

PAPER • OPEN ACCESS

## Carbon footprint analysis for Sunway University campus

To cite this article: A Devandran *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **765** 012062

View the [article online](#) for updates and enhancements.

### You may also like

- [A double win: new pathways to reduce greenhouse gas emissions and improve water quality in New Zealand](#)

Mario A Fernandez and Adam J Daigneault

- [What is the potential of cropland albedo management in the fight against global warming? A case study based on the use of cover crops](#)

Dominique Carrer, Gaétan Pique, Morgan Ferlicoq et al.

- [The contribution of carbon dioxide emissions from the aviation sector to future climate change](#)

E Terrenoire, D A Hauglustaine, T Gasser et al.



The Electrochemical Society  
Advancing solid state & electrochemical science & technology

242nd ECS Meeting

Oct 9 – 13, 2022 • Atlanta, GA, US

Abstract submission deadline: **April 8, 2022**

Connect. Engage. Champion. Empower. Accelerate.

**MOVE SCIENCE FORWARD**



Submit your abstract



## Carbon footprint analysis for Sunway University campus

A Devandran<sup>1\*</sup>, M Dewika<sup>1</sup>, J NorRuwaida<sup>2</sup>, Y Y Sara<sup>3</sup>  
and M P Khairunnisa<sup>2</sup>

<sup>1</sup> Centre of American Education, Sunway University, Bandar Sunway, 47500 Selangor, Malaysia.

<sup>2</sup> Air Resources Research Laboratory, Malaysia Japan International Institute of Technology, 54100 UTM Kuala Lumpur, Malaysia.

<sup>3</sup> School of Environmental Engineering, University Malaysia Perlis, 02600 Arau, Perlis, Malaysia

E-mail: devana@sunway.edu.my

**Abstract.** Carbon footprint can be quantified from the emission of carbon dioxide gas (CO<sub>2</sub>) through human activities, whereby it has impacted the environment. Burning of crude oil as a main source of fuel for combustion to provide energy for transportation and electricity production, releases various Greenhouse gas (GHG), mainly CO<sub>2</sub> gas. Hence, a study was conducted at Sunway University to calculate its carbon emission from electricity consumption and transportation usage by campus dwellers (Sunwayians) whereby CO<sub>2</sub> equivalent (CO<sub>2</sub>eq) computations were performed on monthly electricity consumption for the year 2018 till 2019 and the number of vehicles parked within the campus. Behavioural and awareness studies were performed based on survey questionnaires. Results indicated that the total Carbon Footprint from CO<sub>2</sub> emission for electricity consumption were 10,369 MTCO<sub>2</sub>eq and 10,005 MTCO<sub>2</sub>eq for year 2018 and 2019, respectively while emission from transportations scored 0.383 MTCO<sub>2</sub>eq per day. The survey showed that a significant correlation between Sunwayians and awareness on sustainable activities on campus. The results of CO<sub>2</sub> equivalent for Sunway University would serve as a baseline study for future target setting and strategies in Carbon Footprint for the University management near future.



## 1. Introduction

In accordance with Kyoto Protocol, Greenhouse gas (GHG) is identified as a combination of six different types of gases, such as, carbon dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFC's), perfluorocarbons (PFC's) and sulphur hexafluoride (SF<sub>6</sub>) [1]. Among all of these six gases, CO<sub>2</sub> gas is at the top of the list as it is emitted from various human activities and the CO<sub>2</sub> gas emission can be quantified as Carbon Footprint by converting it to carbon dioxide equivalent (CO<sub>2</sub>eq).

Activities such as production and packaging of food, transportation, manufacturing of goods, medical treatment and applications, building residential and industrial area, releases huge amount of GHG's leaving a huge trail of Carbon Footprint. It was reported by IPCC that, since the end of 19<sup>th</sup> century, the CO<sub>2</sub> emission to the atmosphere has increased by 40%, especially from fossil fuel combustion with an increase of approximately 1°C of global warming temperature above pre-industrial level (IPCC, 2018). Consumption of electricity (energy source), considerably the largest sector, which is a necessity in human life, for household and workplace consumption with the current advancement in technological gadgets, emits a remarkable amount of CO<sub>2</sub> as a source of power generation, is from the combustion of fossil fuel and coal. The second largest emission of CO<sub>2</sub> comes from transportation whereby, usage of many type of vehicles which runs on hydrocarbon products or generally called as automobile fuel [2].

Like many developing countries, Malaysia has pledged to United Nations Framework Convention on Climate Change (UNFCCC) to reduce the CO<sub>2</sub> emission to a range between 40-45% before 2050, which corresponds to Paris Accord where the global temperature rise is capped at 1.5 °C for the coming century [3]. Many studies and research have been conducted to identify sustainable development solutions at different levels, from society, industries, higher educational institutions and others sectors to reduce carbon footprint [4].

Sustainability initiatives taken by Universities usually follows the two most established and globally recognised University ranking tools. Firstly, the UI Green Metric™ World University ranking that takes into consideration of Environment, Economy and Social framework towards a green and sustainable University. The other is Sustainability Tracking, Assessment and Rating System™ (STARS) which is a self-reporting framework that measures the sustainability performance of Universities especially for those taking their first steps in the implementation of sustainable goals [5][6]. Public Universities in Malaysia, such as University Technology Malaysia (UTM), University Putra Malaysia (UPM) and University Malaysia Sabah had

participated in UI Green Matric ranking to evaluate their sustainable initiatives and framework [7][8].

The motivation of this study is to identify areas which needs to be improvised to reduce the emission of CO<sub>2</sub> gas and assess the behaviour of staffs and students as higher education institutions and schools would be the ultimate place to cultivate awareness and instil social responsibility towards sustainable practises which would indirectly convey the message to the community at large.

## 2. Research Methodology

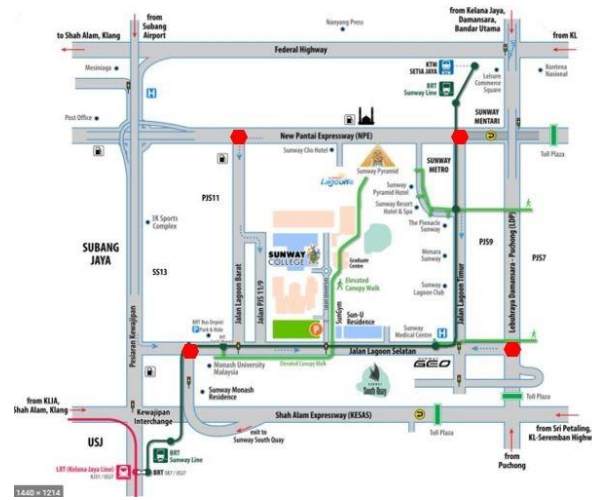
Two major factors contributing to campus Carbon Footprint, mainly from electricity consumption and emission from transportation fuel is choose to be analysed by applying a calculating tool to estimate the total CO<sub>2</sub> emission as metric ton of carbon equivalent.

Carbon Footprint from electricity usage was estimated by using formula (1) as indicated in the table 1 below with the secondary data on monthly electricity bill from North and South buildings together with New University Building which was collected from Facilities Department for the year 2018 and 2019.

**Table 1:** Source of Electricity Emission Factor.

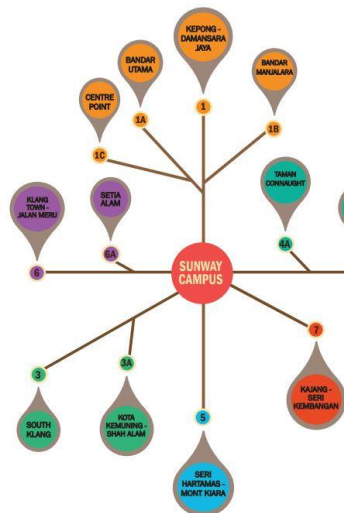
Variables	Formula	
Electricity consumption	<b>CO<sub>2</sub> = Amt X E<sub>EF</sub> (1)</b>	E <sub>EF</sub> value:
	<b>CO<sub>2</sub> = CO<sub>2</sub> equivalent in metric ton (MTCO<sub>2</sub>eq)</b>	0.672 MTCO <sub>2</sub> eq per MW/hr
	<b>Amt = Average Monthly Electricity usage</b>	Source: [9]
	<b>E<sub>EF</sub> = Electricity Emission Factor</b>	

The estimation of Carbon Footprint from transportations' fuel combustion, record of total number of car park which is available around Sunway University Campus for Sunwayians is used with the assumption that all vehicles parked were cars using petrol as their fuel. The distance of 1.0 km is capped as the distance travelled by Sunwayians to campus, from various location within Klang Valley as shown in figure 1 for this study, with a reason that the Carbon Footprint is estimated for Sunway University Campus.



**Figure 1.** Direction map to Sunway University Campus by road from 4 main entry point. (\*Source: Facilities Department, Sunway University)

Number of bus service to transport Sunwayians from various locations were also obtained from University Student Services Department as shown in figure 2.



**Figure 2.** Pick-up location for bus service to Sunway University Campus By using formula (2), Carbon Footprint from transportation calculated as shown in table 2. (\*Source: Facilities Department, Sunway University).

**Table 2.** Source of Fuel Emission Factor

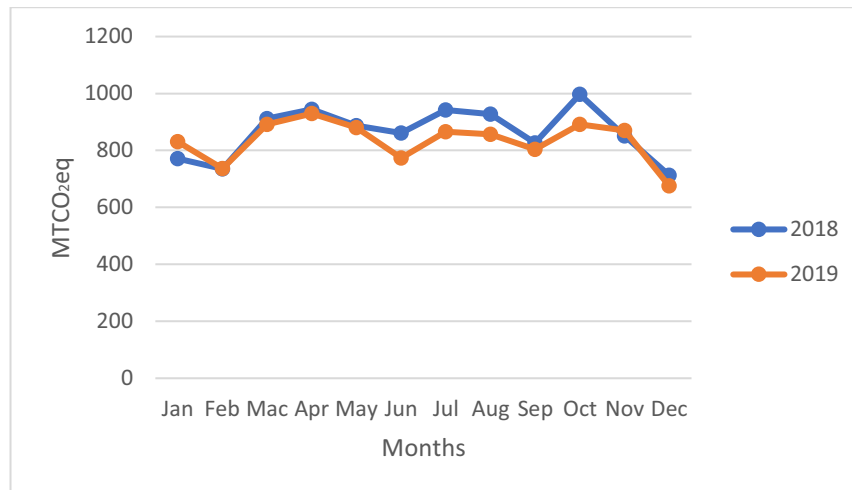
Variables	Formula	
Combustion of fossil fuel	$CO_2 = \text{Ady} \times E_{EF} \text{ (2)}$	$E_{EF}$ of car (petrol)
I. Petrol	$CO_2 = CO_2 \text{ equivalent}$ in ton	0.242 kgCO <sub>2</sub> eq per km.
II. Diesel	$\text{Ady} = \text{Average}$ distance travelled for vehicle (in km)	$E_{EF}$ of bus (diesel) 0.136 kgCO <sub>2</sub> eq per km.
	$E_{EF} = \text{Fuel Emission}$ Factor	Source: [10]

Convenient sampling method is used for the questionnaires as it was randomly distributed to Sunwayians to determine their daily habitual on campus and identify their awareness towards sustainable initiatives on campus. This method was chosen as the respondent were Sunway students and staffs for this study which was readily available within campus and collection of data can be done within a short time period due to time constrain.

### 3. Results and Discussion

#### 3.1 CO<sub>2</sub> emission from electricity usage

Figure 3 shows the monthly trend of total carbon emission from electricity consumption calculated for Sunway University Campus from all 3 buildings where in year 2018 and 2019, the total amount of carbon emission was 10,369 MTCO<sub>2</sub>eq and 10,005 MTCO<sub>2</sub>eq respectively. Similarities can be observed between both trend line as the student intake and semester calendar co-insides throughout the year. Lowest carbon emission for the month of December was observed as most of the students and staff were having year end break which reduces activities on campus. However, for the months of April-May and October-November, higher carbon emission was recorded mainly due to concurrent classes and final exams for foundation programs such as A-Levels, AUSMAT and MUFY.

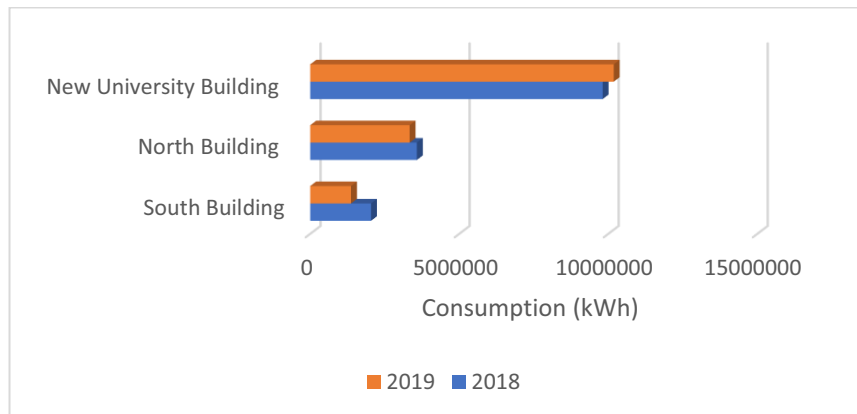


**Figure 3.** Monthly trendline of Total Carbon emission from all 3 campus buildings of electricity consumption.

However, there is a decrease by 3.1% or 364 MTCO<sub>2</sub>eq from the total CO<sub>2</sub> emission in 2019 compared to the previous year because the University has taken various energy saving initiatives, implementing in stages since the end of 2014. University management had started to change all indoor and outdoor lights gradually with LED lamps, installation of motion sensor light, all purchased desktop computers, and devices are enabled with energy-smart saving mode and installation of solar panels on building rooftops as an initiative to self-sustain from purchased electricity.

Figure 4 depicts the total electricity consumption in kW/hr by each campus building for the year 2018 and 2019 where Sunway University Campus comprises of North and South College Buildings, 4 floors in each building and New University Building, 12 floor height. It was observed that the overall electricity purchased in year 2018 and 2019 was 15,429,587 kW/hr and 14,888,007 kW/hr respectively. There is a reduction in electricity usage in year 2019 compared to the previous year, among the three buildings, except for the consumption from New University Building with an increase by 372,375 kW/hr in 2019. In comparison to both the college buildings, North College Building purchased 3,578,547 kW/hr and 3,336,065 kW/hr in year 2018 and 2019 respectively, higher than South College Building in electricity consumption due to the location of Marketing Department, Foundation Programme administrative offices, Security and Admission Offices which is located in this building. Daily electricity usage by staff for various purposes

and events during weekends for certain departments to operate, increases electricity consumption.



**Figure 4.** Total electricity consumption by campus building for the year 2018 and 2019.

*3.2 CO<sub>2</sub> emission from Transportation*

Total carbon emission was calculated based on rate of 0.383 MTCO<sub>2</sub>eq per day. Table 3 shows the total CO<sub>2</sub> emission calculation from fuel combustion of vehicles used by Sunwayians commuting to campus. Combustion from petrol fuelled car and diesel fuelled bus emitted a total of 0.381 MTCO<sub>2</sub>eq and 0.02 MTCO<sub>2</sub>eq respectively where it proves that many students and staff prefer to drive to campus rather than to use public transport. This is due to the convenience where they can drive to campus and reach just before their classes and leave once they are done, compared to taking the bus service where they need to get on the bus early and leave back home in the evening

**Table 3.** Total CO<sub>2</sub> emission calculation from fuel combustion from vehicles.

Type of vehicle	Quantity of vehicle	Type of Fuel	Emission factor	Total emission (kgCO <sub>2</sub> eq)	Total emission (MTCO <sub>2</sub> eq)
Car	1574	Petrol	0.242	381	0.381
Private Bus Service	12	Diesel	0.136	2	0.002



Total	383	0.383
-------	-----	-------

Referring to the findings from [6], CO<sub>2</sub> emission from transportation for Universitas Pertamina was calculated from students and staff commuting within campus area with distances less than 1.0km. Therefore, for my study the distance travelled by Sunwayians to campus from both cars and private bus services were capped at 1.0km, from all major entry routes to campus within Klang Valley as this study is on Carbon Footprint for Sunway University Campus. Assumption is also made with the type of vehicle and fuel used by each Sunwayians parked at the allocated parking space surrounding the campus, which is car with petrol fuel, as detailed information could not be obtained within this study period.

### 3.3 Sunwayians habitual towards contribution of Carbon Footprint

Out of 124 voluntarily participated Sunwayians in the questionnaire where 65% comprises of students and the remaining 35% were staff. Participation by gender indicates that 77% were female participants, and 33% were male from both students and staff category. Generally, female gender populations are higher compared to males among students and staffs at Sunway University Campus, which can be related to the higher percentage of female participants compared to male participant.

There is no evidence of significant correlation ( $p > 0.05$ ) between awareness of Sunwayians of CO<sub>2</sub> gas emission from transportation and days they commuted to campus, indirectly contributing to CO<sub>2</sub> gas emission. Out of 75 respondents, 75% of them drives every day in a week to campus followed by 12% driving 4 days in a week, as it can be related for the hypothesis to be rejected. Most of them prefer to drive personally to campus for work or classes, rather than travelling by public transport or car-pool, as it is a more convenient option.

The Chi-square test analysis reported an evidence of statistical significance ( $p < 0.05$ ) between the habits of students and staff to switch off the light when they leave the room in order to save electricity. Out of the total respondents, 88% answered 'Yes' as in they would switch off the light and the remaining 12%, whom are students entirely, answered 'No' to this question. All of the staff responded to switch off the light as they are more responsible and aware of these basic practises which would reduce the electricity usage indirectly.

There is a significant correlation ( $p < 0.05$ ) based on Chi-square test analysis between the awareness of Sunwayians on sustainable initiatives implemented by the University and their active participation in them. From the total 124 Sunwayians respondents, 114 of them have answered 'Yes' to indicate that

they are aware of the sustainable activities and participated in more than 1 type of the activities.

#### **4. Successful approaches of green initiatives at Sunway University**

Various efforts taken by the University management from the initiatives proposed by Sunway Smart Sustainable Campus Committee (SSCC), such as educating and encouraging participation from Sunwayians, on campus wide green activities, a bottom-up approach, have shown a good response as many Sunwayians participated in these activities on campus.

‘The Last Straw’ campaign is an initiative by Sunway management to stop the use of plastic straws and non-biodegradable single-used plastics materials had shown a great participation from the students and staff as they either bring their own metal straw and food container when buying drink and food. Installation of water dispensers around the campus had also encouraged Sunwayians to bring their own drinking bottles, rather than buying bottled water.

Installation of solar panels on the rooftop of Sunway University Buildings is also a green initiative by the University management to generate electricity and compensate it with the electricity purchased from Tenaga Nasional Berhad (TNB). Canopy walk is a 360m long pedestrian walkway that connects Sunway University Building to Sunway Pyramid Mall, Monash University campus and Sunway Medical Centre. The walkway is a facility that allows students to find alternative parking so that they can continue to attend classes conveniently and punctually.

#### **5 Conclusion**

The main aim of this study is to identify Carbon Footprint for Sunway University Campus from electricity consumption, transportation and from the habitual of Sunwayians towards sustainable activities on campus. Year 2018 and 2019 recorded total of 10,369 MTCO<sub>2</sub>eq and 10,005 MTCO<sub>2</sub>eq of CO<sub>2</sub> emission, respectively from electricity consumption of all 3 campus buildings. Implementation of energy saving activities had shown a positive result in reducing purchased electricity between the two years.

Moreover, 0.383 MTCO<sub>2</sub>eq per day were estimated from the fuel combustion based on the type of vehicles used by Sunwayians to commute to campus in a day. Although the CO<sub>2</sub> emission reported for Sunway University Campus is tolerable compared to other studies done, various initiatives and plans to reduce Carbon Footprint in the future should be carried out efficiently.

It was observed that the degree of awareness amongst Sunwayians towards their contribution to Carbon Footprint displayed a significant correlation between daily activities with electricity saving through their

acknowledgement and participation on sustainable practices on campus. However, there is no significant correlation between their awareness on CO<sub>2</sub> emission contributing to global warming and their driving habits to campus. Few suggestions from questionnaire to reduce Carbon Footprint on campus from options of activities can be considered to reduce CO<sub>2</sub> emission in the future.

### References

- [1] Reilly J, Mayer M and Harnisch J 2002 *The Kyoto Protocol* 217–29
- [2] Azmi M and Tokai A 2016 *Environ. Syst. Decis.* **36** 335–50
- [3] Rasiah R, Al-Amin AQ, Mintz Habib N, Chowdhury AH, Ramu SC and Ahmed F 2017 *J. Clean Prod.* **167** 163–73
- [4] Ali G, Anbren S and Bashir MK 2018 *Environ. Sci. Pollut. Res.* **25** 3775–84
- [5] Gomez CP and Yin NY 2018 *Proc. Int. Conf. on Built Environ. and Engr.* vol 18 (MATEC Web of Conference) p266
- [6] Ridhosari B and Rahman A 2020 *J. Clean Prod.* 246
- [7] Ghogh Najad P, Ahmad A and Safitri Zen I 2018 *Environ. Ecol. Res.* **6** 203–9
- [8] Nawi NFM and Choy EA 2020 *J. Sustain. Sci. Manag.* **15** 113–24
- [9] Nor Izana MS, Wan Noor Anira HWA, Norizan MA and Siti Rasidah MS 2017 *J. of Sustain. Environ.* 59–72
- [10] Lim M and Hayder G 2019 *Int. J. Eng. Adv. Technol.* **9** 3489–93

### Acknowledgement

We would like to express my very great appreciation to Sunway University for the data provided.