# Carbon Footprint Assessment of Organization for Hotel Industry

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## Abstract

The objective of this research was to study the guidelines for assessing the carbon footprint and reducing greenhouse gas (GHG) emissions of two organizations in the industrial service sector, specifically focusing on Sivatel Hotel Bangkok. This study was conducted using exploratory research based on the carbon footprint assessment framework provided by the Thailand Greenhouse Gas Management Organization (TGO). GHG-emitting activities were categorized into three scopes: Scope 1 – direct GHG emissions, Scope 2 – indirect GHG emissions from energy use, and Scope 3 – other indirect emissions. Data were collected and analyzed from January to December 2024. The results revealed that Sivatel Hotel Bangkok had a total carbon footprint of 2013.16078 tons of carbon dioxide equivalent ($tCO_2e$), consisting of Scope 1 (445.19739 $tCO_2e$), Scope 2 (1,495.09957 $tCO_2e$), and Scope 3(72.86382 $tCO_2e$). The largest emission share, 74.27%, originated from Scope 2 activities.

**Keywords:** Carbon Footprint, Hotel Industry, Greenhouse Gas, Sustainability

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## Introduction

The world is currently facing a climate change crisis, considered a global issue with widespread impacts on quality of life. Countries around the world are increasingly aware of and committed to addressing this challenge, both through policy-level actions and greenhouse gas emission reduction initiatives. This led to the Paris Agreement, signed by 196 countries during COP21 in Paris, France, on December 12, 2015. Its primary objective is to limit global temperature rise to no more than 2°C, ideally 1.5°C. The agreement also aligns with the United Nations' Sustainable Development Goals (SDGs), particularly Goal 13: Climate Action, which sets a target to reduce carbon emissions by 45% by 2030 and achieve net-zero emissions by 2050. Scientists have concluded that climate change is largely driven by human activities, especially fossil fuel combustion (coal, oil, and natural gas) and deforestation ( Sujinna et al, 2024). Since the Industrial Revolution in the late 18th century, atmospheric carbon dioxide levels have risen dramatically, with human economic activities contributing an additional 8 billion tons of $CO_2$ annually, much of which remains in the atmosphere for hundreds of years (Clyde et al, 2024).

GHG emissions occur naturally and through human activities. These gases trap heat in the Earth's atmosphere, moderating the difference between day and night temperatures. However, human activities have increased atmospheric GHG concentrations, reducing the ability of solar heat to reflect back into space, causing the greenhouse effect (Joachim et al, 2024).

The Intergovernmental Panel on Climate Change (IPCC) supports scientists from developing countries, enabling access to new knowledge and collaboration with experts worldwide. This facilitates global cooperation and knowledge exchange on climate change. Although energy efficiency in industrial and residential sectors is improving, full potential has not been reached. Conflicts persist between energy demand and emissions reduction, requiring a balanced approach for climate change mitigation, such as enhancing energy-saving methods or identifying carbon reduction opportunities (Reda et al, 2024).

Carbon Footprint for Organization (CFO) or Corporate Carbon Footprint (CCF) is a tool to quantify GHG emissions from an organization's operations. It is widely used in both public and private sectors to develop effective strategies for reducing emissions at the factory, industrial, and national levels. The calculation includes emissions from fuel combustion, electricity use, waste management, and transportation, presented in tons of $CO_2$ equivalent. Long-term CFO analysis helps organizations identify significant emission sources and develop more effective reduction strategies (TGO, 2022).

## Methodology

The study site for this research was Sivatel Hotel Bangkok. The research was conducted over the period from January to December 2024.

Primary data were obtained from five personnel within Sivatel Hotel Bangkok, selected purposively from those responsible for project implementation. The research team provided preliminary training before data collection. Data were gathered through focused group discussions, in-depth individual interviews, and direct observation.

Secondary data included documents such as expenditure records for organizational activities, academic texts, journals, office records, government reports, and related academic articles.

## Research Instruments

The primary research instrument was a semi-structured interview guide with open-ended questions. It collected general organizational information and data on greenhouse gas emission activities categorized into three groups, in accordance with the Thailand Greenhouse Gas Management Organization's guidelines (2011).

**Data Collection**

Data were collected through focused group discussions, in-depth interviews, direct observation, and document review. All researchers gathered data themselves by directly engaging with primary sources (Grounded Theory). The qualitative data included documents, essays, transcripts, photographs, and objects.

Group discussion transcripts were analyzed carefully to prevent data distortion (Etic). All visual and textual data were categorized for content analysis.

**Data Verification**

Triangulation was used to ensure data reliability. Data were compared across different methods, times, locations, and informants. Consistency across these variables indicated data saturation and trustworthiness.

Carbon Footprint Emission Analysis Based on the Guidelines of the Thailand Greenhouse Gas Management Organization (2011)

(1) Defining Organizational Boundaries

This research focused on a case study of an airline catering company specifically designed for the production of frozen meals supplied to Phuket-based airlines. The purpose was to identify the sources of greenhouse gas emissions and conduct assessments to develop appropriate emission reduction strategies.

(2) Defining Operational Boundaries

Activities within the organization were classified into three categories based on operational boundaries:

• Scope 1 – Direct greenhouse gas emissions from organizational activities, such as fuel combustion and on-site processes.

• Scope 2 – Indirect greenhouse gas emissions from the consumption of purchased electricity, heat, or steam generated by external entities but used within the organization.

• Scope 3 – Other indirect greenhouse gas emissions that occur as a result of organizational activities but fall outside Scope 1 and 2, such as upstream and downstream activities.

(3) Collection and Categorization of Activity Data and Emission Sources

Greenhouse gas-emitting activities were identified, and relevant data were collected and categorized according to the defined operational boundaries.

(4) Data Analysis and Calculation Method for Organizational Greenhouse Gas Emissions

The researchers classified emission data based on the three emission scopes and analyzed each source individually. This approach ensured the accuracy of the carbon emission calculations and supported the development of appropriate emission reduction strategies for the organization. The calculation is based on the following formula:

$$CFO = GHG\ Emission = Activity\ Data \times EF$$

Where: • GHG = Quantity of greenhouse gas emissions

• Activity Data = Data related to activities causing GHG emissions

• EF (Emission Factor) = GHG emission factor for a specific activity

Analysis Guidelines for Sivatel Bangkok Hotel

Scope 1: Direct Greenhouse Gas (GHG) Emissions and Removals by the Organization

1. GHG emissions from stationary combustion

1.1 Diesel consumption for electricity generators. Calculation: 200 liters × 2.7078 kg$CO_2$eq/litter = 541.56 kg$CO_2$eq

1.2 Diesel consumption for fire pump engines. Calculation: 200 liters × 2.7078 kg$CO_2$eq/litter = 541.56 kg$CO_2$eq

1.3 Liquefied Petroleum Gas (LPG) consumption. Calculation: 11,259.71 kg × 3.1134 kg$CO_2$eq/kg = 35,055.77 kg$CO_2$eq

2. GHG emissions from mobile combustion

2.1 Diesel fuel consumption for transportation. Calculation: Distance × Load weight × Emission factor based on vehicle type (tkm). (No data reported by the organization).

2.2 Gasohol 91, E20, E85 consumption for vehicles. Calculation: Fuel consumption × Emission factor according to fuel type (liters). (No data reported by the organization).

2.3 Gasohol 95 consumption for vehicles. Calculation: Fuel consumption × Emission factor according to fuel type (liters). (No data reported by the organization).

3. GHG emissions from fugitive sources and others

3.1 Use of fire suppression agents ($CO_2$). Calculation: Quantity of fire supperssion agent used × GHG emission factor (Unit: kg $CO_2$ based on chemical type). (No data reported by the organization).

3.2 Methane emissions from septic tanks. Calculation: 424.79 kg$CH_4$ × 28 kg$CO_2$eq/kgCH4 = 11,894.06 kg$CO_2$eq

3.3 Methane emissions from wastewater treatment ponds. Calculation: 370.16 kg$CH_4$ × 28 kg$CO_2$eq/kg$CH_4$ = 10,364.39 kg$CO_2$eq

3.4 Use of refrigerant R134a. Calculation: 195.65 HFC-134a × 1,300 kg$CO_2$eq/kgHFC-134a = 254,345 kg$CO_2$eq

3.5 Use of refrigerant R32. Calculation: 195.65 HFC-32 × 677 = 132,455.05 kg$CO_2$eq

Scope 2: Indirect GHG Emissions from Imported Energy

4. GHG emissions from electricity imported for internal use

4.1 Electricity consumption. Calculation: 2,990,797.3 kWh × 0.4999 kg$CO_2$eq/kWh = 1,495,099.57 kg$CO_2$eq

Scope 3: Indirect GHG Emissions from Trans-portation and Other Activities

5. Indirect GHG emissions from the purchase of raw materials and services (Purchased goods and services)

5.1 Tap water purchased by the organization. Calculation: 19,279 $m^3$ × 0.7948 kg$CO_2$eq /$m^3$= 15,332.95 kg$CO_2$eq

5.2 White A4 and A3 paper usage. Calculation: 1,125 kg × 2.1020 kg$CO_2$eq /kg= 2,364.75 kg$CO_2$eq

6. Indirect GHG emissions from the disposal of products sold by the organization

6.1 Waste generated within the hotel. Calculation: 23,778.5 kg × 2.3200 kg$CO_2$eq/kg = 55,166.12 kg$CO_2$eq

(5) Uncertainty Assessment and Management

This step is crucial to demonstrate the reliability and quality of the GHG emission and removal data collected. Uncertainty may arise from the use of emission factors from various references during calculation. The outcomes of the uncertainty assessment should be reviewed and validated by the responsible personnel or the organization conducting the assessment.

## Results

### The carbon footprint assessment

The carbon footprint assessment and GHG emission reduction guidelines were studied for two service-sector organizations, with a focus on Sivatel Hotel Bangkok. The methodology followed the TGO's organizational carbon footprint framework, categorizing GHG emissions into three scopes: Scope 1 (direct emissions), Scope 2 (indirect emissions from energy use), and Scope 3 (other indirect emissions). Data were collected from January to December 2024.

The total carbon footprint of Sivatel Hotel Bangkok was found to be 2013.16078 tons of $CO_2$ equivalent ($tCO_2e$). This included: Scope 1 ( 445.19739 $tCO_2e$) , Scope 2 ( 1,495.09957 $tCO_2e$) and Scope 3 ( 72.86382 $tCO_2e$) . The largest emissions source was Scope 2, accounting for 74.27% of the total emissions. (Figure 1)

### Carbon Reduction Strategies

Carbon reduction in the hotel industry is a key component of sustainable development, especially in light of the global climate crisis. Hotels, as part of the service industry, consume large amounts of energy and emit substantial greenhouse gases through electricity, water use, air conditioning, transportation, and waste management.

The recommended strategies for reducing carbon emissions in the hotel sector include:

1. Energy Management: Installing renewable energy systems (e.g., solar panels). Sivatel Hotel could install a 15 kWp system (26 panels, 610W each) to supply electricity to guest rooms on floors 26 and 27, producing 18,790 kWh/year and reducing electricity bills by 6,100 THB/month with a 10-year payback period. Additional energy-saving measures include LED lighting, smart systems for lighting and air conditioning, and upgrading to energy-efficient appliances (e.g., 5-star air conditioners). Adjusting central temperatures by 1°C could reduce energy use by 6%.

2. Water and Waste Management: Reusing greywater for irrigation, installing water-saving fixtures, separating and recycling waste (e.g., plastics, glass, paper), and using biodegradable products to reduce single-use plastics. (Figure 2)

3. Refrigerant Substitution: Replace R-410a (GWP 2,088) with R-290 (GWP ~3), a more environmentally friendly hydrocarbon refrigerant.

4. Promoting Eco-friendly Behavior: Encourage guests to reuse linens, promote cycling or electric transport, and use signage and digital platforms to raise awareness.

5. Digital Transformation: Reducing paper use through digitization. The ‘SCGP Recycle’ project recycled 47,830 kg of paper, equivalent to planting 813 trees and reducing $CO_2$ emissions by 32,524 kg.

6. Carbon Footprint Management: Conduct carbon assessments, create GHG inventories, and

purchase carbon offsets (e.g., from forest restoration or renewable energy projects).

7. Environmental Certifications: Obtain certifycations like Green Hotel, ISO 14001, or LEED, and join environmental initiatives such as Green Hotel and Green Leaf.

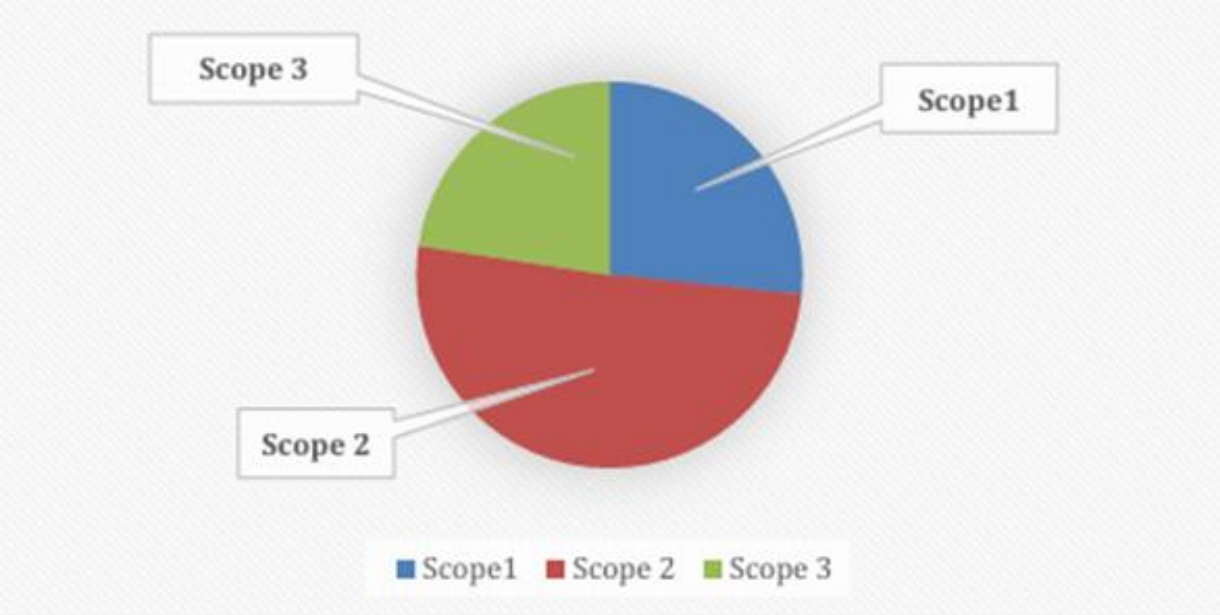


**Figure 1.** The carbon footprint assessment of Sivatel Hotel Bangkok.

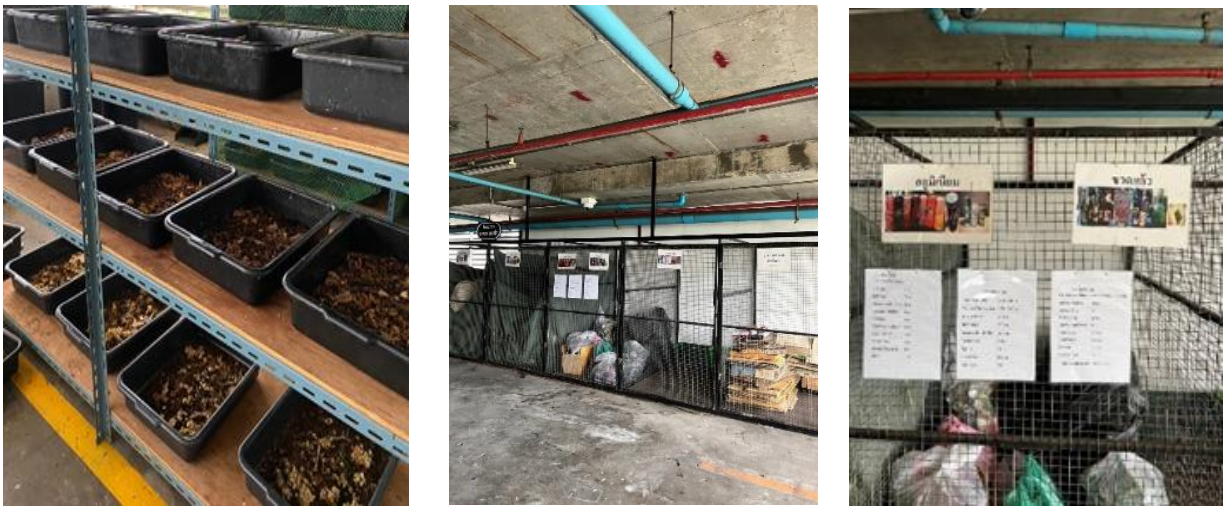

**Figure 2.** Carbon reduction strategies on waste management activities of the hotel

## Conclusion

This study assessed the carbon footprint and proposed emission reduction strategies for Sivatel Hotel Bangkok using TGO's guidelines. Emissions were classified into three scopes, with Scope 2 contributing the highest share as 74.27% of the total emissions (2,013.16078 $tCO_2e$).

The hotel industry can implement several strategies to reduce carbon emissions including energy management, waste reduction, refrigerant replacement, eco-friendly behavior promotion, digital transformation, carbon offset programs, and environmental certifications. These actions support sustainable development and align with climate action goals.

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