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ORGANISATION CARBON FOOTPRINT ASSESSMENT AND GREENHOUSE GAS REDUCTION EMISSION OF YALA RAJABHAT UNIVERSITY, THAILAND

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Abstract: This research aims to study carbon footprint assessment and the guidelines for reducing greenhouse gas emissions at the Yala Rajabhat University in southern Thailand. Data was collected from January to December 2020 for evaluating greenhouse gas emissions. The methodology followed the guidelines of the Thailand Greenhouse Gas Management Organisation (Public Organisation). The greenhouse gas emissions can be classified into three categories: (1) Direct GHG emissions, (2) electricity indirect GHG emissions, and (3) other indirect GHG emissions. The results showed that Scope 2 indirect greenhouse gas emissions from energy consumption had the highest amount of greenhouse gas emissions at 1,625,941.82 kilogrammes of carbon dioxide equivalent ($kgCO_2e$/year). Amount of greenhouse gas emissions were 182,144.76 and 28,545.71 $kgCO_2e$/year for Scope 3 and Scope 1, respectively. Guidelines for reducing greenhouse gas emissions electricity consumption of the Yala Rajabhat University urgently needed. To reduce the amount of carbon footprint. This can be done in the form of (1) energy management, including reducing electricity use, (2) solid waste management using the 3Rs (Reduce, Reuse, Recycle) principle, and (3) fuel efficiency and renewable energy adoption.

Keywords: Assessment, organisation, carbon footprint, greenhouse gas, Yala Rajabhat University.

Introduction

Climate change is among the gravest global environmental challenges, primarily driven by human activity. The Paris Agreement establishes a comprehensive international framework, urging nations to curtail their greenhouse gas emissions significantly, with the ultimate aim of mitigating a global temperature rise in the upcoming decades (García-Alaminos *et al*., 2022; Cano *et al.*, 2023). The problem of climate change and greenhouse gas emissions are of uttermost important in global context. Thailand contributes a total of 318,662 gigagrams of carbon dioxide equivalent ($GgCO_2eq$), or 318.66 million metric tonnes of carbon dioxide equivalent ($MtCO_2eq$). The emissions from the transportation sector were 61,175 $GgCO_2eq$, or 61.18 $MtCO_2eq$, representing 25.82% of the greenhouse gas emissions from the energy sector, or 19.2% of greenhouse gas emissions (Office of Transport and Traffic Policy and planning, 2020). Thailand's electricity sector is responsible for approximately 39% of the country's greenhouse gas emissions, or 86.87 $MtCO_2eq$ (Electricity Generating Authority of Thailand, 2020). Since the economy fell from 145.5 million tonnes of CO_2 in 1998 to 263.4 million tonnes of CO_2 in 2018, countries have tended to increase their emissions by an average of 3.0% per year, in line with the country's average 3.7% annual increase in energy consumption. However, CO_2 emissions from energy use in 2019 decreased by 4.9% to 250.4 million tonnes, compared with the same period in 2018. This is due to the increasing use of renewable energy, as well as government policies promoting renewable energy. In 2019, Thailand's use of renewable energy increased by 6.4%, reducing CO_2 emissions from energy

consumption even as energy consumption decreased further (Energy Policy and Planning Office Ministry of Energy, 2020). Thailand has established national development strategies in accordance with the framework of its 20-year national strategy 2018-2037, under the theme 5th strategy on growing a greener quality of life. The 3rd strategy objective of climate-friendly sustainable development is to reduce greenhouse gas emissions and establish a low-carbon society (Office of the Secretary of the National Strategy Board, 2018). Thailand has set out in its national development strategy, according to the 20-year national strategic framework 2018-2037 under the issue of 5th strategy: i.e., growth based on an environmentally friendly quality of life and the three strategic issues and fostering sustainable development in a climate-friendly community. The goal is to reduce greenhouse gas emissions and establish a society with a low carbon footprint (Office of the National Economic and Social Development Board, 2017). The 12th national economic and social development plan, 2017-2021, encompass 4th strategy, green growth for sustainable development. Objective 4 is to increase the effectiveness of greenhouse gas reduction and climate change adaptation. The 20-year national research and innovation strategy, 2017-2036, has placed an emphasis on reducing greenhouse gas emissions, identified research issues on climate change management and the environment to adapt to climate change, and increased the potential for reducing greenhouse gas emissions. In Thailand, there are also organisations concerned with greenhouse gas management (Research and Innovation Policy Council, 2017).

Based on previous research, a multitude of organisations has recognised the importance of calculating their carbon footprint. Remarkably, nearly 1,400 universities worldwide have actively supported and endorsed sustainability in higher education declarations (Usubharatana & Phungrussami, 2014; Maimun *et al*., 2018; Sudha & Hirun, 2019; Chaivanich, 2020; Haseeb *et al*., 2022). Not only industry contributes to greenhouse gas emissions. It affects the greenhouse gas emissions of organisations such as the government, state enterprises, and universities. Universities, as organisations engaged in education, research and community services, play an essential role in promoting sustainability and should be an example of a sustainable organisation. The carbon footprint is a very useful decision-making tool that allows organisations to measure and communicate the effect of their activities on the environment (Valls-Val & Bovea, 2022). However, the situation can be notably contradictory, particularly in developing countries, where many educational institutes lack awareness and responsibility concerning their roles and obligations toward environmental improvement. As a consequence, they may inadvertently contribute to unsustainability by excessively exploiting resources and generating significant greenhouse gas emissions (Haseeb *et al.,* 2022).

The Yala Rajabhat University in southern Thailand is dedicated to producing graduates with a bachelor's degree with a strong emphasis on local development in the southern border provinces. The philosophy of this higher education institution revolves around human resource development for a higher quality of life, achieved through the integration of universal scientific knowledge and local wisdom. The university's vision is embodied in being known as 'The Wisdom Bank University.' Yala Rajabhat University has seven organisations: The Office of the President, the Office of Academic Services and Information Technology, the Southern Border Research and Development Institute, the Faculty of Education, the Faculty of Humanities and Social Sciences, the Faculty of Science Technology and Agriculture, and the Faculty of Management Science. The Yala Rajabhat University is another organisation that generates greenhouse gases due to activities occurring within the organisation, such as the use of electricity, paper, and tap water. The carbon footprint of the organisation has not yet been evaluated. The university's policy emphasises on being a green university to increase the institution's ranking. A global green university, according to the UI Green Metric World Green Universities Rankings, measures

the university's sustainability efforts. If a carbon footprint is measured, specific environmental and energy outcomes can be predicted based on the results of the study. Consequently, it is intriguing to examine the company's carbon footprint assessment. The Yala Rajabhat University is investigating the source and amount of greenhouse gases generated by the university's operations. As a database for analysing resource use and environmental emissions, it is a guide for establishing policies and guidelines to reduce energy consumption in organisations. This can be used to develop future strategies for reducing greenhouse gas emissions, allowing the university to become greener and more sustainable.

Materials and Methods

In the Yala Rajabhat University carbon footprint assessment study, both direct and indirect greenhouse gas emissions have been evaluated as shown in Figure 1. The following operation methods are described in the Thailand Greenhouse Gas Management Organisation (Public Organisation) carbon footprint assessment.

(1) Sample population: Main campus area University of Yala Rajabhat and MAE LAN learning centre.

(2) Instructional resources:

   (a) Origin investigation and greenhouse gas emissions.

   (b) Secondary data records for each activity emitting greenhouse gases.

   (c) Interviews to collect information on activities involving greenhouse gas emissions.

(3) Collection of data:

   (a) Sending a letter to the department heads requesting permission to collect data.

   (b) Conducting a study to determine the carbon footprint of the organisation.

   (c) Collecting data from January to December 2020 using the year as a baseline, Yala Rajabhat University provided the following information in relation to the evaluation of the organisation's carbon footprint: Fundamental details and organisational structure, organisation's energy-saving policies and measures, global warming reduction management, and number of service users (students/staff).

(4) Determining the geographic origin of greenhouse gas emissions.

(5) Examining activities that generate greenhouse gas emissions, which can be categorised into three groups:

   (a) Scope 1 direct GHG emissions including mower trimmer and chole, large tractor, and vehicle.

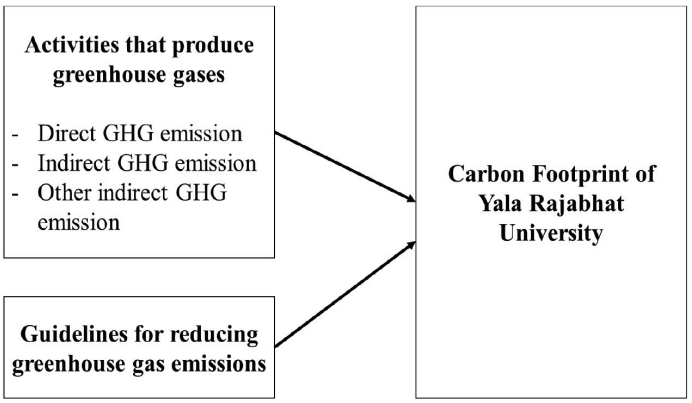

Figure 1: Conceptual framework

(b) Scope 2 electricity indirect GHG emissions including electricity usage.

(c) Scope 3 other indirect GHG emissions including solid waste disposal and transportation.

(6) Creating a list of products that emit greenhouse gases.

(7) Evaluating the organisation's greenhouse gas emissions data by using the formula to calculate the greenhouse gas emissions.

$$\text{GHG emission} = (\text{Activity data}) \times (\text{Emission factor})$$

where activity data includes primary or secondary data on fuel consumption of vehicles in litres (L), electricity usage measured in kilowatt-hours (kWh), and solid waste weight in kilogrammes (kg) or tonnes.

The emission factor is a constant that converts activity data greenhouse gas emissions using the standard of the emission factor as stated by the Thailand Greenhouse Gas Management Organisation (Public Organisation) carbon footprint assessment.

(8) Summarising results and develop recommendations for reducing greenhouse gas emissions in the organisation's specific operations.

(9) Analysing the data based on basic average statistics. Average deviation to evaluate the variability in the carbon footprint of the organisation. Explain and categorise the qualitative data in order to analyse them as shown in Figure 2.

Results and Discussion

Analysis of Greenhouse Gas Emissions

The analysis of the greenhouse gas emissions assessment results from the activity data and the amount of greenhouse gas emissions of the Yala Rajabhat University, divided the greenhouse gas emissions into three scopes: Scope 1 direct GHG emissions, Scope 2 electricity indirect GHG emissions, and Scope 3 other indirect GHG Emissions.

Scope 1 (direct GHG emissions) of the university's greenhouse gas emissions, according to the Thailand Greenhouse Gas Management Organisation (TGO), consists of many categories. Yala Rajabhat University only operates on fuel consumption because the other categories do not occur at the university. The

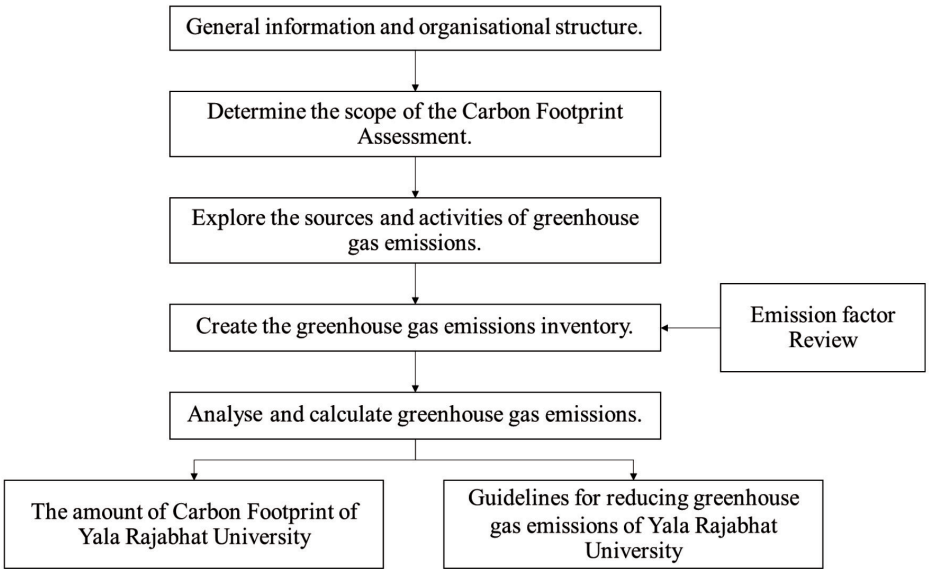

Figure 2: Methodology

data collected from Yala Rajabhat University reveals that the total fuel consumption, including mower trimmers and chole, and vehicles in the year 2020 amounted to 940 and 4,228 L/year. The fuel used is Gasohol 91, with a greenhouse gas emission of 2,058.22 and 9,257.63 kgCO2e/year. Meanwhile, large tractors and vehicles amounted to 700 and 5,577.73 L/year. The fuel used is diesel, with a greenhouse gas emission of 1,921.22 and 15,308.64 kgCO2e/year, as shown in Figure 3.

Scope 1 direct GHG emissions, showed the emissions of greenhouse gas directly from the Yala Rajabhat University between January to December 2020 which is from the total fuel consumption of Yala Rajabhat University in 2020 accounted for 28,545.71 $kgCO_2e$/year. Similarly, the annual equivalent in which the diesel-fuelled vehicle activity has more greenhouse gas emissions is 17,229.86 $kgCO_2e$/year as shown in Figure 4. The number of vehicles to use diesel fuel is more than vehicles using gasoline, and there are 14 diesel-powered vehicles and 5 gasoline-powered vehicles.

Scope 2 electricity indirect GHG emissions, showed that the volume of direct greenhouse gas emissions of the Yala Rajabhat University from January to December 2020 had the electricity consumption activity of the Yala Rajabhat University with electricity consumption up

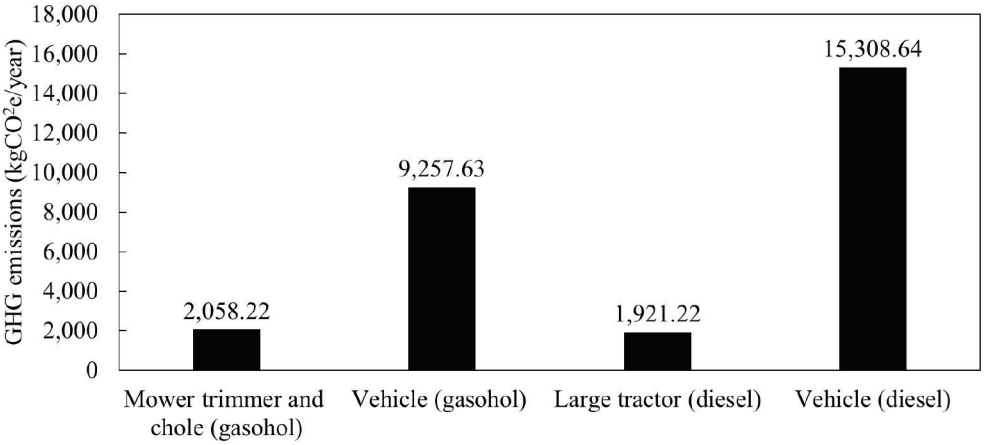

Figure 3: The amount of greenhouse gas emissions (Scope 1 Direct GHG emissions)

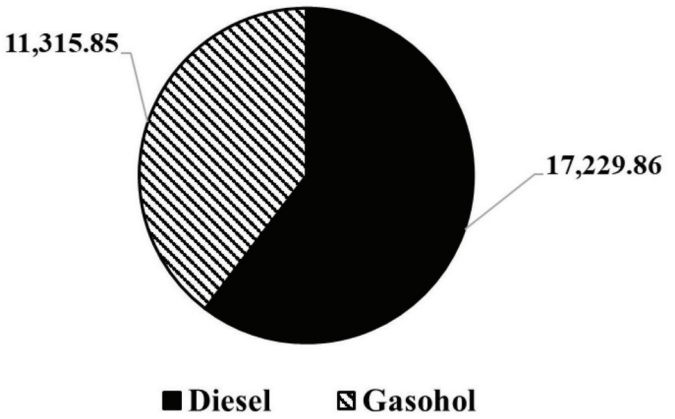

Figure 4: Amount of greenhouse gas emissions Scope 1, the direct greenhouse gas emissions of Yala Rajabhat University

to 2,898,292.02 kWh/year. In this case, it is represented by the amount of greenhouse gas emissions equal to 1,625,941.82 $kgCO_2e$/year. The results show that during March the highest electricity consumption was 349,233.01 kWh, accounting for the amount of greenhouse gas emissions equal to 195,919.72 $kgCO_2e$. However, the least amount of electricity consumption is April, and the electricity consumption is 137,913.00 kWh, accounting for releasing greenhouse gas with 77,369.19 $kgCO_2e$ due to the epidemic situation of COVID-19. In this case, the government-imposed lock down measures, resulting in no travel activity and reduced electricity cost. Therefore, it is the least valuable level in April and less than other months between April-July. When the COVID-19 situation started to improve from August onwards, the university began to open teaching in a normal format, increasing energy consumption. As a result, the amount of carbon dioxide emissions has increased as shown in Figure 5. In additional, the electricity used after COVID-19 from August until December 2020 was less than before the COVID-19 lockdown can be attributed to a combination of factors. Firstly, the continuation of remote learning and work arrangements has likely resulted in fewer individuals physically present on campus, leading to a diminished need for energy in classrooms and offices. Secondly, the curtailment or cancellation of various campus events and extracurricular activities during the pandemic has contributed to decreased demand for electricity associated with lighting, heating, cooling, and audio-visual equipment in event spaces.

Scope 3 (other indirect GHG emissions) of the organisation's greenhouse gas emissions, according to the Thailand Greenhouse Gas Management Organisation (TGO), consists of 15 categories. Yala Rajabhat University focuses on the waste generated in operations, as the remaining 14 categories do not occur at the university, and some of these categories are also included in Scopes 1 and 2.

Scope 3 (other indirect GHG emissions) showed the indirect greenhouse gas emissions of the Yala Rajabhat University in January to December 2020. It was found that the solid waste disposal activities of the Yala Rajabhat University by collecting and transporting the solid waste disposed of by a landfill method of Yala Municipality, generated greenhouse gas emissions of 182,144.76 $kgCO_2e$/year as shown in Table 1.

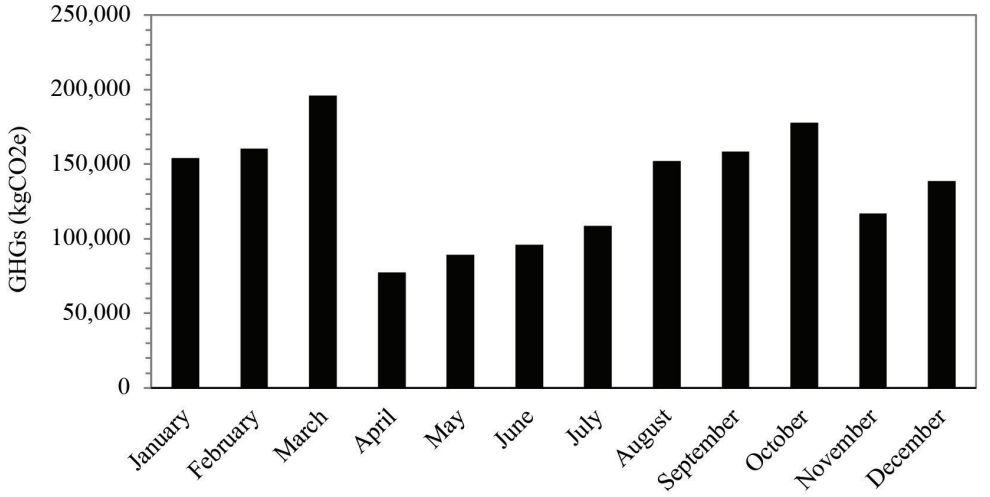

Figure 5: Amount of greenhouse gas emissions Scope 2, the indirect greenhouse gas emissions of Yala Rajabhat University

Table 1: The amount of indirect greenhouse gas emissions from solid waste disposal activities of the Yala Rajabhat University

Source of GHGs Emissions	The Amount of Solid Waste (kg/year)	Emission Factor	The Amount of GHGs Emissions ($kgCO_2e$/year)
Transportation of solid waste to a landfill	216,000	0.0705 $kgCO_2e$/ton-km	144.00
Transportation return from landfill	216,000	0.4461 $kgCO_2e$/km	107.16
Disposal via landfill	216,000	0.8421 $kgCO_2e$/kg	181,893.60
Total			**182,114.76**

Greenhouse gas emission assessment of the Yala Rajabhat University from January-December 2020 with all three scopes; Scope 1 direct GHG emissions, Scope 2 energy indirect GHG emissions, and Scope 3 other indirect GHG emissions are summarised. The GHG emissions from the Scope 2 indirect greenhouse gas emissions from electricity use were the highest, accounting for 88.53% whereas Scope 1 direct GHG emissions from the vehicle of universities was the lowest at 1.55% as shown in Figure 6 and Table 2. The most significant contribution to carbon dioxide emissions in Scope 2 was electricity consumption, consistent with the studies by Usubharatana *et al.* (2014), Maimun *et al.* (2018), Sudha *et al.* (2019), and Chainanis (2020). Puttipiriyangkul (2018) studied the assessment of carbon footprints and a reduction in greenhouse gases at Suranaree University of Technology. It was found that the highest greenhouse gas emissions came from Scope 2 activities, accounting for 66% of the total emissions. This was followed by Scope 1 and Scope 3 activities, accounting for 27% and 6%, respectively. Sikiwat *et al*. (2020) studied the greenhouse gas emissions by the Faculty of Public Health, which are 1,594 tonnes CO_2e/year. The highest emissions came from electricity consumption, general waste disposal, and water usage, with 1,470.97, 30.87, and 26.13 tonnes CO_2e/year, accounting for 92.3, 1.9, and 1.6%, respectively. Sriapai and Phoochinda (2021) studied the carbon footprint of an organisation and strategies for reducing greenhouse gas emissions at Ratchaphiphat Hospital, Bangkok. It was discovered that Scope 2 activities had the

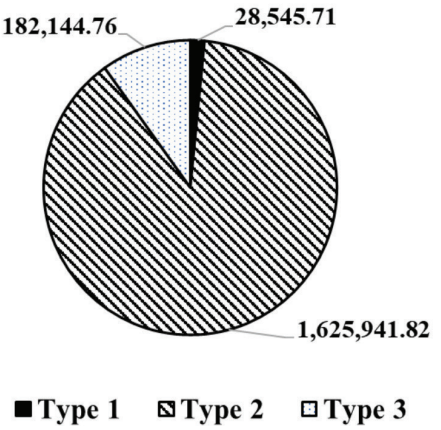

Figure 6: Amounts of greenhouse gas emissions from three scopes of the Yala Rajabhat University

highest greenhouse gas emissions at 48.43% of the total, followed by Scope 1 at 29.24%, Scope 3 at 13.40%, and additional reported scope at 8.93%. From the above, it can be confirmed that the majority of greenhouse gas emissions from each organisation stems from Scope 2, so the most urgent approach to addressing greenhouse gas reduction is for organisations to collaborate in reducing electricity consumption, leading toward a sustainable green organisation.

Guideline for Reducing Greenhouse Gas Emission of the Yala Rajabhat University

The greenhouse gas emissions assessment analysis from the activity data and the amount of greenhouse gas emissions of the Yala Rajabhat University show that highest greenhouse gas emissions from the Scope 2 indirect GHG emissions from the use of energy is equal to 1,625,941.82 $kgCO_2e$/year accounting for 88.53% of total greenhouse gas emissions. The largest amount of greenhouse gas emissions is generated by the use of electricity within the university, followed by Scope 3 other indirect greenhouse gas emissions from the transport of solid waste for disposal.

Therefore, guidelines should focus on the category with the most greenhouse gas emissions, reducing energy consumption, and the amount of waste generated within the university, as follows:

(1) Reducing greenhouse gas emissions in the form of energy management, such as scheduling to turn on and off the lights. Turn off the air conditioner and non-essential electrical equipment during the break from 12.00-13.00 and set the air conditioner no lower than 25°C turning off the air conditioner at least 15 minutes before the end of the workday. A twitching light switch should be installed to turn off lamps that are not in use and energy-saving lamps should be selected. The use of alternative energy sources, such as installing solar cells, should also be considered.

(2) Reducing greenhouse gas emissions in the form of environmental management, such as solid waste management through policy promotion using the 3Rs (Reduce, Reuse, Recycle) principle. Efforts should be made to separate organic solid waste for use in various fields, including fertilisation and fermentation for biogas production. Finally,

Table 2: Assessment results for three scopes of Yala Rajabhat University's greenhouse gas emissions

Scopes of GHG Emissions Activities	GHG Emissions Activities ($kgCO_2e$/year)
Scope 1 Direct GHG emission	
- Mower trimmer and chole (gasohol)	2,058.22
- Large tractor (diesel)	1,921.22
- Vehicle (gasohol)	9,257.63
- Vehicle (diesel)	15,308.64
Total of Scope 1	**28,545.71**
Scope 2 Energy indirect GHG emission	
- Electrical usage	1,625,941.82
Total of Scope 2	**1,625,941.82**
Scope 3 Other indirect GHG emissions	
- Solid waste disposal	181,893.60
- Solid waste transportation	251.16
Total of Scope 3	**182,144.76**
The total amount of GHG emissions of three scopes	**1,836,632.29**

planting trees is encouraged to reduce global warming.

(3) Reducing greenhouse gas emissions in the form of reducing fuel consumption, such as avoiding using the car unnecessarily. Efficient driving with a speed of not more than 90 kilometres per hour. The driver must inspect the condition and check the car regularly. Renewable energy such as biodiesel or gasohol should be selected, if possible.

Conclusions

The activity of greenhouse gas emissions of Yala Rajabhat University from January to December 2020. Scope 2 (indirect greenhouse gas emissions from electricity) is the highest among all three scopes, accounting for 88.53%, with the amount of greenhouse gas emissions equal to 1,625,941.82 $kgCO_2e$/year. Scope 1 (direct university greenhouse gas emissions) is the lowest, accounting for 1.55%, with greenhouse gas emissions equal to 28,545.71 $kgCO_2e$/year. Scope 3 (other indirect greenhouse gas emissions) from solid waste disposal of Yala Rajabhat University with the method of disposal landfill in Yala municipality, are the greenhouse gas emissions of 182,144.76 $kgCO_2e$/year.

Guidelines for reducing greenhouse gas emissions in energy management are crucial as they address the highest source of emissions. To achieve this, several measures can be taken, including (1) energy-saving in lighting and air conditioning, (2) solid waste management, and (3) fuel efficiency and renewable energy adoption. It is vital to maintain detailed records of greenhouse gas emissions from each university department. In-depth data analysis will facilitate more effective problem-solving and contribute to the future development of a sustainable green university.

The research significantly enhances the body of knowledge by offering practical and comprehensive guidelines for mitigating greenhouse gas emissions in the realm of university energy management. It focuses on a critical and urgent issue, emphasising the need for a multi-faceted approach. The inclusion of specific measures, such as energy-saving practices, waste management strategies, and the adoption of renewable energy sources, provides a tangible framework for institutions to follow.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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