Yogesh Sharma, Kuldeep Kumar Swarnkar / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 3, Issue 1, January -February 2013, pp.803-810

Energy-cost analysis of alternative sources

Yogesh Sharma*, Kuldeep Kumar Swarnkar**

*(M.E. Student, Electrical Engineering Department MITS, Gwalior (M.P)

**(Asst. Professor, Electrical Engineering Department MITS, Gwalior (M.P)

ABSTRACT

In this paper, a comparative analysis of alternative energy sources has been carried out to ascertain their suitability in terms of availability, cost, advantages and disadvantages among other factors. The selected energy alternatives are solar and inverters. The case study-site is my house unit within the most commercial city in Gwalior. The data collection was carried out for the selected sites coupled with their energy auditing to obtain the total energy consumed at house. An energy sizing analysis helped in determining the energy specifications and installation-cost of the alternative energy sources in the surveyed sites. The results obtained presented guiding principles among other solutions on our house be powered by applying the method of selective-loading to reduce energy cost.

Keywords: Alternative energy sources; cost-analysis; electricity; energy auditing at house.

I. INTRODUCTION

The development of any society is anchored on the steady supply of power which is an elixir to manufacturing companies. It is therefore a matter of utmost importance to analyse other means of energy supplies in term of cost-effectiveness, reliability, availability and environmental compatibility so as to alleviate the energy crisis prevalent in some developing countries. Alternative energy sources such solar cells and battery-powered inverters as researched in this work have become increasingly popular subjects Many of these reports show that global warming has rapidly increased from anthropogenic.[1] Various energy resources are available in the Government of India has set a target of 215,804MW power generations by March 2012. The targeted capacity addition is 78,700MW in the 11th five year plan(2007-2012).The successful launch of nine large sized coal based Ultra Mega Power Projects(UMPP).full benefits of these projects are envisaged to come up in the 12th plan, however two units(2 x660MW) of saran UMPP in Madhya Pradesh.[2]

Table .1 the table is gives the perspective plan for electrical power generation in India [2]

Installed capacity	Thermal plant	Hydro plant	Nuclear plant	Gas plant	Total
March 2010	84198 MW	36877.7 MW	4560 MW	17056 MW	159398.49 MW
year 2012 (perspective)	114490 MW	57789 MW	12100 MW	31425 MW	215804 MW

- Inadequate electricity supply to household, offices and industries: It is increasingly becoming difficult to get energy for domestic utilization. People now depend on generating set for their energy supply.

- Low industrial productivity: For many industries, technical changes are found to increase the shares relative to those from other inputs of production. Changes in electrical inputs contribute to notable Alterations in output values. The unavailability of this crucial requirement of production has hampered Production of goods and services.

- Pollution of the environment: Noise and air pollution caused by the use of generating sets as energy Sources create immeasurable level of health hazards to all forms of life in the environment.

- High cost of commodities: There is existing relationship between the price of commodities and energy. Energy is part of cost of production; exorbitant expenditure on energy will eventually lead to high cost of the product.

- Increase in overhead costs of production: Overhead cost is the money spent on rent, insurance, electricity and other things to keep the business running. Huge amount is spent of fuelling generating sets for production of goods and services, this tends to increase the overhead cost.

The general objective of this work is to minimize the adverse effects of over dependence on national electric energy generation which is unreliable in many developing countries. In attaining this general goal some specific objectives were considered. Namely ascertaining the positive and negative aspects of alternative sources of energy; analyzing the effectiveness, feasibility and viability of other alternatives energy to electricity; determining cost-implication of choosing alternative sources [1].

II THEORETICAL CONCEPTS

Inverters and solar cells-The inverter is the heart of all but the smallest power systems. It is an electronic device that converts direct current DC power from batteries or solar modules into alternating AC power to operate lights, appliances or anything that normally operates on power supplied by the utility grid. The electrically-rechargeable-battery-powered inverters which have been considered in this work come in many varieties, sizes and qualities and offer various features that specializes them for particular applications. There have been a large number of articles written concerning power conversion in recent years. This can be attributed in part to the rise in popularity of high voltage DC transmission systems and their integration with existing AC supply grids. There is also a consistent demand for high efficiency inverter devices for lower power applications like houses, caravans, UPS and developing countries of the world. The resulting AC converted by inverters can be at any required voltage and frequency with the use of appropriate transformers, switching and control circuits. Due to the higher operating frequencies, inverters yield higher, more economical output power. This increased power source efficiency translates to decreased utility costs. Virtually all the inverters used with alternative power systems are transistorized, solid state devices [10]This report focuses on DC to AC power inverters, which aim to efficiently transform a DC power source to a high voltage AC source, similar to power that would be available at an electrical wall outlet. Inverters are used for many applications, as in situations where low voltage DC sources such as batteries, solar panels or fuel cells must be converted so that devices can run off of AC power. One example of such a situation would be converting electrical power from a car battery to run a laptop, TV or cell phone [10].

On the market today are two different types of power inverters, modified sine wave and pure sine wave generators. These inverters differ in their outputs, providing varying levels of efficiency and distortion that can affect electronic devices in different ways. A modified sine wave is similar to a square wave but instead has a “stepping” look to it that relates more in shape to a sine wave. Pure sine wave inverters are able to simulate precisely the AC power that is delivered by a wall outlet. Usually sine wave inverters are more expensive then modified sine wave generators due to the added circuitry.[4] This cost, however, is made up for in its ability to provide power to all AC electronic devices, allow inductive loads to run faster and quieter, and reduce the audible and electric noise in audio equipment, TV’s and fluorescent lights.

Pulse Width Modulation-In electronic power converters and motors, PWM is used extensively as a means of powering alternating current (AC) devices with an available direct current (DC) source or for advanced DC/AC conversion. Variation of duty cycle in the PWM signal to provide a DC voltage across the load in a specific pattern will appear to the load as an AC signal, or can control the speed of motors that would otherwise run only at full speed or off. This is further explained in this section. The pattern at which the duty cycle of a PWM signal varies can be created through simple analog components, a digital microcontroller, or specific PWM integrated circuits. Analog PWM control requires the generation of both reference and carrier signals that feed into a comparator which creates output signals based on the difference between the signals.[1,5] The reference signal is sinusoidal and at the frequency of the desired output signal, while the carrier signal is often either a saw tooth or triangular wave at a frequency significantly greater than the reference. When the carrier signal exceeds the reference, the comparator output signal is at one state, and when the reference is at a higher voltage, the output is at its second state.

Load-selection and Installation of Inverters-A key consideration in the design and operation of inverters is how to achieve high efficiency with varying Power output. It is necessary to maintain the inverter at or near full load in order to operate in the high efficiency region. However, this is not possible. Some installations would never reach their rated power due to deficient tilt, orientation or irradiation in the region [5]. Inverters are very easy to install. Most of them are "plug and play" devices, especially smaller, low-wattage inverters. The selection of a location where the DC low voltage cable is the shortest possible distance to the battery is important as the longer a DC cable runs the greater the voltage loss. Ventilation is also an important factor to consider when installing inverter. Inverters generate a fair amount of heat, and therefore use cooling fans and heat dissipation fins to prevent overheating. More so, the unit must not be allowed to come in contact with any liquids or condensing humidity. Here in, the rules for choosing an inverter based on the load selection are discussed.

- The first step in selecting an inverter is to match the inverter to the voltage of the battery that will be used to power the system.

- The devices to be powered with the inverter must be determined. The wattage rating of the inverter must exceed the total wattage of all the devices to be run simultaneously. For instance, running a 600-watt blender and a 600-watt coffee maker at the same time needs an inverter capable of a 1,200-watt output.

- It must be ascertained that the inverter's peak rating is higher than the peak wattage of the device you intend to power.

The final specification to look for is the wave output of the inverter. If there is the need to power any of the equipment that is sensitive to square waves, an inverter with a "perfect sine" wave output should be used. [1]

Solar energy can be used to generate power in two-way; solar-thermal conversion and solar electric (photovoltaic) conversion. Solar-Thermal is heating of fluids to produce steam to drive turbines for large-scale centralized generation solar electric or photovoltaic technology uses the sun's energy to make electricity. Learning from the word itself, the prefix "photo" means "produced by light," and the suffix "voltaic" refers to "electricity produced by a chemical reaction." PV technology produces electricity directly from the electrons freed by the interaction of sunlight with certain semiconductor materials, such as silicon, in the PV module. The electrons are collected to form a direct current (DC) of electricity. The basic building block of PV technology is the solar "cell." Many cells may be wired together to produce a PV "module," and many modules are linked together to form a PV "array." PV modules sold commercially range in power output from about 10 watts to 300 watts, and produce a direct current like that from a car's battery.[6,7]

A complete PV system usually consists of one or more modules connected to an inverter that changes the PV's DC electricity to alternating current (AC) electricity to power your electrical devices and to be compatible with the electric grid.1 Batteries are sometimes included in a system to provide back-up power in case of utility power outages. PV cells can be made from several processes or technologies. They all do the same job produce electricity from sunlight.

The basic types of inverters include:

- True sine wave inverter. If you plan to take advantage of net metering (see "What is Net Metering?") and feed electricity into the transmission grid, then you must have this type of inverter. Most households use alternating current in their electric circuits, with power supplied from the utility at 120 volts and 60 cycles per second. A true sine wave inverter transforms the direct current from the PV modules to alternating current of 120 volts and 60 cycles per second. This transformation may also synchronize your system with the utility's system. Modified sine wave inverter. Similar to a true sine wave inverter, a modified inverter does not provide the same quality of 60 cycle-current that can be fed back to the utility grid. This quality of power, however, can be used at your home to power many AC loads.[5]

PV systems produce power intermittently because they work only when the sun is shining. More electricity is produced on a clear, sunny day with more intense sunlight and with a more direct light angle, as when the sun is perpendicular to the surface of the PV modules. Cloudy days can significantly reduce output, and of course no power is produced at night. PV systems work best during summer months when the sun is higher in the sky and the days are longer.[6] Because of these variations, it is difficult for PV systems to furnish all the power you need, and are typically used in conjunction with utility-supplied electricity. To make the best use of your PV system, you need most or the sun's entire path to be clear and not shaded by trees, roof gables, chimneys, buildings, or other features of your home and the surrounding landscape. Shading will substantially reduce the amount of electricity that your system can produce.

III RESEARCH METHODOLOGY

The research methodology of this study is presented in three stages, namely, (i) Site selection (ii) Energy Auditing (iii) Energy cost analysis. The reasons for selecting the case study sites and performing energy audit for the sites, the different types of cost analysis and phases of energy audits applied in the work are all discussed in this section.

(A) Site Selection

The site selected is a location is the most commercial city in Gwalior. The case study is typical at house is a one story building. The most important reasons for selecting these sites are because the locations are in an area where energy consumption is frequent and mostly unavailable and hence the rate of electricity is on the high side due to the unsteady power supply.

(B) Energy Auditing

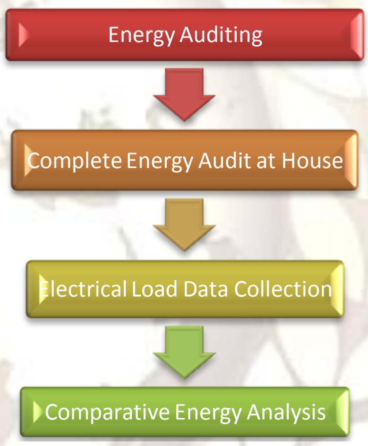
Energy audit is defined as the verification, monitoring and analysis of use of energy in different equipment is total sum of energy consumed. Energy audits carried out at the site were for the following reasons: (i) to ascertain the total energy consumed in the house (ii) to discover the Appliances that consumes most energy (iii) to reduce avoidable expenses on energy. Energy audits considered in this work can be broadly be classified as:

- Preliminary audit
- Detailed audit
- investment-grade audit

Preliminary audit-: The preliminary audit alternately called a simple audit, screening audit or walk-through audit is the simplest and quickest type of audit It involves minimal interviews with site operating Personnel, a brief review of facility utility bills and other Operating data, and a walk- through is least costly and identifies preliminary scope of energy saving. [2] A visual inspection of the facility provides useful information and way to further detail analysis. Mini audit is the requires tests and measurements to quantify energy uses and losses and determine the economic for changes. Maxi audit is one step ahead than the mini audit. It contains all the functions like lighting, process etc, energy consumption and their evaluation. It also require a model analysis, Utility bills are collected for a 12 month-period to allow the auditor to evaluate the facility's energy/demand rate structures, and energy usage profiles. Additional metering of specific energy consuming systems is often performed to supplement utility data. In-depth interviews with the facility operating personnel systems as well as insight into variations in daily and annual energy consumption and demand A detailed financial analysis is Performed for each measure based on detailed Implementation cost estimates; sites-specific operating cost savings, and the consumer's investment criteria. Investment-Grade Audit: The investment- grade audit alternatively called a comprehensive audit, detailed audit, maxi-audit or technical analysis audit expands on the general audit described above by providing energy use characteristics of both the existing facility and all energy conservation measures identified. The building model is calibrated against actual utility data to provide a realistic baseline which is used to complete operating savings for proposed measures. [1]In a comprehensive or investment grade audit extensive attention is given to understanding not only the operating characteristics of all energy consuming systems but also situations that cause load profile variations on both an annual and daily basis. Also existing utility data is supplemented with sub-metering of major energy consuming systems and monitoring of System operating characteristics.

Phases of energy auditing: The Phases involved in the energy auditing were: (i) data collection (ii) data Verification (iii) energy-saving opportunities (iv) energy conservation opportunities (v) executive summary. In data collection, visitation was done on the case studies the results show the data collected for Study site at the house one story building. Data verification is the process of checking for the Accuracy and adequacy of the data collected. This Procedure is carried out due to challenges that might have been faced while performing the study. The energy saving opportunities technique aids the selection of load at the house how to some bulb are replace by the CFL that more energy saving. Because it is reduce the more energy consumption to be minimum electrical energy. It is also include the other no. of appliances equipment being used. The energy wastage is identifying in the house.

Fig .1 Methodology frame work for energy auditing



(C) Energy-Cost Analysis

There are several cost analysis methods that have been propounded such as: (i) Cost-of-illness analysis (ii) Cost-minimization analysis (iii) Cost-effectiveness analysis (CEA) (iv) Cost-utility analysis (CUA) (v) Cost consequence analysis (vi) Cost-benefit analysis (CBA). Cost-of-illness analysis is a determination Cost-of-illness (COI) was the first economic evaluation technique used in the health field. The principal aim was to measure the economic burden of illness to society. **Cost-minimization** is a tool used in pharmacy co economics and is applied when comparing multiple drugs of equal efficacy and equal tolerability assumed to produce equivalent outcomes. Cost-effectiveness analysis (CEA) is a comparison of costs in pecuniary units with outcomes in quantitative non- pecuniary units, e.g., reduced quietus or death rate. Cost utility analysis (CUA) is a form of cost effectiveness analysis that compares costs in pecuniary units with outcomes in terms of their utility, usually to the patient, measured. Cost-consequence analysis is a form of cost-effectiveness analysis that presents costs and outcomes in discrete categories, without aggregating or weighting them. Cost-benefit analysis (CBA) compares costs and benefits, both of which are quantified in common pecuniary units.[3] Economic analysis involves comparing the costs and consequences of different interventions, enabling conclusions to be drawn about their relative efficiency. Benefit–cost ratio: monetary or welfare benefit per currency unit spent. The goal of CBA is to identify whether the benefits of an intervention exceed its costs. A positive net social benefit indicates that an intervention is worthwhile from an economic perspective. However, as public funds are limited, some ranking of the alternatives is necessary to enable decision makers to choose the interventions that have the highest return on investment and/or bring the greatest benefit to target populations. Therefore, the primary output of a CBA is: The *benefit–cost ratio* (BCR), which shows the factor by which economic benefits exceed the economic costs. However, the ratio itself is not the only information of interest to decision-makers, who may also wish to know how quickly the investment will be paid back, the attractiveness of the investment compared to placing the funds in a bank and earning interest, and so on. Therefore, the following summary measures are important additional outputs of a CBA, and can help make the case for investment in interventions to reduce population exposure to IAP The *economic internal rate of return* (EIRR) shows the return on investment of the intervention, which is the discount rate at which the future expected stream of benefits equals the future expected stream of costs. The *net present value* (NPV) shows the net monetary or welfare gain that can be expected from the intervention in currency units of the base period (start of project). The *break-even point* shows the time period after which the economic benefits from an intervention will equal the resources invested in the intervention. In addition to these summary outputs of CBA, the component parts themselves, such as cost or outcome data, can be used for decision-making.[3] For example, a comparative cost analysis of a stove manufacture and distribution programmed in several regions of a country would enable conclusions to be drawn about which ones perform better and why. An economic costing also contributes to price/tariff setting for public services, and to allocation of government budgets. Furthermore, the financial viewpoint can be presented by disaggregating cost and outcome data into financial impact versus purely economic impact. The next section elaborates on the distinction between economic and financial analysis

Their suitability of any of these methods depend upon the purpose of the assessment the availability of data and other resources the cost benefit analysis method was applied to this work. From fig. 1. The different sources of energy analyzed for the selected sites were (i) Solar (ii) Inverters (iii) Electricity supply (iv) Load selections were done for the cases of solar and inverters and energy cost estimates and were obtained and comparisons made based on Solar energy systems reduce your electricity Costs, depending on system size. Utility prices are only going up every year. Solar energy provides you security from rising Electricity rates.

The cost analysis for the inverter and solar (PVC).According to electrical energy meter at house, Site selection house load – 5000wh to 7000wh (approximately) Calculation of electricity bill unit following equation.

$$U = W \times H / 1000$$

Where U= electricity bill unit, W= watt, H = hour.

This selection Energy-cost analysis carried out on electricity supply and collection of data on billing for a period of one year.

A Solar Photo Voltaic system consists of just 4 main elements: Solar panels, Panel mounting structures with Suitable wiring, Inverter, Batteries.

Table .2 Solar Module Specifications

Particular	Solar power plant
Capacity	5 KW
Units	1 Unit
Application	Solar power back up for existing electrical appliances viz., Tube lights, Fans, Computers, Printers, cooler, etc..
Scope of Supply	System includes Solar Module, Battery, Inverter
Solar Panel Wattage	200 Wp X 25 No
Battery Rating	12 V 150 Ah X 3 No's
Not in Scope	Civil Work, Conduit material and Wiring
Warranty	1 Year for the system and 10 Years for Solar Panel
Life of the System Solar Modules Battery Inverter	 20 – 25 Years 3 – 5 Years 5 Years
cost of installing of solar power plant (approximately) for 10 year & also including battery cost after 3 year	512000/-

.

(IV) RESULTS AND DISCUSSIONS

Comparison of the sources of energy was made. Compares (i) the total cost of setting up Inverters and solar units for selected loading (ii) cost of electricity supply for complete loading at the site considered. Results show that the cost required for setting up solar energy usage for the home is highest despite the selective loading.

Table .3 Comparisons of the alternative sources of energy into electricity billing cost for 10 and 25 year

Electricity bill monthly	Unit of per month	Unit of per kwh	Electricity bill cost per month
Jan	720	8	5760
Feb	684	8	5472
Mar	728	8	5824
Apl	800	8	6400
May	925	8	7400
June	1000	8	8000
July	920	8	7360
Aug	840	8	6720
Sep	810	8	6480
Oct	710	8	5680
Nov	524	8	4192
Dec	621	8	4968
Total bill for one year cost			**74845**
Approximately after 10 year electricity bill cost	**10 year**		**74845x10= 748450/-**
Approximately after 25 year electricity bill cost	**25 year**		**74845x25=1871125/-**
Solar system fixed cost	**10 year 5KW cost-60-90 rupees per watt**	**90 rupees per watt 6 battery cost Total**	**464000/- 48000/- 512000/-**
Solar system fixed cost	**10 year, 5KW**	**80 rupees per watt 6 battery Total cost**	**439000/- 54000/- 493000/-**
Solar system fixed cost	**25 year , 5KW**	**90 rupees. Battery 21 Total cost**	**489000/- 189000/- 678000/-**

Note- there are not including the maintained cost of solar unit

Show that the result in comparison table in solar system and electricity bill cost variation In table 3, comparison of all the sources of energy was made compares (i) the total cost of setting up inverters and solar units for selected loading (ii) cost of electricity supply for complete loading at the site considered. Results show that the cost required for setting up solar energy usage for the home is highest despite the selective loading. The energy-cost variations for the inverter and solar presented in according, presents a guide for the choice and cost implications for solar or Inverter systems set up as energy sources for house

The combines the energy-cost analysis with selective loadings to predict house Requirements for different in KVA. Is the comparison of energy cost extrapolated over ten years for house use respectively The cost for using solar and inverters are high initially but tend to be regular and stable over the years. The regular uses the future indicate the Cost-Benefit points for using the inverter at the house respectively. Beyond these points the cost of using inverters becomes lower (though for selected loading) than other alternatives for some period of time until major replacements or servicing are needed for the inverters. The comparison also takes into consideration the maintenance and re-charging cost of the inverter and the solar units. However, selected loading was used for all the other alternative sources of energy to electricity in this comparison the initially cost of solar system is high. But solar system is most economic in future we are save the **65%** money in ten year approximately same as this example

For example

Table .4 Comparisons between Marurti Swift Petrol and Diesel cost

Car	Approximately Cost of car	Average of car
Maruti swift petrol	5 lakh	14 km/1lt.
Maruti swift diesel	7 lakh	21km/1lt.

We show that in the table that is initial cost is of petrol car is less than to diesel car but average is more diesels into petrol car. So that in the future the diesel car is most economic compare the petrol car because average is high and diesel cost is low compare to petrol cost in the same case for solar system initial cost is high but in future is money saving.

(V)CONCLUSION AND RECOMMENDATIONS

The main objective of this work which is to present a quantitative energy and cost-predicting analysis of energy sources using at house as case study and thereby proffer Alternative and immediate alleviating measures to unsteady National electric supply in some developing countries while embarking on upgrading has been achieved. In the process of the work, energy audits, net load selections and cost estimations were carried out for selected site representative of house usage. The cost implications of employing alternative sources of energy such as Inverters and Solar panels were the closely surveyed while those for energy sources. The results obtained presented guiding steps among other solutions on how homes can be powered by applying the method of selective loading to reduce the cost of setting up Alternative sources to electricity such as inverters and solar units. Though the need for the affected developing countries to step up their national power supply cannot be over stated, the following are suggestions based on this work.

- The usage of energy saving bulbs should be encouraged in house. This energy saving bulbs can replace the conventional CFL 15W, fluorescent and security light which consume a lot of energy.
- Energy conservation culture must be imbibed to eradicate the culture of energy wastage.
- There should be public awareness on the advantages of using these alternative sources of energy.
- People must inculcate the culture of close monitoring of their energy bills and fossil fuels bills while adequate record should be kept to ascertain their expenditure.
- If we are using the 5 star rating electrical appliances save lots of energy

(VI) REFERENCES

[1] Simolowo Oluwafunbi Emmanuel and Oladele Samuel" Energy-cost analysis of alternative sources to electricity in Nigeria" indjst.org Vol. 5 No. 1 (Jan 2012) ,PP1946-1952.

[2] Suresh Kumar soni & Manoj Nair'' Energy Conservation And Management '' satya prakashan tech India publications new delhi-2012.

[3] Guy Hutton &Eva Rehfuess" Guidelines for conducting cost–benefit analysis of household energy and health interventions" WHO Library Cataloguing-in-Publication Data World Health Organization.

[4] Hart, D. (2000). Introduction to Power Electronics. Upper Saddle River, NJ: Prentice Hall.

[5] Jim Doucet & Dan Eggleston & Jeremy Shaw" DC/AC Pure Sine Wave Inverter" MQP Terms ABC 2006-2007

[6] Dolf Gielen "Solar Photovoltaics Renewable Energy Technologies: Cost Analysis Series" Volume 1: Power SectorIssue 4/5

[7] Abdulkarim HT (2004) Techno-economic analysis of solar energy for electric power generation in Nigeria. http://www.journal.au.edu/au_techno/2005/apr05/vol8no 4_abstract09.pdf.

[8] Akarakiri JB (2002) Rural energy in Nigeria: The electricity alternative. Domestic Use of Energy http://active.cput.ac.za/energy/web/due/papers/2002/05 _JB_Akarakiri.doc.

[9]. Akin I (2008) Nigeria's dual energy problems: Policy Issues and challenges. Intl. Assoc. Energy Econ. Publ. (4th Qtr.) pp: 17-21.

[10]. Ezekoye BA and Ugha VN (2007) Characterizations and performance of a solid-state Inverter and its Applications in photovoltaic. Pacific J. sci. & Tech. 8(1), 4-11.

[11]. Iran Daily (2006) Solar energy potential in Nigeria. http://www.ecofriend.org/entry/solar-power-brings-lightto- the-dark-nigerian-village/.

[12] Mohan N, Robbins W and Undeland T (1995) Power electronics - converters, applications and design. Wiley and Sons, NY.