



CURATING
TOMORROW

In partnership with



Measuring and Reporting Greenhouse Gas Emissions

An introduction for museums and cultural institutions

How can museums and cultural institutions measure and reduce their greenhouse gas emissions?



Curating Tomorrow is a consultancy for museums and the heritage sector, helping utilize their unique resources to enhance their contributions to society and the natural environment, the UN Sustainable Development Goals (SDGs), climate action and nature conservation, human rights and Disaster Risk Reduction. Curating Tomorrow provides training and development, advice and support to identify and produce strategies, policies and plans, directed towards sustainable development outcomes.

Co2Action is a sustainability consultancy that focuses on the quantitative aspects of climate change and impact reporting. Their goal is to guide clients toward emissions reduction in a quick and cost-effective manner to help drive toward a net zero future. By providing carbon accounting and ESG disclosure services, they help businesses assess impacts, set targets for reduction, and reduce those impacts through engineering and administrative means.

As a partnership combining expertise in museums, climate action, and greenhouse gas (GHG) accounting, we can help you understand climate change and climate action in the round:

- How to measure and report your operational emissions and set priorities for impactful action.
- How to build staff awareness, ability and confidence to act on climate change.
- How to support public climate empowerment through your events, exhibitions, an other activities.

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Section 1

INTRODUCTION AND BACKGROUND

What is greenhouse gas (GHG) accounting?

There is a lot of talk about net zero and climate action in museums and cultural institutions, including galleries, libraries, and archives (referred to as MCIs throughout this guide), but how can institutions accurately assess their environmental impact and evaluate progress towards their climate goals? This guide has been created to help you understand greenhouse gas (GHG) emissions accounting, and how you can use it to assess, calculate, and report your emissions with confidence.

The details of this guide have been developed within the guidelines, methodologies, and standards of the Greenhouse Gas (GHG) Protocol.¹ The Protocol was developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) in the late 1990s and is one of the most widely used standards for GHG accounting.

This guide shows how common activities of MCIs relate to the classes of emissions (Scopes and Categories) used in GHG accounting and aims to help you to begin your first GHG inventory, or to better understand your existing reporting and reporting requirements.

For information on climate change, climate impacts, the need for climate action and how museums can contribute to climate action, see 'Mobilising Museums for Climate Action', which is available as a PDF and in an online version (readable in different languages). This resource was developed as part of the project Museums for Climate Action, in 2021.

For more information on museums and the Sustainable Development Goals, see 'Museums and the Sustainable Development Goals: a how-to guide for museums, galleries, the cultural sector and their partners'², and 'Mainstreaming the Sustainable Development Goals: a results framework for galleries, libraries, archives and museums'³, which helps set goals and targets, and make and deliver plans for sustainable development outcomes.

For more information on Action for Climate Empowerment - the name given to the all-of-society and public-facing aspects of the UNFCCC and Paris Agreement - see 'Action for Climate Empowerment: a guide for galleries, libraries, archives and museums'⁴.



Who is this guide for?

This guide is designed for any museum or cultural institution that is interested in understanding, measuring and reducing its emissions to contribute to climate action.

This guide does not aim to be a replacement for undertaking a full greenhouse gas inventory, but it intends to help anyone wanting to take the first steps. It should also help you critically assess data you may already have, and better understand reports that may have been provided to you by third parties.

Directors and managers can use this guide to understand the importance and benefits of GHG accounting and emissions reporting, and how to disclose their activities and emissions with greater confidence and ability.

Building managers can increase their understanding of how buildings, energy and waste relate to the different Scope 3 Categories.

Those involved in **procurement decisions** can use the guide to understand the implications of procurement options.

Those involved in **developing collections and exhibitions** can use it to understand how those activities relate to the different Scope 3 Categories.

Those involved in **public education and communication**, including educators and marketing teams, can use this guide to understand the principles of GHG accounting, to incorporate into public-facing activities and messages.

Principles of GHG accounting

The GHG Protocol sets out the following principles for GHG accounting and reporting:⁵

RELEVANCE: Ensure the GHG inventory appropriately reflects the GHG emissions of the company and serves the decision-making needs of users - both internal and external to the company.

COMPLETENESS: Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusions.

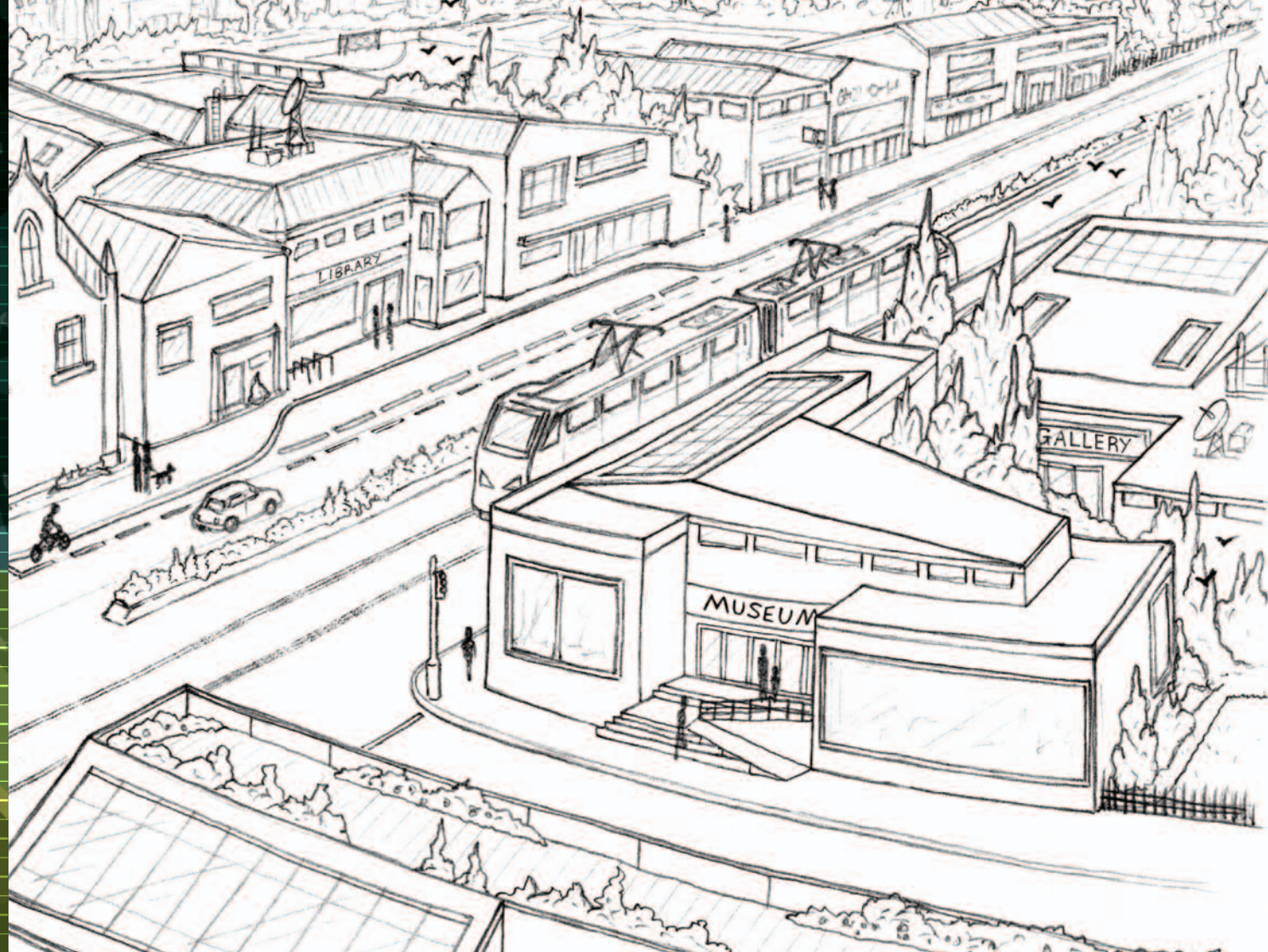
CONSISTENCY: Use consistent methodologies to allow for meaningful comparisons of emissions over time. Transparently document any changes to the data, inventory boundary, methods, or any other relevant factors in the time series.

TRANSPARENCY: Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.

ACCURACY: Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

This guide aims to help you to measure, monitor and report your emissions in line with these principles.

The GHG Protocol is widely used, and these principles are also incorporated into national reporting in some countries. For example, they underpin the 'Environmental Reporting Guidelines' issued by the UK Government (2019)⁶, which in turn underpin the 'Sustainability Reporting Guidance' (2021) issued by the UK Treasury⁷ for statutory sustainability reporting by public bodies.



The vision:

climate awareness, ambition, accountability and action

Imagine if every museum, library and archive understood how its activities contributed to climate change.

It would be able to focus its efforts on the activities that would make the biggest contribution to climate action.

It could report on its climate action progress openly and honestly to its funders, partners and stakeholders.

People would be able to ask their institutions what they were doing to take climate action, and have confidence that they were being provided with the right information.

Museums, libraries and other cultural institutions could be more effective in public education and awareness programmes related to climate action.

GHG accounting can build awareness of activities and their emissions, build confidence and focus that help raise ambition to take more impactful climate action, help public institutions to be accountable to society, fulfil public trust, and help institutions - and all those who work in them - to take part in climate action.

That is the purpose of this guide.

What is climate change?

Article 1 of the United Nations Framework Convention on Climate Change (UNFCCC)⁸ defines climate change as: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.”

The UNFCCC makes a distinction ⁹ between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes. Throughout this guide, references to ‘climate change’ refer to the definition in the UNFCCC, that is, the human-induced (anthropogenic) alteration of the climate.

What are greenhouse gases?

Climate change is primarily caused by altering the chemical composition of the atmosphere through the addition of greenhouse gases (GHGs) from a variety of human activities. Greenhouse gases cause the increased warming of the atmosphere through their physical properties that trap heat in the atmosphere. This has a wide variety of consequences for society and the environment, some of which are very severe.

The Kyoto Protocol¹⁰ identifies seven greenhouse gases:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF₆)
- Nitrogen trifluoride (NF₃) (added in 2013)

As each of these gases accumulate in the atmosphere they increase radiative forcing¹¹, which causes the average temperature of the atmosphere to increase.

Carbon dioxide (CO₂)

Carbon dioxide is the primary greenhouse gas emitted through human activities. For example, in 2020, CO₂ accounted for about 79% of all U.S. greenhouse gas emissions from human activities. Carbon dioxide is naturally present in the atmosphere as part of the Earth’s carbon cycle, but human-related emissions are responsible for the increase that has occurred in the atmosphere since the industrial revolution. The main human activity that emits CO₂ is the combustion of fossil fuels (coal, natural gas and oil) for energy and transportation.¹²

Methane (CH₄)

Methane (CH₄) is a hydrocarbon that is a primary component of natural gas. CH₄ is emitted from a variety of anthropogenic and natural sources. Anthropogenic emission sources include landfills, oil and natural gas systems, agricultural activities, coal mining, stationary and mobile combustion, wastewater treatment, and certain industrial processes.

Methane is the second most abundant anthropogenic GHG after carbon dioxide, accounting for about 20% of global emissions. Over the last two centuries, methane concentrations in the atmosphere have more than doubled, largely due to human-related activities.¹³

Nitrous oxide (N₂O)

Nitrous oxide is a colourless gas naturally present in the atmosphere as part of the Earth's nitrogen cycle and has a variety of natural sources. Human activities such as agriculture, fuel combustion, wastewater management, and industrial processes are increasing the amount of N₂O in the atmosphere. Nitrous oxide molecules stay in the atmosphere for an average of 114 years before being removed by a sink or destroyed through chemical reactions.¹⁴

Less common GHGs

These include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF₆). Nitrogen trifluoride (NF₃) was added to the list in 2013. The fluorine gases are rarer than carbon dioxide and methane but are especially powerful greenhouse gases.

Black carbon/soot

Although not a greenhouse gas, black carbon (soot) is also responsible for global heating as it absorbs heat.

What activities produce greenhouse gases?

Many human activities result in the production of greenhouse gases that are released into the atmosphere, causing climate change. These include¹⁵:

- **Burning fossil fuels** as a source of energy, in homes, industry, and transport (CO₂ and CH₄).
- **Production of fertilisers** (CO₂) and their over-application to land (N₂O).
- **Production of concrete and cement** (CO₂).
- **Release of other greenhouse gases** from domestic and industrial settings (fluorine gases).
- **General wastefulness** from over-production or over-consumption of natural resources, waste of used resources that could be reused or recycled, and high-energy lifestyles among a relatively small proportion of people (all greenhouse gases).
- **Destroying forests**, especially by burning. Most forest clearance is for agriculture (CO₂ and CH₄).
- **Release of methane and other greenhouse gases** from melting permafrost, paddy fields, and drying peatlands (CO₂ and CH₄).
- **Degrading land and soil** so that it releases greenhouse gases or is unable to remove them from the atmosphere (CO₂ and CH₄).
- **Increasing numbers of cows, sheep, and goats** which release methane through their digestion process (CH₄).

The UNFCCC and Paris Agreement

One of the outcomes of the 1992 Rio Earth Summit was an international agreement: the United Nations Framework Convention on Climate Change (UNFCCC). Countries committed to the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system...”¹⁶

Since it came into force, in 1994, signatories (called Parties) have met yearly to monitor progress and debate issues, at conferences called the COP (Conference of the Parties). Important developments since 1994 include the Kyoto Protocol, which further committed signatories to reduce (rather than stabilize) greenhouse gas emissions, and the Paris Agreement of 2015, which set to limit average temperature rise well below 2°C, and preferably to 1.5 °C compared to 1900 levels. Countries make their own plans to deliver these commitments, called Nationally Determined Contributions.

Each country has its own approach to managing emissions: some countries have laws regarding emissions and emissions reductions, and sectors within countries also often have regulations for measuring and reducing emissions, all of which are relevant to GHG accounting.

That means that, depending on where you are, you might have to measure emissions to comply with the law or with a funder’s regulations. Wherever you are, it could be considered good practice for public institutions, such as museums and other cultural institutions, to measure, reduce and disclose their emissions for public accountability and transparency.

The Glasgow Work Programme on Action for Climate Empowerment, adopted at COP26 in 2021 and to run till 2031, specifies the importance of museums, cultural institutions and other sustainable development actors in climate empowerment. It provides an excellent framework to take ambitious, co-ordinated climate action, including training, public access to information, evaluating and communicating climate action. GHG accounting can support these aspects of the new programme.



GHG accounting as part of sustainable development

Sustainable development means focused activity to achieve a more harmonious balance of considerations of people, planet, and prosperity, which means working to advance positive benefits and removing negative impacts. Sustainable development is a presumption in many planning processes.

The main programme to support sustainable development is Agenda 2030¹⁷, which is largely achieved through 17 Sustainable Development Goals (SDGs). Climate action has its own dedicated goal, SDG 13, but climate change and climate action are related to all 17 SDGs and found in many other targets.

GHG accounting relates directly to several SDGs and targets, most notably the following two targets:



SDG 12 aims to “Ensure sustainable consumption and production patterns”. Within this goal, target 12.6 specifically encourages companies to adopt sustainable practices and sustainability reporting, which includes GHG accounting.

SDG 13 aims to “Take urgent action to combat climate change and its impacts”. Within this goal, target SDG 13.3 aims to strengthen organizations’ and communities’ capacities to take climate action, through education and training, skills, and participation.

This guide is intended to support museums and cultural institutions to take action for these two SDG targets, which in turn support many other SDGs and targets. The guide aims to build your capacities - knowledge, confidence, ability - to measure, reduce and report emissions in your MCI. Measuring and reporting GHG emissions is important for achieving SDG 7 on clean energy, SDG 9 on sustainable infrastructure, SDG 11 on sustainable cities and communities, and SDG 16 on effective, accountable and transparent institutions.

Why should museums and cultural institutions measure their greenhouse gas emissions?

In order to reduce or enhance emissions, make plans, and demonstrate results, emissions must be measured. As the saying goes, 'If you can measure it, you can manage it'.

Most of the main schemes provide guidance and support to measure, manage and report emissions. For example, UN Climate Neutral Now¹⁸ identifies the following reasons for measuring emissions and participating in the initiative:

- Understand your emissions.
- Receive support to start the process to calculate a carbon footprint.
- Receive advice on how to reduce a carbon footprint.
- Reduce costs, through resource and energy efficiency.
- Demonstrate leadership.
- Be recognised as participating in an UN-led initiative.
- Use of the logo to demonstrate participation.
- Potential to be highlighted to other participants through communications.
- Eligibility to gain additional recognition through award schemes.
- Identify risks and opportunities arising from emissions and related activities.
- Brand recognition.
- Motivate employees.
- Potential to participate in additional schemes, where eligible (e.g. Race to Zero).
- Align with existing carbon neutrality standards such as PAS 2060.
- Be prepared to submit to other emissions reporting, at local or sector level.
- An opportunity for recognition, especially in countries and sectors that do not have recognition schemes

See 'Schemes and initiatives to take part in' section for more information on Climate Neutral Now.

Section 2

GREENHOUSE GAS (GHG) ACCOUNTING

Greenhouse gas (GHG) accounting

GHG accounting is a methodology used by organizations to inventory their emissions by using published Emission Factors to calculate the quantity of GHG emissions related to their activity. When developing a GHG emissions inventory, it is important to understand how emissions are categorized and calculated. But before trying to estimate its emissions, the organization needs to set clear boundaries to develop this calculation. It is often hard to track every step of the operation, but there are some ways to approximate, and different approaches that will be explained further in this guide.

After having done the calculation, the goal is to make a strategy to reduce the emissions. There are different targets that organizations can consider, but the most relevant nowadays is called net zero. This concept is easy to understand but hard to achieve. According to the United Nations¹⁹, net zero refers to “cutting greenhouse gas emissions to as close to zero as possible, with any remaining emissions re-absorbed from the atmosphere, by oceans and forests for instance.” This means making every possible effort to reduce emissions through engineering, behaviour and administrative actions until... as possible; and by reabsorbing the remaining emissions using methods (e.g. carbon offsetting) that are aligned with some basic principles²⁰ that favour carbon removal over carbon reduction.

Increasingly, museums and cultural institutions are setting environmental targets and making environmental claims, notably around working towards net zero by a particular date. To be credible - and realistic - these claims need to be backed up with an explanation of which aspects of their activity are covered in their net zero targets claims, together with plans and open and transparent reporting.

This section introduces the technicalities of GHG accounting and includes examples in the context of museums and cultural institutions.

Climate neutrality, carbon neutrality and net zero

When developing a GHG inventory, it is necessary to have a clear goal that you are working towards, and also a clear understanding of what the different goals mean. The terminology of climate neutral, carbon neutral, and net zero can be confusing, but there are important differences. While there are no universally agreed definitions, the UN Climate Neutral Now initiative²¹ uses the terms in the following ways:

Climate neutrality

Climate neutrality can be described as a balance between GHG emissions and removals. It is achievable at a global/planetary level and at a stakeholder (companies, organizations, subnational authorities, individuals) level. At stakeholder level, only carbon credits from projects that capture GHGs in the long term can be used. In practice, an organization may purchase long-term, verified carbon credits on a one-time or recurring basis to offset emissions and achieve climate neutrality.

Carbon neutrality

Carbon neutrality is action by a stakeholder (company, organization, subnational authority, individual) to reduce and avoid emissions, and then compensate for the remaining emissions through the use of carbon credits. The use of carbon credits from projects that reduce, avoid and temporarily capture GHGs is possible. This is not applicable at a global/planetary level due to potential double-counting.

Net zero

Net zero is regarded as synonymous with carbon neutrality. The most important thing to note is that the priority in all of these must be a firm commitment to rapidly reducing greenhouse gas emissions, before any consideration of offsetting in whatever form. The key difference between climate neutrality and carbon neutrality/net zero is that climate neutrality does not allow for the use of short-term offsets: only projects supporting long-term storage of greenhouse gases are permissible.

How are greenhouse gas emissions categorized?

Global standards for emissions accounting divide emissions into three classes by source, which are referred to as Scopes. In general, these Scopes describe how much operational control an organization has over a given emissions source. The three Scopes are:

- **Scope 1:**
Direct emissions from releases of GHG to the atmosphere or from fuel combustion in sources owned or operated by the reporting organization.
- **Scope 2:**
Indirect emissions from purchased electricity, steam, and other utilities, in terms of the emissions produced in the production of that energy.
- **Scope 3:**
Optional emissions. Examples include employee business travel and commuting, consumption of goods and services (which includes visitor travel to museums), investments, and waste management.

The GHG Protocol separates Scope 3 emissions into 15 accounting Categories, as follows:

	Category	Description
1	Purchased goods and services	emissions from the production of products purchased or acquired
2	Capital goods	emissions from the production of capital goods
3	Fuel and energy-related activities	emissions related to the production of fuels and energy purchased and consumed
4	Upstream transportation and distribution	transportation and distribution of products purchased
5	Waste generated in operations	emissions from third-party disposal and treatment of waste generated
6	Business travel	emissions from employees' transportation for business-related activities
7	Employee commuting	emissions from employees' transportation between their homes and their worksites
8	Upstream leased assets	emissions from the operation of leased assets (e.g. storage in buildings owned by others)
9	Downstream transportation and distribution	emissions from transportation and distribution of sold products in vehicles and facilities owned by third parties [includes emissions resulting from visitor travel to reporting organization] ²²

	Category	Description
10	Processing of sold products	emissions from processing of sold intermediate products by third parties subsequent to sale
11	Use of sold products	emissions from the use of goods and services sold [includes free goods and services]
12	End-of-life treatment of sold products	emissions from the waste disposal and treatment of products sold [or otherwise produced]
13	Downstream leased assets	emissions from the operation of assets that are owned by the reporting organization
14	Franchises	emissions from the operation of franchises [e.g. book production or distribution, marketing distribution]
15	Investments	emissions associated with the reporting company's investments [e.g. activity related to endowments, pension funds, bank accounts]

Emission Factors

Emission Factors are used to calculate the GHG emissions resulting from given activities. These Factors convert the units of a specific activity to a mass of GHG emissions and are developed by understanding the chemical or physical reactions that produce GHG emissions. There are separate Factors for calculating the emissions of different GHGs (i.e. CH₄, N₂O, CO₂), but some Emission Factors account for all GHGs from a source and output in units of CO₂e.

Example Emission Factors from the UK GHG conversion factors database²³

CO ₂ emissions from a petrol-powered medium car	0.30122 kg CO ₂ /vehicle-mile
CO ₂ emissions from supplied electricity	0.21016 kg CO ₂ /kWh
CO ₂ emissions from landfilling of household waste	446.242 kg CO ₂ e/tonne

Example: How to use Emission Factors

One must collect activity data and then find the applicable Emission Factor with which to calculate GHG emissions. Most Emission Factors are used in the same manner as presented by the equation below.

GHG emissions = [activity data] x [Emission Factor]

Using the example Emission Factors provided on the opposite page, we will calculate the GHG emissions for average UK driving distances, electricity consumption, and waste disposal.

Driving (6,800 miles/year ²⁴) x (0.30122 kg CO ₂ /mile) =	2,050 kg CO₂/person-year
Electricity (3,954 kWh/household ²⁵) x (0.21016 kg CO ₂ /kWh) =	830 kg CO₂/household-year
Waste (0.2 tonnes/person ²⁶) x (446.242 kg CO ₂ e/tonne) =	89 kg CO₂e/person-year

Emission Factors for business activities are generally tailored to specific countries and regions and can generally be found on environmental agency websites (e.g. the US Environmental Protection Agency, the UK Environmental Agency, etc.). For each activity performed within Scope 1, 2, and 3 emissions Categories, Emission Factors should be cited from reputable sources. Some sources for Emission Factors are provided below.

[Intergovernmental Panel on Climate Change - Emission Factor Database](#)
[United Kingdom Government - Greenhouse gas reporting: conversion factors](#)
[United States Environmental Protection Agency - GHG Emission Factors Hub](#)
[Australia National Greenhouse Accounts Factors: 2021](#)
[Greenhouse Gas Protocol - Calculation Tools](#)
[European Environmental Agency - Emission Factor Database](#)
[Germany - Umweltbundesamt, CO2 Emission Factors for Fossil Fuels](#)
[Spain - Emission Factors 2021](#)

Converting measurements

You should be careful to ensure that all the terms in your emissions calculation are in agreement with one another. For example, if you have an Emission Factor that is based on kilolitres (1,000 litres), but your measurement of fuel used in an activity is in litres, you will need to convert the Emission Factor into litres, or the fuel measurement into kilolitres.

Prefixes
Prefixes are commonly used with units of power, energy, and distance. As an example, we will use units of Watts to show equivalencies.

0.000001 gigawatts (GW) = 0.001 megawatts (MW) = 1 kilowatt (kW) = 1,000 watts (W)

Mass			
1,000 kilograms	=	1 metric ton (mt)	= 1 tonne (t)
1 pound (lb)	=	16 ounces (oz)	
1 ounce (oz)	=	28.34952 grams (g)	
1 kilogram (kg)	=	2.2046 pounds (lb)	
1 metric ton (mt)	=	1.1023 US short tons	

Volume			
1 litre (L)	=	0.001 cubic meters (m³)	
1 cubic meter (m³)	=	35.335 cubic feet (ft³)	
1 litre (L)	=	0.264 US gallons (gal)	

Distance			
1 centimeter (cm)	=	0.3937 inches (in)	
1 foot (ft)	=	12 inches (in)	
1 yard (yd)	=	3 feet (ft)	
1 meter (m)	=	3.281 feet (ft)	
1 meter (m)	=	1.0936 yards (yd)	
1 kilometer (km)	=	0.62 miles (mi)	

Check your units
The desired outcome of most GHG calculations is to end up with values in units of kg or tonnes of CO₂ equivalents. To reach this outcome, it is important to verify that unit conversions are done properly by ensuring that other units of measurement such as km, L, gal, etc. are ‘cancelled out’ when using Emission Factors.

For example, if 1 passenger flies 1,000 km on a plane, we ensure that the units in the emission factor are based on passengers and distance (km), so that they cancel each other to yield emissions in units of kg CO₂e.

1 passenger × 1,000 km × 0.245877 $\frac{\text{Kg CO}_2\text{e}}{\text{Passenger-km}}$ = 246 kg CO₂e

1 passenger × ~~1,000 km~~ × 0.245877 $\frac{\text{Kg CO}_2\text{e}}{\text{Passenger-km}}$ = 246 kg CO₂e

Global warming potential (GWP)

As defined by GHG Protocol, GWP is “a factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO2.”²⁷ In more simple terms, different gases have different effects on the atmosphere based on their residence time in the atmosphere, their ability to increase radiative forcing, and the time horizon being considered. For the purposes of this guide, the GWPs recommended are based on a time horizon of 100 years.²⁸

The global warming potentials of different GHGs are provided in the table below (from the IPCC Fifth Assessment Report, 2014).

Gas		Global Warming Potential
Carbon dioxide	CO ₂	1
Methane	CH ₄	28
Nitrous oxide	N ₂ O	265
Hydrofluorocarbons	HFCs	4,000-12,400
Perfluorocarbons	PFCs	6,630-17,400
Sulphur hexafluoride	SF ₆	23,500
Nitrogen trifluoride	NF ₃	16,100

CO₂ equivalency (CO₂e)

Because different greenhouse gases vary in their Global Warming Potential, it is important to calculate emissions in a consistent unit.

Carbon dioxide equivalent (CO₂e for short) is the universal unit of measurement to indicate the global warming potential (GWP) of each greenhouse gas, expressed in terms of the GWP of one unit of carbon dioxide.

To convert values into units of CO₂e, one must multiply the quantity of a given GHG by its GWP. Examples are provided on the following pages.

Mass of a given GHG

X

GWP

=

Mass in CO₂e

Example 1: GHG emissions from a refrigerant leak

An archive in Barcelona has an outdated refrigeration system that contains HFC-134a. The refrigerator coils were damaged during construction activities, resulting in the release of approximately 1 kg of refrigerant. Spain's Ministerio para la Transición Ecológica y el Reto Demográfico (Ministry for the Ecological Transition and the Demographic Challenge) has quantified the GWP of HCF-134a as 1,430. The main GHG accountant for the facility would like to convert that quantity into units of carbon dioxide equivalents for inventory purposes.

(Mass of GHG)	x	(GWP)	=	(CO ₂ e)
1 kg HFC-134a	x	1,430	=	1,430 kg CO ₂ e

Example 2: Calculating emissions in units of CO₂e with common GHGs

Some organizations, such as the US EPA, provide Emission Factors separately for CO₂, CH₄, N₂O, and other GHGs. At times, it is convenient to combine these Factors into one that directly calculates in units of CO₂e.

Emission Factors (EF) for passenger car transportation:	CO ₂	0.332 kg CO ₂ /mile
	CH ₄	0.007 g CH ₄ /mile
	N ₂ O	0.007 g N ₂ O/mile

Using global warming potentials for CH₄ and N₂O, we can sum these Factors together. Note that units must be consistent prior to combining these Factors.

$$[EF_{CO_2e}] = [EFCO_2] + (GWP_{CH_4} \times [EF_{CH_4}]) + (GWP_{N_2O} \times [EF_{N_2O}])$$
$$[EF_{CO_2e}] = [0.332 \text{ kg CO}_2/\text{mi}] + (28 \times [0.000007 \text{ kg CH}_4/\text{mi}]) + (265 \times [0.000007 \text{ kg N}_2\text{O}/\text{mi}])$$
$$[EF_{CO_2e}] = [0.332 \text{ kg CO}_2\text{e}/\text{mi}] + [0.000196 \text{ kg CO}_2\text{e}/\text{mi}] + [0.001855 \text{ kg CO}_2\text{e}/\text{mi}]$$
$$[EF_{CO_2e}] = 0.33451 \text{ kg CO}_2\text{e}/\text{mi}$$

Note that inclusion of CO₂ equivalent emissions from CH₄ and N₂O makes less than 1% of a difference for this specific use case. Though it is a small impact, it is still important to account for all emissions, especially for larger organizations.

Steps to developing your GHG inventory



1. Identify the purpose of your GHG inventory

What is the primary reason your organization wants to evaluate its emissions? Is your organization's net zero goal approaching faster than anticipated? Is there a new set of regulations to comply with? Are stakeholders demanding transparency?

Organizations may have different motivators for setting up an initial inventory, which may lead to different approaches. As an example, net zero aspirations may only be applicable for Scope 1 and 2 emissions, while regulatory requirements may require reporting for certain Scope 3.

2. Set boundaries for creating your GHG inventory

When setting boundaries for an initial inventory, many factors will affect how calculations proceed. It is recommended that your organization develop an internal standard operating procedure that details what sources will be accounted for, what methodologies will be used, who will be responsible, and how frequently it is updated.

By documenting the boundaries, methodologies and assumptions that will be used for the inventory, the organization will be better prepared to set operational boundaries for the calculation.

3. Collect data and calculate

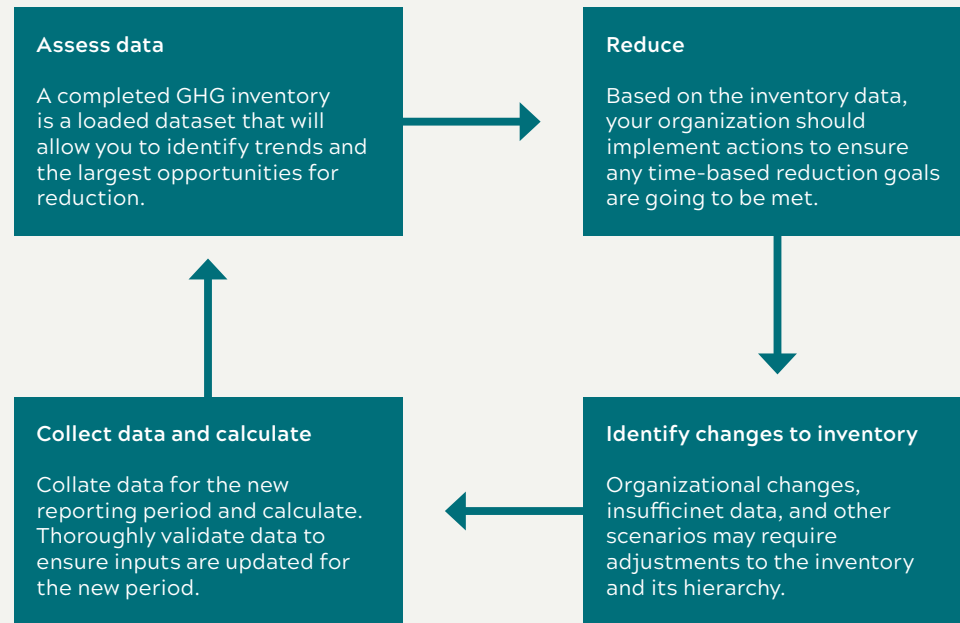
With an operational hierarchy developed, proceed to collecting the relevant input data necessary to calculate GHG emissions. Different approaches should be taken depending on the complexity of an organization. Consider using questionnaires, facility key contacts, GHG accounting software, etc. to facilitate this task.

Data collection is often the most time-consuming piece of crafting an inventory, so organizations should allow plenty of time for this step.

4. Understand your operational footprint and supply chain

Now that boundaries have been set on Scopes, organizational accounting, and other methodologies, your organization should begin creating a hierarchy that will be used to organize data into facilities, regions, operation types, etc.

Begin by creating a hierarchy for Scope 1 and 2 sources and then move on to mapping the supply chain, beginning with suppliers that likely have the largest impact.



Ownership v. operatorship methodologies

Before starting the GHG accounting itself, you must establish the limits of the organization and its impacts: imaginary lines that tell you what should be included in the inventory. For example, where you are working in partnership with another organization, you will have to decide on an approach on who should account for emissions from partnership activities or shared assets.

Organizational boundaries: which operations will be considered in the inventory? Will your organization include only owned and operated assets, or will all equity emissions be included? These differing methods are described by the control approach and equity approach:

- **Control Approach:** The organization considers 100% of the GHG emissions and removals in the facilities over which it has operational or financial control. Operational control means that the organization has the authority to modify the operational policies. It considers everything under its operating permit. Financial control means that the organization has the authority to direct the financial policies of the company.
- **Equity Share Approach:** The organization is responsible for its part of emissions and removals only. The accounting is made according to the share distribution of the company operating. It does not depend on operational or financial control.

Example: how to apply boundaries

An art collective is developing its first GHG inventory and needs to understand how to account for emissions from activities related to its partnerships, joint ventures, and joint-operating agreements.

The organization has a stake in 3 different facilities

- **Facility A** is 100% owned and operated by the art collective.
Facility A emits 1,500 tonnes CO₂e per year.
- **Facility B** is a 50/50 joint venture.
The art collective has financial and operational control of the facility.
Facility B emits 2,400 tonnes CO₂e per year.
- **Facility C** is a 30/70 joint venture.
A third party has financial and operational control of the facility and has 70% equity.
Facility C emits 1,800 tonnes CO₂e per year.

Control Approach

Facility A
(100%) x (1,500 mt CO₂e/year) = 1,500 mt/yr

+

Facility B
(100%) x (2,400 mt CO₂e/year) = 2,400 mt/yr

+

Facility C
(0%) x (1,800 mt CO₂e/year) = 0 mt/yr

3,900 mt CO₂e per year

Equity Share Approach

Facility A
(100%) x (1,500 mt CO₂e/year) = 1,500 mt/yr

+

Facility B
(50%) x (2,400 mt CO₂e/year) = 1,200 mt/yr

+

Facility C
(30%) x (1,800 mt CO₂e/year) = 540 mt/yr

3,240 mt CO₂e per year

Total emission accounting will vary between the two approaches, so it is important to choose a method and clearly state assumptions during the calculation phase.

Defining GHG inventory boundaries

Inventory boundaries are those imaginary lines that define emission sources, geographic area, time frame, and gases to account for.

Which sources of emissions are going to be included and how are they categorized? An organization must account for all GHG emission and removal sources and allocate these to the three Scopes.

Though it is possible to calculate emissions deep into an organization's supply chain, it is more practical to focus on the emission categories that represent the bulk of its carbon footprint.

When evaluating boundaries, it may be helpful for your organization to conduct a workshop to review the applicability of each Scope and the Scope 3 Categories.

Where to begin?

So, which sources of emissions should be included in your organization's GHG inventory? As described in the 'How are greenhouse gas emissions categorized?' section, GHG emissions are divided into three different Scopes. Emissions directly attributable to a reporting organization's operations are accounted for in Scope 1 and 2 calculations while Scope 3 accounts for emissions related to that organization's supply chain.

Under most existing disclosure and reporting requirements, accounting of Scope 1 and 2 emissions is mandatory, as the activities included in these categories are under the direct control of the organization.

Fewer disclosure and reporting requirements exist for Scope 3 emissions, as they are not under the operational control of a reporting organization. Some countries and frameworks require disclosure for Scope 3 categories over which entities have more ability to influence, such as Category 6 - business travel.

When developing your organization's GHG inventory, begin with quantifying Scope 1 and 2 emissions, as they are easy to calculate and are the most relevant for reporting purposes. For Scope 3 accounting, begin by quantifying any categories that have mandatory reporting requirements in your country's or auditor's reporting regime, then move on to quantifying the largest Scope 3 emissions sources.

Increasing difficulty in data collection and quantification

Easy	Scope 1 - Direct GHG Emissions Scope 2 - Indirect GHG Emissions
Fairly easy	Scope 3, Category 6 - Business travel Scope 3, Category 4 - Upstream transportation and distribution Scope 3, Category 9 - Downstream transportation and distribution Scope 3, Category 5 - Waste generated in operations Scope 3, Category 7 - Employee commuting Scope 3, Category 13 - Downstream leased assets Scope 3, Category 8 - Upstream leased assets Scope 3, Category 3 - Fuel and energy-related activities Scope 3, Category 14 - Franchises Scope 3, Category 15 - Investments
More difficult	Scope 3, Category 11 - Use of sold products Scope 3, Category 12 - End-of-life treatment of sold products Scope 3, Category 10 - Processing of sold products Scope 3, Category 1 - Purchased goods and services Scope 3, Category 2 - Capital goods

Section 3

UNDERSTANDING EMISSIONS SCOPES AND CATEGORIES

Understanding emissions Scopes and Categories

This section explores the three Scopes of emissions, and the 15 Categories of Scope 3 emissions. It provides examples of where you would find the necessary data to calculate emissions, and provides worked examples related to the work of MCIs.

Scope 1 Emissions - Direct Emissions

Scope 1 emissions are direct GHG emissions that occur from sources controlled or owned by an organization.²⁹ This Scope of emissions is most associated with fuel combustion from boilers, furnaces, generators, and petroleum-fuelled vehicles owned by the reporting organization. Other direct sources include non-combustion processes that directly release greenhouse gases, such as leaks from refrigerant piping.

What does this mean for museums and cultural institutions?
Scope 1 emissions are generated on site and from vehicles owned by the organization. Because Scope 1 emissions come directly from an organization’s operations, they will require quantification and disclosure in countries with mandatory reporting requirements. For MCIs, Scope 1 emissions will likely be lower than those from Scope 2 and Scope 3, as they generally do not consume much fuel onsite. The most common sources of Scope 1 emissions in MCIs would be on-site power generators, gas or oil heaters, kitchen equipment, vehicles owned by the organization, and refrigeration systems.

For processes that consume fuels (natural gas, gasoline, heating oil, etc.), the simplest way to calculate Scope 1 emissions is to collect total fuel consumption data and convert those values into emissions with Emission Factors based on fuel volume or mass. In general, fuel consumption data can be collected from utility bills for natural gas, fuel receipts/bills, and other sources such as specification sheets for combustion equipment.

For MCIs with refrigeration or air conditioning systems, they will likely emit refrigerants over time through small leaks called fugitive emissions. Many refrigerants are potent greenhouse gases, with GWPs that can be more than 10,000. These Emission Factors can be estimated using fugitive Emission Factors or by accounting for quantities of refrigerant that are added to refrigeration or air conditioning equipment during maintenance.

Example problem: emergency power generation

A science museum in Liverpool needs to purchase a new backup electricity generator and would like to determine which fuel source would have the lowest GHG emissions. In previous years, the museum’s onsite generator produced 500,000 kWh of electricity.

Relevant Emission Factors³⁰ : Natural gas 0.18316 kg CO₂e/kWh (Gross CV)
Diesel 0.23686 kg CO₂e/kWh (Gross CV)

Potential emissions from natural gas generator
(500,000 kWh/yr) x (0.18316 kg CO₂e/kWh) = **91,580 kg CO₂e/yr**

Potential emissions from diesel generator
(500,000 kWh/yr) x (0.23686 kg CO₂e/kWh) = **118,430 kg CO₂e/yr**

By installing a natural gas generator, the museum can avoid the emissions of approximately **27 tonnes of CO₂e per year**.

Scope 2 Emissions - Indirect Emissions from Supplied Utilities

According to the GHG Protocol³¹, Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the organization. Although these emissions physically occur at the facility (such as a power station) where they are generated, they are accounted for in an organization’s GHG inventory because they are a result of the organization’s energy use. Scope 2 emissions are usually calculated from energy/utility bills, but may also be done using onsite utility meters if necessary.

What does this mean for museums and cultural institutions?
Like Scope 1 emissions, Scope 2 disclosures are often required by regulatory bodies. This Scope of emissions will most commonly be assessed for supplied electricity but includes other less common utilities such as steam or heat. Because this category quantifies emissions from utilities provided by a third party, utility bills provide the data and makes calculations simple. This category will require more resources to calculate if the reporting organization owns and operates many facilities.

Emission Factors for Scope 2 emissions vary by region, as every location on an electrical grid receives electricity that is generated by various sources (nuclear, wind, solar, oil, natural gas, coal, etc.). Because of the variability in emissions, most countries can provide Emission Factors for a given country, region, state, or even smaller localities.

Example problem: renewable electricity plans

A fine arts gallery in Houston is interested in sourcing 100% renewable energy from a wind power company and would like to calculate the emissions reduction associated with the change. The museum consumes approximately 3,500 MWh of electricity per year.

Relevant Emission Factors:	The US EPA ³² provides Emission Factors based on which electricity grid subregion an organization is located in. Houston is located within the ERCT eGrid subregion.	
Carbon dioxide		868.6 lb CO ₂ /MWh
Methane (GWP 28)		0.057 lb CH ₄ /MWh
Nitrous Oxide (GWP 265)		0008 lb N ₂ O/MWh

Step 1: Calculate an Emission Factor in CO₂e, by incorporating GWP of other GHGs

$$(868.6 \text{ lb CO}_2/\text{MWh}) + [28 \times (0.057 \text{ lb CH}_4/\text{MWh})] + [265 \times (0.008 \text{ lb N}_2\text{O}/\text{MWh})]$$
$$= 868.6 + 1.596 + 2.12 = 872.3 \text{ lb CO}_2\text{e}/\text{MWh}$$

Step 2: Calculate annual emissions

$$(3,500 \text{ MWh}/\text{yr}) \times (872.3 \text{ lb CO}_2\text{e}/\text{MWh}) = \mathbf{3,053,050 \text{ lb CO}_2\text{e}/\text{yr}}$$

Step 3: Convert to other units (optional)

$$(3,053,050 \text{ lb CO}_2\text{e}/\text{yr}) \times (0.4536 \text{ kg}/\text{lb}) = \mathbf{1,384,863 \text{ kg CO}_2\text{e}/\text{yr}}$$
$$(1,384,863 \text{ kg CO}_2\text{e}/\text{yr}) / (1,000 \text{ kg}/\text{tonne}) = \mathbf{1,385 \text{ tonnes CO}_2\text{e}/\text{yr}}$$

By changing electricity providers to one that provides 100% renewable energy, the gallery can reduce its Scope 2 emissions by approximately 1,385 tonnes CO₂e per year.

Scope 3 Emissions - Indirect Supply Chain Emissions

Scope 3 emissions cover a broader range of activities an organization may undertake. Scope 3 emissions are divided into emissions arising from upstream and downstream supply chain activities. Upstream supply chain activities include purchased goods and services, capital goods, fuel and energy-related activities, transportation and distribution, waste generated in operations, business travel, employee commuting, and leased assets. Downstream supply chain activities include transportation and distribution, processing of sold products, use of sold products, end-of-life treatment for sold products, leased assets, franchises, and investments.³³

Determining the applicability of Scope 3 Categories

Scope 3 emissions categories are intended to be able to capture all emissions associated with a particular operation. In practice, MCIs may not find all Scope 3 Categories to be relevant. You can determine the applicability and relevance of each Category by conducting a workshop or independent review prior to beginning any calculation of emissions. As an example, many museums and cultural institutions do not manufacture or sell goods to customers, which would make Categories 10-12 irrelevant.

After determining which Scope 3 Categories are relevant to an organization's operation, one must begin to prioritize which categories to develop and calculate first. Certain Categories are inherently easier to begin with due to availability of data and Emission Factors, such as those related to travel (Categories 6, 7) and transport (Categories 4, 9).

When beginning to account for the less tangible Categories such as Category 1 - Purchased goods and services, it is important to begin by qualitatively identifying which practices would likely be the largest contributor to emissions based on the applicable organization's operation. For example, if a museum spends a large portion of its budget on exhibition displays and lighting, it is likely that these goods would have a more significant carbon footprint than other goods purchased by the museum. By focusing on larger sources of emissions first, an organization will be able to account for their emissions with more certainty in less time.

Scope 3, Category 1. Purchased goods and services

Definition from the Scope 3 Standard:

Extraction, production, and transportation of goods and services purchased or acquired by the reporting company in the reporting year, not otherwise included in Categories 2 - 8³⁴.

Purchased goods and services is the category that best represents the lifecycles of products and services that are purchased by an organization. Because lifecycles of a product cover cradle-to-grave impacts, this emissions category can be the broadest in scope and the most difficult to quantify.

What does this mean for museums and cultural institutions?

This category includes any art, exhibit, display material, as well as any equipment or furniture that was manufactured by a third party and purchased by the organization, which likely makes up most objects in a MCI's collection. This Category also includes emissions from any services that were purchased, for example design or marketing services.

Because Category 1 accounts for the lifecycle of products and services purchased by an organization from a third party, these emissions can be difficult to estimate. In practice, MCIs should first work with suppliers to request relevant data. If a third party is unable to furnish such data, the MCI may choose to estimate these emissions by collecting relevant lifecycle assessment data, making reasonable assumptions about the lifecycle of a product, or by using spend-based Emission Factors, which estimate emissions based on the value of purchased goods and services.

Example problem 1: new furniture

A history museum in Brussels intends to purchase 25 benches from a third party in the upcoming year. To account for Scope 3, Category 1 emissions, the museum sent a request to the bench manufacturer to estimate the emissions associated with the production of the benches.

The manufacturer was unable to furnish emissions data but did share specifications for each bench. Each bench is made of high-density polyethylene (HDPE) and weighs 100 kilograms. The UK-published GHG reporting conversion factors include a Factor for HDPE production (including forming). The relevant Factor is 3,269.84 kg CO₂e per mt.³⁵

Based on these parameters, we calculate emissions associated with the new benches.

$$(25 \text{ benches}) \times (100 \text{ kg HDPE/bench}) / (1,000 \text{ kg/mt}) = 2.5 \text{ mt HDPE}$$

$$(2.5 \text{ mt HDPE}) \times (3,269.84 \text{ kg CO}_2\text{e/mt HDPE}) / (1,000 \text{ kg/mt}) = \mathbf{8.2 \text{ mt CO}_2\text{e}}$$

Example problem 2: art restoration services provided by third party

An art restoration service company has been working with an arts museum in Paris. Recently, the museum sent the restoration company a request for the emissions associated with their services so that the museum can begin accounting for their Scope 3, Category 1 emissions.

The restoration company has already calculated Scope 1 and 2 emissions for reporting purposes, estimated around 150 mt CO₂e per year. Because the company supports over 20 different entities, they decide to estimate their emissions associated with the art museum by estimating the percentage of services provided to the museum per year.

Based on a time commitment of 40% per year devoted to restoring works from the art museum, the restoration company is able to provide an estimate as follows.

$$(150 \text{ mt CO}_2\text{e per year}) \times (0.4) = \mathbf{60 \text{ mt CO}_2\text{e per year attributable to services to the art museum}}$$

Scope 3, Category 2. Capital goods

Definition from the Scope 3 Standard:
Category 2 includes all upstream (i.e. cradle-to-gate) emissions from the production of capital goods purchased or acquired by the reporting company in the reporting year.

Emissions from the use of capital goods by the reporting company are accounted for in either Scope 1 or Scope 2, rather than in Scope 3.

What does this mean for museums and cultural institutions?
Category 2 emissions are of the same nature as those in Category 1 but apply to capital purchases only. Purchases can be categorized as Category 1 or Category 2 depending on how a museum or cultural institution defines a capital purchase.

As this category is associated with capital costs, these emissions may be associated with activities such as the construction of a new building, the purchase of an irreplaceable piece, unique commission or other expensive and one-off activities.

Example problem: **marble statue for entrance hall**
A history museum in Stockholm has received capital funding to commission a statue for the entrance hall, made of a 2m x 2m x 3m piece of Swedish green marble. The marble will be sourced from a quarry in Kolmården, transported to an artist’s workshop in Huddinge to be carved, and then transported to the museum for installation. The museum has requested that data be collected along the lifecycle of this piece so that its associated emissions can be estimated.

The third parties involved in creating and transporting the sculpture have provided the museum with the following data that can be used to calculate the Scope 3, Category 2 emissions.

- Diesel consumed at quarry to extract the marble slab: 800 litres
- Transport distance from quarry to artist workshop using 1 semi-truck: 176 km
- Electricity consumed during 6 months of sculpting: 6,500 kWh
- Transport distance to museum: 16 km
- Diesel consumed by crane during sculpture installation: 200 litres

- Relevant Emission Factors³⁷
- Diesel combustion: 3,160 kg CO₂/mt diesel
 - Transport: 0.486 g CO₂/km
 - Electricity: 23 kg CO₂/megawatt hour

Emissions Calculation:

Fuel consumed by equipment (non-transport):
(1,000 litres) x (0.00085 mt/litre) x (3,160 kg CO₂/mt diesel) = 2,686 kg CO₂

Electricity:
(6,500 kWh) x (0.001 MWh/kWh) x (23 kg CO₂/MWh) = 150 kg CO₂

Transportation:
(0.486 g CO₂/km) x (192 km) = 93.3 g CO₂ = 0.09 kg CO₂

Scope 3, Category 2 emissions associated with the marble statue are approximately **2.8 mt CO₂**

Scope 3, Category 3. Fuel and energy-related activities

Definition from the Scope 3 Standard:

Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company in the reporting year, not already accounted for in Scope 1 or Scope 2, including:

- **Upstream emissions of purchased fuels (extraction, production and transportation of fuels consumed by the reporting company).**
- **Upstream emissions of purchased electricity (extraction, production and transportation of fuels consumed in the generation of electricity, steam, heating, and cooling consumed by the reporting company).**
- **Transmission and distribution (T&D) losses (generation of electricity, steam, heating and cooling that is consumed, i.e. lost, in a T&D system) - reported by end user.**
- **Generation of purchased electricity that is sold to end users (generation of electricity, steam, heating and cooling that is purchased by the reporting company and sold to end users) - reported by utility company or energy retailer only.³⁸**

What does this mean for museums and cultural institutions?

Category 3 is a place to account for the upstream lifecycle emissions of consumed fuel and energy (i.e. emissions from extraction, transport, and refining of petroleum products); and serves as a catch-all for any energy or fuel-related emissions not accounted for in other Scope 1 or Scope 3 Categories

This category can be used to account for scenarios where energy or fuel are used by a third party in association with the organization's items or exhibits, such as if a third party is displaying an exhibit on loan and it requires lighting or particular environmental conditions that require energy.

Example problem: neon light exhibit on loan to third party

A modern art museum in London plans to loan a neon light exhibit to another museum in Latvia for eight months. Based on measurements from a power consumption monitor, the exhibit draws 1,000 watts of power when turned on. The exhibit is powered between 0900 and 1800 every day. The museum in London intends to account for these emissions within their Scope 3 emissions, and have chosen to include them in Scope 3, Category 3, as they are accounting for energy consumption that is not part of their Scope 1 or 2 emissions.

Relevant Emission Factor³⁹: 0.109 mt CO₂/MWh (electricity emissions in Latvia)

Emissions Calculation:

Step 1: Calculate total power used

(8 months) x (30.5 days/month) x (9 hours/day) = 2,196 hours

(1,000 watts) x (2,196 hours) x (0.001 kWh/Wh) = 2,196 kWh

Step 2: Calculate emissions

(2,196 kWh) x (0.001 MWh/kWh) x (0.109 mt CO₂/MWh) = **0.24 mt CO₂**

Note that the emissions associated with the power consumption of this exhibit while on loan are likely negligible in comparison to other emissions categories. The museum may choose to exclude these emissions when defining boundaries for their GHG inventory.

Scope 3, Category 4. Upstream transportation and distribution

Definition from the Scope 3 Standard:
Transportation and distribution of products purchased by the reporting company in the reporting year between a company’s tier 1 suppliers and its own operations (in vehicles and facilities not owned or controlled by the reporting company), transportation and distribution services purchased by the reporting company in the reporting year, including inbound logistics, outbound logistics (e.g., of sold products), and transportation and distribution between a company’s own facilities (in vehicles and facilities not owned or controlled by the reporting company).⁴⁰

What does this mean for museums and cultural institutions?
Any movement of goods from suppliers to an MCI or between MCI facilities (if moved by a third party) is considered an upstream movement. For MCIs, this category would more commonly be used to account for the latter scenario, as Category 1 includes transportation of purchased goods and services.

Emissions from sending loans would be included in this Category where the transportation costs are covered by the lender. This is because the transportation service is purchased by the lender and the lender has operational control over the method of transportation.

Example problem: rotating exhibit

A museum conglomerate in Australia will be displaying an exhibition at its four museums in Adelaide, Melbourne, Sydney, and Brisbane. At the end of each quarter, a third-party company will move the exhibit to the next museum. The exhibition begins its journey in Adelaide and will be returned after the exhibition tour is complete. The exhibit is transported by one diesel semi-trailer truck that meets Euro iv design standards and has an average fuel consumption of 53.1 litres per 100 km. Calculate the Scope 3, Category 4 emissions associated with this third-party transportation in units of tonnes CO₂e.

Distance travelled:

Adelaide	—————>	Melbourne	727 km
Melbourne	—————>	Sydney	1,015 km
Sydney	—————>	Brisbane	910 km
Brisbane	—————>	Adelaide	1,385 km
Total transport distance			4,037 km

Fuel consumed:

$(4,037 \text{ km}) \times (53.1 \text{ L} / 100 \text{ km}) = 2,144 \text{ litres} = 2.14 \text{ kilolitres of diesel}$

Emissions:

The National Greenhouse Accounts Factors⁴¹ for transport provided by the Australian government include two Factors for calculation - one is the energy-content Factor in units of gigajoules per kilolitre and the other is an Emission Factor in units of kg CO₂e per gigajoule of energy. Emissions are to be calculated using the following equation. Note that the Factors for CH₄ and N₂O include a conversion into units of CO₂e.

$(\text{kg of CO}_2\text{e}) = (\text{energy-content Factor}) \times (\text{Emission Factor}) \times (\text{fuel consumed})$

$\text{CO}_2 = (38.6 \text{ GJ/kL}) \times (69.9 \text{ kg CO}_2\text{e/GJ}) \times (2.14 \text{ kL}) = 5,774 \text{ kg CO}_2\text{e}$

$\text{CH}_4 = (38.6 \text{ GJ/kL}) \times (0.07 \text{ kg CO}_2\text{e/GJ}) \times (2.14 \text{ kL}) = 6 \text{ kg CO}_2\text{e}$

$\text{N}_2\text{O} = (38.6 \text{ GJ/kL}) \times (0.4 \text{ kg CO}_2\text{e/GJ}) \times (2.14 \text{ kL}) = 33 \text{ kg CO}_2\text{e}$

$\text{Total Scope 3, Category 4 emissions} = 5,813 \text{ kg CO}_2\text{e} = \mathbf{5.8 \text{ metric tons CO}_2\text{e}}$

Scope 3, Category 5. Waste generated in operations

Definition from the Scope 3 Standard:
Disposal and treatment of waste generated in the reporting company’s operations in the reporting year (in facilities not owned or controlled by the reporting company).⁴²

Note that Emission Factors associated with waste management will vary based on country and region. It is recommended that you use Emission Factors for the relevant country or region for these calculations.

What does this mean for museums and cultural institutions?
Recycling, composting and repurposing of goods reduce the emissions associated with the end-of-life of wastes when compared to landfilling. In addition to the associated benefits of circularity, a properly maintained waste-management programme can help a museum reduce its emissions. It is important to maintain good data with respect to the quantities and end- disposal methods for each waste stream.

Example problem: **waste management and recycling**
A history museum in Massachusetts recently implemented a new recycling programme for bottles, aluminium cans, and cardboard. These three materials are sent for recycling while other wastes are sent to a nearby landfill. Last year, the museum recycled 5 short tons of plastic bottles, 3 short tons of aluminium cans and 8 short tons of cardboard (a short ton is 2,000 lb). Approximately 165 short tons of municipal solid waste were sent to a landfill for disposal. Calculate the Scope 3, Category 5 emissions from this facility.

The US EPA^{43*} provides the following relevant Emission Factors:

Recycled high density polyethylene bottles:	0.21 mt CO ₂ e/short ton of material
Recycled aluminium cans:	0.06 mt CO ₂ e/short ton of material
Recycled cardboard:	0.11 mt CO ₂ e/short ton of material
Landfilled municipal solid waste (MSW):	0.52 mt CO ₂ e/short ton of material

Emission Calculation:

Bottles	(0.21 mt CO ₂ e/short ton) x (5 short tons) =	1.05 mt CO ₂ e
Aluminium	(0.06 mt CO ₂ e/short ton) x (3 short tons) =	0.18 mt CO ₂ e
Cardboard	(0.11 mt CO ₂ e/short ton) x (8 short tons) =	0.88 mt CO ₂ e
MSW	(0.52 mt CO ₂ e/short ton) x (165 short tons) =	85.8 mt CO ₂ e

The museum’s total Scope 3, Category 5 emissions for last year are **87.9 mt CO₂e**. Note that the emissions associated with waste management are significantly lower for most materials when they are sent for beneficial reuse rather than to landfill.

**Countries using imperial system units often have Emission Factors that require imperial unit inputs and generate metric system outputs. Be diligent in labelling calculations to ensure units are used correctly.*

Scope 3, Category 6. Business travel

Definition from the Scope 3 Standard:
Transportation of employees for business-related activities during the reporting year (in vehicles not owned or operated by the reporting company).⁴⁴

What does this mean for museums and cultural institutions?
With proper records of travel itineraries and expenses, emissions within Category 6 are among the easiest to calculate due to widely available Emission Factors for transit. When calculating these emissions, start with itineraries that include air travel, as air travel has significantly higher emissions than other forms of travel.

Example problem: business travel within the UK

The curator of a history museum in Edinburgh travels on a quarterly basis to London for work that cannot be managed over teleconference. To help meet the museum’s emission-reduction goals, the curator would like to understand the differences in emissions between travelling by car, bus, rail, and air.

Emission Factors ⁴⁵ :	Domestic air	0.24587 kg CO ₂ e/passenger-km
	Medium petrol car	0.18785 kg CO ₂ e/km
	National rail	0.03549 kg CO ₂ e/passenger-km
	Coach (bus)	0.02684 kg CO ₂ e/passenger-km

Emissions Calculation:

Air		
Edinburgh to London Gatwick, 574 km (1.25 hours)		
2 x (574km) x (0.24587 kg CO ₂ e/passenger-km) x (4 trips/yr) =		1,127 kg per year
Car		
Via main roads, 650 km (7.5 hours)		
2 x (650 km) x (0.18785 kg CO ₂ e/km) x (4 trips/yr) =		977 kg per year
Rail		
Via Caledonian Sleeper, 645 km (7.5 hours)		
2 x (645 km) x (0.03549 kg CO ₂ e/passenger-km) x (4 trips/yr) =		183 kg per year
Bus		
Via National Express, 553 km (9.5 hours)		
2 x (553 km) x (0.02684 kg CO ₂ e/passenger-km) x (4 trips/yr) =		119 kg per year

Based on the Emission Factors provided by the United Kingdom, the curator can reduce their annual business travel emissions by 80-90% if they choose to travel by bus or rail, instead of by car or plane. With sufficient planning, the curator can help the museum avoid approximately 1 tonne per year in Scope 3, Category 6 emissions.

Scope 3, Category 7. Employee commuting

Definition from the Scope 3 Standard: Transportation of employees between their homes and their worksites during the reporting year (in vehicles or commuting services not owned or operated by the reporting company).⁴⁶

What does this mean for museums and cultural institutions? Depending on the privacy laws in the country that an MCI is in, employee commuting emissions can either be estimated using survey data or calculated specifically for each employee. In countries where personal information is not legally accessible, a simple survey can help an MCI calculate Category 7 emissions. An example problem of how to estimate commuting emissions is provided opposite.

Example problem: employee commuting

A museum in Miami has 100 employees working 240 days per year. None of the employees share their journeys. To better understand the emissions associated with employee commutes, the museum sent a voluntary survey to its employees about their commuting methods.

To illustrate the relative impacts of different modes of travel, this problem assumes that the survey results state that 25 people take each mode of travel and commute 3 miles round trip. Below are the relevant EPA Emission Factors⁴⁷.

Emission Factors:	Passenger car	0.341 kg CO ₂ e/vehicle-mile
	Rail	0.106 kg CO ₂ e/passenger-mile
	Bus	0.054 kg CO ₂ e/passenger-mile
	Walking	0 kg CO ₂ e/mile

Emissions Calculation:

- Passenger car commuters:
(25 employees) x (3 mi/day) x (240 days) x (0.341 kg CO₂e/vehicle-mile) = 6.1 mt CO₂e
- Rail commuters:
(25 employees) x (3 mi/day) x (240 days) x (0.106 kg CO₂e/vehicle-mile) = 1.9 mt CO₂e
- Bus commuters:
(25 employees) x (3 mi/day) x (240 days) x (0.054 kg CO₂e/vehicle-mile) = 0.9 mt CO₂e
- Walking commuters:
(25 employees) x (3 mi/day) x (240 days) x (0 kg CO₂e/mile) = 0 mt CO₂e

The museum’s estimated Scope 3, Category 7 emissions for each year are **8.9 mt CO₂e**. The museum can reduce the largest quantity of emissions by focusing on those travelling by passenger car. This can be done by offering employee incentives, such as interest-free loans for season tickets for public transport and supporting remote working from home.

Scope 3, Category 8. Upstream leased assets

Definition from the Scope 3 Standard:
Operation of assets leased by the reporting company (lessee) in the reporting year and not included in Scope 1 and Scope 2 - reported by lessee.⁴⁸

What does this mean for museums and cultural institutions?
Upstream leased assets are assets leased and operated by the reporting organization. Assets that the reporting organization owns and leases to a third party are included in Category 13 - Downstream leased assets.

Typical stationary assets in this category are offices, storage, and warehouses. An MCI may also account for the emissions resulting from leased vehicles and other equipment that are operated by the reporting organization. Depending on the leasing model, an organization may include these emissions in Scope 1 and 2, or in Scope 3, Category 8.

Example problem: leasing a floor of a building from a university in California

A children’s museum in California leases an entire floor of a building for one year from a local university to operate a school program. The building has a total area of 6,000 square feet, of which the museum leases 1,000 square feet. The university has collected utility data for the year and shared with the museum that the entire building consumed 428,600 kWh of electricity and 14 million standard cubic feet (scf) of natural gas.

The Emission Factors provided by the US EPA include those for natural gas based on standard cubic foot (scf) and those for the electrical grid that covers California.

Emission Factors ⁴⁹ :	Natural Gas	0.05449 kg CO ₂ e/scf
	Electricity	515.5 lb CO ₂ e/MWh

First, we calculate the Scope 1 and 2 emissions for the building.

Scope 1:
 $(14,000,000 \text{ scf natural gas}) \times (0.05449 \text{ kg CO}_2\text{e/scf}) = 762,860 \text{ kg CO}_2\text{e} = 762.9 \text{ mt CO}_2\text{e}$

Scope 2:
 $(428,600 \text{ kWh}) / (1,000 \text{ kWh/MWh}) \times (515.5 \text{ lb CO}_2\text{e/MWh}) = 220,943 \text{ lb CO}_2\text{e}$
 $(220,943 \text{ lb CO}_2\text{e}) / (2.2046 \text{ lb/kg}) = 100,220 \text{ kg CO}_2\text{e} = 100.2 \text{ mt CO}_2\text{e}$

Total Scope 1+2 emissions for building = **863.1 mt CO₂e**

Next, we calculate how much of the building’s emissions can be accounted for by the museum based on a physical allocation.

$(1,000 \text{ sq ft museum area}) / (6,000 \text{ sq ft total area}) \times (863.1 \text{ mt CO}_2\text{e}) = 143.9 \text{ mt CO}_2\text{e}$

The university will account for all 863.1 mt CO₂e in their Scope 1 and 2 emissions while the museum will only account for the emissions attributed to their leased space, 143.9 mt CO₂e, as their Scope 3, Category 8 emissions.

Scope 3, Category 9. Downstream transportation and distribution

Definition from the Scope 3 Standard:
Transportation and distribution of products sold by the reporting company in the reporting year between the reporting company’s operations and the end consumer (if not paid for by the reporting company), including retail and storage (in vehicles and facilities not owned or controlled by the reporting company).⁵⁰

According to the Scope 3 Standard⁵¹, this Category may also be used to include estimated emissions associated with visitors to an MCI. The Protocol states (p.47): “Companies may include emissions from customers traveling to retail stores in this category, which can be significant for companies that own or operate retail facilities (...) A reporting company’s Scope 3 emissions from downstream transportation and distribution include the Scope 1 and Scope 2 emissions of transportation companies, distribution companies, retailers, and (optionally) customers.”

What does this mean for museums and cultural institutions?
Museums and cultural institutions are visitor attractions; they may attract visitors from around the world and are popular destinations for tourists. Depending on the popularity of a given MCI, international visitor travel may be the organization’s largest source of GHG emissions. Local travel can still be a significant contributor to an MCI’s emissions, because of the large number of trips involved.

Because visitor trips are are not always the main reason for visitor travel to an MCI, quantification of the emissions associated with visitor travel requires many assumptions and would benefit significantly from survey data from museums as well as a given country’s tourism agency.

If you want to more accurately quantify emissions associated with visitor travel, you could use a simple survey to be provided to each visitor (or a sample of visitors) through electronic, verbal, or handwritten means. This survey should include the following questions to aid in the estimation of emissions:

Example Survey

How many people are in your group?
.....

From what town/city and country did you travel to visit [insert MCI name]?
.....

Circle the primary mode of travel you took to visit [insert MCI name]
Plane Car Trail Bus/Coach Bike Walk
.....

How long will you be visiting the town the MCI is in (number of days)?
.....

How long will/did you spend at the museum (hours)?
.....

Based on the visitor responses, you will be able to estimate the associated emissions, by using an allocation based on the percentage of time a visitor will spend at your MCI during their trip. As an example, if a family of 10 flies from New York to Delhi (2.8 metric tons CO₂e per person) and spends 50% of their time at an MCI, we can estimate the travel emissions attributable to the museum from the group's visit to be **14 metric tons CO₂e ((2.8 x 10) x 0.5)**.

Without sufficient survey data, your organization may be able to estimate and then refine an emissions quantity by using tourism and visitor statistics with assumptions. An example of this calculation is provided on the next page.

Example problem: **estimating visitor travel emissions**

A large museum in France is interested in understanding the scale of emissions associated with international visitors, based on limited data to support the calculation.

Last year, the museum welcomed 3 million visitors from over 140 countries, but 90% of the visitors came from the United States, Germany, China, Italy, and Spain. Data collected by the museum and provided by the French tourism agency are provided in the table below. According to the museum, the average visitor spends 4 hours viewing exhibits. Using a proportional time-allocation method, we can calculate how much of each visitor's trip was spent at the museum.

Country	% of visitor	# of visitors	trip length ⁵²	% of trip spent at museum
United States	25	750,000	9 days	1.9%
Germany	25	750,000	2 days	8.3%
China	15	450,000	8 days	2.1%
Italy	15	450,000	5 days	3.3%
Spain	10	300,000	4 days	4.2%

Because the museum data does not provide detail on travel routes, they assume travel distances between the busiest airport in the origin country and Charles de Gaulle airport in Paris. Emission Factors from the French Ministère de la Transition écologique⁵³ are also included in the chart:

Country	Airport of origin	Flight distance (km)	Emission Factor based on distance
United States	Atlanta	7,072	91 g CO ₂ e/passenger-km
Germany	Frankfurt	448	117 g CO ₂ e/passenger-km
China	Guangzhou	9,511	101 g CO ₂ e/passenger-km
Italy	Rome	1,102	95 g CO ₂ e/passenger-km
Spain	Madrid	1,063	95 g CO ₂ e/passenger-km

To calculate an estimate of the visitor air travel emissions attributable to a visit to the museum, we use the following formula that accounts for % of the trip spent at the museum:
Emissions = [Number of Visitors] x [% of Trip in Museum] x [Avg. distance] x [Emission Factor]

To provide an example, below is the calculation conducted for the USA visitor data:
[750,000 visitors] x [1.9%] x [7,072 km] x [0.091 kg CO₂e/pass-km] = **9,170 mt CO₂e**

Country of origin	Emissions estimate
United States	9,170 mt CO ₂ e
Germany	3,263 mt CO ₂ e
China	9,078 mt CO ₂ e
Italy	1,555 mt CO ₂ e
Spain	1,272 mt CO ₂ e
Total	24,338 mt CO ₂ e

Though tourists may spend a small fraction of their trip visiting the museum, the emissions generated by international flights are significant when applying a time-based method. As this methodology is more qualitative based on the number of assumptions made, the museum could improve the emissions data through focussed visitor surveys.

Outside of visitor travel, Category 9 is very similar to Category 4 - Upstream transportation and distribution, except Category 9 focuses on the transport of goods from the reporting organization to a third party, using transportation not owned or operated by the reporting organization (if the transportation was provided by the reporting organization, the emissions would be part of its Scope 1 or 2 emissions depending on fuel and energy source).

Example problem: traveling exhibition from Buenos Aires to Punta Arenas

An extensive essay collection owned by a library in Buenos Aires is to be loaned to another library in Punta Arenas. The 5.51 tonne collection is to be transported by plane and medium-duty truck, which will be paid for by the receiving facility. What are the Scope 3, Category 9 emissions from this transport scenario?

Distances:	Buenos Aires museum to airport by truck	30.6 km
	Buenos Aires to Punta Arenas by plane	1,142.6 km
	Punta Arenas airport to museum by truck	22.5 km
Emission Factors ⁵⁴ : Aircraft		
		1.0189 kg CO ₂ e/tonne-km
Heavy goods vehicle - Rigid (>3.5 - 7.5 tonnes)		0.48058 kg CO ₂ e/km

Emissions Calculation:

Buenos Aires museum to the airport by truck:
(30.6 km) x (5.51 tonnes) x (0.48058 kg CO₂e/tonne-km) = 81 kg CO₂e

Buenos Aires to Punta Arenas by plane:
(1142.6 km) x (5.51 tonnes) x (1.0189 kg CO₂e/tonne-km) = 6,414.7 kg CO₂e

Airport to the museum in Punta Arenas by truck:
(22.5 km) x (5.51 tonnes) x (0.48058 kg CO₂e/tonne-km) = 59.6 kg CO₂e

The library’s total Scope 3, Category 9 emissions for the traveling exhibition for last year are **6,555.3 kg CO₂e = 6.6 mt CO₂e**

Example problem: choosing transport methods

A museum in Rome offers an exhibition for hire. A borrower in Barcelona has asked the museum what the impact of different transportation methods would be on the resulting emissions for a round trip journey. Options would be to transport it by air, by road or by sea. The exhibition weighs 5 tonnes, including crates and packaging materials.

Emission Factors ⁵⁵ :	Aircraft	1.0189 kg CO ₂ e/tonne-km
	Heavy goods vehicle (>3.5 - 7.5 tonnes)	0.48674 kg CO ₂ e/tonne-km
	Container ship	0.2028 kg CO ₂ e/tonne-km
Distance by transport mode ⁵⁶ :		
Air		859 km
Road		1,357 km
Sea		955 km

Emissions Calculation:

Air: (2 trips) x (1.0189 kg CO₂e/tonne-km) x (5 tonne) x (859 km) = **8,752 kg CO₂e**

Road: (2 trips) x (0.48674 kg CO₂e/tonne-km) x (5 tonne) x (1,357 km) = **6,605 kg CO₂e**

Sea: (2 trips) x (0.2028 kg CO₂e/tonne-km) x (5 tonne) x (955 km) = **1,937 kg CO₂e**

Assuming that each mode of travel is > 95% of the total journey, the calculation shows that shipment of the exhibition by sea results in significantly lower GHG emissions than shipping by air or road.

Scope 3, Category 10. Processing of sold products

Definition from the Scope 3 Standard: Processing of intermediate products sold in the reporting year by downstream companies (e.g. manufacturers). The minimum boundary for this category includes Scope 1 and Scope 2 emissions of downstream companies that occur during processing (e.g. from energy use).⁵⁷

What does this mean for museums and cultural institutions?
Category 10 is likely to be more relevant for service providers in the MCI space, as it is intended for products that are unfinished or incomplete that will be processed by a third party prior to sale.

The intention of this category is to aid in calculating the lifecycle GHG footprint of a product from the perspective of an intermediate or primary goods provider.

Example problem: frame manufacturer

A frame manufacturing company has been partnering with an Irish art gallery for 5 years. The frame manufacturer processes raw wood into frames but does not finish the frames with stains or paints.

The art gallery takes the unfinished frames and finishes them to match each painting prior to selling the pieces to customers. To complete their Category 10 emissions calculation, the frame manufacturer has requested Scope 1 and 2 data from the art gallery associated with the final processing of frames.

The art gallery frames artwork and restores old pieces at a nearby workshop that they own. According to their calculations based on utility data, they estimate their Scope 1 emissions at 5 tons CO₂e and their Scope 2 emissions at 142 tons CO₂e. Based on the hours worked by the framing employees versus the restoration employees, they estimate that 40% of the utilities consumed are associated with framing.

Based on the allocation provided by the art gallery, we calculate the associated Category 10 emissions:

Scope 1: (5 tons CO₂e) x (0.4) = 2 tons CO₂e

Scope 2: (142 tons CO₂e) x (0.4) = 56.8 tons CO₂e

The Category 10 emissions quantity for the frame manufacturing company is **58.8 mt CO₂e**

Scope 3, Category 11. Use of sold products

Definition from the Scope 3 Standard:

A reporting company's Scope 3 emissions from the use of sold products include the Scope 1 and Scope 2 emissions of end users. End users include both consumers and business customers that use final products. The minimum boundary for this category is the direct use-phase emissions of sold products over their expected lifetime. Reporting the indirect use-phase emissions of sold products over their expected lifetime is optional.⁵⁸

What does this mean for museums and cultural institutions?

This emissions category includes emissions arising from the use of goods, which are emissions resulting from sold products that directly consume energy (electricity or fuel) or emit GHGs during their use. Category 11 will have varying applicability to MCIs, mostly applicable to goods sold in gift shops or online.

Example problem: novelty items

A medieval museum in Swansea has a gift shop with novelty items for sale. Last year, the museum sold approximately 5,000 units of their best-selling product - a decorative 'fire-breathing dragon'.

Each dragon is fuelled with butane and consumes approximately 1.8 grams per year under moderate use. What are the Category 11 emissions associated with the sale of dragons last year?

Emission Factor⁵⁹: 1.75 kg CO₂e per litre butane.

Because our Emission Factor is based on volume (litres) and our fuel quantity is provided in mass (grams), we must find an appropriate density of butane to convert.

In its liquid state at standard temperature and pressure, butane has a density that is 0.6⁶⁰ that of water, which is 1,000 grams/litre, so butane's density is 600 grams/litre.

Fuel consumption = (5,000 ornamental dragons) x (1.8 grams/yr) / (600 grams/litre) = 15 litres/yr

Emissions = (1.75 kg CO₂e/litre) x (15 litres/yr) = 26.25 kg CO₂e per year

If each dragon will experience the average level of use, one year of sales will attribute approximately **26 kg CO₂e per year** to the museum's Category 11 emissions.

Scope 3, Category 12. End-of-life treatment of sold products

Definition from the Scope 3 Standard:
Waste disposal and treatment of products sold by the reporting company (in the reporting year) at the end of their life.⁶¹

What does this mean for museums and cultural institutions?
Any product sold or distributed by an MCI will eventually reach the end of its life. This category will have similar calculations to those in Scope 3, Category 5 - waste generated in operations, but will not be based on easily trackable data, as it focuses on how certain products might be managed by a consumer.

The primary data supporting Category 12 calculations are the quantities of goods sold and the assumed end-of-life management for each product (i.e. compost, recycle, landfill, incinerated). The reporting organization may choose to make assumption based on its own management of similar goods, or it could use information provided by government and other agencies regarding end-of-life treatments.

Example problem: emissions from gift shop goods
A museum in Scotland sells branded notebooks at the gift shop that are manufactured using 100% recyclable paper. In the reporting period, the organization sold 3,125 units, equivalent to 1,250 kg of product.

According to a study by Zero Waste Scotland based on 2014-2015 data, approximately 73% of paper goods in Scotland were recycled by households.

Based on this figure, we calculate the Category 12 emissions under the assumption that 73% of the paper notebooks are recycled and 27% are sent to landfill.

Below are the relevant Emission Factors provided by the UK government for end-of-life treatment for paper materials.

Emission Factors ⁶² : Closed Loop Recycling	0.021 kg CO ₂ e/kg
Landfill	1.041 kg CO ₂ e/kg

Emissions Calculation:
(1,250 kg notebooks) x (27% to landfill) x (1.041 kg CO₂e/kg paper) = **351 kg CO₂e**
(1,250 kg notebooks) x (73% to recycling) x (0.021 kg CO₂e/kg paper) = **19 kg CO₂e**

The museum's total Scope 3, Category 12 emissions for last year are **370 kg CO₂e**.

Note that although the museum cannot manage the end-of-life treatment by a consumer, they can influence consumer decisions by using more recyclable/reusable materials and incorporate recommendations for recycling.

Scope 3, Category 13. Downstream leased assets

Definition from the Scope 3 Standard:
Operation of assets owned by the reporting company (lessor) and leased to other entities in the reporting year, not included in Scope 1 and Scope 2 - reported by the lessor.

The minimum boundary for this category is Scope 1 and Scope 2 emissions of lessees that occur during the operation of leased assets. Reporting the life cycle emissions associated with manufacturing or constructing leased assets is optional.⁶³

What does this mean for museums and cultural institutions?
Museums and cultural institutions that own property and lease facilities to a third party should account for the Scope 1 and 2 emissions from those facilities. This category is considered separately from Scopes 1 and 2 for leased facilities, to allow a reporting organization to separately identify emissions from their facilities that are under the operational control of a third party.

In practice, an MCI with few leased facilities may choose to incorporate those emissions into their Scope 1 and 2 accounting. If the MCI has a large quantity of leased assets, they will likely choose to account for these emissions in Scope 3, Category 13.

Example problem: leased spaces

A museum in Nairobi purchased five warehouses that were used to temporarily store exhibits while the main museum was under construction. Once construction ended, the museum decided to lease these 5 facilities to non-MCI businesses.

Under the lease agreement for each facility, the museum included a clause for the lessee to provide it with Scope 1 and 2 emissions data on a quarterly basis to be included in annual reporting.

After a year of data collection, each facility provided their Scope 1 and 2 emissions to the museum.

Facility	Scope 1 emissions	Scope 2 emissions
1	100 mt CO ₂ e	50 mt CO ₂ e
2	20 mt CO ₂ e	200 mt CO ₂ e
3	5 mt CO ₂ e	100 mt CO ₂ e
4	230 mt CO ₂ e	230 mt CO ₂ e
5	20 mt CO ₂ e	30 mt CO ₂ e

In their own GHG inventory, the museum calculated their Scope 1 emissions to be 50 metric tons CO₂e and their Scope 2 emissions to be 100 metric tons CO₂e. Because the leased assets are under third-party operatorship, they decide to include these emissions within Scope 3, Category 13 emissions.

Scope 1 total: 100 + 20 + 5 + 230 + 20 = 375 mt CO₂e
Scope 2 total: 50 + 200 + 100 + 230 + 30 = 610 mt CO₂e
Scope 3, Category 13 total: 375 + 610 = 985 mt CO₂e

The museum's Scope 3, Category 13 emissions are **985 mt CO₂e**.

Scope 3, Category 14. Franchises

Definition from the Scope 3 Standard:
Operation of franchises in the reporting year, not included in Scope 1 and Scope 2 - reported by the franchisor. The boundary for this category includes Scopes 1 and 2 emissions of franchisees that occur during the operation of franchises. The life cycle emissions associated with manufacturing or constructing franchises are optional⁶⁴.

What does this mean for museums and cultural institutions?
Franchises in this context are entities that use the name, likeness, and other defining attributes of an MCI through a franchising agreement. Third-party franchises located onsite of an MCI would be accounted for in leased asset categories.

MCIs that follow a franchise model should understand the cumulative impact of the franchise across its operations. Because of the lack of operational control, a franchisor should include the Scope 1 and 2 emissions from each franchise location in Scope 3, Category 14. Note that a franchisor may choose to incorporate reduction initiatives and reporting requirements in their franchising agreements.

Example problem: **exhibition for license**
A museum consultancy based in Berlin offers an exhibition for license that conveys full rights for a third-party to display without a time limit. The exhibition includes 25 illustrations and captions that detail the impacts of climate change on nature. According to the exhibition agreement, licensees must abide by the following parameters for the exhibition:

- Boards must be printed on cardboard with a CO₂e footprint below 1 kg CO₂/kg cardboard.
- All boards are size A2 with a thickness of 3mm.
- Each board must be illuminated by a 14-watt LED accent light.

Though the relative impact of an individual licensee is low, the museum consultancy anticipates that over 100 locations in Europe will display the exhibition for the entirety of next year. They would like to understand whether the associated emissions would be significant enough to include in their GHG inventory for next year within Scope 3, Category 14.

We begin by estimating the lifecycle emissions from the cardboard used for the exhibits based on the total mass of cardboard:

Relevant Emission Factors: Conventional cardboard tube⁶⁵ 0.723 kg CO₂e/kg cardboard

$(25 \text{ pieces}) \times (420\text{mm} \times 594\text{mm} \times 3\text{mm}) / (1,000 \text{ mm}^3/\text{cm}^3) = 18,711 \text{ cm}^3 \text{ cardboard per exhibit}$

$18,711 \text{ cm}^3 \times (0.689 \text{ g/cm}^3 \text{ cardboard}) / (1,000 \text{ g/kg}) = 12.89 \text{ kg cardboard per exhibit}$

$(12.89 \text{ kg cardboard per exhibits}) \times (0.723 \text{ kg CO}_2\text{/kg cardboard}) \times (100 \text{ exhibits}) / (1,000 \text{ kg/t})$

= 0.93 tonnes CO₂e

Assuming each licensee operates approximately 10 hours per day, 300 days per year, we estimate emissions using an EU-wide electricity Emission Factor.

Estimate electricity consumption emissions:

$(25 \text{ lights/exhibit}) \times (100 \text{ exhibits}) = 2,500 \text{ lights}$

$(2,500 \text{ lights}) \times (0.014 \text{ kW/light}) \times (10 \text{ hr/day}) \times (300 \text{ days}) / (1,000 \text{ kW/MW}) = 105 \text{ MWh}$

$(105 \text{ MWh}) \times (0.460 \text{ t CO}_2\text{·MWh}^{66}) = \textbf{48 tonnes CO}_2\text{e per year}$

Without calculating emissions from the printing, transportation, etc., associated with licensing activities, we can see that the emission quantities will likely be significant enough to warrant inclusion in annual reporting for the museum consultancy.

Scope 3, Category 15. Investments

Definition from the Scope 3 Standard: Category 15 includes Scope 3 emissions associated with the reporting company’s investments in the reporting year, not already included in Scope 1 or Scope 2. This category is applicable to investors, profit driven or not, and companies that provide financial services. Investments are categorized as a downstream Scope 3 category because providing capital or financing is a service provided by the reporting company.⁶⁷

What does this mean for museums and cultural institutions?
MCI’s investments generally fall in two categories - equity investments and managed investments. The former includes investments in subsidiaries, joint ventures, and other non-operated scenarios while the latter generally involves investments in publicly traded companies and other forms of assets.

For MCIs with equity investments, the Scope 1 and 2 emissions from those investments may be accounted for in this Category on an equity basis (i.e. 20% equity requires accounting for 20% of the Scope 1 and 2 emissions from that asset).

In a similar manner, MCIs should account for the emissions from investments that are part of a managed portfolio, which may be in the form of an endowment or pension plan. These emissions will also be calculated on an equity basis, but the equity stake will generally be lower than the situation described earlier.

Example problem: endowment fund emissions

A space museum in the United States maintains a sizable endowment fund that provides steady annual income in the form of dividends. Though the investments provide steady income, the museum is reconsidering its investments in publicly traded shares in resource-extractive industries. The museum board of trustees would like to assess the Category 15 emissions from these investments before deciding to divest.

Company 1: Oil exploration and production
Museum shares held: 500,000 shares (\$80 million) of 1.92 billion shares in circulation
Scope 1 and 2 emissions of oil company: 58,000,000 mt CO₂e

(500,000 / 1,920,000,000) x (58,000,000 metric tons CO₂e) = **15,104 mt CO₂e**

Company 2: Coal mining
Museum assets: 50,000 shares (\$2.7 million) of 50 million shares in circulation
Scope 1 and 2 emissions of mining company: 562,000 mt CO₂e

(50,000 / 50,000,000) x (562,000 metric tons CO₂e) = **562 mt CO₂e**

The museum has quantified its Scope 1 and 2 emissions to be 25,000 metric tons of CO₂e. In comparison to its own emissions, the Category 15 emissions associated with endowment investments are significant and represent an opportunity for the museum to reduce its carbon footprint.

Section 4

HOW CAN GHG EMISSIONS BE REDUCED IN MUSEUMS AND CULTURAL INSTITUTIONS?

How can GHG emissions be reduced in museums and cultural institutions?

After developing an initial GHG inventory, museums and cultural institutions should begin a journey of continual improvement and seek opportunities to reduce their emissions.

At a basic level, an MCI's reduction strategy can begin with a few questions based on data collected for the GHG inventory:

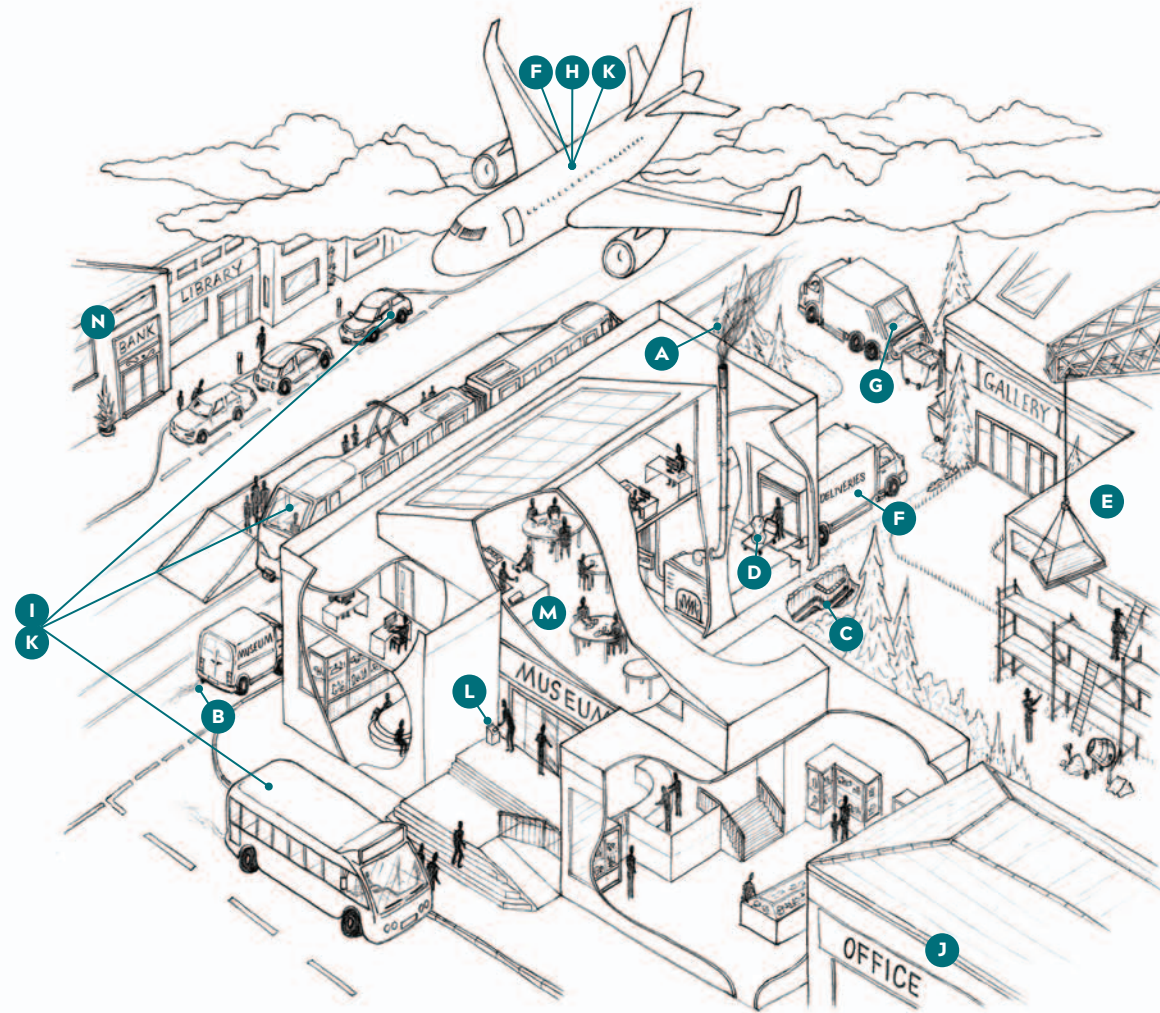
- What are the largest sources of GHG emissions?
- What actions can be taken to reduce GHG emissions from each category?
- What actions to reduce GHG emissions are cost-effective and/or simple to implement?

Pragmatic emission-reduction strategies can be developed by involving staff in workshops to take account of different constraints and opportunities (budget, engineering, contractual, grants).

Some opportunities, such as the installation of LED lighting, may be simple to implement and be a net cost-benefit activity, but others may require significantly more effort to realize GHG reductions.

The following subsections provide primers for workshop discussion and reduction opportunities for the three emission Scopes. For each consideration, three types of reduction strategies will be discussed - behavioural changes, capital improvements, and efficiency improvements/small wins.

Illustration: How MCI activities relate to emissions Scopes and Categories



A	Releasing greenhouse gases from burning and leaks on site, Scope 1
B	Releasing greenhouse gases from fleet vehicles, Scope 1
C	Production of electricity and steam, Scope 2
D	Emissions from manufacture of purchased goods, Scope 3, Category 1
E	Capital projects and purchases, Scope 3, Category 2
F	Transportation of purchased goods, Scope 3, Category 4
G	Waste and waste treatment, Scope 3, Category 5
H	Travel for work purposes, Scope 3, Category 6
I	Daily commuting for work, Scope 3, Category 7
J	Emissions from leased buildings, Scope 3, Category 8
K	Emissions from visitor travel, Scope 3, Category 9
L	Emissions from disposal of products purchased by visitors, Scope 3, Category 12
M	Emissions from a café franchise, Scope 3, Category 14
N	Emissions from investments, Scope 3, Category 15

Scope 1 reductions

In MCIs, combustion is generally used for facility heating, transportation in vehicles owned by the reporting organization, and electricity generation. Direct emissions of GHGs are generally related to old refrigeration systems. Though many are quick to jump into identifying opportunities to implement capital improvements to reduce Scope 1 emissions, it is important to first consider behavioural changes.

Behavioural change

For these emissions sources, a cost-effective first step will generally involve identifying opportunities to first reduce fuel consumption through administrative or procedural changes.

- Reduce indoor heating temperatures by 1 degree
- Implement limits on travel in company-owned vehicles
- Turn off non-critical electrical infrastructure during closed hours
- Implement a reliability process for refrigeration systems

By implementing behavioral changes first, an MCI will benefit from a reduction in emissions and operating costs and will continue to benefit from efficiency improvements if capital improvements are made.

Capital improvements

When reduction strategies are developed, they often focus on capital improvements that alter the operation of an organization. These improvements can significantly reduce emissions for an organization, but considerations must be made about cost, feasibility, and the remaining operational life of existing equipment. In general, most capital reduction opportunities for Scope 1 emissions involve electrification, which moves emissions sources further upstream to utility providers.

- Replace gas- or oil-fired heaters with electrical systems (with energy production from renewable sources)
- Replace vehicle fleet with electric cars, and/or reduce the need for fleet vehicles
- Install solar PV and battery power system

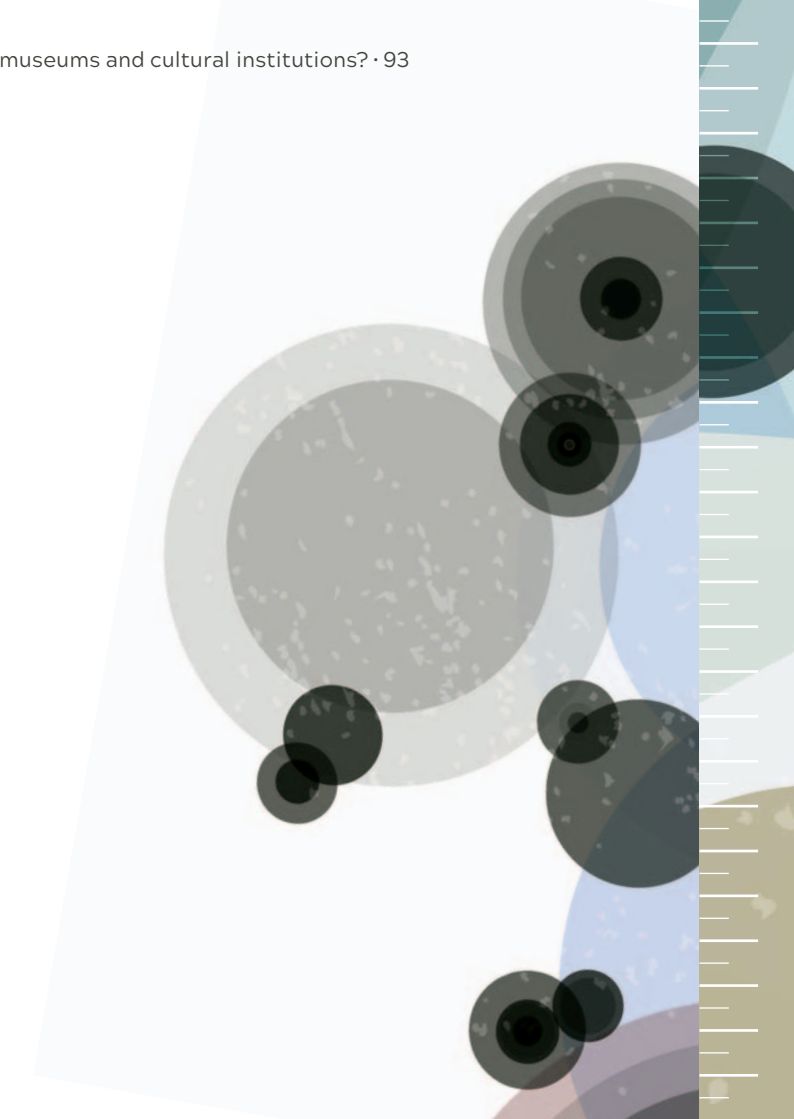
Though these changes may result in a reduction in GHGs, it is important to recognize that many capital changes do not make emissions disappear, as they tend to relocate emissions to different Scope Categories.

Scope 2 reductions

Because Scope 2 emissions are being generated at power generation facilities, few facility modifications will lead to significant reductions, but improving energy efficiency is always a good place to begin. Most organizations begin this journey through the installation of LED lights and can move on to purchasing more efficient equipment, such as air-conditioning units.

Depending on the location of a facility, the reporting organization may be able to purchase renewable electricity from a third-party provider through contracts referred to as Power Purchase Agreements (PPAs). For those entities that are unable to purchase renewable electricity, alternatives including virtual power purchase agreements (VPPAs), guarantees of origin (Gos), and renewable energy credits (RECs). The latter agreements function similarly to carbon credits, in that an organization purchases renewable power by the megawatt-hour that can be used to reduce Scope 2 emissions when considering market-based approaches.

The impacts of these administrative mechanisms on Scope 2 accounting can be explored in more depth in the Greenhouse Gas Protocol Scope 2 Guidance.



Scope 3 reductions

As discussed in previous sections, Scope 3 emissions vary widely by activity and reporting organization. This Scope of emissions includes a wide variety of sources and types of emissions, so it is important to understand your organization's supply chain in depth to prioritize emission-reduction opportunities. Because this Scope involves an organization's supply chain, many of the recommendations for reduction are based on influencing the behaviour of suppliers, partners and visitors.

The table on the following pages provides a non-exhaustive list of opportunities for MCIs to reduce their Scope 3 emissions by category.

	Category	Description	Possible activities for MCIs to implement
1	Purchased goods and services	emissions from the production of products and services purchased or acquired	purchase fewer goods and services; consume less, purchase low or, ideally, zero-carbon goods and services, purchase second-hand goods
2	Capital goods	emissions from the production of capital goods	purchase second-hand capital goods (e.g. vehicles, equipment), purchase fewer capital goods through greater sharing of resources
3	Fuel and energy-related activities	emissions related to the production of fuels and energy purchased and consumed	switch to renewable energy sources, maximize energy efficiency, consume less energy, change environmental requirements to be more in keeping with Paris Agreement targets, and where environmental controls are absolutely necessary for collections stores and exhibitions, implement them through targeted localization
4	Upstream transportation and distribution	transportation and distribution of products purchased	purchase fewer products, reduce transportation emissions by insisting on low or, ideally, zero-carbon emissions transport, maximize the efficiency of transportation of purchased products, loans etc.
5	Waste generated in operations	emissions from third-party disposal and treatment of waste generated	consume less to produce less waste, enhance sharing and reuse of resources to minimize waste production

6	Business travel	emissions from the transportation of employees for business-related activities	reduce business travel emissions, notably through reducing business travel and replacing with online meetings
7	Employee commuting	emissions from the transportation of employees between their homes and their worksites	provide employees with support (season ticket loans) to use public transport, encourage and empower employees to work from home
8	Upstream leased assets	emissions from the operation of assets that are leased (e.g. storage in buildings owned by others)	reduce the need for leased assets by prioritizing disposal and or/dispersion of low quality or unused assets, and greater sharing of assets among partners to reduce the need for storage
9	Downstream transportation and distribution	emissions from transportation and distribution of sold products in vehicles and facilities owned by others.	reduce travel resulting from museum activities, including visitor travel, touring exhibitions, and where travel cannot be reduced, reduce the emissions by choosing low-emissions transportation methods, and through collaboration to ensure the effectiveness of travel itineraries
10	Processing of sold products	emissions from processing of sold intermediate products by third parties subsequent to sale	reduce emissions by reducing the number and impact of touring exhibitions, reduce emissions involved in the production of e.g. publications and other merchandise

11	Use of sold products	emissions from the use of goods and services sold [includes free goods and services]	reduce sale of goods that require use of fuel or electricity in their use, whether in shops, or in terms of exhibitions for hire
12	End-of-life treatment of sold products	emissions from the waste disposal and treatment of products sold [or otherwise produced]	reduce emissions from waste from temporary exhibitions by reducing their production, minimizing construction, increasing sharing of resources with other museums and other organizations, and prioritizing easily disposable and biodegradable materials
13	Downstream leased assets	emissions from the operation of assets that are owned by the reporting organization	reduce the number of assets leased (where there are any), design contracts that require emissions reporting and reductions by lessees
14	Franchises	emissions from the operation of franchises (e.g. book production or distribution, marketing distribution)	ensure that any franchised operations prioritize sustainable practices in line with Paris Agreement targets
15	Investments	emissions associated with the reporting company's investments (e.g. activity related to endowments, pension funds, bank accounts)	ensure investments of all kinds are directed towards sustainable development, eliminating support and benefit from activities that are socially and environmentally damaging; partnerships and relationships may be considered as a form of investment

Section 5

REPORTING AND COMMUNICATING EMISSIONS REDUCTIONS

Reporting and communicating emissions reductions

In order to report GHG emissions, the organization must decide which standard to follow. The GHG Protocol, which is the basis for this document, is the world's most widely used greenhouse gas accounting standard⁶⁸, but there are different options, some of which are listed below

World Business Council for Sustainable Development and World Resources Institute - GHG Protocol (2001 - last updated in 2015)⁶⁹:

This series of documents establishes comprehensive global standardized frameworks to measure and manage greenhouse gas emissions from private-and-public sector operations, value chains and mitigation actions.

International Organization for Standardization (ISO) - ISO 14064 family (2018/2019)

- ISO 14064-1:2018 (2018)⁷⁰: Principles and requirements at the organization level for the quantification and reporting of greenhouse gas emissions and removals. It includes requirements for the design, development, management, reporting and verification of an organization's GHG inventory.
- ISO 14064-2:2019 (2019)⁷¹: Principles, requirements and guides at the project level for the quantification, monitoring, and reporting of activities intended to cause greenhouse gas emission reductions or removal enhancements. It includes requirements for planning a GHG project, identifying and selecting GHG sources, sinks, and reservoirs relevant to the project and baseline scenario, monitoring, quantifying, documenting and reporting GHG project performance, and managing data quality
- ISO 14064-3:2019 (2019)⁷²: Principles, requirements and guides for verifying and validating greenhouse gas statements. It applies to organizations, projects and products.

Agence d l'Environnement et de la Maîtrise de l'Energie (French Environment and Energy Management Agency - ADEME) - Bilan Carbone® (2001 - last updated in 2017)⁷³:

Bilan Carbone® is designed to compile an exhaustive inventory of GHG emitted by an organization, an event or a project. According to the Association Bilan Carbone, the methodology is also an environmental management tool, serving as a guide and supporting resource for organizations as they develop their climate and energy transition actions.

British Standard Institute - PAS 2060:2010 (2010 - last updated in 2014)⁷⁴:

This standard helps organizations demonstrate that their carbon neutrality claims are accurate, credible and verified, and provides guidance on how to quantify, reduce and offset GHG emissions. The PAS 2060 covers activities, products, projects, services, buildings, events, and cities

Making environmental claims

Increasingly, MCIs are making environmental claims about their commitment to environmental action, notably around reducing emissions, working towards carbon neutrality or net zero by a particular date, being ‘environmentally friendly’, being committed to sustainability, or working to be ‘more sustainable’.

To be credible and realistic, these claims need to be backed up with an explanation. For example, an MCI making a net zero claim should be clear on which aspects of its activity are covered in the claim, especially the Scope 3 Categories they are including or excluding. The claim should be accompanied by a clear plan to reduce emissions, and open and transparent reporting.

Making robust claims that the MCI understands helps protect the public’s right to accurate information, protects the institution’s reputation, helps drive genuine climate action, and prevents ‘greenwashing’.

Green Claims Code

In the UK, the Competition and Markets Authority (the UK’s primary competition and consumer authority) has developed a Green Claims Code (2021)⁷⁵, to help businesses understand and comply with their existing obligations under consumer protection law when they are making environmental claims. Environmental claims are claims “which suggest that a product, service, process, brand or business is better for the environment [as a whole, or to climate, air, soil or water]. They include claims that suggest or create the impression that a product or a service:

- has a positive environmental impact or no impact on the environment;
- is less damaging to the environment than a previous version of the same good or service; or
- is less damaging to the environment than competing goods or services.”

The Green Claims Code states that environmental claims are genuine when they properly describe the impact of the product, service, process, brand, or business, and do not hide or misrepresent crucial information. Misleading environmental claims occur when a business makes claims about its products, services, processes, brands, or operations as a whole, or omits or hides information, to give the impression they are less harmful or more beneficial to the environment than they really are.

The Green Claims Code consists of six principles:

1. Claims must be truthful and accurate
2. Claims must be clear and unambiguous
3. Claims must not omit or hide important relevant information
4. Comparisons must be fair and meaningful
5. Claims must consider the full life cycle of the product or service
6. Claims must be substantiated

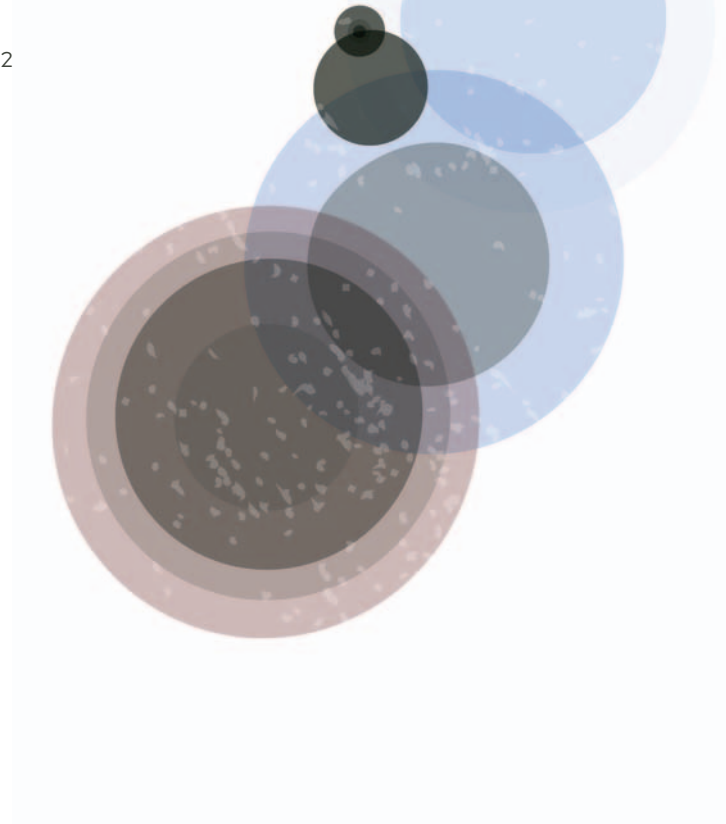
The Code can be used by MCIs to assess their existing environmental claims and as they develop new claims, to ensure they meet these requirements, and to provide complete information openly and transparently to visitors, funders, and other stakeholders.

Those who direct and fund the work of MCIs can use these principles to drive ambition and accountability among MCIs.

The Oxford Principles for Net Zero Aligned Carbon Offsetting

The Oxford Principles for Net Zero Aligned Carbon Offsetting⁷⁶ (Oxford Offsetting Principles for short) were developed in 2020 as a set of best-practice guidelines on how to use offsetting in ways that genuinely support climate action. The principles are as follows, in summary:

1. **Cut emissions, use high-quality offsets**, and regularly revise the offsetting strategy as best practice evolves. Crucially, organisations should prioritise reducing their emissions, to minimise the need for offsets in the first place, using offsets that are verifiable and correctly accounted for, and by being part of certified schemes (such as the Certified Emissions Reduction scheme).
2. **Shift to carbon removal offsetting**, rather than emissions reduction offsetting.
3. **Shift to long-lived carbon storage**, so that offsets cannot be easily reversed.
4. **Support the development of net zero aligned offsetting**, by using long-term agreements, forming alliances for offsetting with peers, and supporting the restoration of natural and seminatural ecosystems above and beyond offsetting but as a responsibility in its own right.



The UN High Level Champions and Oxford Net Zero

The UN High Level Champions and Oxford Net Zero have developed a toolkit⁷⁷ to help ensure that net zero claims are credible and to help organizations make appropriate net zero plans. These are the ‘guard rails’ of net zero. The toolkit is based on six questions:

1. **Is it about now?**
There should be a focus on action right now, to a 50% reduction in emissions by 2030.
2. **Is there a plan?**
There should be a plan of immediate actions and in the next five years.
3. **Is it fast enough?**
Plans should help get to net zero emissions before 2050, and as fast as possible.
4. **Can you see progress?**
Progress should be reported publicly, at least annually, and for all 3 Scopes.
5. **What does it cover?**
The commitment to net zero should cover all three Scopes of emissions.
6. **Is it just offsetting?**
Reduction of emissions should be the priority, and offsetting does not substitute or delay decarbonisation.

RESOURCES

The [UNFCCC Climate Neutral Now](#) initiative encourages organizations to make a commitment to reduce their greenhouse gas emissions, with a four-step approach: measure, reduce, report, and contribute. Over 400 organisations take part. Their participation is formally recognised by the United Nations. Climate Neutral Now is free to participate in, and a participant can withdraw from the scheme at any time.

Carbon offsets supporting a range of projects can be purchased from the UNFCCC Carbon Offset Platform. These are Certified Emission Reductions (CERs) that are part of the Clean Development Mechanism.

[Greenhouse Gas Protocol](#) maintains sets of standards and guidance documents that enable organizations to assess their emissions across the value chain. The ‘Corporate Standard’ sets out requirements and guidance on preparing a GHG emissions inventory. The ‘Scope 3 Standard’ allows companies to assess their entire value chain emissions and identify where to focus reduction efforts. These standards are accompanied by ‘Scope 2 Guidance’ and ‘Scope 3 Guidance’, which provide more detailed information on the respective Scopes.

The [Scope 3 Evaluator tool](#) is a free online tool from the Greenhouse Gas Protocol and Quantis that makes it easier for organizations to measure, report and reduce emissions throughout their value chain.

The [Climate Toolkit](#) provides guidance notes for museums on many aspects of reducing greenhouse gas emissions, with case studies on how US museums and botanic gardens are already reducing their carbon footprint.

The [Science-based Targets Initiative \(SBTi\)](#) drives ambitious climate action in the private sector by enabling companies [but open to organisations of all kinds] to set science-based emission-reduction targets.

The [SME Climate Hub](#) is based on a commitment to reduce greenhouse gas emissions by 50% by 2030 and net zero by 2050, and to report on a yearly basis. Museums can take part in the SME Climate Hub, and so join the Race to Zero campaign. The SME Climate Hub has a repository of tools to help organisations to measure, reduce and offset their emissions.

Carbon calculators for the cultural sector are available from [Julie’s Bicycle](#) and the [Gallery Climate Coalition](#). In using such calculators it is important to understand what is included and excluded.

Appendix A

GLOSSARY

Anthropogenic climate change:
The human impact on Earth’s climate. Human-induced climate change is directly linked to the amount of fossil fuels burned, aerosol releases and land alteration from agriculture and deforestation.

Carbon footprint:
A calculation that estimates the amount of emissions in carbon dioxide equivalent that a country, a business, an organization, an individual, or another stakeholder is responsible for.

Climate neutrality:
Climate neutrality refers to the idea of achieving net zero greenhouse gas emissions by balancing those emissions so they are equal (or less than) the emissions that get removed through the planet’s natural absorption; in basic terms it means we reduce our emissions through climate action.⁷⁸

CO₂ equivalent (CO₂e):
The universal unit of measurement to indicate the global warming potential (GWP) of each greenhouse gas, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate the impact of releasing (or avoiding releasing) different greenhouse gases against a common basis.

Emission Factor:
A conversion factor allowing GHG emissions to be estimated from a unit of available activity data.

Global warming potential (GWP):
A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO₂.

Greenhouse gases (GHGs):
Gases that trap heat or longwave radiation in the atmosphere. Their presence in the atmosphere makes the Earth’s surface warmer. Sunlight or shortwave radiation easily passes through these gases and the atmosphere, is absorbed by the surface of the earth, and is released again as heat or longwave radiation. The molecular structure of GHGs allows them to absorb this released heat and re-emit it back to the earth. This heat-trapping phenomenon is known as the greenhouse effect.

Lifecycle analysis:
Assessment of the sum of a product’s environmental impacts at each step in its life cycle, including resource extraction, production, use and waste disposal.

Net zero:
Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon).⁷⁹

Scope 1 emissions:
Direct GHG emissions from sources that are owned or controlled by the organization.

Scope 2 emissions:
GHG emissions specific to utilities that are a consequence of the operations of an organization but occur at sources owned or controlled by another company.

Scope 3 emissions:
GHG emissions that are a consequence of the operations of an organization but occur at sources owned or controlled by another company.

Value-chain emissions:
Emissions from the upstream and downstream activities associated with an organization’s operations.

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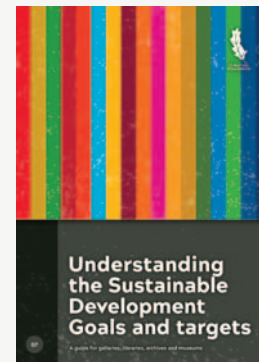


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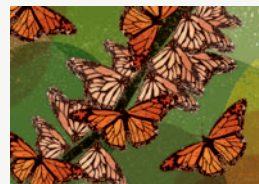
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