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The carbon footprint assessment from electricity of undergraduate students at Mahidol University Amnatcharoen Campus for Eco University

Kulsuwan, P.[1*], Sirisathit, P.[2] and Srisuwan, C.[3]

Innovation for Social and Environmental Management Program, Mahidol University Amnatcharoen campus, Thailand.

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Abstract The assessment of carbon dioxide equivalent emissions per year in study class resulted to assess the students for a total of carbon dioxide emissions at 1,784.32 ton CO_2/Capital, with an average of 1.64 ton CO_2 /Capital/person. The consideration by year class of study found that the year class with highest amount of carbon dioxide equivalent emissions was the 2nd year,which averaged 767.52 ton CO_2/Capital including 2 programs: Bachelor of Public Health Program and Bachelor of Science Program in Agriculture. The knowledge on electrical energy usage of the students showed the most of aware in "maintenance of electrical appliances helps to save energy", and followed by the knowledge that "put too many stuffs in the refrigerator will cause to consume more power than usual" and "electricity generation in Thailand does not use fuel". The behavioral aspect found that the electrical energy usage behavior of students was recorded at often level consume. The information obtained from this research is expected to be a guideline for creating a policy to conserve electrical energy and reduce carbon dioxide emissions at Mahidol University Amnatcharoen Campus.

Keywords: Carbon footprint, electrical energy usage behavior, greenhouse gas

Introduction

Climate Change mainly is caused by emission of greenhouse gases in the atmosphere that is increasing in volume caused by human activities directly and indirectly. The increase in greenhouse gas results in changes in the composition of the earth's atmosphere (Ratha, 2011) Greenhouse gases are natural gas and caused by human activities. (Thanacharoenchanapas, 2015). The global climate change is a key for many countries to establish a policy to reduce greenhouse gases in the atmosphere in various ways, including Kyoto Protocol on carbon taxes determination, and determination of measures show the amount of greenhouse gas of products, etc. Therefore, preparation of calculation of greenhouse gas emissions is considered to be one of the beginning ways to

* **Corresponding Author:** Kulsuwan, P.**; Email:** patticha.kul@mahidol.ac.th

solve environmental problems. In calculating the greenhouse gas emissions in Thailand, there are divided into 3 types:- carbon footprint emissions in forms of Carbon Footprint of Product, Carbon Footprint of Organization and Carbon Reduction Label. The Carbon Footprint of Organization refers to the greenhouse gas emissions and removals from various activities of the organization, such as fuel combustion, electrical energy use, waste disposition and transportation (Khumsap, 2016).

The Mahidol University Amnatcharoen Campus has a policy to focus on reducing the use of various resources, which is aimed to become an eco-university. The key principle is to use natural resources efficiently as a low carbon society, in various projects such as garbage bank, refraining from using foam boxes in university area, etc. In addition, there is an increase in construction from the expansion of the university, resulted in a high number of students and resource usage. Reducing the use of resources may not be concerned the best solution for environmental problems but how to maximize the use and minimize waste to the environment. If the environment is good, it will be good health.

Therefore, The carbon footprint Assessment from Electricity of Undergraduate Students Mahidol University Amnatcharoen Campus for Eco Universitywas to prepare a database for using resources to emit greenhouse gases and will be used to plan the efficient resource management and reduction of greenhouse gas emissions to towards a low carbon society. And in the future, there should be a link to the surrounding communities and collaborative networks of the university to become an eco-town, and emphasizing the use of available resources to maximize benefit with least environmental impact to achieve sustainable development.

Materials and Methods

Population and samples

Students who studied at Mahidol University Amnatcharoen Campus, in 2nd semester of academic year 2017, which consisted of 126 students in Bachelor of Public Health Program and 31 students in Bachelor of Science Program in Agriculture . The samples were calculated by using purposive sampling and calculation according to Yamane's formula to determine the sample size (Yamane, 1973) as follows:-

$$n = \frac{N}{1+Ne^2}$$

Where, e is the error of the samples
N is the size of the population
n is the size of the samples with an error of 95%

$$\text{Samples} = \frac{157}{1+ (157 \times 0.05)} = 147$$

Create and find quality of methods

Questionnaire on The carbon footprint Assessment from Electricity of Undergraduate Students Mahidol University Amnatcharoen Campus for Eco University, with closed-ended questions consisting of Part 1: General information of respondents, Part 2: Inquire on electrical energy usage, Part 3: Inquire on knowledge of electrical energy usage, and Part 4: Inquire on electrical energy usage behavior, the criteria for interpretation is as follows. The average score of 4.51 - 5.00 means the students had the behavior at a regular level, the average score of 3.51 - 4.50 means students had the behavior at a frequent level, the average score of 2.51 - 3.50 means that students had the behavior at sometimes level, the average score of 1.51 - 2.50 means that the students had the behavior at rarely level. and the average score of 1.00 – 1.50 means that the students had the behavior at never level (Srisa-at, 2002).

Creating and determining quality of tools used in the research on The carbon footprint Assessment from Electricity of Undergraduate Students Mahidol University Amnatcharoen Campus for Eco University are as the following steps: 1. Study data about the carbon footprint Assessment from Electricity, 2. Prepare an outline of the questionnaire on The carbon footprint Assessment from Electricity of Undergraduate Students Mahidol University Amnatcharoen Campus for Eco University, 3. Determine a content validity of the questionnaire, determine the Index of Item - Objective Congruence (IOC) of each question in order to review the research methodology, consistency and association of questions on content and objectives, 4. Determine validity by having the experts to check the questionnaire to consider the structure of the questionnaire, content suitability and suitability of the content used for improvement before being applied to non-actual samples with 5 experts examining, 5. Improve the questionnaire according to advice of the experts and 6. Determine reliability. The researcher tried out the questionnaire with a sample group with the same characteristics as the actual sample group, 10 persons, to check if each question can be interpreted directly and appropriately and then to be improved correctly and calculated to determine the reliability by using the Cronbach's coefficient alpha formula.

Data collection

This research the two types of data was collected : 1)Secondary data collection is to collect data as an supplementary information to the research, studying information from books, journals, articles, academic papers and various related websites to be used as a guideline for this research on the part of assessment of carbon footprint from the use of electrical energy and energy consumption behaviour and 2) Primary data collection Is a collection of data using the questionnaire of The carbon footprint Assessment from Electricity of Undergraduate Students Mahidol University Amnatcharoen Campus for Eco University.

Data analysis

Quantitative data analysis Data analysis in this research includes descriptive statistics, percentages, mean, standard deviation and Calculation for CO_2 emission analysis is based on the formula as below. step 1 calculate for the power, step 2 calculate for the electrical energy used and step 3 calculate for CO2 Emission.

*Note: Emission factor of electrical energy consumption = 0.5610 (Greenhouse Gas Management Organization, 2010).

Results

Knowledge on electrical energy usage

Result revealed that the knowledge on electrical energy usage of students, 70% –students gave the correct answer and 30% gave the wrong answer (Table 1). The question-by-question basis found that the most students gave correct in "maintenance of electrical appliances helps to save energy", averaged 89.80 percent, and followed by " put─too many stuffs in the refrigerator will consume more power than usual", averaged 82.80 percent, and "electricity generation in Thailand does not use fuel", averaged 79.60 percent. The least number gave the correct answer was "fluorescent lamps consume more power than incandescent lamps", which averaged 53.50 percent.

Electrical energy usage behavior of students

Result revealed that the electrical energy usage behavior of students was averaged 3.67. It was found that the most frequently performed behavior

was “you will notify to replace the lamp if you find that the lamp is damaged” which averaged 4.88, and followed by “you will not put any hot or warm food in the refrigerator” averaged 4.77 and “when you leave the room, you explore the power plug and remove it every time” and “if turn on the air conditioner, it will close the electric fan immediately” averaged 4.64. The least frequently performed behavior was “you do not wipe your hair to be dried before using the hair dryer” averaged 2.09 (Table 2).

Table 1. Number and percentage of students classified by knowledge on electrical energy usage (n = 157)

Knowledge on electrical energy usage	**Correct Answer**		**Wrong Answer**	
	Number (persons)	**Percentage**	**Number (persons)**	**Percentage**
Put too many stuffs in the refrigerator will consume more power than usual.	130	82.80	27	17.20
Spraying fabrics with too much water saves electrical energy upon iron.	98	62.40	59	37.60
Turn off ~~a~~ TV with ~~a~~ remote, the TV still consumes power.	121	77.10	36	22.90
Electrical appliances with a lot of wattage consume a lot of energy.	87	55.40	70	44.60
Leaving a notebook or mobile phone battery charger plugged causes electrical power consumption.	114	72.60	43	27.40
Fluorescent lamps consume more power than Incandescent lamps.	84	53.50	73	46.50
The 2-door refrigerator consumes more power than a single-door refrigerator in the same size.	88	56.10	69	43.90
Items in the refrigerator with a lot of ice formed in the icebox take long time to be cold or are not cold much.	111	70.70	46	29.30
Maintenance of electrical appliances helps to save energy more.	141	89.80	16	10.20
Electricity generation in Thailand does not use fuel.	125	79.60	32	20.40
Mean		**70.00**		**30.00**

Table 2. Mean and standard deviation of electrical energy usage behavior (n = 157)

Electrical energy usage behavior	$\overline{X}$	S.D.	Level
You set the time for turning off the computer display when not in use for more than 15 minutes	3.30	0.90	sometimes
You switch off the computer screen when not in use.	4.51	0.78	regularly
When you leave the room, you explore the power plug and remove it every time	4.64	0.71	regularly
You unplug the kettle if you find the water has been boiled.	2.69	1.66	sometimes
You will turn off the lights in the bathroom every time you finish using.	4.29	0.87	frequently
You will notify to replace the lamp if you find that the lamp is damaged.	4.88	0.46	regularly
When you find that someone has left the light turned on, you will close immediately.	3.50	1.36	sometimes
You close and unplug the computer after using	4.20	0.75	frequently
When you find that the door is open, you will immediately close to reduce the work load of the air conditioner.	4.01	1.40	frequently
You do not wipe your hair to be almost dried before using the hair dryer.	2.09	1.52	rarely
You will not put any hot or warm food in the refrigerator.	4.77	0.63	regularly
Setting the air conditioning temperature not less than 25 degrees is to save electricity in the workplace.	4.36	1.20	requently
You leave the air conditioner on so that you will feel cold when you enter the room	2.27	1.67	rqrely
You often keep the refrigerator door open while you want to drink cold water from the refrigerator.	3.36	1.70	sometime
You turn off the TV with the remote-control system without switching off at the TV.	3.50	1.61	sometime
You will recommend other people how to use electricity economically.	3.36	1.60	frequently
You use a lamp at the desk or set a lamp at specific point instead of turning on light for the entire room.	2.80	1.70	sometimes
You leave the TV on.	3.45	1.86	sometimes
If turning on the air conditioner, I will close the fan immediately.	4.64	0.66	regularly
You open the refrigerator for a long time each time.	2.50	1.67	rarely
Total average	**3.67**	**0.23**	**frequently**

Assessment of carbon dioxide equivalent emissions per student year class

The results of the study, it is estimated that the total carbon dioxide emissions of students was 1,784.32 ton CO_2/capital, with an average of 1.64 ton CO_2/Capital/person. And considering by year class of study, it is found that the year class with highest amount of carbon dioxide equivalent emissions is the 2nd year, at 767.52 ton CO_2/Capital (including 2 programs), followed by the 3rd year with carbon dioxide equivalent emissions at 657.54 ton CO2 / Capital (including 2 programs). The year class with lowest carbon dioxide equivalent emissions is the 4th year (including 1 program) at 357.16 ton CO_2 /Capital.

Discussion

Based on the results of the study, it is estimated that the total carbon dioxide emissions of students was 1,784.32 ton CO_2/capital .The year class with lowest carbon dioxide equivalent emissions is the 4th year, making it possible to use for planning for managing to reduce greenhouse gas emissions in the future in accordance with the research of Usuparat and Phuengrasamee (2014) finding that the total carbon footprint of 34,355 tons of carbon dioxide equivalent enabled the organization to use as a database for analyzing the use of resources and pollution emissions to the environment and use for planning and managing to reduce greenhouse gas emissions in the future.

For the knowledge about electrical energy usage of the students in overall, 70% of students gave the correct answer and 30% of them gave the wrong answer. On a question-by-question basis, the one which most of them gave a correct answer is “Maintenance of electrical appliances helps to save energy”. And the electrical energy usage behavior of students in overall was at often level. When considering each item, it was found that the most frequently performed behavior is “You will notify to replace the lamp if you find that the lamp is damaged”. This is consistent with Marans and Edelstein (2010) where the study results showed that the behavior and attitude on energy conservation could be adjusted to be better, and Chantakham (2006) finding that the samples had an supportive attitude towards energy conservation and media exposure behavior and participation in energy conservation activities at frequent level.

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