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Evaluation of Household Carbon Absorption for Greenhouse Modeling in East Lombok Regency

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ABSTRACT

Attention and efforts to reduce greenhouse gases including carbon dioxide is increasing, and begun to be socialized at household level. This study aims to calculate total carbon emissions from household activities that use energy, for evaluation the carbon absorption. The research method was a qualitative survey using questionnaires and field observations from 380 residents spread over 7 villages in Selong sub-district, East Lombok Regency, West Nusa Tenggara Province. Complementary data obtained from literature studies regarding the provisions and rules used. The findings show that indirect emissions originating from electricity use dominate with 69% (481.91638 ton CO_2/year), which shows very high dependency. The general type of settlement was a mixture of residential and economic activities, which easy to find small shops, service kiosks such as laundry, computer and internet rental, grocery, rented and boarding houses that causes high demand for electricity. Electrical energy comes from diesel power plants that still use coal and other fossil fuels in the production process. Evaluation of emission absorption shows unbalance. It is necessary to save energy usage and also make efforts to find and utilize renewable energy sources and designing scenarios to optimize open spaces, both by increasing the number and model themselves.

1. INTRODUCTION

West Nusa Tenggara Province (NTB) is very concerned about environmental issues. One of their commitments is to realize low carbon and pro environmentally sustainable development [1]. NTB Government issued policies were: 1) Governor Regulation No. 51 of 2012 concerning Regional Action Plans Greenhouse Gases; 2) Governor Regulation No. 36 of 2018 concerning Regional Action Plans about SDGs 2019 – 2023; 3) Governor Regulation 2019 about Regional Action Plans for Climate Change Adaptation; 4) Local Regulations No. 3 of 2019 about Regional Energy General Plan for NTB Province; 5) Memorandum of Understanding between National Development Planning Agency with the Government of Low Carbon Development Planning and Regional Climate Resilience in 2022 – 202; 6) Integration of low development policies carbon and climate resilience in the Regions into the Regional Planning Document, RRPD 2024 – 2026 and RPJMD 2026 – 2030; and 7) Draft Governor Regulation on Low Development Carbon and Climate Resilience in NTB in 2023 [2]. Transportation emissions in NTB are based on tons of carbon equivalent dioxide or tCO2. It reached 3,480,000 tCO2e per year in 2018 and fell 21% in 2019 to 2,740,000 tCO2e per year. It becomes 51% in 2020, a total of 1,330,000 tCO2e per year. However, this condition cannot be offset by the increase in greenhouse gasses from very dynamic household activities with the use of household equipment that produces carbon emissions.

The Central Government has set a target to reduce carbon emissions in the province of West Nusa Tenggara (NTB) by 3 million tonnes. The Central Government has targeted net zero emissions (NZE) or net zero emissions by 2060. Even though the target given is quite large, NTB targets NZE to be achieved ten years earlier, namely 2050. Many steps have been taken to achieve a reduction in carbon emissions of 3 million tons. The Ministry is targeting NTB to halt the rate of deforestation so that it can reduce the rate of emissions by 2 million tonnes equivalent. Then, there is a degradation of 1 million tonnes equivalent to the forest. So NTB must reduce emissions by 3 million tonnes of carbon dioxide equivalent by 2060, but target it by 2050 [3].

Three largest sectors that cause carbon emissions in NTB. First, in the energy sector, various industries still use coal and petroleum as a fuel for electricity generation. Next, the forestry sector, because of logging and forest encroachment, releases carbon dioxide into the air. And the third sector is waste management. Garbage is one of the biggest contributors to emissions in NTB because it releases methane gas. This research is an initial stage and basic research, as part of the literature construction that will be developed and applied for emission-free house model technology in the West Nusa Tenggara Province. Recent research directly supports the regional government's zero-emissions initiative.

East Lombok Regency is one of the districts in NTB

Province with the largest population and the highest population density. Selong is the capital of the district located in the Selong sub-district. Selong is an urban area with outward development, creating urban sprawl and sub-urban areas. Urban development causes a shift in residential concentration, population growth and activities increased at a community level. That makes the concentration of carbon emissions from various community activities in Selong and the surrounding area even higher. This research was carried out as an effort to assist local governments in their greenhouse gas inventory activities by tracing the carbon footprint of households.

Household is one of the places where a lot of time is spent by residents to do various things that could cause carbon emission. Carbon footprint is a measure of the total amount of carbon dioxide emissions caused by excess activity or accumulation of use of the product in everyday life, directly and indirectly. Total carbon emission at household scale determine by traces household activity carbon emission from daily use of energy for preserved food (LPG), electrical and transportation as primary and secondary emission.

In the last few decades, climate change become an important topic because it concerns human life. It cannot be separated from the greenhouse effect and its causes. To understand more deeply about climate change and its effects, the urban heat island phenomenon could be a good example. An increase in the temperature of the surrounding environment due to high levels of human activity combined with characteristics above the ground surface, both natural (topography) and artificial (buildings) [4, 5] can have an effect similar to the effect of greenhouse gases on changes in the earth's climate [6].

Changes in physical environmental characteristics such as urbanization also have an effect on microclimate change. The biggest contributor to greenhouse gas emissions is carbon dioxide. One source of greenhouse gases is anthropogenic emissions. These emissions come from human activities such as the use of fossil fuels, electricity generation, the use of electronic goods, motorized vehicles and industrial activities. Energy pattern consumption [7-9] influenced the amount of carbon emissions released into the environment.

The urban heat island phenomenon will also have micro climate change effects. Release emission also releases heat to the air. It caused increasing in temperature humidity index and made discomfort index higher [10, 11]. It will increase energy consumption for cooling [7, 12, 13] especially for buildings [14, 15] and for tropic or arid region.

Minimize the effects of climate change on a large scale may be very difficult and takes great effort, perseverance and commitment from various parties. It needs a policy to reduce emissions [15-17] try some approach or modelling [4, 18] to reach it and of course do the action that can be started on a small scale, at the neighborhood level or household scale [19, 20]. Started with inventory of what activities use energy [16] that will release heat to the surrounding environment as well as carbon emissions, and carry out estimated calculations of carbon emissions from household activities [9, 21] to get an idea of what anticipatory steps are most relevant and possible in efforts to mitigate climate change.

2. METHOD

Primary data collected by questionnaire or observation of households as respondents in the study area. Questionnaire design contains two components. The first component relates to the question of sources of direct emissions produced from households as LPG fuel, and fuel oil for transport needs. Second component related to the question of indirect emission sources comes from the amount of electricity used. We used an open questionnaire type because we wanted to know the details of the emission sources of each house and the amount of emissions produced directly or indirectly. A face-to-face questionnaire was used to analyze the consumption characteristic of energy from fossil fuel of residents in August 2023. The questionnaire survey was conducted among 380 residents in 7 villages as a sampling area to investigate the living consumption characteristics for transportation, electrical equipment and lighting, also energy for preserving food, especially LPG for cooking.

Field observations verify environmental conditions near each respondent's residence, specifically concerning ground surface type (e.g., paved or earthen). The records are comprehensive, including tree and plant species, yard size, and residential ownership.

All the survey data were analyzed by simple statistical method because this research intended to be descriptive data overview of carbon emissions produced by households. As initial needs, analysis data for the development of emission-free home models only uses descriptive statistics.

2.1 Study area

This research is the first of a planned three years. Its geographic scope is West Nusa Tenggara Province. Therefore, location samples are needed as initial data requirements for developing and applying a carbon-free house model. East Lombok was chosen as the initial sample because this regency has the largest population and the highest density compared to 9 regency/town in West Nusa Tenggara. Then in East Lombok, samples taken from Selong District considering that this district is the center of government and has a high density compared to the other 20 sub-districts. Seven villages in Selong District were selected which represented area populations with different levels of density. Hoped this data provides a comprehensive overview of carbon gas from households with characteristics in the town/district center

The research took place in East Lombok Regency, precisely in Selong which is the sub-district capital. Selong sub-district consists of 12 villages with 31.68 km.sq. Determining the area for sampling is represented by population density. Seven villages were taken which represent sub-urban area of Selong sub-district (Pancor, Sandubaya, Rakam, Kembang Sari, Majidi, Kelayu Utara and Kelayu Jorong). Distance of the village from the head of sub-district capital is around 1-6 kilometers.

2.2 Sampling

Based on population density, there 3 classes of area in Selong; high, moderate and low density. Respondents determined by Krejcie and Morgan's rule [22] based on the number of households from each village at sampling area. Average number of respondents in each village was 54 families except in Pancor (56 families). The basis for selecting households used as sample respondents was determined purposively, considering having a yard that could be planted with trees or other types of plants. This is known from the initial survey conducted before research activities were performed.

2.3 Calculation of total carbon emission

The footprint of carbon gas emissions produced by household activities in this study uses the multiplication of activity data with emission factors. Activity data is energy per unit of time. Total emissions of carbon dioxide gas resulting from direct and indirect emissions. Direct emissions are calculated based on energy consumption from motorized vehicle fuel consumption and the use of liquid petroleum gas (LPG) as energy for providing food to households. Calculation of the amount of transportation carbon dioxide emissions and household LPG use follow the rules from the 2019 IPCC Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Transportation CO_2 Emission=Σ (number of vehicle units X fossil fuel consumption X heating value X fuel emission factor) (1)

Liquid Petroleum Gas (LPG) CO_2 Emission=Σ (number of LPG consumption X LPG emission factor) (2)

Heating value used to convert fuel units into energy units (joules). It varies according to the type of fuel used. The heating value used in this research refers to the regulations issued by Indonesian Ministry of Energy and Mineral Resources for direct and indirect emissions. Heating value of LPG was $43{,}8.10^{-6}$ TJ/kg. Next, multiplied with specific emission factor (63100) [23].

Calculation of secondary CO_2 emissions from electricity, by multiplied it with electricity network emission factor for Lombok area (1.61 ton CO_2/MWh).

Electrical CO_2 emission=Σ (number of electrical consumption X electrical emission factor) (3)

Total CO_2 emission=Σ Direct Emission +Σ Indirect Emission (4)

2.4 Calculation and evaluation of carbon absorption

Calculating carbon absorption using a simple formula, only just multiplying the number of existing trees with carbon absorption value based on tree types [20], as seen in the table mentioned below. Evaluation of carbon absorption at household scale conducted by comparing estimated carbon emissions and carbon absorption values based on the number and types of trees found at the sampling location.

3. RESULT AND DISCUSSION

3.1 Household carbon emission

Calculation of carbon emissions at household scale in this study comes from primary emissions and secondary emissions. The results of the calculation will be total household emissions. Primary emissions are obtained from the use of LPG and use of fossil fuel (include *pertalite, pertamax* and *pertamax* plus) for motor vehicles. Secondary emissions are calculated from electricity use, both for lighting and for electronic equipment. Calculation from both household's sources carbon emission can be seen in Table 1 and Figure 1. Result from calculation of total carbon emissions in different units depicted in Table 2. Contribution as emission source from each village shown in Figures 2 to 4 shows the percentage of emission from direct and indirect emission.

Table 1. Total amount of household carbon emission from main sources at Selong sub-district year 2023 (kg CO_2/year)

Villages	LPG Emission	Transportation Emission	Electrical Emission	Total
Pancor	29923.90	15291.13	10413.77	149358.80
Kembang Sari	15687.22	15768.63	60617.52	92073.36
Kelayu Selatan	13430.84	10719.16	64355.01	88505.00
Rakam	17513.81	18372.95	79772.18	115658.95
Majidi	16224.45	11328.39	56983.84	84536.68
Kelayu Jorong	13215.94	12980.44	45706.46	71902.85
Sandubaya	15982.69	14681.90	70337.60	101002.19
Total	**121978.84**	**99142.60**	**481916.38**	**703037.83**

Sources: primary data calculation, 2023.

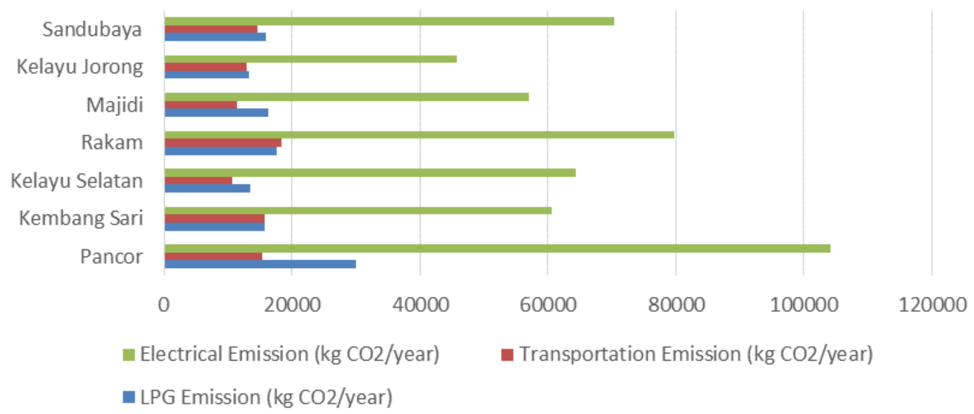

Figure 1. Household carbon emission at Selong sub-district year 2023

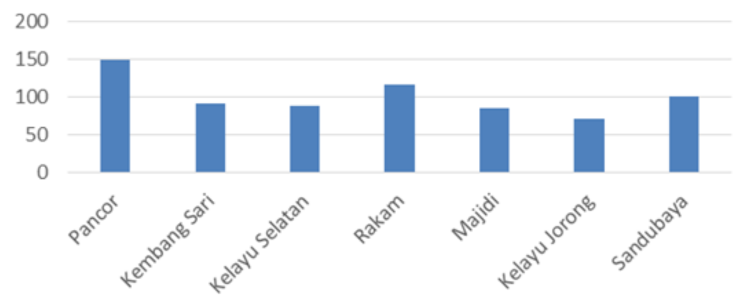

Figure 2. Total carbon emission (ton CO_2/year) at Selong sub-district year 2023

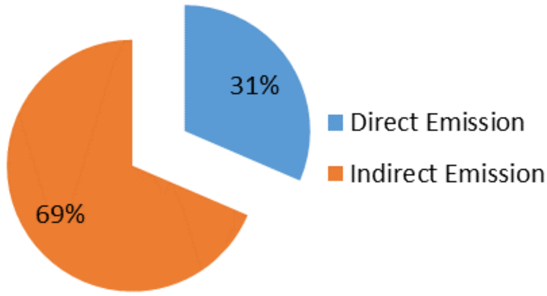

Figure 3. Percentage of total emission from primary source at household scale in Selong sub-distict year 2023

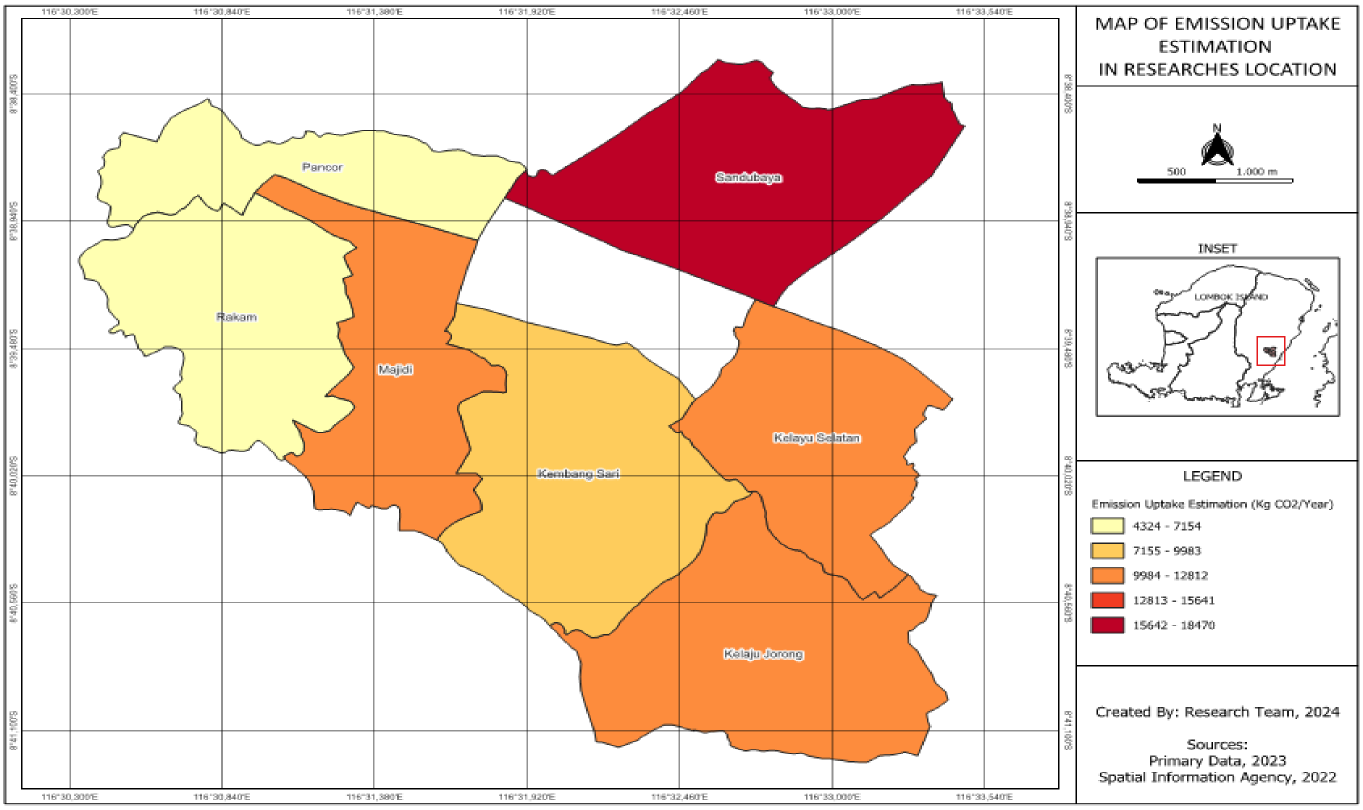

Figure 4. Map of emission uptake estimation at researches locations

Table 2. Total carbon dioxide emission from household in Selong sub-district year 2023

Villages	Total Household Emission (kg CO_2 /year)	Total Household Emission (ton CO_2/year)
Pancor	149358.8011	149.3588011
Kembang Sari	92073.3634	92.0733634
Kelayu Selatan	88505.0043	88.5050043
Rakam	115658.9466	115.6589466
Majidi	84536.6752	84.5366752
Kelayu Jorong	71902.8492	71.9028492
Sandubaya	101002.1926	101.0021926
Total	**70.037.83**	**703.03783**

Sources: primary data calculation, 2023.

3.2 Carbon absorption

Not all houses have yards that can be planted with either perennials or shrubs and flowers. In the research location, which is a sub-urban area, this condition was also found, but in several respondents' houses, several types of plants could be found.

Table 3. Numbers and absorption capacity by plants variety

No.	Plants Name	Absorption Capacity (kg CO_2/year)
1	Mango (Mangifera indica)	445.3
2	Jackfruit (Artocarpus heterophyllus)	126.51
3	Srikaya (Annona squamosa)	77.96
4	Coconut (Cocos nucifera)	48.03
5	Kind of Bananas (Musa acuminate)	48.03
6	Guava (Psidium guajava)	44.55
7	Sapodilla (Manilkara zapota)	12.7
8	Papaya (Carica papaya)	36.19
9	Longan (Dimocarpus longan)	12.7
10	Avocado (Persea americana)	0.63
11	Matoa (Pometia pinnata)	329.76
12	Soursop (Annona muricata)	75.29
13	Kind of Orange (Citrus)	1.55
14	Rambutan (Nephelium lappaceum)	2.19

Sources: Fadhilah et al. [20].

From field observations, it was found 14 types of trees were commonly planted by residents, both in their yards and gardens around their homes. This type of plant is a seasonal fruit plant which bears fruit once a year. The reason they plant this type usually for cool the environment around to make the air more comfort and to get fruit that can be consumed themselves or sold. Trees type commonly found at the research site and their value to reduce emission can be seen in Table 3.

From the table, mango has been the most popular tree to plant by residents because Mango trees have a wide canopy and can grow tall. The wide canopy can protect the house and yard from exposure to the hot sun during the day and also create a calm atmosphere, even in the middle of a hot day. Apart from protecting the house from sunlight, mango trees also protect the house from air pollution, especially if the house is on the side of a highway. Dust will be blocked by the large tree canopy so that the house will be cooler.

Examination of the data presented in Table 3, about substantial carbon sequestration potential, shows that *matoa* trees warrant prioritized cultivation. Home owners that have *matoa* trees said that leaf size, minimizing cleanup efforts, influenced their planting choice. The appeal of the *matoa* fruit's taste and aroma is its primary attribute. At the research site, *matoa* fruit consumption is prevalent among personnel, yet it remains unavailable for commercial sale. The time to fruit is a factor homeowners must consider when choosing trees for their yards.

When field observations were performed, it was found that several houses had vertical gardens and rooftop garden. Unfortunately, it was not the house of the respondent being observed. This can be an alternative to get around limited land because it can help reduce emissions from the household, although its effectiveness still needs to be improved because both types of private gardens contain vegetables or medicinal plants (herbs).

Even though the research was only conducted in seven villages which are part of the outskirts of Selong Town or peri-urban areas, with dense of community activity, especially in the economic sector, this is quite a contribution to energy consumption which will ultimately lead to high carbon emissions released into the air. This can be minimized naturally by the plant's presence, which can absorb carbon through the process of photosynthesis. The existence of trees in terms of number, type and ability to absorb carbon is an important thing to study, so that it can be used as an alternative to reduce the amount of carbon from various community activities that release carbon into the environment.

From Table 4 and Figure 5, the evidence shows that the locations with the highest number of trees are in 5 locations with over 100 trees per 54-56 respondents, so on average 1 household has 2 woody trees. The data presented in Table 4 and Figure 5 demonstrate a linear relationship; specifically, an increase in tree quantity corresponds to a proportional increase in uptake. Kelayu Jorong, Sandubaya and South Kelayu are areas with quite large levels of carbon uptake in this study. This is possible because in terms of environmental physiology, these three areas are areas with environmental conditions that are still quite natural. Even in Kelayu Jorong there are still several springs found, so the area is relatively fertile and there is also quite a lot of agricultural activity.

Table 4. Total estimated absorption of carbon emissions by existing household trees in 7 sub-districts in Selong district

No.	Village	Respondent (people)	Existing Trees	Emission Uptake Estimation (kg CO_2/year)	Emission Uptake Estimation (ton CO_2/year)	Total Emission (ton CO_2/year)	Absorption Balance	Average Absorption/House (ton CO_2/year)
1	Pancor	56	48	4324.7520	4.324752	149.358801126	Not balance	0.077227714
2	Kembang Sari	54	104	9370.2960	9.370296	92.073363643	Not balance	0.173524
3	Kelayu Selatan	54	138	12433.6620	12.433662	88.5050043	Not balance	0.230253
4	Rakam	54	66	5946.5340	5.946534	115.6589466	Not balance	0.110121
5	Majidi	54	111	10000.9890	10.000989	84.5366752	Not balance	0.1852035
6	Kelayu Jorong	54	125	11262.3750	11.262375	71.90284922	Not balance	0.2085625
7	Sandubaya	54	205	18470.2950	18.470295	101.0021926	Not balance	0.3420425
	Total	**380**	**797**	**71808.9030**	**71.808903**	**703.0378327**	**Un-balance**	**1.326934214**

Sources: primary data calculation, 2023.

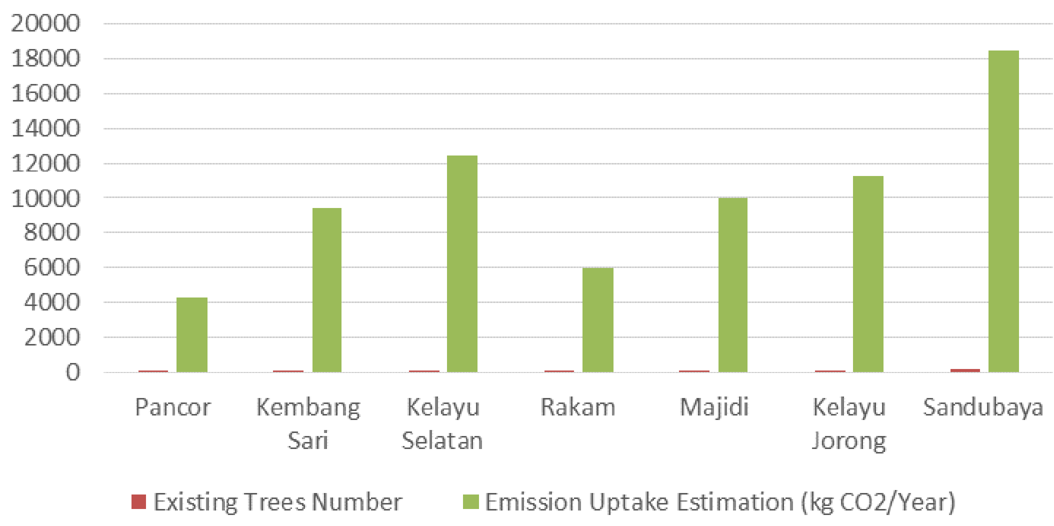

Figure 5. Comparison of existing tress numbers and emission uptake estimation (kg CO_2/year)

3.3 Discussion

People lifestyle has a very significant contribution to global warming. Carbon emissions from large-scale industrial activities do appear to have a very large impact, but there are sources of emissions that may be look give small impact as sources of emissions that originating from household activities. Based on data from Indonesian Ministry of Energy and Mineral Resources, housing sector contributes 4.63 percent of emissions, but probably this value will continue to increase in future.

Increase in population lead to an increase in the need for housing, which of course also increases energy demand. Activities that need energy, increase the emission too. In residential areas, is a common thing if there are small-scale industrial activities which certainly have an impact on increasing energy needs, either in the form of electricity, LPG or fossil fuels at production process, that contribute to additional emissions released into the environment.

As seen in Figure 1, area with highest carbon emissions is Pancor and the lowest is Kelayu Jorong. This is due to the difference in main activities in those areas. Pancor is a center of economic activity but Kelayu Jorong still dominated by agriculture activities and the furthest distance from sub-district capital (6 kilometers). District market, bus terminal, shopping center and service activities even in the education sector too, centralized at Pancor.

An education-based Islamic foundation named NWDI (*Nahdatul Wathan Diniyah Islamiyah*), located in Pancor. Large number of schools owned by this foundation, ranging from kindergarten to academy and university, has emergence of new settlement enclaves and increasing number of residents from outer area, even from outside the West Nusa Tenggara province. People as newcomer in this mostly students that studying at the largest private universities in West Nusa Tenggara province (Figure 6). This condition causes quite a lot of residents setting their homes as boarding places for students as well as for people who work around the Pancor area. It also causes high energy demand, especially electricity.

Figure 6. One of buildings at Hamzanwadi University at Pancor, East Lombok Regency

More population and dense settlement increase activities to meet various needs causes increase in energy needs used to prepare all these needs. Dense occupants in each house cause more emissions which affect air quality and surrounding environmental conditions. People lifestyle has a very significant contribution to global warming. Carbon emissions from large-scale industrial activities do appear to have a very large impact, but there are sources of emissions that may look give small impact as sources of emissions that originating from household activities. Based on data from Indonesian Ministry of Energy and Mineral Resources, housing sector contributes 4.63 percent of emissions, but probably this value will continue to increase in future.

Figure 1 also shows that the biggest contributor to carbon emissions in a household is the use of electricity, meanwhile, Figures 2 and Figure 3 show the total carbon emissions per household and the percentage of the main sources of emissions produced. It is not surprising because with modern era lifestyles, people's dependence on electricity is very high. Almost all equipment that helps comfort and then carry out daily activities uses electricity as its propulsion. Carbon emissions originating from use of fuel in motor vehicles and LPG for prepared food are not too different in their emission contributor as seen at Figure 7. Almost all homes have motorbikes as the main transportation, especially students who board. For daily meals, they also cook using LPG gas or buy ready-to-eat food at stalls which often found at residential complexes, which of course are also cooked using the same gas during the cooking process. Only Pancor continues to provide high value as a contributor for LPG.

Figure 7. Land use in a residence for micro-scale economic activities to fulfill daily needs, which can increase energy consumption, such electricity, fuel and LPG gas

This is understandable because as the center of almost all activities, whether economic, education, services and so on, the road network is also very diverse at Pancor, ranging from main roads to small roads in residential areas. Road networks associated with economic activities. Population density, both natives and newcomer increasing daily need for efficiency and effectively, led to emergence micro-scale economic activities, such as food stalls or ready-to-eat food outlets. That’s why Pancor contribute the highest carbon emissions from LPG use.

Contribution of transportation aspect not to differ in all sample’s location, probably caused by the ownership status of vehicle. Not everyone has a private vehicle. It found that 32-48% of respondents did not have private vehicles and did mobility using public vehicles. Common public transportation are city cars, horse-drawn carriages and motorcycle taxis. Rakam shows slightly different values because mobility in this area quite high due to average population works outside, so transportation need is higher than other research locations.

Cities for the last two decades have been at the forefront of climate action. Urban trees are doing a lot to influence how much CO_2 we have in the air. This also applies in small towns like Selong. Implementation of Regional Regulation Number

2 of 2012 is regarding regional spatial planning for East Lombok Regency for the period 2012-2023 has regulated space zoning for various purposes [24], including public spaces as RTH and urban green belts. RTH as urban forests is very important because it is one counterbalance to carbon emissions originating from daily community activities.

Forest edges tree release and store carbon at similar rates as forest interiors, but Hundertmark et al. [25] found edge trees grow faster than deep in the forest, and that soil in urban areas can hoard more carbon dioxide than previously thought. The rates of carbon uptake, the rates of photosynthesis are higher. The trees are growing faster because a tree growing in the city is not competing with other trees for light. There is a lot of water, because humans irrigate them with a sprinkler system, or the trees can also tap sewer lines and water lines. And there's extra nitrogen coming down in the rainwater that acts as a fertilizer.

We should have lots of trees in cities. But there is a lot more nuance to that statement. We need to think about where is there space for trees to grow and thrive. Planting trees in urban areas, whether in residential complexes, commerce, offices, industrial areas and even on empty land such as open spaces and on roadsides, can help reduce emissions as seen at Figure 8. Trees in the city road network system are planted at the boundaries of the useful space of roads, medians, or alternatively, it can be found on the dividing line, below the attachment to Public Works Minister's Regulation No. 5/PRT/M/2012, which concerns guidelines for road network tree planting. The choice of tree species as shown in Figure 8 is also under these regulations, because the location is at a road intersection, so one of permitted plant to be planted are tree species that do not obstruct traffic users' view of road signs and traffic lights. This is the basis for choosing the type of palm plant by local government of East Lombok Regency.

Facts also show that along the roads in Selong sub-district, there are still various trees, both to shade the roads (palm, trembesi, tanjung and mahagony) and trees from which the fruit can be harvested (jackfruit, mango, kind of cherry that called *kersen*/*talok*, water apple, breadfruit, and so on). This can be an easier step towards greening cities, especially in cities with higher emission concentrations.

Their results can challenge current ideas about conservation and the value of urban forests as more than places for recreation. This concept can be combined with the existence of green open spaces (RTH) such as those in East Lombok district, especially those in Selong sub-district. At this location there are four green open spaces in the form of city park, namely Selong Town Park, Selong Forest Park, Tugu Park and one relatively new public space (Pancor Park). The last one mentioned cannot be categorized as a green open space because of the lack of trees in that location because it has only been planted for approximately 2 years and its function is only aimed at aesthetic value and comfort.

The importance of public spaces like RTH is rising as the population increases. Three public spaces are found in urban areas of the East Lombok Regency. The number of public spaces currently available is not enough to meet the needs of the community because their functions are quite diverse, however, the local government states that public open spaces have the potential to continue to increase, adapting to the needs of the population, because according to Law No. 26/2007 concerning Spatial Planning [26] explicitly stipulates that the proportion of green open space in a city must be at least 30 percent of the area.

Figure 8. One corner of Selong Town, in front of the Selong Town Park with palm trees and trembesi (*Samanea saman*) as road shade

We also need to think about how susceptible they might be in the future to climate change, because some studies have shown that even though trees are growing faster from more sunlight, hotter temperatures cause growth rates of edge trees to plummet. This is in accordance with the results of research by Ilwan and Rita [27] which studied the health of trees along roads in Selong City. The research results show that there are 2 types of damage to trees, biological factors (disease, pests, weeds and animals) and environmental factors (fire and/or weather).

However, most of the studies about activities to reduce greenhouse gases for mitigation from the source of industrial scale. It has not yet led to a reduction in household scale emissions comprehensively, just try to compare it with estimation of existing trees at the house of respondent found. All areas examined in this study show an imbalance between the emissions emitted and the natural ability of the environment to absorb them through absorption by trees as seen in Figure 4. Even though there are slight differences, there are still visible differences in the range of estimated values for carbon absorption per village. Things that can be done to reduce emissions on a household scale are by planting trees or making vertical gardens or rooftop gardens [20, 28]. Of course, use plant species that have high emission absorption capacity, as seen as Tabel 3. Local governments can also require every resident to have at least one tall and shady tree.

Lifestyle will determine amount of goods consumed, paper used, electricity used and transportation model boarded. In reality, the higher a person's economic level, the higher they are one's consumption level. Research on carbon emissions originating from households has been widely discussed due to the number of houses with all the activities of their inhabitants in a large scope will also have a big impact. Research on carbon emissions originating from households mostly only calculates the amount of electrical energy consumption used to cool rooms, the amount of income allocated for household electricity consumption for air conditioning use for reasons of convenience.

Each region has its own characteristics in terms of size and causes of emissions, their implications for emissions reduction strategies require handling varies according to the conditions of each region. Under the mandate in Presidential Regulation no. 61 of 2011 concerning National Action Plan for Reducing Greenhouse Gas Emissions (RAN-GRK), so that every region in provinces and districts should prepares Regional Action

Plans for Emission Reduction Greenhouse (RAD-GRK), which is adapted to conditions and problems [29]. This step is very necessary to support efforts of the government in reducing GHG emissions.

Downgrade scenario emissions can be achieved through optimizing land management because the regulation in the base level is exist (RTRW). The basic problem is whether the local government and community can implement it according to the rules and sustainably. This requires coordination and the willingness of all parties involved actively. In terms of regulations, there must be a commitment from all relevant parties and strict sanctions as reinforcement. This requires continuous socialization and supervision.

The initial findings from this research have been presented at a focus group discussion forum which was attended by academics, NGOs, Regional Planning and Development Agency, Environmental Service, and community leaders. There are several important points that must be underlined in order to make efforts to use home yard land a success to start steps to reduce carbon emissions on a household scale. The suggestions given are as a village/district scale pilot project. The ideal management concept is in the community, by increasing community capacity through an empowerment approach, especially for vulnerable groups (house wives and underprivileged families).

While regional regulations (PERDA) are deemed crucial, a phased approach, starting with pilot projects at the village/district level, guided by "regent's regulations," is recommended. This prioritization addresses the protracted process of PERDA ratification and strengthens local policy development.

4. CONCLUSIONS

The results of the study show that energy consumption, especially electricity, dominates the cause of high carbon emissions, while efforts to reduce emissions at the household level focus on the existence and types of trees, which when compared to the emissions produced are still far from balanced. The results show that absorption is only 0.2%, so it needs more detailed efforts to increase emission absorption.

This study is limited to the use of plant species as an alternative carbon absorber. This can be developed further to test variables other than plant species, such as the origin of materials used for buildings, types of land use that are more effective at absorbing carbon, and others.

The SEM equation model used to take policies in each more varied sample area in the future, and will be conducted in further research with populations from the center of town at buffer area, and also from rural areas. For this initial stage, SEM has not been used because it is still a sample area with characteristics of town/district centers.

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