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Assessment of Carbon Footprint from Integrated Innovation Camp Activities

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Abstract

This study evaluated the carbon footprint generated by activities conducted during the KU Innovation Camp, which integrated multiple scientific disciplines. The camp served as a platform for students to develop innovative solutions while participating in various activities that contribute to carbon emissions. The objective of this study is to evaluate carbon footprint from key activities, including transportation, energy consumption, food and beverages, accommodation, and waste management. The assessment revealed a total carbon footprint of 12.35 tCO_2e, originating from the following sources: food and beverages (4.71 tCO_2e, 38.12%), electricity (3.05 tCO_2e, 24.70%), accommodation (2.23 tCO_2e, 18.03%), transportation (2.07 tCO_2e, 16.72%), waste (0.30 tCO_2e, 2.42%), and souvenirs (0.0002 tCO_2e, 0.002%). Scenario were simulated to propose strategies for reducing carbon emissions. These strategies include optimization of food and beverage by adjusting meal type and implementing energy conservation practices. These measures can reduce the carbon footprint from 12.35 tCO_2e to 10.82 tCO_2e, a reduction of 1.53 tCO_2e (12.39%).

Keywords: Carbon footprint; Greenhouse gas emission; Innovation camp

1. Introduction

Climate change has emerged as one of the most pressing global challenges of the 21st century, with rising average temperatures exerting profound impacts on ecosystems, economies, and communities worldwide (IPCC, 2021). The scientific consensus emphasizes the urgency of mitigating greenhouse gas (GHG) emissions to avert catastrophic environmental consequences. The United Nations Framework Convention on Climate Change (UNFCCC) was established to drive collective action in mitigating greenhouse gas (GHG) emissions (UNFCCC, 2022). One of the most significant milestones in this effort is the Paris Agreement, adopted in 2015, which aims to limit global temperature rise to well below 2 °C above pre-industrial levels, with an aspirational target of 1.5 °C (United Nations, 2015). Achieving these goals requires transformative actions across various sectors, from energy and transportation to waste management and sustainable event practices (UNEP, 2020). A key component of the Paris Agreement is the development of Nationally Determined Contributions (NDCs), in which each signatory country commits to specific emission reduction targets. Thailand has pledged to reduce its GHG emissions by 40% by 2030 under enhanced NDC commitments and has set ambitious long-term goals, including achieving carbon neutrality by 2050 and net-zero emissions by 2065 (ISDNRE, 2023). In alignment with national goals, Kasetsart University (KU) has launched

its "KU Goes Green and Carbon Neutrality" initiative, aiming to achieve carbon neutrality by 2035 and positioning itself as a leader in sustainability within higher education.

In 2024, the Faculty of Environment, in collaboration with the Faculty of Agro-Industry and the Faculty of Fisheries, organized a sustainable and initiative project called "the 4th Integrated Innovation Camp" at Kasetsart University. This event brought together students from different faculties of KU to develop innovative solutions addressing environmental and community challenges in Laem Phak Bia, Phetchaburi Province. Activities during the camp, including transportation, energy use, food and beverage services, accommodations, and waste management, were identified as potential sources of GHG emissions. To advance sustainable event management, assessing and mitigating the carbon footprint of event is necessary. However, limited studies have systematically evaluated the carbon footprint for university event in Thailand, highlighting a knowledge gap in understanding the environmental impact of such activities. While existing studies focus on corporate and government-organized sustainable events, comprehensive carbon footprint assessments specific to academic event remain scarce.

This study aims to quantify the carbon footprint of the KU Innovation Camp by identifying major emission sources and analyzing their relative contributions. The findings will provide recommendations for reducing carbon emissions in future university events, contributing to sustainable event management and supporting KU's commitment to carbon neutrality. Furthermore, this research serves as a valuable reference for academic institutions seeking to integrate sustainability into event planning and management.

2. Methodology

2.1 Study scope and boundary

The carbon footprint evaluation for the 4th Integrated Innovation Camp encompasses activities conducted between 23 August 2024 and 25 September 2024, across two primary locations: Kasetsart University and the Environmental Research and Development (LERD) Project in Phetchaburi. Table 1 outlines the five key sub-events, detailing their respective activities, venues, durations, and the number of participants involved.

2.2 Assessment of carbon footprint

The carbon footprint of the 4th KU-Integrated Innovation Camp was assessed through three key steps: defining operational boundaries, collecting activity data, and calculating greenhouse gas (GHG) emissions using appropriate emission factors (EFs). The methodology of assessment followed the guidelines set by the Thailand Greenhouse Gas Management Organization (TGO), which aligns with the ISO 14064 and ISO 14067 guidelines for carbon footprint assessment (TGO, 2015). To systematically classify emissions, GHG

Table 1. Key activities and associated details of the 4th Integrated Innovation Camp

Sub-event	Activities	Duration	Venue	Participants
1	Kickoff Meeting	3 hrs	Kasetsart University	225
2	Site Visit and Team Building Workshop	2 days/ overnight	LERD, Phetburi	121
3	"Creativity Meets Technologies" workshop	2 days	Kasetsart University	258
4	Data Collection in Target Community Areas	2 days/ overnight	LERD, Phetburi	161
5	"Meeting Coach" session	3 hrs	Kasetsart University	142

emissions from various activities were categorized into three scopes:

Scope 1 (Direct emissions) includes emissions from food and beverage consumption, primarily related to meal served and food waste.

Scope 2 (Indirect emissions from energy use) covers emissions generated from electricity consumption at event venues, including air conditioning, lighting, and audio-visual equipment.

Scope 3 (Other indirect emissions) encompasses emissions resulting from participant transportation, accommodation, souvenir production, and waste management, which are associated with activities not directly controlled by the event organizers.

Activity data (AD) related to the carbon footprint of the 4th KU-Integrated Innovation Camp includes the number of participants, transportation modes, energy usage, meal consumption, accommodation arrangements, and waste generation. Data were gathered from event records, participant surveys, and direct observations at both Kasetsart University and LERD, Phetchaburi. Table 2 summarized the activities, parameters and sources of activity data used to calculate the carbon footprint of the 4th KU-Integrated Innovation Camp.

Emission factors (Table 3) were obtained from the TGO and other recognized sources to convert activity data into carbon dioxide equivalent (CO_2e) emissions as shown in Equation 1.

$$\mathrm{CF}\ (\mathrm{CO_{2e}}) = \text{Activity data [unit]} \times \mathrm{CO_2}\ \text{Emission factors}\ \left[\frac{\mathrm{CO_{2e}}}{\text{Unit}}\right] \quad (1)$$

The resulting carbon footprint values ($kgCO_2e$) provided a basis for assessing the environmental impact of the event. These findings can help inform strategies for reducing emissions and promoting more sustainable academic events in the future.

2.3 Data analysis and scenario simulation

After calculating the total greenhouse gas emissions for the event, a scenario simulation analysis was conducted to evaluate potential strategies for reducing the carbon footprint of future university

Table 2. Parameters and sources of activity data used to calculate the carbon footprint of the 4th KU-Integrated Innovation Camp

Scope	Activities	Parameters	Sources
1	Food and beverage	Types of meals Total meals of the event Total sets of meal served	Personal communication and observation
2	Electricity usage	Power (kW) of electrical appliances: air condition, lights, computer, audio, etc. Quantity of appliances Duration of usage	Survey and record
3	Transportation	Type of transportation Type of fuel Distance	Questionnaire Survey and observation
	Souvenir	Type and number of souvenirs Souvenir components by material type Weight ratio of materials	Direct measurement
	Accommodation	Type of accommodation Star rating of the hotels Number of nights stay Number of guests	Personal communication and observation
	Waste management	Composition of waste Amount of waste Waste handling	Personal communication and observation

events. The simulations were designed to assess the impact of alternative methods in key emission categories, allowing for the identification of feasible low-carbon strategies. The key scenarios considered included:

• Optimization of food and beverage by adjusting meal types from buffet-style service to pre-portioned staple meals

• Energy efficiency by implementing energy-efficient lighting, air conditioning, and equipment usage practices.

Each scenario was analyzed by adjusting input parameters in the carbon footprint calculation model and recalculating emissions to determine the potential reduction in $kgCO_2$-equivalent ($kgCO_2e$). The findings from the scenario analysis will be used to develop recommendations for future event planning at Kasetsart University. These recommendations will support the university's goal of carbon neutrality by identifying the most effective and practical emission reduction strategies for academic events.

Table 3. Emission factors used in the calculation of carbon footprint

Parameters	Unit	Emission factor ($kgCO_2e$/unit)	Reference
Food and Drink			
Simple staple food	set	1.6500	TGO
Vegetarian food	set	1.1200	TGO
General buffet	set	2.2700	TGO
International buffet	set	3.9300	TGO
Snack and drink	set	0.2170	TGO
Vegetarian snack and drink	set	0.1464	TGO
Disposable food containers (only plastic)	set	0.1310	TGO
Disposable beverage containers (only plastic)	bottle	0.1596	TGO
Electricity, grid mix			
Electricity, grid mix year 2016-2018; LCA	kWh	0.4999	Thai National LCI Database
Travel			
Private passenger car	km-person	0.1622	TGO
Electric automobiles	km-person	0.0756	TGO
Pick up	km-person	0.2466	TGO
Personal van	km-person	0.2686	TGO
Taxi	km-person	0.1893	TGO
Motorcycle	km-person	0.0579	TGO
Bus	km-person	0.0300	TGO
Public van	km-person	0.0269	TGO
Bicycle or walk	km-person	0.0000	TGO
Train	journey-person	0.7102	TGO
Accommodation			TGO
1- and 2-star hotel	night-person	6.0800	TGO
3-star hotel	night-person	8.1000	TGO
4-star hotel	night-person	9.1400	TGO
5-star hotel	night-person	14.2100	TGO
Souvenir			
Paper	kg	2.1639	TGO
Plastic	kg	6.7071	TGO
Metal	kg	6.3369	TGO
Fabric	kg	11.5000	TGO
Wood	kg	0.3841	TGO
Other	kg	11.5000	TGO
Waste			
Paper	kg	2.9300	TGO
Plastic	kg	2.3200	TGO
Fabric	kg	2.0000	TGO
Food Scraps	kg	2.5300	TGO
Wood	kg	3.3300	TGO
Other	kg	2.3200	TGO

3. Results and Discussion

3.1 Carbon footprint from event activities

The carbon footprint of the KU innovation camp was assessed by analyzing emissions from five key activities: the kickoff meeting, site survey and team building activity, "Creativity Meets Technologies" workshop, data collection in target community areas, and the "Meeting Coaches" session. Each activity had unique emission sources, which were quantified and categorized under transportation, electricity consumption, food and beverage provision, accommodation, waste management, and souvenir distribution. Understanding the specific contributions of each activity is crucial for developing strategies to mitigate the carbon footprint of future events.

The "Kickoff Meeting" event, conducted at KU within 3 hours, generated a total greenhouse gas emission of 0.20 tCO_2e (Figure 1). The primary contributor to these emissions was transportation, as the event attracted a large number of attendees, including university affiliates, external guests, media representatives, and food vendors. Electricity usage, food and beverages, waste management, and souvenirs also contributed to the overall footprint. The per capita emissions were 9 $kgCO_2e$ per person-day.

The "Site Visit and Team Building" workshop, conducted at the Laem Phak Bia Environmental Research and Development (LERD) Project in Phetchaburi Province spanned two days and included overnight accommodation at a three-star facility. The total emissions for this event were 3.83 tCO_2e (Figure 2), with the highest share attributed to food and beverage consumption. The buffet-style meal service, which included excess food preparation and single-use drink containers, significantly contributed to emissions. Accommodation, electricity usage, transportation, and waste management were also notable sources, with per-person emissions calculated at 0.032 tCO_2e per day.

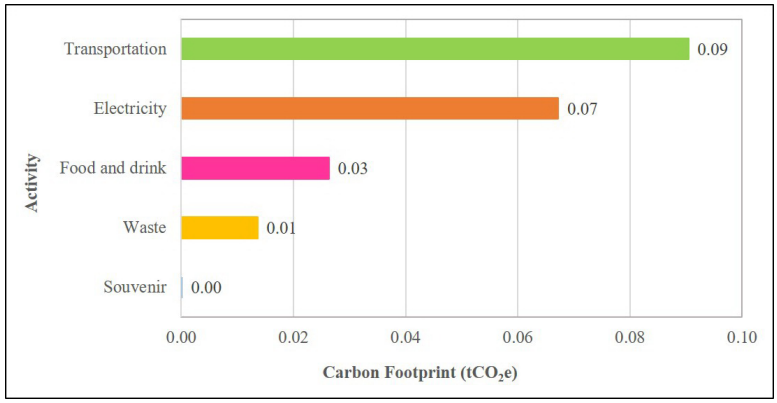

Figure 1. Carbon footprint from different sources of the "Kickoff Meeting" event.

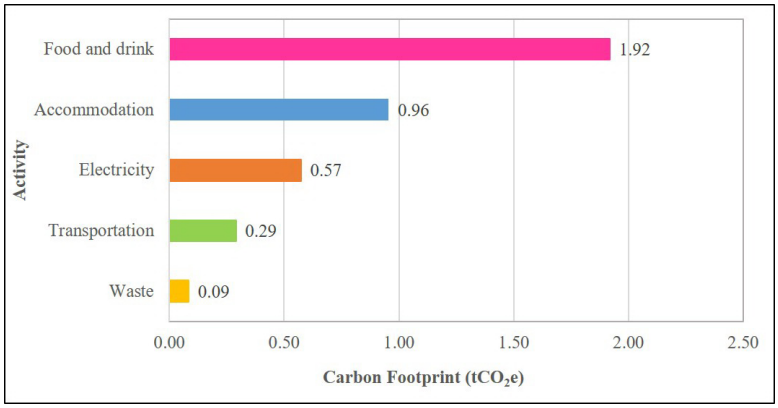

Figure 2. Carbon footprint different sources of the "Site Visit and Team-Building" workshop.

The "Creativity Meets Technologies" workshop, conducted at KU for 2 days from 9.00 am. to 4.00 pm. without overnight stay, resulted in emissions totaling 2.85 tCO_2e (Figure 3). Electricity consumption was the largest contributor due to the extensive use of electrical appliances, including air conditioning, audio-visual systems, and even ice cream freezers for refreshment. Other significant sources included food and beverages, travel, waste management, and souvenirs. The emissions per person per day were recorded at 0.011 tCO_2e.

The "Data Collection in Target Community Areas" activity was held at the LERD Project in Phetchaburi for two days and overnight stay with accommodations at a three-star facility. According to Figure 4, the largest contributors of carbon footprint were food and beverages, followed by accommodation, transportation, electricity usage, and waste management. This sub-event resulted in the highest emissions among all sub-activities, totaling 5.02 tCO_2e. The activity of food and beverages included five general buffet meals and four snack breaks. Additionally, the need for extensive travel from Bangkok to Phetchaburi, including the use of 15 vans together with private vehicles and on-site transportation for data collection, significantly increased emissions. The per capita emissions were 0.031 tCO_2e per person-day.

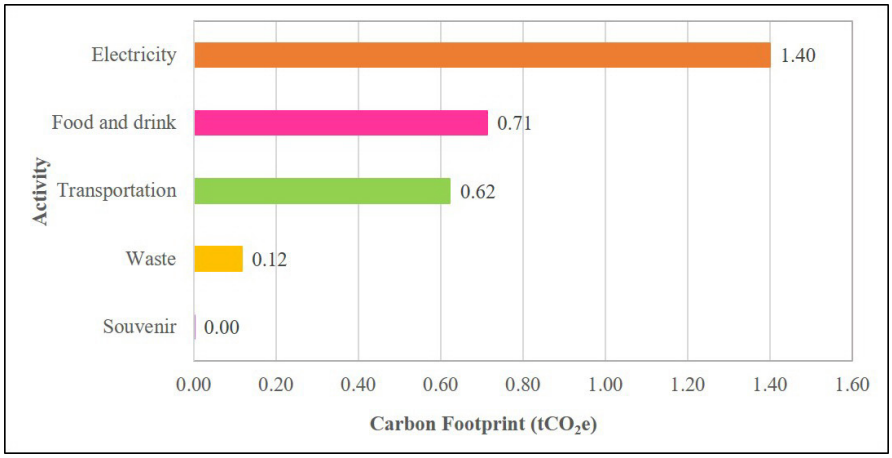

Figure 3. Carbon footprint from different sources of the "Creativity Meets Technologies" workshop

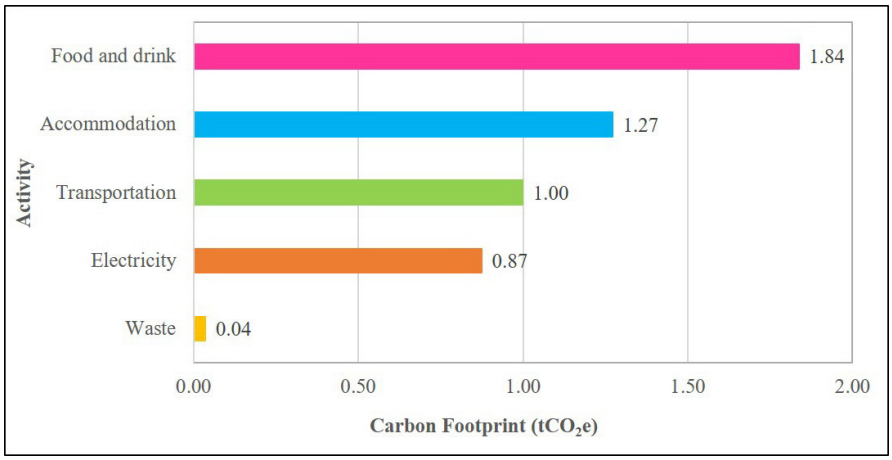

Figure 4. Carbon footprint from different sources of the "Data Collection in Target Community Areas" activity

The "Meeting Coaches" session, conducted at KU for three hours, had the lowest carbon footprint among all activities, totaling 0.46 tCO_2e (Figure 5). The primary sources of emissions were food and beverages, electricity usage, transportation, and waste management. The reliance on single-use containers and the need for additional lighting due to the venue's high ceiling contributed to the overall emissions. The per capita emissions were 0.0033 tCO_2e per person-day.

The cumulative analysis across all activities (Figure 6) indicated a total carbon footprint of 12.36 tCO_2e. The largest contributor was food and beverage consumption, accounting for 38.12% of the total emissions (Figure 7). This was largely due to the nature of meal provisions, especially in overnight activities where buffet-style catering was used extensively. Transportation was the second-largest contributor in events with a high proportion of external participants, while electricity consumption remained a significant factor throughout all activities, contributing 24.70% of total emissions. Accommodation accounted for 18.03%, travel for 16.72%, waste management for 2.42%, and souvenirs contributed a negligible 0.002%. These findings align with prior research on event sustainability and tourism carbon footprints. For example, Campos et al. (2022) highlighted that food-related emissions tend to be the highest in large-scale events, irrespective of calculation methods used. Similar trends were observed in studies on sports and academic events, where meal provisions significantly influenced the overall carbon footprint (Herold *et al.,* 2024). Understanding these emission sources is fundamental to developing targeted strategies for reduction.

3.2 Scenario simulations and proposed mitigation strategies

3.2.1 Greenhouse gas reduction scenarios

To explore potential mitigation measures, two key scenarios were simulated:

• Scenario 1: Optimization of food and beverage by adjusting meal types from buffet-style service to pre-portioned staple meals resulted in a projected emission reduction of 22.93%. This approach minimizes food waste and reduces the energy required for meal preparation and service.

• Scenario 2: Energy efficiency by implementing energy conservation measures, such as turning off lighting, air conditioning, and electronic devices during breaks, demonstrated a potential emission reduction of 14.70% (Table 4).

3.2.2 Additional recommendations for approaching carbon neutrality

Beside the simulated scenarios, additional recommendations include:

• *Encouraging sustainable transportation options:* Promoting public transport and carpooling among participants can significantly reduce travel-related emissions (McCullough *et al.,* 2023).

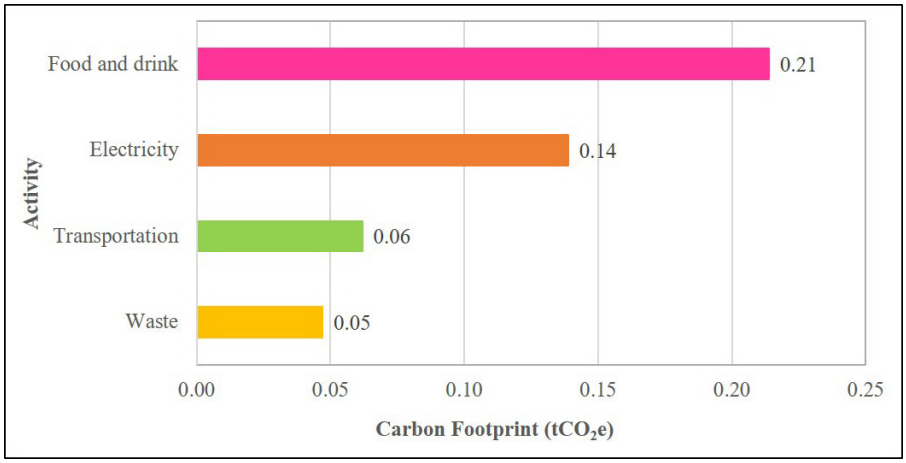

Figure 5. Carbon footprint from different sources of the "Meeting Coaches" session

Table 4. Scenario simulation for greenhouse gas reduction

Sub-event	Total emission (tCO_2e/ Sub-event)	Scenario 1: Optimization of food & beverage			Scenario 2: Energy efficiency			Total reduction for sub-event (tCO_2e)
		Baseline (tCO_2e)	Simulated (tCO_2e)	Reduced (tCO_2e)	Baseline (tCO_2e)	Simulated (tCO_2e)	Reduced (tCO_2e)	
Kickoff Meeting	0.20	0.0026	0.0026	-	1.92	0.067	-	-
Site Visit and Team Building Workshop	3.83	1.92	1.32	0.60 (31.25%)	0.71	0.52	0.05 (8.77%)	0.65 (16.97%)
"Creativity Meets Technologies" workshop	2.85	0.71	0.71	-	1.84	1.21	0.19 (13.57%)	0.19 (6.67%)
Data Collection in Target Community Areas	5.02	1.84	1.36	0.48 (26.09%)	0.21	0.66	0.21 (24.14%)	0.69 (13.74%)
"Meeting Coach" session	0.46	0.21	0.21	-	4.71	0.14	-	-
Total	**12.36**	**4.71**	**3.60**	**1.08 (22.39%)**	**1.92**	**2.60**	**0.45 (14.70%)**	**1.53 (12.39%)**

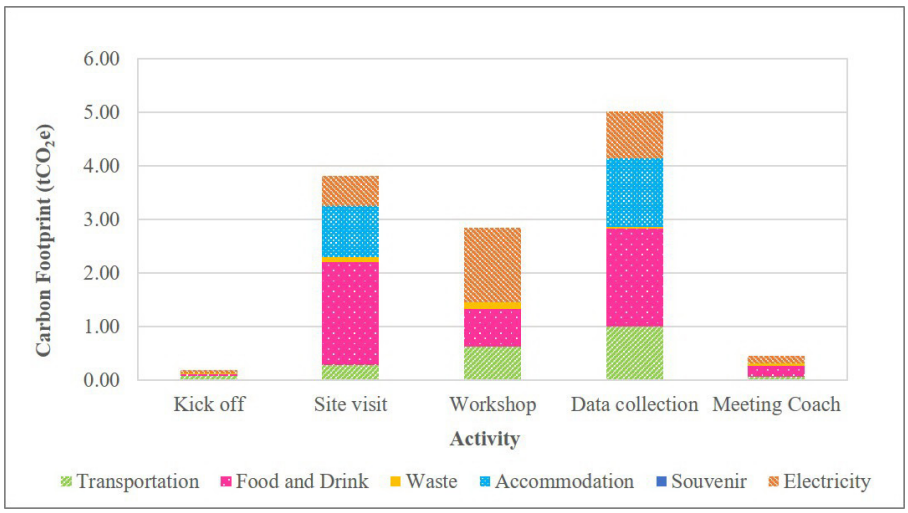

Figure 6. Carbon footprint from different activities of the KU Integrated Innovation Camp

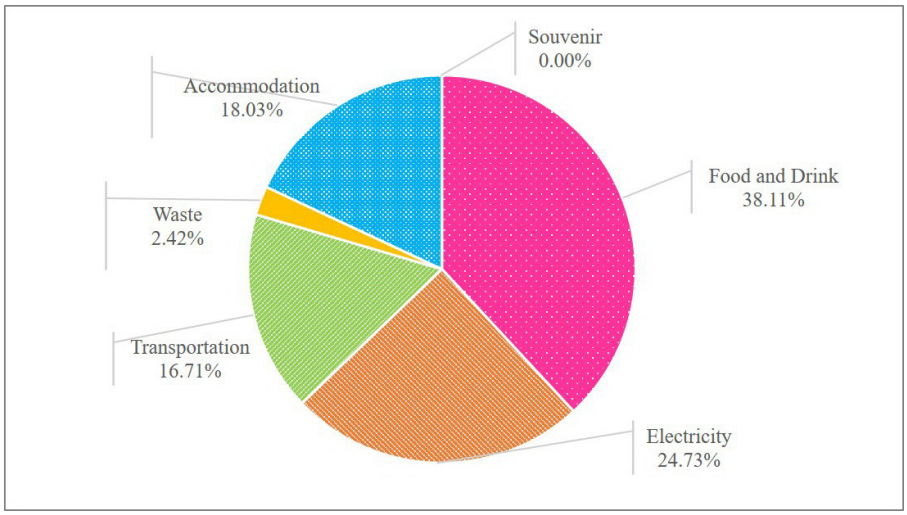

Figure 7. Contribution of individual source on carbon footprint of the KU Integrated Innovation Camp

• *Enhancing waste management practices:* Introducing a structured waste segregation system for composting food waste and recycling plastic can further decrease emissions.

• *Carbon offsetting initiatives:* Despite efforts to reduce emissions, achieving full carbon neutrality may require offsetting mechanisms, such as purchasing carbon credits or engaging in reforestation projects. In Thailand, TGO facilitates carbon credit programs that can be leveraged for offsetting residual emissions. Given that the event generated 12.35 tCO_2e, planting approximately 200 eucalyptus trees per rai, with an absorption rate of 4.67 tCO_2e per rai per year, could neutralize emissions within three years (TGO, 2016).

4. Conclusion

This study evaluated the carbon footprint of the integrated innovation camp at Kasetsart University, revealing total emissions of 12.36 tCO_2e. Among the five activities assessed, the "Data Collection in Target Community Areas" activity exhibited the highest emissions at 5.02 tCO_2e. A breakdown of emissions

by scope indicated that food and beverage were the dominant contributors, accounting for 38.12% of total emissions. Two mitigation scenarios were analyzed: meal type adjustment and energy conservation strategies, yielding a combined potential reduction of 1.53 tCO_2e (12.39%). Additional recommendations, such as promoting sustainable transport, waste segregation, and carbon offsetting, were also proposed to guide future event planning towards greater sustainability. These findings provide a practical framework for Kasetsart University and other institutions seeking to minimize their carbon footprint in academic and innovation-driven events.

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