GCC

Methodology - Carbon Calculator 2.0

Contents

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1. What's Included in GCC's Tool and Why?

The aim of GCC's carbon calculator is not to create a perfectly accurate inventory of your emissions. The aim is to give you enough information, of good enough quality, for you to get started on taking action to decarbonise your operations.

We have tried to strike a balance between making the tool easy to use, while still being accurate enough to give useful guidance on where and how to cut your climate impact. For most arts organisations, the largest parts of their footprint will be staff flights, building energy and international shipping. For this reason, we strongly advise that all GCC members gather the best quality data that they can in these areas, and minimise the estimates and assumptions they use.

For the other sections of the tool, we have tried to make it as easy as possible to fill them in quickly, and have provided some potential shortcuts and estimation methods for when detailed data may not be easily available. This is to give you a broad picture of your wider footprint as soon as possible, so you can get started on taking action. However, if any category of emissions where you have used estimates or assumptions appears to be significant (e.g. more than 5% of your footprint), we would advise taking time to gather more detailed and accurate data here when you can.

Not every section of the tool will be relevant to everyone. For example, not everyone will have purchased external accommodation, or offsite storage, or air conditioning refrigerants in any given year. Visitor travel might not be relevant to an arts publication or an artist's studio; a solo artist who works from home will not have commuting emissions (but will need to count the energy from their home working space under "building emissions").

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2. Scopes and Boundaries

The calculator gives results in "carbon dioxide equivalent" (CO_2e), which includes the warming effects of methane, nitrous oxide, and refrigerant gases. Meaning other Greenhouse Gas Emissions *are* included in the results even though we often just use 'carbon', this is just a shorthand.

The tool gives you the option of viewing which Scopes your emissions fall into. Scopes 1, 2 and 3 are categories of emissions used in formal carbon reporting under the internationally recognised Greenhouse Gas Protocol. They are designed to prevent double counting between the footprints of different organisations on a national and international scale. Some organisations may need to use these categories in some statutory reporting to government bodies or funders. However, in day-to-day arts sector carbon management we find it more useful to focus on whichever areas of emissions are the most significant for your particular organisation, and where you have the greatest control and potential for change, rather than worrying too much about which Scope they fall into.

Rather than including every possible category of emission, the tool purposefully focuses on the significant areas where you are most likely to be able to make a difference.

For the sake of clarity, these scopes are defined as:

- **Scope 1** includes all greenhouse gases that have been directly emitted by your own organisation's activities (e.g. gas burned to heat your building, fuel burned in a car you own, refrigerant chemical leaking from your own air conditioners)
- **Scope 2** is emissions from electricity or purchased steam, where you are the final user of the energy but the greenhouse gases were emitted elsewhere, eg at a power station; and
- **Scope 3** is sometimes called "value chain emissions", is everything else (including shipping, flights, and other purchased goods and services). There are 15 potential Scope 3 subcategories.

The tool should allow you to measure all of your Scope 1 and Scope 2 emissions, plus the subcategories of Scope 3 that we believe are likely to be significant, possible to measure, and where you have a meaningful level of control.

The table below shows which categories within the tool fall into which Scopes.

Main activities measured by the tool	**Scope**	**Scope 3 Category (if relevant)**
Business Flights	3	Category 6 - Business travel
Surface Travel - direct fuel purchase	1	n/a
Surface Travel - other	3	Category 6 - Business travel
Accommodation	3	Category 1 - Purchased goods and services
Long distance freight	3	Category 4 (Upstream distribution) and Category 9 (Downstream distribution)

Local freight	3	Category 4 (Upstream distribution) and Category 9 (Downstream distribution)
Building Energy - Electricity and Steam	2	n/a
Building Energy - Direct fuel burning	1	n/a
Refrigerants	1	n/a
Offsite Storage	3	Category 1 - Purchased goods and services
Material Use	3	Category 1 - Purchased goods and services and Category 2 – Capital Goods
Digital Emissions	3	Category 1 - Purchased goods and services

Shared Emissions (not part of core target but still important for action)	**Scope**	**Scope 3 Category (if relevant)**
Visitor Travel	3	Category 11 - Use of products
Staff Commuting	3	Category 7 - Employee commuting
Home Working	3	Category 7 - Employee commuting

Most of the remaining Scope 3 categories are excluded because they are unlikely to apply to the great majority of GCC members – with the exception of waste, capital developments, major catering/retail purchasing, and "well-to-tank" emissions. The reasons behind the exclusion from the tool of these four categories are explained in the next section.

For a full list of Scope 3 categories, and a full explanation of why some are included in the tool and some are not, see Appendix 1.

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3. What the Calculator Doesn't Measure

Due to the intentional design of our tool - namely, prioritising usability and keeping a focus on the key impact areas for the sector - it cannot capture every possible source of emissions. This is true of the areas outlined below that require a more specialised approach and for these reasons, certain categories have been intentionally left out. For users who have robust data on these areas from other tools, the 'Custom Input' feature allows you to include them in your carbon report. For major developments, catering, or waste disposal, we recommend a separate, professional audit to ensure these significant emissions are properly accounted for.

Significant Capital Developments (building works, refurbishments)
If an arts organisation is undergoing major redevelopment work this would fall into Scope 3 Category 2 (Capital Goods). However, the footprint of major building work is not included in the tool, as we would advise carrying out a separate footprinting audit on any planned works of this scale, in order to minimise them in advance and ensure that every opportunity is taken to reduce ongoing emissions in the future. Every building project is likely to have a significant footprint that should be predicted and reduced as a core part of the planning process, with a professional carbon audit. A universal online carbon calculator would not be appropriate for this.

Waste Disposal
Under the Greenhouse Gas Protocol standards, the footprint of waste disposal (Scope 3 Category 5) is calculated in a way that usually gives it a minimal carbon footprint. This is because most of the emissions from resource and material use are counted at the manufacturing phase, and not at the disposal phase, to avoid double counting. We have therefore excluded waste from the tool, as it is unlikely to make up a significant part of your carbon footprint. Instead, we would recommend carrying out a waste audit as a separate exercise, and develop a waste strategy based not just on carbon emissions but on the wider goals of circularity and tackling the plastics and toxicity crises. See GCC's separate guidance on waste. We are hoping to also develop a separate tool that focuses on these issues, distinct from our carbon tools – watch this space.

"Well-to-Tank" (WTT) Emissions
These are also known as "Fuel and energy related emissions", (Scope 3 Category 3), and represent the upstream impacts of digging up and transporting the fossil fuels that end up being burned in the planes, cars, trains, buildings, power stations etc in the other Scopes and Categories. GCC does not include WTT emissions, in order to follow the same methodology as Julie's Bicycle's carbon tools, and ensure our results are broadly compatible. These emissions would only add a small percentage to the final total, and are not something that an arts organisation can tackle directly - the only sure way to reduce them is to reduce fossil fuel use, which is something that everyone will need to do anyway in order to reduce emissions in all other categories. Excluding WTT emissions should not significantly affect the action plans that GCC members will need to make, and also makes the tool slightly simpler for us to manage and maintain.

Purchases for Major Catering and Retail Operations

A small number of GCC members run large shops, restaurants or cafes, that carry out volumes of purchasing too large and complex to be covered by a web tool like this one. We are looking into ways to develop separate tools to estimate these emissions, to at least give a sense of their scale. However, in any case we would strongly advise carrying out a professional carbon audit of these emissions, at least as a one-off, in order to develop strategies for minimising them.

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4. Shared Emissions

There are two categories of emissions that we believe GCC members should measure, but not include in their core 2030 targets. These are Visitor Travel and Staff Commuting (which includes home working emissions). Responsibility for these emissions are shared between you, your visitors and your staff. The tool therefore calculates Visitor Travel and Staff Commuting emissions separately and does not add them to your main target.

Even though you do not have complete control over these emissions, you do have a significant influence over them and so share the responsibility to monitor and decrease these emissions. For certain GCC members (i.e. those with significant public footfall and/or staff numbers) these emissions are likely to be significant, so we strongly recommend that you measure and report on them. However, they should be considered separately from your core operational footprint and not included in your 2030 reduction target. “Shared responsibility” emissions should instead have their own discrete reduction plan, developed in partnership with other organisations and individuals who also have a stake in those emissions.

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5. The Numbers Behind the Calculations

The GCC Carbon Calculator uses carefully selected factors and metrics to ensure accurate, relevant, and actionable estimates across various emissions sources. We use internationally recognised data sources, such as the UK Department for Energy Security and Net Zero (DEFRA/BEIS), as well as international databases, to calculate emissions for air travel, shipping, energy, refrigerants, local freight, and more. These factors have been chosen to provide transparency and consistency for users, while allowing for flexibility where exact data is unavailable. To ensure consistency across carbon reporting tools, GCC have aligned factors, where appropriate, with other tools. Each category is designed to give users an accurate sense of their carbon footprint based on real-life data wherever possible, but also offers estimations where necessary. The underpinning factors will be updated annually or as and when new data sets become available.

a. Air Travel

The automated distances are calculated based on the airport's geographical locations and the curvature of the Earth.

The carbon factors are from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS). We are including the extra warming caused by the Radiative Forcing ("RF") from burning jet fuel at high altitude, which can add 70 – 90% to the climate impact of each flight due to the chemical reactions, vapour trails and impacts on cloud formation that are unique to aviation. Some carbon tools and databases (such as US EPA and IATA) do not include this extra RF warming, as the exact figure is still subject to some debate by climate scientists. However, as it is a real effect that gives aviation a significantly higher climate impact than just the CO_2 emitted by burning the fuel, we believe that excluding it would be significantly less accurate than including it.

The UK Government factors include different carbon numbers for different classes of flight. This is because the more expensive seat classes take up greater space on the plane, and thus are responsible for a larger share of the total emissions of the flight.

The carbon factor for private jet travel is based on the average of 1300 gCO_2e/pkm calculated by Transport & Environment (See page 12), but with 70% added for the extra Radiative Forcing, as above.

b. Shipping

We know that shipping companies do not always report the total weight of packaging they add to a shipment (particularly for road freight, where volume tends to be a more important factor than weight). Where this added weight is unknown, the tool can optionally add an extra 30% to the weight transported, to represent this. This figure is based on data from GCC members, about the typical weight of packaging added by shippers. However, this will of course be approximate, and so we would strongly recommend speaking to your shippers and trying to obtain the real packaging weights wherever possible.

All the carbon factors are based on the actual physical weight of materials transported, including the packaging – often known on shipping paperwork as "gross weight". This is different from *volumetric weight*, which is a figure based on the space taken up by a piece of cargo, not its real-life tonnes and kg. To calculate the footprint properly, we need to know the gross weight, not the volumetric weight (which can vary hugely based on the density of the materials being shipped).

Sometimes shippers do not clearly specify whether they are giving you figures in gross weight or volumetric weight – they may use catch-all terms like "chargeable weight" (which can mean either gross weight or volumetric weight, depending on the circumstances), or simply "weight". Please speak to your shipper in these circumstances and ask for the figures in gross weight wherever possible.

If data are only available as volumetric weight, then the tool can make a *very* rough estimate of the gross weight, based on the data from GCC members that shows the average volumetric weight measurement is around 1.73 times higher than the gross weight. However, this should be seen as a broad approximation only, as this ratio can vary greatly between items of cargo. We would strongly recommend obtaining the gross weight wherever possible.

Most factors for the different freight options (including air, road and sea) are taken from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS). Freight is an international business, and so these factors are broadly applicable in different countries and regions.

For air freight, we are including the extra warming caused by the Radiative Forcing ("RF") from burning jet fuel at high altitude, which can add 70 – 90% to the climate impact of each flight due to the chemical reactions, vapour trails and impacts on cloud formation that are unique to aviation (see "Air Travel").

The automated distances for air transport are calculated based on the airport's geographical locations and the curvature of the Earth. For road and sea distances, we hope to obtain the necessary funding to automate these in the future.

The carbon factors for electric vehicles are taken from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS), but are then scaled up or down based on the carbon intensity of the electricity grid of the country where the vehicle is being used. This assumes that electric vehicles have broadly the same average efficiency in different countries.

The electric vehicle factors also assume that these vehicles are not usually being charged at a location where you are also paying the electricity bill, e.g. one of your own galleries. In other words, we are assuming that the electricity used to charge the vehicles is additional to the electricity consumed in your own buildings.

The simplest method for calculating road freight is where the weight of material transported is known. This allows the tool to use the unit "tonne-km" (ie the transport of 1 tonne of material 1 km), and to calculate a footprint based on the average load of the vehicle type in question, without needing to know the details of exactly how much of the vehicle was taken up with your cargo compared with anyone else's.

Where the exact weight transported is not known, then we cannot use the "average footprint of transporting 1 tonne by 1 km using this particular type of truck" factors. Instead, we need to know roughly what percentage of the truck/van is taken up with your goods, which can be challenging to find out.

This second calculation method may also be useful for those GCC members who want to enter more details about specific shipments where they have taken action to minimise the footprint by using particularly efficient vehicles, consolidating journeys etc.

c. Energy

The carbon factors for piped gas – and for steam and district heating based on piped gas – are from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS), as are the factors for wood fuel, and for UK electricity.

The factors for electricity in every other country are taken from carbonfootprint.com. After careful research these factors were chosen because:

- They cover a large (and expanding) number of countries, including separate factors for all US states
- They are updated annually
- They use a transparent methodology
- Unlike some factor databases they separate out the direct emissions from power stations from the Well-To-Tank (WTT) emissions of the fuels, allowing us to be consistent in our methodology by not including WTT and remaining in line with Julie's Bicycle and other arts carbon tools (see Scopes and Boundaries, above.

Before 2022, a number of countries were not yet included in the carbonfootprint.com electricity database. Electricity factors for missing countries in these older years have been taken from the ICRC's Humanitarian Carbon Calculator instead. The average global electricity factor has been taken from ember-climate.org.

Note that all electricity calculations are based on the average carbon intensity of the relevant national grid (aka location-based), rather than the energy mixes claimed by energy supply companies (aka market-based), including "green" suppliers. This method better reflects the reality of how electricity usage affects carbon emissions, as explained by Ethical Consumer here.

The average figures for estimating the energy per square metre in different types of building are taken from the following sources:

- UK: CIBSE Energy Benchmarking Dashboard
- US (including individual states): EIA
- EU countries: PCAF

These three regions cover the majority of GCC members at the time of launch. For the rest of the world, the UK numbers are used as a ballpark figure. If there is significant demand for these estimates from other specific countries or regions, we will seek to add them into the tool.

Note that each of these three databases contains energy usage for slightly different categories of building. All three (CIBSE, EIA and PCAF) have data specific to offices and warehouses/storage facilities; however, only CIBSE and EIA have energy data specific to museums/galleries. PCAF has data for the much broader category of "Leisure and sports facilities". Fortunately, PCAF also includes data from the UK, allowing some crossover comparison with the CIBSE database. The energy use of museums and galleries in the EU has therefore been estimated by scaling the CIBSE UK museum/gallery figure up or down, based on how European energy use within the PCAF "Leisure and sport facilities" category compares with the UK. For example, the energy use per square metre of a "leisure and sport facility" is 60% higher in Estonia than in the UK, according to the PCAF database. So to estimate the energy use per m^2 of an Estonian art gallery, we add 60% to the UK museum/gallery energy use figure from the CIBSE database.

Another complicating factor is that the PCAF database only records the *total* energy use per m^2, and doesn't specify how much of that energy is electricity and how much is gas. We have therefore estimated this split for each country based on the figures in the following scientific paper, which suggests that Northern European countries use 70% gas and 30% electricity, Southern Europe uses 50% gas and 50% electricity, and central Europe somewhere in between.

All of the above should make clear that the estimated energy figures in the tool should be seen as illustrative ballpark numbers only, not as precise results. They are intended to give you a sense of the likely scale of the emissions from the energy use in a particular building, to help inform your wider plans and target-setting where bills or metre readings are not available. However, we would strongly advise seeking out real-life energy data wherever possible, especially if these emissions appear to make up a significant part of your footprint.

Refrigerants

The carbon factors for refrigerants are from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS).

Many refrigerant chemicals are powerful greenhouse gases in their own right. Whenever new chemicals need to be added to an air conditioning or refrigeration system to top it up, this means an equivalent amount has previously leaked out into the air, creating a climate impact. This impact is what is being measured by the tool.

Note that Refrigerants are not included as a category in the Project version of the tool, as it is extremely difficult to allocate refrigerant use to short periods of usage, and the amounts involved are likely to be very small.

Offsite Storage

The carbon factors for piped gas and UK electricity are from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS); the factors for electricity in every other country are taken from carbonfootprint.com, as per “Building Energy”, above.

The estimation tool for cases where energy data from the storage company are not available also uses the following data:

- If square metre usage figures are available, then the average energy use of warehouse/storage space per m^2 from the appropriate region are used to estimate the electricity and gas use, as per “Energy”, above.
- If m^2 figures are not available, but m^3 figures are known, then we need to estimate how much floorspace in m^2 is being covered by that m^3 volume. The tool does this based on the maximum height that can be safely stacked onto a wooden pallet, which gives an approximate ratio of 0.45 m^2 for every $m^3$of storage. Of course, a lot of art storage involves shelving rather than stacking up from floor level, but we believe this ratio is good enough to give an approximate figure for when better numbers are not available.

Note that it was not possible to obtain average energy use data specifically for art storage facilities. The available studies seem to contain a wide range of results based on very specific types of facility and location, with no general averages available. So the broader "warehouse/storage" figures from CIBSE, EIA and/or PCAF have been used for now, but with the hope that more art-specific storage energy data may become available as more GCC members gather this data directly from their own storage suppliers.

As with the main building energy estimation tool above, all results from the offsite storage carbon estimator should *not* be treated as precise results but as illustrative only, to give a sense of the rough scale of these emissions for the purpose of planning decarbonisation action. If your storage emissions appear to be significant using this estimation tool, then we would strongly advise speaking to your storage provider to obtain more accurate energy usage numbers (see the user guide for help on this).

d. Local Freight

Factors for the different van and truck sizes are taken from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS).

The carbon factors for electric vans are taken from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS), but are then scaled up or down based on the carbon intensity of the electricity grid of the country where the vehicle is being used. This assumes that electric vehicles have broadly the same average efficiency in different countries.

The electric vehicle factors also assume that these vehicles are not usually being charged at a location where you are also paying the electricity bill, e.g. one of your own galleries. In other words, we are assuming that the electricity used to charge the vehicles is additional to the electricity consumed in your own buildings.

Electric cargo bike and electric motorcycle emissions have been derived from the following studies, and are then adjusted according to the carbon intensity of the electricity in the country of use and this article.

Where the journey is entirely your responsibility – e.g. you have hired a courier or van-driving service to take an item directly from A to B – then vehicle-km factors are used, as the emissions from the entire vehicle need to be added to your footprint.

Where your shipment is added to other people's deliveries and transported together (e.g. via a postal service or general delivery company), then tonne-km factors are used, as only the share of the vehicle emission required for the transport of your specific items need to be added to your footprint.

e. Surface Travel

The carbon factors for fuels (diesel/petrol/LPG) are from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS).

The carbon factors for electric cars are taken from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS), but are then scaled up or down based on the carbon intensity of the electricity grid of the country where the car is being used. This assumes that electric vehicles have broadly the same average efficiency in different countries.

The electric car factors also assume that these cars are not usually being charged at a location where you are also paying the electricity bill, e.g. one of your own galleries. In other words, we are assuming that the electricity used to charge the cars is additional to the electricity consumed in your own buildings.

The factors for most cars/private vehicles (including hybrids and motorcycles) are also from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS). Where the factors are based on size of vehicle (small/medium/large), these are broadly applicable in different countries and regions. However, the factors for *average* vehicles have been recalculated by region, because cars on the road in different countries (particularly the US) are of different average sizes. These have been estimated as follows:

- UK average car: factor from DEFRA/BEIS
- US average car: factor from US EPA
- Europe non-UK average car: no average factor for cars on the road is available. The EU gathers data on the fuel efficiency of the new cars *sold* each year, but not the average mix of cars on the road in those years. However, this research paper reviews the fuel efficiency of new cars in a number of different countries and regions, including both the US and EU, allowing us to calculate that an average new car sold in the EU between 2013 and 2021 produced, on average, 73.3% of the CO_2e per km of a new car sold in the US over that time. Assuming that this ratio holds more generally for cars on the road, not just for new cars sold, allows us to assume that the average car in the EU produces 73.3% of the emissions per km of the average car in the US. The EU average car emissions has therefore been derived from the US EPA average car factor.

Most European GCC members outside the UK are based in EU countries, so the EU figures are used here as a proxy for Europe as a whole.

These three regions cover the majority of GCC members at the time of launch. For the rest of the world, the UK numbers are used as a ballpark midpoint figure (they sit between the US and EU). If there is significant demand for these estimates from other specific countries or regions, we will seek to add them into the tool.

For public transport, the following factors have been used:

- UK bus, taxi, intercity rail, local rail and metro/subway: DEFRA/BEIS
- US bus, taxi, intercity rail, local rail and metro/subway: US EPA. Note that no specific taxi figure is available from the US EPA, so the average car figure has been used here. Europe non-UK bus, taxi, intercity rail, local rail and metro/subway: The Humanitarian Carbon Calculator (for local and intercity trains), and DEFRA/BEIS for the remainder. These forms of travel will make up a relatively small part of most GCC member footprints, and so the UK is probably a good enough proxy here.
- Rest of World bus, taxi, intercity rail, local rail and metro/subway: These public figures from the International Energy Agency are used where possible, for average global rail and bus emissions per passenger-km. For subway/metro emissions, the US is used as a proxy; for taxis, the UK is used as a proxy, in each case because these factors seem to represent the middle ground.
- Ferry factors: Factors for ocean-going ferries that carry both passengers and cargo are taken from DEFRA/BEIS. Factors for local river ferries are taken from ADEME Base Carbone. Note that the ocean ferry factors are based on the majority of the emissions being allocated to the cargo, as this typically takes up 80 – 90% of the weight carried, with passengers being only 10 – 20%.
- Note that where IEA figures are used, they have been scaled down slightly to remove Well-to-Tank emissions, to ensure they are consistent with all other factors in this tool.

Where the details of individual journeys are not known, the tool can make a rough estimate for train and taxi travel based on the amount of money spent. These estimates are based on average prices from these sources:

- Euro News
- Taipei Times
- Quora

- Fleet Lodging
- Finder
- Numbeo

Any train or taxi emissions calculated from cost should be taken to be very approximate. We would strongly advise gathering more detailed data in this area if these emissions appear to make up a significant part of your footprint.

f. Accommodation

Hotel per-night factors for most countries are taken from the UK Department for Energy Security and Net Zero (aka DEFRA/BEIS). Not every country is included in every year of this data; where figures are missing for some years, previous or later years are used as a proxy.

A number of European countries are not included in the UK Department for Energy Security and Net Zero hotel factor list. Emissions per night for hotels in these countries have been derived by taking an average of all other European hotel factors.

A global average of all known hotel factors is used as an average for all other countries not included on the main list.

For self-catering, we use the average energy use (electricity and gas) per m^2 per day of a residential property in the appropriate region, and apply the relevant local electricity factor and gas factor (see "Building Energy", above).

The average figures for estimating the energy per square metre in residential properties are taken from the following sources:

- UK: CIBSE Energy Benchmarking Dashboard
- US including individual states: EIA
- EU countries: BSO

These three regions cover the majority of GCC members at the time of launch. For the rest of the world, the UK numbers are used as a ballpark figure. If there is significant demand for these estimates from other specific countries or regions, we will seek to add them into the tool.

Where the square meterage of a property is not known, the average floorspace sizes of different properties have been estimated as follows:

- Flat or 1-bedroom house; 1 to 2 people: 50 m2
- 2-3 bedroom house; 2 to 3 people: 76 m2
- 4+ bedroom home; 4 to 5 people: 112 m2

These sizes are based on figures from CIBSE and Ofgem in the UK.

g. Materials

The tool calculates the carbon footprint of manufacturing these materials, plus their average transport into the global marketplace. This will cover the great majority of their climate impact, as the "last leg" of transport from point of sale to the consumer only adds a small percentage to the footprint in most cases.

If, however, you wish to include this extra leg of inbound transport, then you can do so by adding those journeys into the "Local Freight" or "Long-Distance Freight" sections of the calculator. Please note that for consistency, you should include this for all purchased materials, or for the same subset of purchased materials year-on-year.

Where possible, material use factors have been taken from the EcoInvent database (v3.10, cut-off, IPCC 2021). We are grateful to Professor Matthew Eckelman of Northeastern University and the STiCH carbon calculator for collaborating with us on this project, and helping us with access to EcoInvent factors for educational non-profit purposes.

Where relevant factors are not available in EcoInvent (particularly for average material categories), the following sources have also been used:

- UK Department for Energy Security and Net Zero (aka DEFRA/BEIS) 2023
- Idemat 2023
- ICE Database (University of Bath, 2019)
- STiCH calculator, including their LCA of nitrile, latex and cotton gloves
- OEKOBAUDAT
- CORRIM
- Base Carbone – ADEME
- WRAP
- A multilevel carbon and water footprint dataset of food commodities | Scientific Data
- FIRA furniture factors but with updated underlying factors for materials and energy
- Individual Environmental Product Declarations (EPDs)
- SUSTAINABILITY DATA | Clayworks

- Environmental impacts associated with the production, use, and end-of-life of a woollen garment | The International Journal of Life Cycle Assessment
- The life cycle assessment of energy and carbon emissions on wool and nylon carpets in the United States - ScienceDirect
- Environmental Product Declaration (EPD)
- https://www.rockfon.co.uk/

The laptop factors are based on manufacturer data, as researched and analysed by Alistair Alexander of Reclaimed Systems.

Where LCAs or EPDs have been used, only the emissions from manufacturing plus transport to the global markets have been counted, to remain consistent with the other databases.

Some estimates have been made about the typical material makeup of certain items (eg mirrors).

Note that life cycle analysis for hempcrete actually found it to be carbon negative over its lifespan, but this has been counted as zero to avoid complicating the results of the tool.

We have worked with STiCH and UAP's Artwork Ingredient List to ensure that our methodology is as closely aligned as possible with theirs, so if any GCC members are using their tools for their material footprint they should come up with roughly the same result using our tool. The key difference is that the GCC tool is based on global average material factors, whereas AIL is able to be more specific about the precise origin of art materials, as they are providing a bespoke service to each client rather than a universal tool. In most cases, this will not make a large difference however, as most of the materials in question are globally-traded and will often come from the same mix of origins.

For more details about any of the assumptions or estimates used for specific materials, please contact us.

h. Digital

Video call emissions are based on energy usage numbers from this Zoom calculator, converted into emissions from the global average carbon intensity of electricity from ember-climate.org

We hope to have the funding in the future to automate the website carbon figure from webcarbon.com

Cloud storage emissions are based on detailed research by Alistair Alexander of Reclaimed Systems. They include the emissions from manufacturing/maintaining the server banks, in addition to the energy required to run them. This is why even renewably-powered local servers have some carbon footprint. Note that we do not use the carbon emissions of server banks as directly reported by Amazon and others, as their calculations often use "market-based" rather than "location-based" electricity factors (see the "Energy" section).

No consistent agreed figures exist for the carbon footprint of emails. The only carbon factors available are some rough estimates by Mike Berners-Lee in 2010. We have taken his middle estimate from this date (4 grams of CO_2e per email, as also referred to by other experts) and applied it very broadly here. Note that this is only to give a very approximate and illustrative number for the sake of comparison with other parts of your footprint, and should not be taken as an accurate carbon assessment.

We are aware that all of the figures above could change rapidly over the coming years, with the growth of AI/machine learning as a particular risk factor that could increase the energy consumption of all digital services that incorporate it into their day-to-day processes. If you use a particularly large amount of processing power in your day-to-day work (eg for creating digital artworks) we would be interested in talking to you about how we develop our tools in this area.

i. Commuting & Visitor Travel

Carbon factors for private vehicles and public transport in different countries and regions are taken from the same sources as in the "Surface Travel" section.

The estimation tools are based on the following data:

- UK average travel distances to galleries/museums
- Average travel methods for leisure purposes and commuting purposes: UK National Travel Survey (Tables NTS0308, NTS0409a, and NTS0409b, using data year 2019 as most recent non-COVID year), US NHTS
- Average car occupancies for leisure purposes and commuting purposes: UK National Travel Survey (Table NTS0907, using data year 2019 as most recent non-COVID year), US NHTS Summary Travel Trends,

Typical travel distances and methods for an urban European gallery are based on data kindly provided by arts organisations in European cities, including the National Gallery London.

Typical travel distances and methods for a rural/ suburban European gallery are based on average travel methods and distances for leisure purposes from the UK National Travel

Survey.

Typical travel distances and methods for urban and rural/suburban US galleries are based on data kindly provided by MOCA, the Discovery Museum Acton, and Environment & Culture Partners.

Important Note: GCC members based in New York City will find that these tools will almost certainly overestimate their visitor travel and commuting emissions, because NYC has a much higher usage of public transit than the average US city.

Visitor travel in these estimation tools includes surface travel only, not international journeys. In most cases, someone flying into a city/country will be planning to undertake multiple activities there, and so figuring out the appropriate amount of the visitor's aviation emissions to allocate to a specific art gallery visit will vary greatly between situations and institutions. We would be very interested to hear from any GCC members who have attempted to calculate this.

Please note that all these estimation tools are intended to give approximate figures only, to give you a sense of the scale of the shared emissions from visitor travel and commuting. To tackle these emissions properly, we would strongly advise undertaking visitor and staff travel surveys.

j. 'Custom'

Please contact us to check before adding anything into this section of the tool. It is intended as a space to include any emissions that you have calculated outside this tool but wish to include in your total – for example, emissions from waste, building projects, or retail/catering purchasing that cannot currently be calculated within the tool. However, it is important to check that any numbers added in here were calculated using compatible methodology and carbon factors to the ones within the tool itself.

If you have already calculated parts of your footprint with the Julie's Bicycle carbon tools, you can either upload the raw data you used for the JB tool into the GCC calculator, or if that is too complex for any reason then you can add in the calculated carbon totals in the "Custom" section of the GCC tool. An important exception to this is if you have calculated a Waste footprint with the JB tools, as their methodology differs from ours with regard to waste and this could lead to double-counting.

6. Annual vs Project Mode

The key differences within Project Mode, as compared to Annual Mode, are as follows:

- Building energy is calculated based on the length of that building's usage in the project, and exactly what space within the building is used, rather than (as in Annual Mode) the full emissions of the building over a year. This requires some slightly different data entry in order to calculate it.
- In Project Mode, there is a function for estimating the "back office energy" associated with a project, which isn't necessary in Annual Mode (where the full emissions of buildings and staff are calculated in a different way). This back office energy is estimated based on the average energy use per m^2 of buildings in that country/region (see the main "Building Energy" section, above).
- Project Mode does not request data on refrigerant use in buildings, as this is hard to break down into time periods shorter than a year and is likely to only make up a small part of the footprint.

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7. Quick Calculator

The Quick Estimate Calculator provides rapid, comparative estimates of the carbon footprint for flights, long-distance travel, freight, and lighting. This tool is designed to help you make informed decisions about reducing your organisation's CO2e emissions by offering swift calculations.

Results from the quick calculator are approximate, using general assumptions. For example, the quick calculator assumes that standard-size vehicles are used for Staff Travel. Because of this you might find that results vary slightly from results in the main calculator. If you need more precise data, you can enter detailed information into the main calculator.

The carbon factors here are the same as used elsewhere in the tool for travel, freight and energy use.

- Typical bulb wattages are taken from LED Lumens To Watts Conversion Chart - The Lightbulb
- Driving distances between major cities are taken from Engineering toolbox and infoplease

- Ocean distances are taken from searates.com.
- Flight distances are calculated based on latitude and longitude

If you opt in for including flight information within staff travel, then air travel within staff travel is calculated by the distance from city to city, accounting for the curvature of the earth, not airport to airport, so is an approximate. This is due to the fact that some cities have multiple airports, and calculations for all modes of transport are aligned under cities. To get more accurate data you can input any further details you have on air travel within the main calculator.

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8. Year-on-year changes in conversion factors

Carbon conversion factors don't stay static. Electricity grids become higher or lower carbon, as power stations or wind/solar sources are added or removed; the efficiency of the average car, bus, or plane goes up or down; new research improves the accuracy of previously used figures.

To comply with best practice, and mandatory reporting standards, the GCC carbon calculator contains a different set of annual carbon factors for every year between 2018 and 2024. This means that when you use the calculator, the factors that are applied to your data will change depending on the date of your measured activities.

The tool will use factors from the year in which most of your calculation falls. So if you're doing an annual footprint stretching from April 2023 to March 2024, the calculator will apply the 2023 carbon factors to the whole calculation, as most of your report falls in the 2023 calendar year. This is referred to as the "majority" method by the UK government and others. It prevents any confusion that might be caused by the carbon factors switching partway through a report. It also makes it easier to distinguish between year-on-year changes in carbon emissions that are based on changes in your operations, and those that are due to changes in carbon factors.

Where a report falls exactly between two years, the calculator will use the most recent year to select the carbon factors. If a long project stretches across more than two years, then the tool will use factors from whichever year makes up the largest chunk of the project, or if it's a tie between multiple years then the calculator will choose the most recent of those years. In these cases, however, we would advise breaking multi-year projects down into smaller year-on-year reports for greater accuracy.

Examples of factor changes between years

Some factors change gradually with time and follow a general trend. For example, the carbon footprint of electricity grids in North America, the UK and the EU have (with some exceptions and fluctuations) been falling between 2018 and 2024, as coal power stations have closed and more renewables have been brought on line in many countries and regions. The same is broadly true for the average footprint per km for vehicles in these regions, which has also been gently falling, driven by fuel efficiency legislation.

However, there can also be significant shifts in factors between two years, driven by major events or recalculations. One important example is the carbon factors for passenger flights to and from the UK, which rose significantly between 2022 and 2023, and remained high in 2024. This is because these factors are calculated (by the UK government) based on the most recently available data for aviation practice and flight efficiency, which is usually from a year or two earlier, as it takes a while for the data to be gathered, checked and processed. As a result, the 2023 and 2024 factors for UK passenger flights are based on aviation data from 2020 – 2022, when the COVID pandemic meant that planes to and from the UK were flying at much lower than usual capacity. While of course the pandemic caused a major drop in flights, it also meant that the planes that *did* fly were less likely to be full, so the average footprint per passenger was higher. This temporary increase in the footprint per passenger is working its way through the carbon factors, and should be expected to fall again in the near future.

However, this increase has been partly counteracted by a change in the factor methodology. Up until 2022, the UK government were using a multiplier of 1.9 to estimate the extra global heating (radiative forcing, or "RF") caused when planes burn jet fuel at high altitude. This is a large additional impact on top of the heating caused by the standard greenhouse gases released by burning the fuel. In 2023, the UK government decided to reduce this multiplier to 1.7, in line with the latest science and international policy. This somewhat ameliorated the rise in UK aviation factors due to the COVID pandemic (and led some factors for non-UK flights to slightly fall).

Meanwhile, the carbon factors for a number of freight vehicles – particularly vans – rose slightly between 2023 and 2024, after several years of gradual reduction. This was due to improvements in the underlying methodology, which now better captures the extra emissions from "cold starts", when a vehicle starts a journey with its engine cold.

Another notable change for 2024 is an increase in the carbon factors for paper and card. This is because the UK government changed its source for these factors in 2024, to bring them more into line with other international greenhouse gas databases. We have followed suit, and adjusted the paper and cardboard factors across the calculator to reflect this *from 2024 onwards.*

When these kinds of methodological improvements are made to emissions factors, it is not standard practice to retrospectively change the factors in the previous years (as this could get extremely complicated and confusing), unless some kind of very serious error has occurred which needs fixing. Instead, we continue to use past factors to calculate past years, as these are the best available snapshot of the carbon intensity of those activities, using the best data that were available at that time.

How to handle carbon factor changes in your own reporting

If your annual footprint doesn't seem to be neatly tracking your real-life changes in practice – for example, if you reduced your flights by 5% but your flight footprint slightly increased, or if your electricity consumption stayed stable but your electricity footprint fell – this is probably due to changes in the underlying carbon factors. You can check this by creating a couple of fictional test projects with identical flights, energy use or whatever else you want to check, and setting them in the years you want to compare. This will show you how much the factors for those activities have changed between those years. You can then flag this up in your reporting.

It's important to note that we expect the carbon factors that underlie the main parts of arts organisations' footprints to decline between now and 2030. There will be occasional upward fluctuations caused by external shocks (such as the COVID pandemic) or methodology improvements, but the general direction of travel right now is for the decarbonisation of vehicles, manufacturing and energy grids across the global economy. So don't feel disheartened if the occasional factor increase seems to disrupt your progress towards your carbon targets – just keep on pushing in the right direction and the factors should shift back in your direction again!

(Of course, this doesn't mean that we can sit back and wait for everything to decarbonise around us – while gradual progress is being made in the wider economy, it is not yet happening fast enough to hold temperature rises at 1.5 degrees. This is why the arts have a crucial role in setting a positive example on carbon reduction, and helping to inspire and drive faster action elsewhere.)

These examples highlight an important point: all carbon factors are based on averages and the best available data. They should not be treated as definitive or highly accurate – and the same is therefore true of any carbon footprints or audits carried out using those factors. The aim of carbon calculations is to give "good enough" numbers for us to set targets and develop action plans that focus on the most important areas and match the scale of change required to tackle the climate crisis. The occasional fluctuation in the underlying numbers can complicate the picture, but should not be seen as a significant barrier to our overarching mission of greenhouse gas reduction. The important thing is to keep on heading in the right direction, at the scale required, as fast as we can.

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9. Appendix

Scope 3 Category	**GCC calculator elements in this category**	**Notes**
Category 1 - Purchased goods and services	Material Use, Digital Emissions and Accommodation	Other major purchases that could fit here but are not yet included are items purchased for large-scale retail, and ingredients purchased for large catering operations. These are not yet included as they are only relevant for a small number of GCC members and are difficult to measure, although we are working on tools that should help to estimate these missing elements. There are multiple ways to minimise these emissions in the meantime - see the GCC non-profit Decarbonisation Action Plan for more details and advice.
Category 2 - Capital goods:	This covers items in Material Use purchased for long-term use (eg furniture, office equipment, reusable exhibition materials).	If an arts organisation is undergoing major redevelopment work this would also fall into this category, but we would advise carrying out a separate footprinting audit on any planned works of this scale, in order to minimise them in advance and ensure that every opportunity is taken to reduce ongoing emissions in the future.

Category 3 - Fuel- and energy-related activities	None	These are also known as "Well-to-Tank" (WTT) emissions, and represent the upstream impacts of digging up and transporting the fossil fuels that end up being burned in the planes, cars, trains, buildings, power stations etc in the other Scopes and Categories. GCC does not include WTT emissions, in order to follow the same methodology as Julie's Bicycle's carbon tools. These emissions would only add a small percentage to the final total, and are not something that an arts organisation can tackle directly - the only sure way to reduce them is to reduce fossil fuel use across their operations and supply chains, which is something that everyone will need to do anyway in order to reduce emissions in all other categories.
Category 4 - Upstream transportation and distribution	This is part of the freight footprint.	
Category 5 - Waste generated in operations	None	Not included as it would require a waste audit and would only add a small amount to most organisations's emissions, and because GCC is tackling waste elsewhere with a separate target (and potentially a separate tool).
Category 6 - Business travel	Staff Flights and Surface Travel	

Category 7 - Employee commuting	Staff commuting	Included as part of Shared Emissions, not as part of the core target.
Category 8 - Upstream leased assets	n/a	Not relevant for most GCC members, or already counted as part of general operations
Category 9 - Downstream transportation and distribution	This is part of the freight footprint	
Category 10 - Processing of sold/distributed products	n/a	Not relevant for most GCC members
Category 11 - Use of sold/distributed products	Visitor Travel (there is some debate over whether it might potentially fit in a different category, but others in the culture sector have also used this categorisation and it makes sense to us)	This is the category where Visitor Travel falls (as the "products" of an art gallery include visitor art experiences). It is counted in the tool as Shared Emissions, not part of your core target. Other possible elements that could fall here would be if you are creating and selling electrical plug-in artworks that use energy, or NFTs that are on a high-energy "proof of work" blockchain and thus have a significant carbon footprint every time they are traded. These are uncommon cases though, and fall outside the scope of this tool.

Category 12 - End-of-life treatment of sold products	n/a	Not relevant for most GCC members
Category 13 - Downstream leased assets	n/a	Not relevant for most GCC members, or already counted as part of general operations
Category 14 - Franchises:	n/a	Not relevant for most GCC members, or already counted as part of general operations
Category 15 - Investments	n/a	Not relevant for most GCC members (this refers to owning significant stakes in other companies, not the money or investments an organisation might have in the bank/pension funds - GCC has specific advice relating to this, separate from the carbon calculator)

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