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Exploring Ghana's Financial Journey in Energy Economics: Unveiling the Economic Landscape

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Abstract

In today's fast-changing economic, social, and financial landscape, organizations are increasingly recognizing the importance of their most valuable asset: their people. The performance of individuals within these organizations is crucial for achieving overall success. At the same time, the significance of environmental safety and sustainability is gaining prominence in emerging nations, as it positively impacts both the economy and the environment. This analysis focuses on evaluating the activities of the Ghana Statistical Service (GSS) in relation to the implications of energy economics. To conduct this research, a purposeful non-probability Likert scale survey method was employed, involving participants from various departments and agencies within the GSS. The study primarily relies on quantitative data analysis. The results indicate that a majority of GSS employees possess statistical backgrounds, which positions them well to fulfill the organization's mission. Notably, the calculations reveal that as rural financial conditions improve, there is a decrease in the standard deviation of family energy poverty. This finding is consistent across multiple non-technical perspectives. Additionally, the study highlights a higher level of consistency among rural and newly established household units. It is expected that enhanced financial participation among employees will lead to significant reductions in energy poverty. To gain a comprehensive understanding of the impact of access to finance on energy poverty, it is crucial to consider not only consumer poverty but also household net earnings as potential contributing factors.

Keywords

Ghana's Perspective, Economies, Financial Development, Energy, Ghana Statistical Service

1. Introduction

Extensive efforts have been devoted to comprehending the pivotal role of energy

in propelling global economic growth and uplifting living standards. Numerous studies have delved into the intricate relationship between fuel usage and commercial advancement (Agyekum, 2020). However, the influence of national uncertainty on energy consumption and economic progress has regrettably received less attention (Guru & Yadav, 2019). It is imperative to acknowledge that power generation plays a paramount role in shaping and expanding an economic system, as energy is indispensably employed in the production, distribution, and consumption of goods and services. As a nation's economy flourishes, the demand for resources naturally surges. Thus, the identification of factors that impact resource utilization becomes crucial in achieving sustainable economic growth. Several studies have endeavored to investigate the characteristics of energy usage across different countries, aiming to unravel its determinants. The realms of evolutionary biology, environmental economics, and historians of modern economics have all underscored the crucial role of energy in economic output and expansion (Stern, 2019: pp. 28-46). Capital accumulation stands out as one of the primary driving forces behind energy consumption. The development of the financial sector facilitates effective financial management, encourages capital flow and foreign investments, enhances banking operations, mitigates economic risks and loan costs, and facilitates smoother communication between lenders and borrowers. These factors wield a substantial influence on energy requirements by stimulating utilization and private investments. Therefore, attaining a comprehensive understanding of energy consumption becomes imperative, necessitating a meticulous analysis of its utilization. The components of financial development are visually depicted in **Figure 1**.

The pressing economic implications of environmental pollution on a global scale underscore the critical importance of renewable energy sources. The majority of the world's largest energy supplies predominantly come from non-renewable sources such as natural gas, petroleum, and coal, commonly known as "fuels". However, these energy sources come with increasing costs in terms of both production and utilization due to factors such as rapid population growth and

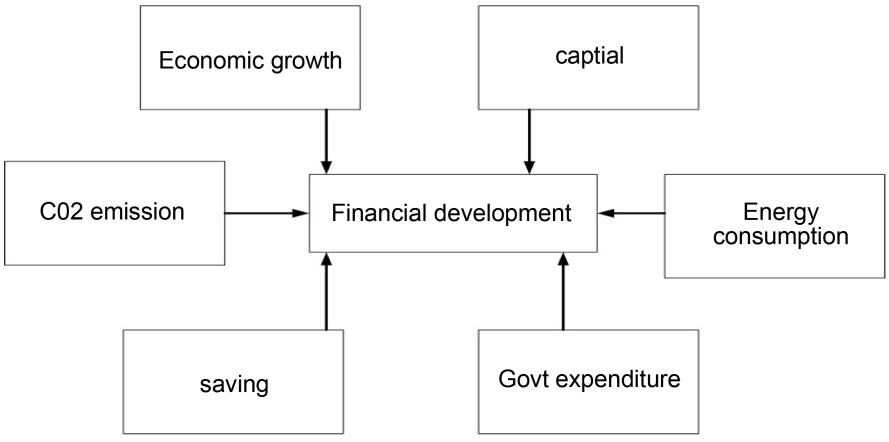


Figure 1. The elements of financial development.

the accelerated pace of modernization (Mukhtarov et al., 2020). Over the past two centuries, hydrocarbons have been extensively used in industrial processes, despite being relatively outdated and costly. One of the key areas of focus in recent economic research revolves around the relationship between economic growth and energy demand. It is widely recognized that the use of fossil fuels contributes to the rise of greenhouse gas emissions, necessitating a thorough examination of the link between energy consumption and overall economic advancement. Additionally, the changing climate will significantly impact green technologies, particularly those reliant on temperature-sensitive processes, as it affects the efficiency of the electricity grid (İmamoğlu, 2019).

The expansion and diversification of contemporary sectors play a crucial role in fostering positive outcomes, including the substitution opportunities between labor-intensive and transitional or primitive techniques. In the case of underdeveloped countries, an a priori assessment suggests that Okun and Perry's analyses may be applicable. However, even under the most extreme assumption that manpower and resources can be perfectly substituted, the need for higher wages and improved working conditions creates hurdles to achieving complete substitution within the limitations of optimal revenue levels. Moreover, the scarcity of skilled workers in developing nations raises serious doubts about the feasibility of full substitution (Chiu & Lee, 2020). These considerations highlight the intricate dynamics at play when assessing the relationship between economic activity and energy usage.

The fundamental principles of economics that guide this analysis are summarized in **Figure 2**.

The limitations of economic resources necessitate the substitution of assets for manpower. Furthermore, the use of transitional systems in industrial processes highlights the temporary nature of these innovations. This not only raises concerns about the feasibility of replacing manual labor with money, but also emphasizes the energy implications of such a substitution. The relationship between fuel and wealth is crucial in understanding the extent of energy usage in emerging

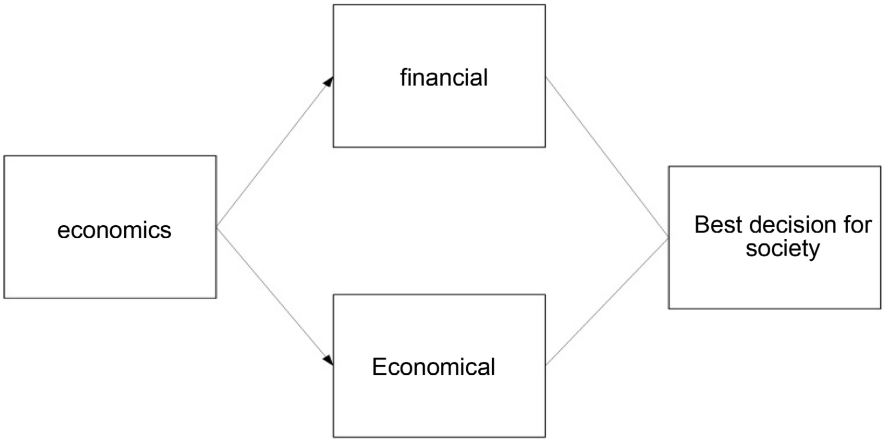


Figure 2. Basic concept of economic.

economies. It is evident that advanced techniques employed in industrial processes contribute to emissions. Prominent economists emphasize that financial integration plays a pivotal role in efficient energy utilization. Direct investment and the quality of institutions have a positive impact on the adoption of sustainable power sources. As economic progress leads to a decrease in the cost of renewable energy, there is an expected rise in demand for these sources. Increased financial capital, investment flow, and technological advancements resulting from income activity have favorable effects on a nation's energy consumption. Lower energy costs and stable investment focus facilitate access to resources, enabling businesses to establish themselves or expand. However, the pursuit of profit can sometimes lead to environmental costs imposed on society. Economic growth also indirectly affects fuel use through increased economic activity. Strong legal structures are essential for supporting financial and economic expansion. Countries with rising prices may experience accelerated growth and a liberalized banking system due to lax regulatory oversight. Deregulation, along with the promotion of efficient market hypothesis and simplified credit access, plays a critical role in development. Stable economic and financial conditions create opportunities for transportation and industrial industries to secure financing, influencing power consumption (Su et al., 2020).

Ghana has been recognized as one of the Sub-Saharan African economies with the fastest growth rate, boasting an annual gross domestic product (GDP) increase of over 5% for several decades. However, the country still faces various challenges, similar to other emerging nations. One of these challenges is the expiration of a current electricity policy agreement with the Ghanaian government in 2021. Despite this, Ghana is making significant progress towards achieving global electricity access.

To address the increasing energy demands caused by recent demographic transition, urbanization, and economic growth, Ghana needs to diversify its power generation capacity. Currently, only a tiny fraction of the total generation capacity, approximately 0.3%, comes from renewable sources such as solar and wind energy. To combat this, the Ghanaian government plans to expand the share of renewable energy generation to about 10%, while also reducing its reliance on solid biomass from 72% to 50% ("Ghana's renewable push" 2023).

Ghana possesses great potential for renewable power, including solar, wind, compost, and biogas energy, as well as hydroelectric, wave and tidal power generation, and biofuels. By tapping into these resources, Ghana aims to enhance its energy production capabilities and reduce its carbon footprint.

The research conducted on this topic has made significant contributions. The study utilized a questionnaire from the Ghana Statistical Service Library as the primary data source and employed the Likert scale method to formulate the survey questions. Statistical analysis of the data was performed using the Statistical Package for Social Sciences (SPSS) software.

The subsequent sections of the research paper are organized as follows: the

second section provides an overview of related works, section 3 details the methods and resources utilized in the study, section 4 presents the analysis and findings, and section 5 concludes the research.

2. Related Work

Recent studies have focused on the relationship between economic growth and financial development, examining the unique dynamics and impacts within Ghana's context. One study (Ibrahim & Alagidede, 2020) utilized a nonlinear autoregressive distributed lag strategy to analyze the asymmetric effects of financial growth on Ghana's economy from 2019 to 2022. The findings revealed a prolonged and imbalanced relationship, characterized by varying long- and short-term impacts influenced by both returns and volatility. This suggests that the nature of disruptions in the financial market determines the extent to which financial deepening affects economic growth. However, this approach may be more costly compared to existing methodologies.

Another paper (Abor & Quartey, 2010: p. 12) specifically analyzed the characteristics, achievements, and challenges faced by Small and Medium Enterprises (SMEs) in Ghana and South Africa as examples of developing economies. SMEs account for approximately 85% of Ghana's manufacturing employment and 92% of enterprises, generating around 70% of the country's exports. Similarly, in South Africa, SMEs constitute 91% of all legal commercial enterprises. The study provides recommendations to governments, international agencies, businesspeople, and SME executives to enhance the domestic economy. However, challenges related to inadequate marketing strategies and production capabilities need to be addressed.

To assess the possibility of transitioning from non-renewable to renewable energy sources, another study (Ankrah & Lin, 2020) employed the nonlinear transfer function methodology in Ghana. The relationship between the two resource types and energy production was estimated using the translog method. The findings indicate that while non-renewable power has a detrimental impact, alternative sources have a negligible influence, with average power compatibility values of 0.14 and 1.875, respectively. Based on these results, the study suggests implementing an optimal power architecture that incorporates both sustainable and non-renewable resources. However, the mathematical manipulation of the translog function presents challenges.

In a study (Afrane et al., 2021) assessing waste management systems in Ghana, namely pyrolysis, gasification, thermal plasma gasifier, and anaerobic digestion, a multicriteria decision analysis was conducted to determine the most beneficial option for development. The study employed a fuzzy logic-based strategy and involved five academic and business specialists who evaluated the four categories using predetermined method parameters. The findings suggest that a combination of methanogenesis and combustion is the most well-balanced waste-to-energy system. However, the reduction analysis is not applicable in multi-criteria analy-

sis for assessing long-term effects such as benefits and costs occurring over various years.

Recent studies have shed light on the challenges and opportunities for green cities in emerging economies. One paper (Debrah et al., 2020) emphasized the lack of awareness about the benefits of a green environment, environmental destruction, inadequate public policies, excessive waste production, and insufficient treatment of effluents as obstacles to sustainable urban planning. The study suggested that Kumasi, Ghana, can restore its reputation as a "Garden City" by implementing appropriate environmental measures and adopting a holistic approach to development. The researchers employed data analysis techniques to analyze the situation and recommended incorporating the concept of green cities into education and training programs for stakeholders. However, the study acknowledged the limitations of quantitative studies in establishing specific empirical links, which may overlook important themes.

In the context of renewable energy targets for developing nations, another study (Afful-Dadzie et al., 2020) used an Electricity Generation Expansion Planning (GEP) method. The researchers modified a typical GEP model to include targets for geothermal energy and limitations on funding for new electricity production. The model, constructed as a Mixed-Integer Linear Program (MILP), aimed to address long-term forecasting and uncertainties in the model. This approach can help identify realistic targets aligned with a country's economic conditions, unmet electricity demand, and acceptable additional costs. However, it should be noted that this approach may involve higher expenses.

A paper (Nock et al., 2020) framed the general strategic scheduling problems using a convenient Mixed-Integer Linear Equation and applied it to a case study of a small nation with a basic electricity network. The study focused on understanding how stakeholder demands for equity and various budget levels affect the optimal distribution of generation between centralized and distributed sources. The findings revealed that stakeholders can achieve a significant increase in energy access equity if they prioritize it, leading to a 72% - 87% improvement. Neglecting equity considerations resulted in higher overall expenditure in urban areas but lower electricity rates. This approach can guide decision-makers in assessing trade-offs between raising electricity costs, reducing energy inequality, and improving energy availability within limited financial constraints. However, it may require more time to predict outcomes.

Considering the scale-up of electricity production and renewable power in Ghana, a study (Ankrah & Lin, 2020) examined the potential and commitment necessary. The study forecasted Ghana's renewable power trend for the next 15 years and found that foreign investment and exchange rates primarily drive renewable power development, while real GDP per capita has an insignificant impact. The study utilized the Vector Error Correction Model (VECM) and Johansen co-integration methodology. However, using a VAR to analyze integrated time-series data poses estimation challenges. Additionally, Ghana's efforts to tran-

sition to alternative energy sources are hindered by fossil fuel usage and wealth maximization.

Examining the impact of energy consumption and economic development on pollution in Pakistan, another study (Khan & Teng, 2019) employed dynamic Autoregressive Distributed Lag (ARDL) computations. The findings indicated that economic growth, coal, petroleum, and gasoline consumption all contribute to environmental degradation in Pakistan in both the short and long term. The study emphasized the importance of promoting sustainable energy sources to mitigate pollution issues. However, it is crucial to ensure that the statistics exhibit a random pattern to avoid biased conclusions.

In terms of scaling up renewables in Ghana, a study (Sun et al., 2020) analyzed key factors and their interactions using time series data and the Vector Autoregression (VAR) approach from 2019 to 2022. The study identified eight key factors, including legislation, population growth, wind power, and electricity prices. The results demonstrated a significant positive relationship between these factors and the deployment of renewable power in Ghana. The Impulse Response Functions (IRFs) showed long-term trajectory development influenced by shocks to the system. However, the study highlighted the risk of false security if delays in policy implementation are high.

Overall, these recent studies provide valuable insights into various aspects of sustainable development, energy transitions, and environmental challenges in emerging economies like Ghana and Pakistan.

3. Materials and Methods

3.1. Data Collection and the Data's Source

Both primary and second-hand sources of data were employed in the study. The questionnaire served as the main data source for the study. The Ghana Statistical Service Library, the internet, the establishment list, yearly reports, and planning processes were some of the secondary sources of information used.

1) Financial modeling:

Financial modeling involves building mathematical models to simulate and analyze various financial scenarios. It can be represented by the following equation:

$$\text{Financial Model}: \text{FM} = \text{f}\left(\text{Costs, Revenues, Investments, Risks}\right)$$

where:

- Costs represents the projected costs associated with energy projects or policies.
- Revenues represents the projected revenues or benefits generated from these projects or policies.
- Investments refers to the initial investment required for the projects or policies.
- Risks accounts for the potential risks and uncertainties involved in the finan-

cial analysis.

2) Cost-Benefit Analysis (CBA):

CBA is a quantitative technique used to assess the financial feasibility of energy projects or policies. It involves comparing the costs and benefits associated with each option. The net benefit can be calculated using the following formula:

$$\text{Net Benefit: NB} = \text{Total Benefits} - \text{Total Costs}$$

3) Return on Investment (ROI):

ROI measures the profitability of an investment. It can be calculated using the following formula:

Return on Investment (ROI):

$$\text{ROI} = \left(\text{Net Profit}/\text{Initial Investment}\right) \times 100$$

where:

- Net Profit represents the difference between the total benefits and total costs.
- Initial Investment refers to the initial capital invested in the energy projects or policies.

4) Net Present Value (NPV):

NPV assesses the value of future cash flows in today's terms. It can be calculated using the following formula:

Net Present Value (NPV):

$$\text{NPV} = \sum \left(CFt / \left(1 + r\right)^t \right) - \text{Initial Investment}$$

where:

- CFt represents the cash flow in year t.
- r is the discount rate used to account for the time value of money.
- t is the time period.

5) Payback Period:

Payback period calculates the time required to recover the initial investment. It can be calculated using the following formula:

Payback Period:

$$\text{Payback Period} = \text{Initial Investment}/\text{Annual Cash Flow}$$

These mathematical models provide a strong foundation for analyzing the financial implications of energy economics in developing countries. However, it's important to consider the specific context, data availability, and project-specific variables when applying these formulas.

3.2. Data Collection Techniques and Tool

The questionnaire used in this research study was designed as the primary tool for data collection, focusing primarily on quantitative data. It consisted of a combination of closed-ended and open-ended questions, tailored to align with the research objectives. The inclusion of open-ended questions allowed respondents to provide detailed insights specifically related to the issues being investi-

gated. These open-ended responses were coded to extract the necessary data for further analysis.

The questionnaire was divided into two main sections. The first section gathered demographic information from respondents, such as their gender, age, and educational background, using a nominal scale. The second section focused on project objectives or psycho-graphic information. The majority of questions in this section were designed using the Likert scale approach. This approach measures respondents' attitudes by asking them to indicate their level of agreement, neutrality, or disagreement with various statements.

It is important to note that the Likert scale approach used in this study does not assume a typical response pattern. Instead, it acknowledges that participants completing the questionnaire may have uncertainties or varying degrees of certainty in their choices. These uncertainties can stem from subjective opinions or objective factors beyond the participants' control (Douven, 2017). **Figure 3** provides an illustration of a Likert scale used in the study, with response options including agree, disagree, and neutral.

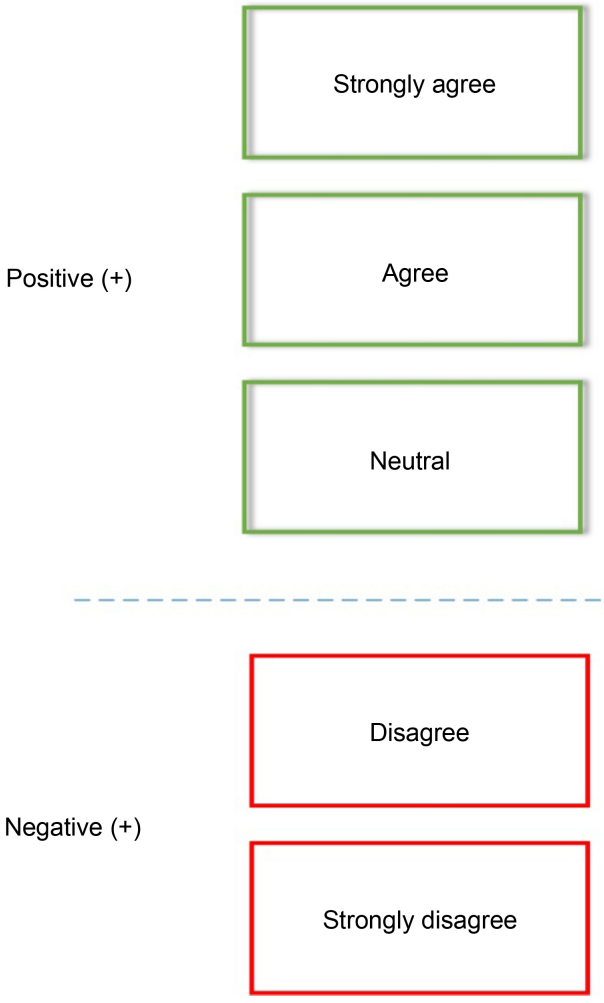


Figure 3. Example of Likert scale agreement.

3.3. Analysing Data

The objective of this study was to utilize the Statistical Package for Social Sciences Software (SPSS) to conduct a rigorous statistical analysis of the collected data. A table-style representation was employed to facilitate efficient and straightforward interpretation of the data. The responses were quantified in terms of percentages, means, and standard deviation. The data consistency was thoroughly examined for both completed surveys. To enhance usability within the SPSS, the components were appropriately categorized based on the responses provided by the respondents. This approach ensured a robust and objective analysis of the data, enabling accurate and meaningful conclusions to be drawn from the study.

4. Results and Discussion

Information on Respondents' Demographics

The article focuses on addressing major questions by presenting the answers in a tabular format. To enhance clarity and reduce uncertainties, the article also includes additional explanations. The main socio-demographic factors examined in this study are the education level, sex, age, and length of time working for the Ghana Statistical Service of the respondents. The outcomes of the study are presented in Table 1. The aim is to provide a comprehensive understanding of the topic by addressing key questions and providing clear visual representations of the data.

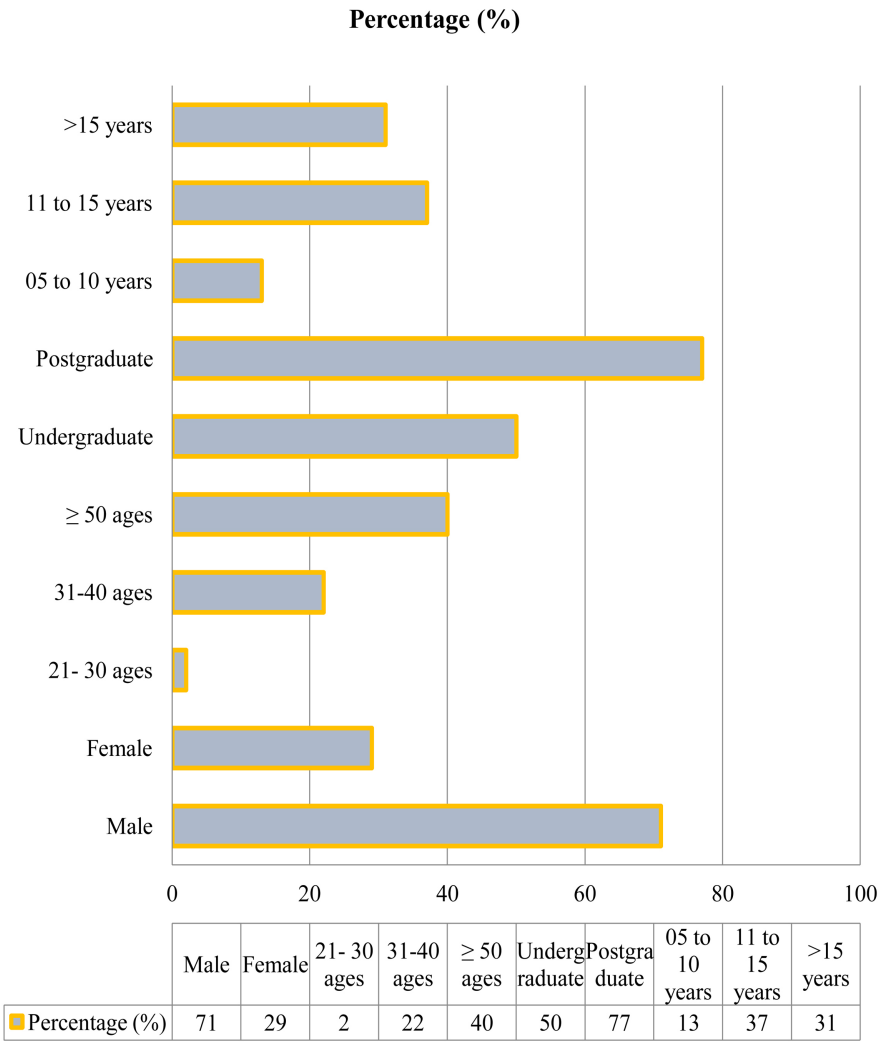
Table 1. A representation of the respondents' demographics from the sample.

Classification	Frequency	Percentage (%)
	Sex	
Male	95	68
Female	45	32
	Age category (years)	
21 - 30	3	2
31 - 40	30	22
≥50	54	40
	Education level	
Undergraduate	-	50
Postgraduate	105	77
	Years spent working with GSS	
5 - 10	17	13
11 - 15	50	37
>15	44	31

According to the data presented in Figure 4, the gender distribution of participants reveals a significant disparity, with 71% being male and only 29% being female. This stark contrast highlights the underrepresentation of female respondents in the survey.

Furthermore, when analyzing the age groups of the participants, it becomes evident that a considerable proportion of the workforce at the Ghana Statistical Service headquarters, approximately 38%, falls within the 50 years or older category. This suggests that a substantial portion of the personnel is approaching retirement age, potentially posing challenges to the continuity and knowledge transfer within the organization.

In contrast, respondents between the ages of 31 and 40 years represent 22% of the total, indicating a relatively younger segment of the workforce. However, it is worth noting that individuals between the ages of 21 and 30 constitute a mere 2% of the participants, suggesting a limited representation of the youngest age group.



	Male	Female	21- 30 ages	31-40 ages	≥ 50 ages	Undergraduate	Postgraduate	05 to 10 years	11 to 15 years	>15 years
Percentage (%)	71	29	2	22	40	50	77	13	37	31

Figure 4. Percentage values according to participants.

Additionally, the data reveals that an overwhelming majority of the respondents, specifically 77%, possess postgraduate or master's degrees. This finding aligns with the Ghana Statistical Service's emphasis on educational qualifications, as a master's degree has become the minimum requirement for participation in the Services under their system of innovation.

Overall, these statistics shed light on the gender disparity, age distribution, and educational qualifications among the survey participants, providing valuable insights into the composition of the Ghana Statistical Service workforce.

There are 30 participants involved in the questionnaires, as indicated in Table 2. It is noteworthy that there is a clear connection between Financial Implications and energy poverty, as evident from the baseline estimates presented in Table 1. By providing estimates for the combined data and utilizing standardized coefficients, it becomes easier to compare and interpret the various estimates

Table 2. Overall assessment of the participants.

(S)	Statements (S)	Agree	Disagree	Neutral
1	If the score for household financial poverty is less than 0.5, the dummy variable is set to 1.	16	14	0
2	In the case of a rural home, a binary variable has the value 1.	14	11	5
3	Whenever a domestic head is retiring or idle, a binary variable becomes 1.	6	18	4
4	Whenever the head of the household works, a binary variable becomes 1.	10	19	1
5	When the head of the family has a bank and otherwise mobile money accounts, a binary variable has the value 1.	8	16	6
6	For the household's overall spending on the children's elementary and secondary schooling, a continuous scale.	10	14	6
7	The overall net income for the household is a continuous variable.	8	14	8
8	If the household head has an insurance policy, a binary variable has the value 1.	9	15	6
9	When households received money transfers from even a financial institution or via mobile financial services, a binary variable's value is 1, for example.	7	10	8
10	If the head of the household possesses credit availability, a binary variable represents 1.	18	6	5

related to Financial Implications and energy poverty.

Statement 10 highlights the correlation between a rise in Financial Implications and household credit availability in domestic energy poverty, with a unanimous agreement from the participants. Conversely, a disagreement arises in statement 4, which suggests that an increase in the head of the household's work has no significant impact. Furthermore, statement 3 and statement 4 indicate that Financial Implications of energy economics are associated with reductions in domestic energy poverty.

In terms of participant demographics, Table 2 reveals that 37% of the total respondents (fifty participants) have been employed by the Ghana Statistical Service for approximately 11 to 15 years. This is followed by 31% (forty-four respondents) who have worked there for over 15 years. Only 12% (17 participants) possess a work experience ranging from 5 to 10 years with the Ghana Statistical Service.

Moving on to Table 3, it sheds light on the participants' general impressions of Ghana's perspectives. They were asked to rank the extent to which they believed fellow participants had benefited from financial implements across ten different categories, using a scale of one to ten. The findings indicate that all categories received favorable evaluations. Notably, the two main factors with the highest overall mean scores were the participants' increased sense of responsibility and involvement in the organization, as well as heightened motivation to work in energy economics.

The overall rating of the participants' opinions regarding the financial implication of energy economy was 0.64 mean, with a standard deviation of 0.51. These values, along with further mean and standard deviation data, are presented in Table 3.

In summary, the data presented in both Table 2 and Table 3 provide insights into the relationship between Financial Implications and energy poverty, the

Table 3. Values for the mean and standard deviation from Ghana's perspective.

Statements	Mean	Standard deviation
S1	0.40	0.48
S2	0.49	0.48
S3	0.06	0.20
S4	0.07	0.27
S5	0.23	0.45
S6	0.64	0.51
S7	0.26	0.45
S8	0.32	0.49
S9	0.29	0.43
S10	0.15	0.31

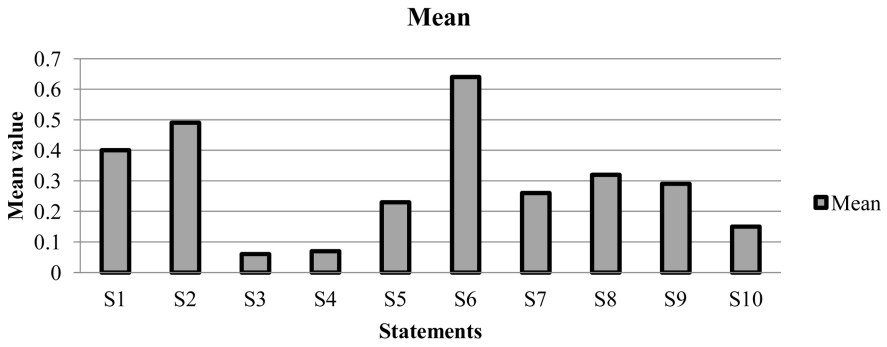


Figure 5. Values for the mean.

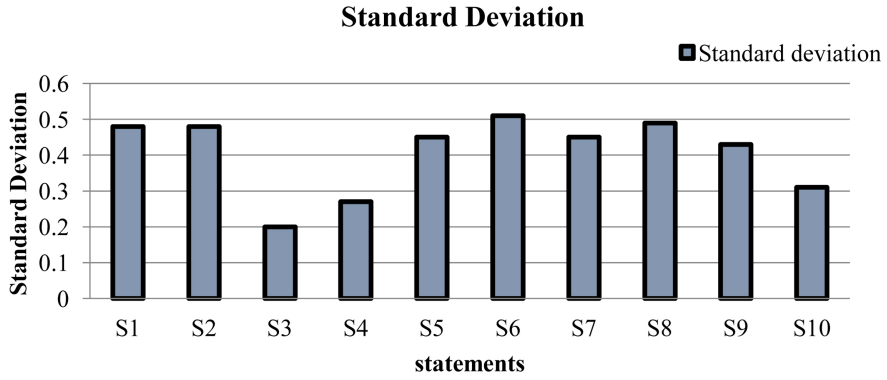


Figure 6. Values for the standard deviation.

demographics of the participants, and their perceptions of Ghana's perspectives. These findings highlight the importance of addressing Financial Implications to combat energy poverty and the participants' positive impressions of the financial implications in energy economics.

Regarding rural and headed homes, the findings strongly indicate a significant improvement in stability. It is highly likely that the most substantial decline in energy poverty will be observed among employees due to their enhanced financial participation. These compelling results are visually represented in Figure 5, which clearly displays the mean values. Furthermore, the standard deviation, as elucidated in the accompanying Figure 6, underscores the robustness and reliability of the findings.

5. Conclusion

In addition to unraveling the intricate dynamics of financial participation and its impact on energy vulnerability in Ghana, this groundbreaking paper makes a significant contribution to the existing body of knowledge by introducing novel methodologies for understanding energy poverty. While well-established economies have been extensively studied, the dearth of reliable data has left a void in the understanding of energy poverty in developing nations. However, this research fills that void by revealing that access to finance consistently yields a more pronounced reduction in energy poverty among rural households compared to

their urban counterparts, regardless of their socio-economic background.

Furthermore, this study sheds light on the pivotal role of financial intermediation in mitigating energy poverty, particularly in households with the head of the household as the primary beneficiary. The research also identifies household total combined earnings and consumption deprivation as crucial mediators between financial inclusion and the depletion of valuable resources.

In light of the global policies already in place to enhance financial inclusion, this research emphasizes the need for additional initiatives aimed at increasing households' net incomes per capita and combating usage poverty. A strategic convergence of efforts to boost financial inclusion and raise household incomes can effectively alleviate energy poverty. Moreover, the research underscores the importance of financial sector authorities establishing robust frameworks that significantly reduce the geographical barriers to accessing banks.

These recommendations are indispensable in achieving the ultimate goal of ensuring universal access to affordable, reliable, and modern energy services. Concurrently, they will contribute to increasing the proportion of renewable energy sources in meeting global energy demands, fostering access to sustainable scientific advancement, and stimulating economic growth in the field of energy production and clean technologies. Achieving these ambitious goals necessitates the collective efforts of individuals and organizations alike, as we strive to create a future where energy poverty becomes an antiquated concept.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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