

# The Moderating Roles of Consumer Profiles and Choice Determinants in the Energy Efficiency and Appliance Purchase relationship in Ghana: Household Refrigerators

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**Abstract**— The purpose of the research is to investigate the profile of consumers and to determine the socio-demographic and economic indicators and purchase choices considered when purchasing brand-new refrigerating appliances in Ghana. The research adopted a quantitative approach. Primary data was gathered using a questionnaire and administered to households. Secondary data was gathered from published reports from the Ghana Energy Commission (EC), the Ghana Ministry of Energy, and credible journals. Cross Tabulation Analysis (CTA) was used to test various relationships on the socio-demographic and economic factors such as age, income class, gender, social status, educational level with the purchasing choice of buying a brand-new refrigerator. The research revealed that most respondents were knowledgeable about the standards and labeling of refrigerators. However, respondents had little knowledge of the energy efficiency of refrigerator use. Respondents considered energy efficiency class, quality, and brand as their choice determinants in the purchase of brand-new refrigerators.

**Keywords**— Consumer, Determinant, Energy efficiency, Refrigerator, Refrigerant, Socio-demographic.

## I. INTRODUCTION

The Energy Commission of Ghana as part of its effort to promote energy efficiency introduced regulations to guide the entry conditions of appliances into the country, have developed standards for household refrigerating appliances (L.I.1958) in 2009, non-ducted air conditioners (L.I.1815) in 2005, LED and self-ballasted fluorescent lamp (L.I.2353) in 2017. There was also the institution of a ban on the importation of used refrigerating appliances, used air conditioners, and incandescent filament lamps (L.I.1932) in 2008. The initiative was basically to transform the market, with broad objectives towards economic sustainability, climate change mitigation, and energy security [1].

Energy efficiency practice is one of the globally accepted demand-side management practices for Green House Gas (GHG) emission reduction [2]. [3], highlight that the energy efficiency challenges in Sub-Saharan Africa (SSA) is a policy defect but addressing this change will save almost 5.7% of the energy used in SSA. Also, electrical equipment purchase decisions are influenced by incentive programs and a mixture of several technical, environmental, demographic, and economic factors [4] [5].

According to [2], in the residential sector, refrigerating appliances consume the highest amount of electricity (924 kWh/year) representing 59% of electricity consumed in homes, followed by lighting systems 261.6 kWh/year representing 17% compared to 400 kWh and 250 kWh per year for USA and Europe respectively. In research by [6], and [7] argued that reducing electricity consumption and cost in the built environment is an effective energy efficiency practice.

[8] researched consumer purchase behavior and suppliers' pricing and innovation decisions to estimate the effect of household electricity price variations on the refrigerator market outcomes using the UK as a case study. They suggested a need for a change in policy direction towards suppliers' pricing and innovation behaviors, which would be effective in achieving energy efficiency gains in the durables market.

[9] studied consumer choice determinants in the purchase of appliances and examined factors that influenced the consideration of the energy efficiency class in Europe. [1] explored how to remove barriers and promote energy efficiency in SSA households. Nonetheless, these researchers did not consider the relationship between the socio-demographic and economic status of households as a predictor of the choice determinant of the purchase of refrigerators. This study seeks to find out what drives consumers' choice for the purchase of brand-new refrigerators concerning energy efficiency.

The rest of the paper is structured as follows. Section 2 provides a literature review on the refrigerator market in Ghana and related issues. Section 3 describes the methodology and data sources. Section 4 outlines the data analysis, with a discussion. Section 5 presents the outcomes and contributions. Finally, the conclusion and policy recommendations offered in section 6.

## II. REFRIGERATOR MARKET IN GHANA

### A. Energy efficiency and refrigerator standards and labeling program in Ghana

According to Gellings, [10] the concept of standards and labeling program was established and propagated several years ago and was classified as one of the demand-side management (DSM) practices by many researchers. Energy efficiency standards and labels (EEL's) are expected to influence consumers' decisions by providing data on the energy consumption of the appliances and help to overcome behavioral barriers to the choice of energy efficiency [4]. Bull [11] highlights that visually augmented energy labels specifically address both the information and the attention deficit of consumers. Energy efficiency standards (EES), labels, and regulations for end-use appliances have been established in most developed countries [12], [13].

The lack of energy performance standards in several countries in SSA exists despite the probability that refrigerator efficiency might be one of the most economical and environmentally positive methods for expanding electrical energy access on the continent [14]. Despite the fact that energy efficiency (EE) is widely acknowledged as the least expensive, and promptly accessible that could help improve energy security, its usage in Ghana has picked up only in recent times. Nonetheless, Ghana has made significant improvements in energy efficiency and energy conservation policy and programs joining Tunisia, Egypt, and South Africa [14], [15]. In SSA, Ghana was the first to develop EES with a regulation designed to meet the cultural, economic, and energy needs of the country [1].

[15] pointed out that electricity consumption in Ghana has been growing above an annual rate of 10%, putting enormous pressure on generation. The residential and commercial sectors are the highest contributors to this phenomenon because of rising per-capita income and dissemination of household's electronics without efficient utilization. This has created a disparity between demand and supply such that the least system disturbance can create a total blackout in some instances. These constraints according to [9] put the country's utility under pressure to make improvements in energy use across all segments. This includes improvements in the way in which energy is used in the residential sector.

The goal of the energy efficiency and conservation policy of Ghana is to promote energy efficiency and to ensure efficient production, transportation, and use of energy in Ghana [16]. The policy has established an appropriate pricing regime to induce domestic and industrial consumers to voluntarily manage their energy [17]. In the works of [18], China has two types of enforcement mechanisms for the policy, which are product certification by a product manufacturer before retail distribution and product compliance verification after retail delivery, and

this the same for Ghana. Consumers can now buy products with low energy consumption by utilizing information on the energy consumption of products [19].

A compliance market surveillance by the Energy Commission 2017 revealed 77.95% of the appliances surveyed were made for (ST) climatic conditions and 20.02% were (T) climatic conditions [20], as presented in Figure 1.

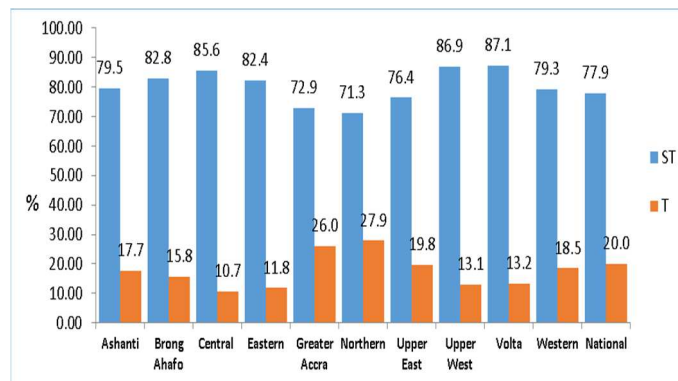


Fig. 1 Penetration of climatic class of the refrigerating appliances [20]

### B. Refrigerator energy efficiency project in Ghana

The Energy Commission has introduced regulations to guide the entry conditions of appliances into the country. Refrigerating appliances are considered highly energy-consuming appliances because they run 24 hours a day throughout the year, accounting for almost 50% of the total energy usage in buildings [21]. When deciding on a choice, consumers buy appliances with much emphasis on the purchase price and little or no consideration to the consequent energy expenses over the operating life of the product [22]. Used, inefficient, and discarded refrigerators imported from Europe and elsewhere dominated the refrigerating appliance market in Ghana by the middle of the 2000s.

These appliances had outlived their technical and economic usefulness in their countries of origin [1]. They usually come in with faulty compressors, thermostats, weak doors, and poor lid seals. Beyond that, they were manufactured for use in the cold climatic zones, which renders them inappropriate for the hot climate. The market share of the used refrigerating appliance was over 70% as against 30% for new and efficient units in the early 2000s. This trend accounted for the excessive energy consumption of refrigerators in Ghana before 2010 [17].

[20] concluded that 1.1 million tonnes of CO<sub>2</sub> was saved by the energy efficiency rebate project. Total energy savings made was about 400GWh, equivalent to 40% of the annual output of the Bui Hydroelectric Power Plant. According to [23], energy efficiency and standards have critical roles in decreasing the energy consumption of room air-conditioners globally because they contribute to the greenhouse effect, and reducing their energy consumption is urgent for energy savings and environmental protection.

### C. Refrigerator market surveillance in Ghana

Every year, the Energy Commission of Ghana conducts its compliance monitoring exercise and from the data collected, the Greater Accra Region has the largest number of shop locations in terms of size (big shops). 4,916 refrigerating appliances were surveyed nationwide, out of which 41.82% were from the Greater Accra Region making it a predominant refrigerating appliance market. The Ashanti Region recorded 12.67% making it the second dominant refrigerating appliance market. Brong Ahafo, Central, Western and Eastern Regions constituted between 7% and 8% of the appliance market [17], as presented in Figure 2.

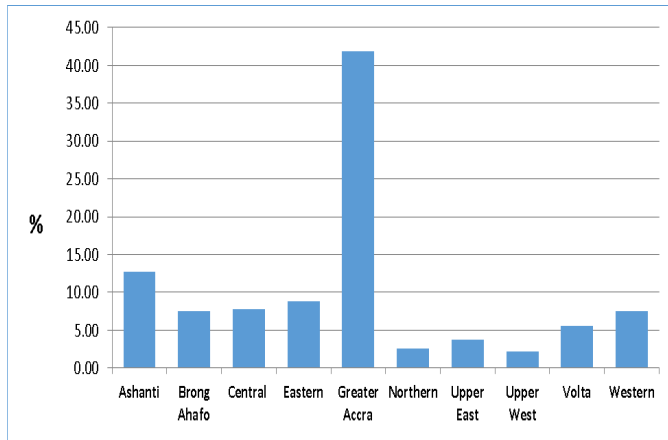


Fig 2. Share of refrigerating appliances surveyed by regions [20]

Household refrigerators are broadly categorized into ten (10) groupings according to the legislative instrument L.I 1958 (2009) of the Energy Commission regulation on standards and labelling of household refrigerators. The classification is based on the design, energy efficiency rating (expressed in stars\*), and type of use. The classification covers larder refrigerator, refrigerator/chillers, refrigerator with no energy efficiency star, refrigerators at various levels of energy efficiency stars, refrigerator/freezer, upright freezer, chest freezer and multi-door or other appliance.

Urbanization is one of the drivers of refrigerator purchase in developing countries, with China (an increasingly urbanized country) having refrigerator procurement surging from 24% in 1994 to 88% in 2014, whereas in Peru and India, considered less urbanized countries, the procurement was only 45% and 25% respectively in 2014 [24], [25].

### D. Type of refrigerants contained in refrigerators in the Ghanaian market

Market surveillance of the Energy Commission identified three types of refrigerants in refrigerating and air-conditioning appliances that are in use in households i.e. R134a, R600a, and R290 refrigerants. 25.57% of the appliances had R134a refrigerant, 72.25% had R600a refrigerant and 0.06% had R290 refrigerant (see Figure 3). Nonetheless, brand-new refrigerators in the Ghanaian markets are usually laden with R600a, R134a, and R290 refrigerants [20]. The prerequisite to controlling the releases of greenhouse gases as contained in the Kyoto Protocol

requires systematic consideration and evaluation of energy-consuming activities. According to [26], the laden R600a, R134a, and R290 refrigerants are climate-friendly and do not pollute the ozone

layer unlike the chlorofluorocarbon type (CFC) refrigerants, such as R12, that have been banned by the Montreal Protocol.

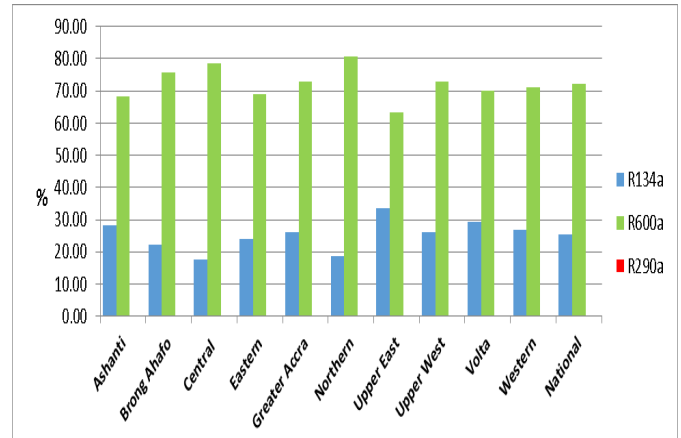


Fig. 3 Share of refrigerants in the appliances surveyed [20]

## III. METHODOLOGY

In other to meet the research objectives, the study adopted a quantitative method. An extensive literature review was undertaken. Primary data was collected using survey questionnaires. This was done to increase the reliability of the analyses and the sampling technique [27]. The research survey was conducted in Accra, using questionnaires. This was because Accra is the capital city with numerous retail shops, housing the major economic and administrative hubs. Respondents were purposively selected. The purposive sampling procedure was adopted because the researcher needed to select respondents who have recently purchased a refrigerator. According to [28], purposive sampling is very suitable when a researcher desires to contact a targeted sample.

The research questionnaire was pre-tested and piloted among ten potential respondents before the main survey. This was done to minimize the challenges that would arise during the actual survey. The final questionnaire was administered to 200 respondents in six (6) districts of Ghana. The respondents were made up of two groups of people. The first group of 100 was made up of consumers on the verge of purchasing in a retail shop. The second group was made up of 100 people who have already purchased the appliance in their homes. One hundred and fifty (150) responses were received of which 70 were from households (46.66 percent). Eighty (80) responses received were from consumers in shops (53.33 percent).

This research used the International Business Machine Statistical Package for Social Sciences version 26 (IBM SPSS) software to analyze the data using cross-tabulation analysis (CTA) to find the relationships among the variables (socio-demography and economic variables). CTA was adopted because of the multiple choices indicated by respondents. Excel was used to display results in graphs and tables to show trends and patterns. The research adopted the subjective evaluative approach to analyze the response from the respondents to

explore the awareness level on energy efficiency measures using a “Yes” or “No” response. This analysis is based on the researcher’s interpretation of the frequencies of various responses.

Again, the Chi-square test (two-sided) was used to examine the differences in appliance purchase choices between genders and shopping preferences. A frequency table (percent) was adopted to analyze the choice made between age groups and social status (married or single). For age analysis, respondents were divided into four groups; younger age (18-30 years), middle-aged (31-45 years), older age (46-60 years), and retirees (above 60 years). The households were categorized into: i) low-income households with monthly income less than GHC1,500 (US\$320); iii) middle-income households with a monthly income of GHC1,500-3,000 (US\$320-640); and high income (with monthly income over GHC3,000 (US\$640).

#### IV. DATA ANALYSIS AND DISCUSSION

A descriptive analysis was adopted for this research to analyse the data. The demographic characteristics of respondents’ influential and technical preferences were compared against their income class. A similar analysis was done on the impact of respondents’ age, gender, social status, and education level during appliance purchases. From a total of one hundred and fifty (150) respondents, 58.7 percent were males while 41.3 percent were females. 42 percent were younger age, 36.7 percent were middle age, and 15.3 percent were older age with 6 percent above sixty. The majority of the respondents were single while the minority were married.

The bulk of respondents (58.7%) were in low-income households. Middle-income households accounted for 31.3 percent and high-income households were 10 percent. 62 percent of the respondent had tertiary education. 32 percent had senior high school education, and 6 percent had a junior high school education. Regarding social status, 41.3 percent were heads of households while 56.67 percent were not.

##### A. Influential factor vs socio-demographic and economic variable

Single, younger age male respondents with tertiary education and high income considered the energy label of the refrigerator as the predominant influence during appliance purchase. Single female respondents on retirement with secondary education and middle income considered the brand of the refrigerator as the predominant influence in their purchase. Single female respondents of older age with a junior high school having high-income considered the design of the refrigerator as the predominant influence. Younger age single female respondents in junior high with low income considered the colour of the refrigerator as the predominant influence. Finally, single middle-age female respondents with tertiary education having a low-income considered price of the refrigerator as the predominant influence.

##### B. Technical choice vs socio-demographic and economic variable

Respondents comprising singles, males, in middle age that had secondary education considered the technology of the refrigerator in their purchase. For annual consumption, male

respondents who were married in their middle ages and had junior high education with a high-income considered capacity of the refrigerator. Again, married male respondents, in older age that had a tertiary education with middle-income considered energy consumption of the refrigerator. Single females, in older age that had secondary education, with high-income considered energy efficiency classes in their purchase.

##### C. Preference choice vs socio-demographic and economic variables

Respondents Regarding preference choice, female married respondents, in the older ages that had junior high education with a lower-income considered cost of the refrigerator in their purchase. Respondents that considered a warranty on the refrigerator were made up of married males on retirement with tertiary education and in the middle-income class. Married males, in the middle ages that had secondary education with lower income considered customer support on the refrigerator. Additionally, single females, on retirement with tertiary education with high income considered the quality of the refrigerator in their purchase.

The research sought to find out individuals’ knowledge of households on energy efficiency practices with brand-new refrigerators. Specifically, awareness of energy efficiency standards and labeling regulation (LI 1958), some energy efficiency refrigerator practices, and consideration of electricity bills before the purchase of a brand-new refrigerator was sought from respondents. Table 1 shows the responses obtained from residents concerning their awareness of refrigerator energy efficiency standards and labeling regulations in Ghana.

TABLE I. RESULTS ON AWARENESS OF ENERGY EFFICIENCY POLICIES

Question	Response	Frequency	%	Mean
Knowledge of efficiency standards of refrigerators	Yes	123	82	1.180
	No	27	18	
Knowledge of frequently opening and closing the doors of a refrigerator consumes more electricity	Yes	104	70.7	1.293
	No	44	29.3	
Knowledge of positioning of a refrigerator close to the wall without space at the back increase’s consumption	Yes	72	48	1.520
	No	78	52	
Knowledge of large ice build-up in the fridge compartment makes the fridge inefficient and consumes more electricity	Yes	71	43.7	1.520
	No	79	52.7	
Consideration of electricity bills when deciding to buy a fridge	Yes	123	82	1.180
	No	27	18	

Table 1 shows 78% of respondents indicated grading of efficiency of the refrigerator as the meaning of star rating, 82% of respondents indicated being aware of the regulation while 18% indicated not being aware of the regulation. The question coded “Yes/No” as 1 and 2 respectively shows a mean value above 1.18 confirming that more of the respondents were aware

of the regulation. This finding culminates in buyers' responses towards refrigerators bearing the energy label. Responses from residents on the meaning of star ratings reveal that more respondents know what the star ratings stand for as a mark of grading of energy efficiency of the refrigerator. Specifically, 78% of respondents indicated grading of efficiency of the refrigerator, 3.3% indicated horsepower and 18.7% said they were not sure. These results suggested that buyers of refrigerator appliances do consider, to an extent, the label information.

The response from buyers toward refrigerator energy efficiency depends on their knowledge of energy efficiency. Respondents were assessed in respect of this and Table 2 presents the responses. On whether a respondent knew the "positioning of a refrigerator close to the wall without space at the back increased consumption", 48% of respondents said "Yes" and 52% said "No".

The research sought to find out whether a respondent knew that "large ice build-up in the fridge compartment makes the fridge inefficient and consumes more electricity". 43.7% of respondents responded "Yes" while 52.7% responded "No". The negatively responded had a mean of 1.52 each confirming they did not know. 82% of respondents indicated that they considered electricity bills when deciding to buy a fridge, while 18% said they did not.

The research sought to find out if gender, marital status, and age affected the choice decision for refrigerator purchase. The responses are presented in Table 2. The table indicates that, for the choice of brand of refrigerator, respondents on retirement considered it most with a percentage of 66.68% as compared to the other age groups. For the choice of design, respondents in middle age considered it most with 21.74% as compared to the other age groups. For the choice of colour of a refrigerator, respondents in the younger age considered it most with 12.70% as compared to the other age group. Finally, for the choices of price and energy efficiency label, older age respondents considered both 36.36% and 54.55% respectively as compared to the other age group respondents.

TABLE II. INFLUENTIAL CHOICE VS AGE GROUP IN THE PURCHASE OF A NEW REFRIGERATOR

Age Group	Price	Colour	Efficiency Label	Design	Brand
18-30	34.92%	12.70%	49.21%	19.05%	61.90%
31-45	36.36%	9.09%	54.55%	10.91%	47.27%
46-60	26.09%	8.70%	43.48%	21.74%	60.87%
Above 60	22.22%	0%	22.22%	0%	66.68%

#### D. Consideration between preference choice and income classes in the purchase of refrigerator

Table 3 below shows the preference choices considered by income class in the purchase of a refrigerator. The proportion of respondents who considered the cost of the refrigerator was highest in the low- and middle-income classes (19.32% and 19.15% of respondents, respectively) as compared to those in the high-income class. The proportion of respondents who

considered the refrigerator quality was highest in the high-income class (93.33%) as compared to the other income classes. With respect to appliance warranty as a choice, the proportion of respondents which considered it was highest in the middle-income class (23.40%) as compared to the other income classes. Finally, for the choice of customer support, the proportion of respondents which considered it was highest in the lower income class (11.36%) as compared to the other income classes.

TABLE III. INFLUENTIAL CHOICE VS AGE GROUP IN THE PURCHASE OF A NEW REFRIGERATOR

Income class	Cost (%)	Quality (%)	Warranty (%)	Customer Support(%)
Below GHC1,500	19.32	81.82	9.09	11.36
GHC1,600-GHC3,000	19.15	80.85	23.40	6.38
Above GHC3,000	6.67	93.33	13.33	6.67

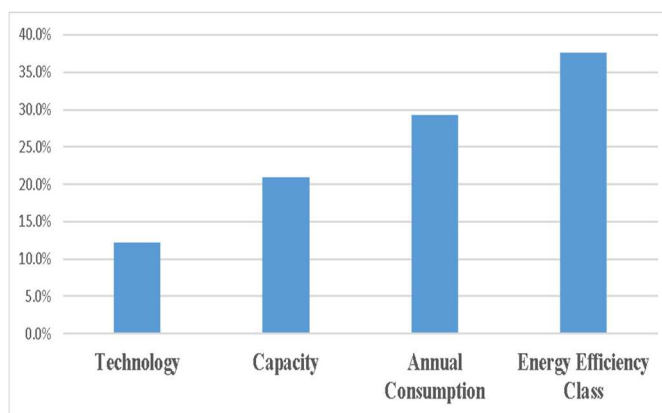


Fig. 4 Technical choices considered in brand new refrigerator purchase. [29]

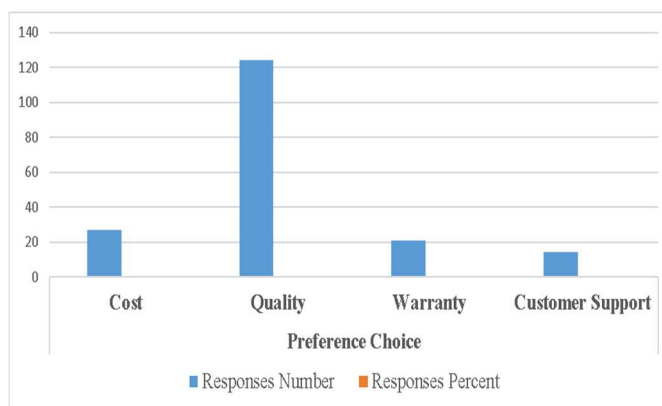
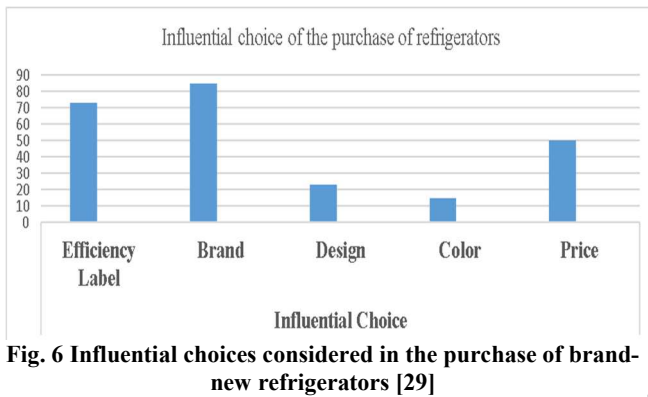


Fig. 5 Preference choice considered in the purchase of brand-new refrigerators [29]



The figures 5, and 6 generally indicate that the respondents overall considered energy efficiency class, quality, and brand as their choice determinants in the purchase of brand-new refrigerator.

## V. OUTCOMES AND CONTRIBUTIONS

Many respondents were aware of refrigerator standards and labeling regulations. Also, they understand the meaning of the star ratings of refrigerators as a grade of energy efficiency. The general responses on the energy efficiency of refrigerators indicated that they did not know much about energy efficiency practices on the handling of refrigerators that increase their electricity bills [32]. It was found that television also dominated as the major medium of their awareness of energy efficiency policy and practices related to refrigerators.

Regarding predominant choices, the middle age group considered energy efficiency label and price, retirees considered brand, while the younger age group considered colour of the refrigerator as the predominant choice determinant. The older age group considered the design of the refrigerator. Married respondents considered capacity and annual electricity consumption while single respondents considered the technology and energy efficiency of the refrigerator. For income class, low-income class respondents considered the price and colour of the refrigerator. The middle-income class considered the brand of the refrigerator. The high-income class considered the energy efficiency label and design of the refrigerator as the predominant choice determinant.

The study found that purchase choices were affected by the socio-demographic and economic status of the household, and the level of knowledge of energy efficiency practices for refrigerators was generally low amongst the respondents.

Again, comparing influential choice versus socio-demographic variables, single younger male respondents with tertiary education and high income considered the energy label of a refrigerator as the predominant choice determinant. Single female retirees with secondary education with - middle-income status considered the brand of the refrigerator. Single female respondents of older age with junior high school education with high income considered the design of the refrigerator. Single and young female respondents with junior high school education with low income considered the colour of the refrigerator. Finally, single female respondents in the middle age with some

education with low income considered the price of a refrigerator as the predominant choice determinant.

From the analysis, it is evident that each class of respondents (male or female, younger or older, married or single) has their predominant choice determinant during refrigerator purchase. This is the basis of their understanding of energy efficiency. Overall, the respondents considered energy efficiency class, quality, and brand of a refrigerator as their choice determinants in the purchase of brand new refrigerators.

## VI. CONCLUSIONS

The research found that the level of households' awareness of standards and labeling refrigerators in the Greater-Accra Region of Ghana was high but very low as far as the energy efficiency tips for refrigerators were concerned. It is therefore recommended that the level of education and awareness creation of the energy efficiency tips for appliances should be increased to enlighten consumers. As confirmed by [31-32], it was established from the study that, television and radio were the most common avenues for dissemination of the information. In addition, energy efficiency should be introduced into the curricula of school so that the younger generation grow up with the habit of efficient energy usage.

The development of new standards can consider the socio-demographic and economic situation of consumers and know which appliances to prioritize in developing standards and labeling for shop owners and importers. The research considered the refrigerating appliance and the choices considered in a purchase. The research needs to be broadened to capture other appliances under the standards and labeling regimes, such as non-ducted air conditioners and lighting appliances.

The study considered only six districts as a representation of the Greater-Accra Region. It is recommended that future research should broaden the scope to the national level to present a more representative reflection of the influence of the socio-demographic and economic status of customers on their choice of purchase of appliances in Ghana.

## REFERENCES

- [1] Agyarko, K.A., Opoku, R. and Van Buskirk, R. Removing barriers and promoting demand-side energy efficiency in households in Sub-Saharan Africa: A case study in Ghana. *Energy Policy* 2020; 137:111149.
- [2] Ouedraogo, N.S. Africa energy future: Alternative scenarios and their implications for sustainable development strategies. *Energy Policy* 2017; 106: 457-471.
- [3] Adom, P.K. and Adams, S. Energy savings in Nigeria. Is there a way of escape from energy inefficiency? *Renew Sustain Energy Rev* 2018; 81:2421-2430.
- [4] Stadelmann, M. and Schubert, R. How do different designs of energy labels influence purchases of household appliances? A field study in Switzerland. *Ecol Econ* 2018; 144:112-123.
- [5] Jain, M., Rao, A.B. and Patwardhan, A. Appliance labeling and consumer heterogeneity: A discrete choice experiment in India. *Appl Energy* 2018; 226: 213-224.

- [6] Craig, C.A. and Feng, S. Exploring utility organization electricity generation, residential electricity consumption, and energy efficiency: a climatic approach. *Applied Energy* 2017; 185:779-790.
- [7] Trianni, A., Cagno, E. and Farné, S. Barriers, drivers and decision-making process for industrial energy efficiency: A broad study among manufacturing small and medium-sized enterprises. *Applied Energy* 2016; 162:1537-1551.
- [8] Cohen, F., Glachant, M. and Söderberg, M. The impact of energy prices on energy efficiency: Evidence from the UK refrigerator market (No. 179). Grantham Research Institute on Climate Change and the Environment; 2015.
- [9] Gaspar, R. and Antunes, D. Energy efficiency and appliance purchases in Europe: consumer profiles and choice determinants. *Energy Policy* 2011; 39(11):7335-7346.
- [10] Gellings, C. W. The concept of demand-side management for electric utilities. *Proceedings of the IEEE* 1985; 73(10):1468-1470.
- [11] Bull, J. J. Loads of green washing — can behavioral economics increase willingness- to-pay for efficient washing machines in the UK? *Energy Policy* 2012; 50:242–252.
- [12] Gerke, B.F., McNeil, M.A. and Tu, T. The International database of efficient appliances (IDEA): A new tool to support appliance energy-efficiency deployment. *Applied Energy* 2017; 205:453-464.
- [13] Baldini, M., Trivella, A. and Wentz, J.W. The impact of socioeconomic and behavioral factors for purchasing energy efficient household appliances: A case study for Denmark. *Energy Policy* 2018; 120:503-513.
- [14] Van Buskirk, R., Sti, E.B., Ahenkorah, A.O. and McNeil, M.A. Refrigerator efficiency in Ghana: Tailoring an appliance market transformation program design for Africa. *Energy policy* 2007; 35(4): 2401-2411.
- [15] Gyamfi, S., Diawuo, F.A., Kumi, E.N., Sika, F. and Modjinou, M. The energy efficiency situation in Ghana. *Renew Sustain Energy Rev* 2018; 82:1415-1423.
- [16] Energy Commission of Ghana L.I1958 Energy Efficiency standards and labelling (Household Refrigerating appliances) Regulation 2009. (Viewed 20 June 2009)
- [17] Energy Commission of Ghana Energy Supply and Demand Outlook for Ghana, (Viewed 10 April 2016); 2016.
- [18] Khanna, N.Z., Zhou, N., Fridley, D. and Fino-Chen, C. Evaluation of China's local enforcement of energy efficiency standards and labeling programs for appliances and equipment. *Energy policy* 2013; 63:646-655.
- [19] Davis, L.W. and Metcalf, G.E. Does better information lead to better choices? Evidence from energy-efficiency labels. *J of the Assoc of Environ and Res Econ* 2016; 3(3):589-625.
- [20] Energy Commission of Ghana. Report on 2017 data collection exercise on refrigerator market data collection, (Viewed 15 July 2017);2017.
- [21] Behrooz, F., Mariun, N., Marhaban, M.H., Radzi, M., Amran, M. and Ramli, A.R. Review of control techniques for HVAC systems— nonlinearity approaches based on fuzzy cognitive maps. *Energies* 2018; 11(3):1-495.
- [22] Constantine, S., Denver, A., Hakim, S., McMahon, J.E. and Rosenquist, G. Ghana residential energy use and appliance ownership survey: Final Report on the Potential Impact of Appliance Performance Standards in Ghana (No. LBNL-43069). Ernest Orlando Lawrence Berkeley National Laboratory, Berkeley, CA (US)(US);1999.
- [23] Wu, J., Xu, Z. and Jiang, F., (2019). Analysis and development trends of Chinese energy efficiency standards for room air conditioners. *Energy policy* 2019; 125:368-383.
- [24] Anon Cool developments, how chilled foods is changing lives. *The Economist*. Available from: <http://www.economist.com/node/21603031>. Accessed 4th April 2018:2014.
- [25] Mugica, I., Roy, S., Poncet, S., Bouchard, J. and Nesreddine, H. Exergy analysis of a parallel-plate active magnetic regenerator with nanofluids. *Entropy* 2017;19(9): 464.
- [26] Zanchi, V., Boban, L. and Soldo, V. Refrigerant Options in the Near Future. *J of Sustain Dev of Energy, Water and Environ Systems* 2019; 7(2):293-304.
- [27] Oppenheim, A.N. *Questionnaire Design, Interviewing and Attitude Measurement*, Bloomsbury Publishing; 2000.
- [28] Tongco, M.D.C. Purposive sampling as a tool for informant selection, *Ethnobotany Research and Applications* 2007; 5:147-158.
- [29] Zan, H. N. Energy Efficiency and Appliance Purchase in Ghana: Consumer Profiles and Choice Determinants of Household Refrigerators. Unpublished master's thesis, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana; 2018.
- [30] Pothitou, M., Hanna, R.F. and Chalvatzis, K.J. ICT entertainment appliances' impact on domestic electricity consumption. *Renew Sustain Energy Rev* 2017; 69:843-853.
- [32] Diawuo, F.A., Pina, A., Baptista, P.C. and Silva, C.A. Energy efficiency deployment: A pathway to sustainable electrification in Ghana. *J Clean Prod* 2018; 186:544-557.