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TRESEARCH

CARBON (C02) FOOTPRINT: AN EMPIRICAL STUDY OF FAMILIES IN THE NIGER DELTA OF NIGERIA

ITUM SAMUEL[1]

[1]Emerald Energy Institute for Petroleum and Energy Economics, Policy and Strategic Studies, University of Port Harcourt, Choba River State Nigeria

Itum Samuel: Itumsamuel@gmail.com

Corresponding Author: ITUM SAMUEL

ABSTRACT

The emission of CO2 has greatly being influenced by human activities over the years; This study aims to calculate the carbon footprint of Warri families based on energy usage and other factors that lead to higher emissions, and to suggest strategies for lowering CO2 emissions into the environment. The quantitative research approach is the strategy for collecting data. Agbargho (Ughelli North), Uvwie Local Government, Warri South, and Udu Local Government are just a few of the various Local Government areas in Delta State represented by the 200 feedbacks that were obtained from the distribution of 300 questionnaires to 300 households and oral interviews. Although we had family sizes of 11 and beyond from the questionnaires, the majority of these homes' family sizes are between four and six, contributing to a thorough demographic diversity. The alternative power supply, transportation, household equipment and devices, daily fuel consumption, each household's automobile mileage, power consumption, and carbon soot deposits reported by households in various Delta State local governments were the sources of the data. It is shown that the typical Delta State family emits roughly 14.193 tonnes of CO2. Furthermore, government policies and the intentional activities of Niger Delta families can lower this value, which will have a major effect on climate change. Everyone has a responsibility to reduce CO2 emissions, which is beneficial for the environment, the economy, and family budgets.

KEYWORDS: Consumption, Carbon, CO2, Energy, Emission, Environment, Family, Household, Reduction.

1.0 INTRODUCTION

Nigeria's economy is entirely dependent on fossil fuels for energy production, manufacturing, which is responsible for the nation's carbon emissions, and national revenue, which accounts for roughly 86% of the country's domestic revenue (Dunne, 2020). According to UNDP (2010), since energy is essential to human progress, it is also critical to end poverty, enhance human welfare, and raise living standards. Climate change is a significant issue that must be resolved quickly. According to Adeyemi et al. (2019), one of the main causes of global warming is carbon dioxide, a gas emitted when fossil fuels are burned. According to Alimi et al. (2016), fossil fuels, which are sources of greenhouse gases, pose a threat to the environment. A steady increase in GHG is linked to decreased water supplies and rising temperatures, which raise the possibility of drought and cause crops and plants to wither and die. It is also crucial to remember that a persistent danger to the climate could result in famine and inevitable fatalities. However, Gershon et al. (2019) contend that the greenhouse effect is caused by human activity and the combustion of hydrocarbon fuel, which releases greenhouse gases like CO2. Short- wave solar radiation penetrates and absorbs energy from the earth's surface due to the naturally occurring composition of greenhouse gases in the atmosphere. In order to lessen environmental degradation caused by the use of fossil fuels, Jeremiah et al. (2018) advise Nigeria to limit its reliance on fossil fuels, even if it may be challenging to completely stop using them. It is well recognized that one of the main causes of global warming is carbon dioxide, a gas emitted when fossil fuels are burned. The goal of this research project is to find areas for improvement with regard to C02 emissions to the environment since if we do nothing, the earth's temperature will continue to rise. Rich and poor countries should reduce their energy production by 4% to 5%, while industrialised nations should reduce their usage and consumption of fossil fuels, which contribute to greenhouse gas emissions, by 1%. Global energy consumption would drop from 1.1% to 0.65% per year if everyone cut productivity to 2.5% (Rezai et al, 2012).

Nonetheless, Jenny & Sara (2016) believes that there is a positive association between per capita GDP per capita, and carbon dioxide emissions, which shows expanding per capita GDP leads to greater carbon dioxide emissions. It backs up the assertion that, according to certain hypotheses, there is no turning point at which emissions begin to decline when GDP is at its peak. The

outcome indicates that market economic processes are insufficient to reduce emissions, necessitating legal control to prevent additional environmental deterioration. Reducing environmental degradation can alter the ecosystem as a whole. Despite an increase in mitigation strategies, GHG emissions have grown over the past few decades, according to an IPCC study from 2014. The earth's temperature will rise in tandem with the growth of green energy gases since there is a clear correlation between the two.

According to a 2014 assessment from the Intergovernmental Panel on Climate Change (IPPC, 2014), the ocean's absorption of CO2 has caused the ocean to become more acidic due to the influence of CO2 emissions since the start of the industrial age. This has resulted in a fall in P.H. of the Ocean surface by 0.1(high confidence), corresponding 26% rise in acidity, assessed as hydrogen ion concentration. According to Adeyemi et al. (2019), burning of fossil fuels is the primary source of air pollution, which also mixes with other industrial activities, agricultural practices, wildfires, dust storms, etc. Furthermore, it caused 4.2 million premature deaths in 2016, about 300,000 of which were in children under five. Similar evidence of exposure to emission compounds such as nitrogen dioxide (N02) and sulphur dioxide (S02) leading to adverse impacts on the environment and human health was presented by Pieprzyk et al. (2009) in support of this report. Humans may develop chronic respiratory conditions as a result of these exposures, as youngsters in the Niger Delta region have already shown. Additionally, the chemicals can exacerbate chronic bronchitis, leukaemia, asthma, and blood diseases.

As a result, humans engage in activities that produce greenhouse gases (GHGs), such as carbon dioxide, carbon monoxide, and methane (CH4). The total amount of GHG produced as a result of these activities is known as the carbon footprint. According to The Nature Conservancy (2021), the average carbon footprint per person in the US is 16 tonnes, which is among the highest rates worldwide. Globally, the average is closer to 4 tonnes; by 2050, it must be less than 2 tonnes. Avoiding a 2°C increase in global temperatures is one approach to accomplish this, according to the IPCC (2014).

2.0 LITERATURE REVIEW

The IPPC report makes it abundantly evident that due of human impact on the climate system, anthropogenic GHG emissions are at an all-time high. The atmosphere and oceans have warmed, sea level has increased, ice and snow have decreased, and the earth's surface has warmed more than in any other decade since 1850. The burning of fossil fuels, deforestation, changes in land use, fertilisation, livestock, etc. are some of the activities that lead to a net rise in emissions.

Susan et al. (2019) examined the impact of natural resource extraction while taking into account the Nigerian Niger Delta Region's economic performance. They discovered that extractive activities have a positive impact on the total state-level revenue in the form of production-based derivation funds from oil-producing states, which has a positive impact on their GDP. GHG emissions during these extraction operations are consistent with the positive correlation between GDP growth and GHG emissions. Gershon and Patricia (2019) looked into and evaluated the amount of greenhouse gases that Port Harcourt families create due to energy use and other causes. Families in Port Harcourt emit 5.21 tonnes of CO2 on average, according to data collected using the input-output approach and questionnaire. According to the study, every household might significantly reduce greenhouse gas emissions by making little adjustments to their daily activities. They believed that tiny savings made by individuals would add enough to create climate change.

The Product Carbon Footprint (PCF) of small electronic devices is thought to produce fewer emissions due to their size, but Yung et al. (2018) investigated the amount of carbon emissions emitted by personal electronic products because he believed that this should not be the case. According to his findings, printed circuit boards were the primary source of carbon emissions, with the extraction of raw materials also having an impact. Sensitivity analysis conducted during the material extraction and manufacturing stages revealed that they produced the most amount of carbon emissions, according to the report.

Balogh & Jambor (2017) used a GMM model on a panel dataset with 168 countries and 24 years of testing to determine the relationship between CO2 and its various causes by utilising a complex model involving economic growth, energy use, industry structure, tourist arrivals, foreign direct investment, trade, and agriculture worldwide. Their findings supported the classic environment Kuznets curve assumptions, showing that while energy from coal increased environmental pollution, nuclear and renewable energy contributed to a decrease in CO2 emissions. Additionally, their findings demonstrated that financial development lowers air pollution.

80% of Nigeria's carbon emissions come from burning fossil fuels, according to a study on CO2 emissions and their effects on the environment by Adeyemi et al. (2019) that used secondary data from the World Development Index (WDI) from 1970 to

2017 using the Johansen co-integration technique. An urgent establishment of a sustainable energy framework that highlights the risks of utilising contaminated fuel is another suggestion. Because millions of Nigerians lack access to electricity, the country has one of the highest energy poverty indices in the world. Nigeria is experiencing significant effects from climate change, including rising temperatures and a lack of access to electricity and air conditioning.

The extent to which population increase among the magnum cum is influenced by carbon emissions Daramola et al.'s (2021) study of oil-producing African nations found a strong and unfavourable relationship. Furthermore, it is crucial to recognise the connection between CO2 emissions, economic growth, and the use of renewable energy. According to research by Ezenwa et al. (2020), there is a two-way causal relationship between economic growth and renewable energy consumption (REC). While REC has a beneficial impact on GDP over the long term, it has a negative impact in the short term. Decarbonising Africa, according to Gershon et al. (2022), lessens the burden of diseases and other environmental issues.

Additionally, a study conducted by Romanus et al. (2019) to determine the effects of oil price shocks on net oil-importing countries revealed that an increase in oil prices temporarily raises GDP per capita in the short term, which contributes to carbon emissions and is consistent with the positive relationship between CO2 and GDP growth. Premium motor spirit (PMS), another name for petrol, is known to release volatile organic compounds (VOCs), which have a negative impact on ground-level ozone production and health consequences. Obindah et. Al (2020) believes that the higher the evaporative quality of gasoline the greater the VOCsemitted into the environment, he therefore recommended that if we want to achieve a reduction equivalent gasoline loss by 97.67% and VOC emission it is important to reduce the vapor quality with efficient recovery and control regulation.

3.0 METHODOLOGY

The increased emission of CO2 into the environment forms the objetive for this study and the need to reduce carbon foot front in the Niger Delta while recommending measures to keep the rise in global avaerage temperature well below 2°C and also limit the increase to I .5°C (UN, 2015) by the United Nations Conference on Climate change International (UNCCCI). Transport, Food, Energy Use, waste managemnt, electronic devices, and daily household activities are major factors that contribute to carbon footprint of the houshold in Warri.

The input-output and questionaire approach was deployed as primary data collection for the factors mentioned which are the most relevant factors that affects and emmits GHG in houshold. These factors includes:

3.0.1 ELECTRICITY SUPPLY TO HOUSEHOLD:

Get Invest Opines that only 40% - 45% of Nigerian have access to electricity as of 2014 (Get. invest, 2021). According to theman average of 3.1 GW was supplied in 2015 which can only cater for one third of the country’s minimum demand forcing customers to rely on privately owned generators" which is a major source of GHG. We deployed Questionnaire to households resident in Warri to find out the following:

a) How often do they enjoy Power supply from BEDC

b) What alternative they use to generate power supply as an alternative to insufficinet or no power supply?

c) How many electricity power generators they have, if their alternative is an electric power generator?

d) How often they use these power generators and how many liters they use on weekly basis ?

3.0.2 TRANSPORTATION:

People prefer to drive from the comfort of their homes as a result of this, the transport sector is one of the biggest sources of anthropogenic greenhouse gases in houses. CO2 is released when fossil fuels like petrol and diesel, which these cars need, are burned. The accumulation of CO2 and other gases warms the atmosphere, leading to climate change. Transportation is responsible for around 28% of greenhouse gas emissions in the United States, according to the EPA (2021). The average passenger car generates 0.78 pounds of CO2 per mile travelled, according to the Centre for Sustainable Systems (2020).

We would investigate the use of questionnaires to determine:

a. The number of cars utilised by each household in Warri b. The frequency of use of these vehicles

b. These vehicles are utilised to calculate mileage.

3.0.3 HOUSE HOLD ELECTRONICS AND GADGETS:

According to a 2020 study by the Centre for Sustainable Systems, residential electricity accounts for 10% of all CO2 emissions in the United States, while residential space heating and cooling accounts for 44% of energy used in homes. Additionally, they stated that the power plant releases an average of 0.953 pounds of CO2 for every kilowatt-hour produced.Additionally, washing machines produce 26 mmt of CO2 annually in the United States. furthermore, we would investigate the use of questionnaires and spoken communication to ascertain:

a. How many refrigerators are currently in use in your home?

b. What is the number of gas or electric burners in a household?

c. How many microwaves are used in each home?

d. How many water (or other) heaters does each household use

e. How many washing machines (Plates and cloths) does each household use

3.0.4 INDUSTRIES LOCATED AROUND COMMERCIAL AREAS:

The Niger Delta is bordered by enterprises that produce greenhouse gases by burning fossil fuels for energy in residential areas. According to the EPA (2021), industries accounted for 23% of greenhouse gas emissions in 2019. Additionally, we would investigate the use of questionnaires and spoken communication to ascertain:

a. If homes have carbon soot (also known as black soot) deposits nearby

3.1 APPLICABLE EQUATION

For the purposes of this study, emissions were viewed from four different perspectives using data and parameters like average car mileage per gallon, energy sources, average driving rate, energy consumption rate, and family size, all of which have a significant impact on carbon emissions.

3.1.1 TRANSPORTATION

The following average carbon content values are used by organisations like the EPA to calculate CO2 emissions: 8,887 grammes of CO2 are released every gallon of petrol. Diesel emits 10,180 grammes of CO2 per gallon. Diesel fuel produces 15% more CO2 per gallon, according to the U.S. Environmental Protection Agency (2014). Nevertheless, vehicles that use diesel fuel have higher economy than comparable vehicles that use petrol, which typically compensates the higher carbon content of diesel fuels. The majority of cars in the Niger Delta run on petrol and travel an average of 4.8 km (3 miles) from a residential area like Energhe to Airport Road (a commercial area), but some go an average of 20 km (12.4 miles) from Agbarho (a residential area) to Jakpa (a commercial and residential area). According to U. S. Environmental Protection Agency, (2014) a gallon of gasoline is burnt every 21.6 mile. Therefore an average vehicle burns

$$\text{CO2 emission per mile} = \frac{8{,}887\ \text{g CO2/gallon}}{21.6\ \text{miles/gallon}} = 411\ \text{g CO2 per mile} = 0.000411\ \text{metric ton CO2 per mile}$$

A gallon of Gasoline = 3.7 liters

Therefore, it is assumed that an average vehicle uses an estimate of 3.7 - 5 liters per mile depending on vehicle/personnel fuel economy.

Therefore, for household per vehicle in a year:

$$\text{CO2 emission} = (\text{CO2 emission per mile}) \times (\text{total mileage in a year}) \times (\text{emission factor})$$

3.1.2 ELECTRIC SUPPLY, HOUSEHOLD ELECTRONICS AND GADGET

According to (Gershon O. a., 2019) emission from Electricity consumptions can be calculated as

$$GHG_{em} = \frac{12 \times \left(\frac{cost}{month}\right) \times \text{emission factor}}{\text{tariff} \div \text{Number of Household Occupants}}$$

MAIN (GRID ELECTRICITY):

$$GHG_{em} = \frac{12 \times \left(\frac{\$}{month}\right) \times KWH \times \left(\frac{\text{tons CO2e}}{kWh}\right)}{\text{Number of Household Occupants}}$$

$$= \frac{12 \times CO2e}{\text{Number of Household Occupants}}$$

HOUSEHOLD GENERATORS:

$$GHGe = \frac{12 \times \left(\frac{liter}{month}\right) \times \text{Energy density} \times \text{Emission factor}}{\text{Number of Household Occupants}}$$

$$= 12 \times \frac{liter}{month} \times \frac{MJ}{L} \times \frac{\text{tons CO2}}{MJ}$$

$$= \frac{12 \times \frac{\text{tons CO2}}{month}}{\text{Number of Household Occupants}}$$

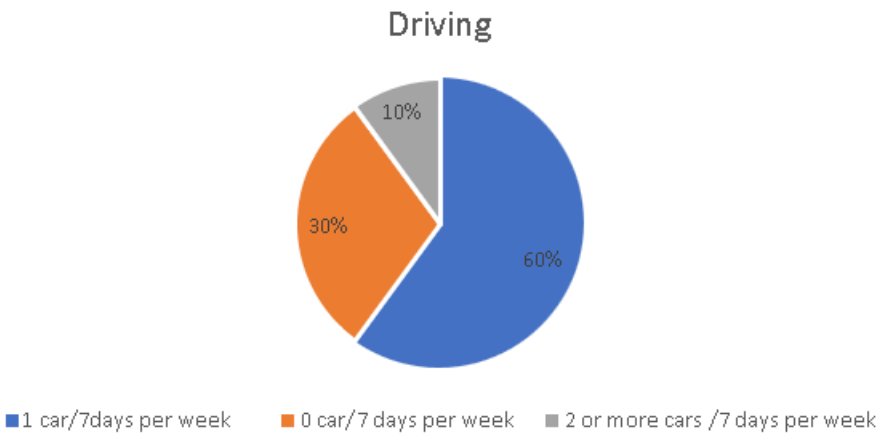
Industries and Commercial areas Located with residential areas: Depots, refineries, airports and commercial areas release CO2 as result burning fossil fuels. Carbon Black Particles (Soot) reduces the quality of air within the environment.

3.3 ANALYSIS AND RESULT

Only 200 responses were obtained from the three hundred (300) questionnaires that were distributed, accounting for around 70% of the Delta State areas that were chosen, including Agbargho (Ughelli North), Uvwie Local Government, Warri South, and Udu Local Government. The questions aim to determine the annual CO2 emissions of an average family in these areas. Using the primary data collection method and the previously indicated methodology, the carbon footprint of an average family in these areas was determined.

3.3.1 DRIVING

According to the data collected, over 60% of households said they now use one personal vehicle every day of the week, 30% said they use public transportation instead of a personal vehicle, and 10% said they use two or more personal vehicles every day of the week.



Those who use 0 car for 7 days per week use public transport for their movement.

A. CO2 EMISSION FROM DRIVING PER MILE IN A YEAR

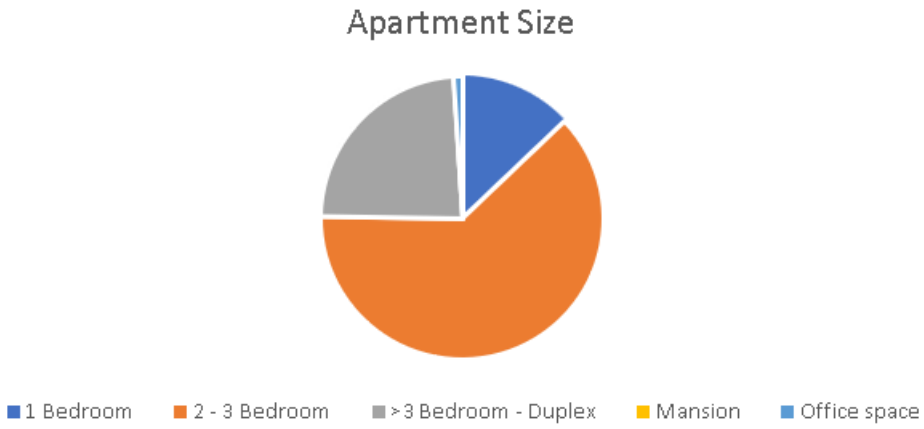
CO2 Emission per mile is 411g Per CO2 per mile = 0.000411 metric ton

An estimated average distance covered by vehicles in Warri per day = (12.4 + 3.4)/2 = 7.7 mile

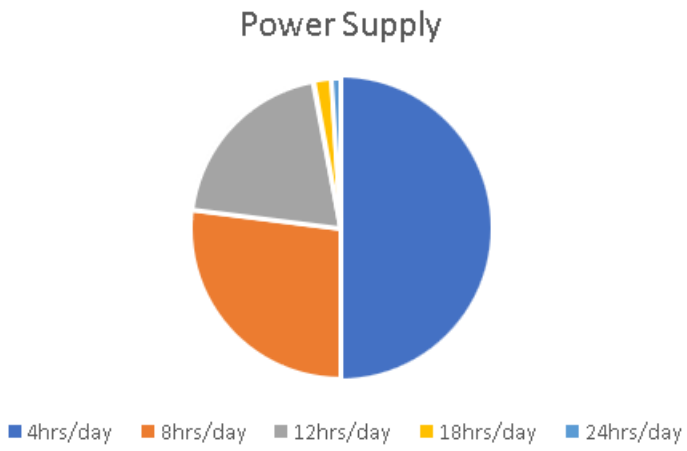
$$\text{CO2 emission per day} = 0.000411 \times 7.7 \times 365 = 1.15 \text{ metric ton CO2 per average car per year}$$

3.3.2 HOME ELECTRICITY

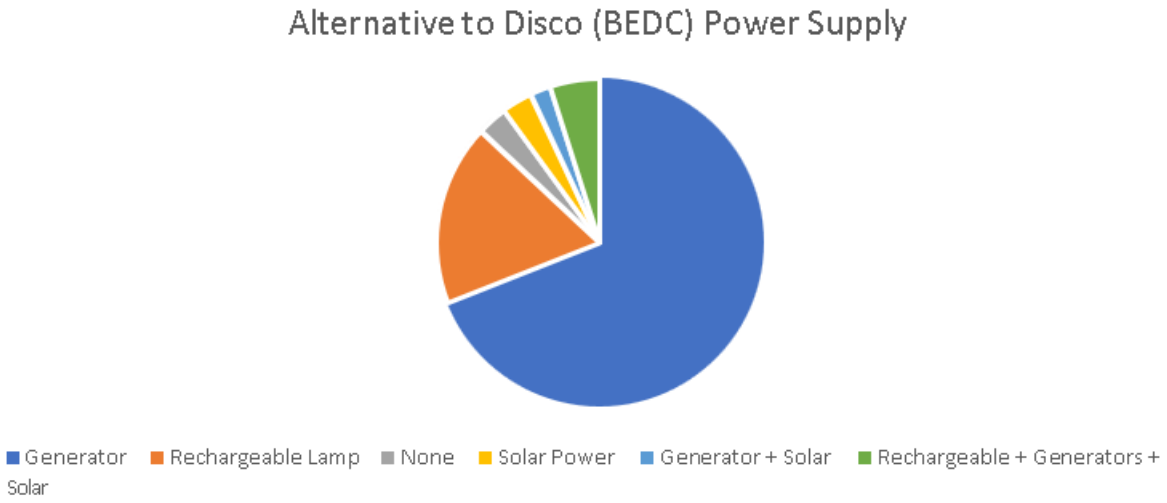
Approximately 62% of respondents said their household now resides in an apartment with two to three bedrooms, 13% said they live in a one-bedroom apartment, 24% said they live in a flat or duplex with more than three bedrooms, and 1% said they live in an office space.



Based on the data collected, 50% of households in Warri receive power from BEDC for 4hrs/day, 27% for 8hrs/day, 20% for 12hrs/day, 2% for 18hrs/day, and 1% for 24hrs/day.

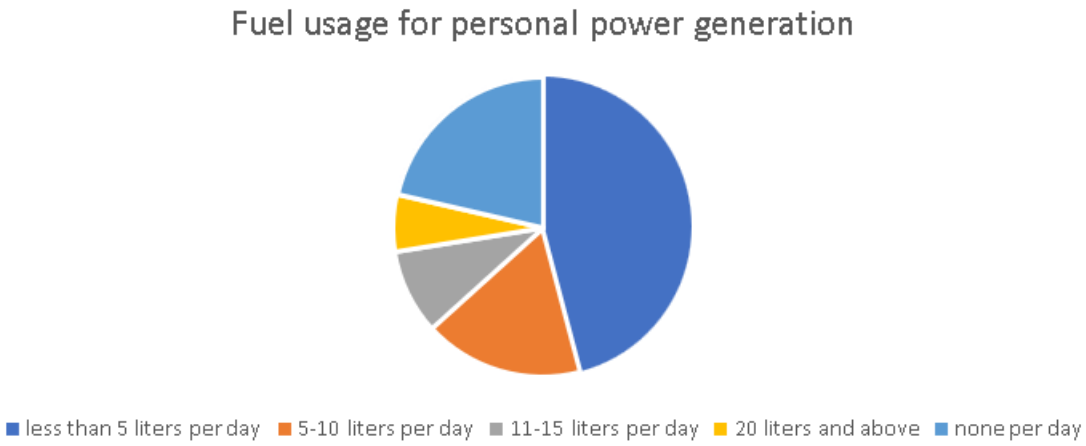


On average, 69% of people use a personal generator in place of a Grid power supply, 18% use rechargeable lamps in the event of a power outage, 3% said they have no light source during the power outage, 3% use solar panels to generate power, 2% use both solar panels, rechargeable lamps, and generators, and 5% use both rechargeable lamps and generators when the disco-BEDC (Grid) power outage.



Fuel Usage Per day per household:

45% indicated 5-10 liters of gasoline per day 17% indicated 11-15 liters per day 9% indicated less than 5 liters per day 6% indicated 20 liters and above per day 21% indicated none, from verbal interview, some people in this category stopped using their personal generators because they lacked sufficient funds to maintain and refill their fuel tanks.



B. CO2 EMISSION FROM GENERATOR USAGE PER YEAR:

Recall that 1 gallon of gasoline = 3.7 liters of gasoline = 8,887 g of CO2 1 Liter = 8,887 / 3.7 = 2,401 g of CO2

An average family uses 7 liters per day of gasoline:

$$7 \times 2{,}401 \times 365 = 6{,}134{,}555 \text{ g per year} = 6.13 \text{ ton of CO2 per year}$$

C. CO2 FROM POWER SUPPLY (DISCO-BEDC)

According to Gershon et al (2019) who studied CO2 footprint of families in Port Harcourt, he wrote that "Around 1.216 lbs (0.55 kg) of CO2 is produced per kilowatt-hour for electricity at its source and 1.307 lbs CO2e (0.59 kg CO2) per Kilowatt-hour delivered electricity (at home)".

An average household in Warri uses

1. Television (32 inch) – 70 watts
2. Iron – 800 watts
3. Fan – 100 watts
4. Fridge – 800 watts
5. Microwave (20%) – 800 watts
6. Water heater (60%) – 3,000 watts
7. Washing machine (30%) – 2,200 watts
8. Bulbs – 200 watts
9. Air condition (40%) – 1,500 watts

Total = 9,470 watts A combined estimated average of 4,735 watts per hour = 4.735 kWh considering the percentage not using microwave, washing machine, air condition and water heater.

Assume an average of 4 hours per day:

$$4.735 \text{ kWh} \times 4 \text{ hrs} \times 365 \text{ days} = 6{,}913.1 \text{ kWh per year}$$

$$6.913 \times 0.59 = 4.09 \text{ ton CO2 per household from electricity use}$$

D. COOKING:

All households indicated the use of cooking gas (LPG) in their household which is the cleanest form of fossil fuel and contains little or no emission (EIA, 2021).

Therefore, the average family in Warri emits about 1.15 + 6.13 + 4.09 = 14.193 tons of CO2 from the above sources alone.

4.0 CONCLUSION AND RECOMMENDATIONS

These measures According to research by Jenny & Sara (2016), there is a positive correlation between GDP and CO2 emissions. This means that any country's GDP will inevitably rise in response to an increase in CO2 emissions. Since market economy mechanisms are insufficient to reduce emissions, the government, private citizens, and partners must work together to prevent further environmental degradation.

Carbon Footprint Reduction Recommendations: When implemented, certain deliberate actions can lower the amount of CO2 emissions into the atmosphere. Government regulations, individual contributions, public awareness campaigns, and the introduction and induction of habits in schools and our surroundings may all be necessary for these efforts. These actions consist of:

1. GROW A TREE CAMPAIGN: By absorbing CO2, plants and trees help clean the air and offset some carbon emissions. According to reports, a fully mature tree can absorb 48 pounds of CO2 annually (American Forest, 2021), which lowers the expense of heating and cooling a home by offering insulation and shade. Every home should think about planting at least two trees per 540 square meters and educate others to do the same. Additionally, I would suggest organising a "Go-Green campaign" for each estate or neighbourhood. This can be made feasible in large part by laws and actions of the government.
2. REPLACE GASOLINE VEHICLES AND DIESEL TRUCKS WITH COMPRESSED NATURAL GAS VEHICLES/TRUCKS: According to Consumer report (2021) the use of CNG can reduce carbon-monoxide emissions to the range of 90 to 95% and Nitrogen–oxide emissions by 35 to 60% compared to gasoline and also pegs fuel savings at about 30% less than gasoline on average although it suggests nearly 40% recently.

A report from Reuter (2021) during an interview with the Petroleum Products Pricing Agency “There is no price increase. The current (gasoline) price is being maintained while consultations are being concluded,” On Thursday, the regulator posted an online notice listing the “guiding price” for “ex-depot”, or wholesale, gasoline at 206.42 naira per liter - well above the previous pump prices of around 167 naira.

Nigeria's government can convert the subsidy funds for gasoline to subsidizing a one-time purchase of CNG-powered vehicles which will in turn save money for the citizens, diversify fossil consumption, decrease emission and save money from gasoline subsidies for the country.

In other words, the same principle can be applied to electric vehicles, but the issue would be the power supply.

3. ENERGY USE: A lot of households from data collected and oral interviews do not use high energy-efficient household equipment and devices that consume a lot of power and emit CO2. E.g a household that uses a refrigerator 800w might decide to buy a 50w refrigerator of the same capacity and volume to replace the 800w refrigerator. The W.H.O. (2008) Suggest that Placing a refrigerator of a Fridge next to a cooker or boiler consumes much more energy than if they were standing alone. Households are also encouraged to use CFL or LED light in place of incandescent bulbs and also switch off lights when they don’t need them. Another recommendation for the WHO (2008) is switching off five lights along the hallway could save costs and avoid about 400kg of CO2 emission per year.
4. ELECTRICITY GENERATION THROUGH SOLID WASTE: Waste disposal contributes to high CO2 emissions to the environment, Power Supply which is a major challenge in Warri and Nigeria can be mitigated through the Waste-To-Energy Technology. According to AKHATOR, et al (2016) “with about 14 million tonnes of combustible waste available in Nigeria, about 4.4TWh of electricity could be generated annually if WTE development in the country receives similar support from the Nigerian government”. This will help keep the environment clean at the same time provide electricity at same time saving the environment from CO2 emission.

5. WASTE MANAGEMENT: The principle of Reuse, Reduce and Recycle should be applied as often as possible. This should include: i. Reduce the use of bottled water and as much as possible use reusable water cans for daily operations. ii. Reuse shopping bags and as much as possible use product that offer refill services.
6. TRANSPORT: CO2 emission will reduce when households are driverless, explore alternative transport options like bicycles for shorter distances, and use a single car for daily activities throughout the week. According to data collected, some families use 2 to 3 cars simultaneously every day of the week, which increases carbon emissions per year per household. The Government can also encourage, develop the public transport system, and make it safer, more convenient, and affordable for all to use. The WHO (2008) also suggests that Speeding uses more petrol and emits more CO2, therefore households should be encouraged and enlightened on how speeding emits CO2. Also driving faster than 80 km per hour increases fuel consumption by 30% compared with driving 80 km per hour and higher gears (4th, 5th, and 6th) are the most economical in terms of fuel consumption.

In Summary, actions based on CO2 emission reduction are also beneficial to health; CO2 emitted by industries in residential areas can be reduced using Carbon taxes. Yue, et al, (2020) affirms that CO2 emission will be significantly reduced reaching the peak value during 2030-2040 in china's power industry, with the use of medium Tax level (TAX-2) which they employed in their research. This can meet the requirements of both CO2 emission reduction effect and cost in the power industry, which will on the long run impact on their economy, because of this effective economic policy tool.

The subject of CO2 emission reduction is everyone's responsibility, good for the environment, excellent for the economy, and good for the family budget.

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