey tool itself identifies where further advice is recommended.

If you don't have the money, then get going with the Easy Wins and Maintenance, and pull together a professional team to revisit the Sustainability Plan in the first phase of your Capital Project.

# 11 Easy Wins

## 1 Introduction

Most arts buildings have some easy wins that can improve sustainability with little cost or effort. The Home Survey tool should identify them, and there's no reason to hold off putting them in hand straightaway.

Make sure you measure energy use beforehand (for example by installing clamp-on meters - see below) so you can see the impact of these Easy Wins on your operation.

## 2 Measuring

One easy win is to improve your knowledge of your building by sub-metering or fitting clamp-on meters to capture where energy is going. They don't save energy in themselves, but they'll help you hone your Sustainability Plan to ensure you're moving towards sustainability as effectively as possible.

## 3 Go Electric

The National Electricity Grid is increasingly powered by renewable energy sources, so switching power use from gas or oil to electricity is an easy way of accessing zero carbon power (see sidebar).

For example, cultural buildings can switch hot water taps from the gas boiler to an electric point-of-use water heater. (NB this may only apply to smaller buildings with lower hot water demand - see section 5). Buildings with catering kitchens might look at electric-only appliances.

## 4 Common Easy Wins

The following list covers some common easy wins that you may be able to put in hand at your building:

### Lean

- Draught proofing windows and doors
- Cavity wall insulation
- Installing a draft lobby or electric 'air curtain' to main doors
- Night Cooling (ventilating large spaces at night so as to bring in cool night air to lower temperatures ahead of each day)
- External features like parasols to minimise summer cooling

### Clean

- Check for nearby district heating connections
- Hot water flow restrictors on taps and showers
- Installing smart heating controls
- Improving lighting controls by installing daylight and/or occupancy sensors
- CO2-controlled ventilation to larger spaces
- Replacing old white appliances with A-rated appliances
- Building Management System (BMS) diagnostics
- Cleaning mechanical ventilation filters

- Checking and aligning hot water operating hours to match occupation
- Improving hot water tank insulation
- Installing /upgrading insulation on hot water pipework

## 5 Sharing

With each piece of work you put in hand, try to record the impact and share it (see Section 9 for more information). It will help others in their decision-making, and make sure the arts sector is spending limited resources as wisely as possible in tackling the climate emergency.

### The National Grid

The electricity grid is on a trajectory to decarbonise, so by moving to electric consumption, arts buildings automatically join a shift towards zero carbon. Currently, there is more opportunity than ever to select low or zero carbon electricity tariffs through green energy suppliers.

Your choice of electricity supplier can ensure that the electricity you buy from the grid is coming from sustainable sources.

*Go to the Toolkit for more information about Green energy suppliers.*

# 12 Maintenance

## 1 Introduction

Maintenance can be hard to prioritise in a difficult commercial climate. But maintenance is essential to sustainability. It ensures that plant works efficiently, and problems are dealt with quickly. In turn, that avoids further deterioration, and the need for building works which bring their own carbon footprint.

## 2 Regular Maintenance

Regular maintenance can increase the serviceable life of plant and equipment, reducing replacement costs. It ensures plant and systems operate at their most efficient, reducing energy use and cost. Although maintenance can be a large expense, it often pays for itself long term.

## 3 Planned Preventive Maintenance

Planned Preventive Maintenance goes beyond reacting to immediate problems by looking longer-term and planning out problems before they occur. It's a necessary step towards a sustainable strategy for regular plant upgrade and replacement.

That, in turn, can steer buildings clear of problems and make capital projects less of a shock to the system.

## 4 Sustainability Upgrades

Maintenance programmes create an opportunity to put in hand key sustainability works.

These may vary from gradually replacing water heaters, to minor insulation works, replacement of windows, or installation of secondary glazing. Carried out progressively, costs can be spread over a number of years.

Maintenance allows significant progress to be maintained on sustainability even while cultural buildings gather themselves for the next big capital project.

Refurbishment tasks typically undertaken within Cultural Buildings	Green Intervention worth considering
Bar or cafe refurbishment	A-rated appliances Underfloor heating Redesigning to suit sustainable service and waste practices
More seats / auditorium extension required	Consider reupholstering rather than replacing. Consider displacement-ventilation opportunities
Toilet upgrades	Increased airtightness around wall/floor junctions
	Install LED lighting
	Improve lighting controls - install daylight and/or occupancy sensors
	Install instantaneous point-of-use water heaters
	Install auto-stop taps
	Underfloor heating
	Upgrade to waterless urinals
Office (or back of house) upgrades	Replace extract-only with mechanical ventilation and heat recovery (MVHR)
	Increased airtightness around wall/floor junctions
	Install LED lighting
	Improve lighting controls - install daylight and/or occupancy sensors
	CO2 controlled ventilation
	Install instantaneous point-of-use water heaters at tea points
Accessibility improvements	Upgrade naturally ventilated spaces to include mechanical ventilation with heat recovery - but seal up any gaps in the fabric too
	Enhance door air leakage improvements
Rewiring whole or part of the building, or extending wiring to new facilities	Install sub-meters on areas known or suspected as high usage
	Replace old light fixtures with LED fixtures
	Install movement-sensor and/or daylight sensor lighting controls where relevant
	Increase electrical load capacity to future-proof electric heat
Replacing lamps - as planned maintenance or through failure	Rationalise switching
	Replace any remaining tungsten or CFL lamps with LED equivalents
Replacing fluorescent tubes with plug-in LED replacements	Replace fluorescent tubes with plug-in LED replacements

## 5 Killing Two Birds with One Stone

Maintenance is also the opportunity to make sure that the journey to sustainability is being managed as cost-efficiently as possible.

While some energy, water or other environmental measures are worth considering at any time, many others become practically or financially viable only when some other refurbishment work is underway. The cheapest time to insulate a roof is when you're replacing the roof coverings. While you've paid for scaffolding to repaint high level windows, that's the moment to install secondary glazing.

The table above offers examples of such opportunities.

Resurfacing roof to cure leaks	Add insulation
	Strengthen to support PV panels, if feasible
	Install skylight to enhance daylight
Replacing rotten windows	Paint the roof surface white to reflect solar radiation and minimise the urban heat island effect
	Ensure good quality double (or triple glazing if the room often needs heating) and insulated frames (required by Building Regulations anyway)
Redecoration	Replace old light fixtures with LED fixtures
	Install movement-sensor and/or daylight sensor lighting controls where relevant. Install wall-mounted thermostats
Replacing gas/oil boiler(s) supplying heat to radiator systems	Check flow and return temperatures that the system runs at. If close to 40° then heat pumps could be considered, but seek professional advice first
	Install heating zone valves
	Install water sub-meters to domestic hot water
	Upgrade insulation to hot water pipework
	Consider upgrading heating emitters (like radiators) to accommodate low-temperature heating.
Replacing gas/oil boiler(s) supplying heat to Air Handling Unit only	Dedicated heat pump or upgrade AHU to include integrated heat pump
Renewing controls	Install or update Building Energy Management System
	Install thermostatic radiator valves (TRVs) on radiators
	Improve timing and zone controls
	Optimised start/stop
Replacing hot water heater	Weather compensation
	Electric point-of-use heaters - especially if pipe runs are long
Chiller needs replacing	Consider a heat pump with simultaneous heating and cooling functionality. Seek professional advice for this.
Replacing/upgrading ventilation plant	Install CO2 sensors to demand-control fresh air rate (post-Install a heat recovery mechanism
	Install units with integrated heat pumps to reduce the demand on fossil-fuel heating.
	Install high efficiency fans with variable speed drives (and suitable controls)
	Install electric and heat sub-meters
	Simplification or upgrade of BMS controls
Adding/refurbishing showers	Install low-flow water efficient shower heads
	Waste water heat recovery system. Use recycled water for flushing WCs? Consider switch to waterless urinals

### Maintenance Contracts

Maintenance contractors need to work to the same sustainability standards you follow yourselves:

- Check out maintenance companies' sustainability policies.
- Score sustainability alongside price in tendering contracts.
- Include Key Performance Indicators in contract requirements.
- Monitor them closely.

Go to the Toolkit for more on procurement and contracts.

# 13 Capital Projects

## 1 Introduction

Some sustainability improvements are major works. Their cost may need fund-raising. They may require planning or listed building permission. They may be so disruptive as to require closure of the buildings.

In that case they need to be achieved as part of a capital project - or through a series of capital projects.

## 2 Prioritising Sustainability

The overwhelming priority for arts capital projects is to make our cultural buildings fit for purpose in the context of the climate emergency.

Of course, the arts have many conflicting priorities, and most capital projects will have multiple goals. In past capital projects, sustainability often dropped to the bottom of this wish-list, superseded by projects that supported artistic growth (a new studio), engagement (teaching space), or audience development and revenue (refurbishing cafés). Funding is easier for high profile projects than for the mundane business of insulating lofts.

Today, sustainability has to be at the heart of investment in buildings. It must come first, not last. It's therefore essential to make sure that sustainability goals are written into the basic aims of all capital projects, and that all stakeholders agree on sustainability as an urgent priority which mustn't be compromised.

It helps if the capital project can be seen as an essential element in a Sustainability Plan with defined goals, targets and dates. In that case it will be clear that if you compromise on sustainability, you'll never reach the targets you all agreed.

## 3 Stakeholders

For that reason, it's important to make sure that stakeholders are fully behind the project, and sign up to its sustainability ambition from the outset.

Achieving Board support is vital for most cultural buildings. The Board must confirm sustainability as a primary aim, as well as providing continuity and supporting staff.

Internal stakeholders may include department heads, who might have their own priorities and agendas. It's important to create a shared goal of sustainability (climate literacy training can help with this).

At the outset, write a list of the external stakeholders who need to give a sustainability project their support. They may include landlords, statutory authorities, and funders. It's usually worth talking to them early to bring them on board and make this a shared journey.

## 4 Starting Out

Your capital project needs to start from defined goals that relate directly to the building's Sustainability Plan.

If you're starting from a Sustainability Plan developed through the Green Book, then you'll have clear goals and a prioritised list of actions to target. That document can be the basis of your early conversations with stakeholders.

The next step will be to get some professional advice to:

- Confirm the sustainability thinking
- Confirm feasibility
- Assess costs

## 5 Building a Team

Cultural buildings are bespoke and require specialist knowledge. The team you need may include architects, sustainability consultants, services and structural engineers, acousticians, fire and access consultants, as well as project managers and cost consultants.

Make sure all of them are experts both in buildings of your specialist type, and in sustainability. Be certain they understand the project's

sustainability goals. To achieve a successful project, you need the right people around you.

Large expert teams can be costly. The more thinking you do for yourself, or supported by a small team, the easier it will be to run through iterations and shape the project to suit your building, and your sustainability goals. Start small and add knowledge as you need it.

Capital projects aren't easy. They need:

- Energy and determination to drive them through
- Flexibility to shape them to changing circumstances

## 6 Heritage

Historic buildings can present difficult challenges for sustainability, and heritage legislation sometimes feels restrictive. Seek specialist help, focus on what's possible, and remember that using an existing building is always more sustainable than building a new one.

Historic England offer useful resources for sustainability: <https://historicengland.org.uk/whats-new/features/climate-change/>.

Many cultural buildings are historic listed structures. Others are unlisted but still of great historic value. Upgrading them to operate

### Masterplanning and Passive Design

'Passive design' means using layout and orientation to avoid energy use. It mostly applies to new buildings but may be relevant to a major refurbishment project where you're rethinking building layout.

For example, a climate-controlled archive in the basement will use less energy than one in an attic, or south-facing room.

Trying to achieve particular environmental conditions in buildings that aren't appropriate for them will always waste energy. Sustainability is easier if you start in the right place.

sustainably requires a high degree of sensitivity and expertise. It will involve nuanced decisions between heritage value and the need to improve building fabric or introduce new services systems.

Some things simply won't be possible. At the same time, historic buildings have already spread their embodied energy over many years. Keeping an existing building in use is far more sustainable than building a new one - even if it's designed to the best modern standards.

Heritage expertise is essential to achieve the best outcome. Historic England should be seen as a partner in this process, not an opponent. Their guidance is invaluable.

Before any works to a historic building, start by commissioning a Conservation Management Plan. It will define the heritage value of the building, guide decision-making about change, and set a framework for stewardship of the building. Engage heritage authorities in the process and make the most of their expertise.

The Conservation Management Plan should include a section on opportunities and challenges relating to sustainability works. If you already have a Conservation Management Plan, update it to include this section.

Your Sustainability Plan should be written in the light of this document. The guidance at the heart of Sustainable Buildings is designed to flag up issues that particularly relate to historic buildings.

See the Toolkit for more information on working with historic buildings.

## 7 Funding

Funding for capital projects is always a challenge. Many organisations in the subsidised or independent sectors will aim for a combination of:

- Arts Council (for their country)
- National Lottery Heritage Fund
- Local Authorities
- Philanthropic Trusts
- Private giving

- Landlords
- A restoration levy on tickets

At present, relatively few funds are targeted at sustainability works. However, this is changing, and increasingly funders are both supporting sustainability - and requiring it.

## 8 Design

Capital projects involve building work - which itself uses resources and has a carbon footprint. The energy that goes into making steel, bricks and concrete is known as 'embodied energy'.

In the climate emergency, it's essential to minimise carbon and use less resource. The first question is to ask whether new building is necessary at all? There are often alternative ways of achieving a company's goals, by reviewing operation, or repurposing existing spaces.

If building is absolutely necessary, make sure your designers are experienced in sustainable design and use materials and techniques that avoid adding to the building's existing carbon 'debt'. Choose long-lived and robust materials which won't need replacing. Guidance for sustainable design can be found at <https://www.leti.london/>.

Measure the embodied carbon 'debt' involved in any building works, as well as the reduction they offer in carbon usage. See the Toolkit for more on embodied energy.

## 9 Contracts

Building is a carbon-intensive process which damages the environment. Your contractors need to match the sustainability ambition of your organisation and design team.

In tendering a building contract, check out the sustainability policies of each contractor. Score sustainability alongside price and quality when you review tender returns and make your selection. Finally, include Key Performance Indicators for sustainability in your contract requirements - and make sure your project managers monitor them closely.

See the Toolkit for more on sustainable procurement and contracts.

## 10 Programming Capital Projects

A perennial issue for arts capital projects is the damaging effect of prolonged closure on audience development, creative momentum, programming and revenue.

Think about project management and sequencing from the outset. If possible, divide the project into 'chunks' that can be carried out sequentially. And allow contingency on each phase of the works. Building works very often run late.

## 11 Sustainability in Operation

Cultural buildings often find that sustainability projects which offered benefit on paper are much less effective in real life. The capital project doesn't end when the builders leave. It's essential to retain designers for a period of occupation and review, to ensure everything is working as effectively as possible.

'Soft Landings' is a helpful government initiative to make sure buildings perform as well as intended: <https://www.bsria.com/uk/consultancy/project-improvement/soft-landings/>

### BREEAM and Other Sustainability Frameworks

In the UK, BREEAM is the most recognised framework for ensuring capital projects are sustainably managed. Planning authorities and funders often require projects to achieve BREEAM 'Excellent' standard.

The most appropriate scheme for refurbishments is BREEAM Refurbishment and Fit-Out. You can find more information here: <https://www.breeam.com/discover/technical-standards/refurbishment-and-fit-out/>

Other standards are available, including the living building challenge (<https://living-future.org/lbc/>). Your professional team can advise on the most appropriate framework to use.

# 14 Infrastructure and Resilience

## 1 Introduction

Adapting our buildings for the climate emergency doesn't only mean making them more sustainable. We need to change them to suit the different ways we now operate; and to stand the more extreme climate conditions they'll face.

## 2 Infrastructure

For your operation to work sustainably, you'll need to make some changes to your building. Here are a few common changes that can help you work in more sustainable ways:

- Drinking-water fountains to reduce reliance on bottled water
- Recycling stations for waste
- Secure bicycle racks to encourage staff, visitors and audiences to travel sustainably. Showers for cycle commuters
- Electric vehicle charging points (including for delivery vehicles)
- More storage helps re-use / recycling of equipment and materials

Once you've developed a sustainability strategy for your operation, identify any building changes needed, and include them in your Sustainability Plan for the building.

## 3 Climate Resilience

The climate is changing fast, and our buildings need to change to remain fit for purpose in new conditions. In the UK we expect:

- Higher temperatures in summer, with more intense heatwaves
- More intensive rainfall, with flash flooding in some regions
- Drought

Resources on climate adaptation are included in the Bibliography.

### Heatwaves

Performance spaces, galleries, reading rooms and workspaces will all be affected by longer and more intense summer heatwaves. Old cooling systems - if you have cooling at all - may already struggle to cope with summer conditions. Even new systems may not be able to manage the temperature peaks we will soon experience.

Summer closures may become the norm for some. However, if you are planning works to your services systems, now is the time to review whether replacement systems can sustainably provide cooling to keep staff and visitors at acceptable temperatures.

Some adaptation options to consider:

- External shading such as shutters on windows or canopies over outdoor areas
- If the building has internal courtyards, making these as green as possible will help cool the surrounding spaces
- If upgrading windows, ensure that they are openable to allow passive ventilation

### Rainfall

Roofs, gutters and downpipes are sized to deal with theoretical 'worst case' rainstorms. However, rainstorms are becoming more intense than previous forecasts, and happening more frequently. Gutters, downpipes and below-ground drainage can be overwhelmed by intense rainfall, leading to catastrophic flood damage.

Older buildings, designed to standards which were still less onerous, are particularly vulnerable. The parapet and valley gutters on historic buildings can easily be flooded by the intense rainfall events of the climate emergency.

Re-engineering the rainwater systems of existing buildings is a mammoth task. It's expensive, disruptive - and in some cases impossible. For example, downpipes may be encased in concrete or hidden behind historic wall finishes, impossible to get at and enlarge.

You'll need specialist help to think through options, look at alternatives, and find the best compromise. Are the bottlenecks in the width of the gutter, the size of the outlet, the downpipe diameter or the below-ground drainage? If you can't make downpipes bigger, can you add additional downpipes, or store water in buffer tanks at high level (structure permitting)? You'll need to think through the system as a whole: there may be no point making downpipes wider if they're flowing into the same drains below ground.

These are significant building works. The time to tackle them is when you're already planning a capital project - for example, to replace roofs and upgrade roof insulation. Works to upgrade rainwater systems are often overlooked, however. The capital project you're looking at today may be your one chance to avoid catastrophic and expensive floods in the future.

Some adaptation options to consider:

- Maximise permeable surfaces around the building, e.g. plant beds or permeable paving
- Green roofs or facades can mitigate run-off (see Section 7)
- If your building is in a flood risk area, door guards or temporary flood barriers will help prevent flood water getting in

### Drought

Equally, intense rainfall can be seen as an opportunity to collect and store water.

Water will increasingly be seen as a scarce resource. At the very least, more water storage will be needed to balance summer droughts with winter rainfall events.

Many buildings, particularly in towns and cities, will struggle to find space for water storage. Green roofs can absorb water (see Section 7). Shared neighbourhood schemes may be worth exploring. Reconfiguring your plant as part of a sustainability project may free up space for rainwater storage.

Stored rainwater can be used in a number of ways. Irrigation is an obvious priority, to avoid drinking water being used for watering plants. Treated rainwater can also be used for flushing toilets, and for showers and laundries. See Section 7 for more information. Seek specialist advice on filtration or UV systems to treat rainwater.

Some adaptation options to consider:

- Water efficiency measures, e.g. low-flow fittings on taps and toilets
- Awareness campaigns to change user behaviour
- Dry planting

### Dry Planting

An obvious impact of drought and a changing climate is to change our approach to planting. Sustainable planting - essential for supporting biodiversity - should avoid thirsty plants with a high irrigation need, and focus instead on plants able to sustain dry periods and drought.

# 15 Zero Carbon and Beyond

## 1 Introduction

The ultimate goal is to achieve zero annual carbon emissions.

That may take several years to achieve. For some, it may be impossible – for example, in a historic buildings which can't be fully insulated, or for organisations who can't raise the funds for all their plans.

In that case, arts buildings can reach 'net zero' by off-setting the amount of carbon they can't get rid of. Off-setting means investing in a scheme (for example, tree-planting) which is calculated to absorb the same amount of carbon as the building is emitting. The hope is that the building's impact is cancelled out: it's 'net zero'.

However, off-setting should be the last resort. The first step is to reduce carbon emissions as quickly and cheaply as practically possible.

### Scope 1, 2 and 3 Emissions

**Scope 1** emissions are caused directly by the organisation, when it burns fossil fuels like oil and gas in a boiler.

**Scope 2** emissions come from indirect energy generation – i.e. when an organisation buys electricity which the electricity company makes by burning fossil fuels in power stations.

Scope 1 and 2 are mostly within an organisation's control. They're the focus of this guide.

**Scope 3** emissions are indirect. They're caused by the journeys audiences make, the carbon emissions of supply companies, and the transport needed to deliver supplies and take away waste. It can be confusing trying to calculate, let alone change them.

Some 'scope 3' emissions are in your control: you choose which supply companies to work with. Others are less so: you can incentivise audiences to travel sustainably, but you can't force them. Focus your energy on the things you can control.

### Defining Net Zero Carbon

In 2019, the UK Green Building Council (UKGBC) produced a framework definition for a net zero carbon building in operation. It defines the steps to achieving a net zero carbon building in operation as follows:

1. **Reduce Operational Energy Use:** Reductions in energy demand and consumption should be prioritised over all other measures. In-use energy consumption should be calculated and publicly disclosed on an annual basis.
2. **Increase Renewable Energy Supply:** On-site renewable energy source should be prioritised. Off-site renewables should demonstrate additionality.
3. **Offset Any Remaining Carbon:** Any remaining carbon should be offset using a recognised offsetting framework. The amount of offsets used should be publicly disclosed.

For existing buildings, the energy scope is defined as all areas under operational control or influence where a net zero carbon balance has been achieved on an annual basis. The

energy scope should be disclosed to allow comparability between buildings.

The framework only addresses "Scope 1 and 2" emissions (see sidebar), which account for the direct building carbon emissions (e.g. from boilers) and purchased energy (e.g. electricity).

For an existing building, net zero carbon is defined as follows:

"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."

Note that energy consumption and carbon emissions are intrinsically linked. Carbon reduction is the ultimate aim, but indicatively, reducing your energy consumption will ensure carbon emissions reductions, and energy consumption is often far easier to manage and control.

## 2 Offsetting

Offsetting can be a minefield. If you decide to off-set residual carbon, it's best to follow UK Green Building Council guidance:

Carbon offsets should either be procured directly or via recognised existing offsetting frameworks. It's essential to demonstrate 'additionality' (i.e. the projects wouldn't be happening anyway), avoid double-counting and provide a clear process for verifying actual carbon savings. Off-setting frameworks worth considering include the Clean Development Mechanism and Gold Standard.

If cultural organisations are on a journey to net zero, then the amount they need to off-set will keep reducing. Regularly balance your need against your off-sets – and don't fall behind on the payments.

## 3 Restorative Action

It will be a challenge for many buildings to reach zero carbon. All the same, it is important to focus on the longer necessity of restoring some of the damage we have already done to the planet.

Ultimately, public buildings should aim to take restorative action by generating electricity, supporting biodiversity, and taking whatever measures they can to address the climate emergency.

The journey need not end at carbon zero.

# sustainable buildings

## THE GUIDANCE

Click [here](#) to fill in the Sustainable Buildings 'Home Survey Tool'.

*The output will be a draft Sustainability Plan which divides the actions you need into three categories - Easy Wins, Maintenance, and Capital Projects, and places them in order of impact (Lean - Clean - Green).*

**Complete the Home Survey Tool to generate an initial Sustainability Plan, then turn to Section 10 for guidance on how to finalise it.**

# **sustainable buildings**

# **TOOLKIT**

*A toolkit of resources for working sustainably can be found on the  
Arts Green Book website at:*

*<https://artsgreenbook.com/sustainablebuildings/toolkit/>*

# Acknowledgements and Thanks

## Thanks

With special thanks to the funders of the Green Book, Arts Council England and the Greater London Authority.

With very special thanks to the many individuals and organisations who have provided input and support in developing the guidance in this volume:

Rachael Roe, Neil Darlison, Pam Vision, Andrew Wylie, Ben Richardson, Duncan Campbell, Sam Rogozinski.

Kevin Appleby, Bill Armitage, Paul Augarde, Emma Ball, Federica Banfi, Gavin Barlow, Anne Basley, Steve Batts, Corinne Beaver, Jane Beese, Ailbe Beirne, Julia Bennett, Anand Bhatt, Lucy Bird, Yves Blais, Daniel Boulger, Mairi Claire Bowser, Simon Branson, Lisa Broadest, Claire Buckley, Alice Burkitt, Nick Butterly, Philip Chandler, Vikki Chapman, Lauren Clark, Kirsten Cockburn, Jon Collins, James Connor, Rosa Corbishley, Samantha Davenport, Mark Davyd, Sandy Dhaliwal, Patrick Dixon, Ellie Dobbs, Jenny Dowell, Stewart Drew, Sarah Ecob, Andrew Ellerby, Jon Emmett, Wieke Eringe, Rebecca Esteves, Harriet Finney, Roland Fischer-Vousden, Niamh Flanagan, Warren Forsyth, Jack Fortescue, Sarah Garbasz, Meirion Gittins, Alan Goode, Kaye Hardyman, Jack Hartshorn, Blerina Hasjani, Richard Heason, Bridgit Heidsieck, James Heston, Ruth Holdsworth, Anthony Hopkins, Alex Horder, Frank Horn, Isobel Hunter, Andrew Hurst, Mark Irvine, Debbie Jardine, Sara Kassam, Helen Keall, Nicola Kettlewood, Richard Kingsnorth, Caroline Jackman, Colin Jackson, Toby James, Claire Jamieson, Alex Jeremy, Laurence Johnson, Susan Johnston, Sara Kassam, Helen Keall, Alisha Kadri, Ayub Khan, Becky Kilner, Gareth Kirkman, Louise Kovacs, John Langford, Helen Lax, Kimberley Lewis, Hana Lewis, Patricia Loughans, Heath Lowndes, Ben Luxford, Charlotte Lythgoe, Georgina Macdonell Finlayson, Hannah Madalska-Gayer, Michelle Man, Jonathan Mansfield, Maya Maricevic, Daniel Martin, Sarah Mears, Ben Melham, Nick Merriman, Andrew Mills, Charlotte Morgan, Frances Morris, Scott Morrison, Nicola Munday, Emma Noyce, Reg Noyes, Greg Parmley, Lisa Ollerhead, Caro Overy, John Owen, Nick Poole, Sarah Potter, Tim Powell, Tom Power, Jonathan Poyner, Richard Priestley, Caroline Rae, Caroline Rice, Wynn Roberts, Bryony Robins, Anne-Marie Robinson, Jess Roper, Judith Rosser-Davies, Chris Ryde, Richard Seward, Tom Schroeder, Carol Scott, Bella Sereno, Matthew Sims, Jess Slack, Louise Smith, Ben Stephen, Molly Rose Street, Hedley Swain, Helen Taylor, Jackie Taylor-Smith, Jemima

Thomas, Steffan Thomas, Deborah Tritton, Suzie Tucker, James Urquhart, Matthew Vass-White, Esme Ward, Hannah White, Dean Whiteside, Beverley Whitrick, Lisa Wilkinson, Emyr Williams, Mark Williams, Helen Wilson, Isabel Wilson, Hannah Wisler, Lucy Wood, Stella Yeung, Blossom Young, Georgina Young, Harry Young.

The above work for or represent:

Academy Music Group, Acme, AEG, The Albany, Arts Council England, Association of Independent Museums, Barbican Arts Centre, BECTU, Beamish Museum, Bristol Beacon, Brighton Centre, Britten Pears Arts, British Association of Concert Halls, British Film Commission, British Film Institute, British Library, Cell Project Space, Chartered Institute of Library and Information Professionals, Chisenhale Dance, Conwy County Borough Council, Cornwall Council, The Crafts Council, Creative Carbon Scotland, Creative Land Trust, Dance City, Dance East, Dance Xchange, De La Warr Pavilion, The Duncairn Centre, Echo Echo Dance, Edge Hill University, Explore York, Fashion District, Feilden Clegg Bradley Studios, Festival Republic, Ffilm Cymru, Film Hub Scotland, Film Hub Wales, Film London, Gallery Climate Coalition, Glasgow Film, Greater London Authority, Hampshire County Council, Hartshorn Hook, Horniman Museum, International Live Music Conference, Jusges' Lodgings Museum, Julie's Bicycle, Kent County Council, Kingsdown House, Kresen Kernow, Lancashire County Council, Leeds City Council, Libraries Connected, Live Green, Livenation, London's Affordable Artists Studio Network, London Borough of Merton, London Borough of Newham, London Symphony Orchestra, Manchester Museum, Manchester International Festival, Manchester Jewish Museum, Manchester Museum, Mortice Consulting, Museum Development North West, Museum of Zoology Cambridge, Music Venue Trust, The National Archives UK, National Museum Directors Council, National Museums Northern Ireland, Natural History Museum, Neath Port Talbot Council, NEC Group, One Dance UK, Paradigm Agency, Pavilion Dance South West, Poplar HARCA, The Pound Arts Centre, RAF Museum, Rambert, The Regent Centre, The Roundhouse, Royal Cornwall Museum, Royal Museums Greenwich, Royal Pavilion and Museums Trust Brighton, Sage Gateshead, St John Smith Square, Savoy Theatre Monmouth, Scottish Ballet, Scottish Classical Music Group, Set Space, Sinema Pontio, The Sound Lounge, Southbank Centre, Southwark Playhouse, Taliesin Arts Centre, Tait, Tate, Theatre and Dance Northern Ireland, The Trampery, Tramway, Tyne and Wear Archives and Museums, UK Cinema Association, UK Fashion and Textile, Victoria and Albert Museum,

Warwickshire County Council, The Welfare, Whitworth Arts Gallery, Woolwich Arsenal, York Museums Trust, Yorkshire Dance.

We apologise if any names have been missed. There are very many others whose thinking has contributed to this guide. We know many more would have liked to help this initiative if time had allowed, and look forward to their thoughts and feedback.

## How the Green Book has been prepared

The Arts Green Book is built on a number of core principles:

- The initiative is backed by a broad partnership of organisations that span the full range of arts.
- The Arts Green Book absorbs and learns from existing guidance for the sector. It does not set out to reinvent the wheel, but to define common standards and shared guidance that will make the journey easier for everyone.
- The guidance is built on numerous conversations and focus groups with working arts practitioners of all sorts. It reflects the actual experience of running Arts buildings.
- The Arts Green Book's guidance is underpinned by the expertise of sustainability consultants Buro Happold.

Sustainable Buildings is based on the input of numerous arts owners and managers, and others, whose names are acknowledged in the next section.

## Future versions of the Green Book

Sustainability advice will change. Future developments of embodied carbon and the circular economy will alter the landscape of sustainability. Emerging technologies like carbon capture may offer new options.

But these things typically change over long periods of time (years and decades). We are in a climate emergency now, and so the best possible thing to do is plan for what you know will be impactful now, and alter the plan as and when required. This guidance will be updated over time to ensure new advances and new technologies are considered.

# Literature Review

To update

Reference / Title	Summary	Year of Publication	Publisher/Author	Link / reference
AIC Museum Environmental Guidelines	<ul style="list-style-type: none"> <li>The American Institute for Conservation of Historic &amp; Artistic Works (AIC) created the Environmental Guidelines Working Group to provide a platform review past practices.</li> <li>Formatted as an article, it presents research findings about the possibilities and constrains of building sustainability requirements on their exhibited or stored historical artefacts.</li> <li>Calls for any new environmental standards for museums to review of the needs of individual objects, groups of objects, and sensitive materials are recognized and addressed by the use of microclimates or other mitigation measures.</li> </ul>	2012 (Updated in 2020)	American Institute for Conservation	<a href="#">American Institute for Conservation Environmental Guidelines</a>
Albert Studio Sustainability Standard	<ul style="list-style-type: none"> <li>The studio sustainability standard is a voluntary standard for studio facilities.</li> <li>6 key areas of focus: Climate, Circularity, Nature, People, Management and Data.</li> <li>Provides guidance for sustainability (environmental and social) improvement</li> <li>Contains pathway to align with Net Zero legislation and current reporting processes, including emissions related to Scopes 1 &amp; 2</li> </ul>	2022	Albert	<a href="#">Albert Studio Sustainability Standard</a>
CILIP - A greener library	<ul style="list-style-type: none"> <li>Practical tips for libraries</li> </ul>	2020	CILIP	<a href="https://www.cilip.org.uk/news/493624/A-greener-library-The-Bodleians-push-for-sustainability.htm">https://www.cilip.org.uk/news/493624/A-greener-library-The-Bodleians-push-for-sustainability.htm</a>
Creating the sustainable public library : the triple bottom line approach	<ul style="list-style-type: none"> <li>A broader exploration of sustainability in libraries</li> <li>More American focused but useful insights nonetheless.</li> </ul>	2018	Santa Barbara, California	ISBN: 9781440857027 1440857024
Benchmarking Energy Use in Performing Arts Buildings	<ul style="list-style-type: none"> <li>Contains a useful benchmark for energy use per floor area and energy use per recommended capacity</li> <li>Is a lot more rigorous than CIBSE TM46 but is a more realistic reflection of how spaces are used.</li> </ul>	2012	Julie's Bicycle	<a href="#">CIBSE - Building Services Knowledge</a>
CIMAM Toolkit for Environmental Sustainability in the Museum Practice	<ul style="list-style-type: none"> <li>International Committee for Museums and Collections of Modern Art (CIMAM) are a global network of museums and museum professionals.</li> <li>The toolkit includes 6 sections: Examples of Immediate Actions, Sustainability Action Plans, Carbon Footprint Calculators and Certificates, Sustainability Consultants, Inspiring Projects, Platforms and Resources.</li> </ul>	2019 (Updated in 2022)	CIMAM	<a href="#">Toolkit on Environmental Sustainability in the Museum Practice</a>
Creative Carbon Scotland Green Arts Initiative	<ul style="list-style-type: none"> <li>Network which aims to build and maintain a Scottish green arts community.</li> <li>Members are encouraged to use the Green Arts Initiative branding on their publicity</li> <li>Focuses on providing support for cultural organisations based in Scotland.</li> </ul>	2013	Creative Carbon Scotland	<a href="#">Creative Carbon Scotland Green Arts Initiative</a>
Gallery Climate Coalition	<ul style="list-style-type: none"> <li>Gallery Climate Coalition (GCC) is an international charity and membership organisation providing environmental sustainability guidelines for the art sector.</li> <li>Aim to facilitate reductions of the sector's carbon emissions by at least 50% by 2030 (in line with the Paris Agreement), through setting goals and developing resources.</li> <li>GCC Provides resources on: Circularity, Decarbonisation Action Plans, Effective Actions, Energy. Gallery Spaces, NFTs &amp; Digital, Packaging &amp; Materials, Shipping, Strategic Climate Funds, Travel Waste &amp; Recycling</li> </ul>	2021	Gallery Climate Coalition	<a href="#">Gallery Climate Coalition Resources</a>
Green Cinema Rating	<ul style="list-style-type: none"> <li>Founded in Germany but used by a handful of cinemas in the UK.</li> <li>Broad coverage of sustainability, not just buildings focused.</li> </ul>	2018	FFA	<a href="https://greenfilmshooting.net/blog/en/green-cinema/">https://greenfilmshooting.net/blog/en/green-cinema/</a>

# Literature Review

## To update

Green Cinema Toolkit	<ul style="list-style-type: none"> <li>• Applicable to multi-arts venues too</li> <li>• Includes case studies and top tips for broader sustainability action</li> </ul>	2020	Independent Cinema Office	<a href="https://www.independentcinemaoffice.org.uk/advice-support/green-cinema-toolkit/">https://www.independentcinemaoffice.org.uk/advice-support/green-cinema-toolkit/</a>
Historic England: Energy Efficiency and Historic Buildings: How to improve energy efficiency	<ul style="list-style-type: none"> <li>• Is a guide to improving energy efficiency in older/heritage buildings</li> <li>• Contains a useful checklist of measures that can be taken</li> <li>• Discusses the use of a 'whole building approach'</li> </ul>	2012	Historic England	<a href="https://www.historicengland.org.uk/energy-efficiency-and-historic-buildings-how-to-improve-energy-efficiency/">Energy Efficiency and Historic Buildings: How to Improve Energy Efficiency (historicengland.org.uk)</a>
Julie's Bicycle: Fit for the Future guide	<ul style="list-style-type: none"> <li>• A guide on how to incorporate sustainability into building design</li> <li>• Contains lots of useful case studies</li> <li>• Contains a summary of technologies</li> <li>• Has a list of places to get funding</li> </ul>	2015	Julie's Bicycle and Arts Council England	<a href="https://www.juliesbicycle.com/fit-for-the-future-guide-2015.pdf">Fit for the Future guide 2015.pdf (juliesbicycle.com)</a>
Julie's Bicycle Renewable and Green Electricity Factsheet	<ul style="list-style-type: none"> <li>• Useful reference to find suppliers of renewable energy</li> <li>• Contains pros and cons lists of different renewable energy sources</li> </ul>	2017	Julie's Bicycle	<a href="https://www.juliesbicycle.com/renewable-and-green-electricity-factsheet-2017/">Renewable and Green Electricity Factsheet 2017 - Julie's Bicycle (juliesbicycle.com)</a>
Julie's Bicycle - Creative Green Tools	<ul style="list-style-type: none"> <li>• Online toolkit that is a set of carbon calculators</li> <li>• Designed specifically for the creative industry</li> </ul>	Updated in 2019	Julie's Bicycle	<a href="https://www.juliesbicycle.com/introducing-the-creative-green-tools/">Introducing the Creative Green Tools - Julie's Bicycle (juliesbicycle.com)</a>
Live Green	<ul style="list-style-type: none"> <li>• LIVE Green - Beyond Zero is an industry campaign to deliver climate action,</li> <li>• Sets out the sector's commitment to reach net zero emissions by the year 2030.</li> <li>• All 13 association members of LIVE have ratified the Beyond Zero Declaration, a voluntary sector-specific commitment to deliver measurable and targeted action on climate change.</li> </ul>	Updated in 2022	LIVE	<a href="https://www.livegreen.org.uk/">Live Green - Beyond Zero</a>
STBA Responsible Retrofit Guidance Wheel	<ul style="list-style-type: none"> <li>• Sustainable Traditional Buildings Alliance (STBA)</li> <li>• Interactive online tool geared towards retrofitting of older buildings</li> <li>• Allows the user look at different measures that can be taken and the risks associated with them</li> </ul>	Updated in 2020	STBA	<a href="https://www.stba.org.uk/responsible-retrofit-guidance-wheel/">STBA Responsible Retrofit Guidance Wheel</a>
RIBA sustainable outcomes guide	<ul style="list-style-type: none"> <li>• Is a useful guide to initially look at</li> <li>• Sets out key performance metrics and targets to meet in order to meet UN sustainability goal</li> </ul>	2019	RIBA	<a href="https://www.riba.org/2019/sustainable-outcomes-guide/">RIBA Sustainable Outcomes Guide</a>
Victoria and Albert Museum, Guidance on producing a sustainability plan	<ul style="list-style-type: none"> <li>• Guidance about how to develop a sustainability plan for a museum</li> <li>• 9 key areas of focus: Sustainability mission, systems approach, wide consultation, scope and boundaries, setting targets, intersectionality, clarity, taking a long term view, stakeholder engagement, and implementation.</li> </ul>	2021	Victoria and Albert Museum	<a href="https://www.vam.ac.uk/articles/guidance-on-producing-a-sustainability-plan-for-museums">Victoria and Albert Guidance: How to write a sustainability plan for museums</a>
White Light Green Guide	<ul style="list-style-type: none"> <li>• A guide on choosing more energy efficient lighting</li> <li>• Mostly focuses on stage lighting and productions but there is a section on lighting around the building</li> <li>• Contains practical and easy to understand tips</li> </ul>	2012	White Light	<a href="https://www.whitelight.org.uk/white-light-green-guide/">White Light Green Guide</a>

# Bibliography

## Bibliography

### (in addition to the literature review)

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- Adapting to climate change: <https://www.creativecarbonscotland.com/resource/creative-carbon-scotlands-guide-to-adapting-to-climate-change/>  
<https://www.cityoflondon.gov.uk/assets/Services-Environment/city-of-london-adaptive-pathways-study.pdf>  
<https://www.london.gov.uk/what-we-do/fire-and-resilience/london-city-resilience-strategy#:~:text=The%20London%20City%20Resilience%20Strategy,future%20success%20of%20the%20capital>
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- Light levels, their impact on urban nature: [https://www.nhm.ac.uk/discover/light-pollution.html?utm\\_source=tw-link-post-20181028-kl&utm\\_medium=social&utm\\_campaign=litd](https://www.nhm.ac.uk/discover/light-pollution.html?utm_source=tw-link-post-20181028-kl&utm_medium=social&utm_campaign=litd)
- Living Building Challenge: <https://living-future.org/lbc/>
- Museum environmental guidelines: [https://www.conservation-wiki.com/wiki/Environmental\\_Guidelines](https://www.conservation-wiki.com/wiki/Environmental_Guidelines)
- Passive Design: [https://www.designingbuildings.co.uk/wiki/Passive\\_building\\_design](https://www.designingbuildings.co.uk/wiki/Passive_building_design)
- Projectors for cinemas: <https://www.sharpnecdisplays.eu/p/laser/en/whylaser.xhtml>
- Comparisons between projector laser and lamp: <https://www.sharpnecdisplays.eu/p/download/v/48e496b225e7a3fe1896cff72194de83/cp/internet/shared/content/footer/teaser/publicweb/productteaser/brochure-tcocomparison/pdf-brochure-tcocomparison-%28english%29.pdf?fn=tco-comparison-laser-vs-lamp-english.pdf>
- Soft Landings: <https://www.bsria.com/uk/consultancy/project-improvement/soft-landings/>
- Sustainability and Ecology in Museum Practice: <https://cimam.org/sustainability-and-ecology-museum-practice/>
- Sustainable design: <https://www.leti.london/>
- Theatre Green Book (Renew Culture and Buro Happold, 2022): <http://theatregreenbook.com>
- Top Ten Actions for the Creative & Recreational Sector: <https://www.businesshub.london/resource/top-ten-actions-for-the-creative-recreational-sector/>
- We Are Albert Studio Sustainability Standard: <https://wearealbert.org/2022/03/08/studio-sustainability-standard/>

*Renew Culture provides guidance and support for the arts in their journey towards sustainability.*

## Renew Culture

*Buro Happold is an international, integrated consultancy of engineers, consultants and advisers. After leading the construction industry in declaring a climate emergency, we've committed to reduce our own impact by achieving challenging science-based targets. We are collectively working towards an equitable and green future by adapting our business to mitigate climate change and the biodiversity crisis and helping others achieve their sustainability goals.*

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