ISSN:2782-8492

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*

Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

COMPARATIVE ANALYSIS OF LOCALLY DEVELOPED AND FACTORY BUILT 2.0 KVA SINE WAVE INVERTER

[*1]Ejiko S. O., [2]Omojogberun V. Y. and [3]Abiola O. S.
Department of Mechanical Eng'g, The Federal Polytechnic, Ado-Ekiti
[*1]jcdatjiko@yahoo.com; ejiko_so@fedpolyado.edu.ng; ORCID No: 0000-0002-2511-9716

ABSTRACT
The epileptic power supply by the national grid has become a major threat to the survival of businesses within the nation. Individuals and companies are investing in alternative power generation that is reliable, effective and readily available. Solar energy is a renewable energy source gaining wider acceptance globally. There is need to produce sub devices for collection of solar energy and its conversion. Inverters are used to convert direct current of solar energy to alternating current which is globally the accepted standard used domestically. The development of a 2.0 kVA sine wave inverter using locally sourced materials was embarked on. Its performance was compared with that of a factory-built inverter to determine the viability of the alternative. The produced inverter uses a 12 V DC power source to generate 220V AC at 50Hz, making it a suitable option for powering home appliances. The inverter system's architecture comprises four distinct stages: oscillation, inverting/switching, voltage transformation, and automatic control/changeover. The initial stage (oscillation), is achieved through a pulse width modulation circuit employing a C1815 transistor. This circuit is powered by DC batteries and produces two (2) pulses that are 180^o off the phase. These pulses are then sent to the inverting/switching stage, which consists of a set of parallel MOSFETs (IRF260N). The transformation stage elevates the oscillation stage's signal to appliance-friendly 220V, 50 Hz AC, while the automatic control stage ensures uninterrupted power by intelligently switching between power supply and inverter during outages. The comparative analysis of both the factory-built inverter and locally developed inverter was carried out and based on the data analysis; the factory-built inverter was seen to be 7.5% more efficient than the locally built Inverter. On the other hand, the locally built Inverter has better output voltage regulation of about 1.8% and is more stable compared to the factory-built Inverter of about 10.43%. Finally, the locally built Inverter on the other hand is less expensive although the factory built Inverter is the overall superior choice based on reliability since it has undergone more rigorous testing and quality control.

KEYWORDS: *Develop, 2.0 KVA Inverter, Current, Transformer, Efficiency and Output Voltage Regulation.*

1.0 INTRODUCTION

Today in Nigeria, continuous power outage is detrimental to the national system power supply causing disruptions in virtually all spheres of life, with our institutions of research not exempted (Akpan and Ewetumo, 2009). Electricity is pivotal in the economic development, poverty reduction and progress of countries (Omojogberun, Kareem and Adeyeri, 2024). The irregular supply of power by Nigeria Power Companies had given course of concern leading to the avalanche of power generating sets and other appliances (Oyedele, Agun and Ejiko, 2008). Economic growth largely depends on energy supply which is fundamental for all countries and on the long run provide grid from several sources that will make power accessible and affordable (Omojogberun. Oigbochie and Onibon, 2022). Electricity is the major dependent factor in today's economy and due to the incessant power failure; alternative power supply has become imperative. A supportive backup device can provide power for require loads and probably household appliances when there is power outage. Immediate response emergency backup systems are designed to activate rapidly and kicks in immediately to provide uninterrupted power supply during power outage. These are critical to life safety and maintaining critical operations that cannot tolerate any downtime (Exro, 2024; Trystar, 2022). A constant flow of electricity is the lifeblood of our modern world, driving productivity and safeguarding vital systems (Sergent, 2013) and having access to electricity is one of the biggest challenges nowadays particularly in developing countries (Molu et al., 2022). Accessibility to electrical power supply is a way out towards improving our human needs (Lar's, 2020). Nigeria with a large huge land mass of 924 x 10^3 km^2 has a mean area of 5.525kWh/m^2/day (Francis, 2013). Ayodele *et al.,* (2006) highlighted the fact that Nigeria is blessed with huge amount of incident ray, capable of generating 1.804 x 1015 kWh of energy yearly, yet the local, state and federal institutions haven't optimized this potential in the powering of available amenities (Ejiko et. al., 2019).

It is of note also that Nigeria has a mean sunshine of 6.25 hours on daily basis, whose interval is from 5.25 hours at the coastal region and 9.0 hours at the boarders of the North (Ejiko, 2015; Ejiko et. al. 2020: Ejiko et. al., 2021). Solar energy are harvested using panels, this panels are utilize to charge batteries. The batteries supplies DC power to the inverter that in turn convert to AC for powering high voltage appliances

An Inverter is an electrical device that plays a critical role in renewable energy system particularly those revolving around Solar panel and wind turbine. The primary function of Inverter devices is to transform Direct Current (DC) generated by photovoltaic cells or wind turbine into Alternating Current (AC) electricity. Alternating current electricity is the standard form of power used in homes, businesses, critical healthcare systems, computerized networks, and scientific laboratories etc (WTS, 2024). The role of inverters in ensuring uninterrupted power supply is paramount, as their absence can paralyze essential services and cripple modern nation's development.

Background

Over the decades electricity has been produced via energy transformation which includes; thermal, solar, hydro, wind and generators (Alhashimi et al., 2020; Adeoye and Oladimeji, 2020). These sources have proved to be effective but due to inadequate facilities required to keep engine's running, solve problems and faults which may occur in the systems, poor maintenance strategy, they tend to disappoint the users at some point in time.

Humans depend on power supply in almost all activities carried out in the homes, offices and security systems. In most developing countries, power supply cannot be relied on as it is unstable. Erratic power supplies have become a persistent foe, disrupting routines and impacting livelihoods. This dire need for stability birthed the ingenious solution: the Inverter. This remarkable power electronics device offers a lifeline, transforming DC from batteries or solar panels into the lifeblood of our homes and businesses – AC electricity. It is characterized with the function of converting DC input voltage into an AC output voltage of the expected or desired frequency and magnitude which is usually determined by applying an inverter transformer. The power output is use to drive MOSFET in conjunction with the inverter. The devices used to make these process possible includes, batteries, fuel cell and direct current (DC) sources or solar cells.

Inverter Basic Design

Inverters are appliances that transform DC power into AC power and their basic design consists of an input stage, a DC-DC conversion stage, and an output stage. The input stage converts the available DC power source into a DC voltage level that is suitable for the DC-DC converter stage. The DC-DC converter stage converts the DC voltage into a

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

high-frequency AC voltage. The output stage converts the high-frequency AC voltage into a low-frequency AC voltage that can be used to power various loads. There are several different types of inverters and are classified according to; output characteristic (Modified Sine wave, Sine wave and Square wave), source of inverter (current or Voltage), types of load (Three phase or Single), pulse width modulation (Simple pulse, Multiple pulse, Sinusoidal single pulse or multiple pulse) and number of output level (regular two or multi-level) (Kansagara, 2018).

Power Supply System of an Inverter

Inverters use a power supply system to convert battery DC voltage to usable AC power. There are two main types of power utilized in inverters: switching power and linear supplies. Power supplies in linear form have the advantage of being simple and easy to design, but they are less efficient than switching power supplies. Switching power supplies are more efficient than linear power supplies, but they are more complex and can be more expensive to design. Switching power supplies generate high frequency noise that can interfere with other electronic devices. Both types of power supplies have their merits and demerits, and the selectable choices are dependent on the inverter requirement specifications (Madsen, 2023). The Inverter consists of some basic parts such as the Power MOSFET, transformer, resistors, capacitor and heat sink.

Metal-Oxide Semiconductor Field-Effect Transistor MOSFET

Power MOSFETs are designed for high power rating devices. They apply power conversion circuits such as DC-DC converters, uninterruptible power supplies and motor drives. Power MOSFETs have several advantages over other power devices, including high switching speeds, low on-resistance, and high blocking voltage. The power MOSFET is a metal effect transistor and can be used as a voltage control device requiring a low input gate voltage. It has high input impedance. The MOSFET operates in two states; ON and OFF. The speed of MOSFET switch is high (Gowri and Madhwen, 2010).

Power Transformer

A transformer uses electromagnetic induction to transmit electrical power from one circuit to another. They consist of two or more coils of wire, called windings that are wound around a magnetic core.

Transformers are used in many applications, including isolators, power distribution and voltage regulation. They are used in many devices, such as audio instrument, power stations and computer monitors.

Classifications of transformer Transformers are classified based on the following:

I. The type of Shell or core type depends on the arrangement of the coils relative to the core.

II. Voltage transformers; step-up transformers, used to increase the voltage supply and step-down transformer, used to reduce down system voltages.

III. Current transformers are used in instrumentation circuits.

IV. Transformers are classified by of number of windings, which includes; single, double, and triple windings.

Working Principle of a Transformer

A transformer is a static device whereby electric energy in the circuit is converted into electrical energy of the same frequency in a circuit. It increases the voltage in a circuit but with a corresponding decrease in current. The operation of a transformer can be understood by considering the two windings as two separate coils. When a current flows via primary winding, it creates a magnetic field that links to the secondary winding. This induces a voltage in the secondary winding that is proportional to the rate of change of the magnetic flux and the number of secondary winding turns. The frequency of the induced

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

voltage is the same as the frequency of the current in the primary winding.

Resistors

Resistors act as gatekeepers for electricity, controlling the flow of current. When placed in series with a light-emitting diode (LED), a resistor limits the current flowing through the LED, preventing it from drawing too much and burning out. However, resistors themselves can also be susceptible to heat damage, especially during soldering.

Capacitor

A capacitor consists of two parallel plates separated by an air vacuum. It thrives on proximity: Larger, closely spaced conductive plates maximize a capacitor's ability to store energy, the historical term "plates." In leakage current, the insulating dielectric, though effective, allows a tiny amount of current to "leak" through, reducing efficiency. Its breakdown voltage sets a limit on how much voltage the capacitor can handle before failing. While for parasitic elements, the conductors introduce unintended resistance and inductance, impacting the capacitor's behaviour at high frequencies. Capacitors are versatile components in electronic circuits, acting as tiny energy reservoirs. They block the flow of alternating current (AC) by storing and releasing energy in a way that opposes AC's constantly changing direction. This makes them ideal for applications like smoothing out the pulsating DC output of power supplies, essential for powering sensitive electronics.

A capacitor is characterized by a constant C, which is define as the ratio of the charge ±Q on each conductor to the voltage V between them; where Q is the quantity of charge, V voltage apply and C capacitance value (Alexander and Sadiku, 2014).

Heat sink

This is a passive thermal management device employed to dissipate heat generated by high-power semiconductors via convective heat transfer to the surrounding ambient air as shown in plate 1. They are utilized when the inherent thermal dissipation capability of the device package is insufficient to maintain optimal operating temperature. The heat sink maximizes surface area directly exposed to the cooling medium via extended fins.

Plate 1: Heat sink for heat absorption

Heat reservoirs act as infinite sources of heat that do not change temperature appreciably when absorbing heat. Actual heat sinks must be at a higher temperature than the surrounding environment in order to effectively dissipate heat through convection, radiation, and conduction (Sergent, 2019)

2.0 METHODOLOGY AND IMPLEMENTATION

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

The main requirements/stages for the design of the sine wave inverter system is as presented in the Figure I.

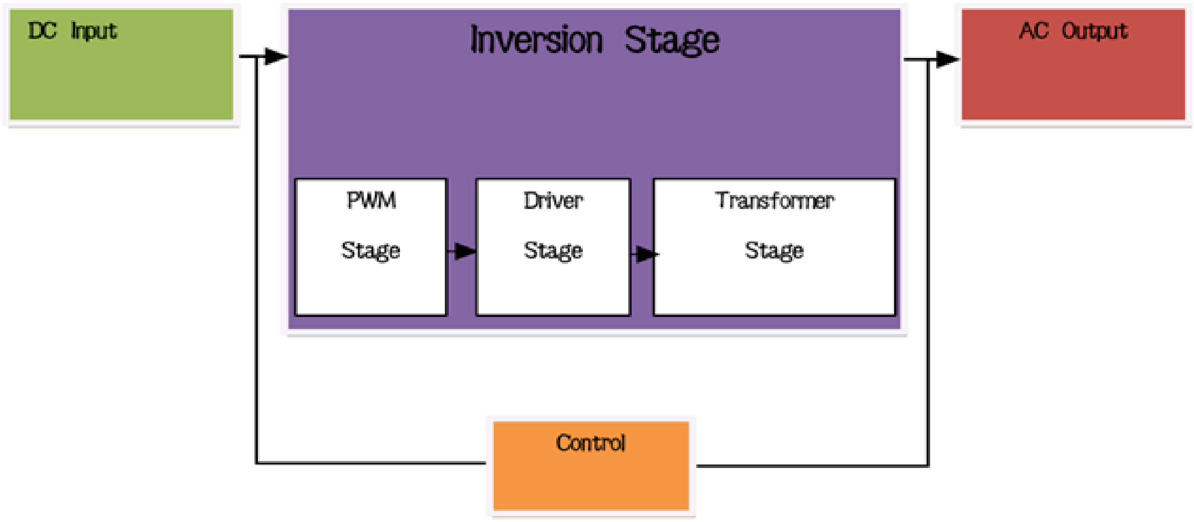

Figure I: Inverter System Block Presentation

D.C. Input

The DC input used in this design is the 12 V input from the deep cycle battery which is used to power the Inverter.

The Inversion Stage

This takes direct current from the power source, modulates it, amplifies it, converts it to alternating current and amplifies it.

Design of Metal-Oxide Semiconductor MOSFET

The MOSFET delivers the required value of load current to the step-up, and then amplify the low voltage so that it can be detected by the inverter's transformer.

By using a power factor (p.f) of 0.8 base on losses that are inherent for 2000VA design as given in Equation I by Gyugyi & Grantham, (2002)

$$P = p.f \times P(KVA) \quad \text{(I)}$$

$P = p.f \times P(KVA) = 0.8 \times 2000\text{VA} = 1600\text{watts} = \frac{P(W)}{V(v)} = \frac{1600}{12} = 133.3\text{ A}$

where

P = Power Measured watts (W)

V = Voltage Measured volt (v)

I = Current in ampere (A).

The power obtained is a product of current and voltage as given by Ejiko and Olaniyi (2018). This simply means a current handling capacity in excess of 133.3 A is required by the power element. The maximum AC power for a class B amplifier for switching on and off the circuit is as given in Equation 2 with reference to 50% loss in current value.

$$P_{ac} = V_{cc} \times \frac{I_{max}}{2} \quad \text{(II)}$$

$$P_{ac} = 12 \times \frac{133.3}{2} = 800\text{ W}$$

where P_{ac} is the maximum AC power, V_{ac} is the AC voltage and I_{max} is the maximum current flow.

The IRF 260 N-channel is the MOSFET used in the design.100 ohms fixed resistors were connected between the gates and programmed to aid fast switching through discharging of residual gate static charges.

The IRFP 260 N data is shown in Table I.

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

Table I: IRF 260 N Specification

PARAMETER	VALUE
Breakdown voltage	200 V
Source Gate voltage (cut-off)	4 V
Gate to source breakdown voltage	20 V
Continuous Drain current @ 25degrees	50 A
Drain current (continuous) @ 100 degrees	35 A
Drain to source resistance R_{DSS}	0.055 Ω
Power dissipation P_d	300 W

For a 100 degrees condition, the required amount of MOSFET N will be used to meet the actual capacity is 4;

$$I = \frac{2000}{12} = 166.7\text{ A}$$
$$N = \frac{166.7}{35} = 4\text{ MOSFETs}$$

Power Transformer Design

Table II shows the ratings of the transformer used in the design.

Table II: Transformer Design Specification

Parameter	Specification ratings
Transformer	2KVA
Frequency	50Hz
Primary voltage	12V
Secondary voltage	220V
Design type	Shell type
Battery peak voltage	12V

$$\text{Voltage per turn} = k\sqrt{s}$$
$$= 1.0 \times \sqrt{2} = 1.414\text{V Per turage}$$
$$per\ turn = k \times s$$
$$1.0 \times 2 = 1.414V\ Per\ turn$$
where S = Output (KVA)
k = 1.0 single phase shell type
For number of turns, we have;
$$N_1 = \frac{V_1}{V_t} = \frac{12}{1.414} = 9\text{turns}$$
$$N_2 = \frac{V_2}{V_t} = \frac{220}{1.414} = 156\text{ turns}$$

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

Control Stage
The control phase of the inverter system consists of automatic switchover from the Inverter input (battery) to the mains supply (AC output) on recovery and vice versa via a relay. Two relays are used for this operation.

A.C. Output
A.C. output is the final stage of the inverter system that powers the load while the inverter is powered. A transformer stepped up the voltage to 220 V AC to create an AC output.

Complete Circuit Diagram Analysis
The complete circuit diagram for the 2 KVA Inverter is as shown in the Figure 2. A vero-board is used for the arrangement of components starting from edge (from left to the right hand side) of the board, starting with relay, followed by diode, resistor, integrated circuit (IC) and transistor, the legs of these components were given a good soldering for permanent contact by 65 W soldering iron with lead alloy.

The bank transistors for inverting stages are bolted to heat sink for heat dissipation and separated from other stage. Connection was made from the bank transistor to the primary transformer with the arrangements of the components on the Printed Circuit Board (PCB).

The breadboard was built first because it is important to insure the design works when tested and to identify any necessary fixes and adjustments before transferring the component to the Vero board for soldering. The layout of the component was first planned before they were placed on a breadboard or tongue board. After testing the circuit on the project board, some necessary adjustments were made and the circuit components were transferred stage by stage to the Vero board and the permanently soldered. The components were soldered cleanly and the copper strips along the Vero board were scraped cleanly where not needed to avoid short circuit. The loops from the mains cable to the transformer and the connecting wires to the transformers is such that the MOSFETs and relays goes to the battery terminals in a careful and neatly packed form. The MOSFETs were fixed onto a heat sink for effective absorption of heat, with a 12 V DC fan to cool the heat sink during operation.

ISSN:2782-8492

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition

Website: *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*

Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND

TETFund/ESS/POLY/ADO-EKITI/ARJ/1

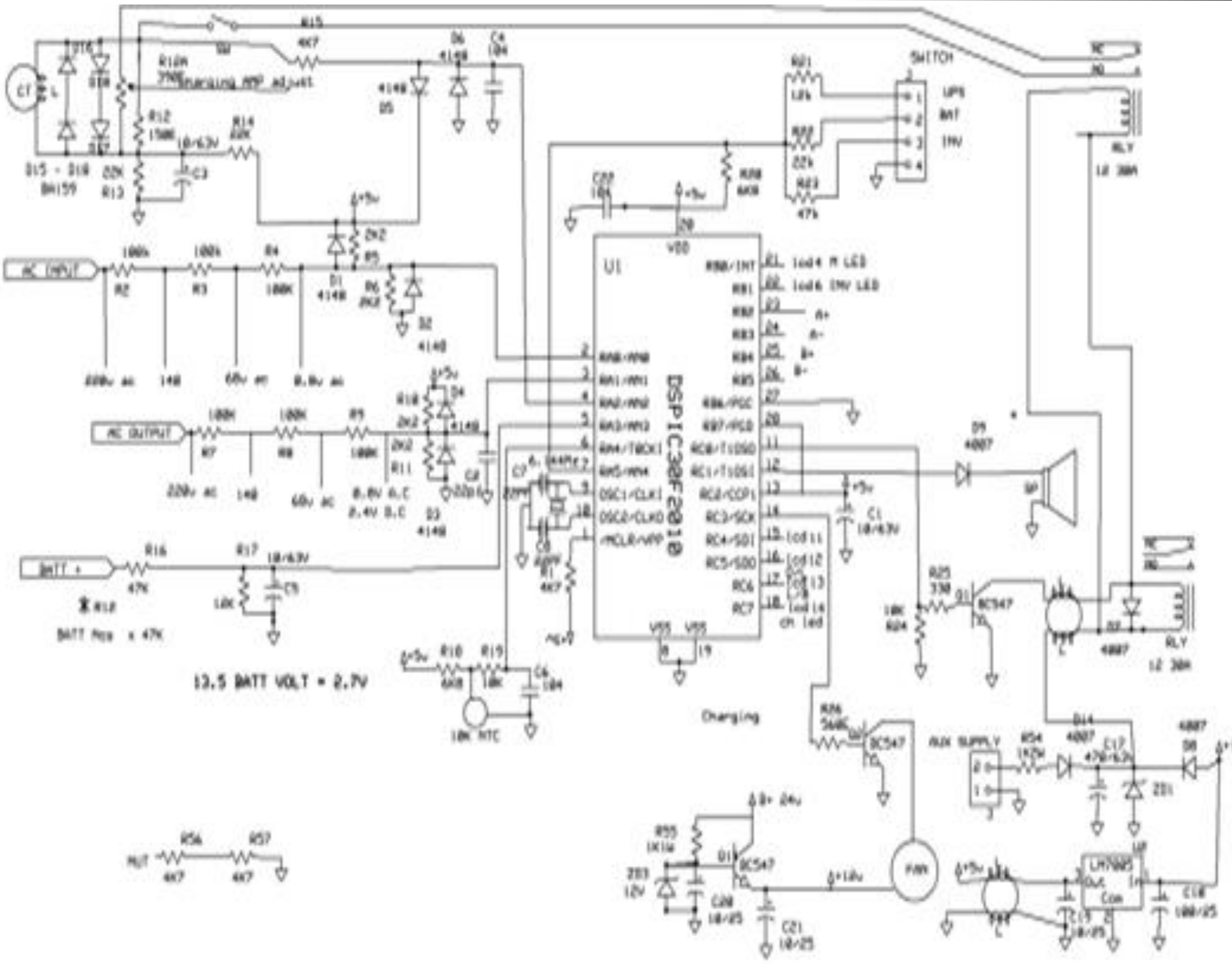

Figure II. Complete Circuit Diagram of the 2 KVA Inverter

In evaluating the dependability and operationality of the electronic components used in this project, a series of rigorous test were carried out to verify their integrity. The circuit was tested thoroughly to ensure it met all the expected requirements. The imported 2 KVA Inverter and the 2 KVA Inverter locally developed were compared and analysed under various load conditions to determine their performance characteristics base on different loading capacity. A comparative analysis is further done to ascertain the efficiency and the output voltage regulation on both Inverters while being subjected to the same working conditions.

Test for Efficiency

The test for efficiency was conducted on both the imported Inverter and the locally developed Inverter and, the results are recorded for each case. The following loads were used in the testing process: Incandescent light bulb, standing fans, television set, soldering iron and electric motor.

Test for the Output voltage regulation

This is a measure of how well the Inverter can maintain a stable output voltage under varying loads and input conditions

3.0 RESULTS AND DISCUSSIONS

A total load of 615 W is applied on both Inverters simultaneously and allowed to run for 3 hours. Table III and IV shows the efficiency test for both the factory-built Inverter and the locally built Inverter respectively.

ISSN:2782-8492

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition

Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees

Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND TETFund/ESS/POLY/ADO-EKITI/ARJ/1

Table III: Efficiency on the Factory built Inverter for a maximum load of 615 W

Time (Minutes)	DC Input Voltage (Volts)	DC Input Current (Amperes)	AC Output voltage (Volts)	AC Output Current (Amperes)	Input Power $Pin = Vin \times Iin$	Output Power $Pout = Vout \times Iout$	Efficiency $= \frac{Pout}{Pin} x \frac{100}{1}$
0	13.1	164	230	3.7	2148.4	851	39.61
30	12.3	166	227	3.4	2041.8	771.8	37.80
60	12.1	165	224	3.6	1996.5	806.4	40.39
90	12.0	164	224	3.5	1968	784	39.84
120	11.9	166	219	3.6	1975.4	788.4	39.91
150	11.8	167	216	3.8	1970.6	820	41.65
180	11.6	166	211	3.5	1925.6	738.5	38.35
							277.55

Average Efficiency = $\frac{\text{Total efficiency for each time period}}{\text{number of time periods}}$ (III)

Average Efficiency = $\frac{277.55}{7}$

Average Efficiency = 39.65%

The average Efficiency for the factory-built inverter is 39.65%.

Table IV: Efficiency on the Locally Developed Inverter for maximum load of 615 W

Time (Minutes)	DC Input Volt (v)	DC Input Cur. (A)	AC Output volt (v)	AC Output Cur. (A)	Input Pow. $Pi = Vin \times Iin$	Output Pow. $Pout = Vout \times Iout$	Eff. = $\frac{Pout}{Pin} x100$
0	13.1	161	222	2.9	2109.1	643.8	30.52
30	12.9	164	221	3.0	2115.1	663	31.35
60	12.1	163	219	2.8	1972.3	613.2	31.08
90	11.7	164	218	2.9	1918.8	632.2	32.95
120	11.3	162	218	2.7	1830.6	588.6	32.15
150	11.1	161	217	2.6	1787.1	564.2	31.57
180	10.6	164	216	2.8	1738.4	604.8	34.79
							224.41

Average Efficiency = $\frac{\text{Total efficiency for each time period}}{\text{number of time periods}}$

Average Efficiency = $\frac{224.41}{7}$

Average Efficiency = 32.06%

The average Efficiency for the locally built inverter is 32.06%

Therefore, the difference in average efficiency of the two inverters is calculated as 39.65% - 32.06% = 7.59%.

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

From the average Efficiency of the two inverters, it was observed that the average Efficiency of the factory-built inverter (39.65%) is slightly higher than that of the average Efficiency of the locally built inverter (32.06%). The average difference of 7.59% tells us that, on average, the factory-built inverter performed 7.59% better than the locally developed inverter. As Table III and Figure IV shows, it was observed that throughout the test period, the factory-built inverter is found to be more efficient than the locally developed. This is base on their functionality which shows that four factory built inverters is capable of performing similar task as five locally built inverters. This implies the locally ones can highly depended upon.

Table V: Efficiency of both inverters at every 30 minutes interval

Time (Minutes)	Factory Built Inverter Efficiency (%)	Locally Developed Inverter Efficiency (%)
0	39.61	30.52
30	37.80	31.35
60	40.39	31.08
90	39.84	32.95
120	39.91	32.15
150	41.65	32.57
180	38.35	34.79

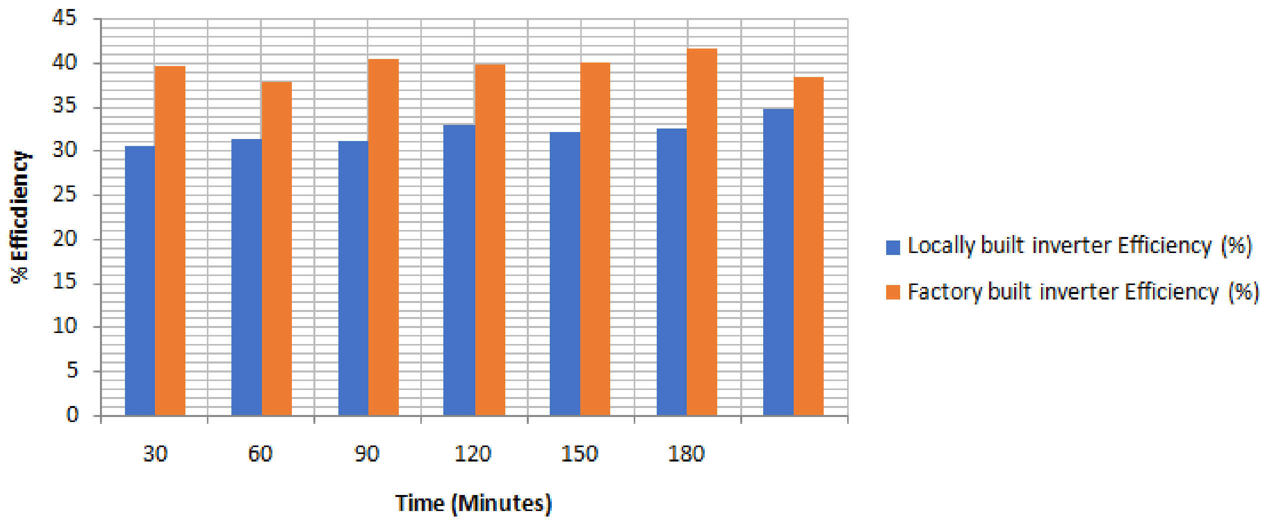

Figure III: Local & Factory Inverters Efficiency at 30 minutes interval.

From the data, the percent voltage regulation for the factory-built inverter was estimated using equation IV as given by Electronics, (2024);

$$\%\,Voltage\ Regulation\ = \frac{Voltage\ (no\ load) - Voltage(full\ load)}{Voltage(no\ load)} \times 100 \qquad \text{(IV)}$$

$$\frac{230 - 206}{230} \times 100 = 10.43\%$$

While the percent voltage regulation for the locally built inverter is

$$\frac{222 - 218}{222} \times 100 = 1.8\%$$

From the data, the percent voltage regulation for the factory-built inverter is approximately 10.43%, while the percent voltage regulation for the locally built inverter is approximately 1.36%.

This indicates that in terms of voltage regulation, the locally built inverter is better than the factory-built inverter. The level of regulation will help in maximizing the life spans of electrical appliance utilize due to the fact that there will be prevention of outrageous voltage that can bridge or burn the system circuit. Figure 4 shows that the factory built inverter voltage decreases as the load increases while the local inverter maintains a relatively steady output voltage at an increasing value of applied loads. At an intercept load value of 400 watts both inverters tends to perform at the same efficiency. The rapid decline in the voltage generated per load shows the limiting capacity of the factory built inverter. This implies certain standard may have been compromise during production.

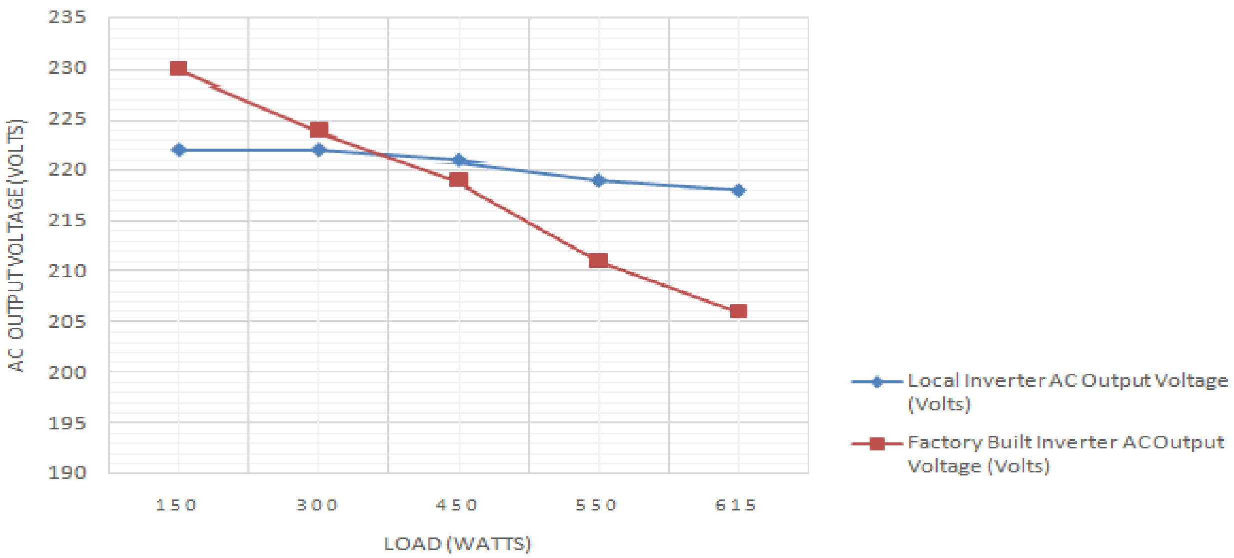

Figure IV: Output voltage of locally and factory-built Inverter

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

The comparative analysis of the locally developed Inverter and the factory-built Inverter was carried out. Based on the data analysis, the factory-built inverter was seen to be more efficient than the locally developed inverter. On the other hand, the locally built inverter has a more stable output voltage regulation than the factory-built inverter and is less expensive even though the factory built is a superior choice based on reliability since it has undergone more rigorous testing and quality control. At lower load within the first 400 watts the factory built inverter tends to perform better in voltage generation than the local inverter, while as the load increases the reverse is the reflection in term of performance. Given the importance of efficiency and voltage regulation in power inverters, it can be concluded that the locally built inverter can be selected for applications such as in renewable energy system and in medical equipment and industrial control systems.

4.2 Recommendation

1. To improve the design, a filter network should be added to reduce the harmonics in the output waveform.
2. Advanced techniques, such as pulse width modulation or direct digital

synthesis, could be used to generate a better output.

3. Microprocessors can be used to handle multiple tasks and improve the portability.

Reference

Adeoye, S. and Oladimeji, T. T. (2020). Power Generation in Nigeria: The Past, Present and Furture. Journal of Earth and Environmental Sciences Research. Vol. 2(2). Pp 1 – 8.

Akpan, V. A and Ewetumo, T. (2009). Design, Development and Construction of a Low Cost Automatic 2 KVA Inverter System. Global Journal of Pure and Applied Sciences. Vol. 16(1).Pp 141 - 149.

Alexander, C., &Sadiku, M. (2008). Fundamentals of electric circuits (8th ed.). New York: McGraw-Hill.

Alhashimi, M. T., Anooz, R. S. A. and Noori, A. S. (2019).Review on Generation Source of Electricity. Journal of Instrumentation and Innovations. Vol. 9(3), Pp 8 – 16.

Ayodele T. R, Akinsanya O. A and Familua A. J. (2006): "Renewable Energy Resources: A Strategy for Electricity Generation In The Millennium Development In Nigeria". Proceeding of 2nd Engineering Forum. Federal Polytechnic, Ado Ekiti. Pp 42 -49

Ejiko S. O., Ejiko S. O. and Filani A. O. (2021) "Holistic Multiple Regression Models Development for Nigeria Azimuth Angle Determination" SSRG International Journal of Mechanical Engineering 8 (9) 7-10, Sep, 2021 doi:10.14445/23488360/IJME-V8I9P101

Ejiko, S.O., Oke P. K., Titiladunayo I. F. and Ogedengbe T. I, (2019) "Application of Mathematical Models and Sensors for Optimization of Solar Energy Collection Using a Developed Tracking Device", International Journal of Scientific Engineering and Science http://ijses.com, 3(1) 22-30

Ejiko, S. O. and Olaniyi, D. (2018) "Development of Regression Models for Appropriate Battery Banking Determination in Solar Power System, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) ISSN: 2320-3331, 13(1) 30-37 www.iosrjournals.org

Ejiko S. O. (2015) "Development of a Dual Axis Tracker", A paper presented at the 10th Engineering Forum, School of Engineering, The Federal Polytechnic, Ado-Ekiti, on 23rd – 26th October, 2015 at Conference Centre, Ado-Ekiti, Ekiti State. 2(10)173-184

Ejiko S. O., Ogunlowo M. and Ukachi P. A. (2020) "Overview of Solar Tracking Device and Development of Light Positioning Detector" World Journal of Engineering Research and Technology (WJERT) 6(3) 46-64.

Electronics Tutorials, (2024) "Transformer Voltage Regulation" retrieved 5th November 2024 from https:/www.electronics-tutorials.ws/transformer/voltage.regulation.html

Exro (2024). The Importance of Emergency Backup Power: How to Enhance Grid Flexibility at a Glance. A Publication of Exro Technologies. .https://www.exro.com>the importance

Francis S. I. (2013): Status of Renewable Energy in Nigeria (online) http://www.renewablenigeria.org/Status_of_Renewable_Energy_in_Nigeria%5B1%5D.pdf Retrieved on the 21st of January, 2013.

Gowri and Madhwen. (2010). *Power Electronic Converters Using MOSFET*. New York: Springer Science and Business Media.McGraw

Hills. Retrieved from https://bard.google.com

Gyugyi, L., & Grantham, E. C. (2002). Power factor correction handbook. (1st Ed., Pp. 12-14). IEEE Press.

Kansagara, R. (2023). Introduction to Different Types of Inverters. A publication of Circuit Digest. Circuitdigest.com

Lar's, L. (2020). Is there a Universal human Right to Electricity? The International Journal of Human Right. Vol. 24(6). Pp711 – 723.

Madsen, J. (2023). Linear versus Switching Power: what's the Difference and Which is Better? A Publication of Bravo Electric Component. Bravoelectric.com.

Molu, R. J. J., Mbasso, W. F., Naossi, S. R. D., Kenfack, S. T. and Wira, P. (2022). Vol. 12(5) Pp 55 – 60.

Omojogberun, Y. V. , Oigbochie, D. , Onibon, G. L. (2022). Harnessing Geothermal Energy As Alternative Source of Energy. International Advanced Research Journal in Science, Engineering and Technology. Vol 9(6). Pp 218 – 223.

Omojogberun, Y. V., Kareem, B., Adeyeri, M. K.(2024). Steam Turbine: A Review on Some Critical Parts. Iconic Research and Engineering Journals. Vol. 7(10) Pp 259 – 266

Oyedele, O.A., Agun B.J. and Ejiko, S.O. (2008), "Energy Mix : Solution to Power Problem in Nigeria", A paper presented at the 4th Engineering Forum , School of Engineering, The Federal Polytechnic, Ado- Ekiti, on 14th – 17th October, 2008 at The Polytechnic Conference Centre, Ado-Ekiti, Ekiti State. Pp 20- 27 https://www.researchgate.net/publication/338371252_ENERGY_MIX_SOLUTION_POWER_ PROBLEM_IN_NIGERIA

Sergent. (2013). IEEE Transactions on Power Electronics -'A Switching-Mode Inverter in the Year1886'. 28(7), Pp. 1936-1940.

Sergent. (2019). Heat Sink 101; A guide to heat sink fundamentals. Retrieved from https://www.clamptek.com/heat-sink-101

Trystar (2022). What is the Difference Between Emergency Power and Standby Power? https://www.trystar.com>article

WTS Energy (2024). What is an Inerter. A Publication of WTS energy. Wtsenergy.com.