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The carbon footprint assessment from electricity in Amnatcharoen Province, Northeastern Thailand

Kulsuwan, P.[*] and Sirisathit, P.

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

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Abstract The carbon footprint assessment dioxide equivalent emissions per year resulted to assess the population for a total of carbon dioxide emissions at 3,663 ton CO_2/Capital, with an average of 1.85 ton CO_2 /Capital/person. The consideration by sex of study found that sex with highest amount of carbon dioxide equivalent emissions was female which averaged 1,896 ton CO_2/Capital. by age range of study found that age range with highest amount of carbon dioxide equivalent emissions was 31-45 years, 892 tons CO_2/Capital. The knowledge on electrical energy usage of the population showed the most of aware in "items in the refrigerator with a lot of ice formed in the icebox take long time to be cold or are not cold much" , and followed by the knowledge that "maintenance of electrical appliances helps to save energy", and " electrical appliances with a lot of wattage consume a lot of energy ". The behavioral aspect found that the electrical energy usage behavior of population was recorded at often level consume. The information obtained from this research is proposed to be a guideline for creating a policy to conserve electrical energy and reduced carbon dioxide emissions in Amnatcharoen province, Northeastern Thailand.

Keywords: Carbon footprint, Electricity usage behavior, Greenhouse gas

Introduction

The climate change is a phenomenon that occurs as a result from human activities, a changes the composition of the Earth's atmosphere both directly and indirectly. The major cause of climate change is burning fossil fuels, an important source of energy in industrial development. Therefore, the climate change can generate the greenhouse effect or global warming by increasing the concentration of greenhouse gases in the atmosphere (Greenhouse Gas Management Organization, 2010).The carbon footprint assessment is an environmental management tool used to evaluate the efficiency of environmental performance in terms of greenhouse gas emissions. The carbon footprint assessment showed the amount of greenhouse gas emissions data and

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

measured the overall carbon dioxide equivalents to burning fuels, the usage of electric power, waste management and transportation (Greenhouse Gas Management Organization, 2010). This leads to the formulation of management guidelines to reduce greenhouse gas effectively. The carbon footprint Assessment from Electricity in Amnatcharoen Province of Northeastern Thailand was conducted to prepare a database for using resources to emit greenhouse gases, and used to plan the efficient resource management and reduction of greenhouse gas emissions towards a low carbon society. The objectives were to investigate the carbon footprint Assessment from Electricity usage in habitation, and to study electrical energy usage behavior of the population in Amnatcharoen Province of Northeastern Thailand.

Materials and methods

Population and samples

People living in Sirisenang Subdistrict Senangkhanikhom District, Amnat Charoen province are covered 6,352 peoples in 1,584 households which used the simple random sampling from representatives of each household 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%

$$\text{Samples} = \frac{1,584}{1+ (1,584) \times (0.05)^2} = 319$$

Create and find quality of methods

Questionnaire on The carbon footprint assessment from electricity in Amnatcharoen Province , Northeastern Thailand, 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 behaviour, the criteria for interpretation. The average scores of 4.51 - 5.00 means people had the behavior at a regular level, the average score of 3.51 - 4.50 means people had the

behavior at a frequent level, the average score of 2.51 - 3.50 means that people had the behavior at sometimes level, the average score of 1.51 - 2.50 means that the people had the behavior at rarely level, and the average score of 1.00 – 1.50 means that the people had the behavior at never level (Srisa-at, 2002).

Creating and determining quality of tools was used in the research on the carbon footprint Assessment from Electricity in Amnatcharoen province, Northeastern Thailand which were used 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 in Amnatcharoen Province of Northeastern Thailand, (3) determine a content validity of the questionnaire, and the Index of Item - Objective Congruence (IOC) of each question 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 questionnaire with a sample group was done with the same characteristics as the actual sample group, 20 persons, if each question can be interpreted directly and appropriately to correctly improve and calculated to determine the reliability by using the Cronbach's coefficient alpha formula.

Data collection

This Two types of data were collected as secondary data collection that collected data for supplementary information, studied information from books, journals, articles, academic papers and various related websites to be used as a guideline for this research as the part of assessment of carbon footprint from the use of electrical energy and energy consumption behaviour and primary data collection was collected by using the questionnaire of the carbon footprint assessment from electricity in Amnatcharoen Province, Northeastern Thailand.

Data analysis

Quantitative data analysis included descriptive statistics, percentages, mean, standard deviation and Calculation for CO_2 Emission Analysis. CO_2 emission analysis was calculated which based on the formula below. Step 1 calculated for the power, step 2 calculated for the used electrical energy and ste3p calculated for CO_2Emission. Emission factor of electrical energy consumption is 0.5610 (Greenhouse Gas Management Organization, 2010).

Results

Knowledge on electrical energy usage

Result revealed that the knowledge on electrical energy usage. 64.88% population gave the corrected answer and 35.12 % gave the wrong answer (Table 1). The question-by-question basis found that the most people gave corrected in "Items in the refrigerator with a lot of ice formed in the icebox take long time to be cold or are not cold much", which averaged of 89.02% and followed by "maintenance of electrical appliances helps to save energy more" averaged of 75.86 %. And "electrical appliances with a lot of wattage consume a lot of energy". The averaged of 75.23 %. The least number gave the corrected answer was "fluorescents lamps consume more power than incandescent lamps" which averaged of 33.85 % percent.

Table 1. Number and percentage of people, classified by knowledge on electrical energy usage (n = 319)

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.	198	62.06	121	37.94
Spraying fabrics with too much water saves electrical energy upon iron.	155	48.58	164	51.42
Turn off ~~a~~ TV with ~~a~~ remote, the TV still consumes power.	196	61.44	123	38.56
Leaving a notebook or mobile phone battery charger plugged causes Electrical appliances with a lot of wattage consume a lot of energy. electrical power consumption.	221	69.27	98	30.73
Fluorescent lamps consume more power than Incandescent lamps.	240	75.23	79	24.77
The 2-door refrigerator consumes more power than a single-door refrigerator in the same size.	108	33.85	211	66.15
Items in the refrigerator with a lot of ice formed in the icebox take long time to be cold or are not cold much.	214	67.08	105	32.92
Maintenance of electrical appliances helps to save energy more.	284	89.02	35	10.98
Electricity generation in Thailand does not use fuel.	242	75.86	77	24.14
	212	66.45	107	33.55
Total average		**64.88**		**35.12**

Table 2. Mean and standard deviation of electrical energy usage behavior (n = 319)

Electrical energy usage behavior	$\overline{X}$	S.D.	Frequency
You set the time for turning off the computer display when not in use for more than 15 minutes	2.86	0.75	sometimes
You switch off the computer screen when not in use.	4.49	0.79	frequently
When you leave the room, you explore the power plug and remove it every time	4.84	0.84	regularly
You unplug the kettle if you find the water has been boiled.	2.96	1.58	sometimes
You will turn off the lights in the bathroom every time you finish using.	4.91	0.89	regularly
You will notify to replace the lamp if you find that the lamp is damaged.	4.82	0.53	regularly
You will not put any hot or warm food in the refrigerator.	4.17	0.96	frequently
When you find that someone has left the light turned on, you will close immediately.	3.92	1.28	frequently
You close and unplug the computer after using		0.71	sometimes
When you find that the door is open, you will immediately close to reduce the work load of the air conditioner.	3.10 4.20	1.32	frequently
You do not wipe your hair to be almost dried before using the hair dryer.		1.01	
Setting the air conditioning temperature not less than 25 degrees is to save electricity in the workplace.	1.95	0.95	rarely
You leave the air conditioner on so that you will feel . cold when you enter the room	4.62	1.01	requently
You often keep the refrigerator door open while you want to drink cold water from the refrigerator.	2.13	1.50	rarely
You turn off the TV with the remote-control system without switching off at the TV.	3.54		frequently
You will recommend other people how to use electricity economically.	4.59	1.30	
You use a lamp at the desk or set a lamp at specific point instead of turning on light for the entire room.	4.86	0.96	regularly
You leave the TV on.	3.12	1.20	regularly
	4.45	1.02	sometimes
			frequently
If turning on the air conditioner, I will close the fan immediately.	4.05	0.66	frequently
You open the refrigerator for a long time each time.	2.64	1.52	sometimes
Total average	**3.81**	**0.76**	**frequently**

Electrical energy usage behavior of people

Result revealed that the electrical energy usage behavior of people were averaged 3.81. It was found that the most frequently performed behavior was "You will turn off the lights in the bathroom every time you finish using". which averaged 4.91 and followed by "You will recommend other people how to use electricity economically" which averaged 4.86. The least frequently performed behavior was " You do not wipe your hair to be almost dried before using the hair dryer" which averaged of 1.95 (Table 2).

Assessment of carbon dioxide equivalent emissions

The results estimated that the total carbon dioxide emissions of people were 3,663 ton CO_2/Capital, with an average of 1.85. ton CO_2/Capital/person. The consideration by sex of study found that sex with highest amount of carbon dioxide equivalent emissions was female which averaged 1,896 ton CO_2/Capital. The age ranged of study found that age ranged with highest amount of carbon dioxide equivalent emissions was 31-45 year 892 ton CO_2/Capital. And followed 16-30 year 638 ton CO_2/Capital.

Discussion

Based on the results, it is estimated that the total carbon dioxide emissions of students was 3,663 ton CO_2/capital. The carbon footprint Assessment dioxide equivalent emissions per year resulted to assess the population for a total of carbon dioxide emissions at 3,663 ton CO2/Capital, with an average of 1.85 ton CO2 /Capital/person. The consideration by sex of study found that sex with highest amount of carbon dioxide equivalent emissions was female which averaged 1,896 ton CO2/Capital. By age range of study found that age range with highest amount of carbon dioxide equivalent emissions was 31-45 year 892 ton CO2/Capital, 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) found 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 and Kulsuwan (2019) finding that the total carbon footprint at 1,784.32 ton CO_2/Capital, with an average of 1.64 ton CO_2 /Capital/person.

For the knowledge about electrical energy usage of the students in overall, 64.88% of students gave the corrected answer and 35.12% of them gave the wrong answer. On a question-by-question basis, the one which most of them gave a corrected answer was "You will turn off the lights in the bathroom every time you finish using". The electrical energy usage behavior of people in overall was found often level. When considering each item, it was found that the most frequently performed behavior was recommended the other people how to use electricity economically. This is consistent with Marans *et a*l. (2010) who stated that the behavior and attitude on energy conservation could be adjusted to be better, and Chantakham (2006) reported that the samples had an supportive attitude towards energy conservation and media exposure behavior and participation in energy conservation activities at frequent level.

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.

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