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Effect of Sustainable Energy Data Centres in The Banking Sector in Ghana

Leslie Mantei Donkor (Engr)

Head, Data-centers at eProcess International Ghana, Data-centers, Digital Infrastructure, Power & Energy Management and Professional Engineer, Ghana
lesliedonkor@gmail.com

Abstract
Africa's energy shortfall requires creative funding. Energy infrastructure projects have been funded domestically by a number of governments on the continent via sovereign bonds, pension funds, and government budgets. The purpose of the study was to assess the effect of sustainable energy data centres in the banking sector in Ghana. The study used descriptive statistics, and regression analysis. This suggests that year is associated with the dependent variables and any increase or decrease in year is expected to influence the dependent variables. It was detected that when consumption of renewable energy, consumption of non-renewable energy, consumption of electricity and year were used to predict CO2 emissions in one model, it was identified that, consumption of non-renewable energy and time do not influence CO2 emissions. The study recommends that policies that promote consumption of renewable energy should be reviewed. There should be further analysis to understand specific temporal trends influencing electricity consumption by examining historical data, policies enacted over time, and technological advancements.

Keywords: Energy, data, consumption

1. Introduction

Economic growth and sustainable development depend on the availability of effective, reasonably priced, and dependable infrastructure data center services (Canning & Pedroni, 2018; Owusu-Manu et al., 2020). The lack of a reliable energy supply at data centres of banking institutions and its inefficiencies comes at a huge cost (Ipin & Ercan, 2021). Power shortages have a negative impact on important economic sectors and are responsible for a 2%–4% decrease in economic growth. The energy crisis cost Ghana's economy almost $24 billion between 2010 and 2015 (Yeboah & Opare, 2018). Africa's energy shortfall requires creative funding (Sackey et al., 2020). Energy infrastructure projects have been funded domestically by a number of governments on the continent via sovereign bonds, pension funds, and government budgets (Africa Progress Panel, 2015). However, around 80% of all energy spending comes from resource mobilization from utility fees and taxes; in 2016, governments in Africa reportedly set aside $6 billion to finance energy infrastructure projects (Yeboah & Opare, 2018). However, there is a significant discrepancy between real spending and allocation. It is recognized that operation and maintenance (O&M) accounts for about 75% of the allocation rather than investment. As a result, only around 0.5% of GDP, or $8 billion, is invested each year (International Energy Agency, 2014). This is dreadfully insufficient to greatly improve corporate operations and increase power access.

In order to arrange additional resources for energy infrastructure, several governments have turned to sovereign debt finance (International Energy Agency, 2014). The ability of different governments on the continent to sufficiently finance energy projects is hampered by inefficiencies in the power sector brought on by underinvestment in O&M and underselling.

It is known that the region loses roughly 8 billion dollars annually as a result of these inefficiencies, institutionalized corruption, and political favoritism (Asiedu, 2002). The annual loss of billions of dollars in revenue has made it imperative to address corruption, illicit financial flow, and opacity in utility management. According to reports, illicit financial flows cost Africa $69 billion in 2012 alone. This amount exceeds the estimated $66 billion required to satisfy the region's energy and climate adaption demands (Yeboah & Opare, 2018). According to Owusu Manu et al. (2008), external funding sources including as official development finance (ODF), Chinese investments, and private participation in infrastructure (PPI) account for about half of the infrastructure investment in the energy sector. Once more, investors in infrastructure projects have extremely few or no long-term financing options due to Ghana's less established capital market (Badu et al., 2013). Some independent power producers (IPP) turn to overseas loans at the risk of foreign exchange due to high capital interest rates and limited access to flexible domestic financing. It is against this backdrop that this study seeks to explore the effect of sustainable energy data centres in the banking sector in Ghana.

2. Literature Review

Historical overview of infrastructure financing in Sub Saharan Africa

In the context of post-colonization and an economic convention that encouraged capital accumulation as the path to economic transformation, most Sub-Saharan African (SSA) nations recognized infrastructure as a crucial sector between the 1950s and the 1970s. Due to favorable external conditions brought about by an increase in commodities, SSA governments made large expenditures in the infrastructure sector (Mengistu, 2013). However, the trend reversed in the 1980s due to a debt crisis, falling commodity prices, and the region's countries' inability to secure more loans to finance development-related infrastructure projects (Farooki, 2012; Mould, 2012). "The international development community at the time held the widely held notion that, under particular market conditions, infrastructure could be financed by the private sector, allowing the countries and their development partners to focus on other economic areas. However, the conditions were unfavorable to the private sector in the SSA countries due to limitations such as a lack of modern technology needed for the lowest level of output and lower population densities, which made the cost of providing infrastructural networks prohibitive. Additionally, the region's war and governance shortcomings produced a cloud of private investment risk that turned off potential investors" (Mould, 2012; p.105). As a result of the lack of investments, the stock of existing infrastructure declined. As a result, by the early 2000s, SSA countries fell behind the majority of emerging nations in terms of infrastructure endowment. This infrastructure gap was quite large, which resulted in low economic growth (Foster et al., 2008).

3. Conventional funding sources

- *Public funding at home.*

Lack of energy access limits economic opportunities and is a significant barrier to Africa's progress (International Energy Agency, 2014). In order to finance infrastructure, the continent has historically relied on domestic public funding sources such as budgetary allocation, taxes and tariffs, and various forms of donor assistance. This has been dreadfully inadequate, despite accounting for a substantial share of the continent's total investments in energy infrastructure (International Monetary Fund, 2014). According to the International Monetary Fund (2014), 72.9% of total infrastructure finance in Africa in 2012 came from domestic public investment, or 59.4 billion dollars. The fact that African countries have usually expanded their investment in infrastructure, especially energy infrastructure, is positive. The energy industry now accounts for about 5% of the infrastructure budget, according to Infrastructure Consortium to Africa, Infrastructure Consortium for Africa (2014). In 2013, 37% of the budget went to the energy sector and 41% went to the transportation sector (Infrastructure Consortium for Africa, 2014). External financing makes up the extra percentage of the previously mentioned domestic finance. The three main external funding sources are PPI, Chinese FDI, and ODF (Sy & Copley, 2017).

- *Financial institutions.*

Commercial banks also provide a means of financing debt. However, among corporate bond financing and loans from European Investment Banks (EIBs), they are often considered the least preferred financing alternative. Refinancing energy infrastructure projects that require an economic lifetime of 20 to 50 years will not benefit from its relatively short maturities of an average of 5 to 10 years (European Commission, 2011). The short-term lending exemplified by commercial banks' loans may be more suitable for privatization and acquisition than long-term bond issuance for funding concessions and PPPs (World Economic Forum, 2010).

- *Multilateral Development Banks.*

Multilateral Development Banks (MDBs) are responsible for providing financial support and professional advice on economic and social developmental activities in developing countries. They are also a vital source of finance for energy infrastructure projects (World Bank and AFDB, 2011). These include the four major regional development banks—ADB, AfDB, EBRD, and IADBG—as well as the banks of the World Bank Group, the Nordic Investment Banks (NIB), and the EIB.

- *Capital markets.*

"Most infrastructure financing usually starts with a medium-term bank loan during the construction phase, followed by a long-term capital market refinance when the project starts to generate revenue that can be used to repay debt financing" according to Irving and Manroth (2009). Therefore, capital markets provide long-term financing as opposed to bank loans. The bond and stock market are examples of capital markets. The bonds have an average maturity period of ten years, which is rather long (European Commission, 2011).

- *Grants.*

In some situations, "equity support" is usually given to facilitate the process of raising the required equity for projects. It is given out in accordance with specific rules to assist the private sector in pursuing certain projects that would not be too costly for it to handle alone (European Commission, 2011). Again, because banks often need developers to commit between 20% and 40% of their equity before granting the remaining cash, grants help get financing in the form of bank loans (Mould, 2012). Organizing energy funding across Europe is the responsibility of the Trans-European Networks for Energy (TENE) and European Energy Programme for Recovery (EEPR) initiatives (European Commission, 2011).

Private participation in infrastructure as innovative approach

According to the World Bank (2013), infrastructure is regarded as a PPI if a company or private investor assumes some of the project's operating risk. PPI requires cooperation between the public and private sectors in order to improve infrastructure stock, quality, and performance through a contractual agreement. PPI is a strategy for increasing the effectiveness of long-term asset lifecycle management, operation, and maintenance. PPPs or the mobilization of private funds through commercial loans are two examples of how it can manifest. For a given project, the private sector offers financial expertise, efficiency, utility self-sustainability, and improved services. The public sector provides investment protection, financing availability, and a favorable business environment (Kirkpatrick et al., 2006).

Again, a favorable regulatory environment is essential for PPI success because the infrastructure sector has inherent monopoly characteristics (Kirkpatrick et al., 2006). Without credit improvement or assurances from the government or multilateral organizations, PPIs might not be feasible. Since the infrastructure sector necessitates some initial investment in building during the early stages with log run earnings, the absence of a strong credit market to offer debt financing alternatives to the private sector will be problematic (Shirley, 2007).

Challenges to the innovative financing of data center energy infrastructure

Even while creative funding is becoming more and more significant on the continent, there are still issues that prevent it from being successfully adopted and implemented (Badu et al., 2012). Some of the obstacles to innovative financing in the energy sector are listed below.

- *Heterogeneity and complexities in contracts.*

According to Chan et al. (2009), contractual agreements related to project financing are incredibly complex and frequently require protracted discussions and time-consuming paperwork to finish. The upfront cost is typically increased by these structural difficulties. According to Chan et al. (2009), project financing has a distinctively high cost of capital since it presents a greater risk to lenders than the conventional method. According to Chan et al. (2009), the private sector is more likely than the public sector to inflate investment in a private sector gain.

- *High up-front cost*

The initial cost of building infrastructure is typically significant. Despite decreased operating costs over the project's lifetime, the operating project's final earnings may not even be significant given the initial high capital cost. Due to contractual and regulatory uncertainty, private sector investors are discouraged from investing in the early stages, and the various governments on the continent are often unable to pay the upfront costs of development (International Energy Agency, 2014). Developer equity, which is costly and hazardous, is the only private financing alternative available in these situations. In order to attract more private sector participation, it is imperative to address the cost of funding for a project's early stages (Sy & Copley, 2017).

- *Lack of transparency.*

For every trustworthy investor, risk evaluation and mitigation strategies are essential. A private investor should ideally base their decision to participate in a similar or identical business on the terms and historical data or information of known contracts. However, circumstances in which such information is either nonexistent or classified cause difficulties and deter investors. Traditional funding bodies have managed to put some conditions to counterbalance increased financial allocation due to the lack of transparency and the high degree of discretion enjoyed by politicians in the subregion (Mengistu, 2013).

- *Currency risk.*

When there is a currency mismatch between assets and liabilities, currency risk may occur. For example, a power plant in Ghana might have energy pricing in cedis and be financed in dollars. When the cedis loses 10% of its value in relation to the dollar, the liabilities increases by 10% while revenues stay the same. An asset-liability mismatch results from this. In PPP, a risk is ideally assigned to a party that can take on the risk at the lowest possible cost or is in the best position to do so. None of the parties involved may be in a good position to assume the risk in some circumstances. A typical private-sector developer cannot affect the exchange rate. Therefore, unhedged currency risk can be well beyond what both parties can handle (Mengistu, 2013).

4. Methodology

The methodological approaches that were used in this article are Descriptive statistics, and regression analysis. The population for this research are the annual electricity consumption (both renewable and non-renewable), and CO2 emissions. Thirteen data points were sampled each from annual electricity consumption, and annual CO2emissions all from 2010 to 2022. All data used in this study were obtained from data gathered and published by public offices in the Ghanaian community space. The documents that contained data points used in this analysis are evidence that the data points are valid and reliable. Through the attempts made by various governments over the past fourteen years to implement them as laws or policies serves as a piloting activity making data certified for use so far as reliability, validity and piloting are concerned. All data used in this article are secondary data which was obtained from credible internet sources. Data was retrieved directly from the websites of banking institutions, companies and organizations. Analysis of data was done with SPSS. Other problems were from the software used, in this case, SPSS. ANOVA was used and tables extracted and further used to find significance of the cases where time was used to predict consumption of electricity, consumption of renewable and non-renewable energy and CO2 emissions to enhance the analysis. Four key areas were discussed in this section of the study. These topics included Total Electricity Consumption over time, Consumption of renewable energy over the years, consumption of non-renewable energy since the last thirteen years, and CO2 emissions from 2010-2022. Further analyses were conducted using regression technique for better understanding of variables used. The section begins with the analysis of the effect of year (time) on electricity consumption, secondly, analysis of effect of time (year) on renewable energy, thirdly, impact of years on non-renewable energy, fourthly, analysis of the effect of time (year) on CO2 emissions. Finally, the effect of time, consumption of renewable and non-renewable energy, and consumption of electricity on CO2 emissions was treated. Data used in the following analysis were obtained from statista.com, World development indicators, Ghana Key Energy Statistics handbook, Ghana Electricity Consumption, Export and Import 1980-2013, Ghana Energy Commission, and Ghana – Countries & Regions – IEA. The Kruskal-Wallis test, mean score ranking, and descriptive statistics were the analytical methods. Additionally, validity and reliability tests were also carried out.

5. Results and Discussion

The aim of this study is the effect of sustainable energy data centers in the banking sector in Ghana. This part of the section contains the charts, paragraphs, and tables that give results which are analyzed and discussed. Four topics are discussed in this section of the study. The section begins with the analysis of the effect of year (time) on electricity consumption, secondly, analysis of effect of time (year) on renewable energy, thirdly, impact of years on non-renewable energy and fourthly, analysis of the effect of time (year) on CO2 emissions. Finally, the effect of time, consumption of renewable and non-renewable energy and consumption of electricity on CO2 emissions was treated.

Analysis of effect of time on Electricity Consumption from 2010-2022

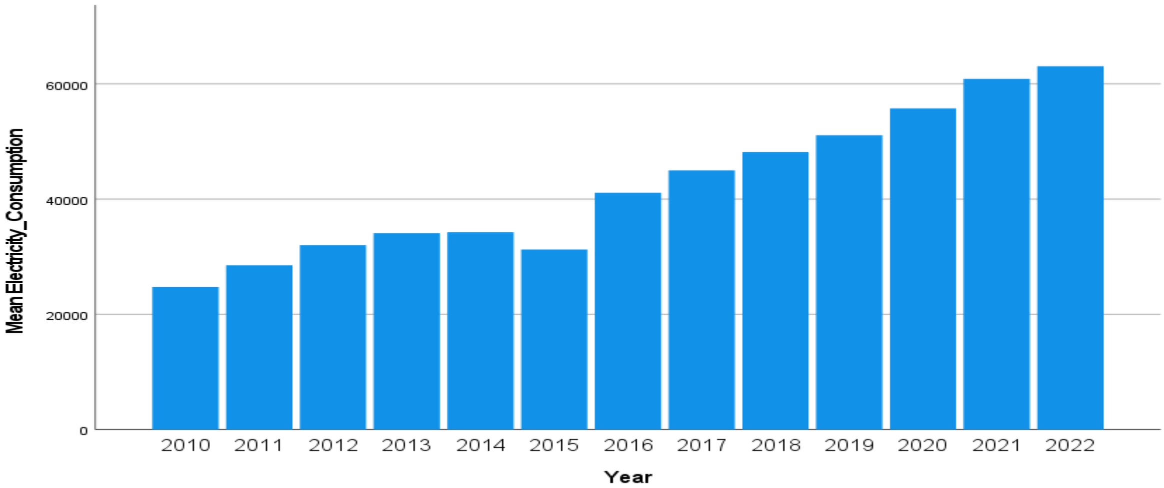

Figure 1: Trend in the total consumption of electricity from 2010-2022

Figure 1 shows a steady increase in electricity consumption from 2010-2013 and then remains constant throughout 2014. Consumption of electricity reduced in 2015 and there was a big leap in 2016 leading to increment. From 2016-2018, there was increment in consumption every year. But consumption rate was constant from 2018 to 2022. The descriptive statistics displays the sample size (N= 13), mean (M= 13772.69), standard deviation (SD=3091.862), skewness = 0.48916287, minimum value (Min= 8913), and maximum value (Max= 20063) respectively. The ANOVA of electricity consumption with time has sig= .000 and it is an indication that Year is statistically significant and therefore suggests that increase in time causes increase in consumption of electricity. Yin, Yamaguchi, Zajch, Uchida and Shimoda (2024) stated that time data is the appropriate data for modeling energy demand in residential buildings. The lowest consumption of electricity occurred in 2010 and the highest occurred in 2022. Because analysis of consumption of electricity with is not enough to achieve the aim of this study work, it was followed with consumption of renewable energy with time.

Effect of years on consumption of renewable energy from 2010-2022

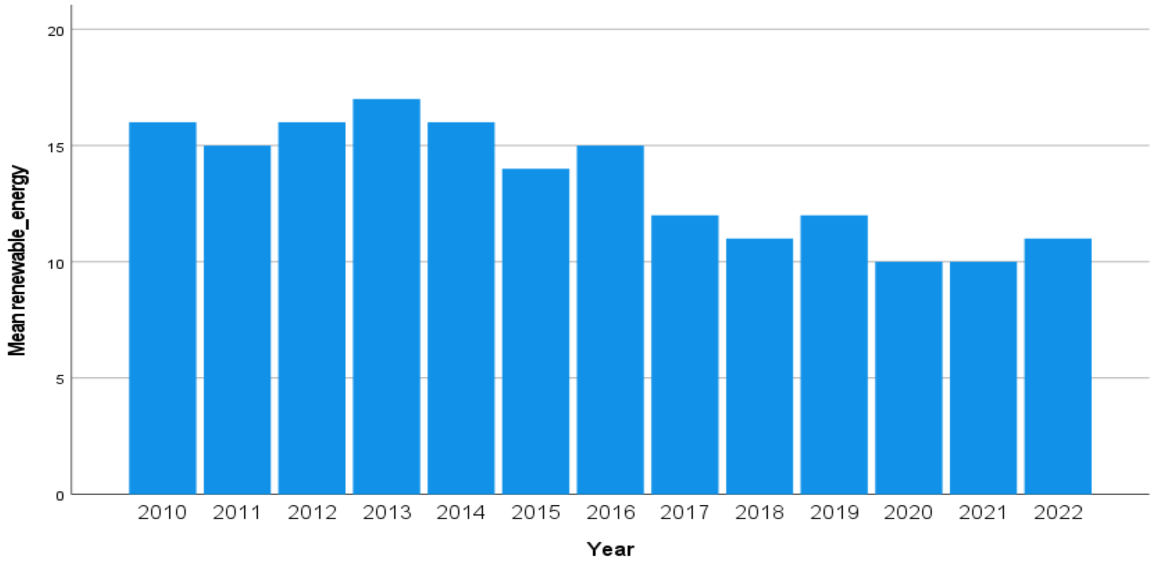

Figure 2: consumption of renewable energy (%) from 2010 to 2022

From Figure 2, it can be determined that the highest consumption of renewable energy occurred in 2013. High levels of consumption are seen from 2010 to 2016 but from 2017 to 2022, there was decline in consumption of renewable energy. Again, renewable energy consumption was constant from 2020 to 2021 and were the least levels of consumption over the thirteen years under review. It can also be said that despite the differences that may exist between the years of consumption, there were fluctuations from year to year. The distribution of consumption of renewable energy with time is, sample size (N= 13) mean (M= 13.46%), standard deviation (SD= 2.537), minimum value (10%) and maximum value (17%). The value of sig.=.000 shows that time is statistically associated with consumption of energy, suggesting that time can be used to predict changes in the consumption of renewable energy. The mean plot indicates that the highest record of consumption of renewable energy was captured on 2013 while the least records were taken on both 2020 and 2021. Analysis of consumption of non-renewable energy follows the queue to further sharpen our understanding of the behavior of sustainable energy and its effects.

Analysis of effect of time (year) on consumption of non-renewable energy from 2010 to 2022

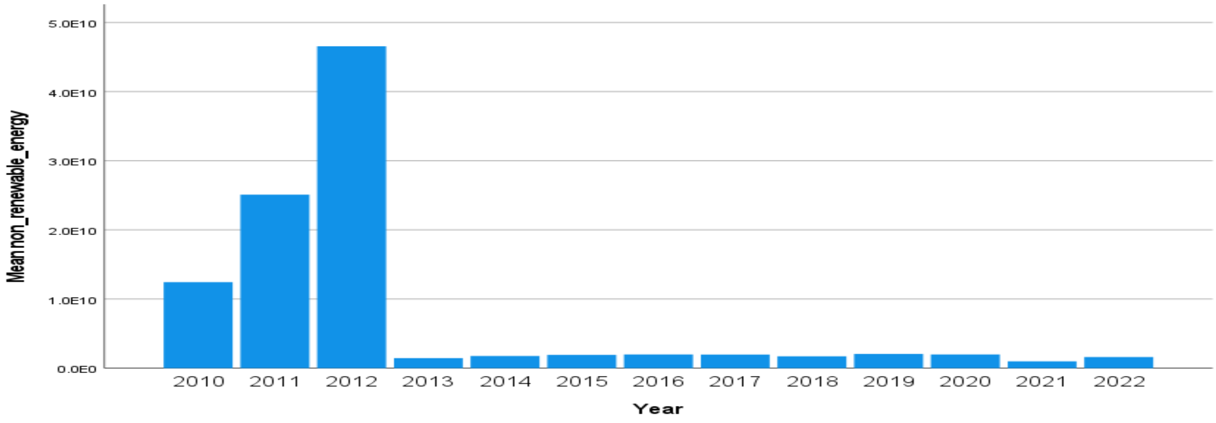

Figure 3: Graph of consumed non-renewable energy from 2010 to 2022

The description in Figure 3 shows that, the highest consumption of non-renewable energy was recorded in 2012 and reduced drastically in 2013 to 2022. From 2010 to 2012, 2010 recorded the least but that year's record was far higher than all records noted from 2013 to 2022. SPSS presented the values of consumed non-renewable energy in scientific notation which can be calculated as, for example, 1.0E10 is 1.0 multiplied by 10 raise to the power 10. Scientific notation format was used to present values on the chart but the distribution of non-renewable consumption is presented in decimal form. Sample size (N= 13), mean (M= 7807970921.30), standard deviation (SD=13513945369.145), minimum value (Min= 983143875), and maximum value (Max= 46563000055). The value of sig. = 0.04 means that time has an impact on consumption of non-renewable energy and so change in time accounts for change in consumption of non-renewable energy. The mean plot specifies that highest consumption of non-renewable energy occurred in 2012 and the least record happened in 2021. The last variable that was analyzed is effect of time on CO2 emissions which will be used in regression analysis later in this study.

Analysis of effect of time (year) on CO2 emissions

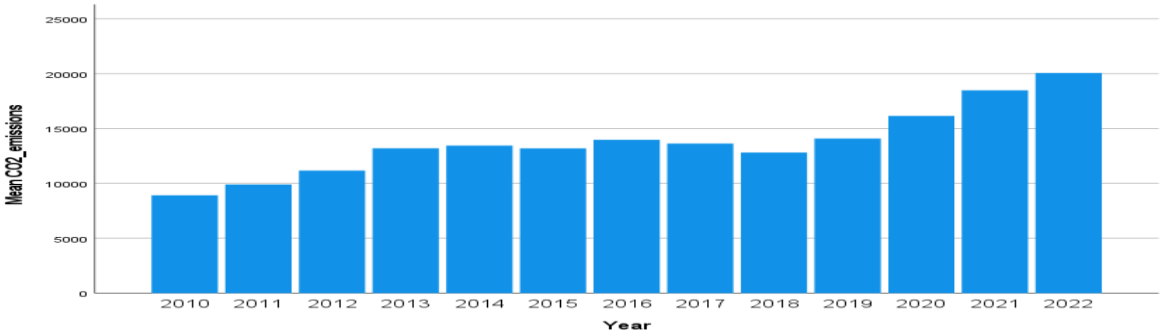

Figure 4: Chart for recorded CO2 emissions from 2010-2022

The figure shows that from 2013 to 2017, there were tiny fluctuations in the increment in emissions of CO2 until 2018 to 2020, when the emissions of CO2 increased continuously from year to year. The distribution of the sample was recorded as follows. Sample size (N= 13), mean (M= 13772.69), standard deviation (SD= 3091.862), minimum (Min= 8913) and (maximum (Max= 20063). This descriptive is followed with information on ANOVA for CO2 emissions against time. It was noted that the value of sig. = .000 shows that time is statistically associated with CO2 emissions. The highest emissions were recorded in 2022 while the lowest emissions were recorded in 2010. Further analysis are made about the effect of time, consumption of electricity, consumption of renewable energy and consumption of non-renewable energy on CO2 emissions in the following paragraphs to properly come to grips with good results that will help in making policies to safeguard our environments and for that matter, save lives.

The effect of electricity consumption in financial institutions, renewable energy consumption, non-renewable energy consumption and year on CO2 emissions

The regression statics for using electricity consumption, renewable energy consumption, non-renewable energy consumption and year to predict possible changes in CO2 emissions. Yang, Zhao and Tan (2020) found from the works of Graham-Hanssen, 2013; Jalas, 2005; Jalas and Juntunen, 2015; Smetschka,et al., 2019; Yu et al., 2019; that some researchers use energy consumption intensity to compare the ways in which emissions are generated. The correlations of consumption of electricity, consumption of renewable energy, consumption of non-renewable energy and time (independent variables). The Pearson correlation value between consumption of non-renewable energy and CO_2 emissions is (***r*** = -.524) designates that there is moderate and negative correlation between CO_2 and non-renewable energy consumption. Again, the Pearson correlation between CO_2 emissions and renewable energy consumption is (***r*** = -.698) indicating that there is a strong and negative correlation between the independent and dependent variables. Furthermore, the correlation between consumption of electricity and CO_2 emission is (r = .904) is an indication that there is a strong and positive correlation between the two variables. Correlation between CO_2 emissions and year is (r = .911) which shows positive and strong relationship between CO_2 emissions and year.

The coefficient of determination for the entire model was given as (r = .953) which is a signpost of strong and positive correlation between the dependent variable and independent variables. The model accounts for 90.8% variations in CO_2 emissions**.** The F statistic in the ANOVA is 19.789 which is larger than $F_{0.05,\,4,\,8}$= 3.84. this is a prove that the entire model is good for making predictions about the dependent variable (CO_2 emissions) and this fact is seconded by a significance value of 0.000. The coefficients of the independent variables are .101 for non-renewable energy consumption, 2.514 for renewable energy consumption, 1.619 for year and .827 for electricity consumption. The static $t_{0.05,\,8}$ =1.860 which is bigger than .101 so non-renewable energy is not significant in the model. The value is smaller than the statistic (2.514) so renewable energy has effect on CO_2 emissions. Again, the table value is bigger than 1.619 so year does not have effect on CO_2 emissions. Lastly, the statistic .827 is greater than the table value (1.860) and for that matter, electricity consumption has an impact on CO_2 emissions.

The regression model is presented as $1639647.809 + 3.472\text{E-}9X_1 + 751.614X_2 + 812.776X_3 + 0.112X_4$
From the model presented above, it interprets that when there is independent variable in the model, CO_2 emissions is expected to increase by 1639647.809 (ktCO_2). If a unit of non-renewable energy is added, emissions of CO_2 is expected to increase by 3.472E-9(ktCO_2), also, if a unit of renewable energy is add, CO_2 emissions will increase by 751.614(ktCO_2), furthermore, addition of a unit of electricity consumption is excepted to increase CO_2 emissions by 812.776(ktCO_2) and finally, a unit addition of year is excepted to increase CO_2 emissions by 0.112(ktCO_2) respectively. There are zeros in the 95% confidence interval so it is not significant. Again, there is 95% confidence that true effect of a unit renewable energy consumption on CO_2 emissions is between the interval increase of 62.304(ktCO_2) and increase of 1440(ktCO_2). It is also ascertained that there is 95% confidence that true effect of a unit in electricity consumption on CO_2 emissions is between a decrease of -.199(ktCO_2) and an increase of .423(ktCO_2). Finally, there is also 95% confidence that true effect of a unit year on CO_2 emissions is between a decrease of -344.560(ktCO_2) and increase of 1970.113(ktCO_2).

6. Findings and Discussions

The number of years has significant effect on electricity consumption, consumption of non-renewable energy, consumption of renewable energy and CO_2 emissions. According to De Lauretis et al., 2017; Druckman et al., 2012; Jalaz, 2012; Ramirez-Mendiola et al., 2018; Wiedenhofer et al., 2018; Yu et al., 2018; Yu et al., 2019), as quoted from the study of Yang et al., (2020), which reported that scholars have come to the conclusion that in order to reduce energy consumption, more studies should be made on people's time-use-pattern as well as institutions especially data centers of banking institutions. This suggests that year is associated with the dependent variables and any increase or decrease in year is expected to influence the dependent variables. It was detected that when consumption of renewable energy, consumption of non-renewable energy, consumption of electricity and year were used to predict CO2 emissions in one model, it was identified that, consumption of non-renewable energy and time do not influence CO2 emissions. CO2 emissions are influenced by consumption of renewable energy and the consumption of electrical energy. Hakan (2024) found that there is a positive relationship between renewable energy consumption and CO2 emissions which is not consistent with general expectations as he concluded.

7. Conclusion

Emissions of CO2 may have been changing with time due to various factors. Consumption of electricity and renewable energies explain variance in CO2 more efficiently than time alone, which goes a long way to indicate that energy consumption practices are solid determinants of emissions than time. There is high consumption of energy in data centers of banking institutions. It is also possible that the patterns in emissions over the time are largely affected by changes in consumption of energy rather than time. Policies that are promoting renewables are influencing CO2emissions trend rather than time. Furthermore, over the years trends in electricity consumption were not affected by consumptions of renewable and non-renewable energy. This could be due to factors such as, energy efficiency, shifts in technology, consumer behavior, economic activities and important trends in consumption of renewable and non-renewable energy that are not captured in the database used in this study. It is also possible that data interaction between variables occurred.

8. Contribution and Recommendations

The study recommends that consumption of energy should be used to predict CO2 emissions. Again, policies that promote consumption of renewable energy should be reviewed. There should be further studies to understand specific temporal trends influencing electricity consumption among industries by examining historical data, policies enacted over time, and technological advancements. Lastly, the impact of energy efficiency programs and technology on electricity usage should be examined.

9. Directions for future research

Concerning the shortcomings in the findings, the study suggests the need for further investigation into the specific factors that influence electricity consumption. This could include exploring other variables such as economic indicators, population growth, or advancements in technology, to deepen our understanding about how far this study has brought us.

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