WWW.IJRPR.COM

**International Journal of Research Publication and Reviews**

Journal homepage: www.ijrpr.com ISSN 2582-7421

# Efficient Electrical Power for ICT in TVET Curriculum Development and Delivery

***Peter O. Aiyelabowo [1], Suraju A. Fadare [2]***

Department of Electrical/Electronics Engineering, Federal Polytechnic, Ilaro, Ogun State, Nigeria. [1,2]

*DOI:* https://doi.org/10.55248/gengpi.5.0724.1740

**A B S T R A C T**

The demand for electric power for various applications have increased over time as it is required for driving the economy of any nation. Its requirement for driving the components of information and communication technology (ICT) cannot be overemphasized. To have a technically viable economy, TVET must be handled well and its curriculum be developed with modern day technology. This electric power so required is not readily available in Nigeria as it experiences too frequent outage. Petrol generators are often time deployed for electric power generation. This deployment pollutes the environment. In this paper, a 2.5 KVA solar-powered motor-drive generator is designed and implemented for ICT equipment. It comprises of a set of solar panels, charge controller, battery bank, dc motor and an alternator. All these components are appropriately selected and coupled together to produce electric power. The system's output was tested and confirmed to conform with standard parameters.

Keywords: Alternator, dc-motor, charge-controller, frequency and voltage

## Introduction

The educational demands of Nigerians have grown with its population. It is then necessary to have a good and tangible preparation for these increased demands in teaching methodology and means of curriculum delivery. Economic advancements through educational system must target quality learning in less time (Osasona, 1987) . To achieve this, new methods for instructional delivery must be adopted.

The world has revolutionized through the emergence of information and communication technology (ICT) (Minna-Eyovwunu, D., Akarue, B. O. & Obavwunuta, O. R., 2019). This emergence has impacted humans' activities, which include entertainment, sports, broadcasting, administration and even education. Unprecedented opportunities have been created in the field of education by the rapid development in ICT.

ICT tools have enriched the traditional means of teaching and learning such that its capacity have improved the quality of teaching and learning diverse educational environments (Mohd N. A., Wahyunah G. Amirul H. A. & Maslin M. ,2022). In ICT computer hardware, network and devices (video, camera and audio) and manipulated by software for processing of information. The facilities implemented in the ICT induced education includes television sets, bulletin boards, radio, record players, disc players, still camera, video camera, projectors, computers, interactive white board, internet and the internet resources etc.

ICT components require electrical power for effective performance. All items mentioned above needs energizing to function. So steady electric power is required for the ICT system. In Nigeria, the grid power experiences continuous outage daily, thus putting out electric power from usage. As good as ICT is for curriculum development and delivery, if there is no power to drive its components its effect will not be felt and curriculum development and delivery will not experience the desired improvement and transformation. In this paper an efficient power supply is designed for the powering of the ICT components for effective curriculum development and delivery.

Man's daily activities have now been tied to the availability of electricity, and the increase in population and the rising electricity demand have brought about the development of energy systems that can provide power that meets man's needs. In recent years, the major challenge to the development of Nigeria economy is the lack of access to sustainable and reliable electricity supply to meet the daily needs of industries and ICT-induced education demands. The most common way of generating electricity from a non-renewable energy source for use as a backup in both residential and industrial application is the petrol or diesel generator, gases like carbon monoxide (CO) released from the combustion of the hydrocarbon fuel at the exhaust are hazardous to human health, poses threat to the environment, and contribute to the depletion of the ozone layer (Abatan, Adewale, & Alabi, 2013). In this work a 2.5KVA solar powered motor-driven (fuel less) generator is designed and implemented.

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of photons that are incident on it to electrical energy, which is a natural and synthetic marvel. It is a vital component in the solar energy system. The solar energy system is a major type of renewable energy system. Many works have been done in this area for the provision of steady electric power. Deepu, B. P. & Kamala, H., (2022) reviewed solar energy from sunlight and discussed their future trends. It emphasizes the various applications and methods to promote the benefits of solar energy and concluded that it has more benefits compared to other forms of energy like fossil fuels and petroleum deposits.

## Methodology

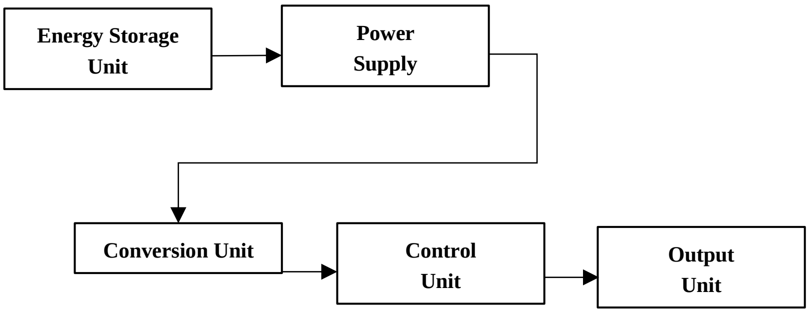


Figure 1: Block diagram

The Solar Powered Motor-Driven Generator consist majorly of five units that works together for the generation of clean electrical energy as shown in Fig. 1.

The Power Supply unit is a solar powered system (renewable energy source) that will be used to charge the battery bank. It consists of the solar panel, solar charge controller, and some electrical cables. Solar Panels, also referred to as photovoltaic cells, are used for converting solar energy from the sun into electrical energy in form of DC current. The solar panels used as the energy source in this project were monocrystalline solar panels. Based on the efficiency, availability and cost of these panels, the panel used for this project was a 180W 18V solar panels. Four pieces of this panel was used to give an overall output of 720W. The four solar panels were connected using series parallel connection, this gives an overall output of 36V 720W.

The Solar Charge Controller is a device used to stabilize the charging voltage from the solar panel to the battery bank. It was connected between the solar panels and the battery bank. The selection criterion for this device was the system DC voltage and the expected maximum current from the solar panel. The maximum expected current from the control panel is 30A. Using a safety factor of 20%, the required minimum current rating of the solar charge controller used was gotten as;

$$I = (1 + 0.2) \times 30 = 36A.$$

A charge controller with a minimum current rating of 36A was needed. But base on the type of charge controller available at the market, a 60A PWM solar charge controller was used in this project.

The Electrical wires used for connecting various components of the solar powered motor-driven generator together were selected strictly based on the standard current rating of electrical cable sizing. For the DC part of the generator, the maximum DC current expected to flow from the battery bank to the DC motor was estimated at 100A. In Accordance to the standard current rating of cables, a $16mm^2$ flexible DC wire was used. While for the AC part of the generator, a 2.5mm flexible wire was used to connect the output of the alternator to the AC outlet. The maximum charging current expected to flow from the solar panel to the battery bank was estimated at 36A. Therefore, a 6mm multiple strand copper wire was used to connect the output of the solar panels to the battery bank through the charge controller.

The Energy Storage unit consists of the battery bank which is used for the initial startup of the system by supplying energy to the D.C. Motor to induce EMF.

The load rating and minimum load duration were the major selection criteria for the battery. A DC system voltage of 24volts was used so as to reduce the maximum DC current at peak load. battery was used as source of power supply unit to the D.C motor in order to induce electromotive force (E.M.F.). Lead acid battery is highly recommended for DC generating system. This serves as storage device for the direct current which is generated from solar energy using solar panels. For this work, two pieces of deep cycle lead-acid battery of output voltage 12V/100AH was used. These batteries were connected in series to form a battery bank of 24V output.

The Conversion unit distinguishes the generating set from the popular fueled generating set. It consists of a DC Motor and an AC Alternator. The DC motor is energized by the battery bank through the DC circuit breaker and the protection circuit. As the Motor gains speed, the AC Generator turns alongside it, due to the direct mechanical coupling. During rotation, the alternator magnetic field rotates with respect to the coil and the rotor produces rotating magnetic flux which rotates alongside and induces an AC voltage across the armature winding. The rotor coil generates between 0-60V DC which will be sensed by the Automatic Voltage Regulator (AVR). AC generators are referred to as alternators. It is the most efficient means of producing electricity since most electrical appliances use AC as their primary source of power.

The choice of selection of generator depends on the power capacity of the overall generating set required. An Alternator that is required for use in a fuel-less generator should be 20% higher than the intended capacity. The intended load capacity for this project was 2000 W and 0.8 power factor is assumed.

$$Apparent\ Power\ (S) = \frac{Real\ Power\ (P)}{Power\ Factor\ (p.f)} \quad (1)$$

$$S = \frac{2000}{0.8} = 2500VA$$

Therefore, a 2.5 kVA AC Generator was selected for the system. The specifications of the AC generator on the name plate were; 220V, 3000RPM, 50Hz. The AC generator was recoiled by a local expert to improve it efficiency.

The type of DC motor used is a Permanent Magnet (PM) type. This is the most common type of DC motor. It is used in fractional horsepower applications, it is made up of two permanent magnets which produce the magnetic field in the stator, i.e., it has good speed control. However, its only drawback is that these permanent magnets lose their magnetic properties over time. The main criterion for the selection of the DC motor is the efficiency of energy transfer from the power supply unit to the AC generator. Thus, for a 50Hz generated voltage using a two-pole AC generator, the required speed is given as;

$$N = \frac{120 \times 50}{2} = \frac{6000}{2} = 3000\ rpm$$

Hence the speed of the motor that was used is 3000 rpm. Recall that the intended load for this project is rated at 2 kW, the motor required to drive the AC generator must be capable of delivering power that is a bit higher than the rated power.

The DC must deliver a minimum of 2.681 hp to the AC generator to produce the rated load at the output. Hence, the specification of the motor selected for this research study is a 3 HP electric DC motor with a maximum operational speed of 3000 rpm.

The Control unit consists of circuit breakers, low battery cutoff circuit, automatic voltage regulator (AVR), and monitor devices (digital DC and AC Meter). The AVR is used to provide stable output voltage (200V -240V) for all appliances.

Circuit Breakers are devices used for control and protection of an electrical circuit. Two different Circuit breakers were used in the system, a double pole circuit breaker was used at the DC input and a single pole circuit breaker was used at the AC output. These devices were used to protect the components from short circuit and overloading.

At the DC input, a Double pole Circuit Breaker was connected in series between the battery bank and the DC motor. The selection criterion for this component was determined by the maximum load current of the DC motor.

Recall that the power of the DC motor is 3hp and a voltage of 24V.

$$P = VI \quad (2)$$

$$I = \frac{P}{V} = \frac{3 \times 746}{24} = 93.25A \cong 94A$$

Based on the rating of the breakers available in the market, a Double Pole DC Circuit Breaker with current rating of 100A was used in this project.

At the AC output, a single pole circuit breaker was connected between the live supply of the AC generator and the AC output. The selection criterion for this component was determined by the maximum AC load current.

The maximum intended load for the system is 2000 W at a voltage of 220 V. Assuming a power factor of 0.8 p.f.

$$P = VI \cos \alpha \quad (3)$$

$$I = \frac{P}{V cos \propto} = \frac{2000}{220} = 9.09A$$

Based on the rating of the breakers available in the market, a Single Pole AC Circuit Breaker with current rating of 10A was selected.

Low Battery Alarm and Cutoff Device were incorporated. They are to provide protection for the battery bank. It protects the battery from been completely drained, thereby improving its efficiency and battery life. It was connected in series between the battery bank and DC motor. The mode of operation of this device is to sound an alarm when the battery voltage falls to a preset value of 22 V and disconnects the DC Motor automatically when the battery voltage fall to a preset value of 20V.

The Output unit consist of the outlet socket. It is used to deliver the generated power to the load.

The conceptual diagram is shown in Fig. 2.

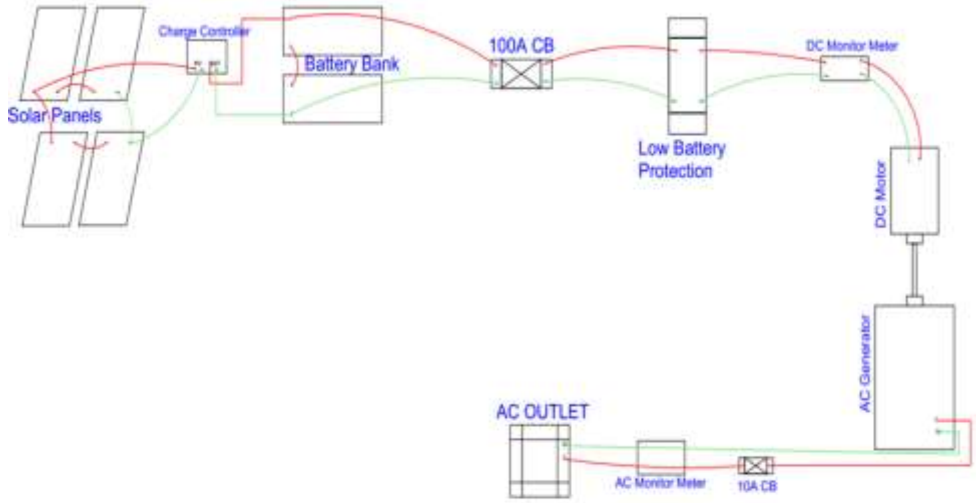


Figure 2: Conceptual diagram

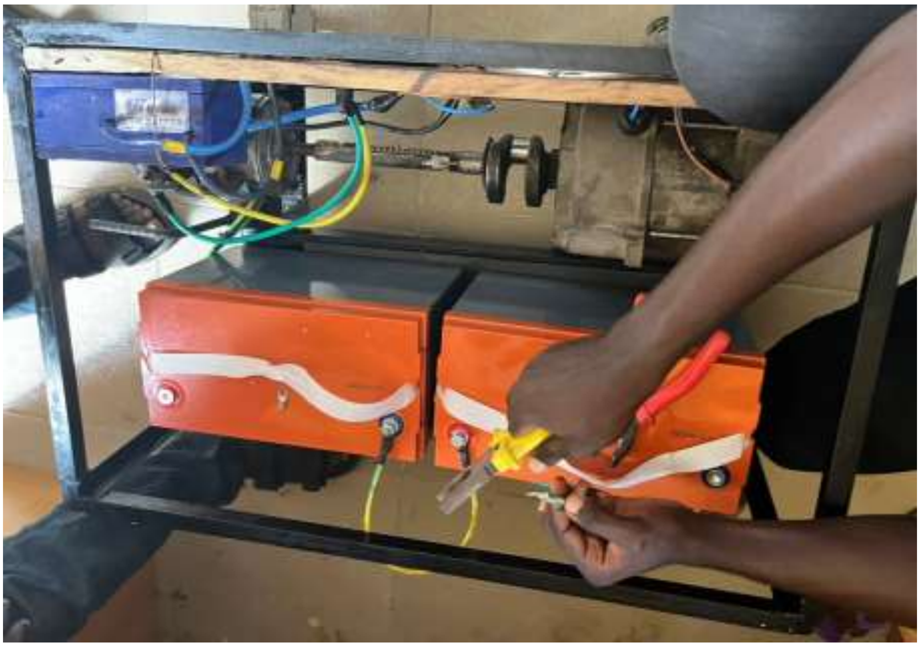

Figure 3: Implemented system

## Results and Discussion

A No-Load Test and Load Test was conducted on the Solar Power Motor-Driven Generator for a period of 4 mins (240 s). Readings of output voltage and frequency was taken at these instances with the digital multimeter. The system's performance was compared with that of the petrol generator. Figure 4 and 5 shows the no-load and on-load (60 W incandescent bulb) ac voltage performances while Figures 6 and 7 reveals the frequency performances.

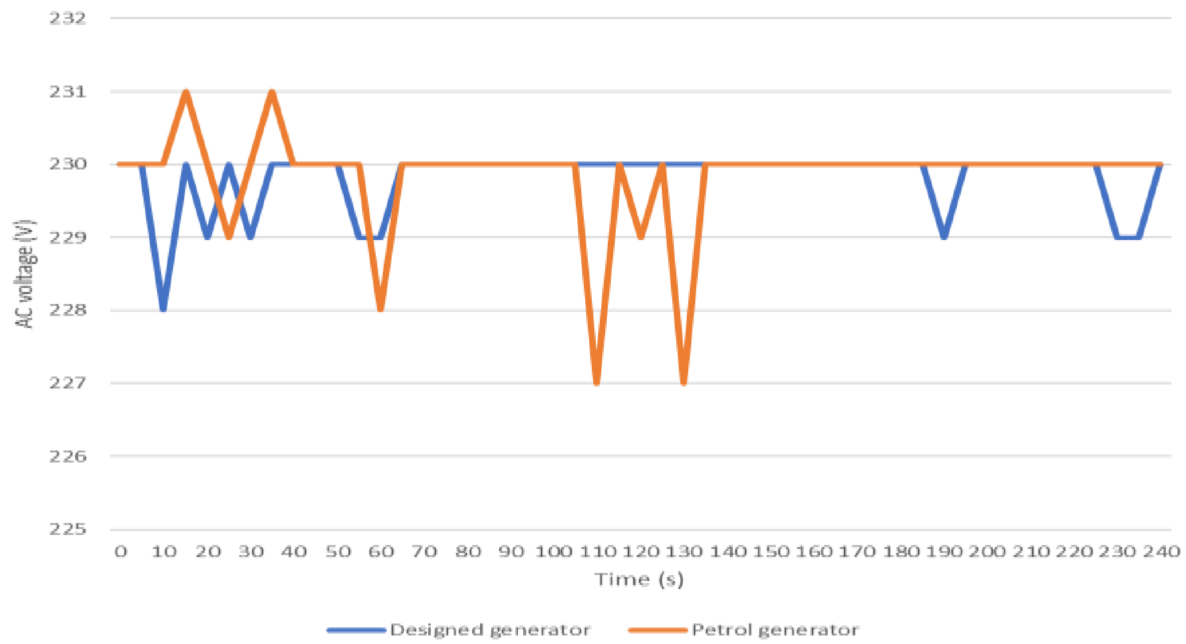


Figure 4: No-load ac voltage performance

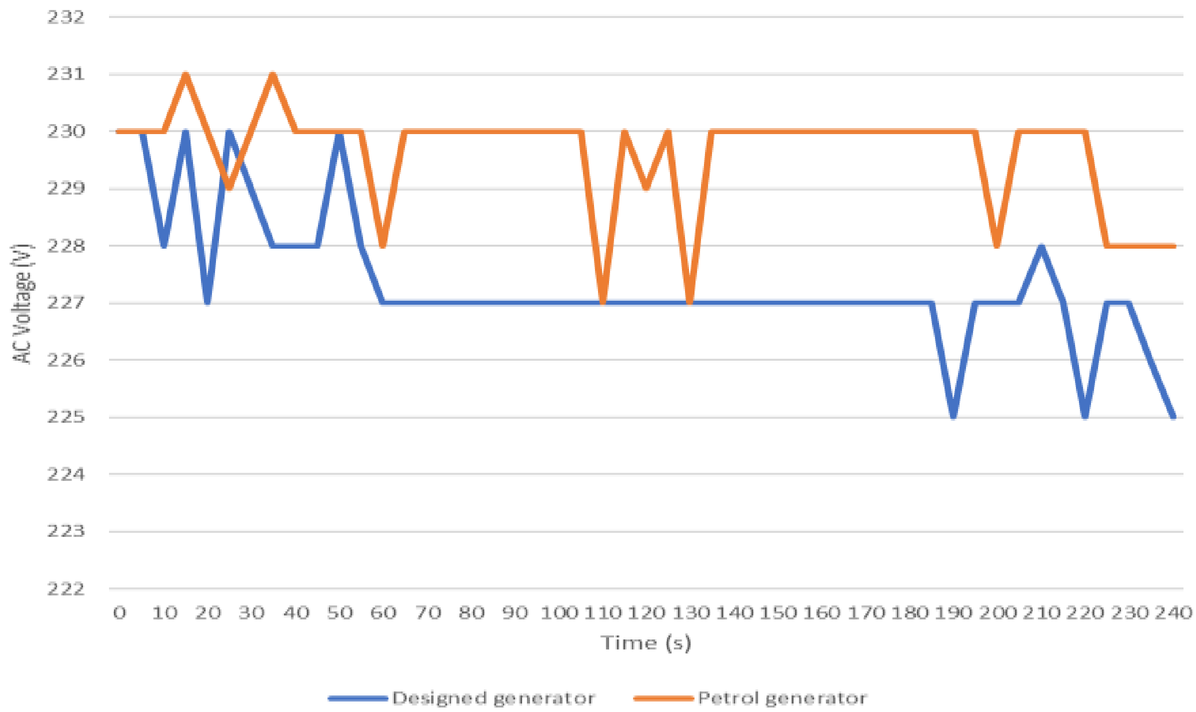


Figure 5: On-load ac voltage performance

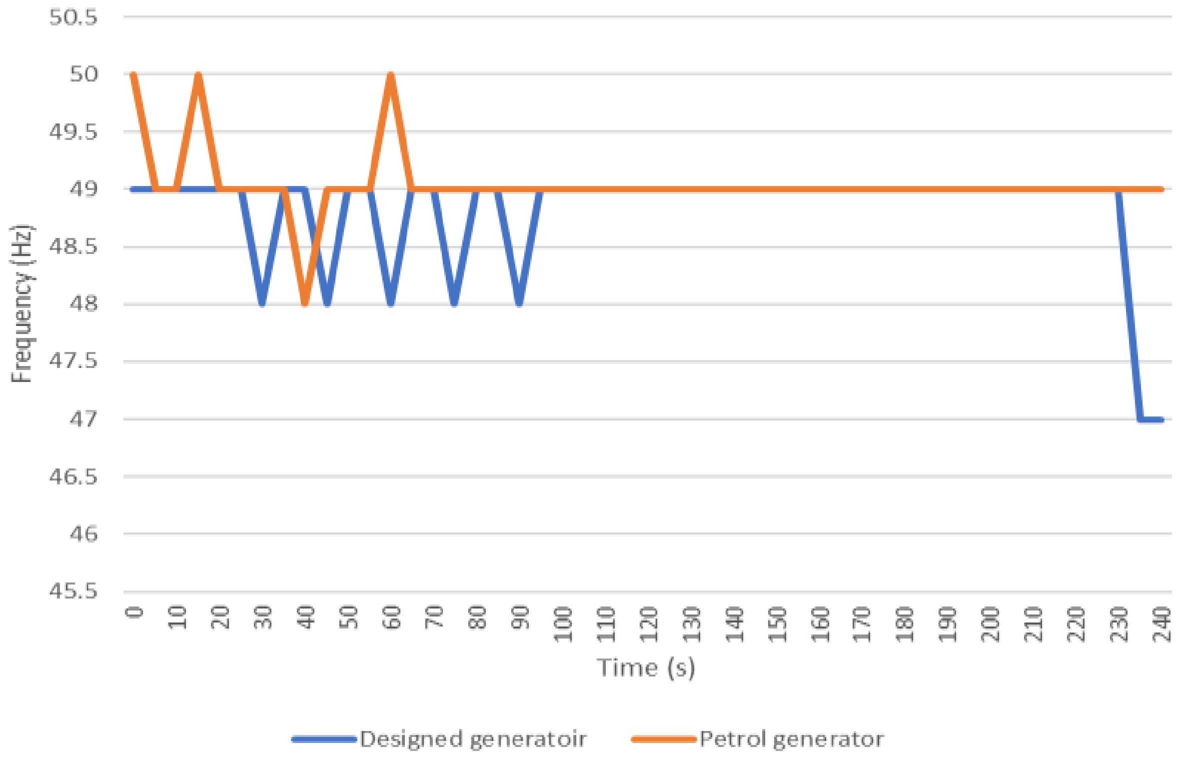


Figure 6: No-load frequency performance

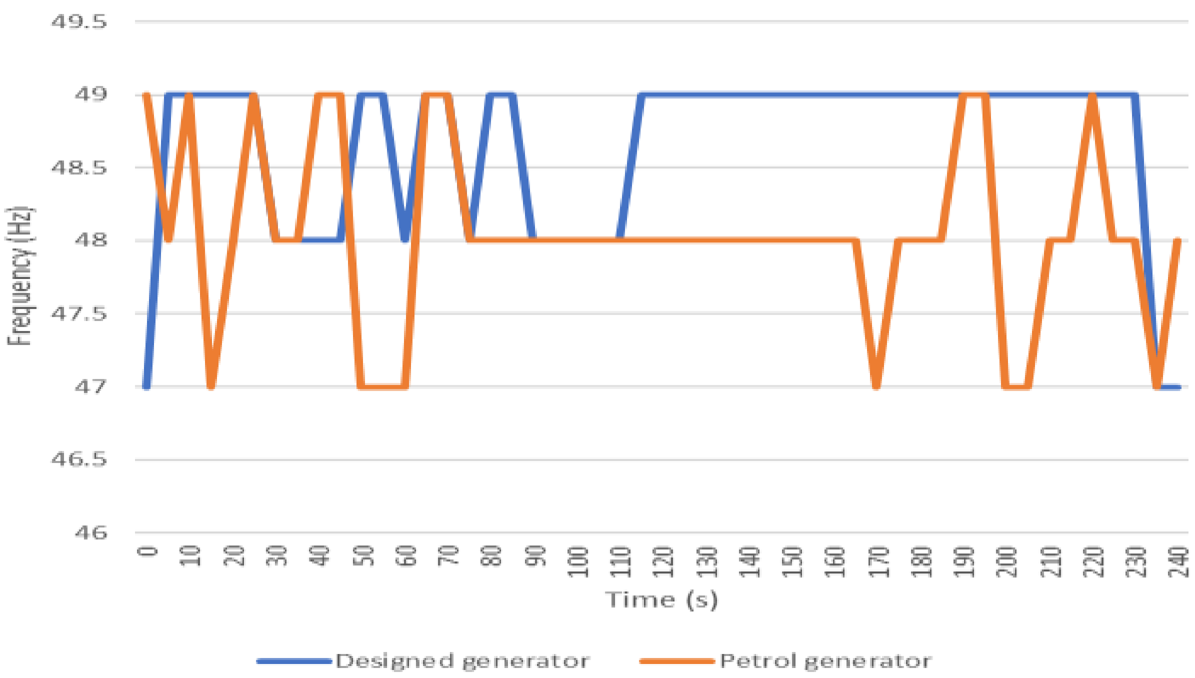


Figure 7: On-load frequency performance

The performance of the ac voltage of the designed system varies slightly from that of the petrol generator. This due to the speed of the dc motor. But the output ac voltage varies within the acceptable standard. Frequency performance also reflects a slight variation, but not too distinct. The system's performance even renders a better performance in the early period of the test.

## Conclusion

A 2.5KVA solar powered motor-driven generating set was designed and implemented. It produces an output ac voltage ranging between 230 V and 227 V and its frequency varies between 50 Hz and 48 Hz. These outputs will efficiently power the ICT gadgets that will be used in the development of TVET curriculum seamlessly. This power is constant, not proned to outages, hence TVET curriculum development will run smoothly.

**References**

Abatan O.A., Adewale A.O., and Alabi A.A. (2013). Electricity Generation from Fuelless Engine in an isolated power generation system, International Journal of Emerging Technology and Advanced Engineering (IJETAE), 3(12), 2250-2459.

Deepu B. P. Kamala H., (2022). Literature Study on Solar Energy Resources – A Geographical Analysis. International Journal of Creative Research Thoughts, 10(4), 865-878

Mohd N. A., Wahyunah G., Amirul H. A., & Maslin M. (2022). The ICT implementation in the TVET teaching and learning environment during the COVID-19 pandemic. International Journal of Advanced Research in Future Ready Learning and Education 27(1), 43-49.

Minna-Eyovwunu, D., Akarue, B. O. & Obavwunuta, O. R. (2019). ICT and Vocational and Technical Education in Tertiary Institution: A Case Study of College of Education Warri, Delta State, Nigeria. International Journal of Innovative Information Systems & Technology Research 7(3), 64-72.

Osasona, I.S. (1987). The effect of Video Tape recording (VTR) Presentation on students teachers attitudes and achievement in selected teacher training colleges in Oyo state. An unpublished Ph.D. thesis of the University of Ibadan, Ibadan.