Energy Consumption and Greenhouse Gas Emissions Among Ibans of Lundu and Bidayuh of Serian

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Abstract

Currently, the trending of energy consumption in Sarawak, Malaysia had changed dramatically due to the increased of electricity supply need which involve in all district and region around the state that influenced by the increasing in population, development of transportation system, and the use of gadget technology in advanced. The excessive amount of energy used may cause the rapid emission of carbon dioxide gas that led to the greenhouse effect that slowly harms the earth. Sarawak is a state in Malaysia that have racial diversity. However, each ethnic has a different lifestyle due to the demographic factor which results in the variation of average household energy consumption. Therefore, a study has been conducted specifically at two different village of varies races which is at Iban (Sea Dayak) village and Bidayuh (Land Dayak) village to study and investigate the changes of lifestyle of the Ibans and Bidayuhs in Sarawak and how it affects energy consumption and greenhouse gas emissions. A spreadsheet excel program has been made so that the comparison for village energy consumption can be determined easily. For this study, a quantitative method has been used in which each resident for selected village was interviewed about the electrical appliance used and been provided a questionnaire for them to fill in. Based on the collected data, formulated excel program is expected to be produced for calculation based on the idea of energy consumption theory. The calculated data will take form based on energy consumption of daily, monthly and yearly activities. The energy consumption will take consideration on various daily activities of Ibans and Bidayuhs. Only certain household electrical appliances were known to consume a lot of electricity at both villages such as lighting, fan, refrigerator, and heating appliance. Based on the comparison, Bidayuhs in Kampung Mentu Pondok, Serian consumed more energy than Ibans in Kampung Sungai Lundu in yearly basis by the difference 1 845.24 kWh. Thus, each house in Kampung Sungai Lundu intimately generates 3 351.30 kWh each year while spending RM 630.14 each year for electric bill. Meanwhile,each house in Kampung Sungai Lundu intimately emits 2 472 968.289 kg CO2 each year.

Keywords: - Energy consumption, village, gas emissions

1. Introduction

1.1 Dayak Community in Malaysia

Malaysia is unique with the multiracial population due to the different ethnics living in the country. According to CIA (2017), 11.8% of indigenous Malaysian is including the Dayak population. The term Dayak was used by the Europeans to refer to the non- Malay inhabitants in Borneo (Benedict, 2014). In Sarawak, many Dayak ethnic groups are known as Iban (Sea Dayak) and Bidayuh (Land Dayak). In Kayan dialect, Livan refers to the Iban which means wanderer or in Iban owns version means person (Chang, 2006). Meanwhile, Bidayuh is inhabitants of land who lives mostly on hills and mountains. According to the Department of Statistics Malaysia (2010), Iban makes up 713 421 out of 2 471 140 Sarawak population while Bidayuh is 8.3% of Sarawak population. This research involves the Iban and Bidayuh since both are the two largest ethnic groups in Sarawak. Thus, it is crucial to study the relationship between Iban dan Bidayuh in terms of energy consumption and its effect on greenhouse gas (GHG) emissions.

1.2 Energy Consumption

Energy of a body is known as its capacity to do work and basic forms of energy can be found such as electrical energy, kinetic energy, potential energy, thermal energy, chemical energy, electrochemical energy, electromagnetic energy, sound energy and nuclear energy (Abdullah, 2013). According to Zamzuri (2010), energy consumption plays a significant role in the economic growth process and the energy consumption patterns in every country and every state in a country are affected more by energy prices. The energy consumption in Malaysia including crude oil and petroleum products, coal, and coke and hydroelectric (Energy Commission, 2011).

Energy use has been associated with population growth and expansion of urban centres. Besides roads, transportation and factory networks are among the most energy intensive facilities. In connection with

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that, the energy utilization for Dayaks (Iban and Bidayuh) in Lundu and Serian has increased as their population increase as shown in Table 1 and Table 2. According to Piper (1999), factors that influence energy use are people factors, building type, occupancy, climate, age of building, construction, and other factors. Table 3 and Table 4 show the average annual energy use based on operating hours and building type. Therefore, the difference between people factors, operating hours, and age of building lead to different patterns in energy consumption between the residents in Lundu and Serian.

Table 1. Population development of Lundu (Department of Statistics Malaysia, 2010)

Area	Status	Population Census 2000-07-05	Population Census 2010-07-06
Lundu	District	28070	33413

Table 2. Population development of Serian (Department of Statistics Malaysia, 2010)

Area	Status	Population Census 2000-07-05	Population Census 2010-07-06
Serian	District	82042	91599

Table 3. Average annual energy use by operating hours (Energy Information Administration, Commercial Buildings Energy Consumption and Expenditures, 1992)

Weekly Operating Hours	Energy Use (Btu/square foot per year)
39 or fewer	33700
33700	67400
40 – 48	66500
67400	79700
49 – 60	99000
66500	145800

Table 4. Average annual energy use by building type (Energy Information Administration, Commercial Buildings Energy Consumption and Expenditures, 1992)

Building Type	Energy Use (Btu/square foot per year)
Education	75200
Food Sales	181500
Food Service	206100
Health Care	228500
Lodging	160100
Mercantile and service	71900
Office	101200
Public Assembly	6800
Public Order and Safety	110600
Religious Worship	29000

1.3 Greenhouse Gas (GHG) Emission

Generally, greenhouse gas (GHG) emissions are described as the accumulation of chemical gases that are being released from the chemical reaction into the atmosphere. According to Perlmutter and Rothstein (2011), the greenhouse gases (GHG) include the water vapour (H2O), ozone (O3), carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and hydro-chlorofluorocarbon (HCFC) as shown in Table 5. Increasing greenhouse gas (GHG) concentration in the environment brings negative impacts especially to the climate system (Wee–Kean et al., 2008). Thus, the greenhouse gas (GHG) emission is harmful to the environment and if excessive, it will result in global warming. In the meantime, Malaysia has decided to reduce their greenhouse gases (GHG) emission by 40% by the end of year 2020 (Shahid, Minhans & Puan, 2014). Optimization of greenhouse gas (GHG) emissions must include the study of energy consumption in the daily activities by Dayak. To date, greenhouse gas (GHG) emission is alarming due to the excessive energy consumption in Malaysia. Therefore, plans are required to maintain the sustainability of energy consumption in Malaysia for clean environment.

Table 5. Greenhouse gas concentrations in 2005 and their lifetimes (Perlmutter & Rothstein, 2011)

Gas	Atmospheric Concentration (ppm)	Lifetime to Reduce Concentration to One-Third
Carbon Dioxide	379	Century
Methane	1.8	Decade
Nitrous Oxide	0.3	Century
CFCs	Various Very Low Concentration	Years to Centuries
HCFCs	Various Very Low Concentration	Years to Centuries

1.4 Research Problem

In Sarawak, the Rural Transformation Development Programme spearheaded by the state government has resulted in massive electrical energy being supplied to the rural areas especially in Lundu and Serian. Thus, the concentration of greenhouse gas (GHG) in the atmosphere has boosted rapidly in rural areas because of high energy consumption by residents. In addition, urbanization of rural areas has resulted in a rise in population which leading to huge demand of energy supply among the residents. As such, this research is carried out to study the energy consumption by the Iban and Bidayuh in Lundu and Serian respectively along with its greenhouse gas (GHG) emission. Meanwhile, both Lundu and Serian have differences in terms of geography and demography. These lead to variation in energy consumption between the residents in Lundu and Serian. A study conducted by Osorio et al. (2016) suggested that high energy demand comes from the areas that mostly have buildings and transports where its usage has impacts on climate and

air quality through the emissions of greenhouse gases and other pollutants.

1.5 Objectives and Scopes of Research

The changing of lifestyle towards modernization and increasing in population among Dayaks have affected their own energy consumption. Thus, the changing in pattern of energy consumption towards increment will increase the emissions of greenhouse gases which can damage the environment which is very important for the new generation. Most of the Dayak's activities have no data or information to be found in learning centres. To date, the household energy consumption of the Dayaks ethnic is not available due to lack of information and research. Thus, this study was conducted to explore the liveliness of Iban and Bidayuh in Sarawak and how the lifestyle is related to the daily energy consumption. Accordingly, the objectives of the study have been formulated as follows:

1. To investigate the trend of energy consumption of Ibans and Bidayuhs in Sarawak.
2. To compare the amount of household energy consumption in electricity between Ibans Sebuyau in Kampung Sungai Lundu, Lundu, Kuching and Bidayuh Sadong in Kampung Mentu Pondok, Mongkos, Serian.
3. To analyze the relationship of household between Iban and Bidayuh along with the household energy consumption between them
4. To propose a guideline for optimizations of energy consumption between the Ibans Bidayuhs in Sarawak.

2. Methodology

2.1 Identification of Suitable Dayaks Village for Research Scope

The study of this research involves two different Dayak ethnic villages. The Ibans scope will be in Kampung Sungai Lundu, Lundu, Kuching while the Bidayuhs scope will be in Kampung Mentu Pondok, Mongkos, Serian. In this study, the focus will be on the energy consumption based on the daily activities of the Ibans and Bidayuhs from the representative villages.

2.2 Study Visit to The Representative Villages

A study visit to the Dayaks' ethnic villages will take place to analyze the related problems encountered by the lifestyles of the Ibans and Bidayuhs. This study visits will expand the research knowledge regarding the Ibans and Bidayuhs culture apart from extracting data of energy consumption of Ibans and Bidayuhs from 3 different households each.

2.3 Building and Organizing Excel Program

Based on the collected data, formulated excel program is expected to be produced for calculation based on the idea of energy consumption theory. The calculated data will take form based on energy consumption of daily, monthly, and yearly activities. The energy consumption will take consideration on various daily activities of Ibans and Bidayuhs. According to Officina Catalana del Canvi Climatic (2013), the greenhouse gases emission (GHG) can be calculated as in Equation (1).

$$\textit{Emission of } CO2\ (kg) = \textit{Emission factor of } CO2\ (kg) \times \textit{Power unit}\ (kWh) \quad (1)$$

2.4 Analyzing and Interpretation

Once the calculation is done, the study will involve the analysis and interpretation of energy consumption from the excel data. The comparison of energy consumption by the Ibans and Bidayuhs are discussed specifically. The discussion is expected to be based on the survey conducted during the study visit.

3. Result and Discussion

3.1 Explanation on Kampung Sungai Lundu and Kampung Mentu Pondok

Fig. 1 shows, Kampung Sungai Lundu is a lowland geography that located 1 km from Lundu Town. This village is located near to a river which is known as Sungai Lundu. To date, Kampung Sungai Lundu has been supplied with electricity from Sarawak Energy. Besides, Kampung Sungai Lundu is populated by the Iban ethnic group. Apart from that, Kampung Sungai Lundu is located next to the main road that has connected Sematan and Lundu town for ages. Thus, Kampung Sungai Lundu has been undergoing a lot development such as building construction. Currently, Kampung Sungai Lundu has more than 300 houses comprising village houses, single houses, and bungalows.

Fig. 1. Lowland background of Kampung Sungai Lundu

Based on Fig. 2 shows, Kampung Mentu Pondok which is in Serian, Sarawak has a hilly geographic map which located 38 km from Serian Town. This village is located near to a river which is known as

Batang Kedup. Kampung Mentu Pondok has been supplied with electricity from Sarawak Energy Bhd. This village was populated by Bidayuh ethnic. Besides that, Kampung Mentu Pondok was located to the main road which connected all the other villages to Serian town for ages. Kampung Sungai Lundu had undergo a lot of development such as building construction such as primary school that is Sk. St Michael Mongkos and a church. For the time being, Kampung Mentu Pondok has more than 150 houses comprising of terrace village houses and single-storey and double-storey village houses.

Fig. 2. Hilly background of Kampung Mentu Pondok

3.2 Energy Consumption and Greenhouse Emission of Kampung Sungai Lundu

Table 6 shows the information of 3 respondents in Kampung Sungai Lundu for the research. Based on the Table 6, 2 respondents own a village house while 1 respondent owns a bungalow. All the respondents have been living in Kampung Sungai Lundu for more than 40 years. Besides, all respondents are natives of Kampung Sungai Lundu itself. Based on the survey conducted, the respondents have different life backgrounds even though the respondents are all Iban.

Firstly, Ms. Hiew Nyuk Chiew is providing rental service for practical students who are undergoing their internship in Hospital Lundu for 4 months. Hence, the total family members in the house is 7. This respondent has charged the house rental for RM 1100 per month. Besides, Ms. Hiew Nyuk Chiew obtained Iban title from the Sarawak Government in 2008. Secondly, Ms. Junai anak Eddie has been living alone for more than 10 years. The respondent's electric bill has been subsided by the Federal Government since 2013 because her monthly bill is less than RM 20.00. Thirdly, Mr. Seli anak Sijun stated that electricity consumption will increase, especially on June and December due to the festival season. Other than that, only 3 family members are living in the house. Above all, the respondents obtain power supply from Sarawak Energy Bhd. A comparison of the data from the range of tests are conducted on both the Bluetooth connectivity and the Wi-Fi modules. The Wi-Fi module proves to be superior to the Bluetooth connectivity module in terms of range of successful connectivity for data transfer and control. This is because the Bluetooth connection got disconnected less than 10 meters from the subject device. However, the Wi-Fi connectivity was able to continue data transfer and control the proposed system output at over 30 meters through the IoT platform without any path interruption.

It should also be noted that the Wi-Fi hotspot used to provide the connectivity was from the Android device. This means that the range achieved was far below the potential of Wi-Fi routers. Industries that utilize LAN covering of over 50 meters and wide area networks (WAN) that range in hundreds of meters of network coverage benefit hugely because the IoT platform will be able to control the proposed system from greater distances over 100 meters.

Table 6. Information section of 3 respondents in Kampung Sungai Lundu

Name	House Category	Years of staying	Type of resident	No. of family member staying in house	Source of power supply	Additional information
Ms Hiew Nyuk Chiew	Village house	>40	Natives	7	Sarawak Energy Bhd	1100 PER MONTH) b. House owner has obtained Iban title from the Sarawak Government on 2008.
Ms. Junai anak Eddie	Village house	>40	Natives	1	Sarawak Energy Bhd	Living alone Federal government subsidies her monthly electrical bill (< RM20.00)
Mr. Seli anak Sijun	Bungalow	>40	Natives	3	Sarawak Energy Berhad	Electricity consumption increases during festival holiday (June and December)

Table 7 shows the spreadsheet programming calculation of energy consumption for the electrical appliances which are actively used by Ms. Junai anak Eddie. Based on Table 7, only refrigerator that emits more than 1 kWh of energy per day at 3.60 kWh per day. Other appliances such as 5 tube lights (T8), iron, rice cooker, television, ceiling fan and stand fan emit energy less than 1 kWh per day.

Table 7. Calculation of daily energy consumption of Ms. Junai anak Eddie

Appliance	Amount	Amount of actively used	Power input per unit (W)	Duration of usage per day (hours)	Total unit power per day (kWh)
Tube light (T8)	10	5	36	3	0.54
Bulb	1	1	23	3	0.07
Iron	1	1	1200	0.17	0.20
Rice Cooker	1	1	600	0.25	0.15
Television	1	1	80	2	0.16
Refrigerator	1	1	150	24	3.60
Ceiling fan	2	1	95	5	0.48
Stand Fan	3	1	50	5	0.25

Table 8 shows the comparison of unit power monthly and yearly (kWh) in 3 respondents' house based on average power unit and estimated power unit. In this research, there are 2 calculations that had been made for data accuracy. Firstly, average power unit (kWh) is taken based on the data shown in each respondent house at the electric meter. Then, estimated power unit (kWh) will be calculated based on the quantity of electrical appliances in the respondents' house and its operating hours.

Table 8. Comparison of unit power monthly and yearly (kWh) in 3 respondents'house based on average power unit and estimated power unit.

House	Hiew Nyuk Chiew	Junai anak Eddie	Seli anak Sijun
Average Power unit, kWh (month)	255	120.00	255.00
Average Power unit, kWh (year)	2 700	1 440.00	3 060.00
Estimated Power unit, kWh (month)	280.681	163.44	393.70
Estimated Power unit, kWh (year)	3 368.172	1 961.28	4 724.44

Based on Table 8, the average power unit (kWh) and estimated power unit (kWh) are calculated on a monthly and daily basis. For each data, estimated power unit (kWh) is slightly higher than the average power unit (kWh). This is because the average power unit (kWh) is measured based on each daily activity of the respondents while estimated power unit is calculated by assuming the respondents use all the appliances at the specific time each day. However, it is noted that the data showed linear pattern between average power unit (kWh) and estimated power unit (kWh) of each respondent.

This is because Mr. Seli anak Sijun has the highest average power unit (kWh) and estimated power unit (kWh) per month. Meanwhile, Ms. Junai anak Eddie has the lowest average power unit (kWh) and estimated power unit (kWh) per month. Apart from that, the yearly average power unit (kWh) and estimated power unit (kWh) do follow the trend shown on a monthly basis.

3.3 Energy Consumption and Greenhouse Emmision of Kampung Mentu Pondok

Table 9 on the other hand shows the information of the 3 respondents' in Kampung Mentu Pondok for this research. Based on Table 9, all the respondents live in a single-storey village house but with different sizes. Just like the respondents in Kampung Sungai Lundu, all the respondents in Kampung Mentu Pondok also have been living for more than 40 years in this village itself. Futhermore, all the respondents are natives of Kampung Mentu Pondok itself and are Bidayuhs' people. From the survey conducted, 2 of the respondents that are Mr Changgan ak Guntor and Mr Tobaias Edgar work as a farmer and 1 respondent that is Mr Garu ak Kalup works as a gardener at the nearest school, that is Sk. St. Michael Mongkos and they live within different number of family members. They highlighted that their electricity consumption increases during festive seasons especially in June and December as their other family members went back home. All the respondents' houses got their power supply from Sarawak Energy.

Table 10 shows the spreadsheet programming that had been done to calculate the energy consumption of electrical appliances which were actively used by Mr Chenggan ak Guntor and his family. Based on Table 3.5, refrigerator shows the highest unit power per day at 3.60 kWh followed by actively used 2 rice cookers at 2.40 kWh per day and 3 units of ceiling fan with 1.71 kWh units per day. The highest amount of active electrical appliances was 7 units of tube lights but they only used less than 1 kWh of electric power per day just like television and phone charger. In the other hand, oven and bread toaster have 0 electric power consumption per day as the respondent does not used it daily but seldom

Table 9. Information section of 3 respondents in Kampung Mentu Pondok

Name	House Category	Years of staying	Type of resident	No. of family member staying in house	Source of power supply	Additional information
Mr Chenggan ak Guntor	Single storey	>40	Natives	6	Sarawak Energy Bhd	Electricity consumption increases during festival holiday (June and December)
Mr Garu ak Kalup	Single storey	>40	Natives	3	Sarawak Energy Bhd	Electricity consumption increases during festival holiday (June and December) Works as a gardener at SK St Michael Mongkos
Mr Tobaias Edgar ak David Apet	Single storey	>40	Natives	5	Sarawak Energy Berhad	Electricity consumption increases during festival holiday (June and December) Works as a farmer

Table 10. Daily energy consumption of Mr Changgan's house

Appliance	Amount	Amount of actively used	Power input per unit (W)	Duration of usage per day (hours)	Total unit power per day (kWh)
Tube light	7	4	36	5	0.72
Oven	1	1	1100	0	0.00
Television	1	1	138	5	0.69
Rice Cooker	2	2	600	2	2.40
Refrigerator	1	1	150	24	3.60
Ceiling Fan	3	3	95	6	1.71
Bread toaster	1	1	1200	0	0.00
Phone Charger	6	6	20	2	0.25

3.4 Comparison of Energy Consumption and Greenhouse Gas Emission in Kampung Sungai Lundu and Kampung Mentu Pondok, Serian.

Table 11 shows the comparison of total power unit of selected items from each village. In this research, tube light (T8), refrigerator and ceiling fans were the most constantly used by each respondent from both villages. Thus, comparisons of these appliances are evaluated through the total unit, total power unit and the average hour from each village. To do so, the total appliances from 3 respondents of each village were taken to evaluate its total power unit. Based on Table 11, both villages have the same average hour for refrigerator. This is because the refrigerator needs to run every day to keep food and beverages stocks in the house. Meanwhile, Kampung Sungai Lundu has more tube lights (T8) than Kampung Mentu Pondok. However, Kampung Mentu Pondok has more ceiling fans compared to Kampung Sungai Lundu. Similarly, the numbers of refrigerators in both villages are almost the same. Above all, the comparisons of the appliances are evaluated daily

Table 11. Comparison of total power unit of selected items in Kampung Sungai Lundu and Kampung Mentu Pondok.

Kampung Sungai Lundu				Kampung Mentu Pondok			
Appliances	Total unit	Total power unit	Average hour (h)	Appliances	Total unit	Total power unit	Average hour (h)
Tube Light (T8)	17	3.78	6	Tube Light (T8)	13	2.23	4.7
Refrigerator	4	14.4	24	Refrigerator	5	18	24
Ceiling fans	5	2.1	5.33	Ceiling fans	11	4.75	4.7

Table 12 shows the comparison of power unit in Kampung Sungai Lundu and Kampung Mentu Pondok. The comparison is evaluated accordingly with estimated power unit and average power unit. Yearly power unit from 3 respondents in each village were summed up. Based on Table 12, Kampung Sungai Lundu has lower estimated and average power unit compared to Kampung Mentu Pondok. This is because each village has different number of appliances to be used daily. However, Table 12 shows that the difference between estimated power unit and average power unit for both village is small. Thus, this research concluded that both villages are actually have the same energy consumption regardless of it lifestyles.

Table 12. Power unit in Kampung Sungai Lundu and Kampung Mentu Pondok

	Yearly	
Villages	**Estimated power unit (kWh)**	**Average power unit (kWh)**
Kampung Sungai Lundu	10 053.89	7 200.00
Kampung Mentu Pondok	11 899.31	8 197.20

Table 13 shows the comparison of electric bill in Kampung Sungai Lundu and Kampung Mentu Pondok. The comparison was done by summing all 3 electric bills from respondents of each village. Thus, each village will have total estimated electric bill and average electric from 3 respondents. Based on Table 13, Kampung Sungai Lundu has lower estimated electric bill compared to Kampung Mentu Pondok. This is because total energy consumption of Kampung Sungai Lundu is lower than Kampung Mentu Pondok. As such, the lower the energy consumption, the lower the electric bill.

Table 13. Electric bill of Kampung Sungai Lundu and Kampung Mentu Pondok

	Yearly	
Villages	**Estimated Electric Bill (RM)**	**Average Electric Bill (RM)**
Kampung Sungai Lundu	1 914.43	1 440.00
Kampung Mentu Pondok	2 257.90	1 476.00

Table 14 shows the yearly greenhouse gas emission of CO2 and HCFC in Kampung Sungai Lundu and Kampung Mentu Pondok. Kampung Sungai Lundu showed higher emission of CO2 compared to Kampung Mentu Pondok. Generally, CO2 is emitted from running electrical appliances and combustion materials. As such, Kampung Sungai Lundu tends to emit more CO2 because of the villager's lifestyle towards the usage of electrical appliances. However, Kampung Mentu Pondok has higher emission of HCFC per year compared to Kampung Sungai Lundu. The emissions of HCFC are mainly from the refrigerator. Thus, any village with more refrigerators tends to cause high emission of HCFC. In short, Kampung Mentu Pondok has higher greenhouse gas emission with more than 9 million kg of emission per year than Kampung Sungai Lundu.

Table 14. Yearly greenhouse gas emission in Kampung Sungai Lundu and Kampung Mentu Pondok

Yearly			
Villages	**Emission of CO2 per year (kg CO2e)**	**Emission of HCFC per year (kg HCFC)**	**Greenhouse gas emission per year (kg)**
Kampung Sungai Lundu	9 038.5605	7 420 687.601	7 429 726.161
Kampung Sungai Lundu	8 008.7325	9 266 400.000	9 274 390.000

Fig. 3. shows the trend of energy consumption of tube light (T8), refrigerator and ceiling fans of which are taken in daily form. Kampung Mentu Pondok has a higher power unit of refrigerator and ceiling fans. However, Kampung Sungai Lundu has a higher power unit of tube light (T8) than Kampung Mendu Pondok. This indicates that the more the electrical appliances are in used, the more the energy consumption.

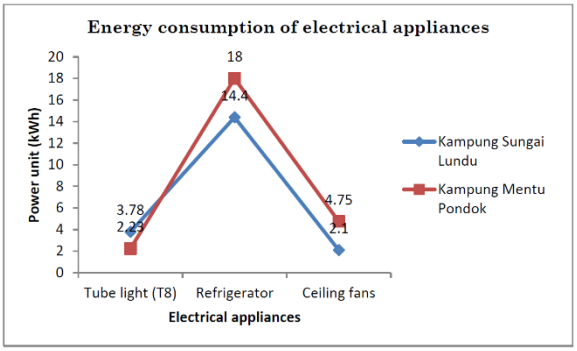

Fig. 3. Energy consumption of electrical appliances

Fig. 4. shows the estimated and average power unit in Kampung Sungai Lundu and Kampung Mentu Pondok. Both villages showed the average power unit is lower than the estimated power unit. Note that the estimated power unit in each village show the limit energy consumption that can be achieved. In this matter, both villages have optimum yearly power unit. Thus, it is crucial for both villages to maintain their energy consumption so that it will not exceed the limit of power unit that each village had. On top of that, Kampung Mentu Pondok has higher yearly power unit than Kampung Sungai Lundu.

Table 15 shows the amount of electric bill, energy consumption and greenhouse gas emission by one house in Kampung Sungai Lundu and Kampung Mentu Pondok. It is clearly shown that Kampung Mentu Pondok has the highest energy consumption since one house is estimated to consume 3 966.44 kWh power unit per year. Apart from that, each house in Kampung Mentu Pondok will emit 3 097 463 kg of greenhouse gases in yearly activities. Therefore, Kampung Sungai Lundu is eco-friendly in energy consumption than Kampung Mentu Pondo.

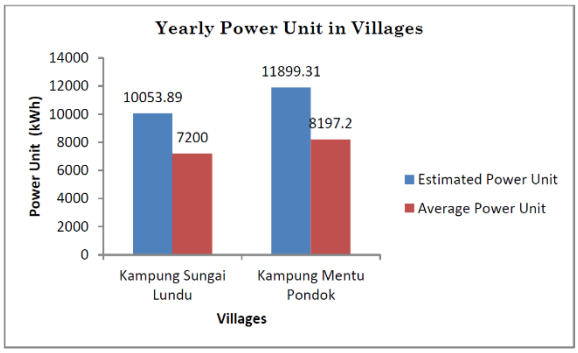

Fig. 4. Yearly power units in village

Table 15. Average energy consumption and greenhouse gas emission by one house of each village

Village	Estimated power unit per year (kWh)	Average power unit per year (kWh)	Estimated Bill per year (RM)	Average Bill per year (RM)	Emission of CO2 per year (kg CO_{2e})	Greenhouse gas emission per year (kg)
Kampung Sungai Lundu	3 351.3	2 400	638.14	480.00	3 012.8535	2 476575.387
Kampung Mentu Pondok	3 966.44	2 732.4	752.63	492.00	2 669.578	3 091 463.00

4. Conclusion

The proposed system of emergency Kampung Sungai Lundu, Lundu and Kampung Mentu Pondok, Serian were chosen based on the criteria of the scope of study which is to compare energy consumption and greenhouse gas emission between Ibans in Lundu and Bidayuhs in Serian. Based on the comparison, Bidayuhs in Kampung Mentu Pondok, Serian consumed more energy than Ibans in Kampung Sungai Lundu in yearly basis by the difference 1 845.24 kWh. Thus, each house in Kampung Sungai Lundu intimately generates 3 351.30 kWh each year while spending RM 630.14 each year for electric bill. Meanwhile,each house in Kampung Sungai Lundu intimately emits 2 472 968.289 kg CO2 each year.As such, Bidayuh's houses in Kampung Mentu Pondok emitted more greenhouse gas emission than Ibans in Kampung Sungai Lundu. The hilly area of Kampung Mentu Pondok,

Serian makes it a bit harder to supply electricity which need much longer electric cables to supply enough electric power to the residents rather than Kampung Sungai Lundu which located at lowland area. This research can be improved by increasing the number of respondents to get more precise and accurate information. The impact of energy consumption on both the environment and communities is profound and multifaceted. Environmentally, excessive energy use contributes significantly to global warming through the emission of greenhouse gases and pollutants, leading to climate change, air and water pollution, and habitat destruction. These effects threaten biodiversity and human health, exacerbating environmental inequalities.

On a community level, energy consumption affects access to resources, economic stability, and public health. Communities reliant on non-renewable energy sources may face economic volatility due to fluctuating energy prices and dependence on external suppliers. Moreover, energy production often involves land use changes and can disrupt local ecosystems, affecting agriculture, water resources, and the overall quality of life.

Addressing these impacts requires a shift towards sustainable energy sources, improved energy efficiency, and equitable access to energy resources. By promoting renewable energy development, reducing energy waste, and prioritizing community engagement in energy decisions, we can mitigate environmental degradation, enhance community resilience, and foster a more sustainable future for all.

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