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A Guide to Sustainable Events: Singapore MICE Carbon Calculator

SGFIN Whitepaper Series #3

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Abstract

This paper presents the construction of the Carbon Calculator for the MICE industry in Singapore. This is a web-based toolkit designed to estimate carbon emissions from a MICE event by the event organizer. The toolkit covers carbon emissions attributable to three aspects: on-site activities, transportation and accommodation. The boundaries of Scope 1, 2 and 3 greenhouse gas emissions are defined according to the principles used by Net Zero Carbon Events (NZCE). We provide a description of the estimation methodology and compute the carbon footprint from emissions-releasing activities and the emission factors in the existing databases. We enhance the estimation accuracy in Singapore's context by considering local MICE characteristics and incorporate local data sources into our calculator. In addition, we provide guidelines to assess the carbon intensity and materiality of environmental impacts of MICE events with benchmark examples. Finally, we illustrate how to use our toolkit using an example.

Keywords: Green Events, Carbon Footprint, Singapore, Calculator, MICE, Net Zero.

JEL Classification: G39, L52, M14, Q51, Q54.

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The toolkit is available at https://www.sgfin.tech/#/mice-carbon-calculator.

About SGFIN

The Sustainable and Green Finance Institute (SGFIN) is a research institute established by the National University of Singapore (NUS). SGFIN aims to develop deep research capabilities in sustainable and green finance with a focal point on Asia, and to provide thought leadership and shape sustainability outcomes in policymaking across the financial sector and the economy at large. Supported by exceptional domain experts across NUS, SGFIN equips businesses with critical cross-disciplinary knowledge, training, and toolkits to integrate sustainability dynamics into their business strategies and investment decisions to better quantify the environmental and social impacts of their business developments, operations, products, and services. In essence, SGFIN aims to help companies embed sustainability as a key pillar in their business decisions.

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Foreword

Carbon calculator has emerged as a useful and widely adopted tool to facilitate carbon footprints tracking from a system's perspective, driving the transition towards a more sustainable future. Taking a ground-up approach, carbon calculator identifies and estimates material environmental and climate impacts generated by various activities such as manufactured goods, buildings, travel and social events. While life cycle assessment framework exists, the usefulness of such data-driven process depends on the design of the toolkit, and more importantly, the quality and accuracy of estimated emission factors. Singapore is a popular destination for international events. Hence, it is useful to offer a contextualised carbon calculator to offer clear insights for event organisers to plan a low-carbon event if possible.

A Guide to Sustainable Events: Singapore MICE Carbon Calculator developed by the Sustainable and Green Finance Institute (SGFIN) at the National University of Singapore (NUS) fills the gap just in time. The MICE Sustainability Roadmap defined by Singapore Tourism Board (STB) and Singapore Association of Convention & Exhibition Organisers & Suppliers (SACEOS) in 2022 signalled Singapore's ambition to become one of the most sustainable MICE destinations in Asia Pacific, while measurement of environmental impacts (especially carbon emissions) requires both technical expertise in environmental impact assessment and understanding of local contexts.

SGFIN integrates these considerations to provide more realistic sustainable event planning for the city-state. We provide solutions in two steps. First, our researchers developed a Singapore event carbon estimation framework that incorporated Singapore-contextualised considerations for onsite activities, hotel accommodation and transportation. The framework, outlined in this Guide, aimed at aligning with the global recognised event carbon standards while delivering estimation accuracy beyond what an international event carbon calculator can offer. Second, we also launched the Singapore MICE Carbon Calculator based on the framework to provide a user-friendly solution for event organizer that minimises user input requirements for a baseline estimate. This is made possible by the extensive local proxies we employed in the calculator.

With more adoption from the industry partners, we hope that this toolkit would make a significant contribution to Singapore's MICE industry as the one-stop solution to a sustainable event planning. And we hope that our toolkit would inspire more global effort to decarbonise the MICE sector.

Prof. Sumit Agarwal
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Low Tuck Kwong Distinguished Professor of Finance at NUS Business School
Professor of Economics and Real Estate
President of Asian Bureau of Finance and Economic Research
September 16, 2024

Executive Summary

The global effort to combat climate change has been stimulated by the scientific evidence on anthropogenic warming compared to pre-industrial levels, as shown in the IPCC reports (IPCC AR5, 2013; IPCC SR1.5, 2018). It is estimated that greenhouse gas (GHG) emissions from human activities are responsible for approximately 1.1 °C of warming since 1850-1900, a level that is significant relative to the estimated internal climate variability. The urgent need to limit the increase in global average temperature to 1.5°C, as outlined in the Paris Agreement, underscores the imperative for decarbonisation across all industry sectors. As one of the major components of global tourism, the meeting, incentive, convention and exhibition (MICE) sector is responsible for a significant share of carbon emissions. The sustainable development of the events industry requires a systematic approach to monitoring and managing the economic, environmental and social (EES) impacts of the activities of diverse stakeholders (ISO 20121, 2012). To address this challenge in Singapore's context, the SGFIN carbon footprint calculator is designed to estimate carbon emissions in Singapore's MICE events based on a comprehensive list of variables. Using a ground-up approach, the toolkit aggregates carbon emissions from three categories of emissions-releasing activities: on-site activities, transportation and accommodation.

Globally, the Net Zero Carbon Events is a leading initiative that builds a framework to facilitate international MICE events on the path to net zero by 2050 (NZCE, 2022). This toolkit is aligned with the framework on multiple fronts including the definition of boundaries of event carbon footprint, the materiality assessment of key emission contributors, and the carbon offsetting strategies. More importantly, it integrates a wealth of both international and local data to enhance the estimation accuracy. The local data sources complement the established international databases of emission factors given Singapore's unique fuel mix, visitors profile, choices of passenger and freight transportation, and event venue locations. Furthermore, the web-based toolkit offers optimised user experience by reducing the set of input variables to only seven global variables and making many assumptions about the default values of variables specific to each source of emissions when not specified by users. A breakdown by source of carbon emissions and the per capita carbon footprint per day are visualised in the outputs and the results can be exported as a PDF report and retrieved again with the reference ID.

This paper provides an illustrative example of a 5-day event carbon footprint. While not representing Singapore's MICE carbon footprint in general, it offers insights for a possible make-up of the total carbon footprint by the source of emissions. Notably, transportation emerges as the predominant contributor, constituting over 85% of total emissions. Accommodation and on-site activities contribute about 11% and 4%, respectively. The users are encouraged to explore the calculator's options to understand their carbon footprints and submit the details of the event to SGFIN for more comprehensive calculation, analysis and certification of event carbon footprint. The benchmarks provided in this toolkit allow event organisers and other stakeholders to assess the "greenness" of the event relative to MICE events and the average daily emissions worldwide.

About the Authors

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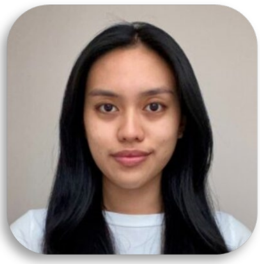

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1 Introduction

Singapore has been a hub for both ASEAN and international meetings, incentives, conventions and exhibitions (MICE). The MICE industry has been a substantial driver for the city-state's economy, supporting more than 34,000 direct and indirect jobs with a value-add of almost S$4 billion in 2019, close to 1% of its gross domestic product (GDP) (The Straits Times, 2022). In January 2022, Singapore received the 2022 Professional Convention Management Association (PCMA) Chair's Award for its contributions to the business events industry in 2021. The pro-business environment and robust event pipeline have made Singapore a desirable venue for MICE events.

The rising awareness of climate change has led to a transition toward a sustainable MICE industry. In October 2022, the Singapore Tourism Board (STB) announced their strategic alliance with Informa Markets and tradeshow ecosystem players to support Singapore's vision to be one of the most sustainable MICE destinations in Asia Pacific by 2030 or earlier (STB, 2022). In December 2022, the MICE Sustainability Committee, a taskforce formed jointly by the STB and Singapore Association of Convention and Exhibition Organisers and Suppliers (SACEOS), launched a MICE Sustainability Roadmap that sets three specific targets regarding sustainability certification for MICE venues and tracking waste and carbon emissions (SACEOS & STB, 2022). The Roadmap also outlined two focus areas, namely reducing, recycling and managing waste as well as reducing energy usage and carbon emissions.

In response to the imperative call for decarbonising the MICE industry, a carbon footprint estimation toolkit has been designed for Singapore MICE events by SGFIN, providing a comprehensive breakdown by the sources of carbon emissions. Using a bottom-up approach to estimating event carbon, the carbon calculator estimates emissions from a wide range of activities during MICE events after using the emission factors from both local and international databases. By actively tracking and recording event carbon footprint, organisers and other event stakeholders can gain a holistic understanding of the environmental impacts of MICE activities. With this dedicated toolkit for Singapore, the local MICE community can be better equipped to identify key emission contributors and proactively mitigate event carbon by opting for low-carbon alternatives, thereby contributing to the national initiative of greening the event.

This whitepaper is prepared to explain the estimation methodology and guide the users of the MICE carbon calculator. This section introduces the background of Singapore's commitment to a sustainable MICE industry, which motivates our research effort. The rest of this paper is organised as follows. Section 2 delves into the mechanism of the calculator with inputs descriptions, GHG calculation formulas, estimation assumptions and data sources. Section 3 provides guidelines for reporting Scope 1, 2 and 3 emissions attributable to event stakeholders, gauging the materiality of event carbon and offsetting event carbon footprint with market instruments. Section 4 concludes the paper with a few use cases of the toolkit.

2 Event Carbon Estimation Methodology

There is a growing consensus on the sources of carbon emissions that are attributable by an event. In particular, the GHG Protocol Corporate Accounting and Reporting Standard (GHG Protocol, 2017) provided the explicit guidance for corporates and other organisations on the accounting principles and estimation of Scope 1, 2 and 3 GHG emissions. Our carbon footprint calculator is aligned with the global standard in specifying covered sources of emissions and their responsible stakeholders. Meanwhile, we also contextualise the estimation by integrating local event scenarios, logistics choices and emission factors in Singapore for improved accuracy in the local setting.

We provide a baseline estimation with minimal inputs in the toolkit, known as ***global inputs***. These global inputs, including the number of attendees, the length of event period and the mode of event setting, are the defining characteristics of a MICE event and the most critical parameters for carbon footprint estimation. Users can improve the accuracy of the estimation by specifying more specific inputs related to ***on-site activities***, ***transportation*** and ***accommodation***. Alternatively, they can send event details to our team for customised event carbon estimation and certification.

The use of creditable and contextualised data sources ensures the estimation accuracy of our toolkit. Apart from considering well established datasets such as the ones used by Net Zero Carbon Events (NZCE, 2022) and Green Events Tool (GET, 2022), our calculator incorporates credible local data sources including the datasets published by Singapore government agencies and authorities. Appendix A summarises a few important data sources used by this toolkit.

Global Inputs Required for Baseline Estimation

#1: Number of physical attendees
#2: Number of virtual attendees
#3: Number of international attendees
#4: Event hours per day
#5: Event period days
#6: Event setting (exhibition/theatre/classroom/cluster/banquet)
#7: Event attendance (throughout event period/one event day)
#8: Meals arrangement (provided/not provided)

2.1 On-site Activities

This subsection discusses GHG emissions from **on-site activities**. The success of event organisation requires coordinated management of the power and air conditioning facilities, food and water supply, and communication. To track the carbon footprint of these components of a MICE event, our calculator formulates the on-site GHG emissions attributable to venue, communication, catering and waste with comprehensive assumptions and approximations, which ensure both user accessibility and input flexibility.

A. Venue

The GHG emission sources attributable to the event venue include on-site energy consumption (including grid electricity consumption from lighting, air conditioning, audio/visual system, etc.), and water consumption. This calculator does not include embodied carbon of building materials unless incurred in space design and production (e.g., stands, booths, carpets and furniture) because neither the event organiser nor the exhibitor shall be responsible for the embodied GHG emissions from the building that hosts the event, a consideration consistent with NZCE (2022).

As the maximum capacity and arrangement of appliances vary according to the specific event setting, carbon emissions from the same venue can also differ significantly due to different usages. Our calculator refers to the floor plans of major expos and conference centres regarding room sizes and capacities, lighting arrangements and audio/visual systems. The users may choose an event setting (e.g., exhibition, theatre, classroom, cluster, banquet) and specify the numbers of rooms of each size according to the capacities described in **Table 1**.

Table 1:
The Capacity Characteristics of Conference Venues

Size (In Ascending Order)	Max Usable Floor Area (sqm)	Height (m)	Capacity (pax)
S1	70	3	50 - 70
S2	125	3	60 - 125
S3	170	3	80 - 170
M1	220	3	110 - 220
M2	500	3	250 - 500
L1	800	3	400 - 800
L2	1,000	8	500 - 1,000
L3	1,500	8	800 - 1,500
XL1	2,000	8	1,000 - 2,000
XL2	4,000	10	2,000 - 4,000
XL3	12,000	10	6,000 - 12,000

Additional Inputs Allowed for Venue Carbon Estimation

#1: Total number of desktops in use
#2: Total number of speakers in use
#3: Total number of projectors in use
#4: British thermal units (BTUs) per sqm per hour
#5: Water consumption per attendee per day

The general formula for the GHG emissions from grid electricity consumption is

$$GHG_{Electricity} = \sum PowerInput \times Devices \times UsageMultiplier \times Duration \times GridEmissionFactor$$

where $PowerInput$ is the power input of appliances and $Devices$ is the number of devices estimated based on the space and arrangement of the venue for a particular event setting. $UsageMultiplier$ is a factor from 0 to 1 which describes average usage rate of the appliance. The factor $Duration$ is estimated as the product of event hours per day and event period days. $GridEmissionFactor$ is a measure of the amount of carbon emissions per unit of electricity generated and is determined by the local electricity generation fuel mix. In Singapore, natural gas made up over 90% of the fuel mix and the operating margin grid emission factor (GEF) has been slightly higher than 0.4 kg CO_2/kWh in recent years according to the Energy Market Authority (EMA, 2023).

The lighting system of MICE events typically consists of a combination of ambiance lights, exhibition lights, wall washers, downlights and cove lighting according to the event setting and event venue facilities. The electricity usage can be estimated based on the following factors:

a) Lumens per sqm: A light intensity measure. The required brightness differs for different event purposes as measured by lumens per square metre.
b) Lumens per watt: A luminous efficiency measure. For example, florescent and incandescent lights are lower in lumens per watt than LED and sodium bulbs.
c) Lighting multiplier: A usage multiplier that indicates if a set of lights are fully turned on, partially turned on or fully switched off. In practice, only selected lights are turned on according to the event purpose.

The lighting plan provides the information of fixtures in the event halls and, with typical brightness requirements for a given room, wattage per fixture can be estimated in different event settings accordingly (Green Business Light UK, 2020).

The heating, ventilation and air conditioning (HVAC) system is a key source of electricity consumption of a MICE event. Cooling is assumed to be the dominant application of the HVAC system in Singapore for its tropical climate. The power consumption of the air conditioning system primarily depends on the following factor:

a) British thermal units (BTUs) per sqm per hour: A BTU is a measure of heat content of fuels or energy sources.

Our calculator adopts a rule of thumb of 200 BTUs/hour per sqm, as recommended by the US Department of Energy (2012). One kilowatt is equivalent to 3,412 BTUs per hour in cooling capacity conversion.

The power consumption from the sound system can be estimated in a similar way. Our calculator assumes that a speaker is needed for every 100 people in a corporate event for the baseline estimation (Kettner Creative, 2020). In addition, we assume that each speaker has the same specs as the Machie SRT210 10-inch 1600-watt loudspeakers for a simplified estimation. Users can input a custom audio multiplier in the event that the event venue only requires audio partially.

Multiple projectors are needed to facilitate presentations and remarks in a large event place. Our calculator assumes that larger room space corresponds to more projectors in use, each using 360 watts. We also accept custom value for the actual number of projectors in use.

Desktop computers are often used to power projectors and the audio system at MICE events. Our calculator assumes an average of three projectors powered by every desktop, floored at one desktop for each room. In addition, each desktop is assumed to use 200 watts. We also accept custom user input of the actual number of desktops in use.

The general formula for GHG emissions from water consumption is

$$GHG_{Water} = WaterUsageRate \times Attendees \times Duration \times (SupplyEmissionFactor + TreatmentEmissionFactor)$$

where $WaterUsageRate$ can be measured by on-site water consumption per person per day and $Attendees$ is the average number of participants attending the event physically. The factor $Duration$ here refers to the event period days.

The GHG emissions related to water consumption can be categorised into those from water supply and those from wastewater treatment. Their respective emission intensities, measured by the GHG emissions per unit volume of water consumption and expressed in kg CO_2e/m^3, are represented by $SupplyEmissionFactor$ and $TreatmentEmissionFactor$ in the formula. Our calculator assumes that the water consumption of physical attendees per day stands at the national daily average for our baseline estimation. In 2022, the average household water consumption was at 149 litres/day (PUB, 2023).

B. Communication

The GHG emission sources attributable to communication include paper and board materials and electronic media. Printed materials such as forms, papers, brochures, name tags and exhibition posters require different categories of paper and board with distinct textures and weights. Likewise, carton boxes can have varying degrees of thickness, resulting in different carbon emissions per item. For example, a copy of newsprint made of uncoated groundwood paper generates significantly lower carbon emissions than a copy of commercial print made of coated woodfree paper of the same weight.

Confederation of European Paper Industries (CEPI, 2017) provided a framework to estimate carbon footprint for paper and board products based on ten important elements known as the "Ten Toes". They included the emissions from the manufacturing, biomass carbon and transportation of paper and board products.

Additional Inputs Allowed for Communication Carbon Estimation

#1: Forms per attendee per day
#2: Commercial prints per attendee per day
#3: Brochures per attendee per day
#4: Tissues per attendee per day
#5: Name tags and lanyards per attendee per day
#6: Exhibition posters
#7: Carton boxes
#8: Backdrop banners
#9: Laptop usage rate

The general formula for GHG emissions from paper and board is given as follows,

$$GHG_{Paper} = \sum PaperSize \times Grammage \times Copies \times PaperEmissionFactor$$

where $Grammage$ is a weight measure for paper, board plastics and fabrics expressed in grams per sqm (gsm). $PaperEmissionFactor$ in this formula is a carbon intensity measure for paper and board products expressed in kg CO_2e per ton. Our calculator uses the results from a US-based study of the life cycle analysis of carbon footprint of paper grades to estimate the emission factors of paper and board products (Tomberlin, Venditti, & Yao, 2020).

Common electronic devices used for communication, besides those attributable to venue, include phones, laptops and tablets. GHG emissions from these devices are also applicable to virtual events such as webinars, presentations and online classes. The estimation of GHG emissions attributable to electronic media follows the same general formula for electricity consumption emissions. The event setting underpins the usage rate of electronic devices for communication. For example, a classroom setting typically sees a significantly higher fraction of laptop usage among the audience than an exhibition. We assume that virtual participants have a 100% laptop usage rate throughout the event period. Our calculator assumes that each laptop used 65 watts, the power needed for a typical office laptop.

C. Catering

The GHG emissions attributable to catering comes from food and beverages (F&B) served and tableware provided.

Growing and processing raw food ingredients are responsible for considerable carbon emissions. Our calculator considers a list of food ingredients (vegetables, fruits, grain, seafood, meat, etc.) and calculates the total food carbon footprint based on their GHG intensities expressed in kg CO_2e per kg.

Additional Inputs Allowed for Catering Carbon Estimation

#1: Cutlery choice
#2: Meals per day
#3: Teas per day
#4: Number of vegetarians
#5: Leafy vegetables per meal per person (g)
#6: Other vegetables per meal per person (g)
#7: Fruits per meal per person (g)
#8: Wheat per meal per person (g)
#9: Rice per meal per person (g)
#10: Eggs per meal per person (g)
#11: Fish per meal per person (g)
#12: Other seafood per meal per person (g)
#13: Chicken per meal per person (g)
#14: Duck per meal per person (g)
#15: Pork per meal per person (g)
#16: Beef per meal per person (g)
#17: Mutton per meal per person (g)

The general formula for GHG emissions from food and beverages is

$$GHG_{Food} = \sum Amount \times Attendees \times Meals \times FoodEmissionFactor$$

where $Amount$ is estimated based on adults' average food consumption in Singapore. $FoodEmissionFactor$ measures the amount of carbon emissions generated for per kg food ingredients supplied. Our calculator adopts the estimates from a study by Ecosperity (2019) to estimate carbon footprint of food and beverages. About 5% of the population in Singapore identifies as vegetarian or vegan according to a survey by YouGov (2023). Our calculator assumes the same percentage for event participants while users may input a custom value according to the actual event participants' profile and catering arrangements. In particular, meat options matter for reducing food catering carbon footprint. On average, carbon emissions from chicken production are less than 1/8 of the emissions from the same amount of beef production.

The general formula for GHG emissions from tableware is as follows,

$$GHG_{Tableware} = Attendees \times Meals \times TablewareEmissionFactor$$

where $TablewareEmissionFactor$ measures carbon emissions from a set of tableware per meal and is sensitive to the choice of tableware. For instance, a polystyrene (PS) cutlery set creates more carbon emissions than a similar cutlery set made from polylactic acid (PLA). Carbon emissions are seen in both manufacturing and disposal of the tableware (Wei, Tan, Dong, & Li, 2022). Our calculator assumes bamboo as the default choice of tableware while users may select from one of polystyrene (PS), polypropylene (PP), polylactic acid (PLA), PLA-PP, bamboo and stainless steel.

D. Waste

The GHG emission sources attributable to waste include metal, wood, paper/cardboard, plastics and food. There are three major strategies to handle waste, namely reuse, recycling and disposal. They are responsible for vastly different carbon emissions. Our calculator assumes zero emissions from waste reuse. We also assume that the percentages of recycled and disposed waste are similar to Singapore's recycling rate provided by Singapore National Environment Agency (NEA, 2023). For example, 99% of metal was recycled in Singapore, compared to the 6% recycling rate for plastics in 2022.

Additional Inputs Allowed for Waste Carbon Estimation

#1: Metal waste (kg)
#2: Wood waste (kg)
#3: Paper/Cardboard (kg)
#4: Plastics waste (kg)
#5: Food waste (kg)
#6: Other waste (kg)

The general formula for GHG emissions from waste is

$$GHG_{Waste} = \sum WasteMass \times [RecyclingRate \times RecyclingEmissionFactor + DisposalRate \times ConbustionEmissionFactor]$$

where $WasteMass$ is the specific type of waste generated on-site (metal, wood, plastics, etc.) in kilograms. $RecyclingRate$ and $DisposalRate$ are the percentages of waste recycled and disposed of respectively. $RecyclingEmissionFactor$ and $ConbustionEmissionFactor$ are carbon intensity measures for waste recycled and disposed of respectively that consider the emissions from transportation, processing, incineration and landfill.

2.2 Transportation

This subsection discusses GHG emissions related to transportation. This calculator covers both passenger and freight transport by air, sea and land given Singapore's major modes of transportation. Transportation is one of the most significant contributors to MICE carbon footprint as the GHG emissions are highly correlated to the distance travelled. Globally, it is estimated that the climate impact of aviation accounted for 3.5% of total anthropogenic warming until 2011 (Lee, et al., 2021). Moreover, this trend is likely to continue and emissions from commercial aircrafts could triple by 2050 considering the growth of passenger flights and freight (Overton, 2022).

A. International Transport

Air travel is the predominant mode of international transport for passengers abroad to and from Singapore. The number of international attendees is a global input that underpins the carbon emissions from international transportation.

The general formula for GHG emissions from international transport is as follows,

$$GHG_{Air} = \sum InternationalAttendees \times AirTrips \times [EconomyClassRate \times EconomyTripEmissions + PremiumClassRate \times PremiumTripEmissions + PrivateJetRate \times PrivateTripEmissions]$$

where $InternationalAttendees$ is the number of international attendees from an origin airport. $EconomyClassRate$, $PremiumClassRate$ and $PrivateJetRate$ are the percentages of air trips via economy-class commercial aviation, premium-class (business and first classes) commercial aviation and private aviation respectively. This carbon calculator assumes that premium-class and private flights to Singapore emit twice and fifteen times as much as their economy-class alternatives on average (ICAO, 2023; Transport & Environment, 2021).

The number of international visitors to Singapore from each country/region is reported by Singapore Department of Statistics and this toolkit aggregates the 2019 monthly statistics to estimate the percentages of travellers from each country/region (SingStat, 2023). Furthermore, this calculator only takes the fraction of MICE travel from each country/region according to the annual statistics from the Singapore Tourism Board (STB) since the major purposes of travel to Singapore may differ among countries and regions. As a result, Southeast Asia was the leading origin of MICE travellers to Singapore in 2019, followed by Greater China, North Asia, South Asia and Europe (STAN, 2020).

Travel distance is the most important metric to measure GHG emissions attributable to air travel. Changi Airport is the only choice for commercial air travel to the city-state, while many countries have multiple major airports for international or domestic travel due to their larger land areas and heavier traffic. This calculator considers at maximum top five international airports by annual international traffic from each country/region and weights them according to the number of international passengers to estimate the effective average GHG emissions from this country/region. For instance, for participants from the US, the calculator takes into account of international passengers from New York City (JFK), Los Angeles (LAX), Miami (MIA), San Franciso (SFO) and Newark (EWR) and weights them accordingly (with airport IATA code).

We recognize that not all selected airports have a direct flight to Singapore (SIN). This calculator prioritises direct flights where available and picks one of the most popular transfer stops otherwise for emissions estimation. For example, since Miami (MIA) does not have an active flight to Singapore (SIN), the carbon emissions from the flight are calculated as the sum of those generated in the domestic trip from Miami (MIA) to Los Angeles (LAX) and those generated in the international trip from Los Angeles (LAX) to Singapore (SIN).

Many airlines disclose carbon emissions on the air tickets and this calculator allows users to input the exact emissions numbers from their flights if available.

Additional Inputs Allowed for International Transport Carbon Estimation

#1: Fraction of premium-class trips
#2: Fraction of private jet trips
#3: Travellers from Southeast Asia
#4: Travellers from Greater China
#5: Travellers from North Asia
#6: Travellers from South Asia
#7: Travellers from West Asia
#8: Travellers from Americas
#9: Travellers from Europe
#10: Travellers from Oceania
#11: Travellers from Africa
#12: Travellers from other regions

B. Local Transport

Both international and local attendees require local transport from their residence in Singapore to the event venue. For local participants, this calculator assumes the number of residents from each planning area and their modes of local transport follow the national census. For international participants, the calculator supports the user's input of residence (defaults to Central) based on which average travel distance can be estimated. The event venue is set as downtown by default because most Singaporean conference centres and MICE amenities are located there.

Additional Inputs Allowed for Local Transport Carbon Estimation
#1: Residing area for international attendees

The general formula for GHG emissions from local transport is

$$GHG_{Land} = \sum Attendees \times Commutes \times Distance \times PassengerEmissionFactor$$

where $Attendees$ is the number of attendees from a planning district, $Commutes$ is the total number of trips during the event period and $Distance$ is the travel distance from the local residence area to the event venue. $PassengerEmissionFactor$ is a measure for carbon emissions through land transport expressed in kg CO_2e/km.

Singapore Census of Population 2020 showed the employed residents by planning area of residence and usual mode of transport to work where public bus and mass rapid transit (MRT) were the available modes of public transport and car, motorcycle and taxi were the most import modes of private transport. For example, the percentage of residents who walk to office was higher in the Central Area than that in the East Area (SingStat, 2021). Our calculator reflects this composition among local and international attendees.

C. Freight

Freight is shipped to Singapore by air, sea or road. Road is the only mode of local transport in Singapore. Sea shipping is a popular and cost-effective method for long-distance shipping, while air freight is commonly used for expedited delivery, particularly by e-commerce companies. Moreover, sea shipping emits significantly lower carbon compared to land and air shipping for the same quantity of freight shipped and is hence the most carbon-efficient mode of transport.

Additional Inputs Allowed for Freight Carbon Estimation
#1: Mass transported by air (kg)
#2: Mass transported by sea (kg)
#3: Mass transported by road (kg)

The general formula for GHG emissions from freight transport is as follows,

$$GHG_{Freight} = \sum FreightMass \times Distance \times FreightEmissionFactor$$

where $FreightMass$ is the mass of freight via a mode of transport, $Distance$ is the average shipping distance from the origin of freight to the event venue in Singapore, and $FreightEmissionFactor$ measures the GHG emissions for per km travelled.

Our calculator assumes the freight shipped from overseas is proportional to the total annual air and sea shipped from each origin provided by SingStat (2023). In 2019, China, Malaysia, Chinese Taipei, United States and Japan were the top exporters to Singapore (OEC, 2023), from which we derived the weighted average travel distance of sea cargos. We assume the average travel distance for local freight to the event venue to be 6.8 km, the national average for all light goods vehicles (LGVs) (Olszewski, Wong, & Luk, 2003).

2.3 Accommodation

This subsection discusses GHG emissions related to accommodation. Globally, the Hotel Carbon Measurement Initiative (HCMI) is the leading methodology for estimating hotel-related carbon footprint. The methodology involves collecting information of energy and water consumption, waste generation and transportation emissions for hotels and their surrounding areas and calculates total carbon emissions accordingly from direct and indirect sources. Our calculator adopts the methodology with the hotel data on energy, water and carbon emissions provided by the Cornell Hotel Sustainability Benchmarking Index (CHSB, 2023) and calculates the total carbon emissions attributable to hotel accommodation based on the number of starred hotel rooms (single and double).

Additional Inputs Allowed for Accommodation Carbon Estimation

#1: Number of hotel accommodation nights
#2: Carbon footprint method
#3: Number of 3-star rooms
#4: Number of 4-star rooms
#5: Number of 5-star rooms
#6: Percent of people for single room
#7: Percent of people for double room

The general formula for GHG emissions from accommodation is as follows,

$$GHG_{Hotel} = \sum StarredRooms \times (0.5 \times PercentDouble + PercentSingle) \times Nights \times DailyEmissions$$

where $StarredRooms$ is the number of (3-, 4- or 5-) starred hotel rooms, $Nights$ is the number of hotel accommodation nights, $PercentDouble$ and $PercentSingle$ are the percentages of people for double and single rooms respectively. $DailyEmissions$ is the average carbon emissions per occupied room estimated based on the HCMI methodology.

The default value for the number of hotel accommodation nights is set either at the total number of event days or the value of one, depending on the selected attendance option. For example, users select "all attendees stay throughout the event period" if it is a multi-day event like an international conference and select "all attendees only for one-day event" if it is a single-day event held in several sessions like a concert. As a result, the calculator assumes that attendees need hotel accommodation throughout the event period in the first scenario and for one night in the second scenario. In case attendees stay for a few extra days before or after the event, users can manually input an average number of event accommodation nights. It is noteworthy, however, that the event organiser is only responsible for carbon footprint of the arranged accommodation and the extra time of accommodation may go beyond the scope of event carbon estimation.

The toolkit provides two methods to estimate the hotel-related GHG emissions. The first method is to measure the GHG emissions directly from occupied rooms and take the average of each class (labelled as "HCMI Occupied Room Carbon Footprint"). The second method is to divide the total GHG emissions of the hotel by the number of occupied rooms of the day (labelled as "Effective Occupied Room Carbon Footprint"). Users may select either method that they believe is appropriate, while the discrepancies are not considerable.

In summary, the framework above breaks down the event carbon footprint by the sources of emissions and summarises the calculation of event carbon attributable to various emissions-releasing activities. Hence, the total carbon footprint of a MICE event can be summed up using the following formula

$$GHG_{Event} = [GHG_{Electricity} + GHG_{Water} + GHG_{Paper} + GHG_{Food} + GHG_{Tableware} + GHG_{Waste}] + [GHG_{Air} + GHG_{Land} + GHG_{Freight}] + [GHG_{Hotel}]$$

The methodology framework is aligned with NZCE (2022) and our carbon footprint calculator can be viewed as an application of its guidelines with Singaporean local contextualised considerations. Furthermore, this toolkit provides the optimised user experience with a baseline estimation that requires only a handful of global inputs. Our design effort strives to have the ideal balance of usability and flexibility to accommodate a wide range of users.

3 Guidelines and Examples

With the methodology framework laid out in the previous section, it is very easy for event organisers and other stakeholders in the MICE industry to see how the event's carbon footprint can be tracked and estimated based on the selected emissions-releasing activities. Yet, we still have a few remaining questions to address: (1) how to define the boundaries of the event carbon footprint according to the Scope 1, 2 and 3 guidelines; (2) which sources of carbon footprint are more impactful than others; (3) how one event's carbon footprint compares with other events in Singapore or globally in terms of carbon intensity; (4) by what means one event's carbon emissions can be offset. These are some fundamental issues raised by NZCE (2022) in the Net Zero Roadmap and the Company Pathway. The following subsections will discuss how these questions can be addressed by our carbon footprint calculator with some guidelines and examples.

3.1 Scope 1, 2 and 3 Emissions for the MICE Industry

The GHG Protocol (2017) outlines the principles to distinguish Scope 1, 2 and 3 GHG emissions at the organisation level that are applicable to both corporate and non-corporate organisations. Nevertheless, it remains a challenging task attributing to stakeholders of an event due to their intertwined responsibilities and sometimes overlapped personnel in the operations. NZCE clears much of the confusion with a framework for Scope 1, 2 and 3 boundaries for the events industry (NZCE, 2022, pp. 39-41). This toolkit follows the framework and provides a summary of the Scope 1, 2 and 3 emissions that each event stakeholder is responsible for in a typical event, as shown in **Table 2**.

Table 2:
Scope 1, 2 and 3 Emissions for Event Stakeholders

Type	Scope 1	Scope 2	Scope 3
Organiser			On-site energy consumption, water, paper and board materials, electronic media, catering, waste, passenger travel, freight transport, accommodation (staff only)
Venue	On-site energy consumption (generated), passenger travel (owned vehicles only)	On-site energy consumption (purchased)	Water, catering (if purchased by venue), passenger travel (staff only), waste, accommodation (staff only)
Service Provider			Electronic media (for virtual conferences), catering (if purchased by service provider), waste (if controlled), passenger travel (staff only), freight transport (if controlled), accommodation (staff only)
Exhibitor			On-site energy consumption, waste (if controlled), passenger travel (staff only), freight transport (if controlled), accommodation (staff only)

The organiser is the organisation that plans and coordinates the MICE events. The venue is the organisation that owns or manages the event venue. The service provider is the vendor or the contractor that supports the goods and services for the event. It can be the food caterer, the production supplier, the general contractor, etc.

Please note that the sources of emissions listed in **Table 2** are not an exhaustive account for all MICE events. Instead, the table represents only the general classification and attribution of GHG emissions in a typical MICE event. Users of our calculator must consider the event-specific arrangements when reporting Scope 1, 2 and 3 emissions.

3.2 Event Carbon Materiality and Intensity: An Example of a 5-day Event

The assessment of carbon footprint from various sources of emissions at an event is critical for identifying the key emission contributors and mitigating event carbon with good targets. The prioritisation in NZCE (2022, pp. 64-65) is based on the level of influence of the MICE industry, magnitude of GHG emissions and significance to stakeholders. While it offers helpful guidance on the materiality of the sources of event carbon, it does not provide specific quantitative measures to visually represent their relative share over total emissions.

We present an example of a 5-day event carbon footprint calculated using this toolkit to illustrate the materiality of each source of GHG emissions by quantities.

First, we assume the following global inputs for an international exhibition held in Singapore Central Area:

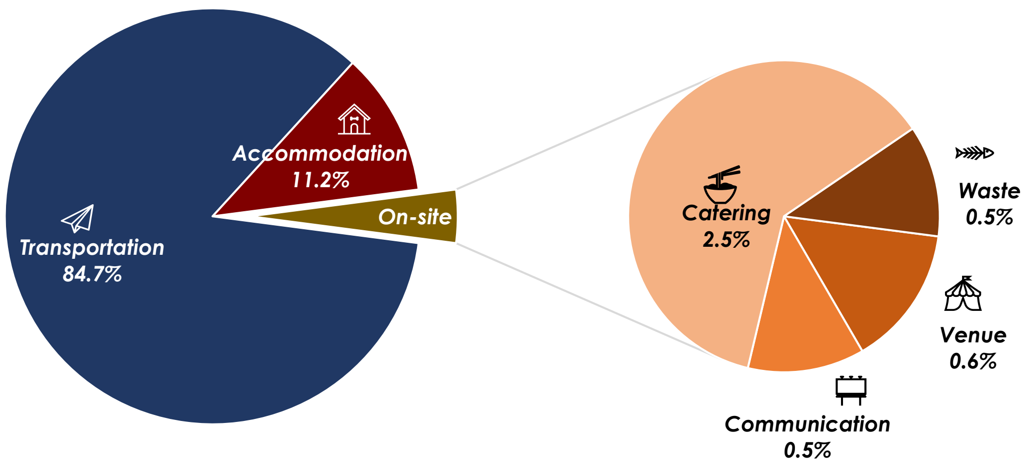
1. Number of physical attendees: 1,000
2. Number of virtual attendees: 200
3. Number of international attendees: 800
4. Event hours per day: 12
5. Event period days: 5
6. Event setting: Exhibition
7. Event attendance: All attendees stay throughout event period
8. Meals arrangement: Yes

We then accept the default values provided for the additional inputs and calculate the event carbon footprint using the baseline estimation with no carbon offset. We attain the results shown in **Table 3**. The percentages of emissions-releasing activities are illustrated on a compound pie chart in **Figure 1**.

Table 3:
A 5-day Event Carbon Footprint with Baseline Estimation (in kg CO_2e)

Category	Source of Emissions	Physical	Virtual	Total
On-site Activities	Venue	3,313	-	3,313
	Communication	2,443	316	2,759
	Catering	14,060	-	14,060
	Waste	2,634	-	2,634
	Subtotal	**22,450**	**316**	**22,766**
Transportation	International (air)	460,323	-	460,323
	Local (land transport)	6,653	-	6,653
	Freight	1,154	-	1,154
	Subtotal	**468,130**	**-**	**468,130**
Accommodation	**Subtotal**	**61,636**	**-**	**61,636**
Summary	Event period days	5	5	5
	Number of attendees	1,000	200	1,200
	Total carbon emissions	**552,216**	**316**	**552,532**
	Average emissions per person per day	**110**	**0.32**	**92**

Figure 1:
A 5-day Carbon Footprint by Source of Emissions



Though the example of a 5-day event carbon footprint is neither a record of an actual exhibition in Singapore nor a benchmark of MICE event carbon in Singapore, the breakdown of emissions presented in **Table 3** and **Figure 1** is worth of further discussion on the relative impacts of tracked sources of emissions described in the previous section. We present a few notable observations from this example.

First, transportation is the dominant source of MICE carbon footprint. International and local transport and freight shipping combined account for about 85% of total carbon emissions. In particular, air travel is the most prominent contributor, responsible for over 80% of emissions alone.

Second, catering is a major source of footprint among on-site activities. Though lower in magnitude, on-site emissions are particularly important for event organisers and other MICE stakeholders. In the example provided, catering is responsible for more carbon emissions than the venue, communication and waste combined. By targeting high-emitting food ingredients such as beef, carbon footprint from food catering can be reduced significantly.

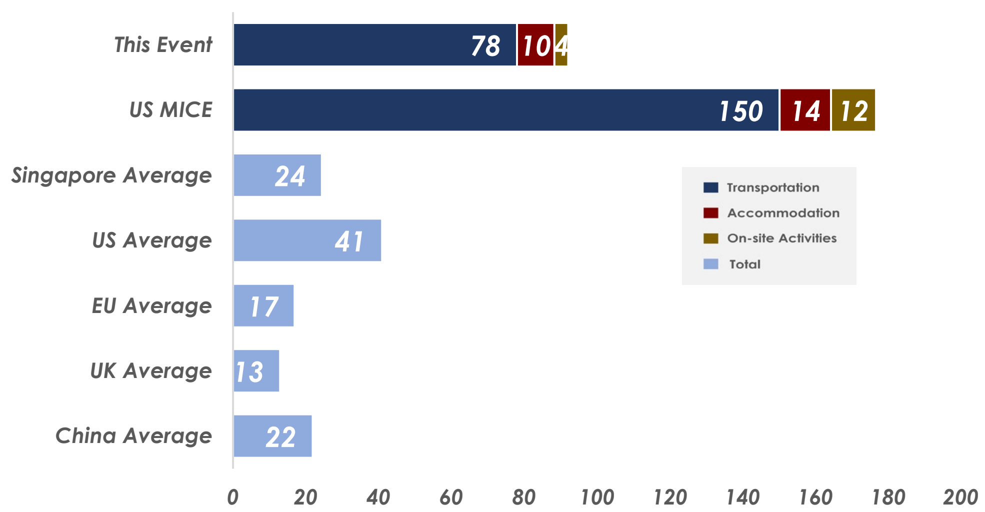
Third, virtual and hybrid events generate drastically lower carbon emissions than in-person events. Most of the event carbon footprint can be avoided if held online, including all emissions from transportation and accommodation, and large amounts from other activities. While most events moved back offline after Covid-19 pandemic, hybrid mode has emerged as a viable choice for some events. Despite the added challenge to the event organisation, the virtual option significantly lowers carbon emissions per person.

Total emissions alone do not depict the full story of the carbon footprint of an event and should be directly compared with other events of the same kind. Carbon intensity is a standardised emissions measure that describes the carbon efficiency of an activity. ***Per capita carbon footprint per day*** is a good intensity measure for MICE events that can be compared across. It is the average emissions divided by the number of participants and the event period days.

3.3 *Benchmarking*

Our calculator visualises the carbon footprint at the event of interest next to the selected benchmarks for per capita carbon footprint per day of MICE events or general purpose in the pie chart shown in **Figure 2**.

Figure 2:
Per capita Daily Carbon Footprint Benchmarked (in kg CO_2e)



It is estimated that a typical US conference participant produces 176.67 kg CO_2e emissions per day (MeetGreen, 2018). While this may not be an appropriate standard for MICE event participants in Singapore because the US is known for having a higher per capita carbon emission among developed countries, we can still use this number as a benchmark to indicate whether the event of interest is more sustainable with a lower per capita carbon footprint per day. In addition, this toolkit also displays the average per capita CO_2 emissions per day in Singapore, the United States, the European Union, the United Kingdom and China for reference (Our World in Data, 2024).

3.4 Carbon Offsetting Strategies

To meet the net zero commitments, ***carbon offsetting*** is often considered as a method besides the direct reduction that allows governments, corporates, organisations and individuals to compensate for their GHG emissions through ***trading credits***. In a cap-and-trade scheme, carbon offset credits can be traded to support other projects with the objectives of carbon reduction, avoidance or removal (WRI, 2010). The design of carbon offsetting strategies should be guided by the Oxford Offsetting Principles (Axelsson, Coldecott, Hepburn, & Smith, 2020), a recommendation by NZCE (2022, p. 48). We should note that NZCE emphasises the role of carbon offsetting as an "interim measure" instead of a permanent solution to net zero in the MICE industry. We concur with this position and assert that the carbon offsetting page as a supporting function in our calculator instead of our suggested counter for the event carbon.

Nevertheless, carbon offsetting has gained popularity among event organisers. For example, Greenbuild 2022 event, the largest annual event for global green building professionals, was 100% offset for its carbon footprint (Greenbuild, 2023). Our calculator allows users to input the units of carbon offset for the event of interests and the amount is deducted upon final calculation of net (unoffset) carbon emissions from the event.

4 Conclusions

This whitepaper presents the mechanics of the SGFIN MICE Carbon Calculator and provides guidelines and examples for the users of the toolkit. The toolkit is designed to estimate carbon emissions at a MICE event in Singapore. We summarise a few contributions of this toolkit and share some used cases.

Our calculator entails a ***framework*** for MICE-related carbon emissions. It identifies on-site activities, transportation and accommodation as three major sources of carbon emissions during the event period. Moreover, it provides a list of variables that need to be considered by event organisers and other stakeholders that underpin the level of emission from each source of emissions. For example, the number of physical participants and the length of event period are global inputs, while the choice of diet and tableware is directly related to on-site food catering emissions only. On the other hand, event stakeholders may consider ways of reducing event carbon by changing the values of these carbon-sensitive variables.

Our calculator can be used to ***estimate carbon footprint*** before and after the event takes place. We make many assumptions based on the existing references that can provide a baseline estimation of event carbon footprint without a lot of input information from the users (as little as seven global inputs only). Users with more granular event information may enter more advanced inputs specific to each of the three major sources of carbon footprint to obtain a more accurate estimate.

Our calculator provides empirical ***guidelines*** and ***benchmarks*** for the level of carbon footprint. For instance, average carbon footprint per person per day is an important metric to gauge the "greenness" of the event. Event organisers and other stakeholders will have a better understanding of the carbon intensity and sustainability performance of the event with the given benchmarks and may adjust the arrangements of the event or offset the event carbon footprint accordingly. The web-based toolkit visualises the estimated carbon emissions with a breakdown of the footprint from on-site activities, transportation and accommodation respectively.

The toolkit is hosted on the SGFIN website with a backend database that is updated regularly based on the latest releases of emission factors and other important variables from a wide range of sources summarised in Appendix A. The website is built to provide an interactive experience for event stakeholders to explore MICE carbon emissions using different inputs with primary estimation results. Last but not least, event organisers may submit relevant files related to a MICE event to our team for a more comprehensive estimation and analysis. The ***certification*** of these results is then conducted by SGFIN, ensuring validation through acknowledgement from a reputable research institute.

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Appendix A – Data Sources for MICE Event Carbon Estimation

The carbon footprint calculator, specifically designed for estimating carbon emissions of Singapore MICE events, leverages the quality of contextualised data to ensure accurate results. In addition to design elements such as transportation arrangements that embed local considerations, this toolkit enhances the estimation accuracy by incorporating local data sources for carbon-intensive elements.

This carbon footprint calculator aligns with the global standard in specifying covered sources of emissions and their responsible stakeholders. Meanwhile, it contextualises the estimation by integrating local event scenarios, logistics choices and emission factors in Singapore for improved accuracy in a local setting.

A few most important data sources this toolkit refers to are listed in **Table A1**.

Table A1:
Data Sources

Source	Description	MICE Data Categories
UK DEFRA GHG Conversion Factors 2023	The United Kingdom Department for Energy Security and Net Zero (DESNZ) has released the GHG conversion factors for UK and international organisations to calculate emissions from a wide range of activities including energy and water consumption, waste management, and transport activities. The attached grand file contains sheets of conversion factors covering various emissions-releasing activities categorised into Scope 1, 2 or 3 emissions.	Fuels, refrigerants, passenger vehicles, delivery vehicles, air travel, water supply and treatment, waste disposal, freighting goods, hotel stay, etc.
US EPA GHG Emission Factors Hub 2023	The United States Environmental Protection Agency (EPA) publishes emission factors for US organisations to calculate and report GHG emissions. Similar to the UK DEFRA Conversion factors, the dataset is updated annually with a comprehensive set of emission factors for fuels, vehicles, materials and waste.	Fuel, passenger vehicles, delivery vehicles, food, waste disposal
ICAO Carbon Emissions Calculator	International Civil Aviation Organisation (ICAO) made public a web-based carbon emissions calculator for passenger flights where users may simply input the origin and destination airports. Carbon emissions are then estimated based on travel distance and load factor with a comprehensive aircraft database.	Passenger flights, freighter flights
Cornell Hotel Sustainability Benchmarking Index 2023	Cornell Hotel Sustainability Benchmarking Index (CHSB) is a carbon footprint dataset based on hotel energy, water and carbon emissions of over 25,000 hotels globally. The industry-led initiative draws on the Hotel Carbon Measurement Initiative (HCMI) methodology	Hotel accommodation

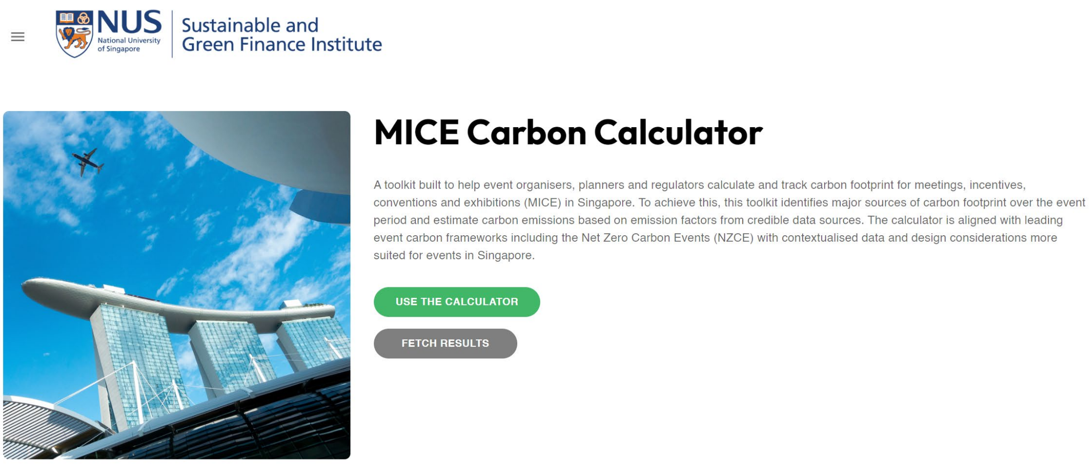
	framework and calculates carbon footprint over daily occupied hotel rooms.	
Singapore Energy Statistics 2023	Singapore Energy Market Authority (EMA) releases the Singapore Energy Statistics (SES) every year that provides a summary of Singapore's energy supply, transformation and consumption landscape. In particular, the authority publishes Singapore's electricity generation fuel mix and grid emission factor.	Fuel mix for electricity generation, grid emission factor
Singapore Waste Statistics and Overall Recycling 2022	Singapore National Environment Agency (NEA) reports Singapore Waste and Recycling Statistics by waste type such as metal, plastics, construction and food.	Waste amounts and recycling rates
Singapore Tourism Statistics 2019	Singapore Tourism Analytics Network (STAN) hosts Singapore Tourism Statistics with regular updates. The site provides data of percentages of visitor arrivals by travel purpose and area of origin.	MICE traveller percentages by area of origin
Singapore National Visitor Arrivals 2019	Singapore Department of Statistics (SingStat) publishes data of national visitors from different regions.	Travellers by area of origin
Ecosperity Environmental Impact of Food in Singapore	Ecosperity is a platform for Temasek to conduct sustainability engagement and advocacy. Their joint study with Deloitte reveals the environmental landscape of food items in Singapore with a life cycle analysis (LCA) unique to Singapore's production, processing and transportation of food (Ecosperity, 2019).	GHG intensities of food ingredients
Singapore Census of Population 2020	Singapore Census of Population 2020 was the sixth national census since Singapore gained independence and was published by Singapore Department of Statistics (SingStat, 2021). "Statistical Release 2" covers households and geographic distribution of transport data, serving as an important reference when considering the choice of local transportation.	Geographic distribution of residents and their modes of transportation to work

Appendix B – User Instructions for the MICE Carbon Calculator

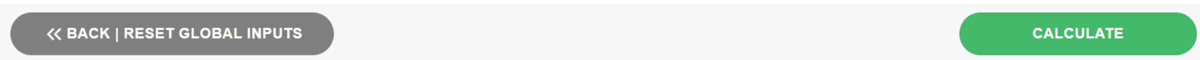
The SGFIN Carbon Calculator is hosted on the SGFIN website that can be used to track event carbon footprint in Singapore for free. The instructions below are prepared to guide the users of the toolkit through a seamless experience with illustrative figures. Once the users submit the input values, the results can be retrieved through a reference ID for unlimited times.

How to Use the Calculator

1. Access the calculator at https://www.sgfin.tech/#/mice-carbon-calculator.
2. Click 'Use the Calculator'.



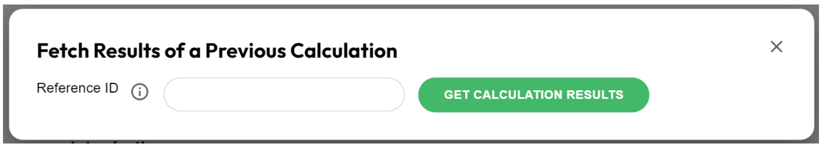
3. Fill in all the fields under the Global Inputs tab. Ensure that none are left blank.
4. Click the 'Next' button on the bottom right. The calculator will perform some pre-calculation of default values to populate the other input fields. At this time, you will see a loading page.
5. Once ready, the other tabs will be displayed. Navigate to each tab and fill in the values for the other input fields.
   a. Some fields are prefilled with default values based on your global inputs.
   b. Some fields will be dependent on global input values and therefore should match accordingly. Some examples include:
      i. Sum of travellers from different regions should be equal the number of international attendees.
      ii. Sum of related fraction values should be equal to 1.
6. Once you have finished filling up the inputs:
   a. If you wish to modify your Global Inputs, click the 'Back' button on the bottom left to reset the calculator.
   b. If you wish to continue, click the 'Calculate' button on the bottom right.



7. Wait for the loading page to disappear. If there are no errors, you should be able to see the Results page. See the above feature list for more details on what each chart is for.
8. Download the PDF report and/or note down the reference ID.

How to Access Previous Results

1. Access the calculator at https://www.sgfin.tech/#/mice-carbon-calculator
2. Click on the 'Fetch Results' button. A pop-up window will appear.

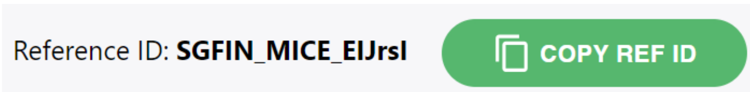


3. Enter the previously saved reference ID into the input bar and click the 'Get Calculation Results' button.
4. Wait for the Results page to load up. See the above feature list for more details on what each chart is for.

Results Features

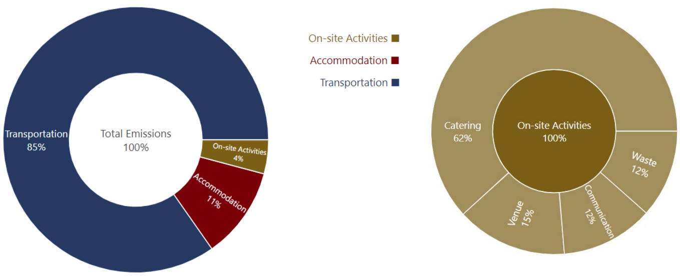
A. Generated Reference ID

Copy and save this reference ID, for easier access to results later.



B. Doughnut Charts: Carbon Footprint Breakdown

The doughnut chart shows a breakdown of carbon footprint emissions by category. Upon clicking on each category, the emissions are further broken down into specific subcategories.



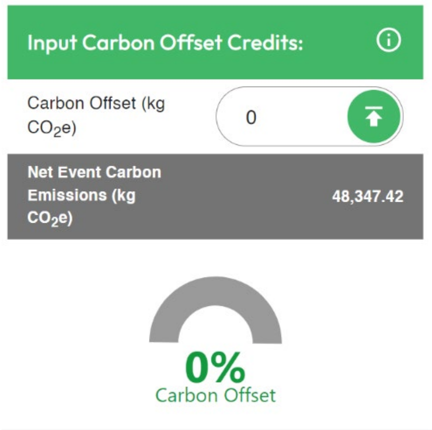
C. Table 1: Carbon Footprint Breakdown

Table 1 shows the same breakdown values but in a table form, as well as displays the carbon footprint generated physically and virtually.

The table includes an adjustable carbon offset value, which you may choose to fill in. Type in a value and click the green button to have the offset reflect in your results.

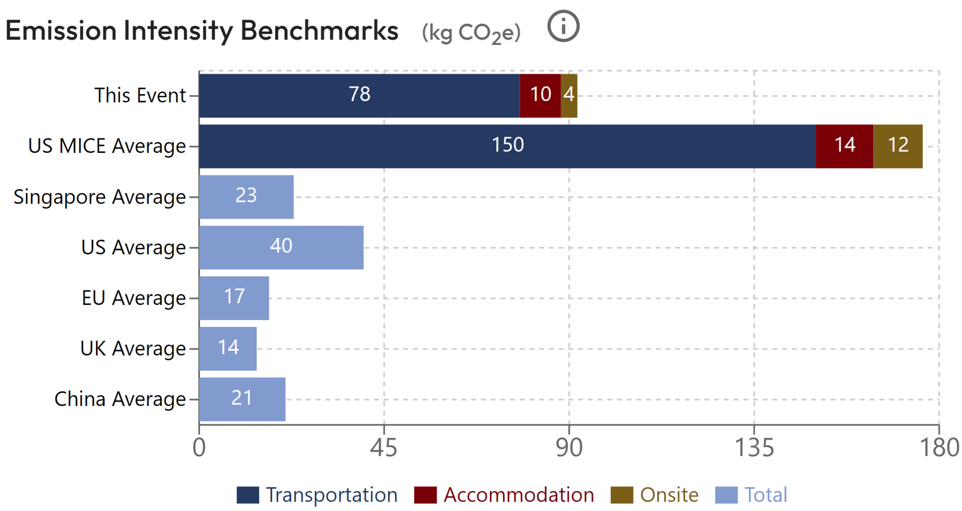
D. Offset Chart

This chart displays the percentage that is offset from your total emissions, based on the carbon offset value provided, if any.



E. Bar Chart: Per Capita Carbon Footprint per Day

This calculator benchmarks the estimated event emission intensity (carbon footprint per person per day) against that of a typical MICE event in the United States and selected economies' general average emission levels. These benchmarks are displayed in this bar chart.



F. Table 2: Per Capita Carbon Footprint per Day by Category

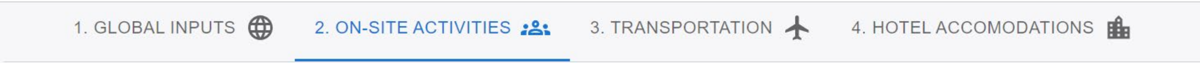
Table 2 shows the average emissions of your event for each category, as well as for the physical and virtual emissions.

G. PDF Preliminary Report

A PDF report of your calculation results can be generated and downloaded by clicking on the 'Export Results as PDF' button on the top right section of the Results page. The same information presented above are reflected in the report for easier sharing.

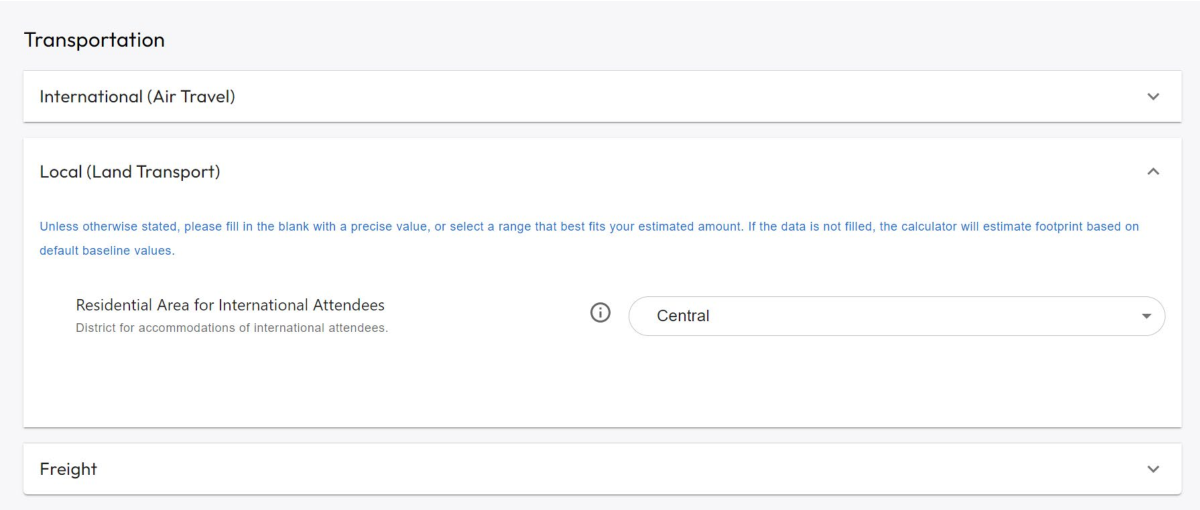
Calculator Features

A. Category Tabs



There are four main tabs, which can be navigated by using the respective tab buttons.

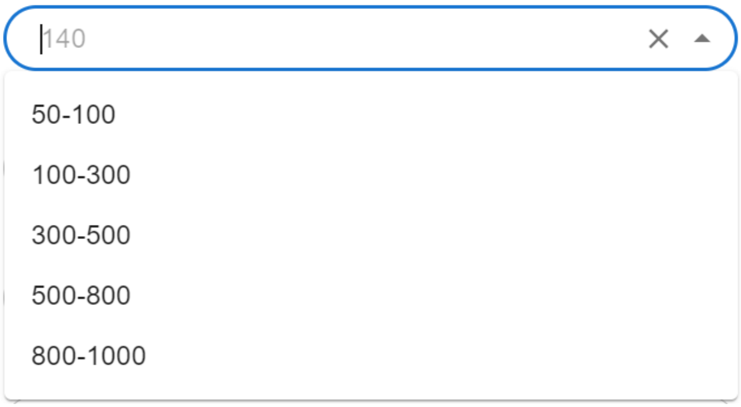
Within each tab, the different subsections can be toggled open or closed to reveal the individual input fields for user input.



B. Input Fields

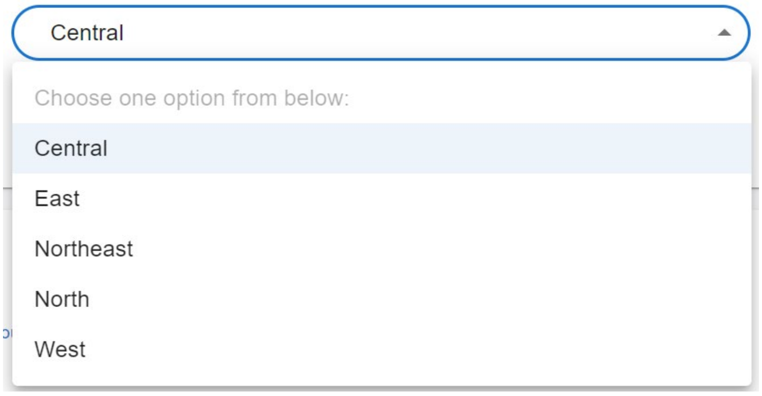
There are three main types of input fields that can be found within the calculator. The interactions with each field will depend on the type.

a. Type 1: Number + Dropdown Input
To fill in this field, you can enter a specific value, or choose an acceptable range from the dropdown list.



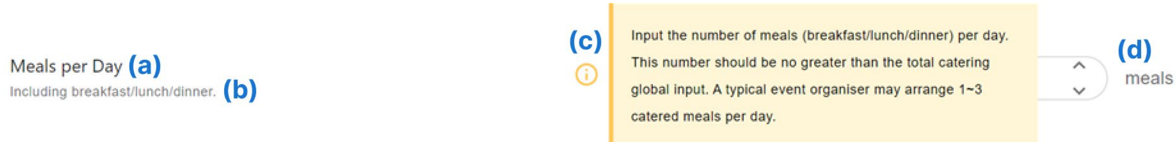
b. Type 2: Number Stepper
To fill in this field, you can enter a specific value, or adjust any value by clicking on the arrow buttons on the right.

c. Type 3: Dropdown List Input
   To fill in this field, you can select one option from the dropdown list.



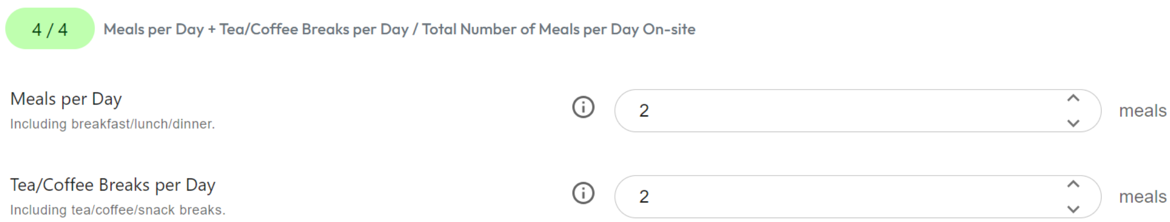
C. Input Field Labels

There are up to four labels on each input field provided for clarity.



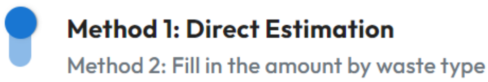
a. **Field label:** This describes what the input should be.
b. **Helper caption:** This may provide more information about what the label is asking for.
c. **Detailed description:** This goes into greater detail about the input and may offer a possible default value or an explanation on how it affects the overall calculation. The description box can be viewed by hovering over the round 'information' icon on the left of the input field.
d. **Units:** This states the units used for each measurement.

D. Sum Validator



This counter appears in multiple sections of the calculator to ensure that user inputs align with the initially provided Global Inputs, and prompts users to correct errors before proceeding to calculate.

E. Switchable Sections



Certain sections can be toggled between two methods of calculation, depending on available information from the user. Click on the switch to toggle between methods.

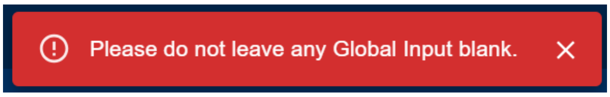
In the above example, if you have more detailed information about the respective amounts of waste per type, you may use method 2, otherwise you may provide a direct estimate using method 1.

F. Error Message Pop-ups

If there are any errors during the calculation process, a red pop-up box will appear on the bottom left corner of the screen with an error message.

a. Empty Fields error

This error appears when an input field (usually a Global Input) has been left empty. You can correct it by typing in a value.



b. Non-numeric Input error

This error appears when a text field contains any non-numeric characters. You can correct it by locating the field with the wrong input and removing any non-numeric characters.