THE THEATRE GREEN BOOK (HONG KONG)

Sustainable Buildings :
Detailed Guidance

First Edition – October 2026

Adaptation by The Hong Kong Academy for Performing Arts

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Building on the second edition of the UK's Theatre Green Book, the Hong Kong Academy for Performing Arts has adapted the first Hong Kong edition to address its teaching needs and production process, providing a reference for the performing arts sector in Hong Kong and the region.

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Green Book Foreword

The Theatre Green Book is an initiative by theatre-makers to move theatre towards sustainability.

Early in the initiative, we divided that challenge into three parts: making productions sustainably, making our theatre buildings sustainable, and reviewing theatres' other operations, from catering to offices, waste to travel. Those three challenges are the three areas of the Theatre Green Book.

This volume, Sustainable Buildings, gives detailed guidance on how to make theatre buildings more sustainable, even though many of them are ageing and starved of investment. It's designed for executive directors and facilities managers, for boards, funders, local authorities and designers – for anyone who faces the challenge of taking a theatre building and making it fit for purpose in the context of the climate emergency.

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

That journey will never be easy – theatre owners know how hard it is to raise funds for investment. But it is essential. Sustainable Buildings gives theatre clear standards for assessing the challenge, selecting priorities – and setting out on the journey.

Lisa Burger and Paddy Dillon, Renew Culture

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Sustainable Buildings

DETAILED GUIDANCE

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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.

Theatre cannot solve the climate crisis alone, but it can play an urgent role in addressing it. Theatre can question and challenge, provoke, entertain and surprise. It can reflect the preoccupations of generations facing a time of dizzying, frightening change.

But to do that, theatre itself needs to work sustainably.

2 A CLEAR PATH TO SUSTAINABILITY

The Theatre Green Book gives theatre a path towards sustainability. It builds on years of work by theatre-makers and sustainability pioneers like Julie's Bicycle, Creative Carbon Scotland, SiPA, Ecostage and others. It maps the journey towards an industry that is low carbon and low waste, values people, and contributes to a more sustainable society.

3 SCOPE OF THE GREEN BOOK

The Green Book divides the challenge into three areas. Together, they will give theatre clear, practical and detailed guidance towards sustainability:

1. Sustainable Productions
2. Sustainable Operations
3. Sustainable Buildings (this volume)

There are some overlaps between Sustainable Operations and Sustainable Buildings. Sustainable Operations covers the challenge

of managing buildings sustainably, whereas Sustainable Buildings shows how to upgrade them to be more sustainable. Whatever your role, it's worth looking at both volumes.

4 SUSTAINABLE BUILDINGS

Theatres are among our most high-profile public buildings. About 34 million theatre tickets are sold each year. Theatres are often the most prominent buildings in a town centre. They are flagships for the arts and culture.

It is all the more important, therefore, that theatre and performance buildings are fit for purpose in the context of the climate emergency.

The challenge is all the harder because theatres have often been starved of investment 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; many services systems are old, inefficient, poorly-controlled – and powered by fossil fuels. It is an urgent task to make theatres fit for purpose. The Theatre Green Book aims to provide a blueprint for this journey.

Fortunately, many theatres have pioneered solutions as part of their recent capital projects, and considerable expertise has built up in the sector, and across the design and construction industry. Sustainable Buildings has been developed by bringing together sustainability and building environments experts Buro Happold, design professionals, and – most importantly – professionals who own and manage theatres, so as to develop holistic guidance in the challenge of making theatre buildings sustainable.

5 SCALE

Theatres vary enormously in type and scale, but the principles of sustainability are the same. This guidance is designed for performance buildings of all kinds. Whether you are managing a large opera house, or trying to improve a small venue, the process of assessing priorities, developing a Sustainability Plan and delivering

improvements is the same, and the guidance will also work for workshop, storage and rehearsal facilities.
This guidance covers theatres of different types (see chapter 3). Later chapters cover all the different ways of tackling sustainability challenges, from easy wins, through maintenance to large-scale capital projects.

6 THE LEGISLATIVE BACKGROUND

Legislation helps. The Buildings Energy Efficiency Ordinance (BEEO Cap. 610) enforces rising standards for energy conservation in Hong Kong. Specifically, the requirements for Major Retrofitting Works apply to existing non-residential building works and tenant fit-outs, enforcing minimum energy efficiency standards via the Building Energy Code (BEC). Additionally, the Buildings Department's Sustainable Building Design Guidelines and local lease conditions may impose strict energy and carbon requirements for building extensions and major alterations. Planning approvals and conditions from the Town Planning Board or requirements for Gross Floor Area Concessions often include stringent sustainability targets, such as a mandatory requirement to achieve a specific 'BEAM Plus' rating.

That legislative background will rightly become more demanding over time. Theatres need to plan now for a world in which sustainability is expected by audiences – and by the law.

NET ZERO CARBON

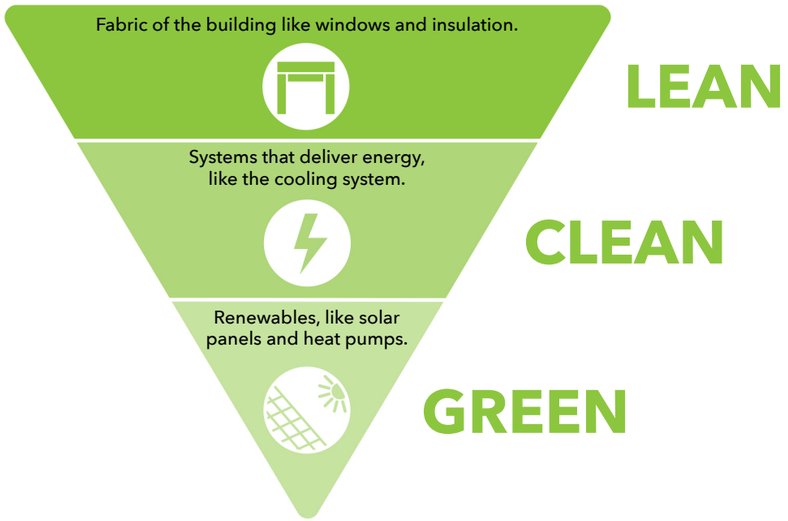
Ideally, all buildings would be 'zero carbon', causing no carbon emissions in the course of an average year. The aim of Sustainable Buildings is to help building owners map the journey to zero carbon.

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'.

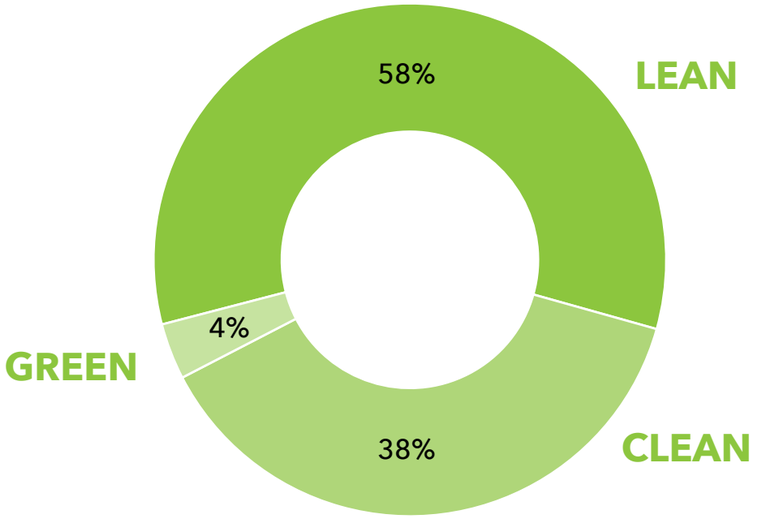
For many existing buildings, achieving net zero on site will be very difficult. In that case, 'net zero' can only be achieved by 'offsetting' carbon use through schemes that (for example) generate green electricity or plant trees elsewhere.

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2. Key Principles



The energy hierarchy



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

1 INSULATION – EFFICIENCY – RENEWABLES

Planning to make a theatre sustainable should be based on the 'energy hierarchy' above.

1. First, make your building need less energy, by improving its building fabric. That means insulation of roofs and walls, windows and doors.
2. Second, make it use less energy through more efficient equipment. That means, first, better equipment that takes less energy to deliver the same amount of heat, light, coolth or ventilation (etc); and second, better controls so you only deliver those services when and where they're needed.
3. Thirdly, generate your own energy by switching to renewable sources. That means photovoltaic cells, heat pumps etc.

Typically, the greatest carbon impact in Hong Kong is achieved at the beginning of the energy hierarchy, by reducing building energy demand first. Hong Kong Green Building Council (HKGBC) data highlights that buildings account for around 90% of electricity use and over 60% of carbon emissions, and that highly energy-efficient buildings can achieve about 65% energy demand reduction from the baseline.

Sustainable Buildings is accompanied by a 'Building Survey tool', which helps generate a Sustainability Plan for your building. It automatically prioritises 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 a theatre '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 zero carbon.

HONG KONG'S NET-ZERO BUILDING STANDARDS

Driven by the Environment and Ecology Bureau's (EEB) goal to achieve carbon neutrality before 2050 (released October 2021), Hong Kong's building sector is heavily targeting decarbonization. Governed by the Hong Kong Green Building Council (HKGBC), this net-zero framework focuses on highly efficient "Zero-Carbon-Ready" designs and offsetting remaining operational and embodied carbon.

To track progress, the HKGBC utilizes International Energy Agency (IEA) criteria via its Zero-Carbon-Ready Building (ZCRB) Certification Scheme. This benchmarking tool allows owners to set decarbonization targets and measure reductions, frequently aiming for a 65% energy demand reduction against international baselines.

3 GO ELECTRIC

Gradually, Hong Kong has been shifting towards generating its electricity from renewable sources. That process is still continuing. It means that one of the main things a theatre 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 Operations section. By including renewable generation in your Sustainability Plan, you can generate electricity at your theatre – 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 theatre productions, reducing waste and eliminating environmentally harmful practices. That keeps it simple and readable, regardless of anyone's prior knowledge.

For a more precise vocabulary for green theatre, see the glossary in the Resources area. The Future Materials Banks keeps an excellent lexicon of general terms at www.futurematerialsbank.com/lexicon.

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3. Building Types

1 DIFFERENT THEATRES

Theatres are all different, but they fall into distinct groups, each of which has its own challenges for sustainability.

HISTORIC THEATRES

Historic theatres, typically have small foyers, large auditoriums, fly-towers above the stage house, and cramped backstage areas. Roofs are usually pitched and slated, with lofts above the auditorium. Ornate facades surround entrances, while elevations elsewhere are plain brick. Internally, public spaces are decorated with elaborate plaster and timber mouldings, while others are plain.

There may have been original natural ventilation ducts in the auditorium. Other areas will be naturally ventilated through windows. Most mechanical and electrical services will have been added later. 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 usually 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 THEATRES

Numerous theatres and arts centres were built in Britain in the post-war boom of the 1960s and 1970s, as modernism first arrived. These theatres vary greatly in size, some doubling as community or arts centres. Most will have more generous public areas and some are equipped with offices, workshops and other ancillary spaces.

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

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

	 HISTORIC	 MID-CENTURY	 RECENT
Description	• Likely to be Victorian or Edwardian. • Likely to be listed under Historical buildings or declared monuments. • Likely to be listed under the Antiquities and Monuments Office (AMO).	• Theatres built in the post-war boom of the 1960's and 1970's, as modernism first arrived.	• Theatres built during or after the 1990's
Likely Fabric	• 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.
Likely Systems	• Extensive "layering" of systems and patchwork fixes. No documentation.	• A degree of layering and patchwork.	• Relatively modern but corming to end of life. • Likely to have some documentation.
Likely potential for improvement	• 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.
Most likely green interventions	• Glazing improvements • Roof insulation • Systems upgrades	• Facade upgrades • Lighting improvements • Renewable energy opportunities	• Lighting improvements • Ventilation enhancements • Renewable energy opportunities

MORE RECENT THEATRES

The theatres, which were built beginning in the early 1990s, have been designed and built to more modern standards, including much higher standards for insulation. Services systems will be newer. Some theatres will have been built as exemplars of sustainability, while others would not reach today's standards.

The earliest of these buildings will now need to replace services systems, creating opportunities to improve sustainability. For others the challenge will be different. Often, new buildings fail to perform as well as their designers intend. The challenge is to make quite complex systems work as efficiently as possible, augmenting and upgrading them as necessary.

2 USING THE THEATRE GREEN BOOK

Every theatre is different, but most will fall into one of the above categories, even if it has been subsequently altered or extended. Many, perhaps most theatres will have carried out upgrades of some kind – whether by insulating roofs, or replacing old boilers – often as part of a capital project. Their Sustainability Plans will take account of what's already been done in identifying next steps and the path to sustainable operation.
Although theatres are different in many ways, the principles of sustainability are the same: to reduce energy consumption and carbon emissions through more effective building fabric (insulation), better services systems (efficiency) and – where possible – renewable energy sources (renewables), while reducing water use and maximising biophilia.

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4. Insulation : 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 skins 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.

2 INSULATION

Insulation 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.

ROOFS

Flat roofs can usually be insulated on the outside when you replace roof coverings. More often, roofs will be insulated internally, by fixing insulation to the underside of rafters and covering it with plasterboard or timber linings. Where roofs cover lofts, it's easiest of all to fit loft insulation directly to the loft floor. (there are no pitched roof theatres in HK)

There are some challenges to watch out for. You will need to check that old roof structures can take the weight of extra insulation. And in historic theatres, the auditorium ceiling mustn't be sealed with loft insulation if you need to inspect a fibrous plaster ceiling 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. It will need planning permission; and isn't possible if the facade has historic mouldings and cornices. This approach may be appropriate in back of house areas, or on plainer, modern buildings. Even then, windows, doors and eaves will need modifying to suit the extra thickness.

Internal cornices, dados and skirtings in historic theatres can also 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 in geometry. It will disturb historic fabric. It will certainly be expensive.

With plainer walls – either in more modern buildings, or in backstage areas – 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.

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. Secondary glazing also avoids the embodied carbon of new replacement windows.

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 audiences gather, causing cold air to escape, energy loss and thermal discomfort internally.

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

'Air curtains' simply blast room temperature air down to try and minimise incoming draughts or small gusts of wind.

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.

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4 SOME CHALLENGES

WINDOWS

Old buildings are leaky.

To reduce energy loss you have to make a building airtight. But that can create a new problem: insufficient ventilation. That isn't a problem in areas with mechanical ventilation such as in Hong Kong.

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 its, 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 Hong Kong buildings built before the mid-1980s.

Guidance can be found from the Environmental Protection Department (EPD)

https://www.epd.gov.hk/epd/english/environmentinhk/air/asbestos/asbestos.html

6 CLIMATE RESILIENCE

Climate change doesn't only require us to make our buildings more efficient. It also places new strains on them. Temperatures are changing, along with rainfall patterns. Extreme weather events are more frequent. Modifying our buildings for climate change means leaner fabric, cleaner services and green energy generation. It also needs us to look at how buildings perform in a changing climate.

We expect over-heating and increased rainfall (and hence flooding) to be far more commonplace, and buildings need to be adapted with this in mind. That may mean larger rainwater pipes and gutters. We've seen public drainage overwhelmed by intense rainfall, so buildings may need to absorb and hold more rainwater on site. Meanwhile, today's cooling systems may be overwhelmed by the extreme heatwaves of the future.

It is vital that those responsible for the future maintenance and adaptation of existing theatre buildings take proper account of what the future is likely to hold.

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5. Efficiency : Building Services

1 INTRODUCTION

A theatre's energy consumption will fall into one of the following categories: cooling systems, general plug-loads, show loads, 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.

Those improvements are of two types:

- Upgrading to more efficient equipment (for example, LED lighting uses less energy to make the same amount of light; modern boilers use less gas to produce the same amount of heat).
- Upgrading controls, so you only deliver services where and when they're needed (for example, timers, thermostats and movement detectors can save you from lighting and empty spaces).

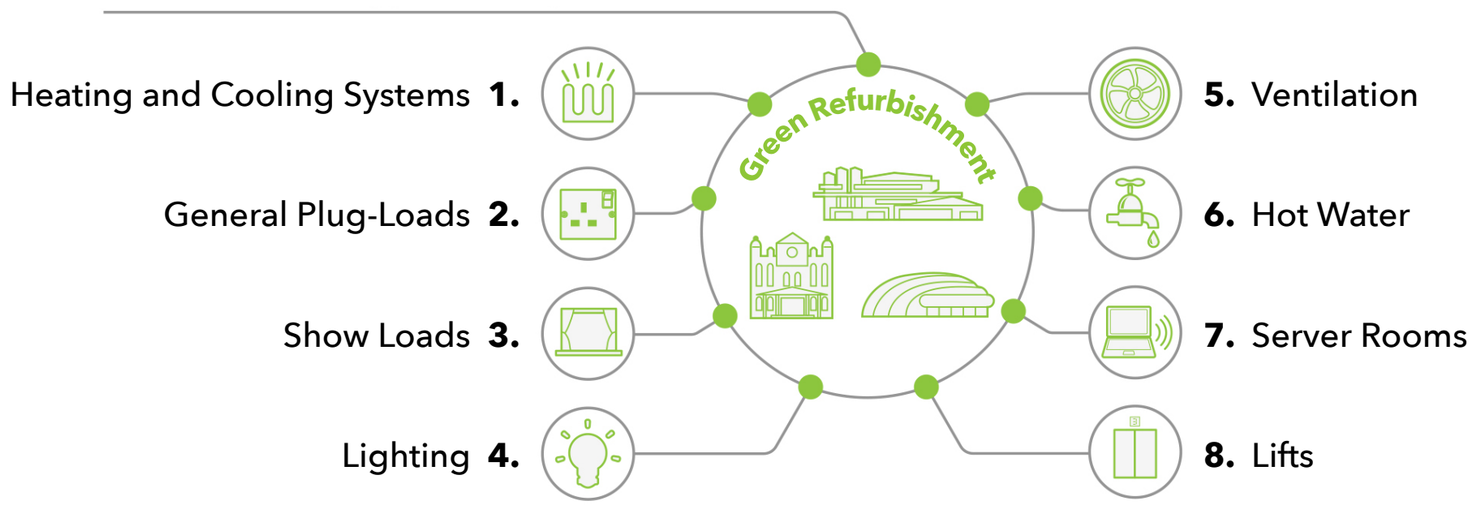
2 KNOWING WHERE YOU ARE

You have to understand how your energy systems work. Some theatres can afford professional facilities teams with a high degree of expertise, and keep good records of services systems, maintenance, and replacement. Others necessarily work with tighter budgets, and may know far less about their buildings 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 systems. You may be able to commission condition surveys from them, or ask them to provide a basic explanation. Utilities bills tell you how much energy you're using. If you sub-meter different areas, you'll learn more about how your energy use is distributed.

Chapter 8 gives more detail on gathering information.

A Theatre's Energy Consumption End-Uses



3 HEATING AND COOLING SYSTEMS

Systems are more sustainable when they can work at lower temperatures. That suggests a shift to underfloor cooling and fan-coil units in the ceiling (which draw in air from the room, heat or cool it, and blow it out again).

Theatres can reduce energy use by re-thinking the temperatures they aim to maintain. Over time, audiences 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

Old boilers should be replaced. 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 chapter 6), though biomass boilers may work in rural areas. A switch to heat pumps does have consequences, though, and 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.

DISTRICT COOLING

A cornerstone of Hong Kong's sustainable infrastructure, cutting air-conditioning electricity use—the city's largest energy consumer. Instead of using individual chillers, a centralized plant produces chilled water and distributes it via insulated underground pipes.

In waterfront hubs like Wan Chai, where HKAPA is located, District Cooling System (DCS) uses sea water cooling, drawing raw seawater from Victoria Harbour to absorb heat in central condensers before discharging it back into the sea.

https://www.emsd.gov.hk/en/energy_efficiency/DCS_in_HK/about_dcs/index.html

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COOLING

Mechanical cooling, commonly referred to as “air conditioning”, is often provided in auditoriums and foyers to keep temperatures down in the summer. As with heating, the first step 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 can be installed to minimise the use of energy.

To reduce energy, much can be achieved with natural cooling methods such as circulating cool night-time air to bring auditorium temperatures down before a show.

4 HOT WATER SYSTEMS

Hot water systems are typically fed from the main boiler plant, but can also have their own local (“point of use”) electric source – which is 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 ad hoc during maintenance, or as part of larger refurbishment projects.

They may not be right for larger theatres 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.

5 VENTILATION

Mechanical ventilation is needed in windowless rooms (like many toilets and basements) to give people enough air to breathe. It’s needed in most auditoriums, 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 always needs two components: fresh air is pumped into the space, and exhaust air is pumped out of it.

Mechanical ventilation is often used to spread coolth and warmth as part of the heating and air conditioning systems, by heating or chilling the air before it’s pumped into each room. Older systems waste energy by exhausting heated air without ‘reclaiming’ the heat. To avoid energy loss, heat can be ‘reclaimed’ from the exhaust air and reused to warm the fresh input air. CO2 sensors can also be installed to ensure the right amount of fresh air is pumped in to suit the current occupancy levels, and to save you running ventilation systems when they’re not needed.

In auditoriums, ‘displacement’ systems (which blow in air beneath seats, close to where the heat / coolth is needed) are far more efficient than traditional systems, which try to blow heat or coolth from the ceiling down to the seats.

6 LIGHTING

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

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

7 GENERAL “PLUG LOADS”

Anything that gets plugged in draws energy and contributes to theatre’s carbon footprint. That means computers, white goods, bar fridges, fan blowers and heaters, communication devices (radio and mobile phones), workshop tools, vending machines – and much else. All those products publish energy data, so when purchasing new, make sure you’re buying as efficiently as possible. And replacing old white goods (for example) can contribute significant savings – but that’s only worth doing if they’re reaching the end of their lives.

8 SHOW LOADS

No matter how efficient the kit you install, it will waste energy if it’s on unnecessarily – for example, if lighting burns all night or radiators heat up empty rooms. Controls are key to any system within the theatre and ensuring they are operating only when needed and to the degree required is vital.
Installing the right controls for heating, cooling and lighting is essential, and can generate significant savings without much cost or disruption.

9 CONTROLS

No matter how efficient the kit you install, it will waste energy if it’s on unnecessarily – for example, if lighting burns all night or radiators heat up empty rooms. Controls are key to any system within the theatre and ensuring they are operating only when needed and to the degree required is vital.

Installing the right controls for cooling and lighting is essential, and can generate significant savings without much cost or disruption.

- Timers switch on systems for hours of operation, and make sure they’re switched off afterwards.
- Thermostats efficiently control temperatures during hours of operation.
- Movement detectors or Presence Sensors switch off lighting in unoccupied rooms and corridors.
- CO2 and VOC detectors make sure ventilation only runs when the air quality is bad.

Once good controls are installed, it’s important to keep managing them. You’ll find more information on building management in the Theatre Green Book, Sustainable Operations.

BUILDING MANAGEMENT SYSTEMS

Building Management Systems (BMS) control services automatically. A good system should be simple to use, with good user guides so that knowledge is not lost when people leave. Well-designed, and operated by well-trained managers, a good BMS can make sure a theatre runs as efficiently as possible.

However, BMSs can be complicated, and require technical knowledge to run them efficiently. Training staff and simplifying controls helps manage your building sustainably.

See the Toolkit for more details.

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6. Renewables

1 INTRODUCTION

Theatres can generate their own electricity on site from renewable sources. Solar Photovoltaics (PVs) create electricity from light.

Turbines generate it from wind. Generating renewable electricity reduces the need to pull energy from the fossil fuel sources that still power much of the utility companies. At slack times, theatres can put spare power back into the grid.

Theatres can also use the energy around them more directly. They use some electricity in the pumps, but don't rely for heating or cooling either on fossil fuels (e.g. in gas boilers), or on pulling electricity off the grid.

This section describes the main ways theatres can turn to sources of renewable energy.

2 SOLAR PV PANELS

Solar photovoltaic ('PV') panels are usually installed on roofs, and generate electricity which can both power systems within the theatre, and, at slack times, be fed back into the utility companies. 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.

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 the weight). However, they are the most common and viable form of renewable energy.

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. They typically work less well for theatres than PVs – particularly if the theatre 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 they don't often apply to theatres. Some rural theatres may be an exception.

5 STORING ENERGY

Energy demand isn't constant. Theatres need a lot of power before and during shows. Hot water is needed for dressing 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.

These typically take the form of batteries for electricity or water tanks for 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.

6 'PAY-BACK'

Renewable energy sources save you buying energy from utility companies. 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. Funds and subsidies are provided by utility companies. Details can be found on their websites.

CLP Power
https://www.clp.com.hk/en/index.html

HK Electric
https://www.hkelectric.com/en/

7 CHALLENGES FOR RENEWABLES

Renewables are a high profile way of showing a theatre's 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 need less energy (insulation), and measures to improve services (efficiency). Indeed, renewable energy will only have its full impact if it's operating on a building that's been upgraded to conserve energy 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.

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7. Biophilia and Water

1 INTRODUCTION

Society is increasingly aware of the challenge we face. Humanity is in a climate and biodiversity state of emergency. Sustainable buildings have an important part to play in supporting biophilia, efficient water and energy use, and a deeper connection to nature. By bringing biophilia principles into design, buildings can become more humane places to work and visit, improving people's wellbeing and creating a stronger sense of place.

2 WATER

Water is a valuable resource. Sustainable water use in the theatre and its surroundings focuses on reducing, recycling and reusing.

Water systems such as toilets and showers can minimise wastage. Not all the water theatres use 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 defined as water that is fit for human consumption and typically meets drinking water standards. Cutting down the use of drinking water can be achieved by:

- Low-flow and waterless fixtures.
- 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 water 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. Dual pipework is 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 theatres it won't be viable.

RAINWATER

Rainwater harvesting means collecting run-off from roofs and terraces to store for future use. Filtered rainwater harvesting 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, particularly in cities.

3 BIOPHILIA

Buildings can nurture biophilia by creating spaces that strengthen people's connection to nature. Green roofs and living walls can all help a theatre feel more alive, restorative, and welcoming.

It's important to understand where you're starting from when improving a theatre's biophilic quality. Are you in the city-centre (like most theatres) or in a more rural setting? Are there existing natural features that should be protected, or opportunities to introduce more nature into the site? Professional advice from an ecologist or biophilic design specialist may be needed to answer some of these questions.

A theatre's sustainability plan must include measures that support biophilia across all buildings and land under its control. If the work involves a capital project, the Local Authority may also require nature-positive design measures as part of their planning conditions.

GREEN ROOFS

Green roofs can clean the air and provide niche urban wildlife habitats. They connect internal and external spaces through roof terraces and planting. Planting can provide a calming environment and contrasting seasonal displays.

It's important to select plants that will support insects, require little irrigation, and survive the dryer, warmer climate that global warming is already producing.

Green roofs can also help by absorbing rain, preventing it from overwhelming drainage systems. Good water management means balancing irrigation needs and water demand as efficiently as possible.

4 OTHER OPPORTUNITIES

It's worth thinking laterally about how a theatre can support biophilia 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.

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, attenuate rain fall and rainwater build-up, increase a building's biophilia and create a point of interest. You'll need advice to make sure the roof is strong enough to take the extra weight.

Go to the Toolkit for more information.

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8. Gathering Information

1 INTRODUCTION

The Theatre Green Book : Sustainable Buildings is supported by a Building Survey tool which asks you a series of questions about your theatre. They'll build up a picture of your theatre's 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 theatre towards sustainability. That process is covered in the next section. Meanwhile, it's important to know how your theatre is performing now. That gives you a baseline. As improvements are made, you'll be able to re-measure, tracking your progress towards zero carbon.

Measuring how your theatre operates allows you to:

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

2 MEASURING ENERGY USE

Electric and gas meter readings are invaluable in the quest to reducing 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 record and regularly check the data, ideally every month. A reading before and after a show will help you understand the significance of your show loads. Each time you instal 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.

The important information to look for is energy consumption in kilowatt-hours (kWh) rather than the power in kilowatts (kW). If you currently have only limited sub-metering, you could instal sub-meters to monitor specific circuits at specific times of the day. Clamp-on electrical meters are a cheap alternative – but have a 20% margin of error.

Air temperature and quality can also be measured, to help you focus cooling and ventilation on the spaces and times which need it most. Monitors are relatively inexpensive to buy. If you have a Building Management System (BMS), this can be a very helpful tool to understand problem areas with your theatre.

Professional consultants use tools to "diagnose" more complex systems and potentially make significant savings. *See the toolkit for more information on Building Management Systems.*

Preparing to achieve BEAM Plus is a formal discipline for measuring your energy use.

3 BENCHMARKING

The most important measure for any theatre is to track your own progress towards zero carbon, measuring current energy use against the moment you prepared your Sustainability Plan. Should you wish to measure yourself against similar theatres, BEAM Plus are available to search on the Hong Kong Green Building Council (HKGBC) website. The key piece of information to look for is the "Annual Energy Use" in kWh/m2/year for both heating and cooling.

From their Creative Green data, Julie's Bicycle (https://juliesbicycle.org/take-action/creative-climate-tools/) 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.

In benchmarking against carbon emissions, remember that your performance can appear to improve simply because of improvements in the national electricity grid. If you want an accurate tracker for reducing your energy use, it's best to focus on 'kwh' (kilowatt hours).

4 HONG KONG'S NET-ZERO BUILDING STANDARDS

When upgrading or retrofitting existing venues to meet modern environmental standards, the carbon cost of the intervention itself must be carefully managed. The HKGBC framework sets science-based benchmarks that cover both operational carbon (emissions from running the building) and embodied carbon (emissions from manufacturing, transporting, and constructing building materials). Carrying out necessary building works to achieve a "Zero-Carbon-Ready" status inherently carries an upfront embodied carbon impact. The Theatre Green Book advocates for a circular approach to building works within Hong Kong's high-density urban landscape: prioritizing the retrofitting of existing structures over demolition, sourcing low-carbon materials, and ensuring that long-term operational savings outweigh upfront emissions, with offsetting reserved strictly for remaining, unavoidable carbon footprints.

5 SHARING

Theatre's journey towards sustainability depends on sharing knowledge, experience and data.

Once you've commissioned BEAM Plus, share it on your webpages and display it in your foyer. Messaging to your audience members can be vitally powerful.

Use theatre networks to share experience and contacts, support others and disseminate lessons learnt.

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9. Developing a Sustainability Plan

1 INTRODUCTION

The Theatre Green Book's Building Survey tool can be downloaded as an Excel workbook from the Resources area. It lists all the actions you can take to upgrade your building for sustainability. These include everything from roof insulation to entrance doors, from the state of your boilers to the possibility of fitting PVs on the roof.

These actions are already divided into three categories:

- Easy Wins
- Maintenance Projects
- Capital Projects

Within each category, actions are listed in order of impact, so you tackle the most important actions first.

For each action, the Building Survey tool asks a question to decide whether that action is possible for your theatre or not. Once you have deleted those actions which are not possible, you have a preliminary Sustainability Plan.

Your Sustainability Plan will answer the two key questions:

- What are the works our theatre needs?
- In what order should we tackle them?

2 WHAT ARE THE WORKS OUR THEATRE NEEDS?

The tool is based around a long list of the possible interventions that will make a theatre building sustainable. As you go through the Building 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.

The tool will narrow down the works your theatre needs. It then helps define the order in which you deliver them.

3 WHAT ORDER SHOULD WE TACKLE THEM?

A good Sustainability Plan balances 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 (Insulation), then services systems (Efficiency), and then adding Renewables.

The Building Survey tool automatically prioritises interventions according to this list, and to the impact they're likely to have on your theatre.

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

WHAT HAS THE MOST IMPACT?

Some high-impact works will involve cost (requiring a lengthy fund-raising process), getting planning or listed building permissions, or closing the theatre 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.

So your overall list of works needs to be triaged into three categories:

- Easy Wins
- Maintenance Projects
- Capital Projects

The Building Survey tool will do this automatically, though further triage will be required to make the list bespoke to your theatre (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 cooling 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 foyer windows, putting in new services systems, or replacing boilers with heat pumps.

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

4 FINALISING THE PLAN

Every theatre is different, and there's only so much that can be done automatically. The final step in making a Sustainability Plan is to go through the Sustainability Plan, and adjust it to reflect the specific needs and challenges of your building. First, you can shift interventions between the three categories of Easy Wins, Maintenance and Capital Projects, depending on your own intimate knowledge of the theatre 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 chapter 11 Maintenance identifies some of the typical refurbishment works theatres regularly undertake. When carrying out these works, there are often green opportunities missed, or where it may cost significantly less to integrate a Green Intervention. 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 a long way short of sustainable. But if they're only a few years old, it makes no sense to replace them until they've given a few more years of life. If your boilers are not yet in need of replacement and are 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.

Remember to go through this exercise with all your buildings.

5 SETTING A TIMELINE

The process outlined above will create a Sustainability Plan that:

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

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

6 THEATRE GREEN BOOK STANDARDS

The Theatre Green Book helps theatres track their transition through three standards: Basic, Intermediate and Advanced. The same standards are used to measure your progress in upgrading your building.

- To reach Basic, make a Sustainability Plan and put in hand the Easy Wins.
- To reach Intermediate, develop the plan with professional help and carry out the Maintenance Projects.
- To reach Advanced, develop and put in hand the Capital projects that will make your building as sustainable as possible.

THE BUILDING SURVEY TOOL

You'll find the Building Survey Tool in the Resources area.

It's been developed to allow theatre owners and managers to create a Sustainability Plan for their theatre. You'll still need professional advice, but the Building Survey Tool will put you in a position to seek the right advice at the right time (see below).

PROFESSIONAL ADVICE

The Theatre Green Book aims to empower theatre 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 then 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.

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 Projects.

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10. Easy Wins

1 INTRODUCTION

Most theatres have some Easy Wins that can improve sustainability with little cost or effort. The Building Survey Tool helps identify them. Energy costs are among a theatre's biggest financial burdens.

Theatres may be able to save as much as 20-25% of these costs through Easy Wins, so there's good reason to put them in hand straightaway.

Try and get measuring in place beforehand (such as 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

Utility companies are 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, theatres can switch hot water taps from the gas boiler to an electric point-of-use water heater. (NB this may only apply to smaller theatres with lower hot water demand – see chapter 5).

4 COMMON EASY WINS

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

INSULATION

- Draught proofing windows and doors
- Installing a draft lobby or electric "air curtain" to main doors
- Night Cooling (see Theatre Green Book volume 3 Sustainable Operations for more info)
- External features like parasols to minimise summer cooling

EFFICIENCY

- Check for nearby district heating cooling connection
- Water flow restrictors on taps and showers
- Installing smart cooling controls
- Improving lighting controls by installing daylight and/or occupancy sensors
- CO2-controlled ventilation to the auditorium
- Replacing old white appliances with Grade 1 Energy Label appliances
- Building Management System (BMS) diagnostics
- Cleaning mechanical ventilation filters
- Checking and aligning hot water operating hours to match occupation
- Improving hot and cold water tank insulation
- Installing / upgrading insulation on hot and cold water pipework

5 SHARING

With each piece of work you put in hand, try to record the impact and share it (see chapter 8 for more information). It will help others in their decision-making, and make sure the theatre sector is spending its limited resources as wisely as possible in tackling the climate emergency

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11. Maintenance Projects

1 INTRODUCTION

Many theatres struggle to maintain their buildings. Busy programming makes maintenance projects difficult. Scarce resources often need to be focused elsewhere. Buildings are sometimes left to take care of themselves, with problems postponed until the next capital project.

Unfortunately, capital projects, taking place every twenty years or so, are themselves a heavy burden. The fundraising effort is challenging. Closure risks losing audiences. Funders prefer new spaces like studios to the unglamorous task of insulating roofs or replacing boilers.

Maintenance is essential to sustainability. Maintenance ensures that:

- Plant works efficiently
- Problems are dealt with quickly, avoiding deterioration of building fabric
- Theatres avoid more major rebuilding and repair, which brings its own carbon footprint in terms of energy and materials

Maintenance is also an opportunity to put in hand mid-scale works for sustainability.

2 REGULAR MAINTENANCES

Regular maintenance can increase the serviceable life of plant and equipment, reducing ongoing replacement costs. It will also ensure plant and systems operate at their most efficient, reducing energy use and cost. Although maintenance can be a large expense, it can often pay 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 theatres clear of problems and make capital projects less of a shock to the system.

4 SUSTAINABILITY UPGRADES

Maintenance programmes are also the 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 theatres gather themselves for the next big capital project.

5 KILLING TWO BIRDS WITH ONE STONE

Maintenance is also the opportunity to make sure that the theatre's 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 BELOW OFFERS EXAMPLES OF SUCH OPPORTUNITIES

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Refurbishment tasks typically undertaken within theatres	Green Interventino worth considering	Green Intervention Reference
Bar refurbishment	Grade 1 Energy Label appliances	C33
	Underfloor cooling	C23
Auditorium seating	Consider displacement-ventilation opportunities	C41
Toilet upgrades	Increased airtightness around wall/floor junctions	L7
	Install LED lighting	C1
	Improve lighting controls - install daylight and/or occupancy sensors	C2
	Install instantaneous point-of-use water heaters	C10
	Replace extract-only with mechanical ventilation and heat recovery (MVHR)	C27
	Install auto-stop taps	
Office (or back of house) upgrades	Increased airtightness around wall/floor junctions	L7
	Install LED lighting	C1
	Improve lighting controls - install daylight and/or occupancy sensor	C2
	CO2 controlled ventilation	C3
	Install instantaneous point-of-use water heaters at tea points	C10
	Upgrade naturally ventilated spaces to include MVHR	C37
Accessibility improvements	Enhance door air leakage improvements	L8
Stage lighting enhancements	Convert stage lights from Tungsten to LED	C13
Rewiring whole or part of the building, or extending wiring to new facilities	Install sub-meters on areas known or suspected as high usage	C15
	Replace old light fixtures with LED fixtures	C1
	Install movement-sensor and/or daylight sensor lighting controls where relevant	C2
	Increase electrical load capacity to future-proof electric heat	
	Rationalise switching	
Lamp replacement	Replace any remaining tungsten or CFL lamps with LED equivalents	C1
	Replace fluorescent tubes with plug-in LED replacements	C1

Refurbishment tasks typically undertaken within theatres	Green Interventino worth considering	Green Intervention Reference
Resurfacing roof to cure leaks	Add insulation	L05
	Strengthen to support PV panels	
	Install skylight to enhance daylight	L06
	Paint surface white to reflect solar radiation and minimse the heat island effect	
Replacing rotten windows	Ensure good quality double (or triple glazing if the room often needs heating) and insulated frames (required by Building Regulations anyway)	L02
Redecoration	Replace old light fixtures with LED fixtures	C01
	Install movement-sensor and/or daylight sensor lighting controls where relevant	C02
Renewing controls	Install or update Building Energy Management System	C16
	Improve timing and zone controls	C18
	Optimised start/stop	C14
	Weather compensation	C14
Replacing hot water	Electric point-of-use heaters – especially if pipe runs are long	C10
Chiller needs replacing	Consider a heat pump with simultaneous heating and cooling functionality	
Replacing /upgrading ventilation plant	Install CO2 sensors to demand-control fresh air rate (post-Covid)	C03
	Install a heat recovery mechanism	
	Install units with integrated heat pumps to reduce the demand on fossil-fuel heating.	C26
	Install high efficiency fans with variable speed drives (and suitable controls)	C25
	Install electric and heat sub-meters	C15
	Simplification or upgrade of BMS controls	C16
Adding/refurbishing showers	Install low-flow water efficient shower heads	C11
	Waste water heat recovery system	C40

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12. Capital Projects

1 INTRODUCTION

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

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

Capital projects aren't new builds. They can be a refurbishment project, or a major overhaul of building systems for more energy (carbon) efficient solutions.

2 PRIORITISING SUSTAINABILITY

Theatres have many conflicting priorities. Most capital projects will have multiple goals, to make the most of closures and fund-raising opportunities. For example, as well as a wish-list of sustainability improvements, theatres may also need to sort out access, re-seat the auditorium, or build a new studio.
In past capital projects, sustainability has often dropped to the bottom of this wish-list, superseded by projects that support artistic growth (a new flying system), engagement (teaching space), or audience development and revenue (replacing the bars). Funding often supports more high-profile projects over the mundane business of insulating lofts.

It's therefore essential to make sure that sustainability goals are written into the basic aims of the capital project, 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 to all that dropping the sustainability elements prevents the theatre reaching targets which everyone has agreed.

3 STAKEHOLDERS

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

The green team support is vital for most theatres. The senior management must establish sustainability as a primary aim, as well as providing continuity and supporting staff.

Internal stakeholders may include department heads who understandably have different 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 theatre's Sustainability Plan.

If you're starting from a Sustainability Plan developed through the Green Book, then you will have some 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

The Net Zero Carbon Building Standard can also strengthen your case for investment, through evidence-based benchmarks and targets for decarbonisation.

5 BUILDING A TEAM

Theatres are bespoke buildings which 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 performance buildings, 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 better the chance of your running through iterations so as to shape the project in a way that suits your theatre, 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

Many theatres are historic listed buildings. Upgrading them to operate 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.

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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. The Theatres Trust is the UK's lead body for theatre buildings and may be able to provide advice and support on sustainability improvements to historic building.

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 theatres.

7 FUNDING

Funding for capital projects is always a challenge. Most theatres will aim for a combination of:

- Arts Council for their country
- Local Authorities
- Philanthropic Trusts
- Private giving
- Landlords
- A restoration levy on tickets
- Bank finance

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

8 PROGRAMMING CAPITAL PROJECTS

A perennial issue for theatre capital projects is the damaging effect of prolonged closure on audience development, artistic momentum and revenue. Think about programming 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.

9 DESIGNING AND BUILDING SUSTAINABLY

Capital projects involve building work – which itself uses resources and has a carbon footprint. The carbon that goes into making steel, bricks, concrete etc is known as 'embodied carbon'. Anyone engaged in building works should minimise embodied carbon by limiting the use of carbon insensitive materials and seeking to use low carbon materials such as stone and timber.

SUSTAINABILITY FRAMEWORKS

In Hong Kong, BEAM Plus is the definitive green building standard required by planning authorities and green funders alike. It provides a comprehensive sustainability framework and guideline covering all aspects of building performance; from integrated design to health and wellbeing, energy, water, materials, and innovation. To secure the 10% Gross Floor Area (GFA) concession under Buildings Department regulations, private developments must register for BEAM Plus, while major government projects are strictly mandated to achieve a Gold rating or above.

YOUR ROLE AS A CLIENT

Embarking on a capital project can be a significant challenge that will require regular decision to be made on all aspects of design and budget allocation. The following sections covering the development of a brief for your designers to respond to, selection of a design team and the approach to material outline the impact a capital project.

Starting with a set of sustainability goals, sustainability frameworks are one way of achieving this, and monitoring these throughout the project will be important to guide your decision making. Publishing these goals to your stakeholders is one way of ensuring that you remain accountable to delivering sustainable outcomes. It is very easy when the project budget comes under pressure to omit some of the sustainable measures of the project.

BRIEFING

The first question is to ask whether any new building is necessary at all? New building damages the planet, and should be avoided if possible. Very often, there are alternative ways of achieving a theatre company's goals, by repurposing existing spaces, or finding operational solutions to a challenge. The less you build, the less harm you cause. Remember, too, that if you enlarge your building, it's likely to use more energy – even if you also carry out sustainability improvements.

If you decide you need to build, then make sure that designing and building sustainably is central to the brief you give your design team.

If you're writing the brief for a capital project, think what your building needs to help you operate more sustainably. Production cycles based on reuse and recycling need more storage, so make that a priority.

Layout changes may reconfigure office space so you need to heat and light less of it during quiet periods.

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DESIGNING

If building is absolutely necessary, make sure your designers are experienced in sustainable design, and expert in the standards and principles of sustainable design and building.

Use materials and techniques that avoid adding to the theatre's existing carbon 'debt'. Where possible, choose long-lived and robust materials which won't need replacing. Seek out reused and recycled materials wherever you can.

Heavy steel and concrete structures are carbon-hungry. They're made heavier if you require an acoustic shell that keeps out all noise, or extreme loading standards for fly-tower or stage. Both have become customary in theatre design (audiences expect a lot, and you never know what a designer may dream up). But ask yourself what you really need. A lighter, smaller building will cause a lot less damage to the earth.

BUILDING

Building's impact on the climate is caused by:

- The energy and resource-depletion embodied in materials like concrete, steel, and bricks.
- The transport needed to bring materials to site, sometimes from far away in the world, and remove waste.
- The energy consumed and waste caused through building processes.

Before you even open a building and start using it, it will already have caused damage to the planet. The embodied carbon in a new building is often equivalent to years and years of operational carbon.

Buildings sometimes claim to be 'zero carbon' because they use relatively little energy. Their ecological harm is hidden in deep concrete foundations, heavy steel frames, and brick fired in energy-intensive kilns. For all those reasons it's important not only to be sure that you need to build, and that you've designed the building as sustainably as possible. Material sourcing, and site operations also need careful planning by expert consultants. Embodied carbon should be measured and shared: it's as important as any financial budget.

BEAM Plus is the best-known (see sidebar on p.22).

See the Toolkit for further guidance.

10 SUSTAINABILITY IN OPERATION

Theatres 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. See 'Soft Landings' (sidebar).

Beyond that, guidance on running your building sustainably will be found in Theatre Green Book : Sustainable Operations.

SOFT LANDINGS

Soft Landings is an initiative to ensure capital projects end smoothly and deliver their intended benefits. It allows for a period for review and monitoring after completion, so as to make sure planned improvements are actually achieved.

You can find more information at: https://www.thenbs.com/ knowledge/what-does-government-soft-landings-mean

Go to the Toolkit for more information

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13. Zero Carbon and Beyond

1 INTRODUCTION

The ultimate goal is to achieve zero carbon emissions each year: to operate without harming the planet.

For most, that will take several years to achieve. It's a transition, not an overnight change. For some, it may be impossible. For example, historic theatres often can't be fully insulated, and will probably always need more energy to run at acceptable temperatures.

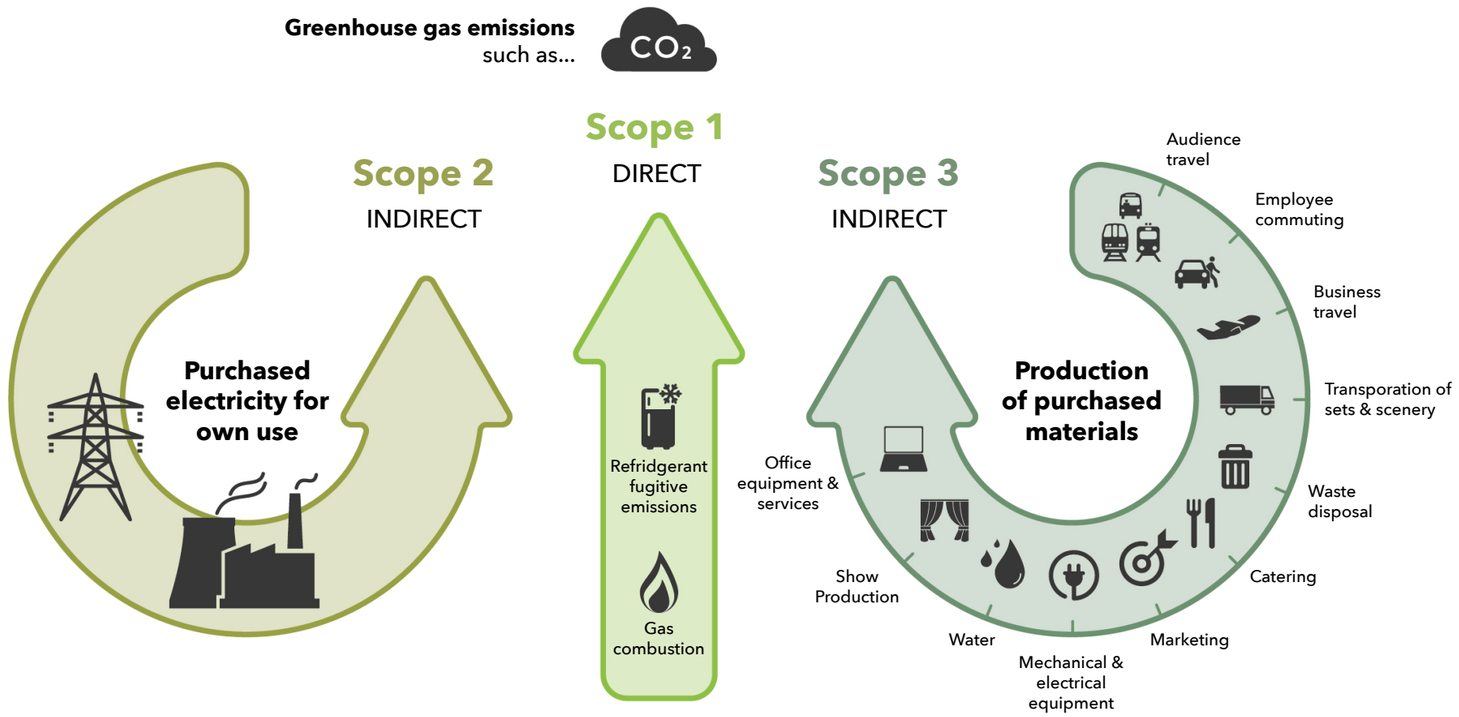
When theatres can't reach zero-carbon operation, they can reach 'net zero' by off-setting the amount of carbon they can't get rid of. Off-setting means calculating your carbon, then investing in a scheme (for example, tree-planting) to absorb the same amount of carbon as the theatre is emitting. In theory, the building's impact is cancelled out: it's 'net zero'.

But accurate carbon calculation is difficult, off-setting is full of complexity, and it can be hard to find schemes you can rely on. Offsetting should always be seen as a last resort. The first step is to reduce carbon emissions as far as practically possible.

2 OFFSETTING

The HKGBC provides carbon offset guidance through its Climate Change Framework for Built Environment, establishing a four-step hierarchy where offsetting is a last resort. Organizations must first prevent, then reduce/optimize, and plan for the future to avoid embodied carbon, before only offsetting residual emissions after all measures are exhausted. Offsetting must occur within the project/organizational boundary or through verified offset schemes, aligning with international best practices where offsets are reserved strictly for unavoidable carbon.

See https://zcrbc.hkgbc.org.hk



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3 REGENERATIVE ACTION

It will be a challenge for many theatres 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 biophilia, and taking whatever measures they can to address the climate emergency.

The journey need not end at carbon zero.

DEFINING EMISSIONS

Scope 1 – Emissions are caused directly by the theatre, when it burns fossil fuels like oil and gas in a boiler.

Scope 2 – Emissions come from indirect energy generation –
i.e. when a theatre buys electricity which the electricity company makes by burning fossil fuels in power stations.

Scope 1 and 2 are mostly within a theatre's control.

Scope 3 – Emissions are indirect. They're far harder for theatres to control. They're caused by the journeys audience make to reach the theatre, the carbon emissions of supply companies, and the transport needed to deliver supplies and take away waste. It's easy to get confused trying to calculate, let alone change them.

DEFINING NET ZERO

The Hong Kong Green Building Council (HKGBC) defines a net zero building in operation through two parallel certification pathways: Net Zero Energy Building and Zero-Carbon-Ready Building. The definitions and core criteria for operation are strictly delineated in the Zero-Carbon-Ready Building Scheme:

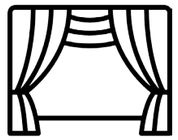
- Net Zero Energy Building: Requires that the annual on-site renewable energy generation must be equal to or greater than the annual energy consumption of the building.
- Zero-Carbon-Ready Building: Aligns with the International Energy Agency (IEA) criteria for highly energy-efficient buildings that rely on a completely decarbonized electricity supply. These buildings must demonstrate a significant reduction in energy demand, achieving around a 65% reduction from baseline figures.
- Operational Requirements: To apply for the Existing Building certification, the property must be occupied and used for at least 24 consecutive months following its occupation approval, with operating data and a minimum 80% average occupancy tracked over the assessment period.

For an existing theatre, 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."

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You'll find tools and more in the RESOURCES area



Sustainable Productions

for…

- *Downloadable Production Calculator*
- *More detailed guidance*
- *Case studies*
- *Toolkit*

Go to ***Productions*** resources



Sustainable Operations

for…

- *Downloadable Operations Tracker*
- *More detailed guidance*
- *Case studies*
- *Toolkit*

Go to ***Operations*** resources



Sustainable Buildings

for…

- *Downloadable Building Survey Tool*
- *More detailed guidance*
- *Case studies*
- *Toolkit*

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Certification

for…

- *Downloadable Self-certification forms*
- *Sustainability Glossary*

Go to ***General*** resources

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Renew Culture are co-founders and co-authors of the Theatre Green Book. We have pioneered the growth of Green Book networks across the world, and are leaders in theatre's journey to sustainability

https://www.renewculture.co.uk

Renew Culture
The Theatre Green Book

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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Next Steps

Next Steps

The Theatre Green Book is a living initiative. While this publication marks the First Edition of the Hong Kong adaptation, the international community continues to develop new resources, standard practices, and toolkits.

Stay Updated

To access the latest international updates, revised editions, and to download the complete suite of Excel-based support tools, including the Production Calculator, Operations Tracker, and Building Survey Tool. Please visit **The Theatre Green Book Official Website** www.theatregreenbook.com

Your Feedback Matters

This Hong Kong edition aims to reflect our unique production culture, supply chains, and teaching needs. As local practitioners use this text and share their findings, further localized versions will be adjusted to better serve our community.

We invite all producers, freelancers, venues, and theatre-makers to send comments, regional data, and feedback for future editions to the HKAPA Theatre Green Book Working Group: theatregreenbook@hkapa.edu

Theatre Green Book
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