Carbon footprint of educational institute:
case study at King Mongkut's University of Technology Thonburi

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Abstract:
This study aims to calculate GHG emission and removal from the related activities in KMUTT during 2011-2013. The scope of assessment was focused only in KMUTT Bangmod Campus, excluding resident halls and Darunsikkhalai School for Innovative Learning (DSIL). The GHG calculation in this study followed the guideline of carbon footprint for organization which divides GHG sources into 3 scopes such as direct GHG emission, indirect GHG emission from purchased energy and other indirect GHG emission (TGO). The activity data were collected from various sources. Fuel consumption and purchased electricity were provided from the Building and Ground Management Institute and Energy Environment Safety and Health (EESH). Water consumption, office supplies and wastes were provided from Treasury office and Prabkaya Recycle Company (Outsource). Results shows that total GHG emissions of KMUTT in 2011-2013 were 11,410, 11,072 and 11,275 tonCO$_2$e/year, respectively. The major sources of GHG emission were purchased electricity accounting for 87.45% of the total emissions, followed by waste (10.94%), transportation of KMUTT vehicle (1.23%), office suppliers (0.34%) and water (0.04%). In addition, GHG removal from waste recycling program (GHG offset) accounted only for 1% of the total GHG emissions. Thus, net GHG emissions per capita for 2011-2013 were 0.57, 0.54 and 0.56 tonCO$_2$e/year/staff and student, respectively. Electricity consumption and waste generation were the hotspots of GHG emission in KMUTT. Accordingly, the potential GHG reductions should be paid more attention to electricity conservation, waste utilization (waste composting) and waste reduction (3Rs).

Keywords: *King Mongkut's University of Technology Thonburi; Carbon Footprint of Organization; Greenhouse Gas emission; Carbon offset*

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1. Introduction

Nowadays, the impact of greenhouse gas (GHG) emissions from anthropogenic sources has been seriously concerned because GHGs are the significant key factors driving the climate change. Carbon Footprint of Organization (CFO) is a concept of estimating GHG emissions from activities of organizations. The benefits of CFO are to investigate the GHG emission baseline, determine the hot spots and finally lead to the GHG reduction potentials for the organization. There are several researches focusing on carbon footprint of Educational Institutes. For example, De Montfort University reported their CFO as 51,080 tonCO$_2$e per year or 2.00 tonCO$_2$e/staff and student/year (Ozawa-Meida et al., 2011). Norwegian University of Technology and Science (NTNU) reported their GHG emission as 92,000 tonCO$_2$e, or 3.61 tonCO$_2$e/staff and student/year (Larsen et al., 2011). In Thailand the department of engineer, Kasetsart University reported their CFO as 1,036.43 tCO$_2$e or 2.28 tCO$_2$e/staff and student/year (Pulpratin et al., 2011). In Thailand, the CFO has been conducted in many organizations such as Pollution Control Department, Charoen Pokphand Foods Public Company Limited, Siam City Cement Public Company Limited and etc., (TGO, 2013).

Among all educational institutes in Thailand, King Mongkut's University of Technology Thonburi (KMUTT) is a leader in Green University. In 2013, KMUTT was the 2nd in Thailand and the 38th in the world ranked by UI GreenMetric World Universities Ranking (2013). Several key performance indicators (KPIs) with different weighting used for scoring were energy and climate change (21%), wastes (18%), water (10%), transportation (18%) educations (18%), setting and infrastructures (15%). GHG emission and reduction policy were categorized in the topic of energy and climate change. Thus, annual GHG accounting is necessary to identify hotspots, propose GHG mitigation measures and follow up the implementing measures. Thus, this study aims to calculate GHG

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emission and removal from the related activities in KMUTT. The results of this study can promote Green University activities and support KPIs for Green University ranking in the future.

2. Methods

The activity data was collected from the related activities in KMUTT during 2011-2013. The scope of assessment was focused only in KMUTT Bangmod Campus, excluding resident halls and Darunsikkhalai School for Innovative Learning (DSIL). The numbers of staffs and students are shown in Table 1 the percentages of students and staffs were approximately 90 % and 10 %, respectively or the ratio of staffs and students in KMUTT was 1:9.

Table 1 Number of staffs and students in KMUTT during 2011-2013

Number (persons)	2011	2012	2013
Student	17,672	17,980	17,714
Staff	2,200	2,145	2,145
Total	19,872	20,125	19,859

The GHG calculation in this study followed the guideline of carbon footprint for organization assessment (TGO, 2011), which divides GHG sources into 3 scopes such as: **Scope 1**: direct GHG emissions from fuel consumption for KMUTT vehicles, **Scope 2**: indirect GHG emissions from purchased electricity, And **Scope 3**: other indirect GHG emissions such as water consumption, office supplies and wastes. The activity data were collected from various sources. Fuel consumption and purchased electricity were provided from the Building and Ground Management Institute and Energy Environment Safety and Health (EESH). Water consumption, office supplies and wastes were provided from Treasury office and Prabkaya Recycle Company (Outsource), respectively. GHG emission was calculated by multiplying emission factors with their activity data as shown in the following equation. The summation of greenhouse gas emission from all activities was reported as the carbon footprint of KMUTT. The lists of emission factors were presented in Table 2.

$$Greenhouse\ gas\ emission\ (CO_{2e}) = \Sigma(Activity\ data \times Emission\ factor) \tag{1}$$

Table 2 Emission factors used in this study (TGO**,** 2011)

Items	Unit	kgCO$_2$e/unit
Diesel	L	2.7446
Gasohol	L	2.0999
Electricity	kWh	0.5610
Tap water	m^3	0.0264
Paper	kg	0.7350
Toilet paper	kg	1.4700
Sanitary bag	kg	1.5200
Ink of printer	kg	2.5000
Waste	kg	2.3200
Glass	kg	1.1870
Plastic	kg	3.7700
Metal	kg	4.4315

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3. Results and discussion

Result shows that GHG emissions of KMUTT during 2011-2013 were not much different. Total GHG emissions of KMUTT in 2011-2013 were 11,410, 11,072 and 11,275 tonCO$_2$e/year, respectively. While GHG removals from waste recycling were 66.98, 104.21 and 112.40 tonCO$_2$e/year, respectively. In Fig. 1, net GHG emissions per capita were 5.16, 5.11 and 5.20 tonCO$_2$e/year/staff, or 0.64, 0.61 and 0.63 tonCO$_2$e/year/student and 0.57, 0.54 and 0.56 tonCO$_2$e/year/staff and student, respectively. However, it is found that the GHG emissions per student and staff in this study were much lower than the studies in De Montfort University and Norwegian University. This is due to different sources of GHG accounting. For example, De Montfort University included GHG emissions from water treatment and travelling of staffs. Norwegian University accounted GHG emissions from medical instruments which were used in the faculty of medicine. Due to the limitation of data acquisition for GHG accounting in KMUTT, the complete database and GHG calculation tools should be developed by following the TGO's guidelines.

In Fig. 2(A), the major sources of GHG emission in 2013 were purchased electricity accounting for 87.45% of the total emissions, followed by wastes (10.94%), transportation of KMUTT vehicle (1.23%), office suppliers (0.34%) and water (0.04%). Thus, electricity consumption and waste generation were the hotspots of GHG emission in KMUTT. The electricity was mainly consumed for air conditioning and lighting in classrooms and activities related to students. Similar to electricity, wastes generated in KMUTT were mainly from students activities. Thus, CFO reduction should be focused on conservation of electricity, energy efficiency improvement in lighting and air conditioning systems, waste reduction and waste recycling. Although these measures have been implemented in KMUTT, the participations are still insufficient. Awareness raising and incentive measures should be proposed to encourage more students and staffs participate in the GHG reduction and GHG offset programs. In Fig. 2(B), GHG removals in 2013 were mainly from plastics (67%) followed by glass (12%), paper (11%) and metal (10%). It is noticed that GHG removal was only for approximately 1% of the total GHG emissions. This study forecasted that if the GHG offset increases 10%, the GHG emissions of KMUTT will be reduced 1,124 tonCO$_2$e/year or 0.06 tonCO$_2$e/year/staff and student.
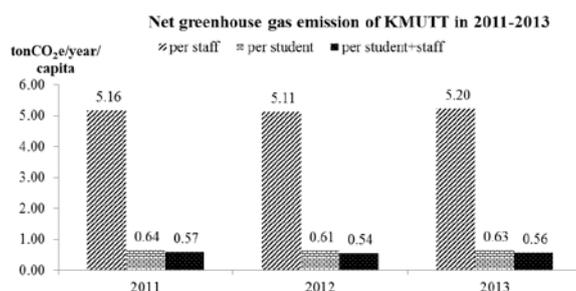

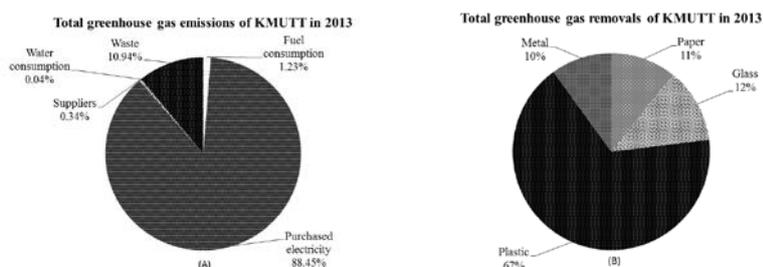**Fig. 1** Net GHG emission per capita of KMUTT in 2011– 2013.

Fig. 2 Total GHG emissions (A) and total GHG removals of KMUTT in 2013 (B).

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4. Conclusion

The GHG emissions of KMUTT in 2011-2013 were 11,410, 11,072 and 11,275 tonCO$_2$e/year, or 0.57, 0.55 and 0.57 tonCO$_2$e/year/staff and student, respectively. Due to the limitation of data acquisition for GHG accounting in KMUTT, the centralized database and GHG calculation tool should be developed. Electricity consumption and waste generation were major hotspots of GHG emission in KMUTT. Accordingly, the potential GHG reductions should be paid more attention to electricity conservation, waste utilization (waste composting) and waste reduction (3Rs). The results from this study will be useful information for Green University project and support KPIs of Green University ranking in the future.

5. Acknowledgement

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