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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT FOR THE FEDERAL UNIVERSITY OF KASHERE, GOMBE INTERCONNECTED SOLAR-HYBRID PROJECTS UNDER THE NIGERIA DISTRIBUTED ACCESS THROUGH RENEWABLE ENERGY SCALE-UP (DARES) - REA-NEP/DARES/C/CQS/071/2025

Submitted

Federal Ministry of Environment

Mabushi, FCT, Abuja.

June 2026

DRAFT FINAL ESIA REPORT

of the Proposed Solar Power Plant and Associated Infrastructure at Federal University of Kashere (FUK), Gombe State

Under the Nigeria Distributed Access Through Renewable Energy Scale-up (DARES)

Submitted

Federal Ministry of Environment

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LIST OF ACRONYMS AND ABBREVIATIONS

APPI	Area of Potential Project Influence
ARAP	Abbreviated Resettlement Action Plan
BMP	Biodiversity Management Plan
BOD	Biochemical Oxygen Demand
COPE	Care of the People
CWD	Coarse woody debris
DRG	Debt Relief Gains
EA	Environmental Assessment
ECN	Energy Commission of Nigeria
EEP	Energizing Education Programme
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EMS	Environmental Management Strategy
ERSED	Erosion and sediment control
ESCP	Erosion and Sediment Control Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FEPA	Federal Environmental Protection Agency
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
GPS	Global Positioning System
Ha	Hectares
HSE	Health, Safety, and Environment
HT	High Tension
ICREEE	Inter-ministerial Committee on Renewable Energy and Energy Efficiency
LGA	Local Government Area
LT	Low Tension
NACOP	National Council on Power
NEEAP	National Energy Efficiency Action Plan
NEP	Nigeria Electrification Project
NEPP	National Electric Power Policy
NERC	Nigerian Electricity Regulatory Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NIMET	Nigerian Meteorological Agency
NML	Noise Management Level
NOx	Nitrogen oxides
NSITF	National Social Insurance Trust Fund
NUC	National University Commission

O&M	Operations and maintenance
PAPs	Project Affected Persons
PCT	Plant Community Type
PESCP	Progressive Erosion and Sediment Control Plan (aka ESCP)
PMP	Project Management Plan
POLAC	Nigeria Police Academy
REA	Rural Electrification Agency
SE4All	Sustainable Energy for All
Sp./spp.	Species/species (plural)
SWMP	Soil and Water Use Management Plan
TCN	Transmission Company of Nigeria
TCP	Traffic Control Plans
TMP	Traffic Management Plan
TWA	Time Weighted Average
VLMP	Vegetation and Land Management Plan
WMP	Waste Management Plan
WPMP	Weed and Pest Management Plan

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Executive Summary

ES01: INTRODUCTION

Nigeria has prioritized expanding electricity access through initiatives such as the Nigeria Electrification Project (NEP), launched in 2018 and implemented by the Rural Electrification Agency with support from the World Bank and African Development Bank. Through mini-grids and solar systems, NEP provided electricity to over seven million people and encouraged private sector participation. Despite these achievements, many rural communities still lack reliable power, making universal electricity access by 2030 a significant challenge.

To address this gap, the Nigeria Distributed Access through Renewable Energy Scale-Up (DARES) Project was introduced as a follow-up initiative. Supported by $750 million in funding, DARES aims to provide electricity access to over 13 million people by expanding mini-grids and solar home systems while attracting private investment through innovative financing and risk-reduction mechanisms. The project builds on the successes of NEP by addressing challenges such as high infrastructure costs and limited financing opportunities. It also supports Nigeria's clean energy and climate objectives by promoting renewable energy solutions and reducing dependence on fossil fuels.

In compliance with Nigeria's Environmental Impact Assessment Act, the proposed project underwent an Environmental and Social Impact Assessment (ESIA) to support informed decision-making and ensure environmental compliance. The ESIA seeks to promote sustainable development by identifying and minimizing potential environmental, socio-economic, and cultural impacts during the planning stage. It also provides baseline environmental data, assesses project risks, and develops a cost-effective Environmental Management Plan (EMP) for impact mitigation throughout the project lifecycle.

The applicable legal and institutional framework to the proposed Project includes, but is not necessarily limited to, the following:

- EIA Act CAP E12 LFN 2004
- National Policy on the Environment, 1989 (revised in 1999 and 2017)
- World Bank Safeguard Policies on Environmental Assessment
- National Environmental (Energy Sector) Regulations, 2014
- National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991, S.I.9
- National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991, S. I. 15
- National Environmental (Sanitation and Wastes Control) Regulations, 2009
- National Environmental (Noise Standards and Control) Regulations, 2009
- Gombe State Ministry of Environment Laws on Environmental Protection
- Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal
- The United Nations Framework Convention on Climate Change
- Declaration of the United Nations Conference on Human Environment
- International Labour Organisation (ILO): ILO-OSH 2001 - Guidelines on Occupational Safety and Health (OSH) Management Systems

ES 02: PROJECT JUSTIFICATION

The section highlights the project's expected benefits, including improved academic and research activities, reduced operational costs, enhanced campus security through solar-powered lighting, and capacity building via a renewable energy training centre. It also emphasizes broader socio-economic

impacts such as job creation, local economic growth, and strengthened institutional partnerships. Project sustainability is addressed from technical, environmental, economic, and social perspectives, supported by robust system design, reduced reliance on fossil fuels, long-term cost savings, and active stakeholder engagement. The involvement of experienced contractors, institutional oversight, and compliance with environmental and social management frameworks further support the project's long-term viability.

Additionally, this section evaluates site selection and technological alternatives, confirming the suitability of the proposed site based on topography, environmental factors, and security considerations. Photovoltaic (PV) solar technology and lithium-ion battery storage were selected as the preferred options due to their efficiency, cost-effectiveness, and lower environmental impact. The section also assesses alternative scenarios, including the "no project" and "delayed project" options, both of which are considered unviable because of persistent energy challenges and economic drawbacks. Consequently, the "go-ahead" option is identified as the most beneficial, offering significant environmental, social, and economic advantages while aligning with national development and clean energy objectives.

ES 03: PROJECT DESCRIPTION

The Federal University Kashere (FUK), established in 2010 and operational since 2011, is located in Kashere, Akko Local Government Area, approximately 63 km from Gombe. The campus hosts six faculties with over 17,000 students and is predominantly residential and academic in character. Grid availability was severely constrained during the audit period (~40%), making FUK functionally off grid in practice. The existing generator fleet (1,930 kVA installed; ~1,235 kW firm de-rated) covers only approximately 32% of the 3.81 MW diversified peak — making the hybrid plant a structural necessity rather than an efficiency measure.

The project is expected to deliver significant socio-economic benefits, including improved healthcare services, sanitation, and reduced mortality rates. It will also enhance tertiary education through improved learning facilities and capacity building in renewable energy technology for staff and students. In addition, the project supports Nigeria's climate and clean energy commitments under the Paris Agreement and contributes to broader government initiatives such as the Nigeria Health Sector Renewal Investment Initiative (NHSRII) and the Nigeria Education Sector Renewal Initiative (NESRI), including the promotion of Science, Technology, Engineering, and Mathematics (STEM) education.

ES04: THE BASELINE ENVIRONMENT

The study adopted a multidisciplinary approach involving field sampling, stakeholder consultations, and literature review to assess the biophysical, socio-economic, and health conditions of the project area. Data were collected using standardized methods and equipment for air quality, noise, soil, vegetation, and wildlife assessments, supported by laboratory analysis and statistical evaluation. Quality assurance and control procedures were implemented throughout the study to ensure accuracy, reliability, and compliance with regulatory and international standards. Findings indicate that the project area lies within the Sudan savanna ecological zone, characterized by a tropical continental climate with average temperatures ranging from 30–40°C and annual rainfall of about 600–1,000 mm. Air quality results showed low concentrations of pollutants, with particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide (CO), sulphur dioxide (SO_2), and nitrogen dioxide (NO_2) remaining within permissible regulatory limits. Ambient noise levels ranged between 45–65 dB(A), which is within acceptable standards for residential and institutional environments. Soil analysis revealed predominantly sandy to loamy soils with moderate fertility, pH values ranging from 6.2–7.4, and heavy metal concentrations below regulatory thresholds. Vegetation was mainly composed of grasses, shrubs, and drought-resistant trees such as

acacia and baobab, while wildlife species observed were typical of savanna ecosystems, though some are under pressure from farming, grazing, and habitat degradation. Socio-economic findings showed that over 60% of residents depend on agriculture and informal trading as their primary sources of livelihood. The study area supports a large institutional and residential population, with a total staff population of 2,519, comprising 827 academic staff and 1,692 non-academic staff. The university also hosts a large daytime population of approximately 19,878 persons, including students and staff, while about 2,346 persons reside on campus, indicating a constant 24-hour electricity demand. Only 29 staff members reside on campus, suggesting that most employees commute daily and are indirectly affected by institutional power supply conditions during working hours. The population is largely young to middle-aged, with moderate literacy levels and access to healthcare and sanitation facilities. Although electricity infrastructure exists, supply is unreliable, with many households relying on generators and solar systems as alternative energy sources. Stakeholder consultations indicated strong community support for the proposed solar project, with expectations of improved electricity supply, job creation, and economic growth. However, the study recommends continuous environmental monitoring, enhanced stakeholder awareness, and targeted measures to address social concerns, including gender-based vulnerabilities, to ensure sustainable project implementation.

ES 05: Potential and Associated Impacts

This chapter assesses the potential environmental and social impacts of the proposed solar power plant throughout its lifecycle, including the pre-construction, construction, commissioning, operation, and decommissioning phases. The assessment applied a structured methodology involving impact identification, interaction matrix screening, and risk evaluation based on impact magnitude, duration, reversibility, and receptor sensitivity. The findings indicate that the project will generate significant environmental and socio-economic benefits, although some negative impacts may occur, particularly during construction and operation. Key positive impacts include improved electricity supply, reduced dependence on fossil fuels, lower greenhouse gas emissions, improved air quality, job creation, enhanced economic activities, and capacity building through a renewable energy training centre. The project is also expected to support improved educational outcomes and increased productivity within the host community. Potential adverse impacts identified during the construction phase include vegetation clearing, soil disturbance, dust emissions, increased noise levels, traffic congestion, occupational health and safety risks, and social concerns such as gender inequality and increased social vices. During operation, impacts are generally minor and include occupational hazards, limited waste generation including e-waste, and possible groundwater abstraction. Decommissioning activities may result in temporary environmental disturbances and loss of project-related employment opportunities.

ES06: Mitigation Measures Impacts

A comprehensive risk assessment matrix, as indicated in Figure 6.1, was used to determine the mitigation requirements for each of the impacts identified. The frequency, severity, sensitivity, scale, longevity, political, economic, legal, reputation/image, and communication/complaints factors were taken into consideration during these assessments. Based on the identified risks, appropriate mitigation measures were recommended, including dust suppression through regular water spraying, mandatory use of personal protective equipment (PPE) by workers, proper waste segregation and disposal practices, implementation of spill prevention and control measures, erosion and sediment control strategies, and effective traffic management to minimize congestion and ensure public and worker safety during project activities.

ES 07: Environmental and Social Management Plan

An Environmental and Social Management Plan (ESMP) comprises several interconnected components designed to manage environmental and social impacts throughout the project lifecycle. Key elements include mitigation measures to prevent, minimize, or compensate for identified impacts, supported by a monitoring plan that defines monitoring parameters, frequency, performance indicators, and responsible parties. The ESMP also establishes institutional arrangements that clarify the roles and responsibilities of project proponents, contractors, supervising agencies, and regulatory authorities to ensure accountability and effective implementation. In addition, the ESMP incorporates environmental and social management procedures such as occupational health and safety (OHS) guidelines, waste management systems, emergency response plans, stakeholder engagement strategies, and grievance redress mechanisms (GRM). It also provides capacity building and training, reporting and documentation systems, and a dedicated implementation budget covering mitigation, monitoring, training, and stakeholder activities. By integrating these requirements into project design and contractual agreements, the ESMP ensures compliance and provides a practical framework for sustainable environmental and social risk management.

ES 08: Stakeholder Engagement and the Grievance Redress Mechanism

Stakeholder engagement and the grievance redress mechanism (GRM) are key components of the ESIA process, ensuring transparency, inclusiveness, and effective communication throughout the project lifecycle. A Stakeholder Engagement Plan (SEP) was developed to guide consultations through meetings, interviews, and focus group discussions, with particular attention given to vulnerable groups. The engagement process enabled stakeholders to receive project information, review disclosed ESIA documents, and provide input that informed project planning and mitigation measures. Stakeholders generally expressed support for the project due to its potential to improve electricity supply, economic opportunities, and public services. However, concerns were raised regarding land acquisition, compensation, environmental impacts during construction, and local employment opportunities. Socio-economic assessments showed that host communities mainly depend on agriculture and small-scale trading, with limited access to reliable electricity, healthcare, and clean water. The project, therefore, aims to ensure equitable benefits, particularly for vulnerable groups such as women and low-income households. The chapter also highlights the Grievance Redress Mechanism (GRM), which provides a structured process for receiving, recording, and resolving complaints within defined timelines, including confidential procedures for sensitive issues such as gender-based violence. Overall, the ESIA for the proposed solar power plant at the Nigeria Police Academy confirms that the project aligns with Nigerian environmental regulations and the World Bank Environmental and Social Standards. An Environmental and Social Management Plan (ESMP) was developed to guide mitigation, monitoring, and compliance activities, with the Rural Electrification Agency responsible for implementation and regulatory compliance.

ES09: Conclusion and Recommendations

The study integrates environmental and social considerations into project planning and implementation in line with the Nigerian EIA Act and the World Bank Environmental and Social Standards. It supports informed decision-making and sustainable development through the early identification and management of potential environmental and socio-economic impacts. The assessment included stakeholder consultations, field surveys, data collection, and literature reviews to establish baseline environmental and social conditions and evaluate potential project impacts. Based on the findings, mitigation measures were developed using established health, safety, and environmental best practices. An Environmental and Social Management Plan (ESMP) was also prepared to guide mitigation implementation and monitor key environmental parameters such as air quality, noise, and groundwater. The Rural Electrification Agency will oversee compliance with regulatory requirements set by the Federal Ministry of Environment and the World Bank.

Key Recommendations

- Ensure full implementation of the Environmental and Social Management Plan (ESMP) throughout the project lifecycle.
- Conduct regular environmental monitoring for air quality, noise, groundwater, and waste management.
- Maintain continuous stakeholder engagement and effective community communication.
- Prioritize local employment, capacity building, and renewable energy training opportunities.
- Implement strong occupational health and safety measures, including emergency response systems.
- Establish and maintain an efficient Grievance Redress Mechanism (GRM) for the timely resolution of complaints.
- Promote proper waste management, including safe disposal of hazardous and electronic waste.
- Ensure compliance with regulatory requirements through continuous oversight by the Rural Electrification Agency and relevant authorities.

ACKNOWLEDGEMENTS

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CHAPTER ONE
INTRODUCTION

1.1 Background Information

The Federal Government of Nigeria partnered with the World Bank to launch the Distributed Access through Renewable Energy Scale-Up (DARES) Project, a $750 million initiative aimed at expanding electricity access to 17.5 million Nigerians in rural and underserved areas. This project builds on the success of the Nigeria Electrification Project (NEP), which has already provided clean and reliable electricity to over seven million people. The key project components are follows;

- Component 1: Solar Hybrid Mini Grids for Rural Economic Development: $410 million IDA commitment to deploy mini-grids for rural economic growth.

- Component 2: Stand-alone Solar Systems for Homes and MSMEs: $300 million IDA commitment to provide solar systems for households and micro, small, and medium-sized enterprises

- Component 3: Technical Assistance: $40 million IDA commitment for technical support and capacity building

The Rural Electrification Agency (REA) is implementing DARES through its existing Project Management Unit (PMU). The project has already shown significant progress, with over 200 mini grids delivered nationwide. REA has also signed grant agreements with eight renewable energy companies to deploy solar home systems and mini grids, aiming to electrify underserved communities and drive economic growth.

In compliance with the Environmental Impact Assessment Act 86 of 1992 (codified as EIA Act CAP E12 LFN2004) and other extant laws of the Federation of Nigeria, the proposed project is subject to the EIA process for informed decision-making and consideration.

1.2 The Applicant

The Rural Electrification Agency (REA) is a Nigerian government agency responsible for ensuring electricity reaches every part of the country. REA focuses on rural electrification projects, providing power solutions for on-grid and off-grid areas with an emphasis on renewable energy. As the Implementing Agency of the Federal Government of Nigeria, the team at REA is tasked with the electrification of rural and unserved communities across Nigeria. MISSION To provide access to reliable electric power supply for rural dwellers irrespective of where they live and what they do, in a way that would allow for a reasonable return on investment through an appropriate tariff that is economically responsive and supportive of the average rural customer. MANDATE - Promote Rural Electrification in the Country - Co-ordinate Rural Electrification Programs in the country - Administer the Rural Electrification Fund (REF) to promote, support, and provide rural electrification through Public and Private Sector Participation. The Abuja Office is located at No. 15 Constitution Avenue, Central Business District, FCT-Abuja.

1.3 Objectives of the EIA

The objectives of this ESIA report are:

- To provide necessary data/evidence that will form the Environmental Impact Statement (EIS) of the proposed installation activities.

- To establish the existing environmental condition/profile of areas that shall include a qualitative and quantitative description of the physical, chemical, biological, hydrological, and social environment of the project areas.
- To review the proposed activities, thereby identifying the potential impacts and associated effects of any hazards posed by the execution of the project.
- To recommend control measures to prevent and/or mitigate identified potential/associated adverse impacts of the installation activities.
- To develop and document a cost-effective Environmental Management Plan (EMP) that recommends plans and procedures to manage the consequences of the installation activities on the environment at different phases of the project.

1.4 Scope of the ESIA Study

- In line with the Terms of Reference (TOR), the scope of the ESIA study covers the following:
- Description of all actions/activities that will be carried out during the Project development and implementation.
- Review of applicable local and international laws, regulations, standards and industry codes that apply to the proposed Project.
- Desktop review of relevant documents pertaining to the Project and the environment where the Project would be located. These documents include the Nigerian Electrification Project (NEP) environmental and social management framework (ESMF), amongst others.
- Perimeter survey of the Project site, including development of survey maps.
- Field data gathering covering biophysical and socio-economic components of the Project's Area of Influence.
- Consultations with relevant stakeholders including government institutions, project-affected people, University management representatives,
- Impacts identification and evaluation, and development of appropriate and practicable mitigation measures and EMP.
- Laboratory analysis of field samples and data analysis and Report preparation and disclosure.

1.5 The Study Area

The Federal University of Kashere is located in Akko Local Government Area, Gombe State, Nigeria. Specifically, the university is situated in Kashere, a small city within the Pindiga administrative territory. Established in 2011 by the Goodluck Jonathan administration, the university aims to increase access to education and promote equity among Nigerian states.

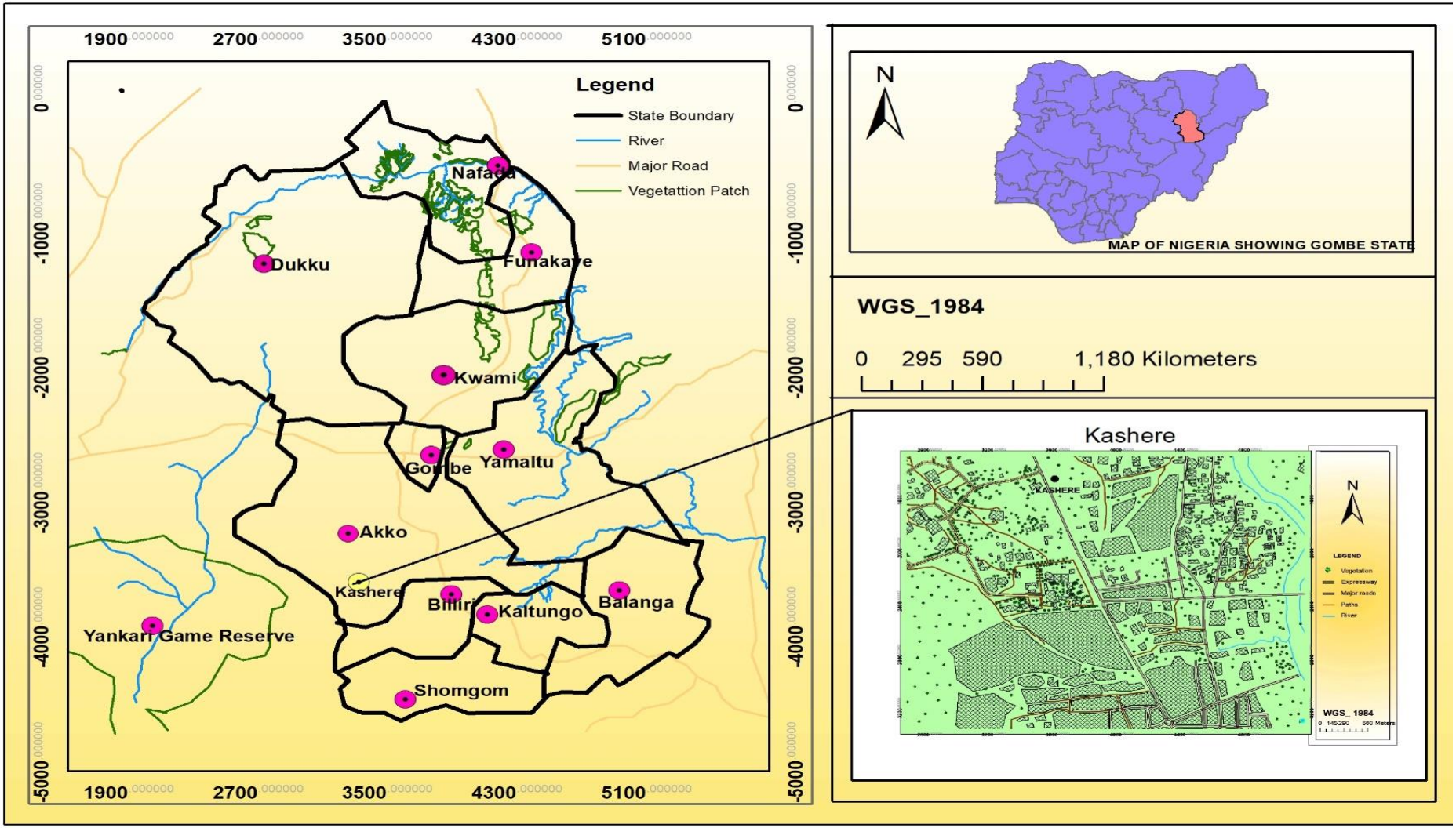

Figure 1: Map of Gombe State Showing Kashere

1.6. Study Approach/ Methodology

The ESIA methodology adopted a systematic and participatory approach, beginning with a reconnaissance survey to gain an understanding of site-specific conditions and potential environmental and social issues. This was complemented by a comprehensive desktop review of relevant project and programme documents to establish the regulatory, institutional, and technical context for the proposed intervention. A scoping study was conducted in consultation with the beneficiary university authorities and representatives of the host community to capture stakeholder perceptions of the project and to identify key environmental and social concerns. This engagement informed the focus of subsequent studies and ensured that locally relevant issues were adequately addressed. Field data collection was carried out to establish baseline environmental and social conditions at the proposed project sites. This included primary and secondary data gathering on noise levels, air quality, water quality, soil characteristics, ecology, and biodiversity. Samples obtained during field surveys were subjected to laboratory analysis to provide quantitative evidence for baseline conditions and impact prediction.

Based on the baseline data and stakeholder inputs, potential environmental and social risks and impacts associated with the project were identified and assessed. Appropriate mitigation and enhancement measures were then developed to address identified risks. These measures were consolidated into an Environmental and Social Management Plan (ESMP), which outlines specific actions, implementation timelines, and institutional responsibilities for managing impacts throughout the project lifecycle.

The ESIA process concluded with the compilation of the assessment report and the execution of required regulatory procedures, including disclosure of the ESIA report in line with national regulations and international best practice. The Federal Ministry of Environment (FMEnv) developed guidelines to be used by project proponents in conducting EIA, in compliance with the EIA Act. Accordingly, the ESIA process follows the steps sequentially as outlined in the procedural guideline indicated in Figure 1.2.

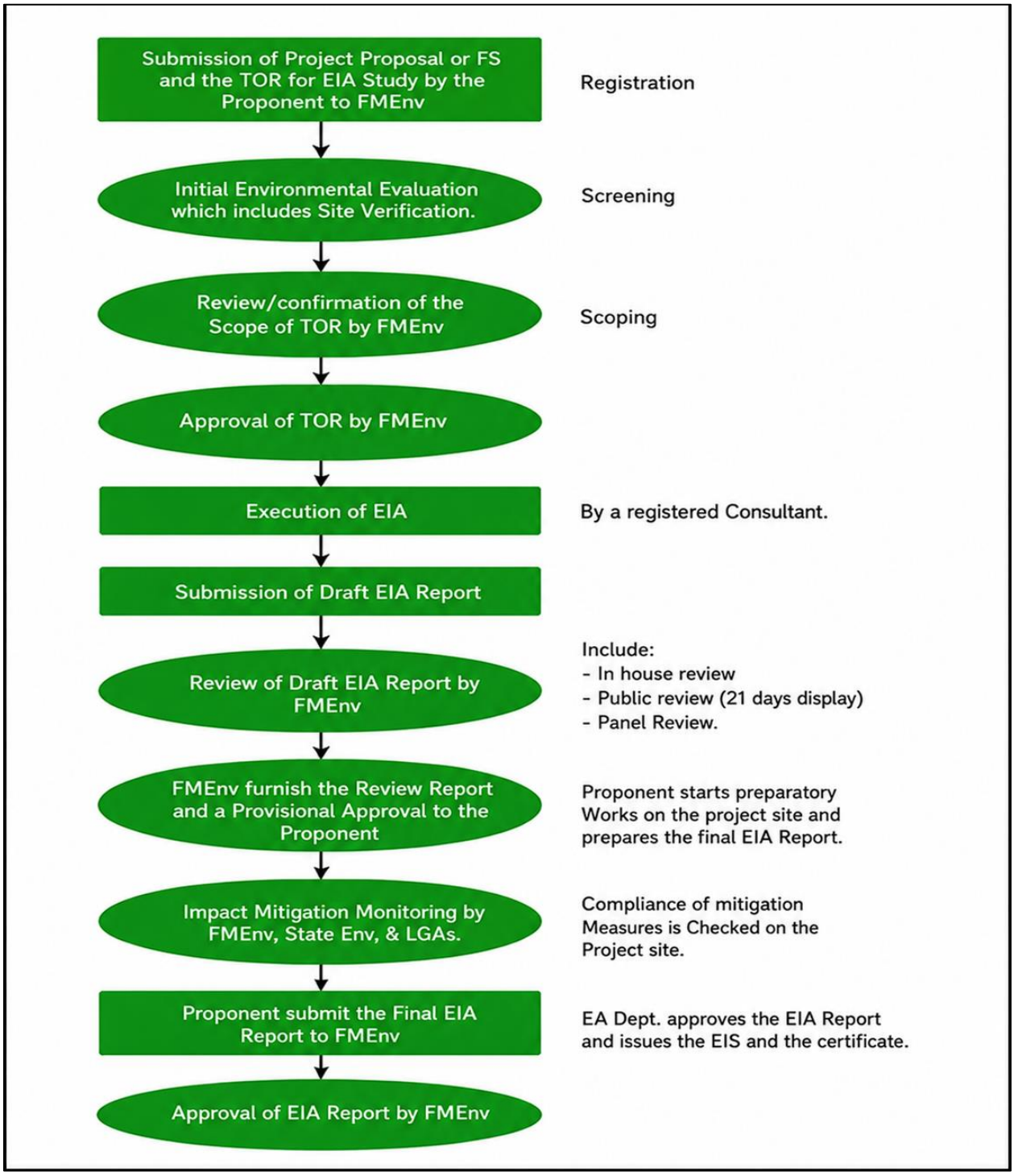

Figure 1.2: Federal Ministry of Environment Environmental Impact Assessment Process *(Source: Environmental assessment department, Federal Ministry of Environment)*

1.7 Limitations of the ESIA Study

This is not unusual - predicting environmental effects can be complex, and some factors might not be fully understood until the project is underway. To manage this uncertainty, a robust Environmental and Social Management Plan (ESMP) is in place. This plan will monitor the project's environmental and social performance throughout its lifecycle, allowing for adjustments as needed to mitigate any unexpected impacts.

1.8 Policy, Legal and Administrative Framework

The proposed Project is part of the Federal Government of Nigeria's Energizing Education Programme, a component of the Nigeria Electrification Project being implemented by the Rural Electrification Agency. Several laws and regulations apply to the energy sector in Nigeria. In addition to the above, several laws, regulations, policies, and instruments have been established to support environmental and social management and the EIA process in Nigeria. This section provides an overview of the relevant statutory regulations, legislation, and guidelines for the proposed Project and the ESIA study. The project shall ensure compliance with the relevant and applicable local and international regulations, policies, and standards throughout its life cycle.

1.8.1 FGN Requirements and Relevant Legislation

The Constitution of the Federal Republic of Nigeria (1999), as the national legal order, recognizes the importance of improving and protecting the environment and makes provision for it. The relevant sections are:

- **Section 20** makes it an objective of the Nigerian State to improve and protect the air, land, water, forest, and wildlife of Nigeria.
- **Section 12** establishes, though impliedly, that international treaties (including environmental treaties) ratified by the National Assembly should be implemented as law in Nigeria; and
- **Sections 33 and 34,** which guarantee fundamental human rights to life and human dignity, respectively, have also been argued to be linked to the need for a healthy and safe environment to give these rights effect.

1.8.2 Policy, Legal, and Institutional Framework

The Policy, Legal, and Institutional Framework guiding the Environmental and Social Impact Assessment (ESIA) for the proposed project is anchored on applicable national policies, laws, and institutional arrangements, as well as relevant international standards. At the national level, the framework is defined by the Federal Ministry of Environment (FMEnv**)** regulations, including the Environmental Impact Assessment Act Cap E12 LFN 2004, FMEnv Procedural Guidelines (2017), and other sectoral environmental, social, health, and safety regulations. The assessment also aligns with the objectives of the Nigeria Electrification Project and the Rural Electrification Agency's implementation framework. At the international level, the ESIA is guided by the African Development Bank Integrated Safeguards System, alongside international good practice such as the IFC Performance Standards and relevant ISO standards, ensuring that the project complies with both national regulatory requirements and global environmental and social sustainability benchmarks.

1.8.3 Policy Framework

1.8.3.1. National Environmental Policy/ National Policy on the Environment (Revised 2016) The national environmental policy launched by Government in November 1989 revised in 2016, prescribed guidelines for achieving sustainable development in fourteen vital sectors of the nation's economy, namely: Human Population; Land Use and Soil Conservation; Water Resources Management; Forestry, Wildlife and Protected Natural Areas; Marine and Coastal Area Resources; Sanitation and Waste Management; Toxic and Hazardous Substances; Mining and Mineral Resources; Agricultural Chemicals; Energy Production; Air Pollution; Noise in the Working Environment; Settlements; Recreational Spaces, Green Belts, Monuments, and Cultural Property.

It also contains Nigeria's commitment to ensure that the country's natural and built environment is safeguarded for the use of present and future generations. This commitment demands that efficient resource management and minimization of environmental impacts be the core requirements of all development activities. Accordingly, this Policy seeks to promote good environmental practices through environmental awareness and education. The goal of the National Policy on the Environment is to 'ensure environmental protection and the conservation of natural resources for sustainable development'. Its strategic objective is to coordinate environmental protection and natural resources conservation for sustainable development.

1.8.3.2 Social Protection Policies

Social protection policy has been on the agenda since 2004, when the National Planning Commission, supported by the international community, drafted a social protection strategy. More recently, the National Social Insurance Trust Fund (NSITF) drafted a social security strategy. The social protection policy approached social protection using a life cycle and gender lens, recognizing both economic and social risks, including, for example, job discrimination and harmful traditional practices. The policy was organised around four main themes: social assistance, social insurance, child protection and the labour market.

However, only a few of the instruments of this approach were adopted in the national implementation plan, most notably the provision of specific and limited social assistance, social insurance (such as expanding national health insurance to the informal sector) and labour market programmes (such as developing labour-intensive programmes). Moreover, in practice, programmes to date have been focused largely on conditional cash transfers and two health financing mechanisms driven by the federal government with little inter-sectoral or state-federal coordination. A significant number of actors are involved in funding and implementing social protection, including those from government, donors, international non-governmental organizations and civil society. Federal government-led social protection includes three main programmes:

i. the conditional cash transfer in Care of the People (COPE) (funded initially through the debt relief gains (DRG fund) targeted at households with specific social categories (those with children of school-going age that are female-headed or contain members who are elderly, physically challenged, or are fistula or HIV/ AIDS patients).

ii. the health fee waiver for pregnant women and children under five (financed through the debt relief gains (DRG fund); and

iii. the community-based health insurance scheme, which was redesigned in 2011 because the previous scheme had design challenges.

Other social assistance programmes are implemented in an ad hoc manner by various government ministries, departments and agencies at state level, and some are funded by international donors. These include conditional cash transfer programmes for girls' education (in three states), child savings accounts, disability grants, health waivers, education support (such as free uniforms) and nutrition support. HIV and AIDS programming at state level also include social protection sub-components (although not as the primary objective), including nutrition, health and education support. Labour market programmes include Federal and State level youth skills and employment programmes, and Nigeria also has agricultural subsidies/inputs.

1.8.3.3 National Policy on Climate Change/ National Climate Change Policy for Nigeria 2021-2030

Given Nigeria's status as a fossil-fuel dependent economy with a large climate sensitive agricultural sector, the development of a climate change policy and response strategy is critical, as climate change presents a serious threat to poverty eradication and sustainable development in general. One of the key pillars of Vision 20:2020 is investment in low-carbon fuels and renewable energy. Achieving the goal of low carbon, high-growth and resilient socio-economic system for equitable and sustainable socio-economic and environmental development faces some challenges which include stability and sustainability of the enabling environment, adequate institutional and human resource capacity and availability of adequate resources to address mitigation and adaptation initiatives to address climate change. Thus, the Government needs to ensure that economic growth, resource management and climate change mitigation and adaptation can all happen simultaneously if this will be done effectively (Department of Climate Change 2017).

The National Climate Change Policy for Nigeria 2021-2030 was established to promote a low-carbon, climate-resilient and gender-responsive sustainable socio-economic development. The revised National Policy on Climate Change was to define a new holistic framework to guide the country's response to the development challenge of climate change.

1.8.3.4 The National Electric Power Policy (NEPP), 2001

To ensure a safe, steady, reliable and progressively improved electric power sector in Nigeria, the Electric Power Reform Implementation Committee (EPIC) was inaugurated by the BPE and resulted in Federal Executive Council (FEC) of Nigeria approving the National Electric Power Policy in September 2001, which recommended, amongst others, the establishment of the electric power sector regulator and the privatization of the electric power sector. The National Electric Power Policy (NEPP), 2001 outlines the realization of an adequate and reliable supply of electricity in three phases - the privatization of the state-own utility NEPA and the introduction of the Independent Power Producers (IPPs); increasing the competition between market participants, partial removal of subsidies, and sale of excess power to distribution companies (DISCOs); and the freedom to select suppliers by large consumers and the creation of a fully liberalized and competitive market.

In 2004, the National Integrated Power Project (NIPP) was initiated to boost power supply by the launch of gas-powered stations. The National Electric Power Policy (NEPP) of 2001 resulted in the Electric Power Sector Reform (EPSRA) Act of 2005, establishing the Nigerian Electricity Regulatory Commission (NERC). The EPSRA provided the statutory basis for the privatization of the power sector.

1.8.3.5 The National Energy Policy (NEP) 2013

The National Energy Policy (NEP) 2013 is a revised version of the NEP 2003, emphasizes the effective and efficient use of energy and proposes major areas to be considered for energy efficiency and conservation including amongst others: transportation, services/commercial sector, and energy efficient building designs.

1.8.3.6 The National Energy Efficiency Action Plans of Nigeria

The first version of the National Energy Efficiency Action Plans (NEEAP) for Nigeria (2015 2030) was approved on July 14, 2016, by the National Council on Power (NACOP). It has been formulated within the framework of United Nations' Sustainable Energy for All (SE4All) and adopted by the Inter-Ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE). The NEEAP includes baseline data and information on energy efficiency activities and programmes in Nigeria, barriers to the development and promotion of energy efficiency in the country and suggested achievable energy efficiency targets, including gender disaggregated indicators, based on national potentials and socio-economic assessments. The implementation of the NEEAP is being monitored by the Federal Ministry of Power.

1.8.4 National Legal Framework

1.8.4.1 The Environmental Impact Assessment Act No. 86, 1992/Environmental Impact

Assessment Act Cap E12 LFN 2004

The EIA Act makes it mandatory for any person, authority, corporate body, private or public, to conduct EIA before the commencement of any new major development or expansion that may likely have significant effects on the environment. The Act sets out the EIA objectives and the procedures for the consideration of EIA of certain public or private projects. The programme is a minor development, which is expected to have minimal impact on the environment. Hence, the programme is categorized as Category II (B) EIA. The EIA guidelines (procedural and sectoral) issued by the FMEnv derive from this Act, and the programme proponents shall conduct their activities in conformance with these guidelines.

1.8.4.2 **Electricity Act 2023**

It is more accurate to refer to the Electricity Act 2023 as the replacement Act, rather than simply calling it an amendment to the EPSRA. The 2023 Act expressly repealed the EPSRA 2005 and established a more comprehensive framework governing generation, transmission, system operation, distribution, supply and trading of electricity, as well as consumer rights and renewable energy.

One of its most important changes is decentralisation. States can now establish and regulate their own intrastate electricity markets, while NERC continues to regulate matters involving interstate electricity, the national grid, transmission, system operation and other federally regulated activities.

1.8.4.3 Energy Commission of Nigeria Act CAP 109 LFN 1990

The Act was promulgated to create the Energy Commission of Nigeria (ECN) with responsibility for coordinating and general surveillance over the systematic development of the various energy resources of Nigeria. Subject to this Act, the ECN is charged with responsibility for the strategic planning and co-

ordination of national policies in the field of energy in all its ramifications. The mandates of ECN include statistical analysis of Electricity Generation, Transmission and Distribution.

1.8.4.4 Land Use Act of 1978 and Resettlement Procedures

The Land Use Act (Cap 202, 1990), now Cap L5 Laws of the Federation of Nigeria 2004, is the key legislation that has direct relevance to this project. Relevant sections of these laws that may relate to this project with respect to land ownership and property rights, resettlement and compensation are summarized in this section. The Land Use Act is the applicable law regarding ownership, transfer, acquisition and all such dealings on Land. The provisions of the Act vast on every parcel of Land, in every State of the Federation, in the Executive Governor of the State. He holds such parcels of land in trust for the people and government of the State.

The Act categorized the land in a State to urban and non-urban or local areas. The administration of the urban land is vested in the Governor, while the latter is vested in the Local Government Councils. At any rate, all land irrespective of the category belongs to the State while individuals only enjoy a right of occupancy as contained in the Certificate of Occupancy, or where the grants are "deemed".

The concept of ownership of land as known in the western context is varied by the Act. The Governor administers the land for the common good and benefits of all Nigerians. The law makes it lawful for the Governor to grant statutory rights of occupancy for all purposes, grant easements appurtenant to statutory rights of occupancy and to demand rent. The Statutory Rights of Occupancy are for a definite time (the limit is 99 years) and may be granted subject to the terms of any contract made between the state Governor and the Holder.

The Local Government Councils may grant customary rights of Occupancy for agriculture (including grazing and ancillary activities), residential and other purposes. But the limit of such grants is 500 hectares for agricultural purposes and 5,000 for grazing, except with the consent of the Governor. The local Government, under the Act is allowed to enter, use and occupy for public purposes any land within its jurisdiction that does not fall within an area compulsorily acquired by the Government of the Federation or of the relevant State, or subject to any laws relating to minerals or mineral oils.

The State is required to establish an administrative system for the revocation of the rights of occupancy and payment of compensation for the affected parties. So, the Land Use Act provides for the establishment of a Land Use and Allocation Committee in each State that determines disputes as to compensation payable for improvements on the land (Section 2 (2)
(c)).

In addition, each Local Government is required to set up a Land Allocation Advisory Committee to advise the Local Government on matters related to the management of land. The holder or occupier of such revoked land is entitled to the value of the unexhausted development as at the date of revocation. (Section 6) (5). Where land subject to customary rights of Occupancy and used for agricultural purposes is revoked under the Land Use Act, the local government can allocate alternative land for the same purposes (section 6) (6).

If Local Government refuses or neglects within a reasonable time to pay compensation to a holder or occupier, the Governor may proceed to effect assessment under section 29 and direct the Local Government to pay the amount of compensation to the holder or occupier. (Section 6) (7).

Where a right of occupancy is revoked on the ground that the land is required by the Local, State or Federal Government for public purposes or for the extraction of building materials, the holder and the occupier shall be entitled to compensation for the value at the date of revocation of their unexhausted improvements. Unexhausted improvement has been defined by the Act as:

> *"anything of any quality permanently attached to the land directly resulting from the expenditure of capital or labour by any occupier or any person acting on his behalf, and increasing the productive capacity the utility or the amenity thereof and includes buildings plantations of long-lived crops or trees, fencing walls, roads and irrigation or reclamation works, but does not include the result of ordinary cultivation other than growing produce*."

Developed Land is also defined in the generous manner under Section 50(1) as follows: land where there exists any physical improvement in road development services, water, electricity, drainage, building, structure or such improvements that may enhance the value of the land for industrial, agricultural or residential purposes.

It follows from the foregoing that compensation is not payable on vacant land on which there exist no physical improvements resulting from the expenditure on capital or labour. The compensation payable is the estimated value of the unexhausted improvements at the date of revocation.

Payment of such compensation to the holder and the occupier as suggested by the Act may appear confusing, as it raises the following question: Does it refer to the holder in physical occupation of the land or two different parties entitled to compensation, perhaps in equal shares?

The correct view appears to follow from the general tenor of the Act.
First, the presumption is more likely to be the owner of such unexhausted improvements. Secondly, the provision of section 6 (5) of the Act, which makes compensation payable to the holder and the occupier according to their respective interests, gives a pre-emptory directive as to who shall be entitled to what.

Again, the Act provides in section 30 that where any dispute arises as to the amount of compensation calculated in accordance with the provisions of section 29, such disputes shall be referred to by the appropriate Land Use and Allocation Committee. It is clear from section 47 (2) of the Act that no further appeal will arise from the decision of such a committee. If this is so, then the provision is not only retrospective but also conflicts with the fundamental principle of natural justice, which requires that a person should not be a judge in his own cause.

The Act must, in making this provision, have proceeded on the basis that the committee is a distinct body quite different from the Governor or the Local Government. It is submitted, however, that it will be difficult to persuade the public that this is so since the members of the committee are all appointees of the Governor. Where a right of occupancy is revoked for public purposes within the state of the

Federation, or on the grounds of the land for the extraction of building materials, the quantum of compensation shall be as follows:

- *In respect of the land, an amount equal to the rent, if any, paid by the occupier during the year in which the right of occupancy was revoked.*
- *In respect of the building, installation or improvements therein, for the amount of the replacement cost of the building, installation or improvements to be assessed based on the prescribed method of assessment as determined by the appropriate officer, less any depreciation, together with interest at the bank rate for delayed payment of compensation. With regards to reclamation works, the quantum of compensation is such cost as may be substantiated by documentary evidence and proof to the satisfaction of the appropriate officer.*
- *In respect of crops on land, the quantum of compensation is an amount equal to the value as prescribed and determined by the appropriate officer.*

Where the right of occupancy revoked is in respect of a part of a larger portion of land, compensation shall be computed in respect of the whole land for an amount equal in rent, if any, paid by the occupier during the year in which the right of occupancy was revoked less a proportionate amount calculated in relation to the area not affected by the revocation; and any interest payable shall be assessed and computed in the like manner.

Where there are any building installation or improvement or crops on the portion revoked, the quantum of compensation shall follow that outlined in paragraph (ii) above and any interest payable shall be computed in like manner.

1.8.4.5 The Nigerian Urban and Regional Planning Act CAP N138, LFN 2004

The Urban and Regional Planning Act is aimed at overseeing realistic, purposeful planning of the country to avoid overcrowding and poor environmental conditions. In this regard, the following sections are relevant:

- **Section 30 (3)** requires a building plan to be drawn by a registered architect or town planner.
- **Section 39 (7)** establishes that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community.
- **Section 59** makes it an offence to disobey a stop-work order. The punishment under this section is a fine not exceeding ₦10,000 (Ten thousand naira) and in the case of a company, a fine not exceeding ₦50,000.
- **Section 72** provides for the preservation and planting of trees for environmental conservation.

1.8.4.6 Harmful Waste (Special Criminal Provisions) ACT CAP H1, LFN 2004

The Harmful Waste Act prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria. The following sections are notable:

- **Section 6** provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.
- **Section 7** makes provision for the punishment accordingly, of any conniving, consenting or negligent officer where the offence is committed by a company.

• **Section 12** defines the civil liability of any offender. He would be liable to people who have suffered injury as a result of his offending act.

1.8.4.7 The Endangered Species Act, CAP E9, LFN 2004

This Act focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction because of overexploitation. These sections are noteworthy:

• **Section 1** prohibits, except under a valid license, hunting, capture or trade in animal species, either presently or likely, in danger of extinction.

• **Section 5** defines the liability of any offender under this Act.

• **Section 7** provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this Act.

•

Most of the proposed program locations are on virgin land that serves as wildlife habitats, which will be impacted by the programme. Hence, the programme activities shall be carried out to comply with the relevant provisions.

1.8.4.8 Inland Fisheries Act, Cap I10, LFN 2004

The Inland Fisheries focused on the protection of the water habitat and its species. The following section is relevant:

 Section 6 prohibits the taking or destruction of fish by harmful means. This offence is punishable with a fine of ₦3,000 or an imprisonment term of 2 years, or both. One of the integral components of solar hybrid systems is battery storage. During the operational phase of the project, there may be the possibility of battery leakages, which may leach into water bodies for project locations with flowing rivers. The chemical contents of these batteries are toxic to aquatic life (fisheries), which necessitates the relevance of this Act.

1.8.4.9 National Commission for Museums and Monuments Act

The Act provides for the dissolution of both the Antiquities Commission and the Federal Department of Antiquities and to create a National Commission for Museums and Monuments, with the responsibilities to establish and administer national museums, antiquities and monuments, including, antiquities, science and technology, warfare, African, Black and other antiquities, arts and crafts, architecture, natural history and educational services among others. Sections 12 to 18 provide the process/steps for the declaration of antiquities as national monuments, while section 19 deals with the restriction of excavations for the purpose of finding antiquities as well as the issuance of permits and section 20 deals with accidental discoveries. In case of any accidental find, the Commission shall be notified within seven (7) days.

1.8.4.10 The Factories Act, 1987 (Factory Act cap 126, LFN, 1990)

The Factories Act, as contained in the Laws of the Federation of Nigeria 1990, seeks to legislate and regulate the conduct of health and safety in the Nigerian work environment. It was enacted in June 1987 with the objective of protecting the workers and other professionals against exposure to occupational hazards. The Director of Factories at the Federal Ministry of Employment, Labour and Productivity is

responsible for the administration of the provisions or requirements of this Act. Section 13 allows an inspector to take emergency measures or request that emergency measures be taken by a person qualified to do so, in cases of pollution or nuisances. This Act deals with working conditions at work sites, including construction sites, such as those to be undertaken under the EEP III. Hence, the occupational requirements applicable to construction sites, as well as other work sites to be used by the program, shall be subject to the provisions of this Act.

1.8.4.11 Labour Act, Cap. L1, LFN 2004

This Act deals with labour issues, including payment of wages, recruitment, discipline, employee welfare, employment of women and child labour. Sections 54 to 58 which deal with employment of women, prescribed period of absence from work for nursing mothers and allows her half an hour twice a day during her working hours to attend to the baby for a period of up to six months after she resumes work. Section 55 also exempted women from night work, except when they are employed as nurses. Sections 59-64 deal with the employment of young adults.

1.8.4.12. Wages Boards and Industrial Councils Act, Cap. W1, LFN 2004

Wages Boards and Industrial Councils Act, Cap. W1, LFN 2004 – provides the legal framework for establishing wages boards and industrial councils to regulate wages and conditions of employment and promote orderly employer–employee relations in Nigeria.

The Act provides for the establishment of a National Wages Board and Area Minimum Wages Committee for States and for Joint Industrial Councils for particular industries. It empowers the Minister to order or direct that an industrial wages board be established to perform, in relation to the workers described in the order and their employers, the functions specified in the provisions of this Act, including the minimum wage. The minimum wage is currently ₦100,000.00 per month, and all individuals contracted/employed in relation to this programme shall not earn less than the minimum wage.

.*1.8.4.13.* Employees' Compensation Act, 2010

The Employees' Compensation Act, 2010 establishes a more comprehensive compensation scheme for employees who suffer work-related injuries, occupational diseases, disabilities or death arising out of or in the course of employment. It also provides benefits for dependants of deceased employees and is administered through the Nigeria Social Insurance Trust Fund (NSITF).

1.8.4.14 National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2007

Administered by the Ministry of Environment, the National Environment Standards and Regulations Enforcement Agency (NESREA) Act of 2007, replaced the Federal Environmental Protection Agency (FEPA) Act. It is the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources. The following sections are worth noting:

- **Section 7** provides authority to ensure compliance with environmental laws, local and international, on environmental sanitation and pollution prevention and control through monitoring and regulatory measures.

- **Section 8 (1)(K)** empowers the Agency to make and review regulations on air and water quality, effluent limitations, control of harmful substances, and other forms of environmental pollution and sanitation.
- **Section 27** prohibits, without lawful authority, the discharge of hazardous substances into the environment. This offence is punishable under this section, with a fine not exceeding 1,000,000 (One Million Naira) and an imprisonment term of 5 years. In the case of a company, there is an additional fine of ₦50,000 for every day the offence persists.

1.8.4.15 National Environmental Regulations:

Section 34 of the NESREA Act, 2007 empowers the Minister of Environment to make regulations for safe and sustainable environment. In exercise of this power, the minister issued the national environmental regulations covering various environmental components and sectors of development. The regulations relevant to the programme are as follows:

- National Environmental (Energy Sector) Regulations, 2014. S.I. 63.
- National Environmental (Electrical/Electronic Sector) Regulations, 2011, S.I. No. 23
- National Environmental (Wetlands, Riverbanks and Lake Shores) Regulations, 2009. S. I. No. 26.
- National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28.
- National Environmental (Watershed, Mountainous, Hilly and Catchment Areas) Regulations, 2009. S. I. No. 27.
- National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28.
- National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35.
- National Environmental (Air Quality Control) Regulations, 2013, S. I. No. 64,
- National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12.
- National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I. No. 22.
- National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2010. S. I. No. 20.

1.8.4.16. EIA Procedural Guidelines:

This procedure prescribes the steps to be followed in the EIA process from project conception to commissioning and post-commissioning impact mitigation, to ensure that the program is implemented with maximum consideration of environmental factors. This ESIA study will be conducted in compliance with this guideline.

1.8.4.17 EIA Sectorial Guidelines (Infrastructures):

This provides general guidelines for EIA of projects in the infrastructure sectors of Nigeria, with specific details for sub-sectors.

1.8.4.18. FMEnv ESMP Guidelines for Solar Mini-Grid Projects in Nigeria

The ESMP Guidelines for Solar Mini-Grid Projects in Nigeria was developed as an abridged form of the EIA Procedures Guidelines with the aim of simplifying the method of preparing ESMPs for proposed solar

mini-grid projects. The simplified method is to also optimise the mini-grid projects EIA timeline and the cost of development.

1.8.5 International Legislation

The International Conventions, to which Nigeria is a signatory, relevant to this programme are as follows:

- African Convention on the Conservation of Nature and Natural Resources
- Convention on Biological Diversity
- Endangered Species (Control of International Trade and Traffic)
- Conservation of Migratory Species of Wild Animals 1973
- Framework Convention on Climate Change 1992
- Convention to Combat Desertification 1994
- Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW)
- Human and Peoples' Rights on the Rights of Women in Africa 2005
- Civil and Political Rights Covenant
- Economic, Social and Cultural Rights Covenant
- Convention on the Elimination of All Forms of Violence Against Women
- Convention on the Rights of the Child

1.8.6 Institutional Framework

This section highlights the relevant institutions through which the planning and implementation of the program will be affected. Several institutions have been identified and will be involved in the overall implementation of this programme. These include:

- The Federal Government of Nigeria (FGN)
- Federal Ministry of Power
- Transmission Company of Nigeria (TCN)
- Federal Ministry of Environment (FMEnv)
- Nigerian Electricity Regulatory Commission (NERC)
- National Environmental Standards and Regulatory Enforcement Agency (NESREA)
- National University Commission (NUC)
- Relevant State Agencies: State Ministry of Lands, State Ministry of Environment and State Environmental Protection Agencies
- Local Government Authority (LGA)

The responsibilities and roles of each of the institutions are discussed below.

1.8.6.1 The Federal Government of Nigeria

Section 20 of the Constitution of Nigeria makes it an objective of the Nigerian State to improve and protect the air, land, water, forest and wildlife of Nigeria. Sections 33 and 34 which guarantee fundamental human rights to life and human dignity, respectively, can also be linked to the need for a healthy and safe environment to give these rights effect. The Executive Council of the Federation approves all national policies including the National Policy on Environment.

1.8.6.2 Federal Ministry of Environment

The Federal Ministry of Environment is responsible for the overall environmental policy of the country. It has the responsibility for EIA implementation, approval and issuance of certificates. It has developed certain guidelines and regulations to protect the environment and promote sustainable development. It will monitor the implementation of mitigation measures when the project commences. They can also issue directives to the project on specific actions related to the environment in the project area. The Ministry normally involves the states and sometimes local governments in this responsibility depending on the specific activity.

1.8.6.3 The National Environment Standards and Regulations Enforcement Agency (NESREA)

Ensures the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources are monitored and complied with. NESREA ensures that the operational phase of the solar power system minigrid project complies with national environmental standards and regulations.

1.8.6.4 The National Universities Commission

The National Universities Commission (the Commission) was established in 1974 by the National Universities Commission Act CAP N81 to advise the Federal and state governments of all aspects of university education and the general development of universities in Nigeria. It is the dynamic regulatory agency acting as a catalyst for positive change and innovation for the delivery of quality university education in Nigeria. It is also the agency for channeling all external aid to the universities in Nigeria; To receive block grants from the Federal Government and allocate them as appropriate.

1.8.6.5 The Federal Ministry of Power

The Federal Ministry of Power is the policy-making arm of the Federal Government with the responsibility for the provision of power in the country. The Ministry is guided by the provisions of the Electricity Act No 28 of 1988, the National Electric Power Policy, 2001, the Electric Power Sector Reform Act, 2005, the Roadmap for Power Sector Reform, 2010, and the National Energy Policy, 2013 as described earlier in section 1.6.4. The following parastatals are under the ministry: Energy Commission of Nigeria (ECN) Nigerian Electricity Regulatory Commission (NERC) Power Holding Company of Nigeria (PHCN) Rural Electrification Agency (REA). The responsibilities of the Federal Ministry of Power are as follows:

- Initiating and formulating broad policies and programmes on the development of the power sector Initiating concessions in the power sector Licensing of electrical contractors and electric generating sets of 1MW capacity and below
- Conducting investigation on electrical accidents and to ensure safety in the electricity industry in Nigeria
- Conducting statutory tests and certification of electric poles (concrete, wooden, steel etc.) and other major electrical materials before they are used on the grid and networks in Nigeria
- Implementing renewable energy programmes/ initiatives (solar, wind, biomass, small hydro etc.) Coordinating activities of the power sector
- Handling policy matters relating to research and development in the power sector

- Promoting the development of hydro power plants through public-private partnership (PPP), participating in bilateral and multilateral relations affecting the power sector
- Facilitating the overall coordination of the activities of the parastatals under their supervision

1.8.6.6 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency. NERC was established in 2005 as part of the economic reform agenda of the Obasanjo administration. The Electric Power Sector Reform Act of 2005 was the legislation that led to the establishment of NERC.

The Commission is required to carry out the following, amongst others:

i. Monitor and regulate the activities of the electricity industry in Nigeria.
ii. Issue licenses to market participants; and
iii. Ensure compliance with market rules and operating guidelines.

To create an enabling investment climate for rural electrification projects, NERC established the Mini-Grid Regulation in 2016; regulatory guidelines for mini-grids less than 100 kW and a light-handed regulation for mini-grids between 100 kW und 1 MW.

1.8.6.7 Transmission Company of Nigeria (TCN)

TCN emerged from the defunct National Electric Power Authority (NEPA) as a product of the merger of the Transmission and Operations sectors on April 1, 2004. TCN was incorporated in November 2005. Being one of the 18 unbundled Business Units under the Power Holding Company of Nigeria (PHCN), TCN was issued a transmission License on 1st July 2006. It was subsequently issued two licenses on June 10, 2013, for electricity transmission and system operations.

1.8.6.8 Rural Electrification Agency

The Rural Electrification Agency was set up by Section 88 of the Electric Power Sector Reform Act 2005 as the Implementing Agency of the FGN tasked with the electrification of rural and unserved communities. The mission is to provide access to a reliable electric power supply for rural dwellers irrespective of where they live and what they do, in a way that would allow for a reasonable return on investment through an appropriate tariff that is economically responsive and supportive of the average rural customer.

1.8.6.9 Federal Ministry of Women Affairs and Social Development

Promote actions to achieve the National Gender Policies and a gender budget among policymakers. The goals of the gender policy, among others, include:

- Eliminate cultural/religious gender-based biases and harmful cultural and religious practices which rise to inequalities in gender-role relations in Nigerian society. A culture that is amenable to development must be dynamic.
- Tap the potential of women for development.
- Eliminate all forms of gender-based violence.
- Ensure equal access to women, boys and girls to both formal and informal education. Women's education is a priority because it is the key to gender equity, justice, and poverty reduction,

improved skills and technological knowledge, as well as the general socioeconomic development of the nation.

1.8.6.10 State Institutions

Gombe State Ministry of Environment

The Ministry of Environment is currently responsible for environmental service matters and resources in the state. Other objectives include initiating formulation, execution, and monitoring of all issues relating to all environmental matters, solid waste management, and mineral resources. A recent law passed established the Gombe State Environmental Law 2021.

Gombe State Ministry of Women Affairs and Social Development

The ministry seeks to empower women and youth, promote the participation of women in governance, pay attention to women in rural areas, enhance the economic self-reliance of women, create awareness, and campaign against gender-based violence, etc.

Gombe State Lands and Survey

This Ministry was created for the purpose of overseeing the land resources in the state. They are also charged with the responsibility to plan, devise and implement the state policies on land and its resources.

1.8.7 Funding Agency Requirements

This programme is funded by the World Bank Therefore, the World Bank Environmental and Social safeguard Standards will be integrated in the project cycle as well as other national and international environmental and social protection requirements, to comply with the best international practices. Both the main environmental and social requirements that the project needs to comply with are described in the following sections.

1.8.7.1 The World Bank Environmental and Social Safeguard Standards

The World Bank policies on the environmental and social safeguard are the fulcrum of its support towards sustainable poverty reduction, particularly in developing countries. The policies aimed at preventing and mitigating undue harm to the people ESIA of the proposed Solar Hybrid Power Plant and Associated Infrastructure in Kashere. As indicated in Table 1.1, the compliance status of the proposed along the various phases are presented below.

Table 1.1: Compliance Matrix for the Power Project

1. Pre-Construction Phase

Aspect	Nigeria Legal Requirements	World Bank Standards Triggered	International Agreements	Key Compliance Actions
Environmental Assessment	EIA Act (Cap E12 LFN 2004)	ESS1: Assessment of Environmental & Social Risks	Paris Agreement	Conduct EIA/ESIA; obtain approval from the Federal Ministry of Environment
Land Acquisition	Land Use Act (1978)	ESS5: Land Acquisition & Resettlement	International Labour Organization (land & livelihood rights)	Secure land titles; compensate affected persons
Stakeholder Engagement	National environmental guidelines	ESS10: Stakeholder Engagement	Aarhus Convention (principles)	Public consultations; disclosure of project info
Biodiversity Screening	NESREA Act	ESS6: Biodiversity Conservation	Convention on Biological Diversity	Identify sensitive habitats; avoid critical areas
Permits & Licensing	NERC mini-grid regulation	ESS1 compliance	NA	Obtain generation/distribution permits

2. Construction Phase

Aspect	Nigeria Legal Requirements	World Bank Standards Triggered	International Agreements	Key Compliance Actions
Occupational Health & Safety	Factories Act; Labour Act	ESS2: Labor & Working Conditions	International Labour Organization conventions	Provide PPE; enforce safety procedures
Waste Management	NESREA Regulations	ESS3: Resource Efficiency & Pollution Prevention	Basel Convention	Proper disposal of hazardous waste (e.g., batteries)
Community Health & Safety	Public Health Act	ESS4: Community Health & Safety	WHO guidelines	Traffic management; site safety measures
Cultural Heritage	National Commission for Museums Act	ESS8: Cultural Heritage	UNESCO conventions	Chance finds procedures in place

3. Operation & Maintenance Phase

Aspect	Nigeria Legal Requirements	World Bank Standards Triggered	International Agreements	Key Compliance Actions
Energy Efficiency	National Energy Policy	ESS3: Resource Efficiency	Paris Agreement	Optimize system performance;
Waste (Batteries, Panels)	NESREA e-waste regulations	ESS3: Resource Efficiency	Basel Convention	Safe recycling/disposal systems
Labor Conditions	Labour Act	ESS2: Labor & Working Conditions	International Labour Organization	Fair wages, worker rights compliance

Community Relations	Local governance laws	ESS10: Stakeholder Engagement	NA	Maintain grievance redress mechanism
Safety & Risk Management	Nigerian Electricity Safety Code	ESS4: Community Health & Safety	NA	Routine inspection and maintenance

4. Decommissioning Phase

Aspect	Nigeria Legal Requirements	World Bank Standards Triggered	International Agreements	Key Compliance Actions
Environmental Restoration	EIA Act (closure requirements)	ESS1-Assessment of Environmental & Social Risks	Convention on Biological Diversity	Site rehabilitation and restoration
Waste Disposal	NESREA Regulations	ESS3: Resource Efficiency	Basel Convention	Dispose of solar panels, batteries safely
Worker Safety	Labour Act	ESS2: Labor & Working Conditions	International Labour Organization	Safe dismantling procedures
Asset Removal & Land Return	Land Use Act	ESS5: Land Acquisition & Resettlement	NA	Restore land to original or agreed condition

1.9 Institutional Arrangements for Environmental and Social Management

REA is responsible for selecting Engineering, Procurement and Construction (EPC) contractor (through competitive process) to build, operate and maintain the proposed power plant, and also build and equip the associated training center. The selected EPC will also be considered for a ten-year operation and maintenance (O&M) contract for the power plant. In the long run, the University will be responsible for operating and maintaining the Project. REA has established a Project Management Unit (PMU) which includes experienced Environmental and Social Safeguard Specialists. The REA-PMU will provide oversight functions for the management of potential environmental and social issues associated with the Project throughout its life cycle. The PMU, in conjunction with the University's Department of Works and Physical Planning, will monitor the hired contractor's E&S performance. The implementation of mitigation measures for potential environmental and social impacts associated with the Project (at various stages) will also be monitored by FMEnv, NESREA, Gombe State Ministry of Environment and other relevant regulatory agencies, as part of their statutory responsibilities. In addition, the World Bank will provide overall supervision, facilitation and coordination of the Project, and monitor Project performance indicators.

1.10. Report on the ESIA Structure

In line with the FMEnv guidelines, this report is structured as follows:

- Preliminary Sections: containing table of contents, lists of ESIA preparers, Executive Summary, amongst others.
- Chapter One: Introduction containing an overview of the proposed Project, the ESIA objectives and study approach, and applicable legal and administrative framework.
- Chapter Two: Project Location and Justification, containing a rationale for the proposed Project as well as the analysis of Project alternatives and development options.
- Chapter Three: Project Description containing the technical elements of the Project. It concisely describes the proposed Project and its geographic and temporal context, including the Project's associated infrastructure.
- Chapter Four: Description of the Environment. It details the baseline data that is relevant to decisions about the Project location, design, development, and operation.
- Chapter Five: Potential and Associated Impacts. This takes into account all relevant environmental and social risks and impacts of the proposed Project, including cumulative impacts.
- Chapter Six: Mitigation measures for the identified negative environmental and social impacts, as well as the enhancement measures for the identified positive impacts.
- Chapter Seven: is the ESMP. It summarizes the key environmental and social measures and actions, and the timeframe, including responsibility for the implementation of the recommended measures. Aso, discusses the decommissioning and remedial plan for the proposed project.
- Chapter Eight: describes the stakeholder engagement activities carried out during the ESIA and an overview of the grievance redress mechanism for the Project.
- Chapter Nine: Conclusion and Recommendations

The report also includes references and appendices.

CHAPTER TWO
PROJECT JUSTIFICATION

2.1 General

This chapter presents the justification for the proposed solar-hybrid power plant and associated infrastructure in the Federal University of Kashere State, as part of the Federal Government of Nigeria (FGN) proposed Nigeria Electrification Project Phase III under the Rural Electrification Agency. It also includes the description of alternatives and development options considered for the proposed Project.

2.2 Need for the Project

Federal Universities in Nigeria continue to experience serious electricity supply challenges despite being the preferred choice for many candidates seeking tertiary education. The University currently receives only about two hours of electricity daily from the national grid, resulting in a heavy dependence on diesel-powered generators. This situation has increased operational costs, maintenance demands, and environmental pollution, while also affecting teaching, research, and administrative activities.
To address these challenges, the Federal Government of Nigeria (FGN), through the Rural Electrification Agency (REA) and with support from the World Bank, is implementing the Nigeria Electrification Project (NEP). The project is designed to improve access to reliable and sustainable electricity through renewable energy solutions in underserved and off-grid areas.

Under the NEP, the Energizing Education Programme (EEP) aims to provide clean, stable, and dedicated power supply to selected Federal Universities and their affiliated Teaching Hospitals nationwide. The programme also aligns with Nigeria's climate commitments under the Paris Agreement by supporting the country's target of reducing carbon emissions by 20–30 percent by 2030.

The proposed intervention is expected to significantly improve the University's energy situation by reducing dependence on diesel generators and ensuring a more reliable power supply. Additional benefits of the project include the establishment of a renewable energy training centre to promote capacity building and professional certification, as well as the installation of solar-powered street lighting to improve campus security and create a safer and more conducive environment for learning and research.

2.3 Value of the Project

The Nigeria Electrification Project (NEP) is a major initiative by the Federal Government of Nigeria, implemented by the Rural Electrification Agency with support from the World Bank, to expand access to reliable electricity especially in underserved and off-grid communities. One of its key components is the Energizing Education Programme (EEP), which focuses specifically on providing sustainable power to federal universities and teaching hospitals.

The US $150 million sovereign loan facility approved by the World Bank is part of the broader NEP financing structure. Because it is a *sovereign loan*, it is borrowed directly by the Federal Government of Nigeria (not private entities), meaning the government is responsible for repayment. The funds are used to support large-scale electrification projects, including solar hybrid power systems, mini-grids, and infrastructure upgrades across educational institutions.

2.4 Project Benefits

The proposed Project is envisaged to have a range of associated benefits, since the importance of gaining access to reliable and steady power supply cannot be overemphasized. Some of the benefits are a function of the objectives of the Project, while others are a function of the way in which the Project is designed to meet its objectives.

- The potential benefits of the proposed Project include but are not necessarily limited to the following:

- Stimulation of academic and research activities within the University because of access to a constant and reliable power supply, thereby promoting educational advancement.

- Increase in social interactions within the University. There will be enhanced security in the University because of more streetlights for illumination, which would help deter opportunistic crimes and gender-based violence.
- Enhancement of learning in renewable energy leading to certification because of a training centre to be provided as part of the Project.
- Improvement in livelihood-enhancing activities within the University.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to the acquisition of new skills and the introduction of all manners of income-generating spill-over effects.
- Increase in local and regional economy through the award of contracts and the purchase of supplies for Project development.
- Increase in financial and technical collaborations between the FGN, the University, REA, World Bank, and other relevant Ministries, Departments, and Agencies (MDAs).

- Contributing to the Nigeria's NDC to cut carbon emissions by 20 % to 30 % by the year 2030, under the Paris Agreement.

2.5 Envisaged Sustainability

2.5.1 Technical Sustainability

The Project is an Energy-as-a-Service (EaaS) model, the same Energy Service Company (ESCO) responsible for the design and construction of the project will also manage its operations and maintenance (O&M) throughout the service period.

The design and construction phases will be supervised by qualified engineers from the REA and the University's Department of Works and Physical Planning to ensure compliance with technical specifications and quality standards. The EPC contractor will also develop standard operating manuals and relevant operational documentation for the Project.

In addition, adequate capacity-building and technical training will be provided to designated University personnel to support effective day-to-day operations and ensure the long-term technical sustainability of the project.

2.5.2 Environmental Sustainability

The project aligns with the Federal Government of Nigeria's (FGN) commitment to minimizing greenhouse gas (GHG) emissions as part of its broader climate change mitigation and adaptation agenda. According to the World Resources Institute Climate Analysis Indicators Tool (WRI CAIT), Nigeria's GHG emissions increased by approximately 25 percent between 1990 and 2014, representing an average annual growth of about 1 percent, while Gross Domestic Product (GDP) expanded by about 245 percent over the same period, averaging 5.5 percent annually. Although economic growth outpaced emissions growth, Nigeria's emissions intensity remained high; in 2014, GHG emissions relative to GDP were about 1.6 times the global average, highlighting significant opportunities for improvement (USAID, 2019). Consequently, the promotion and adoption of renewable energy for electricity generation, a critical driver of sustainable development, has become a central policy priority of the FGN.

Furthermore, the establishment of the Rural Electrification Agency Project Management Unit (REA-PMU), which comprises experienced Environmental and Social Safeguards Specialists, provides institutional capacity for effective oversight and environmentally responsible implementation of the project. In addition, the conduct of this ESIA at an early stage of project development, together with the commitment to implement the recommended mitigation measures and the Environmental and Social Management Plan (ESMP), demonstrates a proactive approach to preventing, minimizing, and managing potential environmental and social risks. Collectively, these measures are designed to ensure the long-term environmental sustainability of the project

2.5.3 Economic Sustainability

The Proposed Nigeria Electrification Project (NEP), implemented by the Rural Electrification Agency (REA) with financing support from the World Bank (WB), is designed to be economically sustainable in both the short and long term through prudent project design, cost efficiency, and strong institutional arrangements.

At the project level, the deployment of solar-hybrid mini-grid systems significantly reduces dependence on diesel generators, which are characterized by high fuel, transportation, and maintenance costs. By substituting diesel-based generation with solar energy, the project delivers substantial savings in operational expenditure over its lifecycle. While initial capital investment in renewable energy infrastructure is relatively high, the long lifespan of solar PV systems and declining technology costs ensure lower levelized cost of electricity (LCOE) over time, making the systems economically competitive and financially viable.

The project also enhances institutional financial sustainability for beneficiary Federal Universities. Reliable and predictable electricity supply reduces recurrent spending on diesel procurement and generator maintenance, allowing institutions to reallocate limited financial resources toward core academic, research, and healthcare functions. Improved power availability also minimizes disruptions to academic calendars and research activities, indirectly strengthening institutional productivity and value for money.

From a macroeconomic perspective, the project supports Nigeria's broader economic sustainability objectives by reducing fossil fuel consumption, lowering foreign exchange expenditure on imported diesel, and contributing to energy security. Local content participation in system installation, operation, and maintenance further stimulates job creation and skills development, supporting local economies and reducing long-term reliance on external technical expertise.

The project's financing structure, based on concessional loans and development partner support, enhances affordability and reduces fiscal pressure on the Federal Government. WB's involvement ensures robust financial appraisal, risk management, and compliance with international best practice, while the phased implementation approach allows lessons learned to be integrated into subsequent deployments, improving cost efficiency and performance.

In addition, the inclusion of capacity-building components, such as renewable energy training centres and skills transfer to local technicians, strengthens long-term economic sustainability by ensuring that system operation and maintenance can be managed locally at lower cost. This reduces downtime, extends asset life, and protects the value of the investment.

Overall, the economic sustainability of the Proposed Nigeria Electrification Project Phase II is underpinned by reduced operating costs, efficient use of public resources, long-term financial savings for beneficiary institutions, and positive spill-over effects on local and national economies. When combined with its environmental and social benefits, the project represents a cost-effective and sustainable investment that supports Nigeria's development goals and clean energy transition

2.5.4 Social Sustainability

Stakeholder consultation was undertaken as an integral part of the ESIA process to ensure that all relevant stakeholders were allowed to contribute to the Project at an early stage of development. This engagement process also helped to establish a strong foundation for building and maintaining positive relationships with stakeholders. The initial stakeholder engagement activities conducted during the ESIA are documented and presented in this report.

To ensure sustained and structured engagement throughout the Project lifecycle, a Stakeholder Engagement Plan (SEP) will be developed and implemented. In addition, the Rural Electrification Agency (REA) has established a Grievance Redress Mechanism (GRM) for the Project. The GRM provides a clear and accessible communication channel through which stakeholders can submit complaints or concerns related to the Project, and it ensures that such grievances are addressed in a timely and effective manner. Comprehensive details of the stakeholder consultations conducted to date for the proposed Project are provided in Chapter 9 of this report.

2.6 Site / Project Selection

2.6.1 Alternatives

The selection of this site was guided by several key considerations, including: (i) the absence of rocky outcrops that could hinder the installation of solar panels; (ii) the lack of ecologically sensitive areas or cultural heritage resources within and around the site; (iii) good accessibility through the existing internal

road network; (iv) the feasibility of achieving a direct connection to the existing switchyard; and (v) enhanced security within the campus environment.

Furthermore, the survey revealed the following key findings:

1. Topography: The site is predominantly gently undulating with a spur in the near right middle with which gave two general slopes towards east and west. The eastern slope is steeper than that of the western side, which is gentler. The maximum and minimum elevations are found to be 402.404 m and 394.339 m, respectively. The difference between the highest and lowest points on the site is approximately 8.065 meters. This natural slope is favorable for drainage.
2. Site Area: The total area within the surveyed perimeter is approximately 7.062 Hectares (70618.91 sq meters).
3. Vegetation: The site is covered by farmland with a few mature trees (about 12 in number).
4. Obstructions: There are no seasonal streams, existing footpaths / overhead low-voltage power lines that traverse the site. However, a small rocky outcrop was also identified in the east-central area of the project site.
5. Accessibility: The site is accessible via an existing tarred road that runs parallel to the eastern and northern sides of the site. Furthermore, there is a provision of a road from the western side; also, the site can be accessed between buildings from the southern side.
6. Shading Analysis: The preliminary data confirms no significant nearby structures or hills that would cause substantial shading on the proposed array.

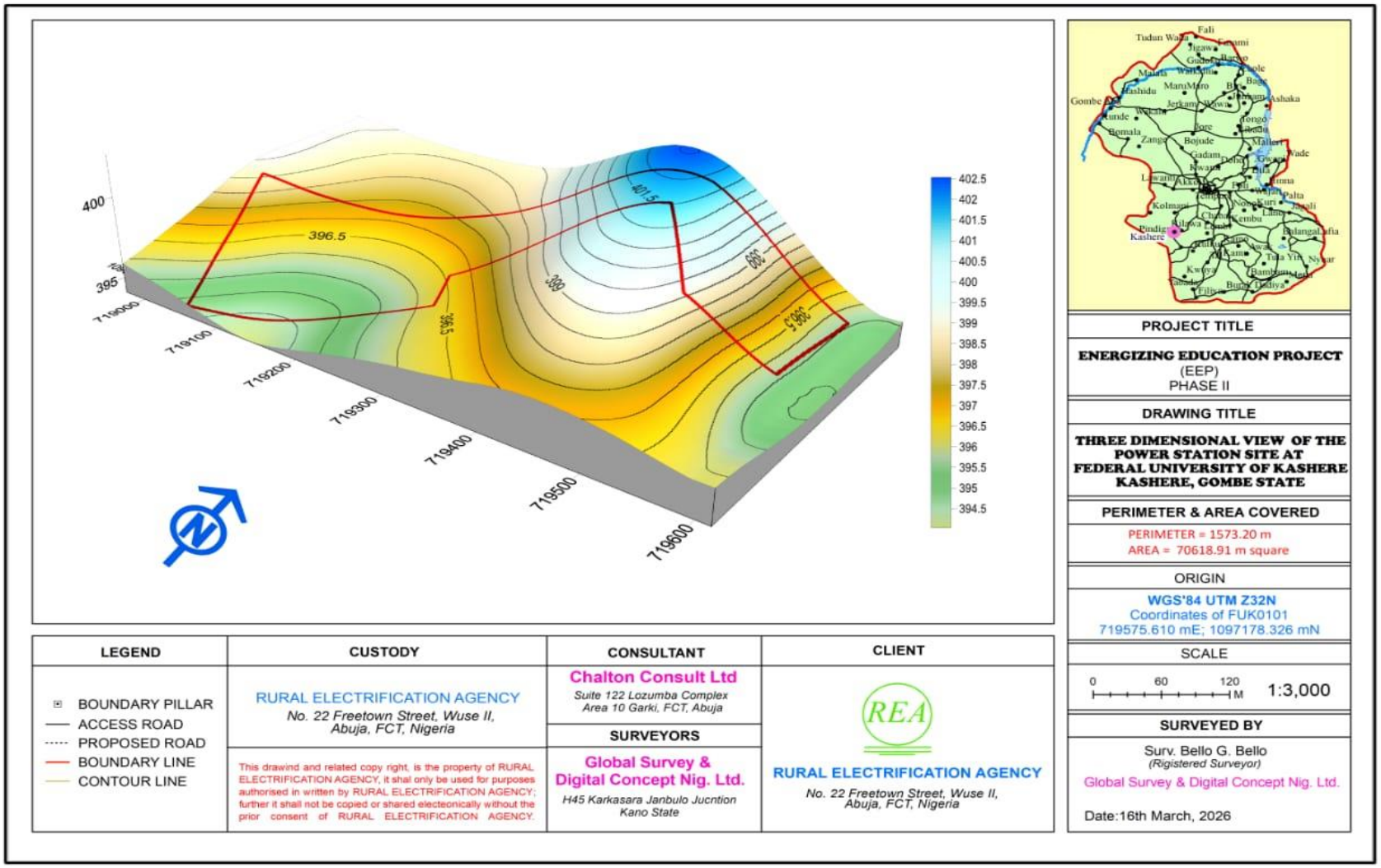

Figure 2.1: Topo map of the Selected Site

2.6.2 Alternatives Considered within the Context of the Proposed Solar-Hybrid Power Plant

The power plant to be provided as part of the proposed Project in Kashere has been conceptualized as a renewable energy source (solar technology) since that is part of the objectives of the EEP initiative (i.e. carbon emission reduction). Thus, this section specifically focuses on the alternatives considered within the proposed solar-hybrid power plant and eliminates discussion on other possible sources of power generation in Nigeria such as the use of natural gas-fired power plants, coal-fired plant, oil-fuel plant, etc.

2.6.2.1 Overview

Solar power generation is currently one of the fastest-growing areas in renewable energy. Beyond panel production, it does not emit any significant GHGs. Compared to alternative renewable generation technologies such as wind turbines or biofuel generators, solar energy is produced by converting the sun's radiation – a process void of any smoke, gas, or other chemical by-product, which makes this technology to meet the clean development mechanism of the Kyoto Protocol. This is the main driving force behind all green energy technology, as nations attempt to meet climate change obligations in curbing emissions.

The use of solar energy for the proposed power plant in Kashere will significantly avoid the generation of GHG emissions associated with fossil-fuel power plants. Thus, the proposed Project will help contribute to Nigeria's NDC on climate change. In addition, the high solar irradiation in Yobe State (as indicated in Figure 2.1) will be able to support the proposed power plant.

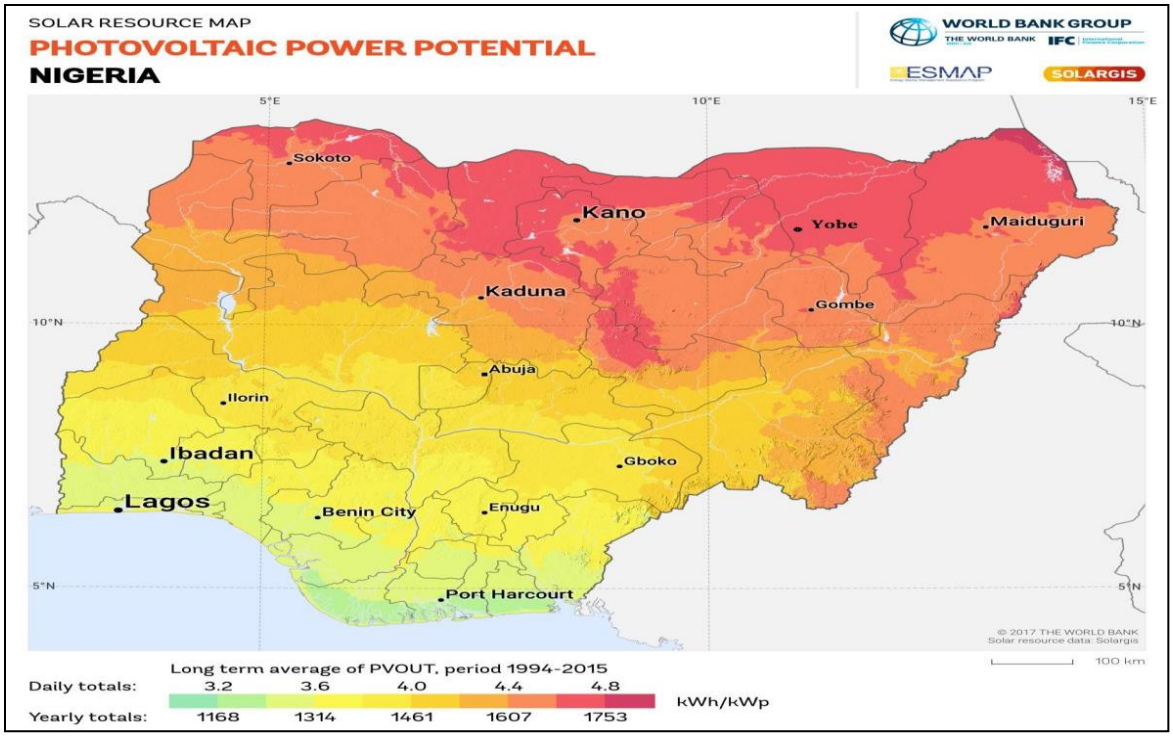

Figure 2.2: Photovoltaic power potential of Nigeria Source: © 2017 The World Bank, Solar resource data: Solargis

2.6.2.2 Solar Power Technology Alternatives

The solar technologies considered for the proposed power plant in FUK are:
For most modern solar projects, Monocrystalline PV panel design is generally considered the best option because it offers:

- Higher efficiency (more power generation per square meter)
- Better performance in low-light conditions
- Longer lifespan (typically 25+ years)
- Lower space requirement
- Better aesthetic appearance

Table 2.1: Common PV Panel Types

Type	Efficiency	Cost	Performance	Best Use
Monocrystalline	High (18–24%)	Higher	Excellent	Commercial and institutional projects
Polycrystalline	Moderate (15–18%)	Moderate	Good	Budget-sensitive projects
Thin-Film	Lower (10–13%)	Lower	Fair	Large open areas with low structural load

Recommended Design

For a university or institutional solar project with continuous electricity demand, a grid-connected monocrystalline PV system with battery backup is usually the most suitable because it provides:

- Reliable power supply
- Reduced dependence on generators
- Higher energy output
- Lower long-term operating costs

2.6.3 Battery Types Alternative

The proposed solar-hybrid power plant in Kashere is an off-grid system, which will involve the storage of power. The batteries for the proposed power plant would be required to meet the demands of heavy cycling (charging and discharging) and irregular full recharging. Table 2.2 presents battery types and alternatives for the proposed project.

Table 2.2: ***Battery Types Alternative***

Battery Type	Technology Description	Advantages	Disadvantages	Lifespan	Maintenance Requirement	Suitability for Solar Hybrid Station
Lithium-ion Battery	Rechargeable battery with high energy density	High efficiency, fast charging, compact size, long lifespan	High initial cost, requires BMS	10–15 years	Low	Excellent for commercial and institutional systems
Lithium Iron Phosphate Battery	Advanced lithium battery with improved safety and stability	Very safe, long cycle life, high efficiency, heat tolerant	Higher upfront investment	10–15 years	Low	Highly recommended solar hybrid stations
Lead-acid Battery	Traditional rechargeable battery technology	Low cost, widely available	Short lifespan, low efficiency, regular maintenance required	3–5 years	High	Suitable for small or low-budget systems
Gel Battery	Sealed lead-acid battery using gel electrolyte	Maintenance-free, spill-resistant	Lower charging speed, moderate lifespan	5–7 years	Low	Suitable for medium-scale installations
Absorbent Glass Mat Battery	Sealed battery using absorbent glass mat separator	Reliable, maintenance-free, moderate cost	Shorter lifespan than lithium batteries	4–7 years	Low	Good for backup and moderate storage applications

Lithium-ion Battery is recommended for the following reasons: High efficiency, fast charging, compact size, long lifespan

2.7 Project Options

2.7.1 No Project Option

One of the reasons for the proposed Project in Kashere is that the current demand for electricity in the University significantly exceeds generation/supply and, and that the current power supply through the grid is unreliable and suffers interruptions. If the Project does not go ahead, access to a reliable, safe, and cheaper power supply may be difficult to realize. In addition, the potential benefits associated with the Project would not be realized. Furthermore, the no project option would mean that the University will continue to significantly rely on diesel-fuel generators for self-generation of power, considering the current situation of electricity supply to the University through the grid. This has serious economic implications for the University and would not also be in line with the FGN's efforts in achieving its carbon emission targets. Thus, the No Project option is not considered a viable option to adopt.

2.7.2 Delayed Option

Adopting the option of delaying the proposed Project would mean postponing its implementation to an indefinite future date. Such an approach is typically considered only under unfavorable circumstances, including periods of political instability, conflict, strong stakeholder opposition, or adverse economic conditions that could hinder the successful execution of the Project. However, none of these limiting conditions exist in relation to the proposed development. On the contrary, the current political and economic climate is supportive of the Project, making this an appropriate time for implementation. Delaying the Project would therefore undermine the extensive preparatory activities already undertaken, including the time, resources, and financial commitments invested in planning and feasibility studies. Furthermore, postponement could expose the Project to inflationary pressures and fluctuations in the cost of materials, labour, and equipment, thereby increasing the overall project cost beyond current estimates. Such increases may negatively affect the long-term economic viability and anticipated benefits of the Project. In view of these considerations, the delayed implementation option is regarded as impractical and unsuitable for the Project.

2.7.3 Go Ahead Option

Allowing the Project to proceed as planned offers multiple and far-reaching benefits. These include improvements in the quality of education, enhanced capacity for research and innovation, expanded training opportunities, and improved security within the University campus. The Project will also provide a reliable power supply, resulting in higher energy output, reduced dependence on generators, and lower long-term operating costs, thereby ensuring a more efficient and sustainable energy system for the University. In addition, the Project will create employment opportunities for Nigerian professionals as well as skilled and semi-skilled craftsmen during both the construction and operational phases.

CHAPTER THREE
PROJECT DESCRIPTION

3.1 Background and Rationale of the Project

The Nigeria Distributed Access through Renewable Energy Scale-Up (DARES) Project is aimed at addressing the persistent electricity deficit in rural and underserved communities across Nigeria. Although the Nigeria Electrification Project (NEP) improved access to electricity through mini-grids and standalone solar systems, millions of Nigerians still lack reliable and affordable power supply.

The project seeks to expand the deployment of decentralized renewable energy solutions by building on the successes recorded under the NEP. It also aims to overcome financing and market barriers that have limited private sector participation in the off-grid energy sector through innovative funding and risk reduction mechanisms.

In addition, the DARES Project supports Nigeria's development and climate goals by promoting clean energy access, reducing greenhouse gas emissions, and contributing to sustainable economic growth and the country's energy transition agenda.

3.2 Project Location

3.2.1 Description of the Project Area of Influence

The proposed project site is located within the main campus of the Federal University of Kashere, situated in Akko Local Government Area of Gombe State, North-Eastern Nigeria. The University campus lies within a strategic educational corridor and is easily accessible through the Gombe–Bauchi highway network. Figure 3.1 illustrates the location of Gombe State within Nigeria as well as the position of the project site within the University campus.

Geographically, the project area falls within the approximate coordinates of Latitude 9°54'41" N to 9°55'55" N and Longitude 10°59'13" E to 11°00'34" E. These coordinates place the site within the Sudan Savannah ecological zone, which is characterized by high solar radiation intensity and favorable climatic conditions for solar photovoltaic energy generation. The area experiences long hours of sunshine throughout most of the year, making it highly suitable for the proposed solar power development.

The specific location earmarked for the solar farm consists of an open and largely undeveloped parcel of land situated behind the Faculty of Education, Faculty of Agricultural Sciences, and the School of Remedial Studies buildings. The selected site is presently free from major structural developments and dense vegetation, thereby minimizing the need for extensive site clearance activities prior to construction.

The choice of the site was informed by several technical and environmental considerations. Firstly, the area has minimal shading from surrounding structures and trees, which is essential for maximizing solar energy capture and improving the efficiency of photovoltaic panels. Secondly, the terrain is relatively flat and stable, reducing the need for significant earthworks and facilitating easier installation of solar infrastructure. In addition, the proximity of the site to the University's existing electricity distribution network makes grid integration more practical and cost-effective, while also reducing transmission losses.

Furthermore, the location provides adequate space for future expansion of the solar facility and associated infrastructure such as battery storage systems, inverter stations, control rooms, and maintenance access routes. The site's position within the University environment also enhances security and ease of monitoring during both the construction and operational phases of the project. Overall, the selected location is considered technically feasible, environmentally suitable, and strategically positioned to support the successful implementation of the proposed solar energy project.

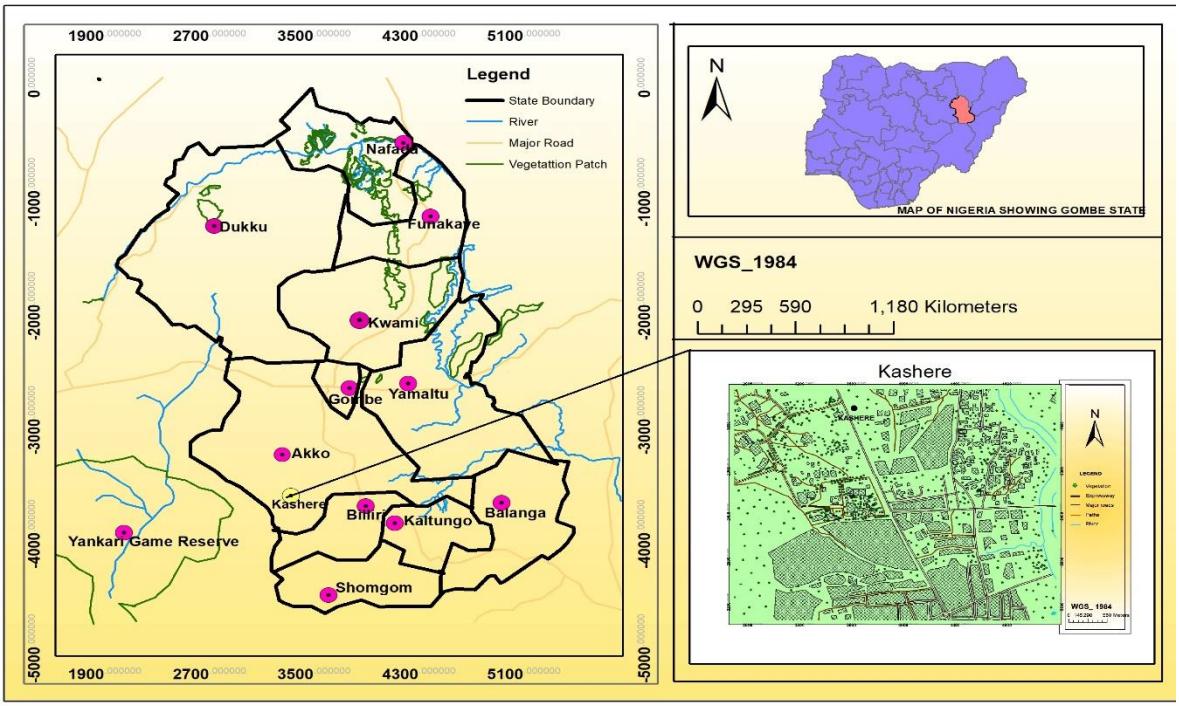

Figure 3.1: Administrative Map of Gombe State Showing the Project Area

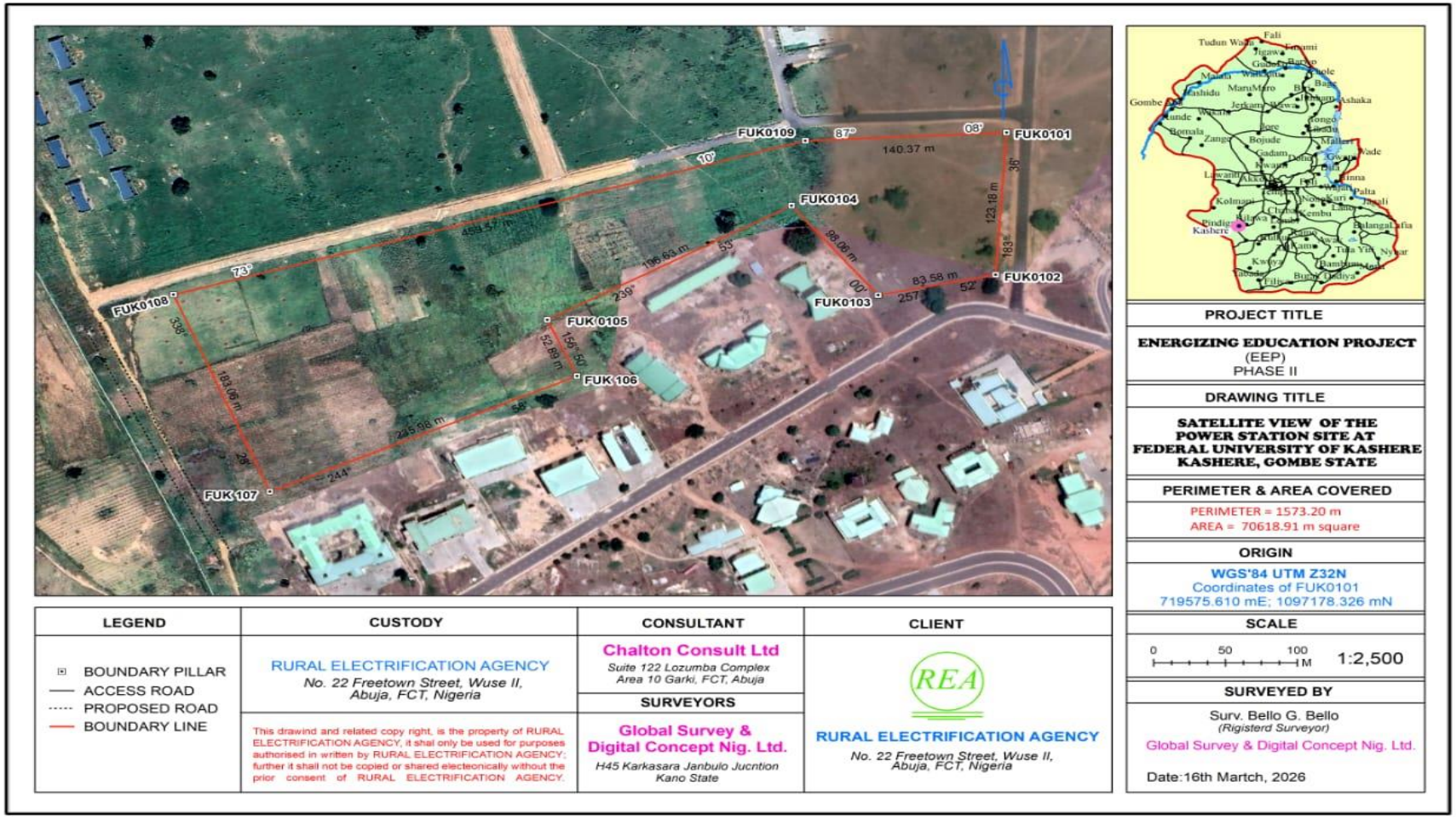

Figure 3.2: Site Aerial Overview

3.3 Project Components

As previously stated, the scope of the EEP includes the provision of an independent power plant, rehabilitation of existing electricity distribution infrastructure, provision of street lighting as well as a renewable energy training centre. However, the Front-End Engineering Design (FEED) for the project is ongoing as at the time of this ESIA study. Therefore, the specifications and number of some of the components to be installed for the proposed project are yet to be finalized. Each of these components relating to the Kashere solar hybrid power project are discussed below.

3.3.1 Proposed Solar-Hybrid Power Plant

Monocrystalline PV Panel Design

A monocrystalline PV panel design consists of several essential components that work together to convert solar energy into usable electricity efficiently and reliably. The primary component is the Photovoltaic Cell, made from high-purity monocrystalline silicon, which converts sunlight into direct current (DC) electricity through the photovoltaic effect. These cells are arranged in series and parallel configurations within the panel to achieve the required voltage and power output.

Tempered Glass Cover and Encapsulation

The solar cells are protected by a tempered glass cover, which shields the panel from environmental conditions such as rain, dust, wind, and physical impact while allowing maximum sunlight transmission. Beneath the glass is an encapsulant layer, commonly made of Ethylene Vinyl Acetate (EVA), which cushions and secures the cells in place. A protective backsheet is installed at the rear of the panel to provide electrical insulation and protect the internal components from moisture and environmental degradation.

Aluminum Frame and Junction Box

An aluminum frame surrounds the panel to provide structural strength and facilitate mounting onto support structures. At the back of the panel is a junction box containing electrical connections and bypass diodes, which help reduce power losses and prevent overheating during partial shading conditions. DC cables and connectors are used to transmit the generated electricity from the panels to other system components.

Mounting Structure and Inverter

The mounting or racking structure is another critical component of the PV system design. It supports the panels at the optimum tilt angle and orientation to maximize solar energy capture while ensuring stability against wind and other environmental loads. For hybrid solar systems, the design also includes an Inverter, which converts the DC electricity produced by the panels into alternating current (AC) suitable for use by electrical appliances and grid integration.

Battery Storage and Safety Components

Additional components include a battery storage system for storing excess energy, a charge controller to regulate battery charging and prevent overcharging or deep discharge, and combiner boxes that consolidate power from multiple PV strings. The system also incorporates earthing and lightning protection measures to ensure electrical safety, as well as monitoring systems that track energy generation, system performance, and operational efficiency.

Provision of Street Lighting

As part of the proposed project, Streetlights will be installed (where required) to ensure that different areas within the campus are well illuminated.

Renewable Energy Training Centre

Students from the campus will be allowed to access the Project site for learning and training purposes. The training center will also include a storage room, a workshop and toilet facilities.

3.4 Engineering Codes and Standards

The Project components shall be designed and installed in compliance with the relevant codes and standards of the British Standard-Europe Norms (BS–EN), the International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), and the Standard Organization of Nigeria (SON). Examples of the relevant codes and standards include ISO 15673:2005 "Guidelines for the simplified design of structural reinforced concrete for buildings" and BS EN 60529:2013 "Degree of Protection by Enclosures (IP Code)", amongst others.

3.5 Project Implementation Phase

3.5.1 Pre-construction Phase Activities

Following the completion of engineering design for the Project and receipt of relevant approvals, the major activities during this phase include site clearing and preparation, and mobilization of equipment, materials and personnel to site. Clearing will involve removal of existing vegetation from the site and preparing a level working surface in readiness for construction activities.

3.5.2 Construction Phase Activities

The construction phase of the Project will include civil, mechanical and electrical works; installation of PV panels and associated plant facilities; construction of a training centre; installation of streetlights as well as underground armoured cable for power evacuation. Also, where required, an upgrade of some of the existing power distribution infrastructure within the University will be carried out.

It is envisaged that approximately 300 people would be required for construction activities. These are divided into low-skilled workers (e.g. construction labour who will make up the majority of workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers and expatriates). Most of the unskilled and semi-skilled workers would be drawn from the nearby local community (located outside the campus) to enhance the job opportunities associated with the proposed Project. A moderate level of migrant workers may also be associated with the construction phase activities (potential impacts associated with the migrant workers, as well as the proffered mitigation measures, are covered in Chapters 5 and 6). No workers' camp is planned to be established on-site during construction.

3.5.3 Commissioning Phase Activities

The commissioning phase of the proposed Project will include testing and checking individual equipment /system, as well as the associated infrastructure to ensure they have been installed correctly and can be handed over for use.

3.5.4 Operational Phase Activities

The operational phase of the Project will involve the generation and distribution of electricity to different sections of the University campus, alongside the operation of the renewable energy training centre to support learning and capacity development in clean energy technologies. To ensure efficient operation of the solar power plant, the EPC Contractor will develop Standard Operating Procedures (SOPs) for the maintenance and management of key components such as solar panels, inverters, batteries, and related infrastructure. These procedures may be reviewed and updated by the Operations and Maintenance (O&M) Contractor during the operational phase. Routine activities will include preventive and corrective maintenance aimed at maintaining optimal system performance throughout the plant's lifespan. Preventive maintenance will involve scheduled inspections and servicing activities such as panel cleaning, inverter maintenance, and structural checks, while corrective maintenance will address equipment faults, repairs, and replacement of damaged components when necessary. The solar photovoltaic (PV) power plant is expected to have an average operational lifespan of about 25 years, with the potential for extended service life through proper maintenance. Even after this period, the PV panels are expected to continue generating up to 90% of their original installed capacity.

3.6 Water Use and Supply

A major advantage of the proposed power plant is its reliance on solar energy, a clean and renewable resource that is naturally abundant and freely available. By generating electricity from solar power, the Project will reduce dependence on fossil fuel-based energy sources and contribute to lower greenhouse gas emissions and improved environmental sustainability. Water demand during the construction phase is expected to be relatively low, as only limited civil works involving concrete mixing will be carried out on-site. The primary use of water will occur during the operational phase, mainly for the periodic cleaning of photovoltaic (PV) panels to maintain their efficiency. Dust accumulation on solar panels, particularly during the dry season, can reduce the amount of sunlight reaching the solar cells and consequently lower energy output. The extent of dust build-up is influenced by factors such as soil characteristics, wind conditions, and the design of the mounting structures.

To optimize water use, panel cleaning activities will be carefully managed and carried out only when necessary. During the rainy season, natural rainfall is expected to reduce the need for frequent cleaning, with manual washing likely limited to a few occasions. However, during the dry season, especially between November and April when dust levels are typically higher in Northern Nigeria, cleaning may be conducted more frequently depending on the level of dust accumulation observed on the panels.

Experience from similar solar energy projects indicates that each PV panel may require approximately five litres of water per cleaning cycle. Based on the estimated number of panels, about 33,000 litres of water will be needed per cleaning operation. The required water supply will be sourced from a borehole to be installed within the Project site. Field assessments and estimated water demand indicate that the volume of water required for occasional panel cleaning is relatively small and is not expected to adversely affect groundwater resources or existing local water use within the area. In addition, groundwater recharge in the Project area is mainly sustained through natural rainfall infiltration, which supports the long-term availability of the resource.

3.7 Health and Safety Requirement

The EPC Contractor will appoint qualified and experienced personnel to oversee the Health, Safety, and Environment (HSE) aspects of the Project. These personnel will ensure compliance with all applicable HSE regulations, standards, and project-specific environmental and social management measures by both the Contractor and subcontractors.

All contractors involved in the Project will be required to develop and implement Occupational Health and Safety (OHS) plans to guide safe working practices throughout the construction and operational phases. Regular HSE training programmes will be conducted to improve workers' awareness of workplace hazards, emergency response procedures, safe work methods, and the proper use of Personal Protective Equipment (PPE). Worker activities will also be controlled through established safety procedures such as Permit-to-Work systems, Job Hazard/Safety Analysis, and routine safety monitoring.

In addition, contractors will carry out regular safety inspections and implement measures aimed at preventing accidents, injuries, and occupational health risks. During construction, a risk assessment approach will be adopted to identify potential hazards associated with different work activities and educate workers on appropriate mitigation measures.

To enhance safety within and around the Project site, warning signs will be installed at strategic locations, while first aid facilities and adequate PPE will be provided for all personnel on-site. Workers, suppliers, and subcontractors will be continuously sensitized on the importance of maintaining safe working conditions and complying with all site safety requirements. Daily toolbox meetings and safety briefings led by onsite HSE officers will also be conducted to reinforce safety awareness. Furthermore, smoking, alcohol consumption, and the use of hard drugs within the Project site will be strictly prohibited to ensure a safe and healthy working environment.

3.8 Labour Requirement

A suitable labour structure for the DARES project would involve a total workforce of about 50 to 60 people**,** depending on the scale and pace of implementation. This workforce would be distributed across skilled, semi-skilled, and unskilled categories to support different phases of the project.

Skilled labour would make up about 30–40% (20-30 workers) and include engineers, project managers, and technical specialists responsible for design, supervision, and quality control. Semi-skilled labour would account for 25–30% (15 workers)**,** mainly technicians and installers who handle system deployment. Unskilled labour would form the largest share, about 30–45% (30–35 workers)**,** supporting construction and basic site activities, especially from local communities.

Overall, this mix ensures technical efficiency while maximizing job creation and local participation, which is essential for the project's sustainability and socio-economic impact.

3.9 Power Supply Arrangements

3.9.1 Institutional Profile

The Federal University Kashere (FUK), established in 2010 and operational since 2011, is located in Kashere, Akko Local Government Area, approximately 63 km from Gombe. The campus hosts six faculties with over 17,000 students and is predominantly residential and academic in character. Grid availability was severely constrained during the audit period (~40%), making FUK functionally off grid in practice. The existing generator fleet (1,930 kVA installed; ~1,235 kW firm de-rated) covers only approximately 32% of the 3.81 MW diversified peak — making the hybrid plant a structural necessity rather than an efficiency measure.

3.9.2 Energy/Load Demand Estimates

The load assessment indicates that the University has a peak power demand of 250.11 kW, an average load of 95.10 kW, and an average daily energy consumption of 2,282.36 kWh, resulting in an annual electricity demand of 833,059.77 kWh. These figures demonstrate a substantial and consistent energy requirement that supports academic, administrative, research, and campus operations. The results highlight the need for a well-sized and reliable power system capable of meeting peak demand while ensuring efficient energy delivery. Implementing the proposed energy solution would enhance energy reliability, reduce dependence on generators, increase energy output, and lower long-term operating costs.

3.9.3 Appliance Audit Overview

A comprehensive appliance audit was conducted across the various clusters and facilities within the Federal University of Kashere (FUK) to establish an accurate understanding of the University's electricity demand profile. The audit involved identifying and quantifying all major electrical appliances, equipment, and loads within academic buildings, administrative offices, laboratories, residential facilities, and support infrastructure. This assessment forms the foundation for estimating current energy consumption, determining peak demand requirements, and developing an appropriately sized renewable energy system.

Table 3.4 presents the full cluster-by-cluster appliance inventory for FUK, detailing the types, quantities, and power ratings of electrical equipment identified during the survey. The inventory provides a comprehensive representation of the University's energy-consuming assets and serves as a key input for load modelling, energy forecasting, and the design of the proposed solar photovoltaic and battery energy storage system. The results also help identify opportunities for energy efficiency improvements and demand-side management measures that can further optimize system performance and reduce long-term operating costs.

Table 3.1: Appliance Audit Overview

Building Cluster	Category	Key Appliances	Connected Load (kW)	Daily Energy (kWh)
Academic Buildings	Lighting	LED Bulb/Panel	134.204	483.134
Academic Buildings	Cooling & Ventilation	AC / Ceiling Fan	431.344	1,552.838

Building Cluster	Category	Key Appliances	Connected Load (kW)	Daily Energy (kWh)
Academic Buildings	ICT & Office	Desktop, Printers	1,512.280	5,444.208
Academic Buildings	Others	Refrigerator, Freezer, Incubator, Centrifuge	16.615	59.814
Administrative	Lighting	LED Bulb/Panel	36.319	147.092
Administrative	Cooling & Ventilation	AC / Ceiling Fan	301.162	1,219.706
Administrative	ICT & Office	Desktop, Printers	133.880	542.214
Administrative	Others	Refrigerator, Microwave, Electric Cooker, Freezer	14.660	59.373
Medical Facilities	Lighting	LED Bulb/Panel	1.159	16.690
Medical Facilities	Cooling & Ventilation	AC / Ceiling Fan	11.350	163.440
Residential	Lighting	LED Bulb/Panel	18.138	57.135
Residential	Cooling & Ventilation	AC / Ceiling Fan	67.680	213.192
Residential	ICT & Office	Desktop, Printers	1.200	3.780
Religious	Lighting	LED Bulb/Panel	0.985	2.413
Religious	Cooling & Ventilation	AC / Ceiling Fan	6.810	16.685
Others	Lighting	LED Bulb/Panel	29.715	166.404
Others	Cooling & Ventilation	AC / Ceiling Fan	172.805	967.708
Others	ICT & Office	Desktop, Printers	12.660	70.896
Others	Catering/Services	Refrigerators, Freezer	4.005	22.708
Utilities/Plants	Lighting	LED Bulb/Panel	0.050	0.540
Utilities/Plants	Cooling & Ventilation	AC / Ceiling Fan	3.000	32.400
CAMPUS TOTAL	—	—	2,910.021	11,242.370

Source: Soltech, 2026

Key Findings from Appliance Audit

- The Academic Buildings cluster is the dominant load contributor in the FUK appliance audit (942.5 kW connected; 2,094.4 kW peak), driven significantly by ICT and office equipment (680.5 kW connected) including a large stock of desktop computers and printers across faculty buildings. This ICT dominance in academic buildings is a distinguishing characteristic of FUK relative to the other sites.

- Cooling and ventilation in academic buildings (194.1 kW connected) ranks second within the cluster and is consistent with the warm savanna climate of Gombe State.
- The Administrative cluster (218.7 kW connected; 486.0 kW peak) is the second largest, with AC systems (135.5 kW) and ICT equipment (60.2 kW) as the principal sub-categories.
- The Residential cluster load (30.5 kW connected from the audited sample) reflects measured occupancy during the logging period. Given the 17,000+ student population, full-occupancy residential load — particularly hostel AC and lighting — is expected to be substantially higher. The bottom-up GFA model (5,049 kW connected for hostel/residence cluster) better represents full-occupancy conditions.
- Medical facilities load is modest (7.5 kW connected) but classified as critical — continuous uninterruptible supply required for clinic operations.
- All 415 campus streetlights are 100% solar standalone LED — zero streetlight load on the hybrid plant. This is the largest standalone solar streetlight fleet of all five project sites.
- The Utilities/Plants cluster (1.4 kW connected) is very small, indicating that water pumping and other utility loads are either not fully captured in the audit or powered separately. This should be confirmed during detailed FEED.

3.9.4 5-Year Load Projections

To ensure that the proposed power system remains adequate throughout its operational life, a five-year load growth assessment was conducted based on projected increases in electricity demand resulting from campus expansion, increased student enrollment, additional facilities, and evolving energy requirements. Three growth scenarios were evaluated: a Base Case assuming 20% annual growth, a Moderate Expansion scenario assuming 30% annual growth, and an Efficiency-Adjusted scenario that incorporates the benefits of energy efficiency measures and demand-side management strategies. The projections provide insight into future energy consumption and peak demand requirements, enabling the development of a resilient and scalable energy infrastructure capable of supporting the University's long-term growth objectives. Table 3.1 presents the 5-year load projection for FUK.

Table 3.2: 5-Year Load Projections

Scenario	Daily Energy (Year 5)	Peak Demand (Year 5)
Base Case (20% growth)	~9.0 MWh/day	~4.67 MW
Moderate Expansion (30% growth)	~9.56 MWh/day	~4.94 MW
Efficiency-Adjusted Year 5	~8.46 MWh/day	~2.55 MW

Source; Soltech, 2026

The results indicate that electricity demand is expected to increase substantially over the next five years under all scenarios. However, the efficiency-adjusted case demonstrates that implementing energy conservation measures can significantly reduce peak demand while maintaining the required energy supply, thereby lowering infrastructure costs and improving overall system performance. These projections underscore the importance of designing a flexible and future-ready power system that can accommodate growth while maximizing operational efficiency and sustainability.

3.9.5 Proposed System Capacity

Based on the current load assessment, projected five-year demand growth, and the need to ensure reliable electricity supply despite frequent grid outages, a preliminary hybrid renewable energy system configuration has been developed. The proposed system is designed to operate primarily in an islanded mode, enabling the University to maintain continuous power supply independent of the national grid when necessary. The configuration combines solar photovoltaic (PV) generation, battery energy storage, and existing generator assets to provide a resilient, cost-effective, and sustainable energy solution. Table 3.2 present the proposed system capacity for FUK.

The solar PV component is intended to serve as the primary source of electricity generation, while the battery energy storage system (BESS) provides energy shifting, nighttime supply, and operational stability. Existing diesel generators will be retained as tertiary backup sources to enhance system reliability during prolonged periods of low solar generation or emergency situations. This integrated approach is expected to maximize renewable energy utilization, reduce fuel consumption, lower operating costs, and significantly decrease dependence on conventional generator-based power generation.

Table 3.3: Proposed System Configuration

System Component	Preliminary Estimate	Justification
Solar PV Capacity	1.8 – 2.0 MWp	Sized to provide the majority of daytime energy demand, support battery charging, and maintain a high renewable-energy contribution under islanded operation. Monocrystalline ground-mounted arrays maximize energy yield per installed capacity.
Battery Energy Storage (BESS)	~5.8 MWh nominal	Based on providing approximately 6 hours of autonomy for a firm nighttime load of 0.7–0.9 MW, ensuring continuity of supply during non-solar periods and grid outages.
Estimated Solar Fraction	70 – 85%	Preliminary estimate reflecting the expected proportion of annual energy supplied by solar PV and stored solar energy before detailed hourly simulation and optimization.
Operating Mode	Islanded (de facto off-grid)	The site's historical grid outage rate (~60% supply unavailability) necessitates a system capable of sustained autonomous operation without dependence on the utility network.
Generator Role	Tertiary backup	Existing generators provide approximately 1,235 kW firm capacity, which covers only about 32% of the site's peak demand. Consequently, generators alone cannot reliably meet load requirements, making the PV–BESS hybrid configuration essential for energy security, with generators reserved for prolonged low-solar conditions, maintenance events, and emergency contingencies.

Source: Soltech, 2026; Note: Preliminary estimates pending PMU confirmation of HOMER Pro simulation outcomes.

3.9.6 Land Requirement

A minimum of 5–8 hectares is anticipated, reflecting the 3.81 MW diversified peak and the campus's off-grid operational context requiring larger BESS provision. The preferred site coordinates have been confirmed and the land acquired by REA for the proposed project is approximately 7.062 hectares (see Figure 3.3).

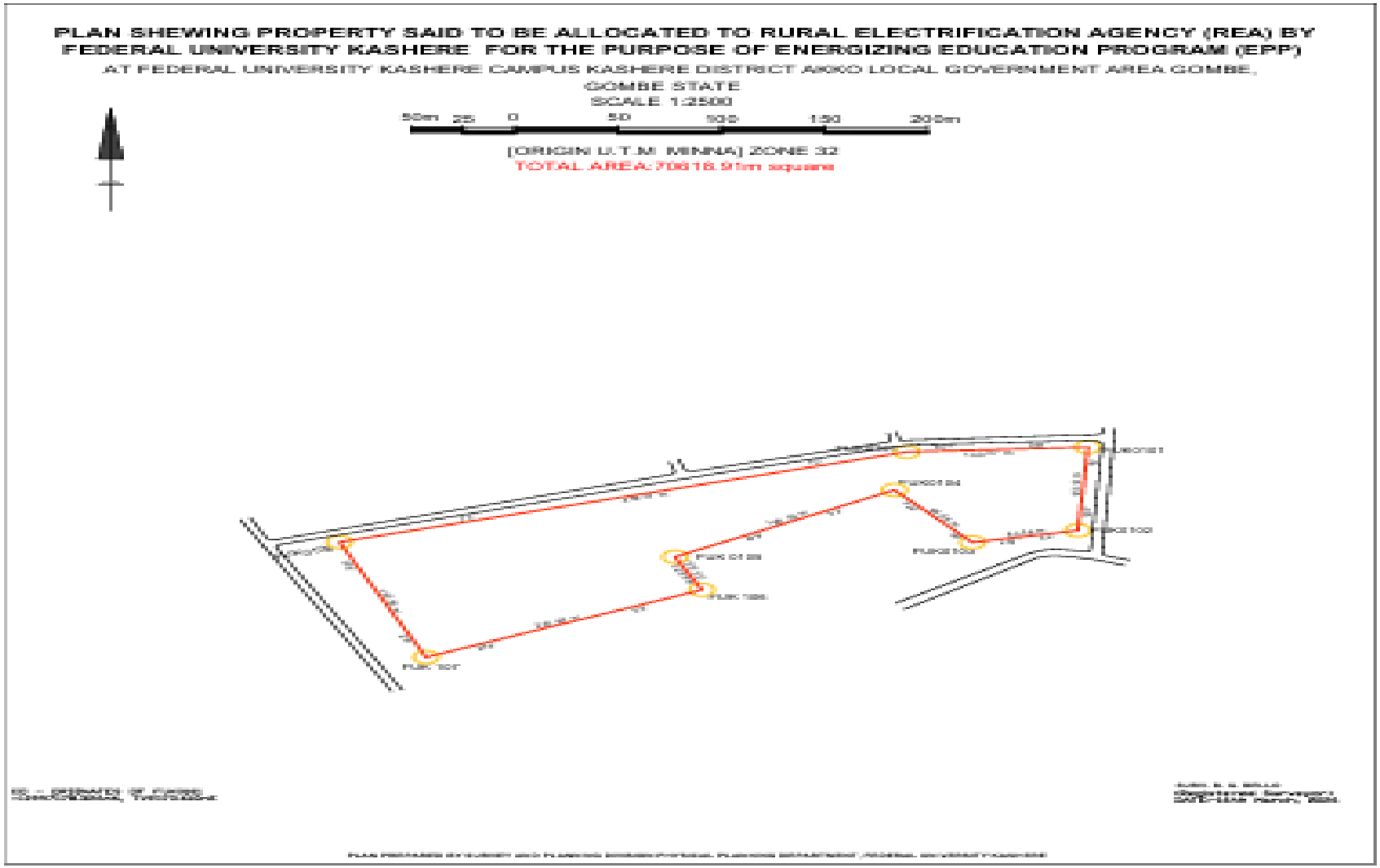

Figure 3.3: Approved Survey Map of the proposed Site within Kashere

Table 3.4: Energy Demand Profile

Parameter	Value	Basis
Installed Connected Load (Nameplate)	5.37 MW	107 buildings; GFA-based calculation
Reconciled Diversified Peak Demand	2.0 – 3.0 MW	Energy logger measurement + coincidence correction
Calibrated Daily Energy Consumption	7.35 MWh/day (Base Case)	Triangulated: Logger + billing (₦25,114/month Nov 2025) + bottom-up
Night Base Load (Firm, calibrated)	0.70 – 0.90 MW	Logger night plateau; heavy residential load
Annual Energy (Base Case)	~2.68 GWh/year	Annualised calibrated baseline
Load Factor	~45%	Derived from logged profile
Dominant Load Category	Cooling & Ventilation	Residential hostel AC; academic cluster AC
Grid Availability During Logging	~40% (60% outage rate)	Functionally off-grid — campus operates on generators

Source: Soltech, 2026

3.10 Waste Management

This section discusses the waste streams associated with the proposed Project and the intended management plan.

3.10.1 Overview

It is the goal of REA that the proposed Project is designed, developed and operated in a sustainable manner. Thus, effective waste management practices that comply with the relevant local requirements and international best practices shall be implemented during all phases of the proposed Project. To achieve this, all contractors engaged during the lifecycle of the Project will put in place and comply with a site waste management plan.

Waste management principles shall be based on an integrated approach which involves a combination of techniques and programs to manage waste. Source reduction is at the top of the approach, followed by reuse and recycling as preferred options to disposal. Generally, waste associated with the proposed Project shall be managed using the following prioritized program:

Reduction at Source – The elimination or minimization of waste generation through equipment modifications and installation of pollution abatement equipment.

Reuse – Using an item for its original purpose, or a similar purpose, in its original form. Waste generated from one operation shall be put to use in other operations where they are found useful without compromising standards and safety.

Recycling – conversion of waste materials into reusable objects. This will involve using FMEnv/NESREA-approved companies involved in the recycling business using best available technology that meet international standards.

Residue Disposal – disposal of wastes in a government-approved dumpsite.

3.10.2 Associated Waste Streams

The waste streams associated with the proposed Project are discussed as follows:

Pre-construction Phase

The waste streams associated with the pre-construction phase of the Project include cleared vegetation (during site preparation), food waste, and general rubbish. The cleared vegetation (mostly grasses) will be removed from the site and allowed to biodegrade at a portion of the site while wood from felled trees will be made available to the local community.

Construction Phase

The planned activities during the construction phase include civil, mechanical and electrical works and installation of PV panels and associated components which will be carried out by a number of construction workers. The waste streams associated with the construction activities include excavated soil, general refuse, garbage, inert construction materials, metal scraps, concrete waste, food waste, and used packaging materials. In line with the NEP ESMF, the EPC Contractor shall put in place and comply with a site waste management plan. The plan shall be developed to address all waste streams associated with the construction activities and comply with relevant regulations. The contractor shall comply with the national requirements and building rules on storage of construction materials.

Furthermore, all concrete mixing will be undertaken on impermeable plastic lining to prevent contamination of the surrounding areas. Scrap metals generated during the construction phase will be collected for recycling in blue coloured waste receptacles for non-hazardous wastes. Excavated soil generated during the foundation work will be arranged according to the various soil layers for reuse as backfill during landscaping and site rehabilitation.

All electronic equipment shall be supplied by credible manufacturers to reduce the risk of generating waste from faulty equipment. All damaged PV panels generated during the installation activities shall be collected in a dedicated container and returned to the manufacturer outside the country for proper recycling since there is currently no recycling facility in Nigeria that handles PV panels.

Litter collection facilities shall be provided and all solid waste materials that are not identified for reuse or recycling will be placed in appropriate on-site storage containers (black-coloured waste receptacles for food waste, blue-coded bins for paper, and yellow-coded bins for general rubbish) and periodically disposed of (at least once a week throughout the construction period or on the need basis depending on the volume of the waste) at a government-approved dumpsite through a third party waste contractor approved by the state environmental agency. It is estimated that approximately 0.225 m^3 of construction debris will be produced per week.

Hazardous waste that could be generated during the construction activities include used oil rags, and spent filters from onsite diesel generator for power sources during construction. Hazardous wastes shall be stored in a manner that prevents the commingling or contact between incompatible wastes, and stored in properly labelled, closed containers prior to evacuation by a third-party waste contractor approved by the state environmental agency for treatment and disposal.

Operational Phase

A major advantage of the proposed power plant is its reliance on solar energy, a clean and renewable resource that is naturally abundant and freely available. By generating electricity from solar power, the Project will reduce dependence on fossil fuel-based energy sources and contribute to lower greenhouse gas emissions and improved environmental sustainability.

Water demand during the construction phase is expected to be relatively low, as only limited civil works involving concrete mixing will be carried out on-site. The primary use of water will occur during the operational phase, mainly for the periodic cleaning of photovoltaic (PV) panels to maintain their efficiency. Dust accumulation on solar panels, particularly during the dry season, can reduce the amount of sunlight reaching the solar cells and consequently lower energy output. The extent of dust build-up is influenced by factors such as soil characteristics, wind conditions, and the design of the mounting structures.

To optimize water use, panel cleaning activities will be carefully managed and carried out only when necessary. During the rainy season, natural rainfall is expected to reduce the need for frequent cleaning, with manual washing likely limited to a few occasions. However, during the dry season, especially between November and April when dust levels are typically higher in Northern Nigeria, cleaning may be conducted more frequently depending on the level of dust accumulation observed on the panels. Experience from similar solar energy projects indicates that each PV panel may require approximately five litres of water per cleaning cycle. Based on the estimated number of panels, about 33,000 litres of water will be needed per cleaning operation. The required water supply will be sourced from a borehole to be installed within the Project site.

Field assessments and estimated water demand indicate that the volume of water required for occasional panel cleaning is relatively small and is not expected to adversely affect groundwater resources or existing local water use within the area. In addition, groundwater recharge in the Project area is mainly sustained through natural rainfall infiltration, which supports the long-term availability of the resource.

Decommissioning

The waste streams associated with the decommissioning phase of the Project would be similar to the construction waste. These will include refuse, e-waste, general rubbish, and demolition of debris. The University should also be encouraged to prepare an e-waste management plan that accounts for safe end-of-life disposal of equipment from solar installations. Wastes will be segregated onsite, and non-reusable / recyclable wastes will be disposed of through an accredited third-party waste contractor. The summary of waste streams associated with the Project is provided in Table 3.5.

Table 3.5: Summary of Wastes Stream associated with the proposed Project and Handling Techniques

Waste Stream	Sources	Project Phase Construction (C), Operation (O), Decommissioning (D)	Handling Techniques
General rubbish, refuse, and putrescible wastes (food wastes)	Wood splinter, domestic waste, food packs, used bottles	C, O, D	On-site waste segregation; disposal of non-reusable waste through a third-party waste contractor approved by the Bayelsa State Environmental Protection Agency.
Cleared vegetation	During site clearing and preparation	C	Composting, collection for biomass fuel
Scrap metals	Used tubular and casings, used iron rods	C, O, D	Scrap metals will be collected for recycling
Excavated materials	Foundation works	C, D	Excavated materials generated during foundation works will be used for backfilling. Excess excavated spoil will be stockpiled and reused as part of materials for the construction of plant buildings.
Waste Stream	**Sources**	**Project Phase** **Construction (C), Operation (O), Decommissioning (D)**	**Handling Techniques**
Damaged/expired PV panels	PV modules	C, O, D	Return to the manufacturer for recycling using the EPR model
Expired inverters	Electrical installation	O, D	Return to the manufacturer for recycling using the EPR model
Damaged/expired Batteries	Power generation	O, D	Return to the manufacturer for recycling using the EPR model
Sanitary waste	Training center	C, O, D	Periodic evacuation of content of the septic tank

3.11 Project Schedule

The proposed Project is planned to be operational by the fourth quarter (Q4) of 2028. The tentative Project schedule is provided in Table 3.6.

Table 3.6: Tentative Project Schedule

Project Schedule	Timeline											
	2026				2027				2028			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site allocation												
Energy demand audit												
Front-End Engineering Design												
ESIA study and Approval												
Selection of EPC Contractor and contract signing												
Civil, electrical, and mechanical design												
Procurement (manufacturing and transportation)												
Preconstruction and construction Phase Activities												
Commissioning												
Commencement of operation												

CHAPTER FOUR
ENVIRONMENTAL BASELINE DESCRIPTION

4.1 Preamble

This chapter presents the descriptions of the biophysical, socioeconomic, and health conditions of the environment, which will provide the basis for potential impact identification and appropriate mitigation measures associated with the development of the project.

4.2 Study Approach

The baseline status of the project area was obtained through consultations with the relevant stakeholders, a review of relevant literature as well as field studies. Environmental data acquisition involved a multidisciplinary approach and was conducted in line with regulatory requirements and best international practices. This approach includes literature desktop review, designing, and development of field sampling strategy; confirmation of the sampling design and locations, pre-mobilization activities (job hazard analysis, sampling equipment/materials calibrations and checks and mobilization to the field; community consultations, sample collection, handling, documentation, and storage protocols and, and demobilization from the field, transfer of sample custody to the laboratory for analysis. A summary of field sampling methods is discussed in the sub-sections below.

4.2.1 Daily Toolbox Meeting

A daily toolbox meeting was held before work to ensure that team members understood the work plan for the day and the security and safety tips. These are geared toward achieving a successful data-gathering exercise and zero incidents.

4.2.2 Baseline Data Collection and Desktop Review

Data gathering for the biophysical and social components of the project environment was undertaken from 14th to 17th February 2026 (dry season). The secondary data collection was obtained from existing sources approved by FMEnv, including the following:

- Stakeholders, including government agencies, community chiefs, elders, women, and youths in various communities and community-based organizations (cooperative societies, development committees, etc).
- Local experts and research, and academic organizations
- The study leveraged on the *ESIA Report on Proposed Muhammadu Buhari Industrial Park (MBIP), 2022. The report has been approved by the Federal Ministry of Environment.*

4.2.3 Sampling Design/ Protocol

The sampling maps provide spatial distributions of the sampling points within the study area (See Figure 4.1).

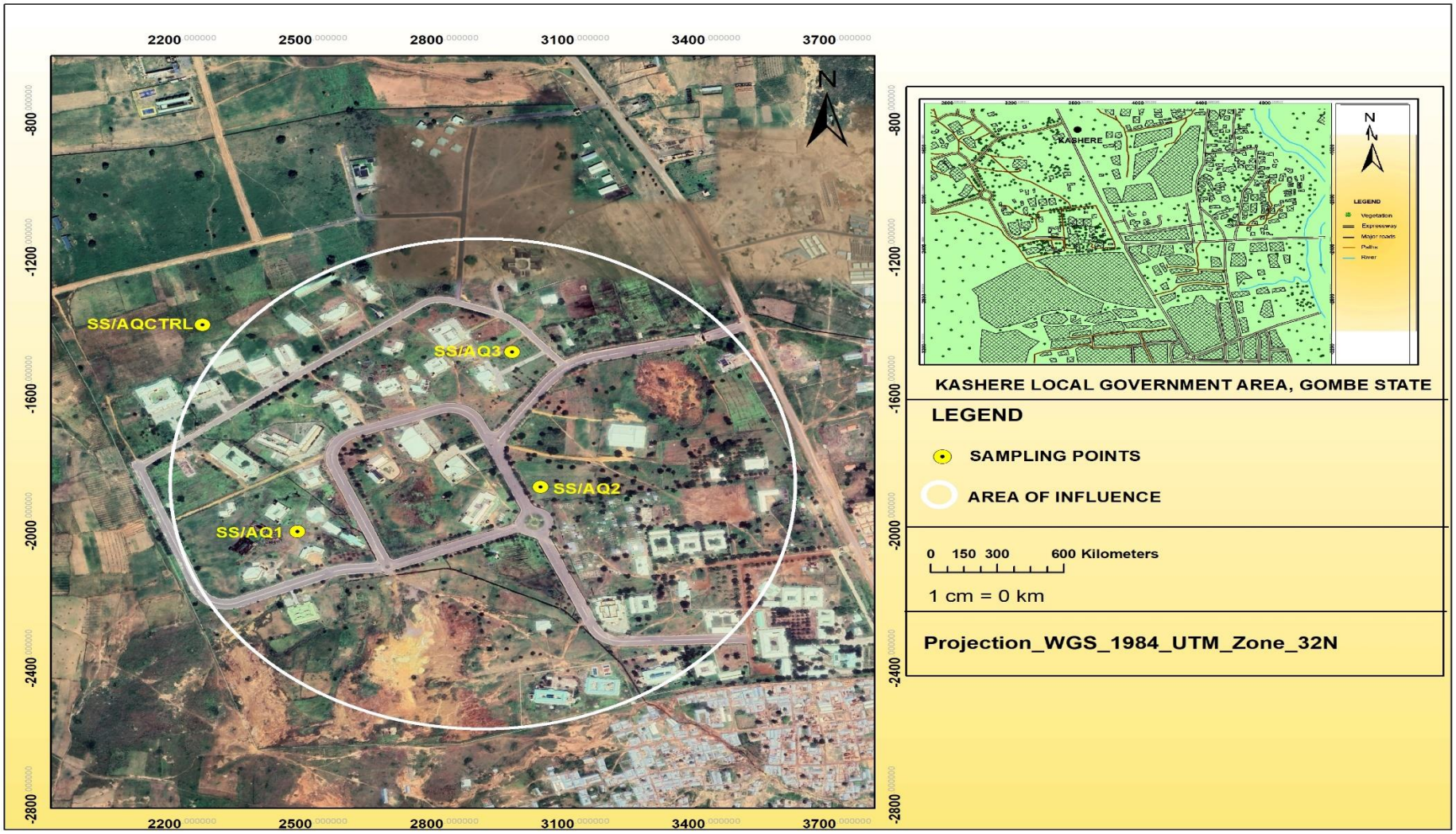

Plate 4.1: Sampling Map

Table 4.1 List of Geographical Coordinates

FEDERAL UNIVERSITY, KASHERE, GOMBE		
SAMPLE ID	**LATITUDE**	**LONGITUDE**
SS/AQ1	9°54'50.21"N	11°0'1.39"E
SS/AQ2	9°54'53.26"N	11°0'13.58"E
SS/AQ3	9°55'2.18"N	11°0'12.50"E
SS/AQCTRL	9°55'3.80"N	10°59'56.44"E

4.3 Field Sampling Equipment and Methods

4.3.1 Meteorology/Air Quality and Noise Measurements

Meteorological elements, namely wind, speed, wind direction, humidity, and temperature, were measured during the fieldwork from 4 predetermined locations (See Sampling Map – Figure 4.1). Each sampling location was adequately georeferenced with a GPS. Kanomax Gas Meter with Model No.2750 was used for the measurement of the following parameters: Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Carbon Dioxide (CO_2), and Hydrogen Sulphide (H_2S). Particulate Meter (PM) with Model No. DT-9880 was used to measure suspended particulate matter (SPM). The Noise levels at each point were measured with an Extech Noise Meter (Model No.407722). The sensor of the noise meter was directed toward the source of noise and the average reading over a period of three minutes was taken to be the Noise level at each point. Plate 4.2 shows air quality and noise measurements being taken during the studies.

4.3.2 Soil Sampling

Topsoil (0-15cm) and bottom soil (15-30cm) samples were collected from 3 points and 1 control using a hand auger. Two (2) auger bores were homogenized to form a composite sample. Samples for microbiology were taken in 25 ml sterilized vials. Samples for physico-chemical parameters were collected in pre-cleaned 250ml amber bottles. The samples were properly labeled and preserved in ice chests at 4°C.

4.3. Vegetation and Wildlife Studies

The vegetation survey was carried out along designated sampling transects/sub-transects. The location of each sampling point was confirmed using GPS. Vegetation was studied in sampling quadrats measuring 20 m x 20 m. For each sampling point, information on habitat, vegetation structure and species were recorded. Habitat data included vegetation description, latitude, longitude, and signs of wildlife. Plant species were categorized into trees (4m or more), shrubs (0.5m to 4m), and herbs (less than 0.5m). Dendrometric parameters recorded included height (m), diameter (cm) and number of trees. A pair of binoculars (Model: Helios Fieldmaster 8x40) was employed to aid in the field identification of trees. Plants were also observed for any disease symptoms/conditions.

Field observations were made at each sampling location for evidence of vertebrate wildlife. Hideouts such as crevices, leaf litter, logs etc. were probed with props to root out any hidden animals. Tree canopies were observed for birds and other arboreal animals such as squirrels and snakes. The indirect count method was employed, particularly for animals that do not readily offer themselves for observation.

4.4 Quality Assurance/Quality Control

Standard methods and procedures were strictly adhered to in the course of this study. The quality assurance program covers all aspects of the study, including sample collection, handling, laboratory analysis, data coding, statistical analysis, presenting and communicating results.

Chain of custody procedures including sample handling, transportation, logging and cross-checking in the laboratory were also implemented. Trip blanks were used to assess the quality assurance/quality control of sample preservation, packaging, shipping, and storage.

Where samples were sent to another laboratory for analysis, a duplicate copy of the samples' information was sent along with the sample to the laboratory, independent of the sample. All movements of the samples were included in the sample record. Basic information was recorded together with the results of the analysis, in a sample registry. With proper, sustained calibration of the instrument and the use of standardized observational procedures, equipment errors were brought to an acceptable minimum.

4.4.1 Sample Handling and Preservation

All the samples collected during the fieldwork were labeled clearly and secured in easily identifiable containers. Each label contained the following Information:

- Date and/or time of sampling
- Sample name and number
- Type of sample
- Type of preservative used if any.

The sampling containers, preservatives used, and holding times for the different parameters of interest for water, benthos, and plankton samples are summarized in Table 4.2.

Table 4.2: Sample Handling and Preservation Methods used during Fieldworks

S/N	Parameters	Sample Vol.	Container	Preservative	Holding Time	Container pretreatment
1.	BTEX	15ml	20ml BTEX Vial	5ml of Methanol	10days	Methanol
2.	Metals, Mn, Fe, Cu, Zn, Ag, Ni, Pb, Cd, Cr, Co, Ca, Mg, K, Na	1L	Plastic	Add 2ml Conc HNO_3 & cool 4 °C ± 2◦C	6 months	Rinsed with 1+1 HNO_3
3.	Physico-Chemical, TSS, COD, O/G, Chloride	2L	Plastic	Cool 4 °C ± 2◦C	28 Days	Rinsed with Distilled water
4.	Hydrocarbons, phenols	1.L	Glass (wide mouth, calibrated)	H_2SO_4 to 2ml & cool 4 °C ± 2◦C	28 Days	Rinsed with Solvent
5.	Zoo-/Phyto-plankton	500ml	Wide mouth plastic bottles	10% Formalin (with Rose Bengal)	-	Rinsed with Distilled water
6.	Microbiology, THB, HUB, Coliform, THF & HUF	200ml	Wide mouth plastic bottles	Cool 4 °C ± 2◦C	As soon as possible	Sterilized
7.	Macrobenthos	1.0L	Plastic	10% Formalin (with Rose Bengal)	-	Rinse with distilled water

4.5 Laboratory Analysis

After the fieldwork exercises, study samples were transported to Tudaka Analytical Nig Limited, Warri, Delta State, Nigeria (accredited by FMENV) for analyses (**Plate 4.3).** Samples brought to the laboratory were analyzed using standard analytical methods. The synoptic description of the laboratory methods and procedures employed for the various physical, chemical, and biological parameters, as well as the detection limits of these parameters in water and sediment samples. The summary of standard methods of environmental analysis is presented in Table 4.3.

Table 4.3: Summary of Laboratory analytical methods used for Water / Sediment Analysis

Parameters	Unit	Method
pH (H2O)		ASTM D 4972
Turbidity	(NTU)	APHA 214
Salinity	$^{0}/_{00}$	API-RP 45
Total Dissolved Solids	(mg/l)	APHA 209C
Total Solids	(mg/l)	APHA 209D
TSS	(mg/l)	APHA 209D
Electrical conductivity	(µS/cm)	APHA 209
Bicarbonate	(mg/l)	API-RP 45
Alkalinity	(mg/l)	APHA 2320-ALKALINITY-B
Acidity	(mg/L)	APHA 2310 B
Ammonia nitrogen	(mg/l)	EPA 350.2
THC	(mg/l)	APR – RP 45
Nitrite	(mg/l)	EPA 354.1
Chloride	(mg/l)	APHA 4500Cl- B
Sulphate	(mg/l)	EPA 375.4
Total Phosphorous	(mg/l) (mg/kg)	APHA 4500 P0 43-
Calcium	(mg/l) (mg/kg)	APHA 3111
Magnesium	(mg/l) (mg/kg)	APHA 3111/ASTM D 3561
Potassium	(mg/l) (mg/kg)	APHA 3111/ASTM D 3561
Cadmium	(mg/l) (mg/kg)	APHA3111
Chromium	(mg/l) (mg/kg)	APHA3111
Lead	(mg/l) (mg/kg)	APHA 3111
Manganese	(mg/l) (mg/kg)	APHA 3111
Iron	(mg/l) (mg/kg)	APHA 3111
Copper	(mg/l) (mg/kg)	APHA 3111
Zinc	(mg/l) (mg/kg)	APHA 3111
PCB	(mg/l) (mg/kg)	EPA method 625

4.6 Climate and Meteorology

Gombe State is in the North-Eastern region of Nigeria and falls within the Sudan Savannah ecological zone. The State experiences a tropical continental climate characterized by distinct wet and dry seasons, relatively high temperatures, and moderate to low annual rainfall. Climatic conditions in the State are largely influenced by the movement of two major air masses: the moist south-westerly maritime air mass from the Atlantic Ocean and the dry north-easterly continental air mass originating from the Sahara Desert.

Table 4.4: Measured Microclimatic Parameters in the Proposed Project Site

	Level	Air Temperature (°C)	Relative Humidity (%)	Atmospheric Pressure (mbar)	Wind	
					Speed (m/s)	Direction
Dry Season	Minimum	33.6	33.0	1004.4	1.6	NE
	Maximum	37.4	35.0	1017.2	3.6	SW
Wet Season	Minimum	36.9	34.8	1004.1	1.7	NE
	Maximum	38.7	37.4	1017.8	4.5	SW

Air Temperature

Temperatures in Gombe State are generally high throughout the year. The hottest period usually occurs between March and May, when daytime temperatures may exceed 38°C. During the cooler months, particularly between December and January, temperatures may drop to about 18–22°C, especially during the early mornings and nights due to the influence of the Harmattan winds.

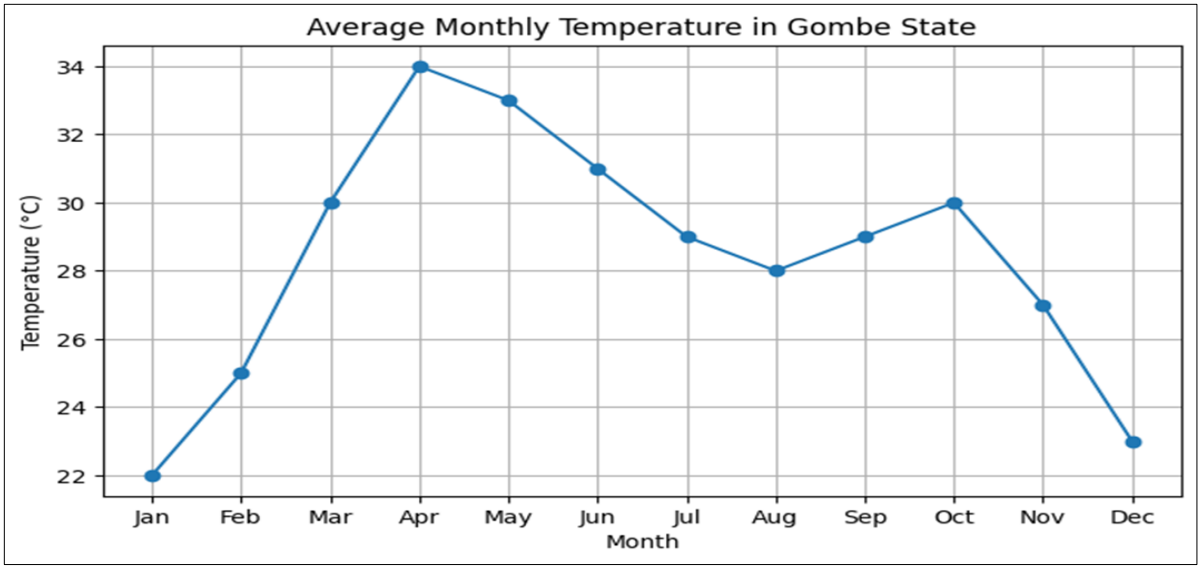

Figure 4.1: Monthly Temperature Distribution in the Proposed Area

(Source: NIMET, 2025)

Rainfall

The rainy season in Gombe State typically lasts from May to October, with peak rainfall occurring between July and September. Average annual rainfall ranges between 850 mm and 1,200 mm depending on location and topography. Rainfall distribution is seasonal and supports agricultural activities across the State.

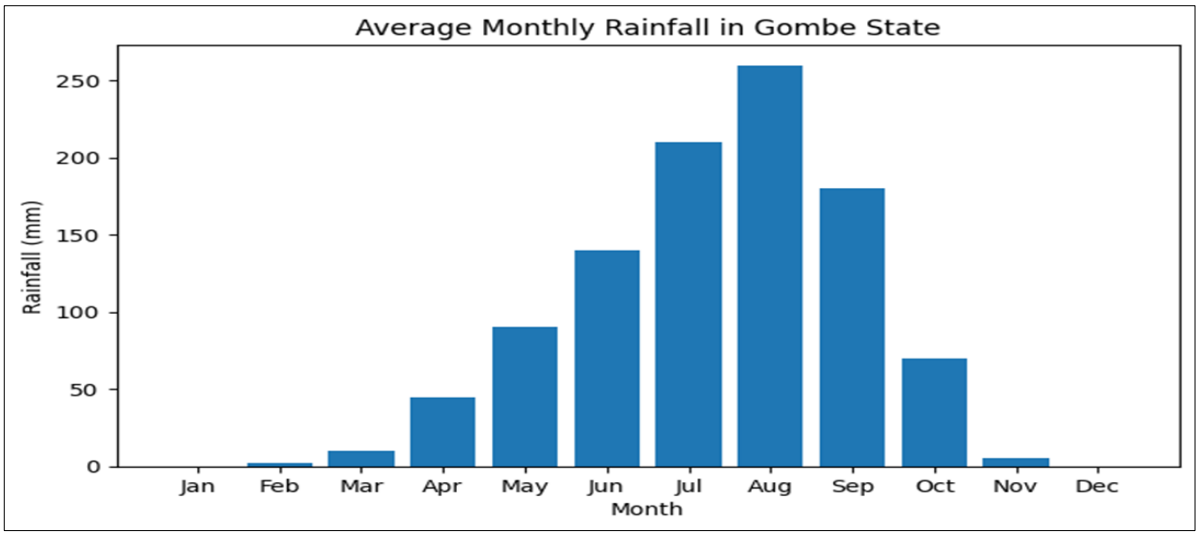

Figure 4.2: Monthly Rainfall in the Proposed Project Area

(Source: NIMET, 2025)

Relative Humility

Gombe experiences significant variations in RH due to its tropical savannah climate and distinct wet and dry seasons. During the dry season, especially under the influence of the Harmattan winds, RH is usually low, often ranging from 15% to 35% during the daytime. This results in dry, dusty air, increased evaporation, dehydration, and discomfort from heat. In contrast, the rainy season brings higher RH levels, sometimes reaching 60%–90%, because of increased rainfall and moist monsoon winds.

The variation in RH greatly affects agriculture, human comfort, and the environment in Gombe. Low RH during the dry season causes rapid loss of soil moisture and increases water demand for crops and humans, while high RH during the wet season supports plant growth but may encourage fungal diseases and mosquito breeding. RH also changes throughout the day: it is usually higher in the morning and night when temperatures are cooler, and lower in the afternoon when temperatures are highest. Therefore, understanding RH is important for weather forecasting, farming activities, health management, and proper storage of agricultural products in Gombe.

Wind Pattern

Wind conditions in the State are influenced by seasonal atmospheric circulation. During the dry season, the north-easterly Harmattan winds dominate, often carrying dust particles that reduce visibility and increase atmospheric dryness. In the rainy season, moist south-westerly winds prevail and contribute to precipitation.

Climate Implications

The climatic and meteorological conditions of Gombe State are favorable for agriculture, livestock production, and renewable energy generation, particularly solar power projects. However, the State is also vulnerable to climate-related challenges such as drought, heat stress, soil erosion, and occasional flooding during periods of intense rainfall.

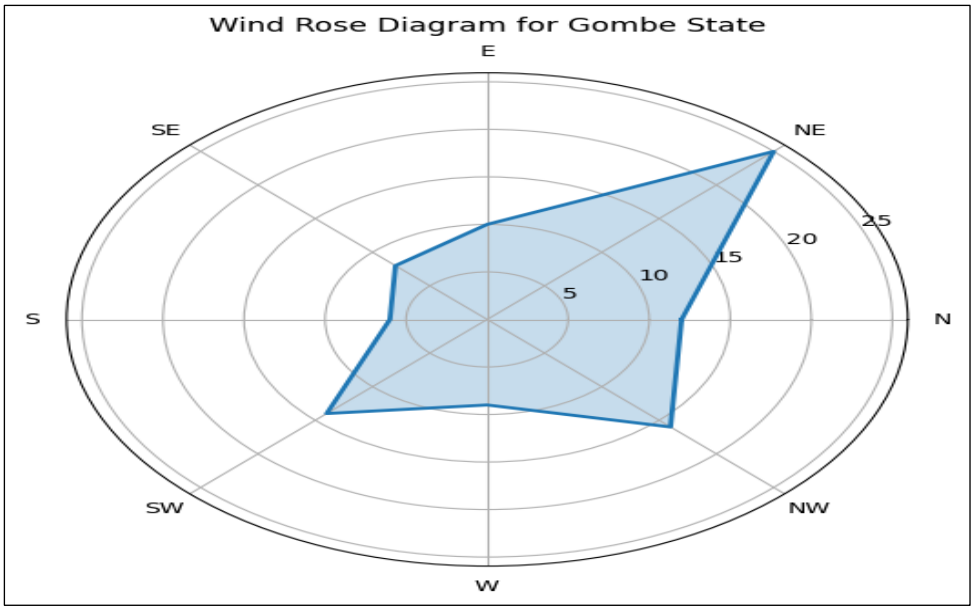

Figure 4. 3: Surface Windrose of the Proposed Project Area (NIMET, 2025)

Sunshine and Solar Radiation

Gombe State receives abundant sunshine throughout the year, with average daily sunshine duration ranging from 6 to 9 hours. The State also experiences high solar radiation intensity, making it highly suitable for solar energy development and other renewable energy projects.

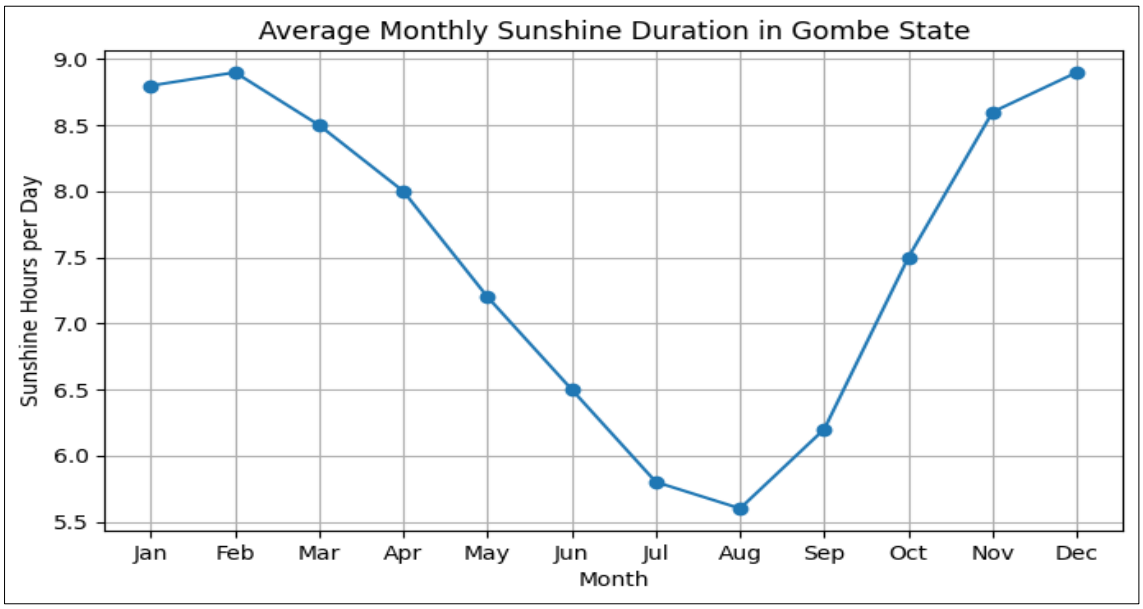

Figure 4. 4: Monthly Sunshine Daily Sunshine Period in the Proposed Area (NIMET, 2025)

4.7 The Local Geology

The proposed Project site at the Federal University of Kashere is located within the geological setting of the Upper Benue Trough in North-Eastern Nigeria. The area is predominantly underlain by sedimentary rock formations consisting mainly of sandstone, shale, clay, and limestone deposits formed

during the Cretaceous period. These formations are characteristic of much of Gombe State and surrounding regions.

The surface geology of the Project area is generally composed of lateritic soils overlying weathered sedimentary materials. The soils are typically reddish-brown, sandy-loamy to clayey in texture, and moderately compacted. These soil conditions provide relatively good bearing capacity for light to medium-scale engineering structures such as solar panel mounting systems, access roads, and ancillary facilities associated with the Project.

Field observations indicate that the Project site is relatively stable with no evidence of major geological hazards such as landslides, faulting, or severe erosion features within the immediate area. The terrain is mostly flat to gently undulating, which further supports the suitability of the site for infrastructure development and minimizes the need for extensive ground modification during construction. Groundwater occurrence in the area is largely associated with weathered and fractured sedimentary formations. Boreholes within the surrounding communities and the University environment serve as important sources of water supply. Recharge of groundwater is primarily dependent on seasonal rainfall infiltration during the wet season.

Overall, the local geological conditions of the Project area are considered favorable for the proposed solar power development, with stable ground conditions, suitable soil characteristics, and minimal geotechnical constraints anticipated during construction and operation.

4.8 The Topography

Gombe State is characterized by a gently undulating terrain dominated by plains, low hills, and broad valleys typical of the Sudan Savannah region of North-Eastern Nigeria. The elevation across the State generally ranges between 300 and 700metres above sea level, with variations influenced by local geological formations and drainage patterns.

The topography of the area surrounding the Federal University of Kashere is relatively flat to gently sloping, making it suitable for infrastructural development and renewable energy projects such as solar photovoltaic installations. The relatively level terrain minimizes the need for extensive earthworks during construction activities and supports efficient site drainage.

Several seasonal streams and minor river channels traverse parts of the State, contributing to the natural drainage system, especially during the rainy season. In some locations, isolated rocky outcrops and low ridges occur, although these features are not dominant within the Project area. The soils are generally sandy-loamy to lateritic in composition, with moderate permeability and good bearing capacity suitable for construction purposes.

The combination of open landscapes, minimal vegetation obstruction, and stable terrain conditions provides favorable environmental and engineering conditions for the proposed solar power development. In addition, the topographic setting supports adequate solar exposure due to the absence of significant shading from surrounding landforms.

4.9 Project Location from Flood Level

The proposed Project site within the main campus of the Federal University of Kashere is located on relatively elevated and gently sloping terrain, which reduces its vulnerability to flooding. Field

observations indicate that the site is not situated within a known floodplain or along the immediate banks of major rivers or perennial streams that could pose significant flood risks.

Natural surface drainage within the area generally follows the existing topographic gradient, allowing stormwater runoff to flow away from the Project site during periods of rainfall. Although temporary surface water accumulation may occur during intense rainfall events, especially within low-lying depressions, the overall flood risk at the proposed solar farm location is considered low to moderate.

The site selection process also considered the need to avoid areas prone to seasonal flooding in order to ensure long-term stability and operational efficiency of the solar infrastructure. In addition, the relatively flat terrain and good drainage characteristics of the area are expected to minimize erosion and waterlogging issues during both the construction and operational phases of the Project.

To further reduce potential flood-related impacts, appropriate stormwater management measures such as drainage channels, runoff control systems, and erosion protection structures will be incorporated into the Project design where necessary. These measures will help maintain site stability, protect electrical infrastructure, and ensure uninterrupted operation of the facility during heavy rainfall events.

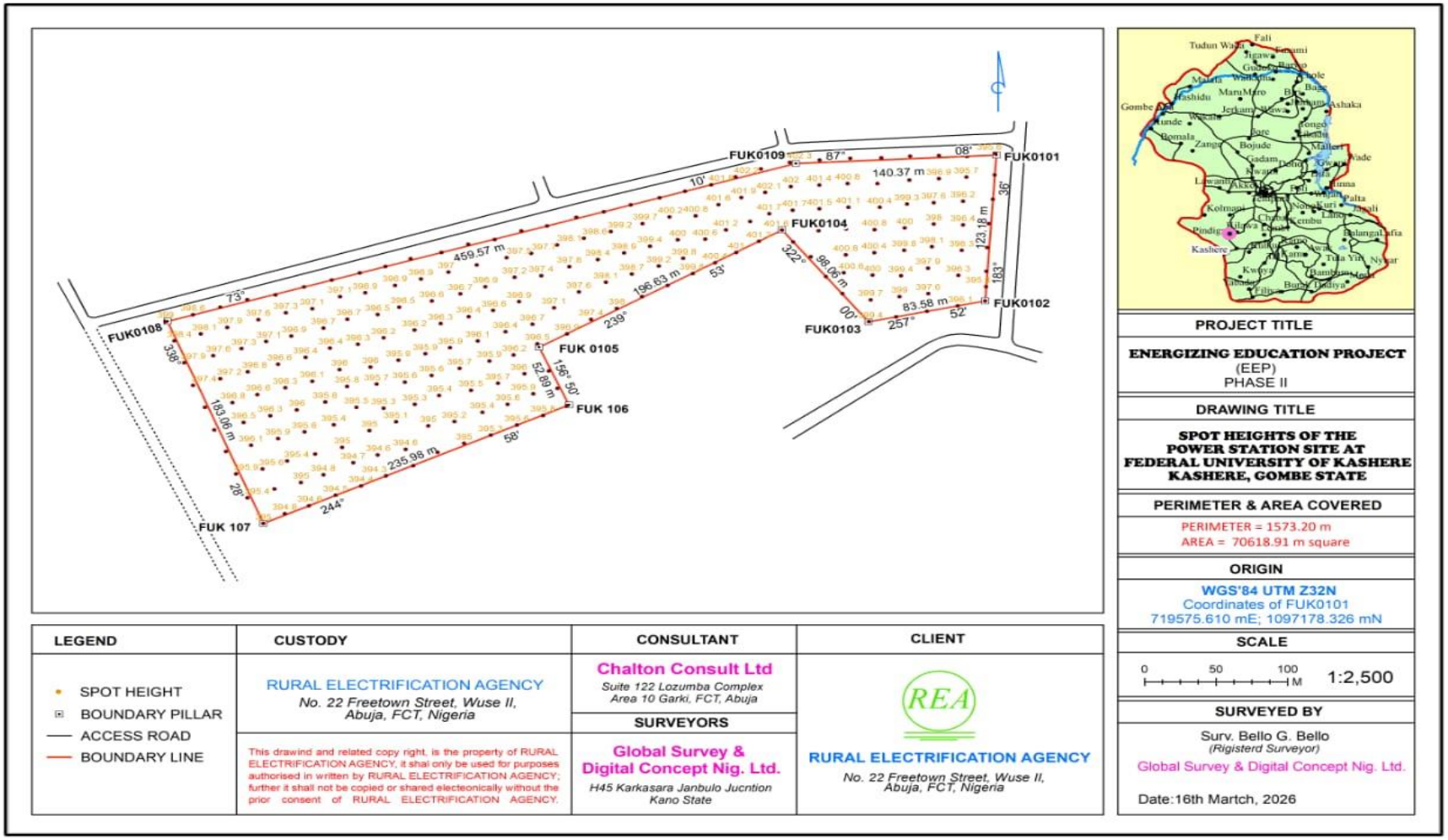

Figure 4.5: Spot Height Mapping of the Proposed Site

4.10 Air Quality and Noise Level

Baseline ambient air quality monitoring carried out within the Project area indicates that the environmental conditions are generally within the permissible limits established by the Federal Ministry of Environment (FMENV). Variations observed between the dry and wet seasons are mainly influenced by climatic conditions, including Harmattan dust, rainfall intensity, temperature, humidity, and wind movement.

Noise Level

Measured daytime noise levels during the dry season ranged between 54.2 and 61.5 dB(A), while control values averaged 63.4 dB(A). During the wet season, values ranged between 55.1 and 67.2 dB(A) with a control value of 68.0 dB(A). These levels are below the FMENV permissible limit of 90 dB(A) for daytime exposure. Slightly elevated wet season values may be associated with increased human activities, vehicular movement, and natural sounds during rainfall events.

Sulphur Oxides (SOx).

SOx concentrations were generally very low across both seasons, ranging from 0 to 1.2 µg/m³ during the dry season and 0 to 0.8 µg/m³ during the wet season. These values are significantly below the FMENV limit of 26 µg/m³, indicating minimal contribution from industrial combustion or fossil fuel emissions within the Project area.

Nitrogen Oxides (NOx)

NOx concentrations ranged between 3.1 and 8.5 µg/m³ in the dry season and 2.5 and 6.3 µg/m³ during the wet season. The recorded values remain far below the FMENV permissible range of 75–113 µg/m³. Slightly higher dry season values may result from dust-generating activities, vehicular emissions, and atmospheric stagnation during hotter months.

Suspended Particulate Matter (SPM)

SPM concentrations showed noticeable seasonal variation. Dry season values ranged between 32 and 48 µg/m³, while wet season concentrations ranged from 28 to 39 µg/m³. Although particulate levels were relatively higher during the dry season due to Harmattan dust and reduced atmospheric moisture, all measured values remained well below the FMENV threshold of 250 µg/m³. Rainfall during the wet season contributes to the removal of suspended particles from the atmosphere through wet deposition.

Volatile Organic Compounds (VOC)

VOC concentrations remained very low, with dry season values ranging from 0 to 2.1 µg/m³ and wet season values ranging from 0 to 1.4 µg/m³. These concentrations are substantially lower than the FMENV limit of 60 µg/m³, indicating limited industrial or chemical emission sources within the Project vicinity.

Carbon Monoxide (CO)

Measured carbon monoxide concentrations ranged between 0.5 and 2.3 µg/m³ during the dry season and 0.3 to 1.8 µg/m³ during the wet season. These values are significantly below the FMENV permissible limit of 11.4 µg/m³. The relatively low concentrations suggest minimal combustion-related pollution sources in the area.

Ozone (O_3)

Ground-level ozone concentrations ranged between 20 and 38 µg/m³ in the dry season and 18 to 32 µg/m³ in the wet season. Although there are no specific FMENV limits for ozone provided in the dataset,

the recorded concentrations are considered moderate and typical of semi-urban environments influenced by sunlight intensity and atmospheric reactions.

Carbon Dioxide (CO_2)
CO_2 concentrations varied from 280 to 460 µg/m³ during the dry season and 390 to 520 µg/m³ in the wet season. Slightly higher wet season values may be linked to increased biological decomposition and atmospheric moisture conditions. Since no FMENV limit is specified for ambient CO_2 in this context, the observed values are considered within normal environmental background levels.

Hydrogen Sulphide (H_2S)
H_2S concentrations were either absent or extremely low throughout both seasons, ranging from 0 to 0.003 µg/m³ in the dry season and 0 to 0.002 µg/m³ during the wet season. These values are below the FMENV limit of 0.01 µg/m³, indicating the absence of significant organic decomposition or industrial sulphide sources.

Air Temperature
Ambient temperatures were generally high, reflecting the tropical savannah climate of the region. Dry season temperatures ranged between 33.5 and 38.2°C, while wet season values ranged from 28.7 to 34.5°C. Higher temperatures during the dry season are associated with intense solar radiation and reduced cloud cover.

Wind Speed
Wind speed measurements ranged from 0.2 to 1.0 m/s during the dry season and 0.8 to 1.6 m/s in the wet season. Increased wind speeds during the rainy season may be linked to seasonal atmospheric circulation and storm activity. Wind movement plays an important role in dispersing airborne pollutants within the Project area.

Relative Humidity
Relative humidity exhibited significant seasonal differences. Dry season values ranged between 30 and 48%, while wet season values increased substantially to between 62 and 84% due to increased rainfall and atmospheric moisture. The lower humidity experienced during the dry season is characteristic of Harmattan conditions in Northern Nigeria.

Table 4.5: Air Quality Around the Project Area (Dry and Wet Seasons)

				ESIA MBIP,2022		
Parameters/Unit	**Units**	**Dry Season Range**	**Dry Season Control**	**Wet Season Range**	**Wet Season Control**	**FMENV Limits (8 hr Avg.)**
Noise Level	dB(A) Day	54.2 – 61.5	63.4	55.1 – 67.2	68.0	90
SOx	µg/m³	0 – 1.2	1.0	0 – 0.8	0.5	26
NOx	µg/m³	3.1 – 8.5	7.4	2.5 – 6.3	5.8	75 – 113
SPM	µg/m³	32 – 48	45.6	28 – 39	35.2	250
VOC	µg/m³	0 – 2.1	1.8	0 – 1.4	1.1	60
CO	µg/m³	0.5 – 2.3	1.9	0.3 – 1.8	1.4	11.4
O_3	µg/m³	20 – 38	35.7	18 – 32	28.5	NA
CO_2	µg/m³	280 – 460	430.5	390 – 520	470.8	NA
H_2S	µg/m³	0 – 0.003	0.002	0 – 0.002	0.001	0.01
Air Temperature	°C	33.5 – 38.2	36.1	28.7 – 34.5	31.6	NA

Wind Speed	m/s	0.2 – 1.0	0.85	0.8 – 1.6	1.2	NA
Humidity	%	30 – 48	41.5	62 – 84	73.2	NA

Source of Data**:** *ESIA Report on Proposed Muhammadu Buhari Industrial Park (MBIP), 2022*

4.11 SOIL QUALITY

4.11.1 Physicochemical Parameters

The soil pH values obtained from the study area showed close agreement with the secondary data from ESIA MBIP (2022), although slight seasonal differences were observed. During the dry season, the measured pH ranged from 5.8–6.3 at 0–15 cm and 5.5–6.1 at 15–30 cm, compared with the control means of 5.4 and 5.2, respectively. This indicates that the study area soils were slightly less acidic than the control values during the dry season. In the wet season, pH increased to 6.2–6.8 at the surface and 6.0–6.5 at the subsurface, which were also slightly higher than the control means of 6.4 and 6.2. The similarity between the measured and control values suggests that the soil acidity status has remained relatively stable over time. The slight increase in wet-season pH compared to the secondary data may reflect increased organic matter decomposition and dilution of acidic compounds by rainfall.

Electrical conductivity (EC) values in the study area were generally higher than the secondary data, particularly during the wet season. In the dry season, EC ranged from 95–128 µS/cm at 0–15 cm and 110–146 µS/cm at 15–30 cm, compared with control means of 105 and 112 µS/cm. While some dry-season values were close to the controls, the upper dry-season values slightly exceeded the baseline data. During the wet season, EC increased significantly to 150–210 µS/cm and 170–235 µS/cm, respectively, compared with control means of 145 and 182 µS/cm. The higher EC values relative to the secondary data suggest increased dissolved ion concentrations in the study area soils, especially during the rainy season. This increase may be associated with enhanced leaching, runoff infiltration, and mobilization of soluble salts during periods of high rainfall.

Soil temperature values were generally comparable to the secondary data but showed slight seasonal deviations. During the dry season, measured temperatures ranged from 33.0–36.5°C at the surface and 31.8–34.2°C at the subsurface, compared with control means of 34.4°C and 32.8°C. The observed dry-season temperatures were therefore slightly higher at some locations than the baseline values. In the wet season, temperatures decreased to 29.5–32.8°C and 28.9–31.7°C, which were close to the control means of 30.4°C and 29.8°C. The overall similarity indicates that seasonal climatic conditions largely controlled soil temperature patterns in both the present study and the secondary dataset.

Nitrate concentrations in the present study were generally higher than the secondary data, particularly during the wet season. Dry-season nitrate concentrations ranged from 0.25–0.68 mg/kg and 0.18–0.55 mg/kg, compared with control means of 0.22 and 0.51 mg/kg. Some dry-season surface values therefore slightly exceeded the baseline data. During the wet season, nitrate increased to 0.75–1.24 mg/kg and 0.60–1.10 mg/kg, compared with control means of 0.92 and 0.81 mg/kg. The higher wet-season concentrations indicate increased nitrogen availability relative to the ESIA MBIP (2022) data. This may reflect enhanced microbial nitrification and decomposition processes under wetter soil conditions.

Table 4.6: Physicochemical Characteristics of Soil Quality Around the Project Area (Wet and Dry Season)

		Concentration		Control		ESIA MBIP,2022			
Parameter	**Unit**	**Dry Season (0–15 cm)**	**Dry Season (15–30 cm)**	**Control Mean (0–15 cm)**	**Control Mean (15–30 cm)**	**Wet Season (0–15 cm)**	**Wet Season (15–30 cm)**	**Control (0–15 cm)**	**Control (15–30 cm)**
pH	-	5.8 – 6.3	5.5 – 6.1	5.4	5.2	6.2 – 6.8	6.0 – 6.5	6.4	6.2
Electrical Conductivity (EC)	µS/cm	95 – 128	110 – 146	105	112	150 – 210	170 – 235	145	182
Temperature	°C	33.0 – 36.5	31.8 – 34.2	34.4	32.8	29.5 – 32.8	28.9 – 31.7	30.4	29.8
Nitrate	mg/kg	0.25 – 0.68	0.18 – 0.55	0.22	0.51	0.75 – 1.24	0.60 – 1.10	0.92	0.81
Ammonia	mg/kg	0.45 – 1.10	0.32 – 0.95	1.95	1.36	1.40 – 2.60	1.10 – 2.15	1.95	1.76
Phosphate	mg/kg	1.2 – 3.5	2.8 – 5.7	3.2	2.6	3.6 – 6.4	5.8 – 9.5	5.2	6.8
Sulphate	mg/kg	7.5 – 11.8	6.2 – 10.4	8.5	11.8	10.6 – 16.5	8.9 – 14.1	12.5	11.8
Chloride	mg/kg	0.8 – 1.9	1.0 – 2.4	0.4	0.1	1.5 – 3.2	2.0 – 3.8	2.4	3.1
Total Organic Carbon (TOC)	%	0.45 – 0.82	0.38 – 0.74	1.00	0.06	0.75 – 1.25	0.62 – 1.10	1.08	0.96
Moisture Content	%	4.8 – 7.5	5.2 – 7.0	8.3	7.1	8.5 – 14.2	9.1 – 15.6	12.3	13.1

Source of Secondary Data: ESIA Report on Proposed Muhammadu Buhari Industrial Park (MBIP), 2022

Ammonia concentrations showed mixed comparisons with the secondary data. During the dry season, measured ammonia concentrations of 0.45–1.10 mg/kg and 0.32–0.95 mg/kg were generally lower than the control means of 1.95 and 1.36 mg/kg. However, during the wet season, concentrations increased substantially to 1.40–2.60 mg/kg and 1.10–2.15 mg/kg, with some values exceeding the control means of 1.95 and 1.76 mg/kg. This suggests that while dry-season ammonia levels remained below baseline conditions, wet-season conditions promoted ammonia accumulation beyond the secondary data values. The increase may be associated with intensified organic matter decomposition and ammonification during the rainy season.

Phosphate concentrations in the study area were generally higher than the secondary data, especially at the subsurface during the wet season. Dry-season phosphate concentrations ranged from 1.2–3.5 mg/kg and 2.8–5.7 mg/kg, compared with control means of 3.2 and 2.6 mg/kg. While some surface dry-season values were lower than the controls, the subsurface concentrations exceeded the baseline values. During the wet season, phosphate increased further to 3.6–6.4 mg/kg and 5.8–9.5 mg/kg, compared with control means of 5.2 and 6.8 mg/kg. The higher wet-season phosphate concentrations suggest increased phosphorus enrichment relative to the ESIA MBIP (2022) data. This may indicate enhanced nutrient transport, runoff infiltration, and leaching processes within the study area.

Sulphate concentrations were also generally higher than the secondary data during the wet season. Dry-season sulphate values ranged from 7.5–11.8 mg/kg and 6.2–10.4 mg/kg, compared with control means of 8.5 and 11.8 mg/kg. Some dry-season values were therefore slightly lower than the baseline data. However, wet-season concentrations increased to 10.6–16.5 mg/kg and 8.9–14.1 mg/kg, exceeding the control means of 12.5 and 11.8 mg/kg at several sampling points. The higher wet-season sulphate concentrations may reflect enhanced mineral dissolution and organic matter decomposition during periods of increased rainfall.

Chloride concentrations in the present study exceeded the secondary data during both seasons. During the dry season, chloride concentrations ranged from 0.8–1.9 mg/kg and 1.0–2.4 mg/kg, compared with extremely low control values of 0.4 and 0.1 mg/kg. During the wet season, chloride increased further to 1.5–3.2 mg/kg and 2.0–3.8 mg/kg, compared with control means of 2.4 and 3.1 mg/kg. The consistently higher chloride concentrations relative to the secondary data suggest increased dissolved salt mobility and possible accumulation within the study area soils.

Total Organic Carbon (TOC) values showed both similarities and differences compared with the secondary data. During the dry season, TOC ranged from 0.45–0.82% and 0.38–0.74%, compared with control means of 1.00 and 0.06%. The surface dry-season values were generally lower than the control surface mean but substantially higher than the control subsurface value. During the wet season, TOC increased to 0.75–1.25% and 0.62–1.10%, closely matching or slightly exceeding the control means of 1.08 and 0.96%. This indicates improved organic carbon accumulation during the wet season relative to the secondary data.

Moisture content values were lower than the secondary data during the dry season but became comparable or slightly higher during the wet season. Dry-season moisture content ranged from 4.8–7.5% and 5.2–7.0%, compared with control means of 8.3 and 7.1%, indicating drier soil conditions than the baseline data. However, during the wet season, moisture content increased significantly to 8.5–14.2% and 9.1–15.6%, compared with control means of 12.3 and 13.1%. Some wet-season subsurface values therefore exceeded the control means, reflecting enhanced water retention and infiltration during the rainy season.

Table 4.7: Major Cations

		Concentration		Control		ESIA MBIP,2022			
Parameter	**Unit**	**Dry Season (0–15 cm)**	**Dry Season (15–30 cm)**	**Control Mean (0–15 cm)**	**Control Mean (15–30 cm)**	**Wet Season (0–15 cm)**	**Wet Season (15–30 cm)**	**Control (0–15 cm)**	**Control (15–30 cm)**
Magnesium	mg/kg	15.2 – 28.4	18.5 – 31.2	23.3	32.1	24.1 – 39.6	28.4 – 42.5	33.8	36.4
Potassium	mg/kg	2.1 – 4.5	2.6 – 5.1	3.1	4.2	4.8 – 7.9	5.5 – 8.4	6.7	7.2
Sodium	mg/kg	5.5 – 10.8	7.2 – 12.5	8.6	5.6	11.4 – 16.7	12.8 – 18.4	14.6	15.2

Source of Secondary Data: ESIA Report on Proposed Muhammadu Buhari Industrial Park (MBIP), 2022

Table 4.8: Heavy Metals

		Concentration		Control		ESIA MBIP,2022			
Parameter	**Unit**	**Dry Season (0–15 cm)**	**Dry Season (15–30 cm)**	**Control Mean (0–15 cm)**	**Control Mean (15–30 cm)**	**Wet Season (0–15 cm)**	**Wet Season (15–30 cm)**	**Control (0–15 cm)**	**Control (15–30 cm)**
Copper	mg/kg	1.2 – 2.8	1.5 – 3.1	3.9	4.8	2.4 – 4.6	3.0 – 5.2	3.6	4.1
Iron	mg/kg	65 – 112	88 – 135	193	120	140 – 215	175 – 248	198	220
Lead	mg/kg	0.05 – 0.42	0.10 – 0.55	0.18	0.11	0.30 – 0.82	0.45 – 0.96	0.78	0.91
Zinc	mg/kg	3.5 – 6.8	4.2 – 7.5	8.8	9.4	5.9 – 9.6	6.8 – 10.4	8.7	9.3
Manganese	mg/kg	0.4 – 1.5	0.7 – 1.8	2.9	2.0	1.2 – 2.7	1.6 – 3.1	2.4	2.8

Source of Secondary Data: ESIA Report on Proposed Muhammadu Buhari Industrial Park (MBIP), 2022

Cations

Magnesium concentrations showed clear seasonal variation and generally increased during the wet season compared with the dry season. During the dry season, magnesium concentrations ranged from 15.2–28.4 mg/kg at 0–15 cm and 18.5–31.2 mg/kg at 15–30 cm, while during the wet season the concentrations increased to 24.1–39.6 mg/kg and 28.4–42.5 mg/kg, respectively. This indicates that wet-season magnesium levels were considerably higher than dry-season levels at both depths. The increase may be attributed to enhanced mineral weathering, dissolution, and mobility of magnesium ions under wetter soil conditions. Subsurface soils consistently recorded slightly higher magnesium concentrations than surface soils, suggesting downward migration and accumulation of magnesium through leaching processes. When compared with the ESIA MBIP (2022) control means, the dry-season concentrations were generally lower than the control values of 23.3 mg/kg and 32.1 mg/kg, particularly at the subsurface. However, wet-season concentrations approached or exceeded the control means of 33.8 mg/kg and 36.4 mg/kg. For instance, the wet-season subsurface magnesium concentration reached 42.5 mg/kg, which exceeded the control mean of 36.4 mg/kg. This suggests increased magnesium enrichment during the wet season relative to the secondary data.

Potassium concentrations also increased significantly from the dry season to the wet season. During the dry season, potassium ranged from 2.1–4.5 mg/kg at 0–15 cm and 2.6–5.1 mg/kg at 15–30 cm, whereas wet-season concentrations increased to 4.8–7.9 mg/kg and 5.5–8.4 mg/kg, respectively. The seasonal increase indicates improved potassium availability during the wet season, likely due to enhanced decomposition of organic matter and increased release of potassium-bearing minerals under moist conditions. Subsurface soils again recorded slightly higher potassium concentrations than surface soils, indicating downward movement of soluble potassium ions through infiltration and leaching. Compared with the ESIA MBIP (2022) control means, the dry-season potassium concentrations were generally lower than the baseline values of 3.1 mg/kg and 4.2 mg/kg, especially at the lower concentration ranges. However, wet-season concentrations were comparable to or slightly higher than the control means of 6.7 mg/kg and 7.2 mg/kg. For example, the wet-season subsurface concentration reached 8.4 mg/kg, exceeding the control mean of 7.2 mg/kg. This suggests that potassium availability increased considerably during the wet season and may reflect enhanced nutrient cycling and accumulation within the study area soils.

Sodium concentrations followed a similar seasonal trend, with higher values recorded during the wet season than the dry season. During the dry season, sodium concentrations ranged from 5.5–10.8 mg/kg at the surface and 7.2–12.5 mg/kg at the subsurface, while wet-season concentrations increased to 11.4–16.7 mg/kg and 12.8–18.4 mg/kg, respectively. The increase in sodium during the wet season may be associated with enhanced dissolution and transport of soluble salts under wetter conditions. Subsurface soils consistently recorded higher sodium concentrations than surface soils, indicating downward migration and accumulation of sodium ions through leaching. Compared with the ESIA MBIP (2022) control values, the dry-season sodium concentrations were generally comparable to or slightly higher than the control means of 8.6 mg/kg and 5.6 mg/kg. Notably, the subsurface dry-season concentrations exceeded the control mean considerably, reaching up to 12.5 mg/kg compared with the control value of 5.6 mg/kg. During the wet season, sodium concentrations remained close to or slightly above the control means of 14.6 mg/kg and 15.2 mg/kg. For example, the wet-season subsurface concentration reached 18.4 mg/kg, exceeding the control mean of 15.2 mg/kg. This suggests moderate sodium enrichment within the study area during the

wet season. However, despite the observed increases, the sodium concentrations remain within acceptable ranges and do not yet indicate sodicity problems in the soil.

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Heavy Metals

Copper concentrations in the study area showed noticeable seasonal variation, with higher values recorded during the wet season than during the dry season. During the dry season, copper concentrations ranged from 1.2–2.8 mg/kg at 0–15 cm and 1.5–3.1 mg/kg at 15–30 cm, while wet-season concentrations increased to 2.4–4.6 mg/kg and 3.0–5.2 mg/kg, respectively. The increase in copper concentration during the wet season may be attributed to enhanced weathering of copper-bearing minerals, increased mobility of dissolved metals under moist conditions, and decomposition of organic matter. Subsurface soils generally recorded slightly higher copper concentrations than surface soils, indicating downward migration and accumulation through leaching processes. Compared with the ESIA MBIP (2022) control means of 3.9 and 4.8 mg/kg during the dry season, the measured dry-season concentrations were generally lower than the baseline values. However, during the wet season, the concentrations approached or slightly exceeded the control means of 3.6 and 4.1 mg/kg. For example, the wet-season subsurface copper concentration reached 5.2 mg/kg, which exceeded the control value of 4.1 mg/kg. This suggests moderate copper enrichment during the wet season relative to the secondary data.

Iron concentrations were the highest among all the heavy metals analyzed and showed substantial seasonal increases. During the dry season, iron concentrations ranged from 65–112 mg/kg at the surface and 88–135 mg/kg at the subsurface, while wet-season concentrations increased markedly to 140–215 mg/kg and 175–248 mg/kg, respectively. The higher wet-season iron concentrations may result from enhanced mineral dissolution and mobilization under wetter soil conditions. Subsurface soils consistently recorded higher iron concentrations than surface soils, indicating accumulation of iron compounds within deeper soil layers. Compared with the ESIA MBIP (2022) control values of 193 and 120 mg/kg during the dry season, the measured dry-season surface concentrations were generally lower than the control, while some subsurface values slightly exceeded the baseline concentration. During the wet season, iron concentrations were comparable to or exceeded the control means of 198 and 220 mg/kg. For instance, the wet-season subsurface concentration reached 248 mg/kg, exceeding the control mean of 220 mg/kg. This suggests that iron mobility and accumulation were enhanced during the rainy season.

Lead concentrations also increased during the wet season. During the dry season, lead ranged from 0.05–0.42 mg/kg at 0–15 cm and 0.10–0.55 mg/kg at 15–30 cm, whereas wet-season concentrations increased to 0.30–0.82 mg/kg and 0.45–0.96 mg/kg, respectively. The increase may be associated with enhanced mobility of dissolved lead particles and runoff infiltration during rainfall periods. Subsurface soils recorded higher lead concentrations than surface soils, suggesting downward migration through leaching. Compared with the ESIA MBIP (2022) control means of 0.18 and 0.11 mg/kg during the dry season, some measured dry-season concentrations exceeded the control values, particularly at the subsurface. During the wet season, lead concentrations were generally comparable to the control means of 0.78 and 0.91 mg/kg, although the upper concentration ranges slightly exceeded these values. For example, the wet-season subsurface concentration reached 0.96 mg/kg, which was slightly above the control value of 0.91 mg/kg. This indicates slight lead enrichment during the wet season, although the concentrations remain relatively low overall.

Zinc concentrations followed a similar seasonal pattern, with higher values observed during the wet season than during the dry season. During the dry season, zinc concentrations ranged from 3.5–6.8 mg/kg at the surface and 4.2–7.5 mg/kg at the subsurface, while wet-season concentrations increased to 5.9–9.6 mg/kg and 6.8–10.4 mg/kg, respectively. The increase in zinc during the wet season may be linked to enhanced mineral weathering and increased mobility of zinc ions under moist conditions. Subsurface soils generally recorded slightly higher zinc concentrations than surface soils, indicating accumulation within deeper soil horizons. Compared with the ESIA MBIP (2022) control means of 8.8 and 9.4 mg/kg during the dry season, the measured dry-season concentrations were generally lower than the baseline values. However, wet-season concentrations approached or slightly exceeded the control means of 8.7 and 9.3 mg/kg. For instance, the wet-season subsurface zinc concentration reached 10.4 mg/kg, exceeding the control mean of 9.3 mg/kg. This suggests increased zinc enrichment during the wet season relative to the secondary data.

Manganese concentrations also increased considerably during the wet season. During the dry season, manganese ranged from 0.4–1.5 mg/kg at 0–15 cm and 0.7–1.8 mg/kg at 15–30 cm, whereas wet-season concentrations increased to 1.2–2.7 mg/kg and 1.6–3.1 mg/kg, respectively. The higher wet-season manganese concentrations may be associated with enhanced decomposition of manganese-bearing minerals and increased ion mobility under wet conditions. Subsurface soils consistently recorded slightly higher manganese concentrations than surface soils, suggesting downward migration and accumulation through leaching. Compared with the ESIA MBIP (2022) control values of 2.9 and 2.0 mg/kg during the dry season, the measured dry-season concentrations were generally lower than the control means. However, wet-season concentrations approached or slightly exceeded the control means of 2.4 and 2.8 mg/kg. For example, the wet-season subsurface manganese concentration reached 3.1 mg/kg, exceeding the control value of 2.8 mg/kg. This indicates moderate manganese enrichment during the rainy season.

4.12 Vegetation Studies

The vegetation of the Project area falls within the Sudan Savannah ecological zone, characterized by scattered trees, shrubs, grasses, and drought-resistant plant species adapted to semi-arid climatic conditions. The vegetation cover within and around the proposed Project site is generally sparse due to human activities such as farming, grazing, bush burning, and infrastructural development.

Plate 4.2: Vegetation Type

Table 4.9: Vegetation Type and Conservation Status

S/N	Common Name	Scientific Name	Vegetation Type	Conservation Status*
1	Neem Tree	*Azadirachta indica*	Exotic Tree	Least Concern (LC)
2	Baobab	*Adansonia digitata*	Indigenous Tree	Least Concern (LC)
3	Shea Butter Tree	*Vitellaria paradoxa*	Savannah Tree	Vulnerable (VU)
4	African Locust Bean	*Parkia biglobosa*	Indigenous Tree	Vulnerable (VU)
5	Acacia	*Acacia senegal*	Savannah Shrub/Tree	Least Concern (LC)
6	Desert Date	*Balanites aegyptiaca*	Drought-resistant Tree	Least Concern (LC)
7	Tamarind	*Tamarindus indica*	Indigenous Tree	Least Concern (LC)
8	Eucalyptus	*Eucalyptus camaldulensis*	Exotic Tree	Least Concern (LC)
9	Guinea Grass	*Panicum maximum*	Grass Species	Least Concern (LC)
10	Spear Grass	*Imperata cylindrica*	Grass Species	Least Concern (LC)
11	Elephant Grass	*Pennisetum purpureum*	Grass Species	Least Concern (LC)
12	Hibiscus Shrub	*Hibiscus sabdariffa*	Shrub	Least Concern (LC)
13	Sickle Bush	*Dichrostachys cinerea*	Shrub	Least Concern (LC)
14	Date Palm	*Phoenix dactylifera*	Cultivated Tree	Least Concern (LC)
15	Wild Fig	*Ficus sycomorus*	Riparian Tree	Least Concern (LC)

Conservation Status Explanation

- *Least Concern (LC): Species that are widespread and currently not at risk of extinction.*
- *Vulnerable (VU): Species considered at risk due to habitat degradation, overexploitation, or environmental pressures.*

Ecological Observations

The Project area is dominated by grasses and scattered drought-tolerant tree species typical of the Sudan Savannah ecosystem. Most plant species identified are common and widely distributed across Northern Nigeria. No critically endangered or endemic plant species were observed within the immediate Project footprint during the baseline assessment.

However, economically important species such as *Vitellaria paradoxa* (Shea Butter Tree) and *Parkia biglobosa* (African Locust Bean) may require conservation attention due to pressures from fuelwood

harvesting, agricultural expansion, and land degradation. Appropriate vegetation management measures should therefore be implemented during Project development to minimize unnecessary clearing and preserve ecologically valuable plant species where practicable**.**

Vegetation within the Sudan Savannah zone of Gombe State is exposed to several environmental stresses and biological agents, including plant pathogens that may affect the health, productivity, and survival of plant species. The occurrence and spread of these pathogens are often influenced by seasonal climatic conditions, especially humidity, rainfall, temperature, and soil moisture.

Table 4.10: Common Plant Pathogens and Their Effects

S/N	Pathogen Type	Common Pathogen	Affected Vegetation	Likely Effects	Conservation Concern
1	Fungus	*Fusarium* spp.	Grasses, shrubs, crops	Root rot and wilting	Moderate
2	Fungus	*Aspergillus* spp.	Stored seeds and crops	Seed deterioration	Low
3	Fungus	*Puccinia* spp. (Rust fungi)	Savannah grasses	Leaf rust and reduced growth	Moderate
4	Bacteria	*Xanthomonas* spp.	Tree and shrub species	Leaf spot and blight	Moderate
5	Virus	Mosaic viruses	Cultivated vegetation	Reduced photosynthesis and growth	Moderate
6	Nematodes	Root-knot nematodes	Agricultural plants	Root deformation and poor nutrient uptake	Moderate
7	Termites (Biological pest)	*Macrotermes* spp.	Trees and woody plants	Stem damage and weakening	High in dry season
8	Parasitic Plant	*Striga* spp.	Grasses and cereal crops	Nutrient depletion and stunted growth	High in farmlands

Seasonal Influence on Pathogens

During the dry season, high temperatures and low humidity reduce the survival rate of many moisture-dependent pathogens. However, drought stress weakens vegetation and increases susceptibility to termite attacks and parasitic infestations such as *Striga* species. Dust accumulation and reduced soil moisture may also limit plant resistance and recovery.

The wet season generally favors the growth and spreads of fungal and bacterial pathogens due to increased humidity, rainfall, and soil moisture. Diseases such as leaf rust, root rot, and bacterial blight are more prevalent during this period because moist conditions promote pathogen reproduction and transmission.

Conservation Considerations

Most vegetation species within the Project area are classified as Least Concern (LC) under conservation categories, indicating that they are relatively widespread and stable. However, some economically and ecologically important species such as:

- *Vitellaria paradoxa* (Shea Butter Tree)

- *Parkia biglobosa* (African Locust Bean)

Wildlife and Conservation Status

Table 4.11: Wildlife and Conservation Status

Common Name	Scientific Name	Group	Conservation Status (IUCN)	Remarks
West African Lion	*Panthera leo senegalensis*	Mammal	Critically Endangered	Extremely rare in West Africa; locally extinct in many areas
African Wild Dog	*Lycaon pictus*	Mammal	Endangered	Declining due to habitat loss and human conflict
Caracal	*Caracal caracal*	Mammal	Least Concern (locally threatened)	Still present but under pressure from hunting
Patas Monkey	*Erythrocebus patas*	Mammal	Near Threatened	Population decreasing, habitat degradation
African Golden Wolf	*Canis lupaster*	Mammal	Least Concern	Adaptable but affected by habitat changes
Spotted Hyena	*Crocuta crocuta*	Mammal	Least Concern	Declining in populated regions
Denham's Bustard	*Neotis denhami*	Bird	Vulnerable	Threatened by hunting and habitat loss
Secretary Bird	*Sagittarius serpentarius*	Bird	Vulnerable	Declining due to agricultural expansion
Northern Ground Hornbill	*Bucorvus abyssinicus*	Bird	Vulnerable	Sensitive to habitat disturbance
Hooded Vulture	*Necrosyrtes monachus*	Bird	Critically Endangered	Rapid decline due to poisoning and human activity
African Grey Hornbill	*Lophoceros nasutus*	Bird	Least Concern	Common but affected by deforestation
Nile Monitor Lizard	*Varanus niloticus*	Reptile	Least Concern	Found near water bodies
African Rock Python	*Python sebae*	Reptile	Near Threatened	Threatened by hunting and habitat loss
Senegal Coucal	*Centropus senegalensis*	Bird	Least Concern	Common in savanna and farmland
Grasshopper (various spp.)	Various	Insect	Not Evaluated	Important for ecosystem food chain

Flora and Fauna of the Project Area

The Project area is located within the Sudan Savannah ecological zone of North-Eastern Nigeria, which is characterized by open grasslands, scattered trees, shrubs, and a variety of wildlife species adapted to semi-arid environmental conditions. Human activities such as farming, grazing, bush burning, and infrastructural development have significantly influenced the natural ecosystem, resulting in relatively sparse vegetation and reduced wildlife diversity within the immediate Project environment.

Flora

The flora of the Project area consists mainly of drought-resistant trees, shrubs, grasses, and herbaceous plant species commonly found in savannah ecosystems. The vegetation is generally open and discontinuous, with grass dominating the ground layer and scattered woody species occurring across the landscape.

Table 4.12: Common Plant Species Identified

S/N	Common Name	Scientific Name	Vegetation Type	Conservation Status
1	Neem Tree	*Azadirachta indica*	Exotic Tree	Least Concern (LC)
2	Baobab	*Adansonia digitata*	Indigenous Tree	Least Concern (LC)
3	African Locust Bean	*Parkia biglobosa*	Savannah Tree	Vulnerable (VU)
4	Shea Butter Tree	*Vitellaria paradoxa*	Indigenous Tree	Vulnerable (VU)
5	Acacia	*Acacia senegal*	Savannah Shrub/Tree	Least Concern (LC)
6	Tamarind	*Tamarindus indica*	Indigenous Tree	Least Concern (LC)
7	Desert Date	*Balanites aegyptiaca*	Drought-resistant Tree	Least Concern (LC)
8	Guinea Grass	*Panicum maximum*	Grass Species	Least Concern (LC)
9	Spear Grass	*Imperata cylindrica*	Grass Species	Least Concern (LC)
10	Elephant Grass	*Pennisetum purpureum*	Grass Species	Least Concern (LC)

Flora Characteristics

The vegetation cover within the Project area is typical of the Sudan Savannah region, with species adapted to prolonged dry seasons and relatively low rainfall conditions. Most of the identified species are common and widely distributed across Northern Nigeria. No endemic or critically endangered plant species were observed during the field assessment.

Fauna

The fauna of the Project area mainly comprises small mammals, reptiles, birds, amphibians, and insects adapted to savannah habitats and human-modified environments. Wildlife abundance within the immediate Project site is relatively low due to ongoing human disturbance and land use activities.

Table 4.13: Common Faunal Species Identified

S/N	Common Name	Scientific Name	Faunal Group	Conservation Status
1	African Giant Rat	*Cricetomys gambianus*	Mammal	Least Concern (LC)
2	Ground Squirrel	*Xerus erythropus*	Mammal	Least Concern (LC)
3	Monitor Lizard	*Varanus niloticus*	Reptile	Least Concern (LC)
4	Agama Lizard	*Agama agama*	Reptile	Least Concern (LC)
5	House Gecko	*Hemidactylus mabouia*	Reptile	Least Concern (LC)
6	Cattle Egret	*Bubulcus ibis*	Bird	Least Concern (LC)
7	Village Weaver	*Ploceus cucullatus*	Bird	Least Concern (LC)
8	Pied Crow	*Corvus albus*	Bird	Least Concern (LC)
9	Grasshopper	*Zonocerus variegatus*	Insect	Least Concern (LC)
10	Termites	*Macrotermes* spp.	Insect	Least Concern (LC)

Fauna Characteristics

The Project area supports mainly adaptable and widespread species capable of surviving under semi-arid and human-influenced conditions. Bird species are relatively common due to the availability of open feeding grounds and scattered vegetation. Small reptiles and rodents are also commonly observed within grassland and shrub areas.

No endangered, endemic, or protected wildlife species were recorded within the immediate Project footprint during the baseline ecological survey. However, seasonal movements of birds and small mammals may occur in response to food availability, rainfall, and habitat conditions.

Ecological Significance and Conservation Considerations

The ecological sensitivity of the Project area is considered relatively low because the site has already experienced varying levels of human disturbance. Nevertheless, certain indigenous tree species such as *Parkia biglobosa* and *Vitellaria paradoxa* possess economic and ecological importance and should be preserved where practicable.

Potential ecological impacts during Project implementation may include temporary vegetation clearing, habitat disturbance, and displacement of small fauna. These impacts are expected to be localized and manageable through proper environmental management measures such as:

- Minimizing unnecessary vegetation removal
- Restricting construction activities to designated areas
- Avoiding bush burning
- Implementing proper waste management practices
- Encouraging re-vegetation and landscape restoration after construction

Overall, the flora and fauna within the Project area are typical of the Sudan Savannah ecosystem and do not indicate the presence of highly sensitive or endangered ecological resources that could significantly constrain the proposed development.

Wildlife Migration Pathways

Field observations and ecological assessments indicate that the proposed Project area does not serve as a major wildlife migration corridor or seasonal migratory route for large mammals or protected fauna species. The surrounding environment is largely characterized by human-modified landscapes including academic buildings, access roads, agricultural fields, and settlement activities, all of which limit large-scale wildlife movement.

Wildlife species commonly observed within the area are primarily small mammals, reptiles, birds, and insects adapted to disturbed savannah habitats. These species generally exhibit localized movement patterns rather than long-distance migration.

Bird Movement

Some seasonal bird movements may occur within the wider savannah ecosystem, particularly during the rainy season when food resources and breeding conditions improve. However, no internationally recognized migratory bird flyways or critical avian habitats were identified within the Project area.

Livestock Movement

Informal movement of domestic livestock such as cattle, goats, and sheep may occasionally occur around surrounding communities due to grazing activities. These movements are socio-economic rather than ecological migration pathways and are not expected to significantly interfere with Project operations.

4.13 Socio-economic and Health Study

This chapter presents the results and analysis of the survey questionnaire conducted as part of the Environmental and Social Impact Assessment (ESIA) for the proposed hybrid solar power plant at Kashere. A total of 40 respondents completed and submitted the questionnaire, providing comprehensive information on socioeconomic and demographic characteristics, health status, standard of living, gender-based violence concerns, environmental and cultural resources, project impact perceptions, and grievance redress mechanisms.

The data collected has been analyzed and presented using various visualization techniques including pie charts and bar charts to facilitate better understanding of the survey findings. The results are organized according to the survey sections: Household Data, Health Status, Standard of Living, Gender-Based Violence/Sexual Exploitation and Abuse, Resources/Cultural Property, Project Activities Impact Evaluation, Grievance Redress Mechanism, and World Bank Environmental and Social Standards (ESS).

Age Distribution and Marital Status

The age distribution of respondents indicates that most of the study population falls within the active and productive age bracket of 18–45 years, accounting for 65% of respondents (26 individuals). This is followed by respondents within the 46–65 years category, representing 30% (12 individuals), while only 5% (2 respondents) were below 18 years of age. The distribution reflects a predominantly young to middle-aged population, which is characteristic of a university environment where students, academic staff, and working-class individuals constitute the larger proportion of the community. The dominance of respondents within the 18–45 years category suggests a socially and economically active population with significant dependence on electricity for academic activities, research, ICT services, communication, and commercial operations. The presence of respondents within the 46–65 years age bracket further indicates the contribution of experienced academic staff, administrative personnel, and business operators who are actively involved in institutional and economic activities within the campus. Overall, the demographic structure demonstrates a population that is highly dependent on reliable electricity supply to support educational, administrative, residential, and commercial functions within the university environment.

The marital status distribution revealed that 55% of the respondents were married, while 45% were single, with no respondent indicating divorce or widowhood as their marital status. The relatively high proportion of single respondents is expected in a university setting, as a large percentage of the population consists of undergraduate students who are predominantly unmarried youths. In contrast, the married respondents were mainly staff members and business operators within the campus community. This demographic composition reflects the mixed social structure of the university environment, where students coexist with employees and entrepreneurs. Married respondents are likely to have greater household and economic responsibilities, making stable electricity supply important for family welfare, productivity, and business sustainability. The findings therefore suggest that reliable electricity supply through the proposed solar photovoltaic project will not only support academic and institutional activities but also improve the socio-economic wellbeing of both students and staff within the university community.

Occupation Distribution

The occupation distribution in Kashere reflects the broader socio-economic structure of rural and peri-urban communities in northern Nigeria, where livelihoods are largely shaped by environmental conditions, cultural practices, and access to resources. The economy is predominantly informal and agrarian, with most residents engaged in primary production and small-scale enterprises.

Agriculture is the dominant occupation in Kashere, employing a large proportion of the population. Farmers cultivate staple crops such as millet, sorghum, maize, and groundnuts, which are well adapted to the semi-arid Sudan savanna climate. Farming is mostly rain-fed and seasonal, with increased activity during the rainy season and reduced productivity during the dry period. In addition to crop farming, many households' practice subsistence agriculture**,** producing mainly for local consumption with limited surplus for sale. Pastoral and agro-pastoral practices are widespread, with herders moving animals in search of pasture and water, especially during the dry season. This occupation plays a crucial role in supporting household livelihoods and food security.

Trade and commerce form another significant component of occupation distribution. Many inhabitants engage in petty trading**,** selling agricultural produce, grains, livestock products, and household goods in local markets. Small-scale businesses such as kiosks, food vending, and craft sales are common, particularly among women and youth. These activities provide daily income and support the circulation of goods within the community.

Artisan and vocational occupations are also present, though on a smaller scale. These include blacksmithing, tailoring, carpentry, leatherwork, and weaving**,** which are traditional skills passed down through generations. Such occupations contribute to local economic diversity and provide essential goods and services to the community.

A portion of the population is involved in public and private sector employment**,** including teaching, civil service, healthcare work, and security services. However, these formal jobs are relatively limited compared to agricultural and informal activities. Youth employment may also include casual labor, transportation services (such as motorcycle riding), and construction work.

Student Population and Staff Strength

The total staff population is 2,519, categorized as follows: Academic Staff: 827, Non-Academic Staff: 1,692, Staff Residing On-Campus: 29.

The relatively small number of on-campus resident staff suggests that most employees commute daily and are affected indirectly by institutional power supply conditions during working hours. The university hosts a large daytime population (~19,878 people) including students and staff. Approximately 2,346 persons reside on campus, indicating constant (24-hour) electricity demand.

High student population suggests significant electricity demand for: Teaching and learning, Research activities, ICT infrastructure and Residential services. The solar project will therefore support both academic productivity and residential welfare.

Diesel Consumption Profile (Last 5 Years)

The analysis of grid electricity expenditure over the last five years indicates that the university spent a total of ₦141,304,215 on public electricity supply. Although this amount appears relatively moderate for an institution of such size and operational capacity, it strongly suggests that the university experiences irregular and unreliable public power supply. The relatively low expenditure on grid electricity implies that the institution cannot depend solely on the national grid to meet its energy demands and has therefore resorted to alternative energy sources to sustain academic, administrative, residential, and commercial activities. In many Nigerian institutions, unstable grid electricity is characterized by frequent outages, voltage fluctuations, and inadequate supply duration, all of which can negatively affect institutional productivity and service delivery.

The assessment further revealed a very high dependence on diesel-powered generators as the major alternative source of electricity. Over the same five-year period, the university consumed approximately 900,000 litres of diesel at a total cost of ₦954,000,000. This translates to an average annual diesel consumption of 180,000 litres and an estimated yearly expenditure of about ₦190,800,000. The diesel expenditure is significantly higher than the total amount spent on grid electricity, indicating that diesel generators account for the dominant share of the institution's energy supply system. This situation reflects the extent to which unreliable public electricity has forced the university to depend on self-generated power to maintain continuous operations across academic facilities, laboratories, administrative offices, hostels, healthcare facilities, and commercial centres within the campus.

The heavy dependence on diesel generators has major financial implications for the institution. The enormous annual expenditure on diesel increases operational costs and places considerable pressure on the university's financial resources. Funds that could otherwise be invested in academic development, research infrastructure, staff welfare, and student services are instead directed toward fuel procurement and generator maintenance. In addition, the university remains highly vulnerable to fluctuations in fuel prices, which can lead to unpredictable increases in energy expenditure and long-term financial instability. The high cost of diesel generation also reduces the overall efficiency and sustainability of the institution's energy management system.

Beyond the economic implications, extensive diesel usage presents serious environmental concerns. Diesel combustion contributes significantly to greenhouse gas (GHG) emissions, which are major contributors to global climate change. In addition, diesel generators produce air pollutants such as particulate matter (PM), nitrogen oxides (NOx), and sulphur oxides (SOx), all of which negatively affect air quality and public health. Continuous generator operations also generate excessive noise pollution, which may disrupt academic activities and reduce environmental comfort within the university environment. The dependence on diesel therefore results in a high institutional carbon footprint and contributes to environmental degradation.

The proposed solar photovoltaic (PV) project offers a sustainable solution to these challenges by reducing the university's reliance on diesel generators and unstable grid electricity. The adoption of solar energy is expected to significantly lower operational energy costs, reduce greenhouse gas emissions, improve environmental quality, and enhance energy reliability across the campus. In addition, the project will

promote clean energy transition and support sustainable institutional development while contributing positively to national and global environmental sustainability goals.

Gender Equity in the Community

Nigeria's legal and policy framework provides a strong foundation for the promotion of gender equality and social inclusion. Section 42 of the Constitution of the Federal Republic of Nigeria guarantees freedom from discrimination on the basis of sex, gender, religion, or ethnicity, thereby ensuring equal rights and opportunities for all citizens. In addition, the National Gender Policy (2021–2026) serves as the country's primary framework for advancing gender equality by addressing gender gaps, promoting women's empowerment, and advocating for 35% affirmative action in political and decision-making positions. The policy also emphasizes equal access to education, employment, leadership opportunities, and socio-economic resources for both men and women. These constitutional and policy provisions collectively support inclusive participation and provide a legal basis for ensuring fairness and equality within institutions and communities.

The findings from the study indicate different approaches through which gender equity is promoted within the community. About 30% of respondents stated that women are elected into public offices, while 25% indicated that gender quotas are maintained in the leadership of community-based organizations. However, the largest proportion of respondents (45%) identified equal access to education and employment opportunities for women as the primary means of ensuring gender equity. This suggests that educational and economic empowerment are widely recognized as essential tools for promoting inclusion and reducing gender disparities. In the university environment, equal access to education and employment enhances women's participation in academic, administrative, and economic activities, thereby contributing to social development, institutional productivity, and improved socio-economic wellbeing within the community.

Vulnerable Group

Vulnerable groups are individuals or populations who, due to certain conditions or circumstances, are at a higher risk of harm, discrimination, or exclusion from social, economic, educational, or health opportunities. They often need special protection, support, or attention in policies, institutions, and community programs to ensure fairness and inclusion. At a university level, vulnerable groups may include Students with disabilities, Students from extremely poor backgrounds, Female students facing gender-related challenges, international students or minorities, Students with mental health difficulties. The Command's does not have any cadet with disabilities.

Resources/Cultural Property

This section assesses environmental challenges in the community and potential impacts of the proposed project on natural and cultural resources.

Expected Environmental Problems from Project Construction

Remarkably, 80% of respondents indicated that they do not expect any of the listed environmental problems (soil infertility, poor drainage, bad roads, low visibility, erosion, flooding, environmental degradation,

infrastructure destruction, land encroachment, or pollution) to result from the proposed solar power project during construction. This unanimous perception reflects strong confidence in the project's environmental safety and proper management.

Positive Impacts of the Proposed Project

Respondents identified multiple positive impacts expected from the project, including constant power supply, increased productivity and efficiency, enhanced research and academic output for lecturers and students, promotion of economic development and prosperity, and reduction of noise and global warming. No negative impacts were identified by respondents, further demonstrating strong community support.

Community Expectations from the Project

The survey revealed several key expectations from the community. Employment of locals and contracting opportunities during construction was expected by 80% of respondents, capacity building for maintenance during implementation by 90%, and community input into final engineering design by 20%. Additionally, respondents emphasized the importance of durability, proper maintenance, and adequate security to protect against theft and robbery.

Grievance Redress Mechanism

The Grievance Redress Mechanism (GRM) within institutional environments in Gombe State plays an important role in promoting fairness, accountability, and peaceful conflict resolution among students, staff, and other stakeholders. Grievance may arise from academic concerns such as grading disputes, supervision challenges, and examination results, as well as administrative issues including delays, misconduct, harassment, discrimination, or unfair treatment in the workplace. Within institutions such as universities and training establishments in Gombe State, an effective GRM provides a formal and transparent process through which complaints can be reported, reviewed, and resolved without fear of victimization. The mechanism is guided by key principles including fairness, impartiality, confidentiality, timely resolution of complaints, non-retaliation against complainants, and proper documentation for accountability purposes. In the context of institutional development projects and educational administration within Gombe State, a functional GRM is essential for maintaining trust, protecting the rights of stakeholders, improving institutional governance, and ensuring a peaceful academic and working environment conducive to learning and productivity.

Step-by-Step Process of Grievance Redress

- Informal Resolution
- Departmental / Faculty Level
- Grievance Committee
- Appeal to the Commandant
- Grievances in the Last Three Years
- Grievance Reporting Channels
- Satisfaction with Grievance Resolution
- Specific Concerns about the Project

CHAPTER FIVE
ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

The project has overall positive impacts by providing a competitive, cost-effective, pollution-free, and reliable mode of solar power. It will certainly meet the ever-increasing demand for power and bridge the gap between demand and supply of power. However, the proposed project may have some negative impact on the environment during site preparation, construction & operation phases. During the construction phase, the impacts may be regarded as temporary or short-term; while long-term impacts may be observed during the operation stage.

5.2 Impact Assessment Overview

The potential for an Environmental and Social impact exists where an environmental and social aspect has been identified i.e. where a project activity has been determined to have the potential to interact with the biophysical and socio-economic environment.
The assessment process was as follows:

- Identification of the various potential impacts using an interaction matrix to show the relationship/ interaction between the project environmental components and planned project activities.
- A screening of potential impacts associated with each phase of the project is performed using a Risk Assessment Matrix, and
- A detailed evaluation of the individual impact-producing factors that comprise each aspect of the project phases is then performed. The significance of the potential impacts is quantified using the same rationale as for the screening.

The assessment of impact significance is both in qualitative and quantitative terms. Qualitatively, the impact significance is ranked on four (4) widely accepted levels: Major, Moderate, Minor and Negligible. The impact assessment covers the entire life cycle of the Project. i.e.: preconstruction, Construction, operation, and decommissioning.

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

A number of project activities would be carried out in phases. These planned activities are what would impact on the environmental components positively or negatively. The PV-based power plant project activities are grouped into five phases as follows:

Pre-Construction phase: Involves activities such as award of contract, project design and planning, consultation, recruitment, site preparation and transportation of the utility scale PV based power plant components to site.

Construction phase: It involves activities such as mobilization of workforce and equipment to site, digging, trenching, bulldozing, grading, soil compaction; and installation of temporary camp and power plant components. This phase is usually a short term one. Commissioning phase: It involves the integrated application of a set of engineering techniques and procedures to check, inspect and test every operational component of the project, from individual functions, such as instruments and equipment, up to complex

amalgamations such as modules, subsystems and systems. Operational phase: This is usually 'long term', involving activities from post construction to pre-decommissioning. It commences once the power plant has been commissioned for use. Activities include use of natural resources (water for domestic uses and cleaning of solar modules), plant and equipment operations, and routine maintenance of equipment and plant. Decommissioning phase: It begins once the power plant use is discontinued or the project life span has come to an end. It should be noted that impacts can occur at any time; during these phases mentioned above i.e. pre-construction, construction and operational phases of the project. Some impacts may, however, occur in some or all phases of the project. To identify environmental and social aspects of the Project, the proposed Project activities were considered in terms of their direct or indirect potential to:

- Interact with the existing natural environment including its physical and biological elements;
- Interact with the existing socio-economic environment; and
- Breach relevant policy, legal and administrative frameworks including national legislation, relevant international legislation/conventions, standards and guidelines, and corporate environmental policy and management systems.

The FMEnv EIA Procedural Guidelines and the World Bank Safeguard Systems and ISO 14001 approach among other references were used in the identification process. The assessment approach generally involved matching the various activities of the different stages of the proposed project (as described in Chapter 3 of this report) with the components of the existing environment. Consequently, the possible changes (and extent of changes) in the environment because of the interactions have been identified/ evaluated, hence mitigation measures are proffered in order to reduce, offset or ameliorate such changes. The potential/ associated adverse and beneficial impacts of the proposed power plant project on the existing environment were identified at this stage of the ESIA.

The Risk Assessment Matrix (RAM) has been employed in determining risks posed by the identified potential/associated impacts of the project to proffer appropriate mitigation measures. In predicting impacts, the experiential/practical 'worst case scenario' approach has been applied to determine the extreme effects of project activities on environmental components, while 'consensus of opinions' has been used to determine the importance of affected environmental components. The impact evaluation results make up the pedestal for developing the ESMP of the proposed project.

5.3.1 Potential Impact Characterization

The following characteristics were also used to define potential impacts that may be associated with the proposed Project:

- Negative: An impact that is considered to represent an adverse change from the baseline or to introduce a new undesirable factor.
- Positive: An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor.
- Direct: Impacts that result from the direct interaction between a planned project activity and the receiving bio-physical and socio-cultural environment.
- Indirect: Impacts that result from other activities that are encouraged to happen because of the project.
- Temporary: Temporary impacts are predicted to be of short duration, reversible and intermittent/occasional in nature

- Short-term: Short-term impacts are predicted to last only for a limited period but will cease on completion of the activity, or as a result of mitigation measures and natural recovery
- Long-term: Impacts that will continue for the life of the project but cease when the project stops operating.
- Permanent: Potential impacts that may occur during the development of the project and cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime
- On-site: Impact that is limited to the project site.
- Local: Impacts that affect locally important environmental resources or are restricted to a single (local) administrative area or a single community.
- Regional: Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries.
- National: Impacts that affect nationally important environmental resources; affect an area that is nationally protected; or have macroeconomic consequences
- Reversible: An impact that the environment can return to its natural state.
- Irreversible: An impact that the environment cannot return to its original state, e.g. the extinction of an animal or plant species
- Cumulative: Potential impacts that may result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project. This also includes synergy with other projects/infrastructure in the project area
- Residual: Both environmental and social impacts that will remain after the application of mitigation measures to project impacts during each of the project phases.

5.3.2 Screening and Scoping for Potential Impacts

The first step in identifying impacts associated with the project is the development of an interaction matrix which shows the relationship/ interaction between the project's environmental and social components and planned project activities. A modified version of the Leopold Interaction-matrix technique was employed to screen and scope for the potential impacts of the proposed Project on the environment. The basis for the screening was derived from the following:

- Knowledge of Project activities.
- Detailed information on the environmental and socio-economic setting of the Project’s area of influence.
- Consultation with relevant stakeholders.
- Review of other ESIA reports on similar projects/environments

Table 5.1: Project Activities – Leopold's Environmental and Social Interaction Matrix (Impact Significance Matrix)

Project Phase	Activity	Air Quality	Ambient Noise	Soil	Landscape / Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities Infrastructure	Employment / Income	Gender Issues	Construction Workers (H&S)	Workplace Health & Safety	General Public
Pre-construction Phase	Site selection	X													
	Site clearing and preparation	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Mobilization of equipment & materials	X	X	X	X										
Construction Phase	Civil works (excavation, trenching, cable laying, foundation, buildings)	X	X	X	X	X	X	X	X	X					
	Installation of power plant & infrastructure	X	X	X	X	X									
	Waste generation and disposal	X	X	X	X	X			X	X	X	X	X		
Commissioning Phase	Testing of power plant & infrastructure	X	X	X											
Operational Phase	Power generation, distribution & training	X	X	X	X			X	X	X	X	X			
	Routine maintenance;	X	X	X	X	X	X	X	X	X					

Project Phase	Activity	Air Quality	Ambient Noise	Soil	Landscape / Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities Infrastructure	Employment / Income	Gender Issues	Construction Workers (H&S)	Workplace Health & Safety	General Public
	waste generation & disposal														
Decommissioning	Loss of employment and business opportunities														
	Reduced power supply to the University		X	X	X	X	X	X	X	X	X	X	X		X
	Risk of injuries from collision with abandoned structures	X	X	X	X	X	X	X	X	X	X	X	X		X
	Risk of accidents during demolition activities		X	X	X	X	X	X	X	X	X	X	X		X
	Increased dust and vehicular emissions	X	X	X	X	X	X	X	X	X	X	X	X		X
	Traffic obstruction from movement of vehicles		X	X	X	X	X	X	X	X	X	X	X		X
	Availability of land for alternative uses	X	X	X	X	X	X	X	X	X	X	X	X		X
	Loss of site aesthetic quality (abandoned/dilapidated structures)	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 5.2: EEP III Solar Power Plant Impacts Categorization -Project Activities and Associated Potential Impacts Matrix

Project Phase / Activity	Associated & Potential Impacts	Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulative	Short Term	Long Term
Pre-construction Phase	Employment opportunities from recruitment	X			X	X			X	
	Business opportunities for local contractors	X			X	X		X	X	
	Skill acquisition and workforce enhancement	X			X	X		X		X
	Improvement in quality of life (compensation)	X			X	X				X
	Conflicts over employment (quotas, methods)		X	X		X		X	X	
	Disputes over MoU with project proponents		X	X		X		X	X	
	Influx of migrant workers & pressure on infrastructure		X	X		X		X	X	X
	Increase in social vices (theft, prostitution)		X	X		X		X	X	X
	Agitations over land disputes & leadership tussles		X	X			X	X	X	X
	Loss of vegetation & forest resources	X		X			X	X		X
	Increased risk of accidents during mobilization	X		X		X			X	
	Risk of armed robbery / hostage situations		X	X			X	X	X	X
	Noise and vibration from heavy equipment	X		X		X		X	X	
	Dust and vehicular emissions	X		X		X		X	X	
	Waste generation (scrap, domestic waste, etc.)	X		X		X		X	X	X

Table 5.3: Commissioning and Operational Phases – Potential Impact Matrix

Project Phase / Activity	Associated & Potential Impacts	Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulative	Short Term	Long Term
Commissioning Phase	Testing and commissioning power supply	X			X	X			X	
Operational Phase	Improved quality of life due to enhanced power supply	X			X	X		X		X
	Improvement in air quality (reduced generator emissions)		X		X	X		X		X
	Reduced demand for petrol and diesel for power generation		X		X	X		X		X
	Injuries/fatalities from operational accidents	X		X			X	X	X	X
	Soil/groundwater contamination from oil/fuel spills	X		X		X		X	X	X
	Workplace accidents (cuts, trips, falls)	X		X		X		X	X	
	Skill acquisition for plant operation personnel	X			X	X		X		X

Table 5.4: Decommissioning Phase – Potential Impact Matrix

Project Phase / Activity	Associated & Potential Impacts	Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulative	Short Term	Long Term
Decommissioning Phase	Loss of employment and business opportunities	X		X		X		X		X
	Reduced power supply to the University	X		X		X			X	X
	Risk of injuries from collision with abandoned structures	X		X		X			X	
	Risk of accidents during demolition activities	X		X		X		X	X	
	Increased dust and vehicular emissions	X		X		X		X	X	
	Traffic obstruction from movement of vehicles		X	X		X		X	X	
	Availability of land for alternative uses	X			X	X				X
	Loss of site aesthetic quality (abandoned/dilapidated structures)	X		X			X	X		X

5.4 Determination of Impact Significance

The significance of impacts that could occur due to the implementation of the project's activities was established based on three steps, which are:

- Impact Magnitude, which combines the extent, duration, scale, and frequency of an impact
- Value/ Sensitivity/ Fragility and importance of the relevant Receptor.
- Identification of the impact significance, which is the cumulative indicator of both above two key variables.

The magnitude of an effect requires quantifying the sources of potential environmental and socio-economic effects from routine and non-routine project activities, such as the extent of land take or predicted change in noise levels. On the other hand, the receptor sensitivity is derived from factors such as:

- Legislative controls.
- Designated status within the land use planning system;
- Number of affected individual receptors;
- Ability of the resource or receptor to absorb change; and
- Public perception about the criticality or sensitivity of the receptors.

The determination of impact significance also entails considering compliance with environmental policies, quality standards and set pollution limits.

5.4.1 Method for Determining Impact Magnitude

Potential negative impacts were assigned Negligible, Low, Medium, and High labels based on their magnitude while for positive impacts, it sufficed to indicate that the project is expected to result in a particular positive impact without assigning a magnitude to it.

5.4.1.1 Defining Magnitude Levels for Biophysical Impacts

A High Magnitude Impact is considered to affect an entire area, physical system or species at sufficient magnitude to cause a significant measurable numerical increase in measured concentrations or levels (when compared with national or international limits and standards specific to the receptors) or a decline in species abundance beyond which natural process would not return that population or species, to its former level within several generations.

A Medium Magnitude Impact occurs at a sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels and may bring about a change in species abundance but does not threaten the integrity of that population or any population dependent on it.

A Low Magnitude Impact affects a specific area, system, aspect (physical), group of localized individuals within a population (biological), and at sufficient magnitude to result in a small increase in measured concentrations or levels over a short time period but does not affect other trophic levels or the population itself, and a localized area.

A Negligible Magnitude Impact results in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation.

5.4.1.2 Defining Magnitude Levels for Socio-economic Impacts

For socio-economic impacts, the magnitude is based on the perspective of those who would be affected by the impact; this considers the likely perceived importance of the impact, the ability of people to manage and adapt to change caused by the impact and the extent to which a human receptor gains or loses access to, or control over socio-economic resources resulting in a positive or negative effect on their well-being. The event magnitude rankings are shown in Table 5.5.

Table 5.5: Event Magnitude Rankings

Importance Level	Description / Attributes
High	• Highly undesirable outcome (e.g., impairment of endangered or protected habitat/species) • Detrimental and prolonged changes to flora and fauna behavior (breeding, spawning, moulting) • Major reduction or disruption in value, function, or service of impacted resource • Occurs during environmentally sensitive periods • Continuous non-compliance with international best practices • Significant negative impact on livelihoods, income, or living conditions affecting a large population, leading to economic loss and possible protests • Reputational damage and/or revenue loss threatening business viability • Increased public health risk leading to injury or fatality • Damage to public infrastructure (e.g., sewer, water pipeline), causing wider environmental or socio-economic impacts
Medium	• Noticeable negative outcome • Measurable reduction or disruption in value, function, or service of impacted resource • Potential non-compliance with international best practices • Moderate negative impact on livelihoods, income, or living conditions • Temporary business disruption causing minor revenue loss • Increased public health risk is manageable with mitigation measures • Disruption to public infrastructure (e.g., road closures) causing inconvenience
Low	• Imperceptible or minimal outcome • Insignificant change in value, function, or service of impacted resource • Fully compliant; no controls required • Minor, localized, temporary, and reversible nuisance to livelihoods or living conditions • Temporary business disruption without revenue loss or reputational impact • No change in community health status • Minor inconvenience from temporary infrastructure disruption

5.4.2 Determining Receptor Sensitivity

Receptor sensitivity refers to the socio-economic and environmental importance of the receptor, including human dependence on the receptor for food and income. It basically considers the type of receptor (namely, biological/ecological, human, and physical receptors) and the impacts that directly affect people. Vital natural resources are considered more important than indirect impacts.

Where the receptor is physical (for example, soil environment) its current quality, sensitivity to change, and importance (on a local, national and international scale) are considered. Where the receptor is biological (for example, the aquatic environment), its local, regional, national or international importance and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered. The receptors' sensitivity is categorized as Low, Medium and High and the criteria for ranking the receptor sensitivity are defined in Table 5.6.

Table 5. 6: Receptor Sensitivity Ranking

Sensitivity Level	Description / Attributes
Low	• Receptors have a moderate to high capacity to adapt to change and maintain or improve quality of life • Individuals who can quickly adapt to temporary disruptions in living conditions, livelihoods, or public infrastructure (e.g., road closures) • Businesses with robust economic models that can easily adjust to restrictions or even benefit from changes
Medium	• Receptors have limited capacity to adapt to change and maintain or improve quality of life • Individuals who depend heavily on their livelihood and have limited ability to adapt to changes • Businesses with limited flexibility that are sensitive to reductions in revenue or reputational impacts
High	• Receptors are vulnerable with little or no capacity to adapt to change or maintain quality of life • Includes vulnerable groups such as homeless individuals, internally displaced people, people without land titles, migrants, or seasonal herders • Individuals with marginal livelihoods, low income, or poor living conditions • Individuals vulnerable due to age, disability, or other factors requiring special assistance • Businesses with marginal economic viability that cannot easily adapt to change

5.4.3 Significance

Risk Assessment Matrix

Magnitude ↓ / Sensitivity →	Low Sensitivity	Medium Sensitivity	High Sensitivity
High Magnitude	Minor	Moderate	Major
Medium Magnitude	Minor	Moderate	Major
Low Magnitude	Negligible	Minor	Moderate

Negligible Significant impacts are where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be 'negligible' or 'imperceptible' or is indistinguishable from natural background variations. An impact of minor significance is one where an effect will be experienced. Still, the impact severity is sufficiently low (with or without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value. An impact of moderate significance is one within accepted limits and standards. Moderate impacts range from a threshold below which the impact is minor, up to a level that might be just short of breaching a permissible limit. Thus, impacts of Negligible, Minor, or Moderate significance are considered as being mitigated as far as practicable and necessary, and therefore, do not require further mitigation.

An impact of major significance is one in which acceptable limits or standards may be exceeded, or a high-magnitude impact occurs to highly valued/sensitive receptors/resources, and for such negative impacts, additional mitigation is required.

Table 5.7: Impact Magnitude Ranking												
Phase	**Activity**	**Air Quality**	**Noise**	**Soil**	**Groundwater / Aquifer**	**Flora**	**Fauna**	**Land Use**	**Infrastructure / Utilities**	**Employment / Income**	**Public Health & Safety**	**Workers Health & Safety**
Pre-construction	Site selection	2(2)	–	–	–	–	–	–	–	–	–	–
	Site clearing & preparation	2(2)	2(2)	2(2)	–	2(1)	–	3(1)	3(1)	+	2(2)	–
	Mobilization of equipment & materials	2(2)	2(2)	–	–	–	–	2(2)	+	–	–	–
Construction	Civil works (excavation, trenching, cable laying, buildings)	2(2)	2(2)	3(1)	2(2)	–	–	3(2)	++	–	2(2)	2(3)
	Installation of plant, batteries, infrastructure	2(2)	2(2)	3(1)	–	–	–	2(2)	–	–	–	–
	Waste generation & disposal	2(2)	–	2(2)	2(1)	–	–	+	–	–	2(2)	2(2)
Commissioning	Testing of plant & infrastructure	2(1)	–	–	–	1(1)	–	1(1)	–	–	–	–
Operational	Power generation & distribution	2(1)	–	–	–	–	–	++	–	–	–	–
	Routine maintenance & waste disposal	2(2)	–	2(2)	2(2)	–	–	2(2)	2(2)	–	2(1)	1(2)
Decommissioning	Land recovery	-	-	-	-	–	–	-	++	–	-	-
	Waste management	2(2)	2(2)	3(1)	2(2)	–	–	2(2)	–	–	–	–

Receptor sensitivity ranking: 1 = Low; 2 = Medium; 3 = High. Impact Magnitude Ranking: 1 = Negligible; 2 = Low; 3 = Medium; 4 = High

5.5 Impacts Discussion

5.5.1 Potential Positive Impacts

The proposed Project seeks to provide an independent and reliable power supply to the Academy through solar energy sources and thus, improve the quality of education and other services within the institution as there will be longer hours available with better illumination for studying. Ultimately, the activities of the project will contribute to the achievement of Nigeria's carbon emission reduction targets (20% reduction by the year 2030) in fulfilment of the nation's Nationally Determined Contributions (NDC) to climate change. The positive impacts' significance is thus considered **high.**

Within the project area, there will be reduced noise and pollutants from generator sets, and natural habitats and human health will be protected from pollution arising from the use of fossil fuels. The renewable energy training centre constructed during the project implementation will provide capacity development through learning renewable energy technologies and practices in the University and consequently, the certification of trained individuals. The positive impacts' significance is thus considered **moderate.**

The installation of streetlights as part of the proposed Project will improve safety by reducing hazards associated with flammable fuels and candles and enhance security within the school. The positive impacts' significance is thus considered **moderate.**

In addition, the project will improve social cohesion and community development and generate new income as it would stimulate economic activities and offer new opportunities for small businesses in the University premises. The employment opportunities for skilled, semi-skilled, and unskilled labour associated with the project will multiply job creation, especially during construction to facilitate overall socioeconomic development. The positive impacts' significance is thus considered **moderate.**

5.5.2 Potential Negative Impacts

The potential adverse impacts from project activities are grouped into the following subjects and discussed further according to the different applicable phases – Preconstruction, Construction, Operation and Decommissioning phase:

- Land use
- Impacts from equipment, personnel and plant material movement;
- Impact on traffic;
- Impact on air;
- Impacts from noise and vibration;
- Impacts on terrestrial flora and fauna;
- Impact on water resources
- Impacts on waste generation;
- Impact on soil quality;
- Visual/ aesthetic impact;
- Social economic impacts;
- Health impacts; and
- Impacts from workplace hazards.

5.5.2.1 Preconstruction/ Mobilization Phase

The pre-construction phase of the proposed Project includes the following activities:

- Site selection
- Site clearing and preparation
- Mobilization of equipment, materials and personnel to site

Site Selection

The Project site is characterized by farmlands (covering approximately 20% of the land) and vegetation which includes grass, shrubs, and a few trees. There are no physical structures on the site. The farmlands are cultivated by staff of school. It was gathered from the University management that the farms plots are usually allocated to staff for short periods or seasonal farming.

Though the management specifies that land is always available for farming for staff, and the land uptake will not pose a risk to the secondary income or food source for the staff, the land take for the project will however result in loss of access to land for the staff pending reallocation to other land areas. Thus, the impact significance of site selection for the proposed Project on the existing land use is rated moderate.

Site Clearing and Preparation

The project site will be cleared of vegetation prior to construction activities. The site clearing activities would involve the use of earth-moving equipment such as tractors. The potential impacts associated with the site clearing activities are discussed as follows:

Potential Impact on Terrestrial Flora and Fauna

Site clearing activities associated with the proposed Project will lead to loss of terrestrial flora on the Project site. The potential impact on the terrestrial flora is considered negative, direct, site specific and largely irreversible. The impact magnitude is medium considering that not all the land area (12.8ha) will be cleared for the Project. However, the sensitivity /importance of the receptor is regarded as low since the Project site is a modified habitat, and none of the plant species identified within the Project site during the baseline survey was found to be endangered or threatened based on the International Union for Conservation of Nature (IUCN)-2018 classification scheme. Also, the local community has no direct or indirect ecosystem services they benefit from the site. Furthermore, there are no protected/conservation areas within the site. The significance of the potential impact of site clearing on the existing terrestrial flora species of the Project site is therefore regarded as minor.

While the plant species are unable to avoid the point of impact, most fauna species may be able to migrate away from unfavourable areas. Animals are generally mobile and, in most cases, can move away from a potential threat. The tolerance levels of some animal species are of such nature that surrounding areas will suffice in habitat requirements of species forced to move from areas of impact.

About the clearing of the Project site prior to the construction phase, the potential impact on terrestrial fauna species may include loss of individual or localized population of fauna species or disturbance to

avifauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species (including avi-fauna) encountered or reported in the project site belongs to the IUCN classification of threatened animal species which include those classified as critically endangered, endangered or vulnerable. The sensitivity of the fauna species recorded on the Project site is thus regarded as **low**. The impact magnitude is **low** given that the site clearing activities would cover approximately 12.8 ha of land allocated for the Project. The potential impact is direct, irreversible, short term and localized. The impact significance is thus considered **minor**.

Potential Impact on Soil

The proposed site clearing and preparation activities could potentially impact the soil environment of the Project site. The potential effects on soil include degradation due to site preparation e.g. compaction of oil because of the movement of earth moving equipment. Soil degradation is the removal, alteration, or damage to soil and associated soil forming processes, usually related to human activities. The stripping of vegetation or disturbance to the natural ground level over disturbance areas will negatively affect soil formation, moisture levels, soil density, soil chemistry, and biological activity. Uncontrolled site clearance of vegetation could lead to direct surface soil exposure and hence erosion of soil which could be significant. The impact magnitude is considered as **medium** as the extent of soil erosion could be high, especially if the site clearing activities are carried out in the wet season. However, based on the results of laboratory analysis conducted on soil samples from the Project area, the Project site is not considered to be significantly prone to land-based erosion. Thus, the impact and significance of site clearing on soil environment of the study area is considered **minor**.

Potential Impact on Air Quality and Ambient Noise

The pollutants which could impair air quality during site clearing activities are particulate matter in form of dust, and NOx, CO, Total Suspended Particulates (TSP), SOx from combustion engines of the earth-moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is low since the activities will be short-term, intermittent, localized and reversible. The site clearing activities will take less than 1 week. The sensitivity of the airshed of the Project area is also regarded as low based on the results of air quality measurements conducted in the area during the field data gathering. The impact significance of site clearing on the ambient air environment of the Project site is **minor**.

Potential Impact on Workers' Safety

Site clearing and preparation are potentially hazardous activities. Accidents may occur especially when those involved are unskilled. Such accidents may result in loss of man-hours, which may ultimately affect the schedule date of completion of the Project development, especially if the man-hour losses are high. The site clearing activities will take about 1 week and the number of workers required will be less than 10. The impact significance is considered to be **minor**.

Mobilization of Equipment, Materials and Personnel to Site

In executing the proposed project, a great deal of haulage/ movement would be undertaken all through the phases of the project. Movements would include transportation of equipment and personnel for construction

and operational phases; and movement of plant components to project site for construction and installation. Anticipated impacts during the mobilization of equipment and personnel to site will include:

Potential Impact on Air Quality and Ambient Noise

Construction equipment and materials will be moved to the Project site prior to the commencement of main construction activities. The potential biophysical impacts associated with the mobilization activities include decrease in ambient air quality of the Project area as a result of emissions from vehicles that will convey materials and equipment to site.

It is anticipated that the potential impacts will be similar to those experienced during site clearing activities. The capacity for assimilation of vehicular emissions and dust associated with the mobilization activities in the Project's AoI is considered to be high. The overall impact significance of mobilization activities on the ambient air quality and noise of the Project area is rated **minor**.

Potential Impact on Infrastructure (Road) Regarding safety along the project route, the mobilization activities during the preconstruction phase of the Project could increase the traffic volume in the Project area (and potential for road accident) as a result of movement of vehicles in and out of the Project site. The social aspects of these activities could lead to accidents, traffic congestion and annoyance from other road users in the area. The magnitude of the impact is considered low since the mobilization activities would be within 1 week. The sensitivity of the receptors is judged as medium given that the existing vehicular movement in the University environment is high. The prominent means of transportation are cars, motorcycles/tricycles, and buses/trucks. The impact significance is considered to be **minor**.

Potential Impact on Workers' Safety

Mobilization of construction materials will involve offloading of heavy consumables such as cement, gravel, etc. Injuries and accidents may occur especially when those involved are unskilled. It is expected that the potential impacts will be similar to those experienced during site clearing and preparation activities. The impact significance is **minor**. Table 5.8 summarizes the potential impacts associated with the pre-construction phase of the proposed Project.

Table 5. 8: Summary of Potential Negative Impacts Associated with the Pre- Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Site Selection/ land	Existing crop farming on site	• Loss of land for farming activities due to land Take for the Project	Moderate
Site clearing and preparation	Terrestrial flora and fauna	• Vegetation loss • Direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project site	Minor

	Soil	• Loss of topsoil • Soil compaction and degradation • Increased erosion potential • Reduction in structural stability and percolative ability of soil	Minor
	Air Quality and Noise	• Air quality impacts due to emissions from site clearing equipment • Increase in ambient noise levels	Minor
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor
Mobilization of construction equipment and materials to site	Air Quality and Noise	• Air quality impacts from vehicular emissions (TSP, NOx, CO, SOx) • Increase in noise levels	Minor
	Infrastructure (road)	• Increase in vehicular movement and traffic including potential for road accident	Minor
	Workers Safety	• Injuries and accidents to workers during loading and offloading of construction materials.	Minor

5.5.2.2 Construction Phase

The construction phase of the proposed Project will include activities such as civil and electrical works (excavation, trenching, concrete mixing, etc.), installation of PV panels and associated components; construction of training centre; installation of streetlights, upgrade of existing electricity distribution infrastructure; and waste generation and disposal.

The potential environmental and social impacts associated with the construction phase of the proposed Project are assessed and discussed as follows:

Equipment, Personnel and Plant Material Movement

As part of the construction phase, personnel and materials would be transported to site on need basis. Transportation could be from workers or visitors to the site. Vehicles to be deployed for construction purposes would include saloons, SUVs and heavy-duty vehicles (such as trucks, excavators, etc).

Movement of vehicles during this phase is important and cannot be avoided as such would impact significantly on the environment as well as on people living within the area in the following ways:

- Vehicular emission of pollutant gases (such as CO, SO2 and NO2) from vehicle exhaust;
- Contribution to global gas warming and ozone layer depletion from pollutant gases emitted from vehicles;
- Increased traffic movement of heavy-duty truck en-route project site;
- Potential accidents to personnel and asset from vehicle movement during construction; and

- Dust emission arising from construction activities at the project site.

The impact from equipment, personnel and plant material movement on surrounding receptors is therefore considered to be of moderate significance prior to mitigation and steps will be taken to minimize the effects.

Civil and Electrical Works, and Installation of Plant Facilities

Potential Impact on Air Quality

At installation and construction phases of the project, the potential sources of emissions would include dust, particulate matter (PM), emissions from heavy trucks and earthmoving equipment that will be operated on the project site. Exhaust emissions during material transportation, stockpiling and equipment transfer during construction activities. It is proposed that the construction phase of the Project would take up to 12 months. These emissions will be localized to the construction site area and will be short-term, the extent of impact would therefore be **medium,** and its significance is rated **minor**

Potential Impact on Noise Levels

The primary short-term noise and vibration impacts are associated with construction and decommissioning activities. During construction activities, work equipment will result in increased noise level and vibration in the area, although noise would not cause a major disturbance to its surroundings. The potential source of noise during the construction phase of the Project includes civil work and installation activities, vehicular movement and operation of construction equipment may lead to elevated noise levels beyond the baseline concentration. Noise may cause a major disturbance to fauna species such as birds and mammals in the area.

These would move further into the forest to avoid the disturbance.

The noise levels from construction activities would be intermittent and localized and are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location. The potential impact magnitude is regarded as low due to the envisaged low extent of its effect. The overall impact significance is considered minor.

Potential Impact on Soil

The proposed construction activities will include excavation, loosening of soil, stockpiling, mixing, filling, etc. These activities can directly impact soil environment negatively contributing to soil degradation and possibly accelerated erosion.

Soil environment of the Project site could be impacted in terms of removal of topsoil and soil compaction, reduction in structural stability and percolative ability of soil, loss of soil dwelling organisms resulting from compaction during excavation activities, installation of PV panels, mounting structures, and 11kv underground cable. These activities also have the potential to increase siltation as a result of accelerated erosion. The impact magnitude is considered to be **medium** considering the number of PV panels to be installed and the distance for burial of the proposed underground cable from the Power Plant to the switchyard. The sensitivity of the soil environment in the Project area is regarded **medium** as the soil in the area is prone to erosion especially during the rainy season. Therefore, the impact significance is considered to be **moderate**.

Potential Impact on Terrestrial Flora and Fauna

The project would require the removal of clearing of vegetation to accommodate the power plant and ancillary structures. Increase in human activity, noise level, creation of areas of bare soil would create a resulting effect which would be the altering of the composition and diversity of flora species in the site as well as migration of fauna species that make use of the plants for food and shelter further away into the forest. Also, the disturbance associated with noise and movement of construction equipment and personnel at the Project site may deter bird species from the area and disrupt the breeding of avifauna. It may also lead to increased risk to species such as snakes, rodents and mammals. The sensitivity of the receptor is judged to be **low**. Based on desktop reviews and field observation, the project area is not known as a migratory route for avifauna species. The impact significance is regarded as **minor**.

Potential impact on Gender

During construction activities, women may experience discrimination as most employment and training opportunities may be provided to men, while women will be left with menial jobs. This may result in marginalization thereby reinforcing gender stereotypes and gender pay gaps. In attempts to reduce the gender knowledge gaps, select female students will undergo end-to-end onthe-job training and capacity building participating in the full construction activity.

Furthermore, there is the possibility that the proposed Project may increase the risk of GBV, as a result of shifting existing power dynamics and financial relationships. This is considered a minor risk as many women in the community are engaged in economic activities.

Potential Impact on Socio-economic and Health

Impacts associated with the construction phase of a project are usually short to medium term in nature, but could have long term effects on the surrounding environment. During construction, the proposed Project has the potential to affect the University community and the nearby community.

With regard to the presence of construction workers on site, the manner in which the workers conduct themselves can affect the University environment and local community in terms of disruption of existing structures due to influx of people. The potential behaviour of workers, most especially male construction workers, may lead to an increase in levels of crime and drug and alcohol abuse, and an increase in incidence of casual sexual relations, which may result in increase in sexually transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies.

Additional pressure may also be placed on existing social infrastructure. Considering that the proposed number of workers for the construction phase of the Project may be relatively high, the potential risk to social structures is regarded as high. However, given that the majority of the construction workers, especially unskilled labour force would be drawn from the local community, the impact significance is considered to be **moderate**.

Potential Impact on Infrastructure (Road)

It is envisaged that movement of personnel and equipment along the road leading to the University would increase once the project commences. The road is slightly busy during the day and as such may lead to

intermittent traffic building up which may not last long with proper coordination. During the installation of streetlights around the University campus, traffic flow might be obstructed along the road paths where the streetlights will be installed if activities are improperly managed. Construction activities may result in a significant increase in movement of vehicles for the transport of construction materials and equipment increasing the risk of traffic-related accidents. The impact magnitude is considered **low** due to the minimal number of Project vehicles and trucks to be used during the construction phase. Therefore, the impact significance is considered **minor**.

Potential Impact on Construction Workers' Safety

Construction sites are potentially hazardous places. Occupational accidents may occur especially when those involved are unskilled. Such occupational accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. Potential impacts to construction workers include increase in noise level and air emissions from construction activities, injuries, electrical shocks, accident, and denial of rights. The impact significance is considered **moderate**.

Waste Generation and Disposal

Wastes from the project are grouped into solid wastes, liquid (wastewater) and air emissions. Solid waste would include; wood, metals, food remains, glass, and refuse etc. Liquid wastes include sewage, while gaseous air pollutants (NO_x, SO_x and CO) would be from exhaust of vehicles. It should be noted however that during their normal operation PV systems emit no gaseous or liquid pollutants, and no radioactive substances.

Potential Impact on Soil

The proposed construction activities will lead to the generation of waste. Improper handling of these wastes or their discharge into the surrounding environment without proper treatment would increase the level of micro-organisms (bacteria, viruses and fungi) that could be pathogenic to staff working in the area. The potential construction wastes to be generated include scrap metals, electrical cables, spent oils, wood/planks, paper waste, leftover sand and gravel, etc. The impact magnitude of the waste on the soil is considered to be **low**. Thus, the impact significance is considered to be **minor**.

Table 5.9: Summary of Potential Negative Impacts Associated with the Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Movement of Equipment, Personnel and Plant Materials	Air Quality	• Vehicular emissions (CO, SO_2, NO_2) from exhaust • Contribution to global warming and ozone layer depletion • Dust emissions from construction activities	Minor
	Social System (Road)	• Increased traffic from heavy-duty trucks en route to project site	Minor

Activity	Receptor	Associated Impact	Significance
	Health & Safety	• Risk of accidents involving personnel and assets due to vehicle movement	Minor
Civil and Electrical Works / Installation Activities	Air Quality	• Emissions from construction equipment (SPM, NOx, CO, SOx) • Dust from land clearing and stockpiles	Minor
	Ambient Noise	• Increased noise levels from construction activities	Minor
	Soil	• Increased erosion from excavation • Reduced soil stability and permeability due to compaction	Moderate
	Terrestrial Flora and Fauna	• Loss of plant species due to invasive species • Loss of fauna due to human activity and noise	Minor
	Groundwater	• Depletion of groundwater from abstraction (e.g., concrete mixing, washing) • Increased sediment load from erosion • Increased runoff and drainage formation from hard surfaces	Minor
	Gender	• Potential discrimination against women and GBV risks	Moderate
	Socio-economic & Health	• Influx of people leading to increased risk of sexually transmitted diseases	Moderate
	Infrastructure (Road)	• Road damage, traffic congestion, and safety concerns	Minor
	Construction Workers Safety	• Risk of injury during construction activities	Moderate
	Soil	• Soil contamination from construction waste (solid and liquid)	Minor
Waste Generation and Disposal	Groundwater	• Contamination from liquid construction waste streams	Minor
	Infrastructure (Waste Management Facility)	• Disposal of waste at existing facilities in project area	Negligible

5.5.2.3 Commissioning Phase

Once the construction phase of the Solar Power Plant is completed, the Plant will be tested to ensure that it has been installed according to the pre-design and operational requirements.

Potential Impact on Noise

During the Plant commissioning, there could be increase in noise level due to humming noise emission from the Plant components (inverters and batteries), vehicular movement (transportation of commissioning officials), public address system, crowd noise, and other ceremonial activities. The impact significance is however rated **minor**.

Potential Impact on Safety

Also, there is potential for occupational hazards during the Plant testing as a result of any wrong electrical connection. The impact significance is considered to be **moderate** on the workers' health and safety. However, the potential hazard of the public during the commissioning activities could be electrical shocks from exposure to wrong electrical connections. This is considered to have a **minor** impact on the public.

Potential Impact on infrastructure (road)

The commissioning phase will lead to an influx of guest and officials which will have an impact on the population and infrastructure (road). Due to the short duration of the commissioning phase (1 day), the impacts are considered to be **negligible**. Table 5.10 summarizes the potential negative impacts associated with the commissioning phase of the proposed Project.

Table 5. 10: Summary of Potential Impact Associated with the Commissioning Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Plant Testing	Ambient Noise	• Increase in ambient noise levels during testing activities	Minor
	Workers	• Occupational health and safety hazards (e.g., injuries, electrocution) due to incorrect electrical connections	Moderate
	Campus Occupants' Safety	• Risk of electrocution from wrong electrical connections	Minor
	Population Influx	• Temporary increase in population during commissioning phase	Negligible
	Infrastructure (Road)	• Increased traffic and risk of road accidents	Negligible

5.5.2.4 Operational Phase

Power Generation and Distribution

Potential Impact on Noise

The potential sources of noise during the Power Plant operations are inverters and batteries. Typically, the designed noise level from an inverter is approximately 30- 35 dB(A) while that of a battery is 15-20 dB(A). The associated noise levels from the inverters and batteries are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location offsite. The impact significance is considered to be **negligible**.

Potential Impact on Gender

Women have conventionally been under-represented in the energy sector; they are often marginalized from many power sector employment and training opportunities. There is a potential that this situation may come to play during the operations phase of the Project as women experience discrimination may be denied training and employment opportunities. Male and female staff will be trained on the management and maintenance of the facility.

Although the number of personnel working at the Project site would reduce, the likelihood of impacts predicted during the construction phase may exist. Therefore, the impact significance is regarded as **minor.**

Potential Impact on Socio-economic and Health

The potential negative impacts on the socio-economic environment (community health and safety) during the operational phase of the Project are related to visual impact and the generation of electromagnetic field (EMF) radiation.

For visual impact, the Project site is not known to be a tourist route or to have any special scenic characteristics, hence it has a limited potential for visual impacts on the receiving environment. However, the facility (primarily the PV panels) will be visible during operation.
The impact significance is considered **negligible.**

Regarding EMF radiation, Solar PV panels, inverters, batteries, and other components that make up solar PV arrays produce extremely low frequency EMF when generating and transmitting electricity. Thus, the potential impact of EMF radiation from the proposed Solar
Power Plant on community health and safety is considered to be **negligible**.

Potential Impact on Occupational Health, Safety and Welfare of Workers

During the Plant operation, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries) including work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions etc. The impact significance is considered to be **moderate** primarily due to the low number of staff (approximately 10) required for operation.

Routine Maintenance, Waste Generation and Disposal

Potential Impact on Soil

Routine maintenance of the Plant will lead to the generation of wastes which can contaminate the soil within the Project site and AoI. The major waste stream will be e-waste generated from spent/damaged components of the Project such as batteries, inverters and PV panels. These wastes will be stored within the Project site according to the manufacturer's instructions. All components to be used for the Project will have to buy back agreements with the manufacturers as specified in the Extended Producer Responsibility Program (EPRP). The impact significance is considered to be **minor**.

Potential Impact on Occupational Health, and Safety of Workers

During routine maintenance, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries). The impact significance is considered to be **minor** primarily due to the low number of staff (approximately) required for maintenance activities and low frequency of maintenance. Table 5.11 summarizes the potential negative impacts associated with the operational phase of the proposed Project.

Table 5. 11: Summary of Potential Negative Impacts Associated with Operational Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Power Generation and Distribution	Noise	• Noise from batteries and inverters during power generation and evacuation	Negligible
	Gender	• Discrimination of women during employment • GBV (sexual harassment, assault, poor working conditions)	Minor
	Socio-economic (Visual)	• Landscape alterations causing unpleasant visual changes in the area	Negligible
	Socio-economic (Health Issues)	• Community health and safety concerns due to electromagnetic field (EMF) radiation	Negligible
	Health, Safety and Welfare of Staff (Plant Operation)	• Electric shock and injuries during plant operation • Work-related issues (discrimination, denial of rights, unfair treatment, poor working conditions)	Moderate
Routine Maintenance	Soil	• Soil contamination from spent batteries and inverters	Minor
	Groundwater	• Groundwater abstraction from cleaning of PV panels	Minor
Waste Generation and Disposal	Soil & Groundwater	• Soil and groundwater contamination from waste streams	Negligible
	Health, Safety and Welfare of Staff (Maintenance)	• Electric shock and injuries during maintenance activities	Minor

5.5.2.5 Potential Cumulative Impacts

Cumulative impacts are those impacts resulting from the combined effects of past, present or reasonably foreseeable actions owing to the project aspects and activities outside the project (GSI, 2003). The concept of cumulative effects is an important one. It holds that, while impacts may be small individually, the overall impact of all environmental changes affecting the receptors taken together can be significant. When a resource is nearing its tolerance threshold, a small change can push it over.

The major existing activities around the Project area are seasonal farmlands. The nature of the activities associated with the proposed Project and the existing activities around the project area, the potential cumulative impacts of the Project on road traffic, ambient noise levels and groundwater availability is considered **low**.

5.6 Risk and Hazard Assessment

Risk assessment refers to the determination of the quantitative or qualitative estimate of risk(s) associated with recognized threats/hazards posed by the project's activities. The assessment of the risks and hazards associated with the proposed project involves:

- Identification of hazards/risks
- Assessing their likelihood of occurrence
- Estimating the consequence/severity of the hazards

Risk assessment refers to the determination of quantitative and/or qualitative estimates of risks associated with identified hazards arising from project activities. The objective is to systematically identify potential hazards, evaluate their likelihood of occurrence, assess the severity of their potential consequences, and determine appropriate mitigation measures to reduce risks to acceptable levels.

The assessment of risks and hazards associated with the proposed project involves the following key steps:

- Identification of hazards and potential risk sources associated with project activities.
- Assessment of the likelihood or probability of occurrence of each identified hazard.
- Evaluation of the potential consequences or severity of impacts should the hazard occur.
- Determination of the overall risk level through a structured Risk Assessment Matrix (RAM).
- Development of mitigation and control measures to eliminate or reduce identified risks.

Risk Assessment Matrix (RAM) Methodology

The Risk Assessment Matrix (RAM) methodology was adopted to evaluate and rank identified project risks. The methodology combines the likelihood of occurrence of a hazard with the severity of its potential consequences to determine the overall risk rating. This approach enables prioritization of risks and supports the development of appropriate mitigation measures.

The risk rating is determined using the following relationship:

Risk Rating = Likelihood × Consequence (Severity)

Likelihood is assessed based on the probability of a hazard occurring during project implementation, while consequence reflects the potential impact on personnel, equipment, the environment, project schedule, and operational continuity. The resulting risk scores are categorized into Low, Medium, High, or Extreme risk levels, allowing management attention and resources to be directed toward the most significant risks.

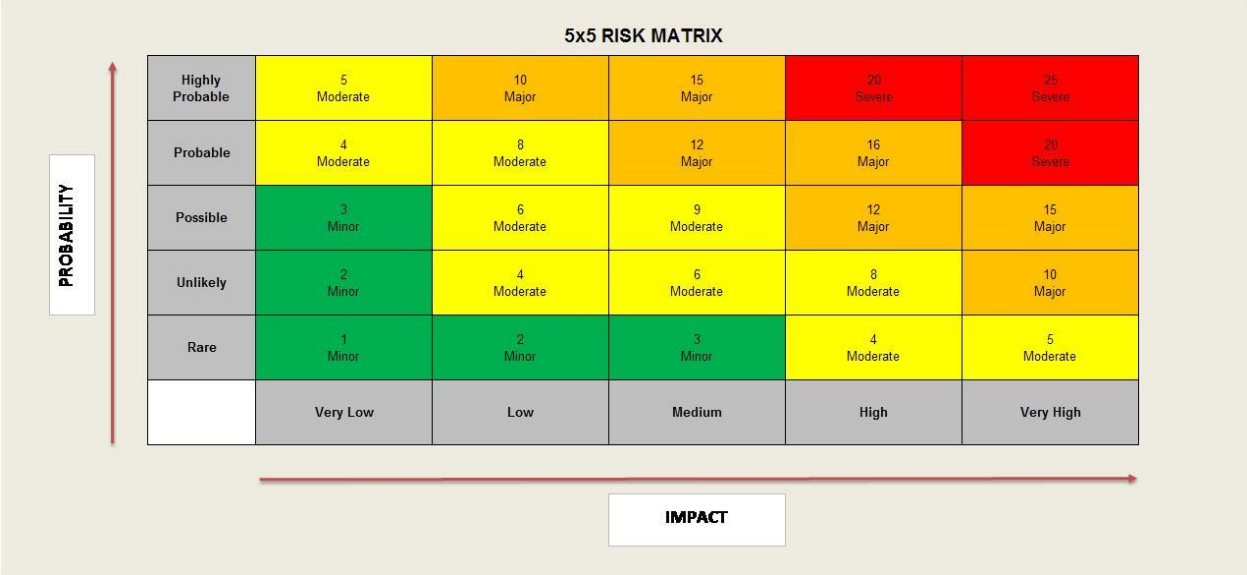

Figure 5.1: Risk Assessment Matrix

5.6.1 Project Specific Risks and Hazards

The potential risks and hazards associated with the proposed project are:

5.6.1.1 Fire and Explosion

The major risk associated with the operation of the plant is fire and explosion because PV systems are subject to electrical faults like other electrical installations such as short circuits, ground faults and reverse currents. Failures within the plant system could cause hotspots that can ignite nearby combustible materials. Faulty installations or failure with DC/AC inverters can also cause photovoltaic fires. Overcharging, high temperatures and physical stress to Lithium-ion battery cells can cause thermal escape, which commonly leads to the destruction of the battery, fire and even explosions. In addition, deep discharge can also cause battery fires. Any outbreak of uncontrolled fire in the area can escalate to dangerous dimensions which could be critical. Thus, this hazard is classified as high risk.

5.6.1.2 Electrocution

Electrocution from direct contact with high-voltage electricity or tools, vehicles, ladders, and other devices that are in contact with high-voltage electricity could occur during the plant operation. This hazard is hardly likely to occur, and it is of minimally severe consequence and is thus classified as moderate risk.

5.6.2. Occupational Hazards

During construction, workers carrying out activities at heights could be exposed to occupational hazards. Electrical accidents may also result in shocks and/or burns, muscle contractions, and traumatic injuries associated with falls after the shock. This hazard is fairly probable although its severity is considered minimal thus it is classified as moderate risk.

5.7. Summary of Anticipated Impacts

These include significant risks such as electric shock and injuries of workers during the construction phase as well as GBV risks and soil degradation. The execution of suitable mitigation measures presented in the next chapter will abate the effect of identified negative impacts/risks to the most minimal level possible and heighten the effects of the identified positive impacts. Table 5.12 is a summary of the general potential site specific environmental and social impacts on the project.

Table 5. 12: Summarized Environmental and Social Impacts of Solar Power Plant			
Category	**Direct Impacts**	**Indirect Impacts**	**Cumulative Impacts**
Environmental Impacts	- Reduction in noise and odours from generator sets - Protection of natural habitats (reduced deforestation) - Reduced fuel consumption and carbon emissions - Lower greenhouse gas (GHG) emissions - Land use and land-use change - Waste production (including battery waste) - Material production impacts - Localized air, water, and soil pollution - Flood and erosion hazards - Occupational health and safety risks	- Improved safety (reduced exposure to flammable fuels) - Reduced indoor air pollution and improved health - Reduced impacts from fuel production chain - Effects on end-user industries - Improved equity of access to clean energy	- Improved quality of education and healthcare services - Long-term GHG emission reduction - Population pressure on biodiversity - Broader ecosystem and climate benefits
Social Impacts	- Longer hours of lighting for studying and productivity - Improved social cohesion and development - Enhanced safety and equitable opportunities for women - Improved access to ICT (radio, TV, mobile, internet) - Access to information and distance education - Temporary land-use or access restrictions	- Reduced household expenditure on fuels (10–15% savings) - Increased savings and investment opportunities - Growth in income-generating activities - Support for small businesses (longer operating hours) - Increased trade and job creation - Improved socioeconomic development	- Risk of land-use conflicts if not properly managed - Need for community engagement and inclusion - Long-term livelihood improvement and economic stability

CHAPTER SIX
MITIGATION MEASURES

6.1 Introduction

This chapter presents the mitigation measures proffered for the associated and potential impacts of the proposed solar-based power plant project in the Federal University of Kashere, Gombe State. A comprehensive risk assessment matrix, as indicated in Figure 6.1, was used to determine the mitigation requirements for each of the impacts identified. The frequency, severity, sensitivity, scale, longevity, political, economic, legal, reputation/ image, and communication/complaints were factors taken into consideration during these assessments.

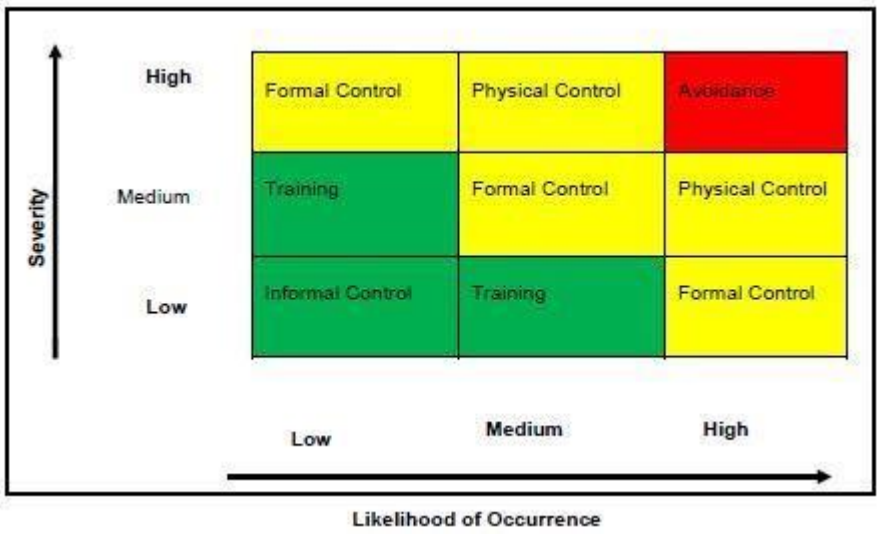

Figure 6. 1: Matrix for Determination of Mitigation Measures
(Source: www.researchgate.net/risk assessment matrix)

Mitigation measures designed to prevent, reduce or control the adverse impacts of the environmental and social aspects of the proposed project to as low as reasonably practicable were considered and documented in this chapter of the report. Subsequently, the specific mitigation measures satisfying the mitigation requirement were established, putting the following into consideration:

- Available resources and competencies.
- On-site conditions; and
- Public concerns and technology.

6.2 Mitigation Measures and Approach

Mitigation refers to measures or interventions necessary to avoid, minimize, reduce, or offset adverse impacts. The approach, as indicated in Table 6.1 for selecting appropriate mitigation measures, includes:

- Anticipate and avoid risks and impacts.

- Where avoidance is not possible, minimize or reduce risks and impacts to acceptable levels.
- Once risks and impacts have been minimized or reduced, mitigate.
- Where significant residual impacts remain, compensate or offset them, where technically and financially feasible.

In proffering mitigation measures for the various negative impacts identified in the previous chapter, preference was given to avoidance or prevention of adverse impacts, which were not feasible. Measures that are practicable and cost-effective using best available technology were suggested to reduce and/or minimize the impacts, while rehabilitation, restoration or compensation was considered as the last resort. The implementation of the proffered mitigation measures highlighted in Table 6.2 are of negligible to minor significance. There are no potential long-term impacts associated with the Project that cannot be mitigated to acceptable levels of residual impact. Table 6. 1 presents the Mitigation Measures for the Potential Negative Impacts of the Proposed Project

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Table 6. 1: Mitigation Measures for the Pre-construction phase of the Proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Site Selection / Land Take	Existing Crop Farming	• Loss of land for farming activities	Moderate	REA shall; • Avoid high-value agricultural land where possible (site optimization) • Provide fair and prompt compensation in line with World Bank ESS5 standards • Implement Livelihood Restoration Plan (LRP) • Engage affected communities through consultation and participation	Minor
Site Clearing & Preparation	Terrestrial Flora & Fauna	• Vegetation loss • Direct and indirect impacts on fauna	Minor	REA shall: • Minimize clearing footprint to only required areas • Pre-clearance ecological surveys and species relocation where necessary • Avoid clearing during breeding seasons • Implement biodiversity management plan	Negligible
	Soil	• Loss of topsoil • Soil compaction and erosion • Reduced soil stability and permeability	Minor	REA shall: • Strip and store topsoil for later reuse (rehabilitation) Restrict movement of heavy machinery to designated routes • Implement erosion control measures (mulching, silt fences) • Progressive site restoration	Negligible
	Air Quality & Noise	• Emissions from equipment • Increased noise levels	Minor	REA shall: • Regular maintenance of machinery to reduce emissions • Use dust suppression methods (water spraying) • Limit work to daytime hours • Provide noise control measures and PPE (ear protection)	Negligible
	Workers Safety	• Injuries and accidents during site clearing	Minor	REA shall:	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Implement Occupational Health & Safety procedures aligned with International Labour Organization standards • Provide PPE (helmets, gloves, boots) • Conduct safety training and toolbox talks • Supervision and enforcement of safety protocols	
Mobilization of Construction Equipment & Materials	Air Quality & Noise	• Vehicular emissions (TSP, NOx, CO, SOx) • Increased noise levels	Minor	REA shall: • Maintain vehicles regularly to meet emission standards • Optimize logistics to reduce trips • Enforce speed limits and idle-time reduction • Use low-sulfur fuels where possible	Negligible

Table 6.2: Mitigation Measures for the Construction phase of the Proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Movement of Equipment, Personnel & Materials	Air Quality	• Vehicular emissions (CO, SO_2, NO_2) • Dust emissions	Minor	REA shall: • Regular vehicle maintenance and emission checks • Use of low-sulfur fuels and efficient engines • Dust suppression (water spraying, covering trucks) • Limit vehicle idling and enforce speed limits	Negligible
	Social System (Road)	• Increased traffic from heavy-duty trucks	Minor	REA shall: • Implement Traffic Management Plan • Schedule deliveries during off-peak hours • Use designated haulage routes • Community awareness and signage	Negligible
	Health & Safety	• Risk of accidents due to vehicle movement	Minor	REA shall: • Driver training and certification	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Speed control and enforcement • Vehicle inspection and maintenance • Use of warning signs and traffic marshals	
Civil & Electrical Works / Installation	Air Quality	• Emissions from equipment • Dust from land clearing and stockpiles	Minor	REA shall: • Maintain construction equipment regularly • Dust suppression measures (watering, covering materials) • Limit activities during high winds • Provide PPE (respirators where necessary)	Negligible
	Ambient Noise	• Increased noise levels	Minor	REA shall: • Restrict noisy activities to daytime hours • Use well-maintained equipment with silencers • Provide hearing protection to workers • Establish buffer zones near sensitive receptors	Negligible
	Soil	• Erosion from excavation • Soil compaction and reduced permeability	Moderate	REA shall: • Implement erosion and sediment control measures (silt fences, drainage control) • Limit heavy machinery movement to designated areas • Progressive rehabilitation and re-vegetation • Proper site grading and drainage design	Minor
	Terrestrial Flora & Fauna	• Loss of plant species (invasive species risk) • Disturbance to fauna	Minor	REA shall: • Control and monitor invasive species • Minimize vegetation clearing • Restrict worker movement to designated areas • Implement biodiversity management plan	Negligible
	Groundwater	• Depletion from abstraction • Increased sediment load and runoff	Minor	REA shall: • Use water-efficient construction practices • Obtain abstraction permits and monitor usage	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Install sediment traps and proper drainage systems • Avoid contamination of water sources	
	Gender	• Discrimination and GBV risks	Moderate	REA shall: • Develop and implement Gender Action Plan and GBV Action Plan aligned with World Bank guidelines • Code of conduct for workers • Awareness training and strict sanctions • Confidential grievance redress mechanism	Minor
	Socio-economic & Health	• Spread of STDs due to influx of workers	Moderate	REA shall: • Community health awareness programs • Provide access to healthcare services and testing • Enforce worker codes of conduct • Collaborate with local health authorities and NGOs	Minor
	Infrastructure (Road)	• Road damage, congestion, safety issues	Minor	REA shall: • Traffic and logistics management plan • Routine road maintenance and repairs • Use appropriate vehicle sizes and loads • Coordination with local authorities	Negligible
	Construction Workers Safety	• Risk of injury during construction	Moderate	REA shall: • Implement Occupational Health & Safety system (aligned with International Labour Organization standards) • PPE provision and enforcement • Safety training, supervision, and emergency preparedness • Regular audits and incident reporting	Minor
	Soil	• Soil contamination from construction waste	Minor	REA shall: • Proper waste segregation and storage • Use lined containment areas for hazardous waste • Spill prevention and response plan	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
				• Disposal through licensed contractors	
Waste Generation & Disposal	Groundwater	• Contamination from liquid waste streams	Minor	REA shall: • Treat wastewater before discharge • Use impermeable liners for storage areas • Regular inspection of waste systems • Compliance with environmental standards	Negligible

Table 6.3: Mitigation Measures for the Installation Phase of the Proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Plant Testing	Ambient Noise	• Increase in ambient noise levels during testing activities	Minor	REA shall: • Restrict testing to daytime hours • Use well-maintained equipment with noise suppression features • Notify nearby occupants in advance • Provide hearing protection (PPE) to workers	Negligible
	Workers	• Occupational health and safety hazards (injuries, electrocution due to incorrect connections)	Moderate	REA shall: • Implement strict electrical safety procedures (lockout/tagout systems) • Ensure only certified personnel handle electrical connections • Provide appropriate PPE (insulated gloves, boots) • Conduct pre-commissioning safety checks and supervision • Emergency response and first aid readiness	Minor
	Campus Occupants' Safety	• Risk of electrocution from wrong electrical connections	Minor	REA shall: • Secure and restrict access to testing areas • Install warning signage and physical barriers • Ensure proper grounding and insulation of systems	Negligible

				• Supervise all testing activities closely	

Table 6.4: Mitigation Measure for the Operational Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Power Generation & Distribution	Gender	• Discrimination of women during employment • GBV (sexual harassment, assault, poor working conditions)	Minor	REA shall: • Implement Gender Action Plan and GBV prevention measures aligned with World Bank guidelines • Enforce equal opportunity employment policy • Worker code of conduct and regular training • Establish confidential grievance redress mechanism	Negligible
	Health, Safety & Welfare of Staff (Plant Operation)	• Electric shock and injuries • Workplace discrimination and unfair treatment	Moderate	REA shall: • Implement Occupational Health & Safety (OHS) system in line with International Labour Organization standards • Install lockout/tagout (LOTO) systems and safety signage • Provide appropriate PPE (insulated gloves, boots, etc.) • Conduct routine safety training and audits • Enforce fair labor practices and worker rights policies	Minor
Routine Maintenance	Soil	• Soil contamination from spent batteries and inverters	Minor	REA shall: • Store hazardous materials in sealed, labeled containers • Implement hazardous waste management plan	Negligible

				• Use certified waste handlers for disposal/recycling • Install secondary containment and spill response systems	
	Groundwater	• Groundwater abstraction from cleaning PV panels	Minor	REA shall: • Use water-efficient or dry-cleaning technologies • Harvest and reuse rainwater where feasible • Monitor abstraction rates and comply with permits • Adopt water conservation measures	Negligible
Waste Generation & Disposal	Health, Safety & Welfare of Staff (Maintenance)	• Electric shock and injuries during maintenance	Minor	REA shall: • Enforce electrical isolation procedures (LOTO) • Provide PPE and insulated tools • Conduct competency-based training • Routine inspection and supervision of maintenance work	Negligible

Table 6.5: Mitigation Measures for the Decommissioning Phase

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Dismantling of Plant & Equipment	Air Quality	• Dust emissions from dismantling activities • Emissions from machinery and vehicles	Minor	REA shall: • Apply dust suppression measures (water spraying) • Use well-maintained, low-emission equipment • Cover trucks transporting materials • Limit unnecessary idling of machinery	Negligible
	Ambient Noise	• Increased noise from dismantling activities	Minor	REA shall: • Restrict activities to daytime hours • Use equipment fitted with silencers • Provide hearing protection (PPE) to workers • Notify nearby communities in advance	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
	Workers Safety	• Injuries from equipment dismantling • Risk of electrocution	Moderate	REA shall: • Implement Occupational Health & Safety procedures aligned with International Labour Organization standards • Apply lockout/tagout (LOTO) systems before dismantling • Provide appropriate PPE (helmets, gloves, insulated gear) • Ensure only trained personnel handle electrical components • Emergency preparedness and supervision	Minor
Removal of Foundations & Civil Works	Soil	• Soil disturbance, erosion, and compaction	Minor	REA shall: • Minimize excavation footprint • Implement erosion and sediment control measures • Reuse and reinstate topsoil • Progressive rehabilitation of disturbed areas	Negligible
	Groundwater	• Potential contamination from spills and exposed materials	Minor	REA shall: • Proper storage and handling of fuels and chemicals REA shall: • Spill prevention and response plans • Avoid discharge of contaminants into soil and water • Regular inspection of work areas	Negligible
Waste Generation & Disposal	Soil & Groundwater	• Contamination from hazardous and non-hazardous waste	Moderate	REA shall: • Implement comprehensive waste management plan (segregation, recycling, disposal) • Use licensed waste contractors • Store hazardous waste in secure, labeled containers with secondary containment • Comply with national and international waste regulations	Minor
	Infrastructure (Waste Facilities)	• Increased burden on existing waste management systems	Minor	REA shall: • Coordinate with approved waste facilities • Schedule waste transport efficiently • Promote recycling and material recovery (e.g., metals, panels)	Negligible

Activity	Receptor	Associated Impact	Significance	Mitigation Measures	Residual Impact
Transportation of Decommissioned Materials	Air Quality & Noise	• Emissions and noise from haulage vehicles	Minor	REA shall: • Maintain vehicles to reduce emissions • Optimize transport logistics • Enforce speed limits and reduce idling • Use designated transport routes	Negligible
	Infrastructure (Road)	• Traffic congestion and road safety risks	Minor	REA shall: • Implement Traffic Management Plan • Use trained drivers and road signage • Schedule transport during off-peak hours • Repair any road damage caused	Negligible
	Community Health & Safety	• Risk of accidents involving local communities	Minor	REA shall: • Community awareness programs • Install warning signs and barriers • Escort oversized loads where necessary • Enforce strict safety protocols	Negligible
Site Restoration & Rehabilitation	Terrestrial Flora & Fauna	• Loss of habitat prior to restoration	Minor	REA shall: • Re-vegetate using native species • Restore natural habitat conditions • Monitor ecological recovery • Prevent introduction of invasive species	Negligible
	Socio-economic	• Temporary loss of employment after project closure	Moderate	REA shall: • Develop worker transition and livelihood restoration programs • Provide skills training and job placement support • Engage stakeholders early on closure plans	Minor

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 Introduction

This section deals with the set of mitigation management measures to be taken to avoid, reduce, mitigate or compensate for adverse environmental, occupational and social impacts with the institutional arrangement, monitoring schedule, parameters to be monitored and soon including tentative monitoring budget. It includes the following aspects:

- Types of Impacts and their Mitigations
- Mitigation Measures
- Environmental Code of Conduct/ Practices (to be attached to bidding documents and/ or contracts)
- Monitoring Plan
- Communication and Documentation
- Cost of ESMP
- Integration with Project (contract clauses, others)
- Grievance Resolution Process
- Plan for stakeholder/ community engagement during pre-construction, construction, and operation phases; the plan should include a community mobilization approach from both social and commercial perspectives.

Further to the impacts assessed in the previous chapter, this section presents more detailed mitigation measures and monitoring requirements that correspond to the impacts examined in the previous section, thus exploring them in more detail. Mitigation measures aim to offset any negative impacts that may result from the project, and monitoring is the process of measuring the success of mitigation measures to assess their effectiveness.

7.2 Objectives of the ESMP

The purpose of the Environmental and Social Management Plan (ESMP) is to ensure that Environmental and Social impacts identified during the ESIA process are effectively addressed during the construction, operation and closure of the project. The ESMP specifies the mitigation and management measures to which the Proponent is committed and shows how the Project will mobilize organizational capacity and resources to implement these measures.

The ESMP will be a living document and will continue to develop during the design and construction phases to enable continuous improvement of the Project's environmental performance.

The specific objectives of the ESMP are to:

- Promote effective environmental and social management and communicate the objectives and requirements of the ESMP.
- Ensure compliance with applicable environmental and social laws, regulations, permit conditions, and Project commitments.

- Define clear roles, responsibilities, and accountability for implementing environmental and social measures.
- Integrate environmental and social considerations into Project planning, design, construction, and operation.
- Apply the mitigation hierarchy by avoiding, minimizing, restoring, and, where necessary, compensating for adverse impacts.
- Enhance positive environmental, social, and economic benefits generated by the Project.
- Serve as an action plan for implementing environmental and social management measures.
- Provide a framework for implementing and monitoring mitigation and enhancement measures identified in the ESIA.
- Support continual improvement through monitoring, reporting, and corrective actions.

7.3 Environmental and Social Management Measures

The recommended environmental and social management measures required to mitigate the identified impacts of the proposed project activities during pre-construction, construction, commissioning, and operation phases are presented in Tables 7.1 to 7.8.

Table 7. 1: Environmental Management Plan for Pre-Construction Phase of the Proposed Project

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
Site Selection / Land Take	• Loss of land for farming activities	REA shall: • Engage affected communities through consultation and participation	Minor	Inspection	Before Mobilization	Evidence of consultations; grievances resolved	EPC Contractor	PMU	1,400
Site Clearing & Preparation	• Vegetation loss • Direct and indirect impacts on fauna	REA shall: • Minimize clearing footprint • Conduct pre-clearance ecological surveys • Avoid clearing during breeding seasons • Implement a biodiversity management plan	Negligible	Inspection	Monthly	Compliance with clearing limits; no unnecessary vegetation loss	EPC Contractor	PMU / POE	2,000
	• Loss of topsoil• Soil compaction and erosion • Reduced soil stability	REA shall: • Strip and store topsoil • Restrict heavy machinery movement • Implement erosion control (mulching, silt fences) • Progressive restoration	Negligible	Inspection	Quarterly	Evidence of top-soil stockpiling; reduced erosion signs	EPC Contractor	PMU	1,800
	• Air emissions from equipment • Increased noise levels	REA shall: • Maintain machinery regularly • Apply dust suppression (water spraying) • Limit work to daytime • Provide PPE for noise protection	Negligible	Inspection	Quarterly	Reduced dust levels; acceptable noise levels	EPC Contractor	PMU	1,500

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
	• Injuries and accidents	REA shall: • Implement OHS procedures (ILO standards) • Provide PPE • Conduct safety training/toolbox talks • Enforce supervision	Nelgiigble	Inspection	Daily	Number of incidents recorded; PPE compliance rate	EPC Contractor	PMU / HSE Officer	2,200
Mobilization of Construction Equipment & Materials	• Vehicular emissions (TSP, NOx, CO, SOx) • Increased noise levels	REA shall: • Maintain vehicles to emission standards • Optimize logistics • Enforce speed limits and reduce idling • Use low-sulfur fuels	Negligible	Inspection	Weekly	Reduced emissions; compliance with transport procedures	EPC Contractor	PMU	1,600

Table 7.2: Environmental Management Plan for Construction Phase of the proposed Project

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
Movement of Equipment, Personnel & Materials	• Vehicular emissions (CO, SO_2, NO_2) • Dust emissions	REA shall: • Maintain vehicles regularly • Use low-sulfur fuels • Apply dust suppression (water spraying, covering trucks)	Negligible	Inspection	Daily	Reduced dust levels; emission compliance	EPC Contractor	PMU	1,500

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
		• Limit idling and enforce speed limits							
	• Increased traffic and congestion	REA shall: • Implement Traffic Management Plan • Schedule deliveries off-peak • Use designated routes • Community awareness and signage	Negligible	Inspection	Daily	Traffic incidents minimized; complaints resolved	EPC Contractor	PMU	1,200
	• Risk of accidents	REA shall: • Train drivers • Enforce speed limits • Conduct vehicle inspections • Use traffic marshals and signage	Negligible	Inspection	Daily	Number of accidents/incidents recorded	EPC Contractor	HSE Officer / PMU	1,300
Civil & Electrical Works / Installation	• Air emissions and dust generation	REA shall: • Maintain equipment • Apply dust suppression • Limit work during high winds • Provide PPE	Negligible	Inspection	Daily	Visible dust reduction; PPE compliance	EPC Contractor	PMU	1,600
	• Increased noise levels	REA shall: Restrict work to daytime	Negligible	Inspection	Daily	Noise complaints minimized	EPC Contractor	PMU	1,200

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
		• Use silencers • Provide hearing protection • Establish buffer zones							
	• Soil erosion and compaction	REA shall: • Install silt fences and drainage • Restrict machinery movement • Rehabilitate progressively • Proper grading	Minor	Inspection	Weekly	Evidence of erosion control measures	EPC Contractor	PMU	1,800
	• Loss of flora and fauna	REA shall: • Minimize clearing • Control invasive species • Restrict worker movement • Implement biodiversity plan	Negligible	Inspection	Weekly	Vegetation condition maintained	EPC Contractor	PMU	1,500
	• Groundwater depletion and contamination	REA shall: • Use water efficiently • Monitor abstraction • Install sediment traps • Prevent contamination	Negligible	Inspection	Monthly	Water usage records; no contamination	EPC Contractor	PMU	1,400

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
	• GBV and discrimination risks	REA shall: • Implement Gender & GBV Action Plans • Enforce code of conduct • Awareness training • Grievance mechanism	Minor	Monitoring	Monthly	Number of GBV cases resolved	EPC Contractor	PMU	2,000
	• Spread of STDs	REA shall: • Health awareness programs • Provide testing access • Enforce worker conduct • Collaborate with health agencies	Minor	Monitoring	Monthly	Participation rates; reported cases	EPC Contractor	PMU	1,800
	• Road damage and congestion	REA shall: • Traffic management plan • Maintain roads • Control vehicle loads • Coordinate with authorities	Negligible	Inspection	Weekly	Road condition maintained	EPC Contractor	PMU	1,500
	• Worker injuries and accidents	REA shall: • Implement OHS system (ILO aligned)	Minor	Inspection	Daily	Incident rate; PPE compliance	EPC Contr		

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
		• Provide PPE • Conduct training • Emergency preparedness							

Table 7.3: Environmental Management Plan for with the Commissioning Phase

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
Plant Testing	• Increase in ambient noise levels during testing activities	REA shall: • Restrict testing to daytime hours • Use well-maintained equipment with noise suppression features • Notify nearby occupants in advance • Provide hearing protection (PPE) to workers	Negligible	Inspection	Daily (during testing)	Noise complaints minimized; PPE usage compliance	EPC Contractor	PMU	1,200
	• Occupational health and safety hazards (injuries, electrocution due to incorrect connections)	REA shall: • Implement electrical safety procedures (lockout/tagout) • Use certified personnel only • Provide PPE (insulated gloves, boots)	Minor	Inspection	Daily (during testing)	Zero fatal incidents; reduced injury rates	EPC Contractor	HSE Officer / PMU	2,000

		• Conduct safety checks and supervision • Ensure emergency response readiness							
	• Risk of electrocution to campus occupants	REA shall: • Restrict access to testing areas • Install warning signage and barriers • Ensure proper grounding and insulation • Supervise all testing activities	Negligible	Inspection	Daily (during testing)	No unauthorized access; zero electrocution incidents	EPC Contractor	PMU	1,000

Table 7.4: Environmental Management Plan for Operational Phase of the proposed Project

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
Power Generation & Distribution	• Discrimination of women in employment • GBV (sexual harassment, assault, poor working conditions)	REA shall: • Implement Gender Action Plan & GBV prevention (World Bank aligned) • Enforce equal opportunity employment • Worker code of conduct & training • Confidential grievance mechanism	Negligible	Monitoring	Monthly	Number of grievances reported/resolved; gender balance in workforce	Plant Operator / EPC	PMU	2,000

	• Electric shock and injuries • Workplace discrimination	REA shall: • Implement OHS system (ILO aligned) • Install LOTO systems & signage • Provide PPE (insulated gloves, boots) • Conduct training & audits • Enforce fair labor practices	Minor	Inspection	Daily	Incident/accident rate; PPE compliance	Plant Operator	HSE Officer / PMU	2,500
Routine Maintenance	• Soil contamination from batteries and inverters	REA shall: • Store hazardous materials in sealed/labeled containers • Implement hazardous waste plan • Use certified waste handlers • Install secondary containment & spill response	Negligible	Inspection	Weekly	No contamination incidents; proper storage observed	Plant Operator	PMU	1,800
	• Groundwater use for panel cleaning	REA shall: • Use water-efficient/dry-cleaning methods • Harvest/reuse rainwater • Monitor abstraction & comply with permits • Apply water conservation measures	Negligible	Monitoring	Monthly	Water usage records; compliance with limits	Plant Operator	PMU	1,500
Waste Generation & Disposal	• Electric shock and injuries during maintenance	REA shall: • Enforce LOTO procedures	Negligible	Inspection	Weekly	Zero fatal incidents; reduced injury rates	Plant Operator	HSE Officer / PMU	1,600

		• Provide PPE & insulated tools • Conduct competency-based training • Routine inspection & supervision							

Table 7.5: Environmental Management Plan for Decommissioning Phase

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
Dismantling of Plant & Equipment	• Dust emissions • Emissions from machinery and vehicles	REA shall: • Apply dust suppression (water spraying) • Use low-emission equipment • Cover haulage trucks • Limit idling	Negligible	Inspection	Daily	Reduced dust levels; emission compliance	EPC Contractor	PMU	1,800
	• Increased noise levels	REA shall: Restrict daytime hours • Use silencers • Provide hearing PPE • Notify nearby communities	Negligible	Inspection	Daily	Noise complaints minimized	EPC Contractor	PMU	1,400
	• Injuries and electrocution risks	REA shall :• Implement OHS procedures (ILO aligned) • Apply LOTO systems • Provide PPE • Use trained personnel • Emergency preparedness	Minor	Inspection	Daily	Incident rates; PPE compliance	EPC Contractor	HSE Officer / PMU	2,500

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
Removal of Foundations & Civil Works	• Soil disturbance, erosion, compaction	REA shall: • Minimize excavation footprint • Implement erosion controls • Reinstate topsoil • Progressive rehabilitation	Negligible	Inspection	Weekly	Evidence of rehabilitation; no erosion	EPC Contractor	PMU	1,700
	• Groundwater contamination risks	REA shall: • Proper storage of fuels/chemicals • Spill prevention & response plan • Prevent contaminant discharge • Regular inspections	Negligible	Inspection	Weekly	No contamination incidents	EPC Contractor	PMU	1,600
Waste Generation & Disposal	• Soil & groundwater contamination from waste	REA shall: • Implement waste management plan • Use licensed contractors • Secure hazardous waste storage • Comply with regulations	Minor	Inspection	Weekly	Proper waste handling; no contamination	EPC Contractor	PMU	2,000
	• Pressure on waste infrastructure	REA shall: • Coordinate with approved facilities • Schedule transport efficiently • Promote recycling and recovery	Negligible	Monitoring	Monthly	Volume of waste recycled; facility compliance	EPC Contractor	PMU	1,300

Activity	Associated Impact	Mitigation Measures	Residual Impact	Monitoring Requirement	Frequency	Performance Indicators	Implementation	Monitoring	Cost (USD)
Transportation of Decommissioned Materials	• Emissions and noise from vehicles	REA shall: • Maintain vehicles • Optimize logistics • Enforce speed limits • Use designated routes	Negligible	Inspection	Weekly	Reduced emissions; compliance with routes	EPC Contractor	PMU	1,500
	• Traffic congestion and road safety risks	REA shall: • Traffic Management Plan • Trained drivers & signage • Off-peak scheduling • Repair road damage	Negligible	Inspection	Weekly	Traffic incidents minimized	EPC Contractor	PMU	1,400
	• Community accident risks	REA shall :• Community awareness programs • Warning signs and barriers • Escort oversized loads • Enforce safety protocols	Negligible	Inspection	Weekly	Zero community incidents	EPC Contractor	PMU	1,600
Site Restoration & Rehabilitation	• Habitat loss before restoration	REA shall: • Re-vegetate with native species • Restore habitat conditions • Monitor ecological recovery • Prevent invasive species	Negligible	Inspection	Monthly	Vegetation regrowth; biodiversity recovery	EPC Contractor	PMU	2,200
	• Loss of employment post-closure	REA shall: • Worker transition programs • Skills training • Job placement support • Stakeholder engagement	Minor	Monitoring	Monthly	Number of workers transitioned	EPC Contractor	PMU	2,000

7.4 Roles, Responsibilities and Accountabilities

The Rural Electrification Agency Project Management Unit (REA-PMU) supervises the implementation of ESMP throughout the project life span, while conformance with the mitigation measures will be ensured by the Engineering, Procurement and Construction (EPC) contractor during the construction phase and by the operations and maintenance (O&M) contractor during the operational phase of the project. Table 7.6 indicates the Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP.

Table 7. 6: The Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP					
Stakeholder	Pre-Construction Phase	Construction Phase	Commissioning Phase	Operational Phase	Decommissioning Phase
Director of Works / Physical Planning	• Approve site and land use • Review ESMP and ensure institutional commitment • Appoint & train Site Engineer • Ensure livelihood restoration before mobilization	• Supervise ESMP implementation • Ensure contractor compliance • Address grievances and enforce corrective actions	• Oversee safe plant testing • Ensure stakeholder communication• Confirm readiness for operation	• Review ESMP reports • Recommend improvements to PMU/O&M • Ensure safeguards (OHS, GBV, environment)	• Oversee decommissioning activities • Ensure site restoration • Support livelihood transition
REA – PMU	• Approve ESMP and integrate into contracts • Coordinate stakeholders and regulators • Allocate ESMP budget	• Monitor compliance and conduct audits • Report to regulators • Enforce corrective actions	• Ensure compliance during testing • Approve transition to operation	• Oversee ESMP implementation • Ensure monitoring, audits, reporting • Address non-compliance	• Supervise dismantling compliance • Ensure waste management • Prepare closure reports
Site Engineer	• Support ESMP planning • Participate in training	• Implement ESMP daily on-site• Monitor EHS compliance • Maintain records and reports	• Supervise testing • Ensure safety procedures (LOTO, PPE) • Report incidents	• Monitor operations & maintenance• Ensure ESMP compliance• Report environmental & safety issues	• Supervise dismantling • Monitor waste handling • Support site rehabilitation

Table 7. 6: The Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP					
Stakeholder	Pre-Construction Phase	Construction Phase	Commissioning Phase	Operational Phase	Decommissioning Phase
NESREA / FMEnv Representatives	• Review and approve ESIA/ESMP• Issue environmental permits	• Monitor ESMP implementation (environmental compliance) • Conduct inspections and enforce regulations • Engage stakeholders on compliance issues	• Monitor compliance during commissioning• Verify environmental and safety readiness	• Monitor ESMP implementation (environmental compliance)• Conduct periodic audits and inspections• Discuss ESMP improvements with PMU, Director, and O&M Contractor to address non-compliance and emerging risks	• Monitor decommissioning activities• Verify environmental restoration• Approve closure compliance• Recommend corrective actions where necessary
State Ministry of Women's Affairs & Social Development (GBV/SEA Service Provider)	• Review Gender/GBV Action Plans • Support stakeholder engagement on GBV risks	• Monitor implementation of gender and GBV mitigation measures • Provide GBV/SEA support services• Conduct awareness programs	• Monitor GBV risk during commissioning activities • Ensure reporting and response mechanisms are active	• Monitor Gender Action Plan implementation• Handle GBV/SEA cases confidentially• Provide survivor support services• Engage with PMU, Director, and Gender Officer on improvements	• Monitor GBV risks during workforce demobilization • Support vulnerable groups and affected persons • Ensure proper closure of GBV cases and services

7.5 Additional Management Plans

During the progression of the project, management plans will be expanded to include specific procedures to guide implementation by the relevant project personnel and institutions including contractors and subcontractors. Such documents will be prepared strictly in line with the requirements set out in the relevant international standards and guidelines and other applicable national and local regulations and guidelines. These additional management plans include the following:

- Stakeholder Engagement Plan
- Emergency Preparedness and Response Plan
- Traffic Management Plan
- Waste Management Plan
- Occupational Health and Safety Plank,
- Local and Employment Management Plan
- Erosion and Sediment Control Management Plan
- Livelihood Restoration Plan

7.6 Environmental Monitoring Program

Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. The key components of the environmental monitoring program that will be developed for this project include:

- Comprehensive identification of high-level issues, risks, opportunities, and gaps in system and operating practices that can impact the ability to achieve the required level of performance.
- Establishment of clear metrics to measure statistically significant performance improvement areas towards goals and targets;
- Establishment of processes to ensure documents and records that are critical to operational excellence are current, controlled, and accessible.
- Establishment and maintenance of appropriate processes for regular monitoring of HSE performance as well as conducting regular environmental audits and evaluations to ensure that the system is implemented and maintained and remains effective.

7.7 Training, Awareness and Capacity Building for Zonal Officers

REA shall identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environmental or social conditions. It is important that employees at each relevant phase of the project are aware of the potential environmental impacts of their activities and the occupational hazards associated with the work; as well as their roles and responsibilities in achieving conformance with the management documented in this report. Thus, a formal training process will be organized for employees on environmental management programs, plans and procedures associated with the project.

All staff employed will be trained in the following:

- General operation of the plant.
- Environmental management.
- Specific job roles and procedures.
- Occupational health and safety; and
- Contingency plans and emergency procedures. Training will include:
- Induction training on appointments.
- Specialist training (as required for specific job roles); and
- Refresher training as required.

Training for the local community on general environmental awareness and ESMP mitigation measures on community health, safety, and security should also be provided.

7.8 ESMP Capacity Building Plan

The various actors involved in the ESMP implementation will need capacity enhancement to ensure adequate understanding of ESMP/ OHS/ Waste Management/ Code of Conduct requirements amongst other areas identified. Proposed topics and target audience is outlined in Table 7.7.

Table 7.7: ESMP Capacity Building Plan

S /N	Training Content	Participants	Delivery Responsibility	Revised Cost (USD)
1	Specialized Training in Environmental & Social Management (ESM) (ESIA, safeguards, monitoring, reporting)	PMU, Environmental & Social Safeguard Officers	Consultant / PMU	4,500
2	ESMP Implementation Training (mitigation measures, roles & responsibilities, monitoring procedures)	Project Team (PMU, Site Engineer, Supervisors)	Consultant / PMU	1,500
3	Contractor Training on ESMP Compliance (mitigation measures, Code of Conduct, OHS requirements)	Contractor's management, workers, HSE Officers	Consultant / PMU	1,500
4	Driver & Traffic Management Training (fleet management, road safety, traffic control within project area)	Drivers, Transport Officers, HSE Officers, Security Personnel	Transport/Traffic Specialist / PMU	1,200
5	GBV/SEA/SH Prevention & Response Training (Code of Conduct, reporting channels, survivor-centered approach)	Project Team, Safeguard Officers, Contractors	GBV Specialist / Consultant / PMU	2,500
6	Grievance Redress Mechanism (GRM) Training (complaint handling, documentation, resolution process)	GRC Members (project & management levels), PMU	Consultant / PMU	2,000

Total Estimated Cost: $13,200

7.9 Record Keeping

The contractor should keep records providing evidence of ongoing mitigation activities. These documents should be made available upon request. The Safeguard Unit should keep records to provide evidence of monitoring activities and effectiveness of the monitoring plan to include monitoring Plan, identified problems/corrective actions and monitoring Reports.

7.10 ESMP Costing

Table 7.10 provides the summary of the cost estimate required to effective and efficiently implement the recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed project. The total cost of implementing the ESMP is estimated at US$ **57,300** with the current Naira value of 135,00.32 to 1 dollar.

Table 7. 8: Cost of ESMP

S/N	ESMP Activity	Cost (USD)	Key Cost Components	Justification
1	Pre-Construction Phase	8,000	Stakeholder engagement, ESMP disclosure, livelihood restoration planning, training of safeguards staff	Required to address social risks early, prevent conflicts, and ensure readiness before project mobilization
2	Construction Phase	13,000	Daily monitoring, mitigation measures (dust, erosion, OHS), PPE, inspections, reporting	Most impact-intensive phase requiring continuous supervision and high resource allocation
3	Commissioning Phase	800	Testing supervision, safety monitoring, stakeholder notification	Short-term phase with limited activities but critical safety requirements
4	Operational Phase	13,500	Routine monitoring, OHS audits, waste management, GBV/SEA implementation, reporting	Long-term phase requiring sustained compliance, monitoring, and system maintenance
5	Decommissioning Phase	4,000	Dismantling supervision, waste disposal, site restoration, livelihood transition	Ensures safe closure, environmental restoration, and social safeguards at project end
6	Mitigation & Monitoring	7,000	Environmental sampling, inspections, compliance audits, documentation	Dedicated funding ensures effective tracking of impacts and regulatory compliance
7	Capacity Building	11,000	ESMP training, OHS training, GBV/SEA awareness, GRM training	Builds stakeholder capacity for effective ESMP implementation and sustainability
	TOTAL	**57,300**		**Cost reflects full lifecycle ESMP implementation aligned with international standards**

7.11 Remediation Plan After Decommissioning/ Closure

Upon the completion of the useful life cycle of a project, there is a need to abandon and/or decommission such a project if it no longer becomes economically viable, either as a result of depleted feedstock or competing technology. The proposed solar project is expected to have a life span of 25 years. It is envisaged

that technology and environmental policies could have changed so drastically by then, hence, a definite decommissioning plan cannot be put in place for now. However, it is of importance that abandonment activities be planned in accordance with the Nigerian regulatory requirements.

7.11.1 Decommissioning Activities

Decommissioning refers to the process of removing all the operating assets of a project after completion of its life cycle. The average life span of the solar Photovoltaic (PV) power plant to be provided as part of the proposed Project is 25years (which can be extended through regular maintenance), while the training center can last for 40 years or more. Even after 25 years, the PV panels can still generate up to 90% of the design capacity.

During decommissioning, REA shall ensure that the project sites are returned to a safe and environmentally acceptable condition. The decommissioning activities will typically include the following: Dismantling and removal of PV panels and associated infrastructure (mounting structure, power evacuation cable, inverters, transformers, batteries, etc.);

- Removal of any sub-surface installations (e.g. underground cables);
- Waste generation and management;
- Restore the environment to allowable baseline conditions and monitor the process in line with legislative and regulatory requirements and best industry standards; and
- Assess the residual impacts, if any, that the project has on the environment; and specifically, if there are any future restrictions for other activities.

7.11.2 Management of Decommissioning Activities

In the event of decommissioning, REA, in conjunction with the leadership of the Academy, shall ensure that the Project site is left in a safe and environmentally acceptable condition. A standard decommissioning, abandonment and closure programme shall be invoked. The tasks will include, amongst others:

- Evacuation of the dismantled PV panels and other related items (such as inverters, and control devices) to the manufacturers for recycling.
- Transportation of spent batteries to recycling facilities;
- Monitoring the abandoned project environment as necessary.

Decommissioning activities will only begin after due consultation with the relevant stakeholders including the regulatory authorities. The decommissioning activities shall be carried out in line with the relevant provisions of the National Guidelines for Decommissioning of Facilities in Nigeria (2017) issued by the FMEnv. Typically, the following actions shall be undertaken for decommissioning: An updated plan which takes into account the most cost-effective and best practicable methods, legal requirements and industry practices at that time for the facility decommissioning shall be developed and submitted to the FMEnv and other relevant regulatory authorities for approval. The plan shall include but not limited to the following: Description of the site and components to be decommissioned.

Description of the decommissioning scope, objectives, end state and strategy;

- Activities to be performed during the decommissioning;

- Schedule of decommissioning activities; or Estimate of the decommissioning cost;
- Estimated inventory of waste streams to be generated during the decommissioning and handling techniques;
- Decommissioning team (qualifications, roles and responsibilities)

- To ensure that due consideration is given to all options a detailed evaluation of facility decommissioning options shall be carried out.
- The options will include facility mothballing, partial facility decommissioning or complete site decommissioning. The evaluation will consider environmental issues in conjunction with technical, safety and cost implications to establish the best practicable environment friendly options for the Project decommissioning.

- A risk assessment shall be conducted to ensure that nothing which could be constituted as a hazard for other users of the site or for the environment in general, will be left at the site.
- The Project site shall be left in a safe and environmentally acceptable condition.

- Hazard identification and analysis shall be conducted to determine special safety concerns to be addressed.
- An appropriate Health, Safety and Environment (HSE) plan shall be implemented to ensure that the decommissioning activities are carried out in an environmentally sound manner and in conformity with relevant laws and regulations guiding such operations

- Third party notifications should be carried out before any demolition and shall be conducted in a phased sequence.

- Socio-economic considerations of facility decommissioning shall be carried out. These will include assessment of potential effects associated with termination of employment (at the end of the operational phase) and measures to minimize the effects by:

- Ensuring that employees are fully informed about the decommissioning and how it will affect them before the project finally closes.

- Building community capacity to manage opportunities and impacts arising from the decommissioning and post-decommissioning phase of the Project.

- Providing training to build local skills tailored to project decommissioning and post-decommissioning activities (e.g. equipment dismantling, rehabilitation activities, monitoring, etc.).

- Providing training to transfer project-learned skills to alternative and secondary industries tailored to respond to the market economy.

- An effective waste management plan shall be developed for the decommissioning activities. The decommissioning options for redundant structures and equipment will include: the complete

dismantling of structures and equipment and the return of all components to the equipment manufacturer for recycling. A detailed record of all suitable recycling materials shall be maintained.

7.11.3 Vegetation Control Plan

Objectives

The overall objective of the Vegetation Control and Management Plan is to maintain vegetation within acceptable limits to ensure reliable operation of the solar mini-grid while conserving environmental resources. The plan seeks to prevent vegetation from shading solar panels, maintain safe access to project infrastructure, reduce the accumulation of combustible materials, protect electrical equipment from vegetation-related damage, and preserve native vegetation where practicable. The plan also aims to control invasive species, minimize soil erosion, support ecological restoration in disturbed areas, and promote sustainable land management practices throughout the project lifecycle.

Implementation Strategy

Vegetation management shall be implemented using an integrated approach that prioritizes mechanical and manual control methods over chemical treatments. Grass cutting, brush clearing, pruning, and manual weeding shall be conducted routinely to maintain vegetation at heights that do not interfere with solar generation or operational safety. Herbicides shall only be used where alternative methods are ineffective and shall be applied by trained personnel in accordance with manufacturer specifications and environmental protection requirements.

Monitoring and Performance Standards

The project operator shall conduct regular inspections to assess vegetation conditions within the solar array, around electrical equipment, along access roads, and at perimeter security fences. Vegetation-related performance indicators shall include the absence of panel shading, maintenance of required equipment clearances, prevention of vegetation-related outages, effective control of invasive species, and the absence of fire incidents attributable to vegetation. Inspection findings shall be documented and corrective actions implemented within specified timeframes.

Roles and Responsibilities

The Project Manager shall have overall responsibility for the implementation of this plan and for ensuring adequate resources are available for vegetation management activities. The Operations and Maintenance Manager shall coordinate routine vegetation control works and ensure that maintenance schedules are adhered to. The Environmental Officer shall monitor environmental compliance, maintain records, and oversee implementation of biodiversity protection measures. The Health, Safety and Environment Officer shall ensure that all vegetation management activities are conducted safely and that fire prevention measures are effectively implemented.

7.11.4 Biodiversity Management Plan

Biodiversity Management Measures

Prior to construction, a biodiversity assessment shall be conducted to identify important habitats, plant species, wildlife populations, and any species of conservation concern. Project infrastructure shall be located, where possible, to avoid sensitive ecological areas. Vegetation clearing shall be restricted to the minimum area required for project development, and native vegetation outside operational areas shall be retained

wherever feasible. Construction activities shall be confined to designated work areas to reduce habitat disturbance. Workers shall be prohibited from hunting, trapping, or disturbing wildlife. Speed limits shall be enforced on access roads to minimize wildlife collisions, and any wildlife encountered during construction shall be protected and relocated where necessary by qualified personnel.

Habitat Restoration and Invasive Species Control
Areas disturbed during construction shall be rehabilitated as soon as practicable through regrading, replacement of topsoil, and revegetation using native plant species. The project shall monitor disturbed areas and implement corrective measures where vegetation establishment is unsuccessful. To prevent the spread of invasive species, equipment entering the site shall be cleaned of soil and plant material.

Monitoring and Reporting
Biodiversity monitoring shall be conducted periodically throughout the construction and operational phases. Monitoring activities shall include vegetation inspections, wildlife observations, invasive species surveys, and assessments of rehabilitated areas. Monitoring results shall be documented and used to evaluate the effectiveness of mitigation measures and identify any corrective actions required. Records of biodiversity-related incidents, monitoring findings, rehabilitation activities, and invasive species management shall be maintained by the project operator and included in environmental performance reports.

Roles and Responsibilities
The Project Manager shall be responsible for the overall implementation of this Biodiversity Management Plan. The Environmental Officer shall oversee biodiversity monitoring, maintain records, and ensure compliance with biodiversity commitments. Contractors and site personnel shall comply with all biodiversity protection measures and report any environmental incidents or wildlife observations during project activities.

Review and Continuous Improvement
This Biodiversity Management Plan shall be reviewed annually and updated as necessary to reflect changes in project activities, environmental conditions, monitoring results, and regulatory requirements. The project shall continually improve biodiversity management practices to ensure effective protection of ecological resources and sustainable operation of the solar mini-grid facility.

7.11.5 Abandonment Plan

Before site abandonment, REA shall establish a standard procedure for incorporating the following practices:

- Identification of the components of the power plant that will be abandoned and/or removed;
- The proposed methods for abandonment or re-use of the plant equipment/material applicable;
- Processes put in place to mitigate potential environmental impacts associated with the abandonment process; and
- Appropriate site rehabilitation programs (including re-vegetation of the site with native plant species) to return the Project site to its original status (as much as possible).

In the event of the project being abandoned, this shall be done in accordance with strict compliance with legislative requirements and international best practices. The decommissioning, abandonment and/or closure programme shall generally be managed by a team of competent personnel from the REA-Project Management

Unit, the Department of Works and the Physical Planning Department of the Academy. The abandonment process shall be carried out as follows:

- Relevant stakeholders shall be duly informed;
- Physical Asset Verification (PAV) of the facilities shall be carried out;
- National Sectoral Regulations, as they affect the abandonment of the project, shall be strictly complied with to ensure:
- Restoration and rehabilitation of the environment.
- Management of residual impacts of the project in strict compliance with extant
- National/ FMEnv sectoral regulations.
- In addition, a site close-out permit shall be obtained as appropriate, and a close-out report shall be prepared and archived for future reference.

CHAPTER EIGHT
STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

8.1 PREAMBLE

Consultations play a crucial role in identifying the key environmental and social issues that are central to the preparation of this ESIA. A Stakeholder Engagement Plan (SEP) was developed to support the effective and sustainable implementation of all phases of the Project lifecycle, including pre-construction, construction, operation, and decommissioning.

The SEP outlines the methods used to identify stakeholders, the approaches adopted for engaging them, and the outcomes of consultations conducted to date. It also details the measures taken by the Project to ensure that relevant information was appropriately disclosed to stakeholders.

8.2 Stakeholder Engagement

A Stakeholder Engagement Plan (SEP) is the process of managing stakeholder expectations, which influences project decisions throughout the life cycle of the project. This process provides a plan to interact effectively with stakeholders and support the project's interests. It is very important to plan these activities well so that they appraise the contribution of stakeholders on projects, manage their expectations, and achieve project objectives. The stakeholder engagement process emphasized free, prior, and informed consultation (FPIC) with affected communities and other relevant stakeholders, while considering appropriate approaches for involving vulnerable and marginalized groups. Consultations included early disclosure of information in formats that are accessible and easily understood, as well as key informant interviews, focus group discussions (segmented by men, women, and youth), and broader public meetings.

Table 8.1: Stakeholders Engagement Plan (SEP)

Groups and individuals	Date	Type of Engagement	Discussion
Management of the University of Kashere	11/02/2026	Consultation /homage	Overview of the ESIA, benefits of the proposed REA Solar project
University Community	12/02/2026	Focal Group Discussion,	An overview of the ESIA and the benefits of the proposed REA solar project.

All consultation activities were properly documented, including relevant data, supporting evidence, participant lists with contact information, and photographic records. Information disclosure complied with the provisions of national regulations, including the EIA Act No. 86 of 1992 (as amended under Cap E12 LFN 2004), as well as the World Bank's Environmental and Social Safeguards Standards (ESSS).

8.3 Objectives of Stakeholder Engagement

The purpose of public participation in an ESIA is to ensure that potentially affected and interested stakeholders are provided with adequate, clear, and accessible information in an objective manner. This enables them to identify key concerns, contribute meaningful input, and propose options for improving project benefits and considering alternatives.

The stakeholder engagement process has been structured in line with the requirements of the Nigerian EIA Act as well as applicable international standards. For this Project, the main objectives of stakeholder engagement are as follows:

- Identify key stakeholders that can influence the Project and its activities;
- Inform and educate stakeholders about the proposed Project;
- Gather local knowledge to improve the understanding of the environmental and social context;
- Better understand the locally important issues;
- Identify the most effective methods and structures through which to disseminate project information, and to ensure regular, accessible, transparent and appropriate consultation;
- Provide a means for stakeholders to have input into the Project planning Process;
- Take into account the views of stakeholders in the development of effective mitigation measures and management plans; and
- Lay the foundation for future stakeholder engagement.

8.4 Disclosure and Participation Plan

Information disclosure is a critical activity, not only as a means of engagement but also as a foundation for enabling other engagement processes to be carried out in an informed and participatory manner. This section outlines the procedures to be followed for information disclosure and stakeholder participation as part of the implementation of the EEP. In accordance with the World Bank Safeguards requirements, the REA is expected to disclose the environmental and social assessment, along with a documented record of stakeholder engagement. This record should include details of the stakeholders consulted, a summary of the feedback received, and a clear explanation of how the feedback was incorporated into the Project, or the reasons why it was not adopted.

8.4.1 Disclosure Mechanism

The process of information disclosure can be undertaken in two ways: either voluntary disclosure or disclosure as part of the regulatory requirements (EIA requirements, public hearing). While regulatory disclosure involves the provisioning of information as required by the authorities and agencies involved in the project, voluntary disclosure refers to the process of disclosing information to the various stakeholders in a voluntary manner. This disclosure not only allows for trust to be built amongst the stakeholders through the sharing of information, but it also allows for more constructive participation in the other processes of consultation and resolution of grievances due to availability of accurate and timely information.

8.4.2 Process for Disclosure of Information

As a standard practice, this ESIA will be released for public review according to the WB disclosure procedures, and for a period of 21 days in accordance with Nigerian Regulatory Frameworks. Distribution of the disclosure material will be done by making them available at venues and locations convenient for the stakeholders and places to which the public have unhindered access. The language of the ESIA is in English. The report will be made accessible for the public at the following locations:

- The EA Department of the Federal Ministry of Environment;
- The Gombe State Ministry of Environment,
- The Federal University of Kashere
- Other designated public locations to ensure wide dissemination of the materials.

Electronic copies of the ESIA report will be made available on the websites of the World Bank and FMEnv, enabling stakeholders with internet access to review information on the proposed development and participate in the public consultation process.

Stakeholder input will be facilitated through various mechanisms, including press releases and media announcements, as well as notifications to local, regional, and national NGOs, relevant professional bodies, and other interested parties regarding the disclosed materials.

8.5 Stakeholder Identification/Mapping and Analysis

The stakeholders were identified based on the direct project beneficiaries, adversely impacted groups, project supporters /proponents, regulatory/ planning,

However, the stakeholders covered are;

- Rural Electricity Agency (REA)
- Federal Ministry of Environment (FMEnv)
- Gombe State Ministry of Environment
- Akko Local Government Area

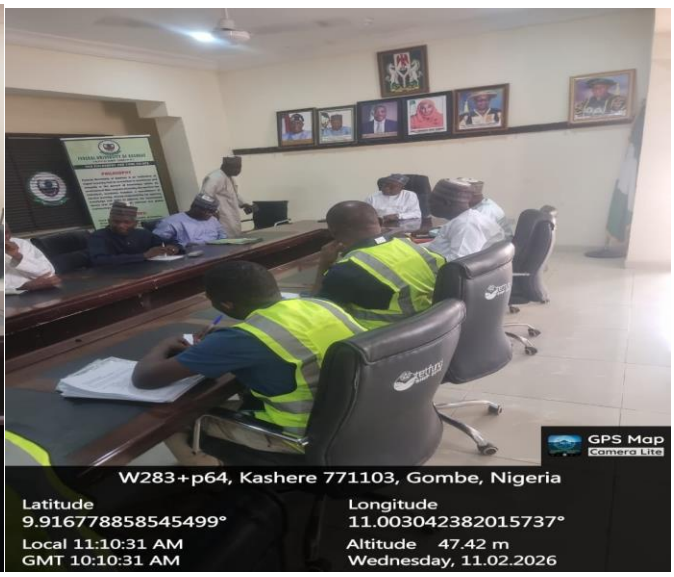
Major Points of the Initial Consultation Key agenda points included:

1. Introduction of Stakeholders
2. Opening Remarks
3. Description of the Proposed Project by REA/Consultant
4. Overview of The ESIA and Public Consultation by Consultant
5. Questions, Comments and Remarks by other stakeholders
6. Closing Remark

Key feedback received during Stakeholder Consultations are presented below;

Table 8.2: Engagement with the Management of the University

Comments / Questions	Corresponding Responses
Whether there were any land-related disputes between the University and host community concerning the proposed project site.	The Vice Chancellor clarified that there were no disputes, as the proposed land is within the legally designated perimeter of the University.
Whether the project would benefit off-campus students and the surrounding host community.	The Vice-Chancellor stated that this would depend on the magnitude, capacity, and coverage of the installed solar plant, but expressed optimism about wider benefits.
Concern about maintenance challenges commonly associated with government projects.	The Director of Works and Maintenance emphasized that sustainability mechanisms should be incorporated into the project design.
Need for adequate security due to reported theft of infrastructure on campus.	University management assured the team of its commitment to proper implementation, supervision, maintenance, and security of the facility.



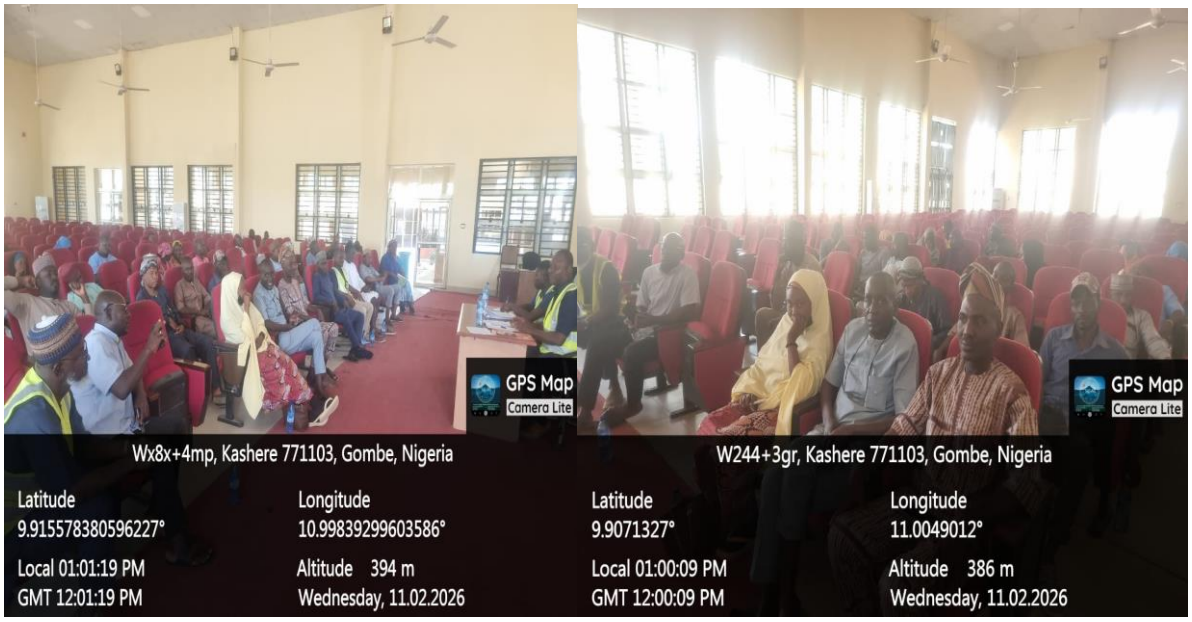


Plate 8.1: Consultation at different Levels

8.6 Grievance Redress Mechanism

A Grievance Redress Mechanism (GRM) shall be established for the proposed Solar Power Plant Project at the Federal University Kashere, Gombe State, to provide an accessible, transparent, and effective process for receiving and resolving complaints or concerns arising from project activities. The GRM is designed to strengthen stakeholder confidence, promote accountability, and ensure that issues affecting students, staff, contractors, and host communities are addressed in a timely and fair manner. The mechanism will serve as an important tool for preventing conflicts and enhancing cooperation among all parties involved in the project implementation.

The primary objective of the GRM is to provide affected persons and stakeholders with a formal platform through which grievances can be lodged and resolved amicably. The mechanism will ensure that complaints relating to environmental impacts, social concerns, labor issues, security matters, or operational disturbances are properly documented, investigated, and addressed. It will also help to improve communication between the project proponents, the University management, the Rural Electrification Agency (REA), contractors, and surrounding communities.

The scope of grievances to be handled under the mechanism includes concerns relating to land use, noise and dust generation, occupational health and safety, damage to infrastructure, employment and labor disputes, community health and security concerns, theft or vandalism of project facilities, and any dissatisfaction associated with project activities. Sensitive issues such as harassment, discrimination, and gender-based violence shall also be handled confidentially and in accordance with established safeguarding procedures.

To ensure effective implementation, a Grievance Redress Committee (GRC) shall be constituted. The committee may comprise representatives of the Federal University Kashere management, the Rural Electrification Agency, Charlton Consult Limited, contractors, community representatives, student

representatives, security personnel, and environmental and social safeguard officers. The committee will be responsible for receiving complaints, conducting investigations, facilitating dialogue among parties, and ensuring that corrective measures are implemented where necessary.

Stakeholders shall be able to submit grievances through multiple channels to ensure accessibility and inclusiveness. Complaints may be lodged verbally or in writing through complaint boxes placed within the University premises, dedicated telephone lines, email addresses, community liaison officers, or directly through the University's Works and Maintenance Department. Anonymous complaints shall also be accepted and treated with confidentiality to encourage openness and protect complainants from fear of retaliation.

Upon receipt of grievance, the complaint shall be formally registered and acknowledged within a reasonable timeframe. The Grievance Redress Committee will then assess and investigate the matter to determine appropriate corrective actions. Resolution outcomes shall be communicated clearly to the complainant, and where necessary, follow-up actions shall be monitored to ensure satisfactory implementation. In situations where the complainant is dissatisfied with the decision reached, an appeal process shall be provided to allow for further review of the grievance.

All grievances and their resolutions shall be documented in a grievance register containing details such as the nature of the complaint, date received, actions taken, resolution status, and date of closure. Periodic monitoring and reporting of grievances will help improve transparency, accountability, and overall project performance. Continuous awareness creation and stakeholder engagement will also be carried out to ensure that all affected persons understand the grievance process and can access it without difficulty.

The establishment of an effective Grievance Redress Mechanism is essential for the successful implementation and sustainability of the proposed solar power project at Federal University Kashere. By ensuring that concerns are addressed promptly and fairly, the GRM will contribute significantly to maintaining good relationships among stakeholders and promoting the long-term social and environmental sustainability of the project.

8.6.1 Grievance Redress Mechanism Process

The key steps in the GRM process are as follows

1. Grievance Submission – Complaint is lodged through available channels.
2. Acknowledgment & Registration – Complaint is recorded and acknowledged.
3. Screening & Assessment – Issue is reviewed and categorized.
4. Investigation – Facts and evidence are collected.
5. Resolution – Appropriate corrective action or solution is provided.
6. Appeal/Escalation – Unresolved complaints may be reviewed at a higher level.
7. Closure & Documentation – Case is closed and documented for future improvement.

8.6.2 Publicizing and Disclosure of the GRM

The GRM will be disclosed to the stakeholders through written and verbal communication. The mediums to be used for this purpose are public meetings, group discussions The GRM disclosure will be done along with the disclosure of other management plans.

8.6.3 Receiving and Recording Grievances

As part of the GRM, the grievances from the stakeholder or their representatives may be communicated verbally (in person or over a telephonic conversation) or in written form to the project representatives or to the designated Grievance Officer (GO) directly. If grievance is received directly by the GO or other project representatives, it will be recorded directly into the Grievance Form as soon as the personnel return to site.

8.6.4 Maintaining a Grievance Register

Each grievance thus received, shall be recorded in a grievance register. This grievance register shall be updated at each stage of the grievance redressal. Once the grievance is recorded in the register, a preliminary analysis shall be undertaken by the social standard officer/ manager to ensure that the grievance is within the scope of the GRM.

8.6.5 Acknowledgment of Grievance

Once the grievance has been recorded, the stakeholder will receive an acknowledgment of receipt along with a summary of the complaint.

8.6.6 Resolution, Escalation, and Closure

Based on the understanding developed, the Social Safeguard Officer, in consultation with relevant departments, shall determine an appropriate resolution to the issue. This may include providing information to clarify the situation, implementing corrective actions to address identified problems, offering compensation; either financial or in kind for any damage caused, and introducing mitigation measures to prevent recurrence. The agreed resolution shall be communicated to the complainant within 10 working days after completion of the site investigation.

Where the issue falls outside the mandate of the Social Safeguard Officer, it shall be escalated to the Head of the PMU under the NEP, and the complainant shall be duly informed of the escalation. The Head of the PMU shall make efforts to resolve the grievance within 10 working days of receiving it.

If grievance remains unresolved and no adequate solution can be identified by the Head of the PMU, a formal response shall be provided to the complainant, along with guidance on alternative avenues for redress. This may include referral to a citizens' rights mediation centre for resolution before pursuing legal action.

At any stage, if the complainant is dissatisfied with the proposed resolution, they may request that the grievance be escalated to the next level. In cases where a grievance is determined to be unfounded, a clear and reasoned explanation shall be provided to the complainant.

8.6.7. Update of Records

The grievance register shall be updated on a weekly basis to reflect the status of each complaint. Once a grievance has been resolved and the outcome communicated to the complainant, it shall be formally closed in the register. The register should also document how each grievance was addressed, providing a clear record of the resolution process. These records will serve as useful references for handling similar grievances in the future. Where there is evidence of recurring issues or repeated grievances, such matters should be escalated to the Head of the PMU under the NEP for assessment to determine whether modifications to the project design are necessary.

CHAPTER NINE

CONCLUSION AND RECOMMENDATIONS

9.1. Conclusion

The Environmental and Social Impact Assessment (ESIA) for the proposed solar power plant at the Federal University of Kashere, Akko LGA, Gombe State, was conducted to comply with relevant government regulations, financiers' requirements, and stakeholder expectations. The study aligns with the Nigerian EIA Act Cap E12 LFN 2004 and the World Bank Environmental and Social Safeguard Standards, ensuring that environmental and social considerations are integrated into the project design and implementation process. The ESIA is intended to support informed decision-making and promote environmentally sustainable and socially responsible development.

As part of the assessment, stakeholder consultations were carried out to identify and address concerns relating to the proposed project, with continued engagement planned throughout the project lifecycle. Baseline environmental and socio-economic conditions were established through field surveys, sampling, literature reviews, and secondary data sources. These baseline data provide a reference for future monitoring and evaluation of the project's environmental and social performance.

The assessment evaluated potential interactions between project activities and the existing environment to identify likely impacts and develop suitable mitigation measures based on industry's best practices and HSE standards. An Environmental and Social Management Plan (ESMP) was also prepared to guide impact management, monitoring, and compliance during project implementation and operation. The Rural Electrification Agency (REA) ensures monitoring of key parameters such as air quality, noise, and groundwater in line with Federal Ministry of Environment (FMEnv) and World Bank requirements. Overall, the findings of the ESIA are expected to support the preparation of the Environmental Impact Statement (EIS) and facilitate the acquisition of necessary permits for the project.

9.2. Recommendation

The ESIA study recommends the following:

- Ensure full implementation of the Environmental and Social Management Plan (ESMP) throughout the project lifecycle.
- Conduct regular environmental monitoring for air quality, noise, groundwater, and waste management.
- Maintain continuous stakeholder engagement and effective community communication.
- Prioritize local employment, capacity building, and renewable energy training opportunities.
- Implement strong occupational health and safety measures, including emergency response systems.
- Establish and maintain an efficient Grievance Redress Mechanism (GRM) for timely resolution of complaints.
- Promote proper waste management, including safe disposal of hazardous and electronic waste.
- Ensure compliance with regulatory requirements through continuous oversight by the Rural Electrification Agency and relevant authorities.

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APPENDICES

Appendix – Laboratory Report -Soil

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15th April 2026

Soil Physico -Chemical Properties of Federal University of Kashere

Parameter	Unit	S1 0–15 cm	S1 15–30 cm	S2 0–15 cm	S2 15–30 cm	S3 0–15 cm	S3 15–30 cm	Control 0–15 cm	Control 15–30 cm
pH	-	5.8	5.5	6.1	5.8	6.3	6.1	5.4	5.2
EC	µS/cm	95	110	116	128	128	146	105	112
Temperature	°C	33.0	31.8	34.8	33.0	36.5	34.2	34.4	32.8
Nitrate	mg/kg	0.25	0.18	0.46	0.36	0.68	0.55	0.22	0.51
Ammonia	mg/kg	0.45	0.32	0.78	0.64	1.10	0.95	1.95	1.36
Phosphate	mg/kg	1.2	2.8	2.4	4.3	3.5	5.7	3.2	2.6
Sulphate	mg/kg	7.5	6.2	9.6	8.3	11.8	10.4	8.5	11.8
Chloride	mg/kg	0.8	1.0	1.4	1.7	1.9	2.4	0.4	0.1
TOC	%	0.45	0.38	0.64	0.56	0.82	0.74	1.00	0.06
Moisture Content	%	4.8	5.2	6.2	6.1	7.5	7.0	8.3	7.1
Magnesium	mg/kg	15.2	18.5	21.6	24.8	28.4	31.2	23.3	32.1
Potassium	mg/kg	2.1	2.6	3.3	3.9	4.5	5.1	3.1	4.2
Sodium	mg/kg	5.5	7.2	8.2	9.7	10.8	12.5	8.6	5.6
Copper	mg/kg	1.2	1.5	2.0	2.3	2.8	3.1	3.9	4.8
Iron	mg/kg	65	88	91	112	112	135	193	120
Lead	mg/kg	0.05	0.10	0.24	0.33	0.42	0.55	0.18	0.11
Zinc	mg/kg	3.5	4.2	5.1	5.9	6.8	7.5	8.8	9.4
Manganese	mg/kg	0.4	0.7	0.9	1.2	1.5	1.8	2.9	2.0

Thank you for your patronage.

Bayo Lawal
Managing Director

TUDAKA Analytical Nig. Ltd.

QUESTIONNAIRES

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PLAN (ESIA) PHASE III: ENERGIZING EDUCATION PROGRAM (EEP) PROJECT

NOTE:

Please read each question carefully. Your answers are completely confidential and will be included only in summaries where individual answers cannot be identified. Unless otherwise instructed, please tick appropriate answer category that best describes your opinion. It will take approximately 20 minutes to complete this questionnaire.

SECTION A: Household data

Location/Name of School.....

1. Gender of Respondent: (a) Male (b) Female
2. Age: (a) Below 18 yrs (b) 18-45 yrs (c) 46-65 yrs (d) Above 66 yrs
3. Marital Status: (a) Single (b) Married (d) Divorced/Separated (e) Widowed
4. Occupation: (a) Civil Servant (b) Daily Labourer (c) Trading & Shop Keeping (d) Artisans (e) Employed (salary)(f) Retired (g) Famer (h) Unemployed (i) Others specify.....
5. Residential Status: (a) Permanent Resident (b) Back Home (Returnee) (c) Nonresidents, Visiting
6. Ethnic Group: (a) Ebira (b) Igala (c) Hausa-Fulani (d) Igbo (e) Hausa Yoruba (f) others.....
7. Religion: (a) Islam (b) Christianity (c) Traditional
8. Relationship to Household Head (HH): (a) Self (b) Spouse (c) Child (d) Parent (e) Other, specify.....
9. Size of the HH .....
10. How long have you been living/working in this area? (a) 0-2 yrs (b) 3-5 yrs (c) 6-9 yrs (d) 10 yrs and Above
11. Education: (a) NO formal education (b) Primary School (c) Secondary School (d) Tertiary (Excluding University) (e) University Graduate (f) University Postgraduate

SECTION B: Health Status

1. How do you manage your health conditions when sick? (a) Attend hospital/clinic (b) Buys drugs from nearby chemist (c) Traditional medicine (d) None (e) Others Specify.....
2. If you do attend hospital/clinic, when last did you visit one? (a) last six months (b) last one year (c) last five years (d) more than five years ago (e) Never visited one.
3. Please tick one or more of the under-mentioned ailment/sicknesses, you suffer from most accordingly?
4.

Ailment	**√**	**Ailment**	**√**

Whooping Cough		Rheumatism	
Tuberculosis		Rashes	
Asthma		Eczema	
Dysentery		Ringworm	
Diarrhoea		Eye pains	
Cholera		Cataract	
Pile		Glaucoma	
Hypertension		Typhoid fever	
Congestive health problem		Malaria	
Pneumonia		Sickle cell anaemia	
Sexually transmitted diseases		Epilepsy	

7. Do you think your health condition will be affected by the proposed Infrastructure intervention? (a) Yes (b) No

8. If yes, how? .....

9. Please suggest how this can be averted during construction and implementation.....

SECTION C. Standard of Living /Socioeconomic Activities

1.0 Assets

1.1 What sort of housing does your household live in?					
a. Construction material - Walls		Plastered mud	c. Number of rooms		1-2
		Cement blocks			3-4
		Other (specify)			Other (specify)
b. Construction material - roofing		Corrugated roofing	d. Other structures on plot		Animal Pen
		Aluminium			Granary
		Asbestos			Shops
		Tile			Kiosks
		Other (specify)			Other (specify)
e. Construction material - floor		Earthen			
		Concretes			
		Tiles			
		Other (specify)			
f. Toilet Facility		Pit latrine			

		Water closet
		Toilet facility outside dwelling
		Pier latrine
		Other (specify)
		None
g. Tenure of housing		Owned
		Rented
		Occupied rent free
		Other
h. Tenure of land		Owned
		Rented
		Occupied rent free
		Lease hold
		Others specify

1.2 Indicate household refuse disposal for solid waste? (Multiple options) (a) Depositing refuse at backyard of the house (b) Dumping in water body (c) Dumping in community refuse/garbage pit/dumpsite (d) Burning after gathering together (e) Waste collector (f) Other specify.....

2.0 Household Services

2.1 Rank in order of availability and usability the source(s) of lighting for the household? (Please use 1, 2,in hierarchical order with 1 indicating the most available and used source)

(a) PHCN	(b) Generator	(c) Lantern	(d) Candle	(e) Palm Oil Lamp	(f) Torchlight Battery	(g) Wood	(h) Kerosene	(i) Gas

2.2 Using the method in 2.1, indicate major source of energy for cooking?

(a) Fire Wood	(b) Coal	(c) Kerosene	(d) Electricity	(e) Animal dropping	(f) Gas	(g) Crop Residue/saw dust	Others

3.0 Sources of Water

Sources	for drinking	for cooking	for bathing and washing
a.Well			
b. Borehole/Water pump			
c. Community tap			
d. Piped water outside dwelling			

e. River			
f. Rain harvesting			
g. Water vendor			
h. Tanked water			
i. Other (specify)			

4.0 Income and source livelihood

Please, state your main income per month and source livelihood	₦

4.1 Remittances

1. Does anyone in the family who lives elsewhere send money to you?	1	YES	2	NO
2. If yes, how much (per month)	₦			

5. In your opinion, how has the standard of living of your household changed over the previous three years? (a) Same (b) Better (c) Worse
6. Is the option in 5 propelled by the state of the electricity provision/availability? (a) Yes (b) No
7. If 6 is YES, do you think the proposed infrastructure intervention will improve the situation? (a) Yes (b) No
8. If 7 is YES specify how the project will improve the situation .....

SECTION D: Gender-Based Violence/Sexual Exploitation and Abuse

1. Are there any provisions which restrict women's access to health and other social services? In particular which:

(Please specify in the space provided for this purpose "yes" or "no")

( ) require the consent of a male relative/husband for a married woman's medical examination or treatment or access to contraceptives or abortion,

( ) require parental consent in case of adolescents' access to contraceptives abortion;

( ) allow medical practitioners to refuse provision of a legal medical service on grounds of conscientious objection

( ) prohibit certain medical services, or require that they be authorized by a physician, even where no medical procedure is required; in particular:

( ) IUDs (intrauterine devices) or hormonal contraceptives

( ) Emergency contraceptives, including the morning-after pill, ( ) Sterilization on request;

( ) Early abortion (in first trimester of pregnancy) at the pregnant woman's request

( ) Medically assisted reproduction (e.g., in vitro fertilization) 2. Are the following acts criminalized?

(Please specify in the space provided for this purpose "yes" or "no")

( ) adultery

( ) prostitution

(If yes, who is criminally responsible? (a) the sex worker (b) the procurer and/or the customer) (c) both

3. Are there any measures and programs put in place in order to increase women's participation safety e.g. in public urban spaces, in public transportation, etc.? (a) Yes (b) No (c) No idea

4. Are there specific training programs for medical and legal professionals on the issue of gender-based discrimination in the area of health and safety? (a) Yes (b) No (c) No idea

5. How do you ensure gender equity in the community? (a) Women are elected in public office (b) Females are given equal opportunity and access to education and employment (c) Quotas on genders are ensures in leadership of community-based organizations (d) Others specify.....

SECTION E: Resources/ Cultural Property

1. Please indicate the environmental problems which your community experiences? (a) Soil infertility (b) Poor drainage system (c) Bad road (d) Bad lands (e) environmental degradation (f) Degraded land (i) Destruction of infrastructures (j) Others

(specify) .....

2. Please indicate the environmental problems which your community would likely experience and whose cause can be linked to the proposed Infrastructure intervention project during construction?

(a) Soil infertility (b) Poor drainage system (c) Bad road (d) Low visibility

(e) Erosion Problems (f) Flooding (g) Environmental degradation

(h) Destruction of infrastructures (i) encroachment of land properties (j) Pollution (air, surface water, ground water, noise) (k) others (specify)

.....

3. Do you think the proposed Infrastructure intervention project will affect any valued resource/cultural/archaeological property in your area? (a) YES (b) NO

4. If yes mention the name(s) of the valued resource/cultural/archaeological property

.....

5. How will valued resource/cultural/archaeological property be affected? (a) Displacement of such valued cultural properties (b) Vandalization of sacred items/locations (c) Possible theft of sacred/archaeological items (d) Others,

specify:.....

SECTION F: Intervention Project Activities Impact Evaluation

1. Are you aware of the proposed Solar Power Project? (a) Yes (b) No

2. If yes, from which source (a) Community meetings (b) Media (TV, Radio, Newspaper, Internet) (c) Others specify.....

3. Do you think the proposed Infrastructure intervention project can cause restiveness in your community? (a) YES (b) NO

4. If 3 is yes how will the proposed Infrastructure intervention result in restiveness? (a) Disrespect of norms and culture by contractors (b) loss of farmland / Property (c) Possible theft of sacred/archaeological items (d) local people not employed during construction (e) Others, specify: .....

5. How will the proposed Infrastructure intervention project impact on your livelihood and environment?

Positive impacts	Negative impacts
(a)	
(b)	
(c)	

6. Can you name some of the animals and other habitat that may be affected by the proposed Infrastructure intervention project? .....

7. What do you expect from the activities of solar power Infrastructure intervention? (a) employment of Locals during construction (b) compensation for those whose properties will be affected (c) capacity building for maintenance during implementation (d) community input into final engineering design (e) Others please specify.....

Section G: Grievance Redress Mechanism

1. Have you had grievances issue in this community in the last three years? (a) Yes (b) No

2. If 1 is yes, what was the cause of the grievance? (a) Land issue (b) theft of valuables (c) vandalization of property (d) Others, please specify.....

3. Who do you report your grievances in this community to? (a) School authority/management (b) Law enforcement (c) My landlord/CDA (d) traditional/community leader (e) Others, please specify.....

4. Are grievances satisfactorily addressed or resolved by option(s) chosen in question 3 above? (a) Yes (b) No

5. Are there any other issue(s) of concerned as regards the proposed intervention project in your area, please state clearly?.....

Section H: World bank ESS

	World Bank ESS	Question	Yes	No
1	ESS1: Assessment and Management of Environmental and Social Risks and Impacts	Will the project activities impact or lead to disruption of the ecosystem?		

2	ESS2: Labour and Working Conditions	Are labour rights and safe working conditions ensured?		
	ESS3: Resource Efficiency and Pollution Prevention	Will waste be generated from this project		
	ESS4: Community Health and Safety	are community health and safety near by be affected by this project?		
	ESS5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	Will farmer within the university by displaced		
	ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	How is biodiversity protected?		

MINUTE OF MEETING HELD AT THE FEDERAL UNIVERSITY KASHERE, GOMBE STATE WITH THE MANAGEMENT OF THE UNIVERSITY.

Title	Stakeholder's Consultation meeting for the Environmental and Social Impact Assessment for the Deployment of the Proposed Solar Power Plant Project in the Federal University Kashere (FUK), Gombe State, Nigeria.
Date	Wednesday 11th February, 2026
Language	English language
Location	Vice Chancellor's Conference Hall, Federal University Kashere, Gombe State
Participants	Prof. Mohammed Inuwa Ja'afar (Vice Chancellor), Prof. S. L. Kela (Deputy Vice-Chancellor, Academic), Prof. A.U. Gurama (Deputy Vice-Chancellor, Admin), Muhammad Imam Yunus (Director, Physical Planning), Abdullahi Adamu Yunusa (Director, Works and Maintenance Services), Mr. Isa Adamu Amaza (Bursar), Alhaji Nasir Lawan Abdullahi (Registrar), Dr. Tukur Abba (University Librarian), Bar Salamatu Isa Waziri(Head of Legal), Engr. Ahmed Hamman (Works dept), Engr Abubakar Manzo (Works dept), Samson Kwasau Gaji (Commercial Rep), Prof. Iyaji Adejoh (Lecturer) and Dr Collins E. Odu (Consultant representative for Charlton Consult Limited).
Introduction	The Deputy Vice-Chancellor, Academics, Prof. S. L. Kela introduced the management team of the Federal University Kashere, starting with the Vice Chancellor, Prof. Mohammed Inuwa Ja'afar, whom he stated just assumed duty and was currently on familiarization tour of the University. Prof. S. L. Kela confirmed that the University was in receipt of a letter dated 15th of January, 2026 from the Rural Electrification Agency (REA) introducing the Charlton Consult limited as one of its consultants to undertake the preliminary studies and design for the proposed Solar Power Plant project. On that note he welcomed and introduced the Consultant representative of Charlton consult and his adhoc team.
Presentation by Charlton Consult Limited	The consultant's representative, Dr Collins Odu congratulated the Vice Chancellor for successfully assuming duty on the day of this visit. He appreciated the management team and other stakeholders for honoring the invitation despite their busy schedules. In his remarks, he explained that the meeting formed part of the Environmental and Social Impact Assessment (ESIA) process, which was a mandatory requirement before the commencement of such a project. The Consultant representative also congratulated the University for been selected to benefit from the Distributed Access through Renewable Electricity Scale-up (DARES) programme of the REA in collaboration with

	the World bank. He stated that access to uninterrupted, reliable and affordable electricity was germane to industrialization and in particular, a must for universities to strive as centers of excellence for research and academic purposes. He mentioned that the proposed project was in line with the Energy Transition Programme and aligns with the SDG 7. The specific purpose of the visit was stated as the conduct of an Environmental and Social Impact Assessment of the proposed Federal Government solar energy installation via the Rural Electrification Agency's Nigeria Electrification project- for energizing the Education sector and specifically within the Federal University of Kashere, Gombe, Gombe State. During the briefing, it was explained that the assessment was intended to evaluate the perceived environmental and social implications of the project from the standpoint of the University's leadership and other stakeholders. The consultant representative noted that the overall objective of the assessment was to confirm and validate that the project was deemed socially responsible and environmentally safe.
Response by the Vice Chancellor	In his response, the Vice-Chancellor, Prof. Mohammed Inuwa Ja'afar described the proposed solar energy project as timely, necessary, and highly welcome, particularly given the persistent electricity challenges facing the University at the time. He noted that inadequate power supply had significantly affected academic, administrative, and research activities within the institution. According to him, the solar plant would greatly enhance energy stability and improve overall institutional productivity. He also explained that the proposed solar power system, when installed will improve the standard of living and provide eco-friendly sustainable energy. He therefore appreciated the Federal Government, the World Bank and the REA for the laudable initiative. The Vice-Chancellor further encouraged the consulting team to collaborate closely with relevant units and stakeholders within the University to ensure proper planning, smooth implementation, and long-term sustainability of the project and assured the visiting team of the University's readiness to partner with REA for a seamless implementation of the project.
Comments and Questions	During the interaction session, enquiry was made as to whether there were any land-related disputes between the University and the host community concerning the proposed project site. Clarification was sought as to whether, upon successful implementation, the project would extend benefits to students residing off-campus and to the surrounding host community. Abdullahi Adamu Yunusa, Director, Works and Maintenance Service, further highlighted that a major challenge commonly associated with government

	projects was the issue of maintenance, which often undermined effective utilization. Prof. Iyaji Adejoh, a lecturer in Sociology Department raised the issue of the need for adequate security for the proposed project consequent upon reported cases of theft of some infrastructure within the campus.
Responses by Stakeholders	The Vice-Chancellor clarified that there were no disputes, as the proposed land was entirely within the legally designated perimeter of the University. The Vice-Chancellor responded that, the extent of benefits to off-campus students and the immediate community would depend largely on the magnitude, capacity, and coverage of the installed solar plant. However, he expressed optimism that the project would have broader positive implications beyond the campus if adequately designed. Abdullahi Adamu Yunusa, Director, Works and Maintenance Service, emphasized that sustainability mechanisms needed to be incorporated into the project design. Nevertheless, the University management speaking through the Vice Chancellor assured the consulting team of its commitment to ensuring proper implementation, supervision, maintenance and security of the facility for optimal functionality. The session ended on a positive note, with mutual assurances of cooperation and commitment toward the successful execution of the proposed solar energy project.
Closing	The meeting came to a close by 12.00 pm.

ATTENDANCE

Management Consultation

Meeting with Vice-Chancellor:
Professor Mohammed Inuwa Ja'afar

The following principal officers were present at the meeting:

1. **Prof. S. L. Kela** – Deputy Vice-Chancellor (Academic)
2. **Muhammad Imam Yunus** – Director, Physical Planning
3. **Abdullahi Adamu Yunusa** – Director, Works and Maintenance Services
4. **Mr. Isa Adamu Amaza** – Bursar
5. **Alhaji Nasir Lawan Abdullahi** – Registrar
6. **Dr. Tukur Abba** – University Librarian

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PLAN (ESIA) PHASE III:
ENERGIZING EDUCATION PROGRAM (EEP) PROJECT

Name of University: Federal University Kashere, Gombe
Location: Kashere Gombe
Date: 11/2/26

Stakeholder Engagement – General

Name	Designation	Contact	Signature
	CHIEF INFO OFFICER	08133773793	
JANET IBRAHIM EZEKIEL	S.T.O Mech	08037709794	
Ahmed U. Hammari	A.S.P FUK	07061336000	
Jibrin Bubu	YELWA PINDIGA	08067275104	
IBRAHIM .S FADA	STUDENT FUK	08060229875	
SALISU ABDULLAHI	PTO (Electrical)	08068354975	
Engr. Abdullahi Abubakar	CE Electrical	07061391164	
Engr. IBRAHIM A. [illegible]	DD PPD	08066874221	
8 Engr Saila Habib	WKS	08030760066	
9 Engr. Fatima Abubakar Yunus	Professor	0803967[illegible]050	
10 IYAJI ADEJOH	CTO (Elect.)	07038097357	
11 Engr. Ibrahim Garba Safiyo	Senior System Analyst	08085596555	
12. Shuaibu Ikra Umar	Focal Person	08036295252	
13 Engr. Ishaq Ahmad Aliyu	Audit Unit	08055015227	
14 Hamsu Yusuf	PTO	0706966981	
15 Muhammad Sani Abdullahi	P.T.O	08107374344	
16 ALKALI SA'AD	FUK STUDENTS	08143700593	
17 MANSUR MUHAMMAD	Chip Ass	09064843163	
18 Aliyu Usman	P. Engineer	08055537309	
19 Abdullahi R. Alkali	P. Surveyor	08034528565	
20 Surv. Bello G. Bello	C. Engr	07038194525	
21 Engr. Muhammad Danazumi	Works Supervisor	08069605991	
22 Abdullahi Mauyo	Community Rep	0810961374	
23 Samson Kwasau Gadi	Student/Commercial	07036444401	
24 Agada Emmanuel Frilos	Enterprenship	08144190940	
25 UMAR A. DANBURAM	Entrepreneurship	08188643977	
26 Habibu Musa	PHYSICS	07035029616	
27 ABDULLAHI MUHAMMAD	Entrepreneurship	08039391517	
28 Abubakar YAYAU	ESLT	08034807756	
29 Abdullahi Usman	ESLT	09035673[illegible]	N