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An Assessment of the Electrical Energy Needs of Beauty Saloon Industry in Ghana

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Abstract: Insufficient and irregular power supply in Ghana has been a matter of concern to all. This situation runs through all industrial, commercial and domestic sectors of the Ghanaian economy, posing much challenge to the economic growth. This study considers the Beauty Salon industry which is one important but neglected industry which depends mostly on power for all its activities, and also consumes a lot of energy. In the beauty salon industry, about 73% of the work force is women which falls under the hairdressing with the remaining being barbers. The research shows that, about 96% of their business operations depend on the National Electric grid. Finding an alternative means to provide electrical power source is of much significance. Notwithstanding this, the total average income of GH₵8,443, expenditure of GH₵3,488 and GH₵1,951 being the expenditure of light provision in the absence of national grid. Aside this, the cost of electricity bills keeps raising making the industry being under critical condition to stay in business. Therefore the study identifies various tools and equipment used in the industry and their power ratings to propose a possible design of photovoltaic (PV) system for the industry. This study proposes a 2.8KW Stand-alone Photovoltaic System to help solve the problem of entrepreneurs in the Beauty Salon industry. In view of this study, it can be recommended that, this PV can be implemented to promote it use in the Beauty Salon industry by the Ghana government and other donor agencies to sustain the burden on the industry. Also the study identifies the need for education of power management as most entrepreneurs in the Beauty industry have little knowledge on it.

Keywords: Assessment, Electrical, Energy, Power, Salon, Solar

1. Introduction

This research analyzed and then proposed designs 2.8KW photovoltaic technology for the private sector businesses. It specifically targets the beauty salon operators in the Kumasi Metropolis. The need for this technology has become a legitimate necessity in the event of continuous and unstable power supply from the national grid to the various consumers. This occurrence has led to hardship many private sector businesses whose main source of operation depends on the national power grid for their services. The choice of the beauty salon is considered due its form of operation and how large the industry's electrical power consumption is. According to this research, Beauty Salon operators depend mostly on electricity for their services to customers, without it there is no effective means of operation. In terms of observational analysis, their activities can be found in the entire Kumasi Metropolis and its environs. The beauty salon business falls under the Small Scale Industry.

Their large number availability is directly proportional to the consumption of power and also partially to the growth of Ghana's economy. Therefore for such an industry there is a need to develop a technology to assist it. Persons engaged in this business are mostly full time workers who also engage in training their apprentices for future expansion of the industry. Looking at this picture and considering the amount of power consumption from the national grid with respect to the ever unstable condition of the Ghana National Power Grid Supplies, this research seeks to lead the way in assessing and designing an effective Photovoltaic system for the survival of this industry which houses a lot of people for their livelihood.

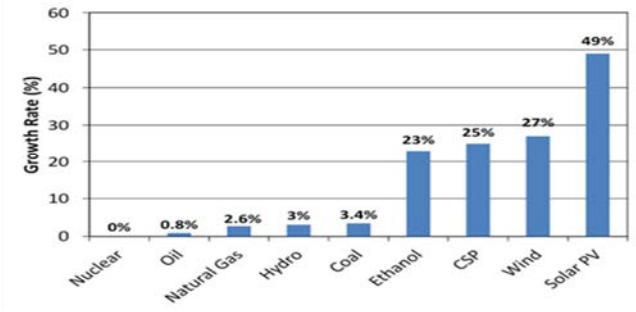
Figure 1. *Showing the decline in the price of solar, from 2009-2030.*

The Implementation of solar plants in the Beauty Salon Industry could be substantially beneficial for all parties involved. The sun is nature's ultimate energy source and can be harnessed using the right technological designs. Fortunately, Ghana finds itself with a lot of sunlight and having averagely the Sun peak-hours[1] between 4.96 and 5.47 (kumasi.climatemps.com, 2015).

Today, the cost of solar implementation and panels are declining and becoming a more feasible idea around the country and is a cleaner way of obtaining a source of energy (Figure 1). This alternative energy source could produce a substantial annual savings. Kumasi has the potential for very high output gains due to the amount of sun shine and space available for the panel mounting. We need to take advantage as a private sector innovation to solve our power problem for continuous operation.

2. Description of Technology/Innovation to Address Problem

Since the industrial revolution in the late 18th and early 19th centuries, society has become fixated on harvesting our limited resources for the production of industrial and consumer goods. The obvious issue with this reliance is that these resources are finite; therefore, there must be a point in the future in which they will run out. With this issue increasing every day as more resources are used, people across the world are looking for a solution that doesn't rely on our finite resources like oil, coal, and even water, turning to "greener" practices like solar and wind energy.



Source: (World Watch Institute, 2015)

Figure 2. *Average global growth rates by energy source over a five year span (2005-2010).*

1 The number of hours the sun shine per day.

These energy sources will be important as society shifts toward renewable energy to solve many of the environmental issues caused by our historically toxic practices, like coal mining, and nuclear fusion. These renewable energy sources also offer imminent financial benefits, as it becomes cheaper to produce and implement them.

Solar has become one of the fastest growing renewable energy sources. It provides an excellent solution to the issue of our diminishing finite resources. Solar also provides energy "security" because it is harvested from our most abundant resource, the sun. For this reason, solar energy will be a viable option for energy as long as the sun exists. Figure 2 shows the global average growth rates for our energy resources from 2005-2010. Solar energy represents the highest growth rate during this time period and continues to grow as technology increases and photovoltaic (PV) cells become more efficient at capturing solar energy. In fact, this graph shows the growth of photovoltaic solar at almost 50% over that five year span; a growth rate that is exponentially higher than the other energy sources shown in the graph. One of the current issues with the implementation of solar energy in the Ghanaian private businesses on a massive scale is the cost of installation, knowledge and maintenance. Because of these high costs, the current price of solar energy is dictating the market, meaning it is not yet cost effective for the average household and small and medium scale industry; however, as technology progresses, it is rapidly becoming cheaper and more readily available (Ren 2014). This gives the assurance that with time solar energy which is abundant in Ghana will be harnessed for effective use. According to annotated source cited by the Solar Energy Industries Association (2013), there is an expected 26% growth in solar energy installations in 2014 alone. During this rapid growth worldwide it is important for Ghana to encourage its private sector economy into the PV technology to reduce the burden on the national power grid.

3. Methods

3.1. Study Setting and Reason Design

The study was confine to Ghana with Kumasi as a case study. The Kumasi Metropolis and its environs have a very big market share in the Ashanti Region of Ghana. Most of its businesses are made up of a lot of small fragmented Small Scale and Medium Scale Industries which contributes much

into the Ghanaian economy. The frequent power problem has led to many of such businesses in wondering situations.

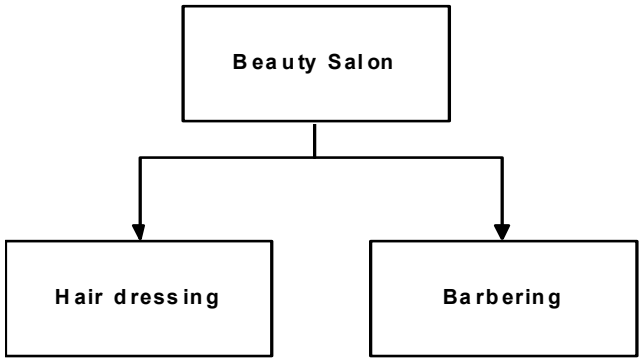
This study uses an exploratory approach to provide flexibility in considering different aspects of problems facing the beauty Salon industry. However, design used is based on simple random sampling of non-probabilistic approach. This approach is chosen because, the actual population size is not known and players in the industry are fragmented across the city. The Electrical energy needs assessment is conducted to help propose a photovoltaic system for its operation while identifying certain challenges. Therefore a survey is conducted on two hundred and twenty (220) different communities in the Kumasi Metropolis. Hence the data collection is purposively stratified as follows: Breman, Abusuah-Kruwah (12), Maakro, Suame (20), Krofoum, Ashtown (20), Duase, Kenyase (20), Santasi (10), Kotei, Ayeduase (20), Buokrom (20), Asem, Akwatialine (20), Ahwiaa, Asafo (20), Ahodwo, Nhyiaso, Adeabeba (20), and Asuofua, Bantema (20). This research presents two hundred and two (202) sampled spaces 91.8% representing of the two hundred and twenty (220) research schedules sent out for data collection.

3.2. Areas of Concentration in the Electrical Needs Assessment Schedule

The following areas were considered with both open and close ended investigation: bio data, load assessment, sources of energy, knowledge on solar systems, and energy management.

3.3. Beauty Salon Setup

The beauty salon setup is made up of two main categories; the hair dressing (ladies) and the hair barbering (gentlemen).



Source: (field design, 2015)

Figure 3. *Two main forms of beauty salons in Kumasi Metropolis.*

For one to enter into the business he/she has to be skillfully trained by a Master [2] who owns a shop for approximately three years. This is because it mostly depends on the learner (apprentice) how fast she/he may learn. Apprentice can chose to work for the master after qualifying as an expect worker having taken an exam to enable him/her earn out a living.

Beauty Salon operations

Salons can provide a host of beauty and pampering services. But rather than work in a salon as a stylist, you may decide to venture out on your own and open your own beauty salon shop. Opening and successfully running any type of business is no easy challenge. But with adequate capital, a good staff and a prime location, you can grow a successful beauty salon.

Step 1. Get an employer identification number and business license. Go to IRS and apply for an employer ID number. Use this number to file taxes. Acquire a license to operate a business in your city by visiting the local assembly and paying the required fee.

Step 2. Begin with a business plan. Provide a description of how you will run the beauty salon. Elements of a professional business plan include items such as a summary, description, marketing ideas, analysis of the competition and long-term outlook. Banks often request business plans before lending money.

Step 3. Brainstorm financing options. According to Power Home Biz (2015), setting up a beauty salon can cost between GHC500.00 and GHC5000.00, on average, this depends on the person's cash at hand. Options for financing a project can include using family and friends support, withdrawing money from savings or applying for a small business loan.

Step 4. Narrow down the types of services offered by your salon and determine their prices. Beauty salons vary. Some only offer hair services, whereas others include nail services and spa service massages and facials. Visit salons in your local area to research pricing information to stay competitive.

Step 5. Secure a location for your salon. Location is crucial to a businesses' success. Prime locations can include those within a busy shopping district or an area that receives a lot of foot traffic. This can help increase visibility and the number of walk-in customers.

Step 6. Purchase equipment. Contact salon equipment suppliers to acquire items such as sinks, styling chairs, booths, a reception desk and hair dryers. If selling nail polish, hair care products and other supplies, contact a beauty supply distributor to stock your shelves.

Step 7. Hire a staff. Advertise for trained staff to work in your salon. If possible, hire stylists who already have a sizable client-base.

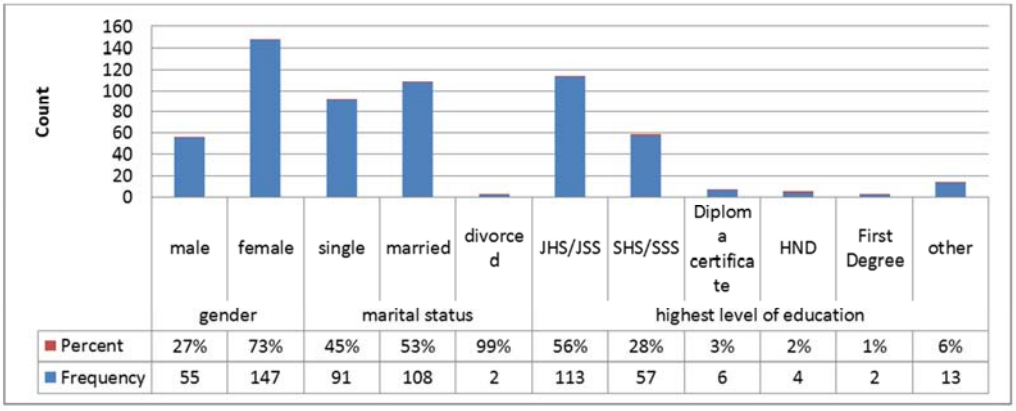
Step 8. Use advertisements and promotions to locate business. Begin advertising your grand opening several weeks before the actual date. Distribute flyers in local neighborhoods, and offer promotions such as half-off products, free food or discounts on services.

4. Findings

4.1. General Information Respondents

Figure 4 shows various kinds of people and their background in the Beauty Salon industry.

2 Master is normally used to describe a skilled trainer in the industry.

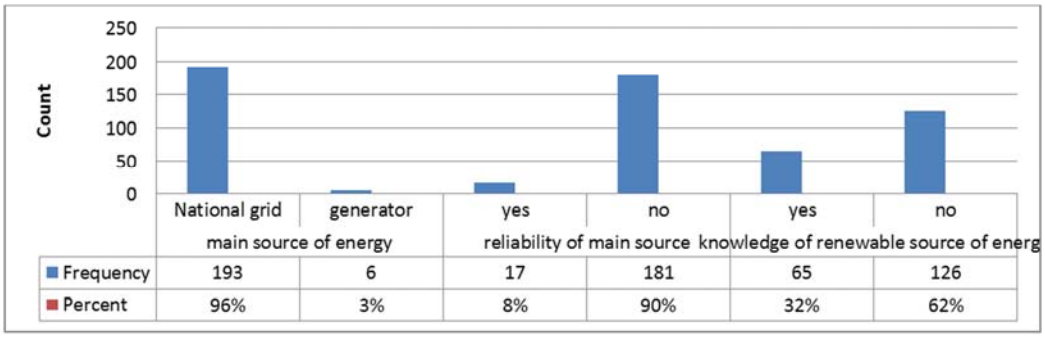


Source: (field data, 2015)

Figure 4. *The background of correspondents' gender, marital status and their educational levels.*

4.2. Sources of Energy for Their Salon Business

In this section respondent's source of energy for their businesses are identified. In Figure5 willingness of the respondents' use of power is tested.

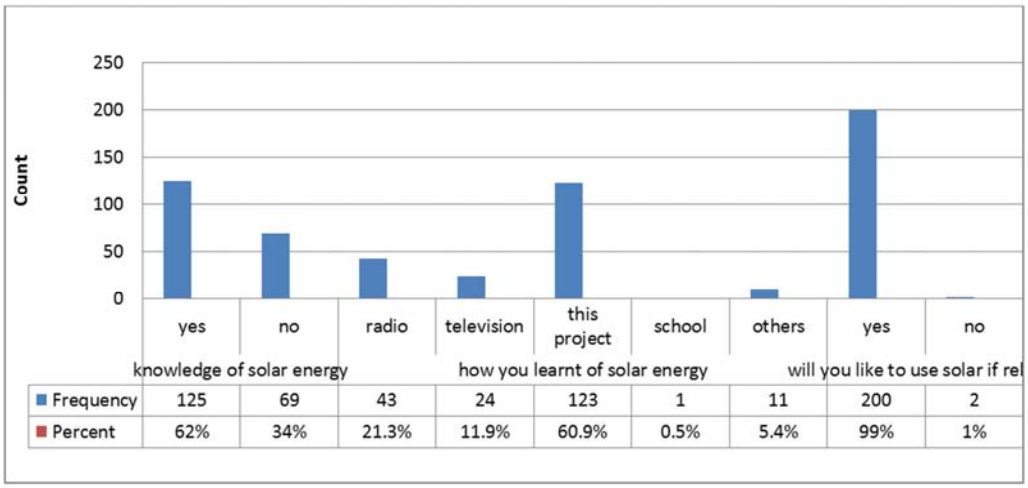


Source: (field data, 2015)

Figure 5. *Sources of energy for business activities.*

4.3. Knowledge on the Photovoltaic System

Figure 6 represents respondents' knowledge on the solar energy system. The means by which he/she acquired the knowledge, and the willingness to use the solar if it is available for.



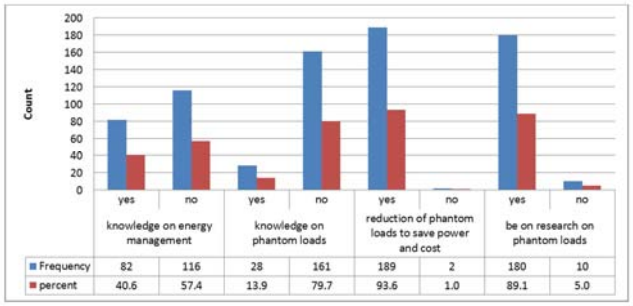
Source: (field data, 2015)

Figure 6. *Respondent knowledge of the solar energy and willingness to use.*

4.4. Energy Management in the Beauty Salon Industry

Energy management has been a source of worry to the Ghanaian populace. Therefore there is the need to also focus on the Beauty Salon industry to check how the energy transmitted to them is managed to avoid excessive use of power supplies. In figure 7 and 8, averagely the industry lack energy management skill but are willing to adopt.

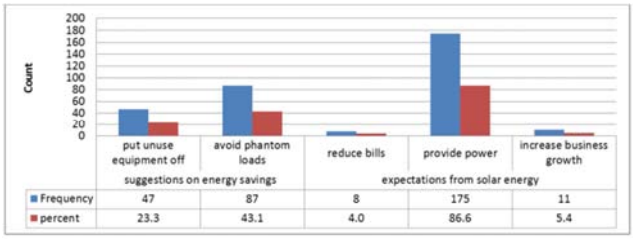
Figure 7 assessed the knowledge on energy management, knowledge, on phantom loads, reduction of phantom loads to saving energy and cost and acceptance to practice on the avoidance. The study shows that about 57% had no knowledge on energy management, in the knowledge on phantom loads, 80% of the respondents have no idea. However, about 94% understood that phantom loads avoidance will help reduce cost of electricity usage.



Source: (field data, 2015)

Figure 7. *Respondent'S willingness to corporate on future energy management plans with phantom loads[3] knowledge.*

In figure 8, the study wanted to know the respondents' knowledge on energy savings and their expectations from the solar energy. It was shown that, about 23% suggested that putting unused equipment off and upon the introduction of the effect of phantom loads, about 43% agreed that it will help save energy. However, about 87% of the respondents are expecting the solar energy to provide electrical power.



Source: (field data, 2015)

Figure 8. *Expectation of respondents about the use of solar energy for the Salon business.*

4.5. Appliances Used by Beauty Salon Operators

According to the study, the appliances use in this industry are purely resistive load[4] and consumes more power than most Small scale businesses such as garment manufacturing, mobile phone repairs and type setting and printing business. Various Power ratings of appliances are shown in Table 1. This reports the maximum, minimum, average, total and frequently used equipment ratings.

Table 1. *Power ratings Appliances in the Beauty Salon industry.*

s/n	Appliance	actual (W)	Min. (W)	Av. (W)	Max. (W)	Total (W)	Mode (W)
1.	Hood Drier (56)[5]	1800	400	1267	3000	184930	1000
2.	Hand Drier (62)	2000	400	1267	2400	225550	2000
3.	Straightener (104)	35	15	45	75	4602	35
4.	Tonging m/c[6] (142)	80	15	48	95	2855	45[a]
5.	Fan (15)	85	40	62	85	11640	45
6.	Light (inside): 5	25	10	41	100	8155	25
7.	Pedicure bowl (174)	100	25	64	105	1801	45
8.	Television (34)	85	30	75	200	12608	80
9.	Wax Plug	100	100	280	540	15416	200
10	Kettle (76)	2000	1000	2165	3000	56300	2000

Source: (field data, 2015)

4.6. The Energy Consumption (KWh)

In assessing the energy consumed a period of six months is collected in Table 2 to know the trend. Sept. 2014 37% accessed their bill showing a total of 7208Wh, 35% for 7129Wh in Oct, 2014 and Feb, 2015 is 5336Wh.

Table 2. *The Energy consumption (Wh) in the Beauty Salon Industry for six months.*

Parameters	Sept, 2014	Oct, 2014	Nov, 2014	Dec, 2014	Jan, 2015	Feb, 2015
Valid N[7]	75 (37%)	71 (35%)	69 (34%)	77 (38%)	93 (46%)	66 (33%)
Mean	96	100	98	87	106	80
Mode	8[a8]	50	150	150	54	50[a]
Minimum	7	4	8	4	5	10
Maximum	312	689	5380	370	829	303
Sum	7208	7129	6792	6759	9884	5336

Source: (field data, 2015)

*4.7. The Cost of Energy (GH₵*Wh) for Six Months*

This is the product of energy consume by amount charged

3 Phantom loads they are loads connected sockets while they are switch off. Consumption still takes place, due to this its sometimes termed Vampire loads.

4 Resistive load

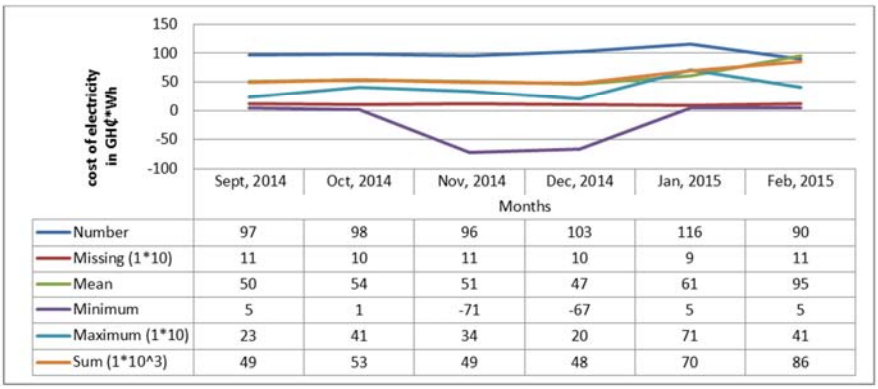
5 Numbers in the brackets represents the available quantities of appliances in the industry.

6 M/c is short form of machine.

7 The number respondents whose data were available

8 Multiple modes exist. The smallest value is shown

by E.C.G. In figure 9 shows a graph of cost billed against the industry over six months. Sept. 2014, 48% accessed their bill showing a total of GH₵49,000, 49% for GH₵53,000 in Oct, 2014 and 45% for Feb, 2015 is GH₵86,000. The negative costs are as a result of overpayments other than the actual cost provided.



Source: (field data, 2015)

Figure 9. *Cost of energy for six months showing varied levels of bills from ECG.*

4.8. Average Income and Expenditure of the Industry

This in Table 3 compared the industry's average daily income and expenditure as against their expenditure on other alternative sources such as generator and plant. It presents a total average income of GH₵8,443, expenditure of GH₵3,488 and GH₵1,951 being the expenditure of light provision in the absence of national grid.

Table 3. *The average income and expenditure of the industry.*

parameters	Average daily		expenditure for alternative source
	income	expenditure	
Valid N	196 (97%)	190 (94%)	75 (37%)
Mean	43	18	26
Minimum	8	3	5
Maximum	200	90	80
Sum	8443	3488	1951

Source: (field data, 2015)

5. Photovoltaic Design for the Beauty Salon

The design is based on a simple power consumption of the Beauty Salon in the study area. It looks a Salon Center with almost all the equipment used in the Industry. The average appliances used in the Industry in appendix A. This includes the estimated consumption levels calculated. In appendix A, the table consists of various loads that are of low consumption as shown in Table1 under actual power (W). This is because most of the load can be use intermittently as not all are will be needed at a go. This will also call for the "energy-how-management" of the PV system user. The total load of the system in the above appendix A table is approximately 2.8KW of load. The daily energy needed for the average Salon business operation is 6.5KWh per day.

5.1. System Configuration

In figure 10 represents an averagely used structure by the Industry with its electrical layouts of plan and side view. It is proposed to install the controller, inverter and batteries in a designed metallic rack or block mounted housing close to the business center to prevent theft. This option may depend on the person's interest. The cable run between the PV modules and controller can be laid underground or overhead.

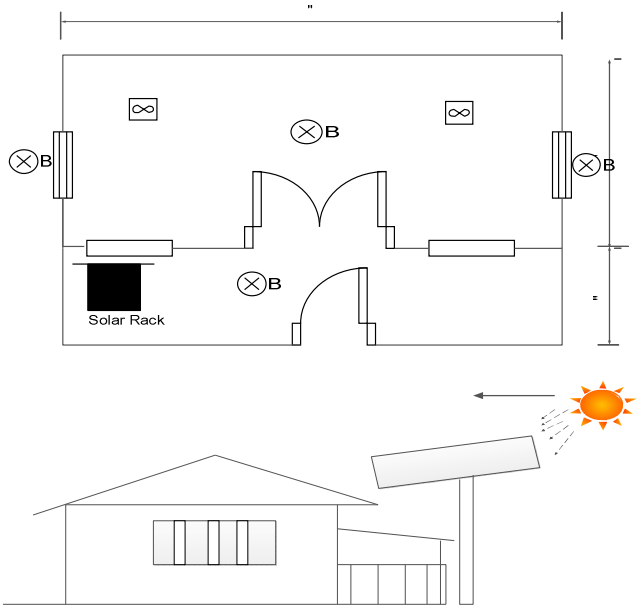


Figure 10. *A typical structure layout of an SBS.*

The latter is less expensive but requires greater care. In mounting the panels, one can choose between roof and patio method. The patio is due to the current settings of its environment.

5.2. Design Considerations

The research design a lot of considerations need to be made. They include technical specifications from makers, system sizing for different analysis.

5.2.1. System Voltage, Photovoltaic (PV) Modules and Battery Sizing

The following are simplified equations (1 to 9) calculating the overall PV of the system design

$$\text{PV panel sizing} = \frac{E_d}{\eta_{tot}} \quad (1)$$

[9] [10]

$$\eta_{tot} = \eta_{batt}(\text{Battery}) * \eta_{inv}(\text{inverter}) * \eta_{wd}\ (\text{wiringand distribution}) \quad (2)$$

$$\text{Battery bank size} = \frac{E_d}{\text{Days of Autonomy (DoA)}} \quad (3)$$

[11]

$$\text{Number of batteries to buy} = \frac{\text{Battery bank size}}{\text{Battery size} * \text{Battery voltage} * \eta_{batt} * \eta_{inv}} \quad (4)$$

$$\text{total daily load require (Ah/day)} = \frac{E_d}{\text{Battery voltage}} \quad (5)$$

$$\text{Reqiured battery bank capacity} = \frac{\text{DoA} * \text{total daily load require}}{\text{Depth of Discharge (DoD)} * \eta_{batt}} \quad (6)$$

[12]

$$\text{Average depth of discharge} = \frac{\text{total daily load require}}{\text{Reqiured battery bank capacity}} * 100\% \quad (7)$$

$$\text{number of batteries in series} = \frac{\text{Panel voltage}}{\text{Battery Voltage}} \quad (8)$$

$$\text{Number of batteries in parallel} = \frac{\text{Reqiured battery bank capacity (Ah)}}{\text{Battery size (Ah)}} \quad (9)$$

Table 4. *Proposed Design outputs of panels and batteries needed for a 2.8KW Appendix A.*

System Parameters	Design out considerations
Avg. Peak Sun Hrs./Day	5.47 sun-hours
PV module STC rating	200 W
Battery size	250 Ah (ampere-hours) each, 3 days storage
Days of autonomy	1 day
PV size required	8 modules required (the number of modules to buy is 17)
Battery voltage	24 V
Battery bank size	6450 Wh storage
Number batteries to buy	3 batteries in parallel
Panel's voltage	48 V
Total daily load require (Ah)	269 Ah/day
Required battery bank capacity	796 Ah
Average depth of discharge	34%

Source: (research design, 2015)

In table 4, all values obtained are by means of the equation 1 to 9 outlined under section 5.1.

5.2.2. Inverter Sizing

The inverter serves as a black box of the system. It simply converts direct current[13] from the PV panels and the battery bank to alternating current[14].

Table 5. *Sizing the Inverter.*

Sizing the Inverter		
Total (W)	7905	W continuous power
total power (surge)	7225	W actual surge power
The actual inverter size	15810	W Surge energy

Source: (research design, 2015)

The total surge power is 4.2KW which includes the power factor taken as 0.9, the inverter efficiency as 85% and the reduction due to system losses.

5.2.3. System Configuration

Illustration in figure 11 is Stand-alone photovoltaic system proposed for adoption as an alternative electricity need of the Beauty Salon Business.

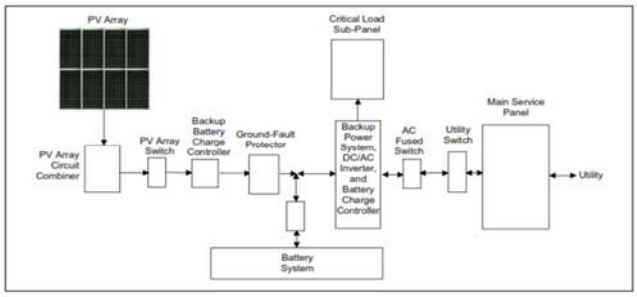


Figure 11. *Stand-alone photovoltaic system block layout.*

6. Discussion

This is based on three main thematic areas; over view of solar energy situation in Ghana, education, income and expenditure levels, and cost consideration

6.1. Over View of Solar Energy Situation in Ghana

Under the National Electrification Scheme (NES) of 1989 has since been the major policy drive in ensuring a wider access to electricity in the country. This is supported by a Self Help Electrification Program (SHEP) instituted by the government to complement the NES. As a result of this Ghana has achieved an estimated 72% access rate of electricity as at 2011. This was an improvement from a lower access rate electricity rate of 15% as at 1990 (AGSI[15], 2011). In spite of this impressive achievement, the rural communities have access to only 27% electricity.

In view of this result, the over 70% of the rural communities that reside in off-grid areas are confronted with

9 E_d is the daily energy demand in KWh

10 η_{tot} the total system efficiency

11 DoA is the number of days the system can operate without sun shine

12 DoD is the rate at which the installed Battery capacity of the system can be said to have being reach its low discharge

13 Direct current is the output electrical signal produced by the PV panel and the battery.

14 Alternating current is the electrical signal output that is needed by most appliances in the Beauty Salons.

15 AGSI is the Association of Ghana Solar Industries

socio-economic challenges that require urgent attention of the government. However, in the last three years, the country has carried its access expansion program to about 80%. This has affected the means of supply creating serious erratic power supply which is affecting all socio-economy activities within the country. Therefore it is necessary to consider the Small Scale industry (Beauty Salon) who operates solely on electricity with Solar Energy Technology.

6.2. Education

In the study, the educational levels of the participants as shown in figure 6 are as follows; only 1% has first degree, 2% has HND, SSS/SHS is 28%, JSS/SHS is 56%, and 6% being operators with no formal education. The implication of this for management is that they have low managerial skill acumen to apply to their business to manage power.as shown clearly in figure 7.

6.3. Income and Expenditure Levels

Little income against high expenditure provides harsh condition of operation. 96% of participants depend on the National rid. The average daily income levels of these participants ranges from a minimum of GH₵8 for 97% and a maximum of GH₵200 from table 3.

The average daily expenditure looks at the daily with generator and without it. In figure12 explains their modal average daily income and expenditures.

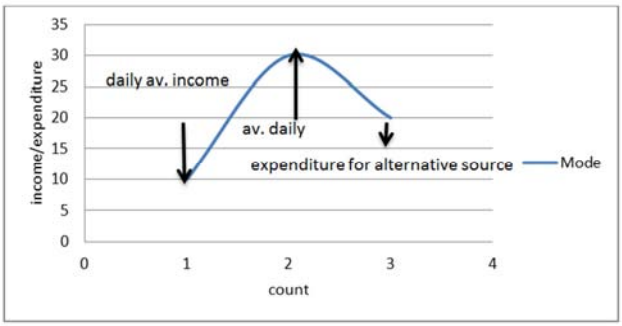


Figure 12. *Participants' modal income and expenditure levels.*

From table 3, the highest daily income is GH₵200 representing 1% of the total respondents and GH₵8 representing 0.5% of respondent. Only 17 respondents constituting 8.6% of earned income between GH₵100 and GH₵200. The implication is that their average daily income is less than their average daily expenditure. This situation makes their lives highly unbearable during National grid off times.

6.4. Cost of Power

In the study the total cost of electricity keeps rising steadily (figure 9). This shows that the business is under critical condition of operation. In the study, it is realized from figure 9 that, between the months of Nov, 20014 (- GH₵71) and Dec, 2014 (-GH₵67) negative cost were recoded as a results E.C.G. owing some respondents. These were the two months which recorded the highest modal consumption level of 150Wh each from table 2. In considering this it was noted that the average payment rate of consumption by respondent is 49.55 0f 202 for the entire six months.

The implications are that; a lot of the respondent in this Industry do not pay bills regularly; the bills sent to them by E.C.G. are delayed. The highest number of bill payment by respondents is 93 making up 46% (93) in Jan, 2015 then dropped to 33% (66 in Feb, 2015) from table 2. These also affect the supply of electricity from National grid.

7. Conclusion

This study was limited to the Beauty Salon Industry electrical needs assessment desirable response with the correct acceptable answers. The study presented a clear format in designing and building of one's own PV technology in the Beauty Salon industry to fore stall the challenges of the inadequate power supply for operation.

It's impressive that the participants were eager to learn through this research schedule to improve and manage the use of power. This includes their willingness to reduce phantom loads and also be on experimental research on how it helps reduce their cost of electricity. The study is of great importance on how our business and house hold and future researchers may look at targeting different sectors of the Ghanaian economy to define their power consumption level for socio-economic impact.

With the PV technology in use the pressure on the National grid will be reduced and the high expenditure by participants would have been the reverse order. The cost of solar is also dependent on the kind of equipment at one's center. This will provide a relief of the amount of money needed for an initial outlay and preferable future capacity additions. In appendix C, according to Solarbuzz (2005) there has been an annual growth of installation of both grid and off-grid PV increase from 1990 to 2004 (in MW[16] of peak capacity). The countries main electricity supply is by means of hydroelectric plant, due to the fall continuous fall of the elevation level of the maximum operating level of 280.0 feet to current level between 240 (minimum operating level and 250 feet has seen the country in much supply challenges (Ghana Energy Commission, 2015). With lack of rainfall it is forecast that the level could go as low as between 240 feet and 230 feet as experience in 2006 and 2007.

With this continuous trend supply it is important for the country to move and encourage various Small Scale Industries into PV technology with the country having abundance of Solar Energy and the continuous increase in PV across the globe.

Furthermore, the convergence of economic forces promotes a set of electricity solutions in appendix D matrix which keeps solar ahead of all fuel types in terms of the PV portable and accessibility (Travis, 2006).

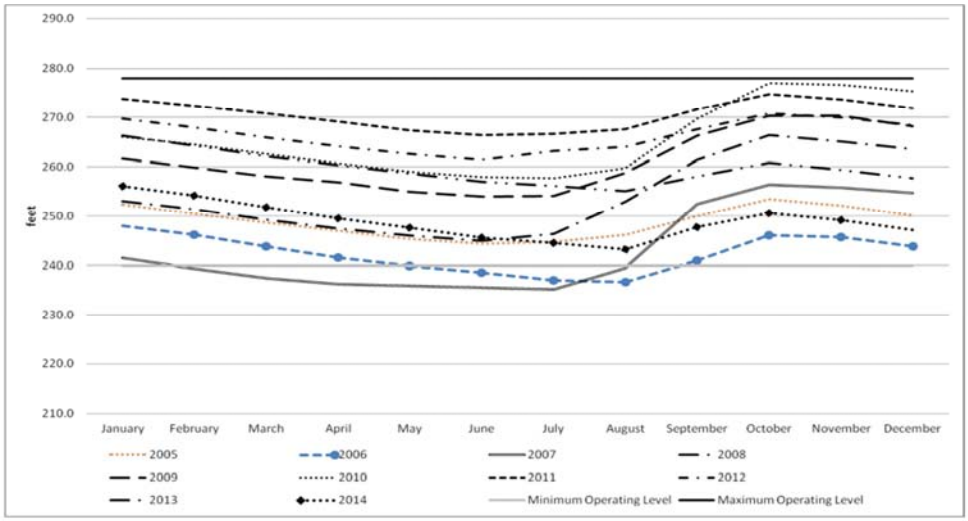
16 MW is mega Watt a power unit.

Appendices

Appendix A.

Table A1. *Proposed Daily Average electricity demand for an average beauty salon.*

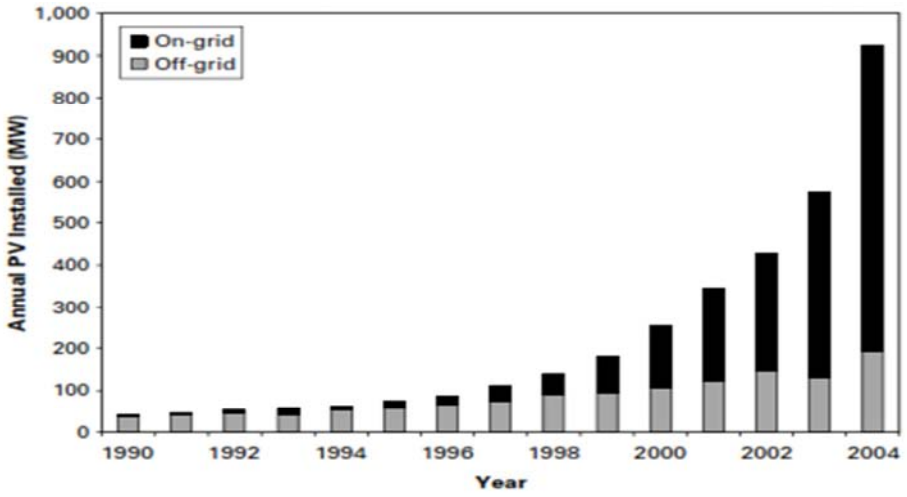
S/N	Load	Qty.	Operating hours	Power (W)	Max Load (W)	Daily energy (Wh)
1	Hood Drier	1	2	980	980	1960
2	Hand Drier	1	2	1600	1600	3200
3	Straightener	0	2	35	0	0
4	Tonging machine	0	1	80	0	0
5	Fan	1	6	55	55	330
6	Light (inside)	2	8	25	50	400
7	Light (outside)	0	12	25	0	0
8	Pedicure bowl	0	1	100	0	0
9	Television	1	8	70	70	560
10	Wax Plug	0	2	100	0	0
11	Kettle	0	1	2500	0	0
Total (KW)					2755	
Total Wh per day						6450



Source: Energy Commission of Ghana (2015)

Figure A1. *Ghana Akosombo hydropower dam water levels from 2005 to 2014*

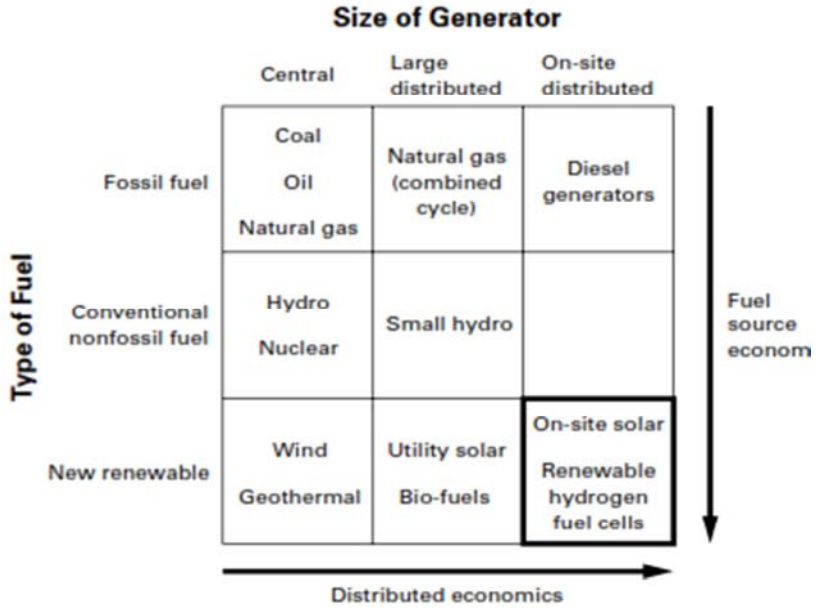
Appendix B.



Source: Solarbuzz (2005).

Figure B1. *Trend in Akosombo Dam Monthly Elevation.*

Appendix C.



Source: Travis (2006)

Figure C1. *Growth in annual installations of grid-connected and off-grid photovoltaic cells, 1990 to 2004 (MW of peak capacity).*

Appendix D.

Table D1. *The convergence of economic forces promotes a new set of electricity solutions.*

	Description	Cost (USD/km)
Distribution Lines	11kV Line	16444
	33kV Line	17523
Transformers	25kVA(11kV)	4500
	25kVA(33kV)	5820

Source: Ministry of Energy, 2005

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