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ELECTRIC POWER SUPPLY, MAIN SOURCE AND BACKING: A SURVEY OF RESIDENTIAL UTILIZATION FEATURES IN OBANTOKO, OGUN STATE, NIGERIA

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Abstract: Limited access to quality and quantity electricity has remained an unresolved scourge in Nigeria. The ravage cuts across all electric energy utilization sectors in the nation most especially in the residential sector. This study highlights the sources of electric power supply, utilization features and effects of electricity deficits in Obantoko residents. A total of 124 households interviewed were selected using systematic random sampling techniques. This comprises of room(s), flat and duplex apartment inhabitants. The findings showed that despite the national grid connection, a significant number of households own and operate generators due to electricity shortfalls in the area. This essentially hamper domestic activities in various homes. The effects on several households includes interruption of work, home discomfort, consequential effect on performance, increase expenditure, undue wastage, stress due to manual/mechanical household works and enjoyment/pleasure disruption. The salvaging role of private generators as an alternative source of power supply does not seem to significantly address the problem of electric power insufficiency in Nigeria as it poses its own challenges. There is therefore the need for improvement of the public source of power supply and adoption of other private alternative sources of electricity supply that have reduced operating cost and health implication

Keywords: Electricity, Household, Energy, Consumption, Source

1. INTRODUCTION

Electricity has over the decade become extensively used in all areas of human endeavour viz administrative, industrial, commercial, and residential areas. Records of established sections where the involvement of electricity has presumed a norm ranges from homes, health care delivery, social services, industry, education, agriculture through to defense and of course in some nations, transportation [1]. Energy supply has become the next important ingredient for living after air and water [2]. A considerable number of studies found in literature buttressed that electricity is one of the most important basic necessities for living [3-10]. Among industrial, commercial and residential electricity consumption sectors, residential utilizations have been observed to have the highest share of electricity consumption, which also varies with location [11-14]. Statistical analysis of electricity consumption (Mega Watts per h) in Nigerian which covers from 1970 – 2004 showed that electricity consumption in the residential sector has consistently dominated other sector from 1978 [15]. Ekpo et al., [15] also observed that as residential electricity consumption rises, the industrial sector continues to fall. Domestic activities such as cooking, refrigerating, washing, ironing, lighting, entertainment, air conditioning, pumping of water etc., involves the use of electricity. Of the total electricity consumption in homes, kitchen, laundry appliances, preservation devices, lighting and home electronics are the main electricity users in a household [16]. Pelesai and ThankGod, [17] stated that Nigerians increasingly buy electrical appliances to consume the power (energy) produced by different sources such as national power grid, chemical batteries, generators and solar panels. Residential electricity consumption has a number of varying factors contributing to the quantity of electricity used by each household, such as Income, price of electricity, degree of urbanization and population variables (18-24). Other factors such as

household size, age distribution of home residents, and climatic condition of an area also contribute to the household's electricity consumption [25-29, 15]. Sule et al., [30], added that the substantial energy utilization witnessed in household sector is caused by considerable energy loss attributable to the use of incandescent lamp.

2. CONSUMPTION CHARACTERISTIC OF ELECTRICITY IN HOMES

Residential electricity consumption has remained among the numerous sectors that contribute to the top hierarchy of electric power usage. The number of equipment and appliances own by a household differs significantly from that of another as well as in their respective utilization characteristics [31]. Individual household demand for electricity is a service derived demand from using different number of appliances and equipment [15, 31]. Appraisal of residential electricity consumption showed that almost half of household electricity is used for lighting, television, radio, air conditioning, refrigeration, ironing, and so on. With the rapid advancements in technological innovations alongside the growth in the domestic electric appliance industry, there seems to be no complete domestic task that does not involve the use of an electrically operated device in one way or the other. EPSERP [32] added that a considerable proportion of residential electricity consumed in Nigeria is by women through household chores and other non residential activities. The involvement of electricity in domestic chores has unreserved advantages in saving time, reduction of stress and energy conservation compared to the manual/mechanical processes. Middle and high-income consumers in urban areas together make up substantial residential electricity consumers. This consumer-class typically uses several household appliances and items that consumes much electric power, such as fridges, air conditioners, electric cookers, water heaters coupled with substantial amounts of light in their homes, [33]. Where the large remaining residential consumers use electric power for lighting, [33]. Over time, as the number of households grows, lifestyle change, more electric appliances are acquired [33, 15]. It is expected that the quantity of electricity generated will also change to keep up with the load. Odularu and Okonkwo [34] found out that as the real gross domestic product grows so do electricity consumption. Typical challenges with residential electricity is its continuous demand and usage, much of which is in the morning and evening hours, besides the other less consumption periods of the day. Thereby posing some kind difficulties in the provision of electricity in the residential sector, [33].

2.1. Quality and quantity of accessible electricity in the nigeria

The power sector of the Nigeria is marked by its erratic nature, frequent interruption, total blackout, insufficient power supply, etc. Power outages for about 26 days per month, which last eight hours per day experienced in Nigeria, is relatively worse than the regional and world average records, [35]. 9% sales lost due to these disruptions and an average of about 97.1% of ownership and operation of private generators by business firms located in Nigeria explain the severity of power problems in the nation [11, 35]. Wastage challenges encountered between the generation and distribution points, especially where installed capacities are far below transmitted plays pivotal role in the quantity and quality of accessible power in Nigeria [36, 37]. Kazeem, [38] echoed that Nigeria has one of the highest transmission losses in the world with a record of 35% loss. The recent daily electricity loss recorded is about 2,993.7 megawatts (MW) [39]. There has been several plans and projections to address the power insufficiency in the country, unfortunately the nation has never met any of her past energy demand projections. Electric power transmission and distribution losses in Nigeria covering 1971 – 2010 showed that Nigeria had her highest loss value of 49.27% of the output in 1981 and the lowest in 2009 with a value of 5.87% of the output. While the power transmission and distribution loss in kilowatt hour is 8.085 billion kWh in 2002 for maximum and a minimum value of 0.25 billion kWh in 1971 [40]. Different administrations in Nigeria had witnessed this inadequate power generation and distribution challenges [41]. According to ECN, [42] several billion dollars of public investment has in the past decade gone into electricity generation and transmission capacity expansion, unfortunately the outcome

contrasts sharply with the extremely frequent electric power interruption and voltage variation. Popoola et al. [43] revealed that the quality of electricity in Nigeria is below 10%. This meager supply of electricity in Nigeria as against the ever increasing demand of same has been a great challenge to the nation. World Bank and some foreign organizations report on countries with electricity access deficit, revealed that Nigeria is the second worst in electricity shortage. The report stated that 82.4 million out of the nation's population of 160 million people lack access to electricity [44]. It was estimated that the supply shortfall is about 80% of the country's potential electricity demand [45]. The total Installed capacity from both thermal and hydro electricity generating plants in Nigeria in 1999 was 5,860 MW and an available capacity of 5,400 MW while the effective capacity was about 1600 MW. Ten years after (2009) the total installed capacity of the generating plants rose to 7,876 MW out of which about 4,000 MW constituted available capacity and effective average daily generated capacity below 2,700 MW. In 2012 a peak of 4,517 MW was attained which latter dropped to 3,443 MW in 2013 [46]. The recent installed capacity is about 10,000 MW within which available capacity of 6,668.6 MW was generated, where effective capacity of 3,400 MW or so is actually generated daily [39]. The challenges of electricity in Nigeria could be put as an outcome of technology, poor maintenance culture, old and insufficient installations, infrastructural decay, vandalism of electrical installations, fire incidents, poor funding, low tariffs, huge debts owed the electricity industry, irregularity of stream flow, power loss experienced from generation to distribution points, distance of generation point to the distribution and inaccurate forecast of electricity consumption determinants and patterns especially from its regional perspective [13, 26, 34, 37, 39, 47-50],

2.2. Power supply potentials in NIGERIA

Nigeria as a nation is enormously endowed with large quantity of non-renewable and renewable primary sources of energy which if properly and substantially harnessed will achieve stability in energy supply to the nation. The country has an estimated natural gas reserve of 185 trillion cubic feet, 35 billion barrels of crude oil and 2.75 billion metric tones of coal reserves [37, 41, 51-54]. According to Uzoma, [41] Nigeria is capable of producing an estimated total exploitable large-scale hydropower potential of 36,000 GWh of electricity annually. The daily electrical energy obtainable from the sun in Nigeria expressed in barrel is equivalent to 4.66 million barrels of oil per day [55]. Other energy resources available for boasting electricity in Nigeria includes wind energy 2.0 - 4.0 m/s, biomass 144 million tons/year and wave and tidal energy 150,000 TJ/ (16.6 × 10⁶ toe/yr) [52]. All these massive primary energy resources for the generation of electricity in the country notwithstanding, Nigeria currently depends on gas-fired thermal and hydropower stations for electricity generation [56-59]. As a consequence, we creating a very wide gap between the electricity generated and the demand in the nation.

2.3. Prevalence of generators in residential sector

Erratic power supply and prolonged power outages experienced in the nation has grossly encouraged a significant percentage of residential and other non-residential electricity consumers to seek alternative sources of power supply [34, 60]. In the event of power outages, private generating plants aid continuation of important electrical appliances where halting will severely affects activities [3]. A large number of households, especially those residing in urban areas, though the figure is uncertain, rely on generators for their electricity needs. Estimated figures from the Global Business Intelligence in 2011 revealed that Nigerians spent about four hundred and fifty five million dollars on generators [39]. The wide spread substitution of private for public provision of electricity explains why the residential electricity consuming class has taken over the electricity consumption leadership in Nigeria. Power interruption challenges for residential consumers are associated with some latent variables such as inconveniences, interference, disruption of housekeeping or leisure activities. Odularu and Okonkwo, [34] reiterated that electricity is necessary for the realization of uninterrupted comfort. The appalling part of owning and operating

private generators includes its relative high operation cost, considerable power insufficiency and the accompanied health issue.

2.4. Power shortage: a conventionality or peculiarity

Electricity demand and supply mismatch is a widespread challenging issue. Most nations of the world strive to establish an efficient and effective power sector that will meet up with the ever increasing energy demand in various nations. Although power shortage is predominantly in developing countries, all nations of the world encounters electric power transmission and distribution losses, challenges which also affect the available electric power in these nations. Among different nations of the world, the United States tops the 2010 electric power transmission and distribution losses chart with a value of 260.999 billion kWh, where Nigeria occupies the forty-fifth position with a value of 4.497 billion kWh. Electric power sector of West African countries are characterized by low performance, limited access to electricity and endemic electric power shortages [45]. Nigeria, Benin, Ghana, Mali, Togo, and Guinea rely significantly on hydroelectricity for power generation [33, 45] which severely affects the power generation in these nations during drought. The power demand in nations like Burkina Faso prompted seeks of electricity importation from neighboring countries [33]. Senegal, Mali and Guinea suffered several years of frequent electricity disruptions owing to insufficient electricity generation capacities as well as low reliability of generating plants [45]. Senegal which mainly generates its own electricity from oil, has experienced frequent power plant outages because of low reliability and fuel procurement difficulties encountered. Outside Africa, India is the worst in electricity deficit as 306 million of Indian population had no access to electricity [43]. Pakistan continual electricity shortages reached crisis proportions in 2013. The nation recorded lightouts for at least 10 hours/day in major cities, and up to 22 hours/day in rural areas [61]. China, which today has excess available capacity to meet current electricity demand has in the past recorded three periods of nationwide power shortages which covers 1978 – 1996, 2003 – 2006 and 2008 [62]. World Bank reported that over 50 million citizens of countries like Bangladesh, Ethiopia, Congo DR, India and Nigeria lack access to electricity [43].

2.5. RESIDENTIAL ELECTRICITY DEMAND AND CONSUMPTION LITERATURES

A considerable number of studies have identified determinants of electricity demand both in developed and developing countries. Below is the classification of various studies as they correlate: Most of the studied literatures adopted development of models in the determination of electricity demand. These studies considered single or a combination of two or more of these variables; real income, electricity price, population growth, structural changes, climatic conditions, urbanization, efficiency improvement using either univariate cointegration approach, multivariate cointegration approach or bounds testing approach in their various studies [8, 15, 63-76]. SocioDemographic factors such as population, urbanization, family size, age distribution, the number of wage earners in the household [15, 77-78]. Experimental investigation of residential electricity demand for consumption conducted at the disaggregated level [8, 21, 64, 67, 70, 76, 79, 80-83]. Analysis of electricity demand for accurate and substantial projection and policy analysis [36, 52].

3. OBJECTIVE OF THE STUDY

Electricity utilization in a household depends on the available appliances and services in which these appliances are engaged in. It is not unusual to expect variation in the factors influencing the demand of electricity in different households. Electricity, like other utilities used in households, is not consumed directly by individuals. Rather, it is a service instigated demand from the energy required for running and operating various electrical appliances and equipment in the household [31]. In this view this study was designed to identify electricity utilisation features and the effects of power shortage challenges in the residential areas.

4. MATERIALS AND METHOD

This research designed to study electric power accessibility and consumption pattern in Obantoko, Ogun State, Nigeria was conducted from May 1 to July 31, 2013. Obantoko, a developing metropolis located at the out sketch of the ancient city of Abeokuta falls within Abeokuta South and Odeda local government areas of Ogun state [84, 85]. The locality is generally characterized by undeveloped large parcels of land that typically separate buildings which are either used as farm lands or dumpsites [86]. The building arrangement in this suburb includes linear, clustered and scattered settlement pattern as all is found in different areas with traces of assigned street names in some areas.

A pretested self administered questionnaire was used for data collection. The households in this study were selected using multi-staged random sampling technique with no exclusion criteria. The community was divided into two zones and further broken down into ten districts. Each of the districts was represented in the study. The response for each question on the questionnaire accommodated any member of the household with the empiric information for the home. A total of 124 households visited were considered appropriate for this study. Others were turned down due to refusal of various participated households to respond to the majority of the questions and absence of the person who could respond to most of the questions when visited. The questions included, sources of electricity for the home, duration of usage of various sources of power supply, the activities in which the supplied electric power are engaged in, effects of electricity deficit from public sources in the household and preference of power source among the available sources of electricity supply.

The data collected was analyzed in simple frequency and percentage format using Statistical Package for Social Science (SPSS) 16.0 version and presented in table and charts.

5. RESULTS AND DISCUSSION

Obantoko population estimated to be 57,750 people in [85] survey was observed to be experiencing progressive population growth in the last eight years. 62 households representing 50% of the household participants are tenants, 58(46.8%) respondents own and live in their houses while 4(3.2%) household participants live in their family/relative house. The dwelling characteristics of the different households in the area includes room(s) 40(32.3%), flat 64(51.6%) and duplex 18(14.5%) apartments. Almost all the buildings 120(96.8%) are connected to the national grid This number contribute to the national population of less than 40% that are connected to the grid system which, according to Nigerian Energy Policy report, 2003 experience power shortage for over 60% of the time [87]. High ownership and operation of private generators 108(87.1%) demonstrated the epileptic state of power supply in the area. The meager electricity supply condition in the area notwithstanding, the vast majority of Obantoko households 82(66.1%) rely on public source of electricity supply as their major source of electricity while generator serves as backup. This was a different case for 44(33.9%) households who observed that generator is their major source of electricity as they mostly engage generators in handling electricity demand services in their homes. This observation agreed with Elendu, [88] that unpredictable supply from national grid cause different households to opt for private source of electricity to ensure supplies in their homes. The predominant use of generator as private source of electricity observed is also in line with Kennedy-Darling et al [89], that generators running on diesel or gasoline are the common form of off-grid electricity supply. Similarly Idiata et al., [90] found that 60% of the Nigerian population depend on generators for electricity supply. Tyler [92], survey also reported that 96 to 98% private generator ownership among rural firms despite the grid connection. The worst average duration of public electricity witnessed in the last six months were 30 min/day and 1hr/day by 24(19.4%) and 20(16.1%) households respectively. There is no household, which observed public power supply above an average of 6hrs/day. This is relatively worse than the national average record of power outages for eight hours per day experienced in the nation [35].

Table 1: Sources and Access to Electricity

Descriptions	Frequency	Percent	
Connection to the national grid	Yes	120	96.8
	No	4	3.2
Major source of electricity supply	National power grid	82	66.1
	Generator	42	33.9
Ownership of private source of electricity	Yes	108	87.1
	No	16	12.9
Type of off grid sources owned	Generator	110	88.7
	Solar	2	1.6
	Others	2	1.6
Public power supply rating by different households	Excellent	8	6.5
	V good	10	8.1
	Good	28	22.6
	Fair	36	29.0
	Poor	26	21.0
	V poor	16	12.9
Average accessible public electricity in last six months	30min/day	24	19.4
	1hr/day	20	16.1
	2hrs/day	10	8.1
	3hrs/day	16	12.9
	4hrs/day	10	8.1
	5hrs/day	14	11.3
	6hrs/day	10	8.1
	Others not stated	16	12.9
Private generating plant usage	Never	18	14.5
	Sometimes	40	32.3
	Always	54	43.5
Offgrid source usage duration	<=1Hr	4	3.2
	2hrs	18	14.5
	3hrs	48	38.7
	4hrs and above	40	32.3

Various views of public electricity supply in Obantoko metropolis varied widely. To 36 households representing 29% of the household participants, electricity supply in the area is fair. While to few 8(6.5%) it is excellent (Table 1).

In compensation for the much inaccessible quantity and quality of electricity in the metropolis, 54 households representing 43.5% household participants always run their generators whereas 40 households representing 32.3% of the household sometimes do. The length of usage recorded among these households ranges from less than one hour (1hr) to 4 hrs and above. The largest proportion of the households 48(38.7%) use generators for 3 hrs on the daily basis. This was followed by 40(32.3%) households that run their generator for 4 hrs and above every day. Individual household demand for electricity is a service derived demand from using different number of appliances and equipment [15, 32]. Figure 2 showed the various activities in which electricity is involved in, in Obantoko households. Among the services obtainable from electric utilities, lighting was the first and has continued to account for significant source of electricity consumption [92]. Globally, almost 1/5th of total electricity generated is consumed by lighting [93]. ECN-UNDP, [94] work also showed that lighting is the second major energy-consuming activities in Nigerian households. The

observation made in this study revealed that 21(16.9%) households mostly engage electric energy for illumination (lighting). This supports the report on global consumption that electric lighting accounted for 99% of the total light consumption [93]. Electricity utility is also involved in the following three groups of activities namely cooking process 12(9.7%), pumping of water 11(8.9%) and housekeeping 8(6.5%) (Figure 1). which in its absence are carried out either manually or manual/mechanically. Access to electric energy and electrically operated equipment reduces excessive workload, drudgery encountered and time involved in repetitive manual or manual/mechanical activities such as, washing clothes, pounding foods, grinding or milling food grains, fetching water etc. it was found in studies that static relaxation imposed on individuals

especially women in repetitive tasks and bending involved in very frequent household activities causes shoulder pain, neck pain, and degeneration of spine [95, 96]. In [96, 97] it was stated that working with the hands above shoulder height involved in some household chores like pounding is stressful and have the tendency of increasing risk impingement syndrome development.

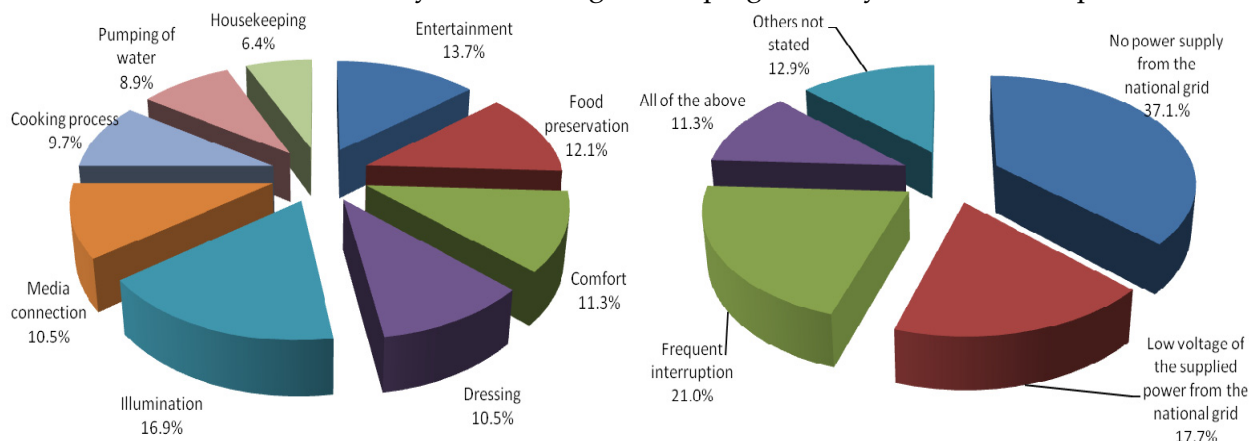


Figure 1: Electricity Consumption Pattern Figure 2: Major Reasons for Using Alternative Power Supply The quantity and quality of electrical energy reaching the electricity consumers via distribution system in Nigeria is very poor. Various problems such as limited exploitation of power generation technology, inadequate power generation and high power losses faced by the power sector of the nation translate to voltage variations and electricity deficits witnessed in all sectors. Frequent interruption, especially at the peak of crucial activity instigated 26(21%) of the household participants to seek alternative source of power supply. To 46(37.1%) household participants, it is outright power supply outage, 22 households representing 17.7% of household participants use private source of power supply due to the low voltage of the supplied power from the public source. Whereas all the above factors coerced 14(11.3%) household participants into private power usage (Figure 2).

Generally, Ogun State has tropical climate. The mean monthly temperature ranges from 23°C in July to 32°C in February, while the rainy season lasts from March to November, followed by dry season [98]. The temperature of the area makes the use of electric fans and air-conditioners essential for space cooling. The services of these space cooling appliances coupled with entertainment equipment enhances good relaxation and comfort 14(11.3%).

The benefits of electricity as found above in numerous household can turn out to be nightmarish in its absence. The erratic power supply in the Obantoko always and sometimes affect the residential activities of 30(24.2%) and 64(51%) of the household participants. In the face electricity outage all electrical appliances stop working, no fan, no air condition, no television, etc. this hinders many domestic activities. The predominant observed variable that electricity deficit effect on Obantoko dwellers is home discomfort 34(27.4%).

Fresh and perishable food products such as fish, meats, fruits, and vegetables can be preserved for several days, weeks or even months by cooling or freezing using refrigerators.

Altering the environmental conditions the food items, disarm and incapacitate the microorganisms which cause off-flavors and odors, slime production, changes in the texture and appearances, and the eventual spoilage of foods [99]. Refrigerator use hinderance in Obantoko community results in undue wastage 12(9.7%) in households. Obvious food wastage in Nigeria is depicted in most refuse dumpsite throughout the nation. Researches [100, 101] observed that household waste and refuse dumpsite in Nigeria is characterized by substantial amount of food waste. Ogbonna et al. [101] echoed that food waste constitute 26.6% of total waste generated in a major city in Nigeria. Enjoyment/pleasure disruption 11(8.9%) and Interruption of work 20(16.1%) are other activities found to be affected by electricity deficit in Obantoko.

Frequent operation of private generators in various households constitute nuisance, health concern [3] and observed consequential effect on performance 9(7.3%). Besides the health issues, running cost of generator which involves refueling, maintenance and repair directly increases the proportion expenditure that goes to energy utilities in 16(12.9%) household participants. This agreed with Kennedy-Darling et al. [89], that private generators are more expensive to compare with the national power grid (Figure 3).

Among the various sources of electricity supply available for residential consumption, both on grid (national power grid) and off grid (generator, inverter and solar panel) sources, majority of Obantoko residents prefer the public source of electricity supply (national power grid) 84(67.7%) due to its relatively cheap cost, load capacity and health assurance.

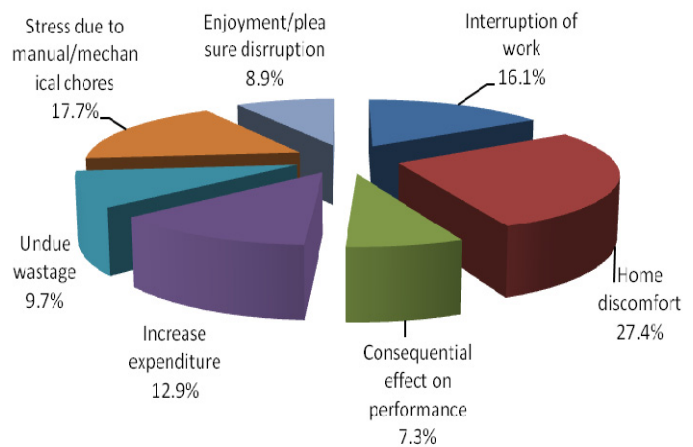


Figure 3: Effects of electricity deficit on households

6. CONCLUSIONS

The importance of electricity in the residential sector cannot be over emphasized. Virtually all domestic activities in the residential sectors involve the use of electricity. Unfortunately, the much needed electric power supply from the national grid which is also the major source of power supply is marked by its frequent interruption, total blackout, insufficient power and voltage variation. The effect of the electricity deficit in different households includes interruption of work, home discomfort, consequential effect on the performance, increase expenditure, undue wastage, stress due to manual/mechanical household chores and enjoyment/pleasure disruption. In an attempt to alliviate these challenges private sources of electricity supply are obtained by different households. Among the various sources of private electricity generation technology available, generator was observed to be the predominant alternative source of power use in the community. This in turn presents another set of problems such as insufficient load capacity, health issues, increased demand for electricity and increased energy utilities expenditure. The issue of electricity deficit is a challenge which demands active participation of both the government and her citizens to address. This could be through prompt payment of bills, avoidance of vandalism of electrical installations, electric energy efficiency and conservation practices, on the part of the citizens; ensuring adequate power generation and distribution by exploiting all the available primary sources of electricity generation in the country, adopting healthy maintenance culture and doing away with old dilapidated installations on the part of the government.

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