The analysis of carbon footprint of the settlement activity in the village of Pedurungan District, Semarang City, Central Java Province

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Abstract. Some important sectors influenced the increase of greenhouse gases, such as waste, transportation, settlement, and agricultural sectors. This research aimed to analyze the amount of CO₂ emissions, map the carbon footprint, and analyze tree capability in reducing CO₂ in 12 villages in Pedurungan district, Semarang city, Central Java. The method used was based on IPCC Guidelines for National Greenhouse Gas Inventories 2006 and Ministry of Environment 2012 about the Implementation of National Greenhouse Gas Inventories Guidelines. The carbon footprint was mapped using ArcGIS software. The results showed that the energy sector produced 13,723.35 tons CO₂ Eq, the transportation sector emitted 1,624.58 tons CO₂ Eq, and the waste sector emitted 7,677.08 CO₂ Eq. The carbon footprint map was presented in three classifications of carbon footprint: lower, middle, and upper, represented by green, yellow, and red colors. An effort to reduce the carbon footprint was planting 300 trees of ten species in the Pedurungan district.

1. Introduction

Global warming is still an internationally discussed topic nowadays. It is due to the impact given by global warming that is increasingly felt. The greenhouse gas effect is considered one of the effects caused by global warming, which has the greatest influence. The greenhouse effect causes energy from sunlight cannot be reflected out of the earth [1]. The main gases categorized as greenhouse gases and can cause global warming are CO₂, CH₄, and N₂O [2].

Climate change and the depletion of the ozone layer are caused by increased carbon dioxide emissions on the earth. Climate change is a global issue that has received special attention. The acceleration of climate change is recognized as the impact of the accelerated increase in population, economic development, industrialization and human behavior that produces greenhouse gas emissions [3]. Greenhouse gas emissions will continue to increase along with the increase in energy. The calculation of greenhouse gas emissions will later measure how much greenhouse gas emissions are produced, called the carbon footprint [4].

Human activities cause high levels of pollution or air pollution, which causes an increase in temperature on earth. The increase in energy use results in fossil fuels such as oil, coal, and gas as an energy source, increasing where the exhaust gases from such energy such as CO₂ are the air's contribution to greenhouse gases (GHG). The household is one of the places where humans carry out
various activities. Each household has various activities and produces different carbon footprint values. This diversity can be adjusted to the activities carried out by the household members concerned [5].

Carbon footprint is a calculation of the total CO\(_2\) emissions directly or indirectly caused by an activity or accumulated through the product life cycle [6]. Carbon dioxide is one of the greenhouse gases (GHG) and the most significant contributing component to GHG, around 30%, followed by CH\(_4\) and N\(_2\)O [7, 8]. The amount of GHG is denoted by carbon dioxide equivalent (CO\(_2\)-eq) or Global Warming Potential (GWP), which is a combination of a large GHG impact based on radiation power and the length of time GHG in the atmosphere [9].

Several sectors that can cause an increase in greenhouse gases are transportation, energy, waste, and clean water. The use of fuel for motorized vehicles that use fossil fuels will produce CO\(_2\) emissions. In the household sector, energy is used for lighting, cooking, cooling or heating, and vehicles for daily activities [10]. The waste sector influences greenhouse gas emissions. This waste usually comes from the generation of waste that accumulates in landfills and burning garbage. Garbage buried in a certain time will decompose and produce gases that spread in the air [11]. The clean water sector is related to electrical energy, where its use comes from water pumps used in households.

There has never been a carbon footprint study in Pedurungan sub-district with the largest population in Semarang City. According to data from the Semarang City Central Statistics Agency (BPS), in 2015, there were 180,282 people, in 2016, there were 181,629 people. In 2017, there were 199,153 people. In 2018 there were 211,376 people, and in 2019 there were 214,689 people. Where the increasing population in a place, the amount of carbon emissions also increases. Based on these conditions, this study focuses on analyzing the carbon footprint of settlement activities in Pedurungan District, Semarang City, Central Java. Knowing the amount of carbon emissions generated based on activities on settlement, transportation, and waste sectors in Pedurungan District and providing information to the local community about the impacts use of fuel, use of electrical energy, consumption of waste that can lead to increased emissions carbon.

2. Method
2.1. Location and time
This research on carbon footprint analysis in the residential sector was carried out in January-February 2021. This research was carried out in 12 urban villages in Pedurungan District, Semarang City, Central Java. Implementation of research by collecting primary data, secondary data and data analysis.

2.2. Tool and material
The tool used in this research is Microsoft Excel 2010 software used to analyze the data statistical, ArcView GIS 10.3 software with spatial data analysis. Mapping is done using ArcGIS, a software-based graphic information system (GIS) [12]. The materials used in this research are primary data and secondary data. Primary data is obtained from field observations and measurements directly in the field. The data obtained from this field observation are the number of electronic equipment, the number of motorized vehicles, the consumption of fuel used for cooking and motor vehicle fuel, the duration and number of uses in one month. The use of clean water and the amount of waste generated in a month. Secondary data is used in the form of demographic data. Map of the research area, classification of electric power, classification of house types.

2.3. Data collection
The carbon footprint was assessed using three basic steps: setting operational limits, collecting data, and calculating emissions using appropriate emission factors [13]. Data collection was carried out in 12 sub-districts in Pedurungan District. The data was collected through observation, direct interviews and from documents. This emission data collection point will describe the emission value of each villages.

Types of data are required in the form of primary data and secondary data. Primary data was obtained through direct observation in the field using questionnaires and interviews with 100 households. Primary data collection is intended to determine the existing condition of Pedurungan District. The data obtained from this field observation are the number of electronic equipment, the number of motorized vehicles, the consumption of fuel used for cooking and motor vehicle fuel, the duration and number of uses in
one month, the use of clean water and the amount of waste generated in a month according to the characteristics research area.

Secondary data was obtained in demographic, physical, meteorological, geographical, and other supporting data obtained from Pedurungan District. The variables used in this study are electric power, type of house, and income per month. Home electrical power is divided into five types of home electrical power of 450 VA, 900 VA, 1300 VA, 2200 VA, and 4400 VA. In addition, the house type variable is also used. According to the Decree of the Minister of Settlement and Regional Infrastructure No. 534/KPTS/M/2001, the type of house based on the type of plot or the size of the plot is divided into small houses, medium and large houses. Here are the groupings:

1. Small house with a house area smaller than 50 m². Housing which is included in the type of small housing is type 21 to 36.
2. Medium house with a house area of 50 m² to 150 m². Housing which is included in the type of medium housing is type 37 to 54.
3. A large house with a house area greater than 150 m². Housing which includes large housing types is type 70 to 120.

The last variable is the amount of basic income of the head of household per month based on Law no. 13 of 2003 concerning Manpower is divided into four categories:

1. < Rp. 750,000
2. Rp. 750,000 – Rp. 1,500,000
3. Rp. 1,500,000 – Rp. 3,000,000
4. > Rp. 3,000,000

The data collection technique was done by a questionnaire [14]. In this study, the questionnaire was distributed to 100 households in Pedurungan District, Semarang City. The content of the questionnaire was:

1. Respondent's data
2. House building area
3. Total income
4. Electric power used
5. Amount of clean water usage
6. Number of vehicles owned
7. Types of fuel used for cooking and vehicles
8. Garbage handling

2.4. Data analysis
Primary data processing is carried out to obtain the value of each household's carbon emissions (primary, secondary, and total emissions) in the study area to obtain carbon emission value in Pedurungan District. Secondary data is used to support primary data processing, such as data on carbon emission factors used to calculate carbon emissions and maps of administrative areas used as maps of the study area. The formula for the calculation is presented in equations (1), (2), (3), (4), (5), (6), (7), (8) and (9).

Residential Sector (The World Bank Group GHG Emissions inventory Management Plan)

\[
\text{CO}_2 \text{ emission} = \text{emission factor} \times \text{fuel consumption} 
\]

Information:
- Consumptionfuel: fuel consumed (kg/month)
- CO₂ emissionsmisi: amount of CO₂ emission primary (kg)
- Factor emission: 1.53

The electric consumption was calculated using the equation:

\[
\text{Electricity Consumption (MWh)} = \text{Power (Watt)} \times \text{Usage Time: 1,000,000}
\]
The energy consumption was calculated using the equation:

\[
\text{Energy Consumption (TJ)} = \text{Electricity Consumption (MWh)} \times \text{SFC} \times \text{Calorific Value}
\]  

The CO₂ emission was calculated using the equation:

\[
\text{CO₂ Emissions} = \text{Emission Factor} \times \text{Electricity Consumption}
\]

Information:
- Electricity consumption: electricity consumed (KWh)
- CO₂ emissions: amount of CO₂ emission secondary (kg)
- Emission factor: 0.77

**Table 1. Fuel SCF value.**

| Generator | Fuel | SCF  | Unit               |
|-----------|------|------|--------------------|
| PLTU      | Coal | 0.54 | Tons of fuel/MWh   |
| MFO       |      | 0.23 | Kiloliter/MWh      |
| Gas       |      | 0.00173 | Mscf/MWH |

Source: [15]

2.4.1. Transportation sector (The World Bank Group GHG Emissions inventory Management Plan)

\[
\text{CO₂ emissions} = \text{Total Vehicle Fuel} \times \text{Emission Factor}
\]

Information:
- Amount of vehicle fuel: total fuel use (L/day)
- CO₂ emissions: amount of CO₂ emission secondary (kg)
- Emission factor: 2.38

**Waste Sector**

\[
\text{CO₂ Emission} = \text{Amount of Waste Generated} \times \text{Emission Factor}
\]

Information:
- Amount of waste generated: waste generated (Volume/day)
- CO₂ emissions: amount of secondary CO₂ emission (kg)
- Emission factor: 1.09

**Clean Water Sector**

\[
\text{Consumption of clean water (liters/day/person)} = \frac{\text{Consumption of clean water (liters/day/person)}}{\text{Population (person)}}
\]

The equation (8) below was used to convert to kgCO₂eq.
Total Emissions (kgCO$_2$eq) = (Emissions i x GWP i) \hspace{1cm} (8)

Information:
Total Emissions (kgCO$_2$eq) : Total emissions from all types of GHG Emissions
i : GHG emission of GHG type i
GWP$_i$ : Value Global Warming Potential GHG type i
i : GHG type

| Greenhouse Gases | Chemical Formula | GWP |
|------------------|------------------|-----|
| carbon dioxide   | CO$_2$           | 1   |

Source: [16]

Measuring the carbon footprint is a step in setting targets for reducing carbon emissions. The population in this study was obtained from a sampling of the head of household (KK), which was 46,880 randomly selected families registered in the administrative area of Pedurungan District, Semarang City. According to [17], one of the methods used to determine the number of samples is using the Slovin formula in equation (9).

$$n = \frac{N}{1+N \cdot \alpha^2}$$ \hspace{1cm} (9)

Information:
n : number of sampled household
N : the total number of household
\alpha : degree of error used

From the above calculation, it is found that the number of samples in the study area is 100 households.

3. Result and discussion
3.1. General conditions of research location
The results of this study are expected to provide benefits for various parties. First, knowledge sharing. This research is to analyze and find out the carbon footprint and its mapping in Pedurungan District. Second, for the government, this research is to analyze and find out the carbon footprint and its mapping in Pedurungan District and line with the policies implemented by the government. Third, for the community, this research is expected to provide information to the local community on the impact of fuel use, use of electrical energy, good waste/garbage, and clean water for research that can lead to an increase in carbon emissions Pedurungan District. The location of the research was carried out in 12 sub-districts in Pedurungan District, Semarang City. Pedurungan District is between 110° 27’ 54” East Longitude and 7° 0’ 33” South Latitude.
The administrative boundaries in the Pedurungan District area are:

- North: Genuk District, Semarang City
- South: Tembalang District, Semarang City
- East: Mranggen District and Demak Regency
- West: Gayamsari District, Semarang City

Pedurungan District is the area with the largest population in Semarang City with a population density of 10,361 people/km² per km² in 2021. The area in Pedurungan District is 20.72 km² which is divided into 12 Kelurahan namely Gemah, Kalicari, Muktiharjo Kidul, Palebon, Pedurungan Kidul, Pedurungan Lor, Pedurungan Tengah, Penggaron Kidul, Plamongansari, Tlogomulyo, Tlogosari Wetan and Tlogosari Lor.

Table 3. Urban village area in Pedurungan District.

| Village           | Area (Km²) | Total Population (Persons) |
|-------------------|------------|----------------------------|
| Gemah             | 1.01       | 15,793                     |
| Kalicari          | 0.80       | 9,433                      |
| Muktiharjo Kidul  | 2.04       | 33,298                     |
| Palebon           | 1.47       | 15,208                     |
| South Pedurungan  | 1.80       | 14,405                     |
| Pedurungan Lor    | 1.36       | 9,429                      |
| Pedurungan Tengah | 1.89       | 15,211                     |
| Penggaron Kidul   | 1.80       | 7,144                      |
| Plamongansari     | 2.35       | 14,116                     |
| Tlogomulyo        | 1.94       | 16,550                     |
| Tlogosari Kulon   | 2.80       | 32,301                     |
| Tlogosari Wetan   | 1.25       | 8,928                      |
| **Total**         | **20.72**  | **191,636**                |

Source: Pedurungan District Data 2021.
The total population in the Pedurungan Subdistrict, Semarang City, in 2021 is 191,636 people, divided into 12 Kelurahan in the region. Carbon emissions in this study focus on CO$_2$. There are emissions in several sectors, namely the housing, transportation, waste and clean water sectors in Pedurungan Village, Semarang City. The residential sector, in this case, is related to the use of household fuel used for cooking and use as electrical energy. Emissions from these four sectors may increase over time due to population growth and increased activity in households. Respondents to meet the data in this study were taken from 12 villages in Pedurungan District, Semarang City, namely Gemah Village, Kalicari, Mukthiharjo Kidul, Palebon, Pedurungan Kidul, Pedurungan Lor, Pedurungan Tengah, Penggaron Kidul, Plamongansari, Tlogomulyo, Tlogosari Kulon and Tlogosari Wetan.

3.2. Residential sector
The data obtained in the residential sector is data obtained from this field observation in the form of the number of electronic equipment, the duration of its use and the amount of fuel consumption used for cooking.

| Village             | CO$_2$ Emissions From Energy Consumption (kg.CO$_2$/month) | CO$_2$ Emissions From LPG (kg.CO$_2$/month) | Total Emissions (Electricity+LPG) (kg.CO$_2$/month) |
|---------------------|----------------------------------------------------------|---------------------------------------------|-----------------------------------------------------|
| Gemah               | 1060.8983                                                | 77.265                                      | 1138.1633                                           |
| Kalicari            | 1010.0552                                                | 79.560                                      | 1089.6152                                           |
| Muktiharjo Kidul    | 1212.0416                                                | 133.110                                     | 1345.1516                                           |
| Palebon             | 1009.0542                                                | 123.165                                     | 1132.2192                                           |
| South Pedurungan    | 947.2078                                                 | 174.420                                     | 1121.6278                                           |
| Pedurungan Kidul    | 956.1321                                                 | 105.570                                     | 1061.7021                                           |
| Pedurungan Tengah   | 1018.7023                                                | 105.570                                     | 1124.2723                                           |
| Penggaron Kidul     | 701.8858                                                 | 77.265                                      | 779.1508                                            |
| Plamongansari       | 957.9416                                                 | 160.650                                     | 1118.5916                                           |
| Tlogomulyo          | 1206.8595                                                | 99.450                                      | 1306.3095                                           |
| Tlogosari Kulon     | 1201.0306                                                | 119.34                                      | 1320.3706                                           |
| Tlogosari Wetan     | 867.6686                                                 | 90.270                                      | 957.9368                                            |

The table above shows that the largest producer of CO$_2$ emissions from the residential sector in Pedurungan District, Semarang City is Muktiharjo Kidul Village, with 1345.1516 kg.CO$_2$/month. This is due to the large consumption of materials that use electricity. The existence of an online learning system and several employees who work at home or known as "work from home" where the Indonesian central government enforces Community Activity Restrictions (PPKM). In the circular letter, PPKM is carried out starting from 11th January to 25th January, 2021, following the Instruction of the Minister of Home Affairs number 1 of 2021. The amount of electrical power installed in a house adjusts to the electricity needs of the house. The greater the electricity demand, then the installed electrical power will be even greater, and in the end, the resulting CO$_2$ emissions will also be even greater.

The lowest producer of CO$_2$ emissions in the residential sector is Penggaron Kidul Village, with 779,1508 kg.CO$_2$/month. Efforts to reduce the amount of carbon emissions in the residential sector can be done by reducing the amount of consumption of electronic devices, using energy-saving lamps such as LED lamps, as well as saving consumption on LPG, not leaving unused electronic equipment in stand-by position, and turning off lights during the day. The lowest producer of CO$_2$ emissions in the residential sector is Penggaron Kidul Village, with 779,1508 kg.CO$_2$/month. This is because the community in the area is an area with the lowest population compared to other urban villages. Efforts to reduce the amount of carbon emissions in the residential sector can be done by reducing the amount of consumption of electronic devices, using energy-saving lamps such as LED lamps, as well as saving consumption on LPG, not leaving unused electronic equipment in stand-by position, and turning off lights during the day.
3.3. Transportation sector

The transportation sector has a high dependence on energy sources. Most motorized vehicle products used in the transportation sector use fuel oil (BBM) as an energy source [18].

Table 5. CO₂ emission calculation results in the transportation sector.

| Village              | Car | Motorcycle | Total Vehicle (L/MONTH) | Emission Factor | CO₂ Emission (Kg.CO₂/Month) |
|----------------------|-----|------------|-------------------------|----------------|-----------------------------|
| Gemah                | 5   | 11         | 190.75                  | 2.38           | 1815.94                    |
| Kalicari             | 2   | 13         | 121                     | 2.38           | 1151.92                    |
| Muktiharjo Kidul     | 5   | 17         | 220.5                   | 2.38           | 2099.16                    |
| Palebon              | 4   | 16         | 181                     | 2.38           | 1347.08                    |
| Pedurungan Kidul     | 4   | 12         | 161.25                  | 2.38           | 1337.56                    |
| Pedurungan Lor       | 2   | 13         | 115.75                  | 2.38           | 1101.94                    |
| Pedurungan Tengah    | 4   | 15         | 174.5                   | 2.38           | 1151.92                    |
| Penggaron Kidul      | 2   | 12         | 109.5                   | 2.38           | 1042.44                    |
| Plamongansari        | 4   | 10         | 148.5                   | 2.38           | 1413.72                    |
| Tlogomulyo           | 5   | 11         | 193.75                  | 2.38           | 1923.04                    |
| Tlogosari Kulon      | 4   | 16         | 194.5                   | 2.38           | 1839.74                    |
| Tlogosari Wetan      | 2   | 12         | 112.25                  | 2.38           | 1068.62                    |

Based on these data, the value of carbon emissions in 12 sub-districts in Pedurungan District, Semarang City is 100 families in the transportation sector, 17293.08 kg CO₂ Eq/month. The diagram above shows the emitters of CO₂-eq from the largest transportation sector in Pedurungan District, namely Muktiharjo Kidul Village, with total emissions of 2099.16 kg CO₂-eq/month. The lowest producer of transportation CO₂ emissions is Penggaron Kidul Village, with total emissions of 1042.44 kg CO₂-eq/month. The greater the use of fuel used, the higher the CO₂ emissions produced. One of the efforts to reduce the amount of emissions is to limit the use of private motorized fuel consumption and use more environmentally friendly fuels, using public transportation, and walking or riding a bicycle if the destination is close. Currently, technology in transportation continues to develop, especially in electric vehicle technology. Renewable energy is getting used more to overcome the excessive use of fossil fuels.

3.4. Waste sector

Table 6. CO₂ emission calculation results in the waste sector.

| Village             | Amount of Waste Produced (Kg) | Emission Factor | CO₂ Emissions (Kg.CO₂/Month) |
|---------------------|------------------------------|-----------------|-------------------------------|
| Gemah               | 18.9                         | 1.09            | 638.631                       |
| Kalicari            | 16.9                         | 1.09            | 571.051                       |
| Muktiharjo Kidul    | 19.8                         | 1.09            | 712.969                       |
| Palebon             | 19.25                        | 1.09            | 650.4575                      |
| South Pedurungan    | 24                           | 1.09            | 810.96                        |
| Pedurungan Kidul    | 19.7                         | 1.09            | 665.663                       |
| Pedurungan Tengah   | 18.45                        | 1.09            | 623.4255                      |
| Penggaron Kidul     | 18.85                        | 1.09            | 636.9415                      |
| Plamongansari       | 16.8                         | 1.09            | 567.672                       |
| Tlogomulyo          | 17.05                        | 1.09            | 576.1195                      |
| Tlogosari Kulon     | 19.7                         | 1.09            | 665.663                       |
| Tlogosari Wetan     | 17.8                         | 1.09            | 520.366                       |
Based on the table above shows that the emitters of CO₂ The largest of the solid waste sector in Pedurungan District, Semarang City is Muktiharjo Kidul Village, with total emissions of 712,969 kg CO₂ Eq/month. While the lowest producer of CO₂ emissions in the solid waste sector is Tlogosari Wetan Village, with 520.366 kg CO₂/month. According to [19], rapidly increasing population growth will affect the high intensity of human activity and lead to an increase in waste production. In addition, the higher the socio-economic status of the community, the more waste per capita is disposed of. Garbage is an environmental problem that always occurs to cause damage to the environment [19]. Waste problems must be handled according to the problem, one of which is waste management. Waste management can be processed according to the type of waste. Types of waste are divided into 2, namely organic waste and inorganic waste. Organic waste is waste that can be decomposed while inorganic waste is waste that is difficult to decompose. Organic waste can be processed into fertilizer (liquid and solid), fish feed, etc. Waste sorting activities from source and composting can reduce carbon emissions from waste management activities [20]. Get into the habit of reducing the use of drinking water from packaged bottles and plastic straws, recycling non-biodegradable waste, reusing (used bottles, used cans, plastic packaging, plastic bags, etc.) into reusable items (plant pots, bags, flowers) ornamental, etc.).

3.5. Clean water sector

Table 7. Results of calculation of water use in activities.

| Village          | Number of people | Water Used (L/day) | Clean Water Consumption Person (L/Day) |
|------------------|------------------|--------------------|--------------------------------------|
| Gemah            | 30               | 3785               | 126.17                               |
| Kalicari         | 26               | 3065               | 117.88                               |
| Muktiharjo Kidul| 29               | 4400               | 151.72                               |
| Palebon          | 30               | 3705               | 123.5                                |
| South Pedurungan | 33               | 4065               | 123.18                               |
| Lor's patronage  | 29               | 3495               | 120.52                               |
| Middle Temptation| 27               | 3295               | 122.04                               |
| South            | 28               | 3425               | 122.32                               |
| Plamongansari    | 25               | 3325               | 133                                  |
| Tlogomulyo       | 27               | 3325               | 123.15                               |
| Tlogosari Kulon  | 29               | 3575               | 123.28                               |
| Tlogosari Wetan  | 28               | 3320               | 118.57                               |

The clean water sector is seen from the many uses or uses of water needed where water is needed in everyday life. The use of clean water for household (domestic) purposes provides results that vary depending on the needs of each household. Water needs are the amount of water that is reasonably needed for human essentials and other activities that require water. Water use is the amount of water used from an existing system regardless of the circumstances. From the table above we can see that in Muktiharjo Kidul Village is the area that uses the most water compared to other villages. The high low carbon footprint of the clean water sector is influenced by the large population, clean water consumption and electricity consumption and energy consumption related to the use of water pumps to meet clean water needs. The most influencing of these factors is electricity consumption due to the carbon footprint generated from the clean water sector related to the amount of electrical energy consumed in meeting the need for clean water. The carbon footprint resulting from burning fuel from power plants. Efforts that can be made to save water are bathing using a shower, replacing manual water faucets with sensor faucets where the use of this sensor faucet can save more than 70% water compared to using manual faucets, when using a sitting toilet it is necessary to use a dual flush type flush system.

3.6. Total emissions carbon footprint
The total carbon footprint emission is the sum of the three sectors, namely the housing, transportation, waste and clean water sectors.

**Figure 2.** Total emissions of CO₂.

In the diagram above, it can be seen that of the total CO₂ emissions, the highest number was produced by Muktiharjo Kidul Village. This is because Muktiharjo Kidul Village produces the highest CO₂ emissions in various sectors. Meanwhile, the lowest CO₂ emitter is produced by Penggaron Kidul Village. Many factors cause an area to produce high CO₂ emissions, namely the development of human or anthropogenic activities that have increased the amount of CO₂ emissions caused by the large amount of fuel used directly or indirectly. Human activity is closely related to energy that can come from anything. The more activities that humans do, the greater the amount of energy needed.

**4. Conclusion**

Muktiharjo Kidul Village is the highest producer of total CO₂ emissions compared to other villages in Pedurungan District, Semarang City, which is 4157.2806 KgCO₂eq/month while the lowest total producer is Penggaron Kidul Village with a total of 2458.5328 KgCO₂eq/month. Suggested solutions to reduce carbon footprints for the household sector to reduce the consumption of goods or services with high emission intensity and another alternative is to consume fuel and electricity with low carbon intensity such as solar cells, and etc.

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