CHAPTER FIVE

5.1 CONCLUSION

The design, construction, and installation of a 2KVA solar-powered inverter system have been successfully executed, marking a significant step toward addressing Nigeria's persistent power supply challenges through sustainable and locally driven solutions. This project investigated the performance and developed a mathematical model to assess the performance index of the locally designed inverter, integrating solar energy as a renewable power source. The system, tailored to deliver a pure sine wave output at 220V, 50Hz, and capable of supporting up to 1600W of load, was rigorously tested to evaluate its efficiency, reliability, and suitability for domestic and small-scale commercial applications.

The performance analysis, as detailed in Chapter Four, demonstrated that the inverter operates with an overall efficiency of 88–90%, closely aligning with the design target of 90%. The equation modeling, derived through linear regression using SPSS-23 software, yielded an adjusted R^2 value of 0.904, indicating that the model is 90.4% capable of predicting the system's performance based on key parameters such as measurement time, load output voltage, and load output current. This high predictive accuracy validates the robustness of the locally designed system, offering a reliable framework for assessing its operational behavior without relying on comparisons with foreign-made inverters. The pure sine wave output, with total harmonic distortion (THD) below 3%, ensures compatibility with sensitive electronics, making the system a viable alternative to imported solutions.

The integration of solar photovoltaic (PV) panels, an MPPT charge controller, and a tubular battery bank enhances the system's sustainability by harnessing Nigeria's abundant solar resources, which average 4.5–6 kWh/m²/day. The 600W solar array efficiently charges the 24V, 100Ah battery bank, enabling the system to support a 1600W load for approximately 1.5 hours daily while maintaining a 50% depth of discharge to prolong battery life. The MPPT controller's ability to optimize energy harvest, even under suboptimal sunlight conditions, underscores the system's adaptability to Nigeria's variable climate.

A key achievement of this project is its emphasis on local manufacturing, utilizing components such as toroidal transformers, circuit boards, and copper wiring sourced from markets in Ilorin, Nigeria. This approach reduced production costs by 20–30% compared to imported systems and fostered economic benefits by supporting local vendors and technicians. The successful deployment of the system in a real-world setting, with user-friendly installation procedures and comprehensive safety features (e.g., overvoltage protection, thermal management), demonstrates its practicality for off-grid and hybrid applications in rural and urban areas.

The project also highlights the limitations of relying on foreign-made inverters, which often suffer from unreliability, high maintenance costs, and incompatibility with local conditions. By developing a performance evaluation model independent of foreign benchmarks, this study establishes a novel approach to assessing locally designed systems. This is particularly relevant in Nigeria, where the proliferation of substandard imported gadgets has raised concerns about durability and performance. The locally designed 2KVA solar-powered inverter, with its robust construction and tailored design, offers a compelling alternative that aligns with the nation's push for energy independence and technological innovation.

In conclusion, this project not only achieves its technical objectives but also contributes to broader socio-economic and environmental goals. By leveraging solar energy and local resources, the 2KVA solar-powered inverter system provides a sustainable, cost-effective, and reliable power solution, paving the way for increased adoption of renewable energy technologies in Nigeria. The performance modeling and successful implementation underscore the potential of local engineering to address critical energy challenges, setting a foundation for future advancements in power electronics and sustainable energy systems.

5.2 RECOMMENDATION

The successful implementation, construction, and installation of the 2KVA solar-powered inverter system have fulfilled the project's aim and objectives, as validated through extensive testing, troubleshooting, and performance analysis. The system's design, which integrates locally sourced components and solar energy, demonstrates the feasibility of producing high-quality power solutions within Nigeria's technological and economic constraints. However, to build on this achievement and enhance the scalability and impact of similar initiatives, several recommendations are proposed for future work and policy considerations.

1. **Enhancement of Local Component Development:** While the project successfully utilized locally sourced materials for components like transformers and circuit boards, some critical integrated circuits (ICs), such as the PIC16F877A microcontroller and IR2110 driver IC, were imported due to their

unavailability in local markets. To reduce dependency on foreign supplies and expedite project timelines, local industries should be encouraged to manufacture these ICs. Government incentives, such as tax breaks or grants for electronics manufacturing, could facilitate this transition. In the interim, bulk procurement of ICs from reliable international suppliers should be streamlined to meet project deadlines, especially for time-bound academic or commercial endeavors.