ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

FOR THE PROPOSED SOLAR-HYBRID POWER PLANT AND ASSOCIATED INFRASTRUCTURE AT THE FEDERAL UNIVERSITY OF AGRICULTURE MUBI (FUAMB) ADAMAWA STATE

UNDER THE NIGERIA ELECTRIFICATION PROJECT (DESERT TO POWER) PHASE II PROJECT

PREPARED FOR: RURAL ELECTRIFICATION AGENCY(REA)
(Nigeria Electrification Project – PMU)

DRAFT FINAL REPORT

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ABBREVIATIONS

AfDB	African Development Bank
APPI	Area of Potential Project Influence
ASTM	American Society for Testing and Materials
BOD	Biochemical Oxygen Demand
BOS	Balance of System
COPE	Care of the People
DRG	Debt Relief Gains
DtP	Desert to Power
ECN	Energy Commission of Nigeria
EEP	Energizing Education Programme
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EPC	Engineering, Procurement and Construction
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
FUAMB	Federal University of Agriculture, Mubi
GPS	Global Positioning System
GRM	Grievance Redress Mechanism
HSE	Health Safety and Environment
HT	High Tension
ICREEE	Inter-ministerial Committee on Renewable Energy and Energy Efficiency
kVA	kilovolt-ampere
KW	Kilowatt
kWac	kilowatts alternating current
kWdc	kilowatts direct current
LGA	Local Government Area
LT	Low Tension
MW	Megawatt
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
NSIFT	National Social Insurance Trust Fund
NUC	National University Commission
OHS	Occupational Health and Safety
PAPs	Project Affected Persons
RAP	Resettlement Action Plan
REA	Rural Electrification Agency
RoW	Right of Way
SE4All	Sustainable Energy for All
STEL	Short Term Exposure Limit
TCN	Transmission Company of Nigeria
TWA	Time Weighted Average

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EXECUTIVE SUMMARY

ES 1: Introduction

The Federal Government of Nigeria (FGN), through the Rural Electrification Agency (REA), is implementing the Nigeria Electrification Project Phase II (Desert-to-Power) with financial support from the African Development Bank (AfDB). The project's primary objective is to accelerate Nigeria's electrification efforts by deploying sustainable, off-grid and grid-connected solar-powered renewable energy solutions. As part of the Energizing Education Programme, the REA intends to electrify 24 Federal Universities and Teaching Hospitals, of which Federal University of Agriculture, Mubi is among the beneficiaries.
This ESIA has been prepared for the proposed site in accordance with the African Development Bank's Integrated Safeguards System (ISS), the Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004, and other applicable Nigerian environmental and sectoral regulations, and international good practice standards.

The relevant National and state environmental and social policies, laws, regulations, and the African Development Bank (AfDB) integrated safeguards as well as other international standards guided the preparation of this ESIA and will further guide the implementation of the project. A highlight of these policies / framework include;

a) Environmental Impact Assessment (EIA) Act CAP E12 LFN 2004
b) EIA Sectoral Guidelines for Power Sector (2013)
c) National Policy on the Environment (Revised 2016)
d) Climate Change Act 2021
e) Natural Resources Conservation Act CAP 349 LFN 1990
f) Nigeria's Nationally Determined Contribution (NDC) under the Paris Agreement of the UNFCCC COP26
g) Guidelines on Environmental Audit 2010
h) National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2018
i) Public Health Act CAP 103 LFN 1995
j) Electric Power Sector Reform Act, 2005
k) Roadmap for Power Sector Reform, 2010
l) National Energy Policy 2013
m) Nigerian Electricity Regulatory Commission (NERC) 2005
n) Energy Commission of Nigeria Act No. 19 of 1989
o) Land Use Act CAP L5 LFN 2004
p) Penal Code Act CAP 53 LFN 2008
q) The Nigerian Urban and Regional Planning Act CAP N138 LFN 2014
r) Employees Compensation Act 2010
s) FMEnv Abandonment Guidelines 1995
t) Adamawa State Environmental Law 2021

The applicable International laws are: -

a) The African Development Bank (AfDB) Integrated Safeguards 2023
b) International Union for the Conservation of Nature and Natural Resources (IUCN) Guidelines, 1996
c) Convention on International Trade in Endangered Species of Wild Fauna and Flora, CITES 1975.

d) Convention on the Protection of the World Cultural and Natural Heritage Sites (World Heritage Convention) 1972
e) United Nations Framework Convention on Climate Change (UNFCCC) 1992

ES 2: Project Justification

Public tertiary institutions in Nigeria continue to experience inadequate and unreliable electricity supply from the national grid, which constrains effective teaching, research activities, and institutional operations. The proposed intervention at the Federal University of Agriculture, Mubi forms part of the Energizing Education Programme under the DtP initiative, aimed at providing dedicated, clean, and reliable electricity to federal universities. The project is intended to address existing power supply limitations at the University, support academic and research activities, reduce dependence on fossil fuel-based generation, and enhance overall institutional efficiency.

Technical sustainability of the proposed solar hybrid mini grid project will be ensured through implementation by qualified Engineering, Procurement and Construction contractors selected by the Rural Electrification Agency through a competitive process in accordance with established technical standards and procedures. Project design, installation, and commissioning activities will be supervised by competent technical personnel from the Rural Electrification Agency in collaboration with the Federal University of Agriculture, Mubi.

Environmental sustainability of the proposed project is supported by the adoption of solar energy as a renewable power source, thereby reducing reliance on fossil fuel-based electricity generation and associated greenhouse gas emissions. The project is designed to promote clean energy utilization while minimizing adverse environmental impacts throughout its lifecycle.

Economic sustainability of the proposed solar hybrid mini grid project will be achieved through reduction in energy expenditure associated with diesel fuel consumption, generator maintenance, and reliance on conventional grid electricity supply. The provision of dedicated renewable power is expected to significantly lower operational energy costs within the Federal University of Agriculture, Mubi, thereby improving overall institutional financial efficiency.

Social sustainability of the proposed project is supported through inclusive stakeholder engagement conducted as part of the ESIA process, ensuring that relevant stakeholders are informed and provided opportunities to contribute to project planning at an early stage. This process has facilitated transparency and strengthened relationships between the project implementing agency, the University, and surrounding communities.

ES 3: Project Description

The Desert-to-Power (DtP) intervention at the Federal University of Agriculture, Mubi in Adamawa State will involve the development of a solar photovoltaic (PV) power plant designed to meet a projected campus power demand of approximately 4 MW, which will convert solar radiation into usable electrical power for distribution within the University campus and will be supported by appropriate operation and maintenance arrangements to ensure long-term performance and sustainability.

The key project components will include:

- Ground-mounted and/or rooftop polycrystalline solar PV modules installed in regular arrays

- ❖ Battery energy storage systems for load balancing and energy reliability
- ❖ Inverters, step-up transformers, marshalling switchgear, and associated power conditioning and control systems
- ❖ Overhead and/or underground electrical conduits and cabling for internal power distribution
- ❖ Interconnection infrastructure linking the solar plant to the University's internal grid (and, where applicable, the national grid)
- ❖ A supervisory control and monitoring system
- ❖ Site office and maintenance building
- ❖ Limited backup generation facilities to enhance system reliability

The proposed project site

The proposed project is to be located within the permanent campus of the University in Mayo Bani community, Mubi North LGA of Adamawa State, North-Eastern Nigeria. The specific project footprint falls within the coordinate range of approximately 10°25′27″N to 10°25′40″N and 13°14′47″E to 13°15′04″E. The allocated land for the proposed solar facilities installation covers approximately 10,000 square metres and comprises three contiguous parcels within the designated permanent campus development area.

The proposed project site, located within the permanent campus of the Federal University of Agriculture, Mubi, currently does not contain any electrical or utility infrastructure. Field observations confirmed the absence of transmission lines, transformers, substations, generators, or internal power distribution facilities within the designated project footprint. The broader premises are characterized by ongoing institutional development, with lecture halls and theatre buildings presently under construction as part of the University's transition to its permanent campus.

Also, the proposed site is technically suitable for the development of the planned solar hybrid mini-grid system. The allocated land is sufficient to accommodate the photovoltaic arrays, battery storage, and associated infrastructure without affecting existing buildings or institutional activities. The generally flat terrain with gentle undulations minimizes the need for major earthworks and supports efficient installation.

ES 4: Description of the Environmental and Social Baseline Conditions

The baseline assessment describes the existing environmental and socio-economic conditions within the project area at the Federal University of Agriculture, Mubi (FUAMB) permanent campus and its area of influence. The purpose is to establish current conditions against which potential project impacts can be assessed and to ensure that project activities do not degrade the existing environmental quality but maintain or improve prevailing conditions.

Physical Environment

- The project area is characterized by a tropical savannah climate, with distinct wet and dry seasons.
- The terrain is generally flat with gentle undulations, suitable for solar infrastructure development.
- The open landscape enhances solar exposure and ease of installation.

Soil Characteristics

The existing soil condition is relatively stable under natural conditions but may degrade if disturbed without proper control measures.

- The soils within the project area are predominantly sandy-silty, loose, and moderately cohesive.
- Laboratory analysis indicates that soil quality is generally within acceptable limits, with no evidence of contamination.
- However, low organic content and weak structural stability make the soil susceptible to erosion, particularly when disturbed.
- Field observations also identified early signs of surface erosion within parts of the site.

Water Quality (Groundwater and Surface Water)

- Groundwater sources within the area show good physicochemical quality, with parameters largely within acceptable standards for potable use.
- No significant contamination from heavy metals or pollutants was observed.
- Groundwater is an important domestic water source within the broader area.
- Surface water bodies in the area show generally acceptable quality, although some parameters indicate slight variability, likely due to natural runoff and seasonal influences.
- No major pollution sources were identified within the immediate project footprint.

Air Quality and Noise

- The baseline air and noise environment is clean and undisturbed, and project activities shall avoid significant deterioration, especially during construction.
- Ambient air quality measurements indicate that key parameters (PM, NO_2, SO_2, CO) are within permissible limits.
- The area is currently free from significant air pollution sources, reflecting its undeveloped nature.
- Noise levels are generally low and consistent with a quiet institutional environment, with minimal anthropogenic disturbance.

Biodiversity

Vegetation within the project footprint is sparse and typical of the Sudan Savannah ecological zone**,** consisting mainly of grasses, shrubs, and a few scattered trees. Species observed include *Azadirachta indica* (Neem)**,** *Parkia clappertoniana* (African locust bean). Other common savannah shrubs and grasses. No endangered, protected, or conservation-significant plant species were identified. Faunal presence is limited to common and adaptable species, including small mammals, reptiles, birds, and insects.

Socio-Economic Environment

- The project site is located within the permanent campus of FUAMB, which is currently under development.
- There are no existing structures or active academic activities at the site.
- The nearest community, Mayo Bani (~400 m away), represents the primary external receptor.
- Local livelihoods in surrounding communities are mainly based on small-scale trading, farming, and informal activities.
- Basic infrastructure such as roads and access routes exists but is still developing within the campus The university operates under a structured administrative system, with governance provided by the University Council and management.
- At present, students and staff operate from a temporary campus located approximately 10 km away, meaning the project site has limited current human activity.

ES 5: Potential and Associated Impacts

The assessment of potential environmental and social impacts associated with the proposed project was carried out across the pre-construction, construction, operation, and decommissioning phases. Most impacts are site-specific, short-term, and reversible. Moderate impacts are primarily associated with construction activities. Major impacts are limited to occupational health and community safety risks if unmanaged. No significant impacts on sensitive ecological receptors or protected areas were identified.

Key Potential Adverse Impacts

These impacts are expected to be temporary, localized, and manageable through proper coordination and mitigation measures.

Pre-Construction Phase

Impacts at this phase are expected to be minimal and short-term, arising mainly from site preparation and mobilization activities:

- Minor removal of sparse Sudan savannah vegetation (grasses and shrubs)
- Localized disturbance of sandy-silty soils, with potential to trigger surface erosion in already vulnerable areas
- Temporary dust emissions from initial site preparation and vehicle movement
- Slight increase in traffic and movement within the campus
- Minor community safety risks associated with mobilization activities
- Potential for low-level stakeholder expectations and grievances if not properly managed

Construction Phase

This phase presents the highest level of environmental and social interaction, due to intensive civil and electrical works, including trenching for distribution lines:

- Increased risk of soil erosion and land disturbance due to excavation, trenching, and grading activities
- Generation of dust and particulate matter affecting local air quality
- Elevated noise levels from construction machinery and installation activities
- Potential for surface runoff and sediment transport during rainfall events
- Generation of construction waste, including debris and packaging materials
- Minor disturbance to sparse vegetation and local fauna
- Temporary disturbance within the developing university environment due to noise and movement of personnel and equipment
- Increased traffic and access disruptions within campus routes
- Potential for unmet employment expectations and minor grievances among nearby communities (e.g., Mayo Bani)
- Interaction between workers and local population, with associated social risks if unmanaged
- Increased risk of workplace accidents, including injuries from equipment handling and excavation activities
- Potential for electrical hazards such as electrical shock or electrocution during cable installation works, equipment connection, testing, and commissioning.
- Risk of falls from height during installation of roof-mounted solar photovoltaic (PV) systems.
- Risk of injuries from falling tools, equipment, or photovoltaic modules during rooftop installation activities.
- Risk of traffic-related incidents due to movement of construction vehicles
- Safety risks to nearby receptors from open trenches and active construction zones

Operation Phase

Operational impacts are generally low in intensity but long-term in nature:

- Minimal environmental emissions, as solar PV systems generate clean energy
- Potential risks of soil and water contamination from improper handling or leakage of battery systems
- Generation of electronic waste (e-waste) from damaged or obsolete components
- Low-level noise emissions from inverters and associated equipment
- Minor visual impacts from installed infrastructure
- Restricted access to operational areas for safety purposes
- Risk of electrical hazards, fire incidents, and unauthorized access to energized components
- Limited but ongoing occupational health and safety risks for operational staff
- Risk of equipment damage, power interruption, or fire resulting from lightning strikes or electrical surges.

Cumulative Impacts

The presence of ongoing construction activities within the FUAMB permanent campus may result in cumulative impacts, including:

- Increased dust levels and noise from simultaneous construction activities
- Higher traffic volumes and safety risks within campus roads
- Increased pressure on soil stability, particularly in erosion-prone areas
- Elevated safety risks due to multiple construction fronts

ES 6: Mitigation Measures

Mitigation measures have been developed to address the identified environmental and social impacts of the proposed Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB). These measures follow the mitigation hierarchy of avoidance, minimization, and control, and are tailored to site-specific conditions.

Pre-Construction Phase

- Restrict vegetation clearance to the approved project footprint and avoid unnecessary disturbance of surrounding vegetation.
- Minimize soil disturbance and implement erosion control measures where exposed soils are susceptible to erosion.
- Suppress dust generation through periodic water spraying where necessary and ensure vehicles and equipment are properly maintained to minimize exhaust emissions.
- Restrict movement of vehicles and equipment to designated access routes and implement basic traffic management measures during mobilization.
- Implement appropriate safety measures, including warning signs and controlled access, to safeguard construction personnel, authorized visitors, and nearby community members during mobilization.
- Maintain effective stakeholder engagement and communication with the University and the Mayo Bani community, supported by an accessible grievance redress mechanism to address stakeholder concerns.

Construction Phase

- Regular water sprinkling to control dust from exposed sandy-silty soils.
- Controlled vegetation clearing limited strictly to the approved project footprint.
- Prompt backfilling of trenches and stabilization of exposed areas to minimize soil erosion.
- Install temporary drainage channels and other erosion control measures to manage stormwater runoff and sediment transport.
- Restrict high-noise construction activities to daytime hours and ensure construction equipment is properly maintained to minimize noise emissions.
- Properly store fuels and lubricants and maintain spill kits for immediate response to accidental spills.
- Segregate construction waste and dispose of it through approved waste management facilities.
- Prepare and implement a Traffic Management Plan, including designated access routes, traffic marshals where necessary, and appropriate warning signs to minimize disruption and enhance road safety.
- Enforce speed limits and safe driving practices for all construction vehicles operating within and around the project site.
- Prioritize employment of qualified local labour where feasible.
- Maintain continuous stakeholder engagement with FUAMB and the Mayo Bani community and operate an accessible Grievance Redress Mechanism (GRM).
- Implement the Labour Management Plan (LMP) and enforce the Workers' Code of Conduct.
- Implement awareness and prevention measures for Gender-Based Violence (GBV), Sexual Exploitation and Abuse (SEA), and Sexual Harassment (SH).
- Provide appropriate Personal Protective Equipment (PPE), conduct regular toolbox talks, and deliver routine occupational health and safety training.
- Implement working-at-height procedures, including the use of approved fall-arrest systems, secured ladders or scaffolding, and supervision by competent personnel during rooftop PV installation.
- Establish exclusion zones beneath rooftop work areas and secure tools and materials to prevent injuries from falling objects.
- Ensure safe handling, installation, testing, and commissioning of electrical components by qualified personnel.
- Implement safe trenching and excavation procedures, including installation of safety signage, barricades, and controlled access around active work areas.
- Schedule construction activities to minimize disruption to ongoing university development activities and maintain regular communication with the University regarding construction schedules.
- Maintain first aid facilities and implement emergency preparedness and response procedures throughout the construction phase.

Operational Phase

- Routine inspection and maintenance of solar panels and equipment
- Regular cleaning of panels to maintain efficiency (dust control)
- Proper housing and ventilation of battery storage systems
- Safe handling, storage, and disposal of e-waste through licensed handlers
- Maintenance of site drainage to prevent erosion and waterlogging
- Continued operation of the Grievance Redress Mechanism (GRM)
- Controlled access to the facility to prevent unauthorized entry
- Ongoing engagement with FUAMB management and users

- Clear safety signage around energized equipment
- Use of qualified personnel for system operation and maintenance
- Enforcement of electrical safety procedures (e.g., lockout/tagout) and a Permit-to-Work (PTW) system for high-risk activities such as electrical maintenance, work at height, hot work, and other hazardous tasks
- Installation and routine maintenance of appropriate lightning protection and surge protection systems to safeguard solar PV arrays, battery storage systems, inverters, transformers, and associated electrical equipment.
- Regular inspection and testing of lightning protection systems, earthing arrangements, and fire protection equipment to minimize the risk of electrical faults and fire hazards
- Regular inspection of equipment to prevent faults and hazards
- Continuous safety training for operational staff

ES 7: Environmental and Social Management Plan (ESMP)

The Environmental and Social Management Plan (ESMP) outlines the measures required to avoid, minimize, and manage the potential adverse impacts identified for the proposed Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB). It also defines the roles, responsibilities, and monitoring framework necessary to ensure effective implementation throughout the project lifecycle. Implementation of mitigation measures will be primarily the responsibility of the Engineering, Procurement, and Construction (EPC) Contractor, particularly during the pre-construction and construction phases**,** where most impacts are anticipated. The Contractor will be required to comply with all environmental and social requirements, including site-specific management plans, health and safety procedures, and good international industry practices.

The Nigeria Electrification Project Project Management Unit (NEP-PMU**)** will provide oversight and supervisory functions**,** ensuring that mitigation measures are properly implemented and that the project remains compliant with applicable environmental and social standards. This will include routine monitoring, reporting, and auditing of Contractor performance. The ESMP also includes environmental and social monitoring, to ensure that impacts are effectively managed and that project implementation aligns with national regulations and AfDB requirements.

The total costs of the ESMP implementation including costs for mitigation, monitoring and capacity building are estimated as: **₦41,470,000.00** (Forty-One Million, Four Hundred and Seventy Thousand Naira, only.*)* the table below:

ITEM	**RESPONSIBILITY**	**COST ESTIMATE**	
		NAIRA (₦)	**USD ($)**
Cost of Mitigation	Contractor	21,100,000.00	15,312.05
Cost of Monitoring	NEP-PMU, MDAs	6,600,000.00	4,789.55
Capacity Building	NEP- PMU/Contractor	10,000,000.00	7,256.89
Sub-total		37,700,000.00	27,358.49
Contingency (10% of sub-total)		3,770,000.00	2,735.85
TOTAL		**41,470,000.00**	**30,094.34**

Exchange Rate $1.00(USD) = ₦1,378 (NGN) – CBN rate as at May, 2026

ES 8: Remediation Plan After Decommissioning and Closure

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 advance in accordance with the Nigerian regulatory requirements.

In the event of decommissioning, NEP, in conjunction with the leadership of Federal University of Agriculture, Mubi (FUAMB), 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.

The key personnel and institutions with major roles in the implementation and monitoring of environmental and social measures for the Project decommissioning/closure are as follows:

- Contractor(s) Engaged for Decommissioning Activities
- NEP-PMU
- FUAMB University Site Manager
- Director of Works and Physical Planning Department in FUAMB
- FMEnv/Adamawa State Ministry of Environment Representatives

ES 9: Stakeholder Engagement and Grievance Redress Mechanism

Stakeholder analysis was undertaken to identify relevant stakeholders, understand their roles, and assess their level of influence and interest in relation to the proposed project. Stakeholder consultations were conducted at various levels to ensure that the views, concerns, and expectations of relevant stakeholders were incorporated into the ESIA process for the Solar Hybrid Mini-Grid Project at FUAMB.

Key Stakeholders Consulted

- University Management (Vice Chancellor and administration)
- Traditional leadership (Hakimi and council members)
- Host community (men, women, youths, elderly, and persons with disabilities)
- Local Government Authority (Mubi North)
- State Ministries (Education and Environment)

Key Concerns Raised

- Demand for transparent and fair employment opportunities, especially for local youths
- Importance of inclusive participation, including women and persons with disabilities
- Need for continuous communication and stakeholder engagement throughout project implementation

- Concern for maintaining peaceful coexistence between workers and host community

Expectations and Requests

- Priority consideration for local labour recruitment
- Provision of skill acquisition opportunities for youths
- Inclusion of women in project-related economic opportunities
- Maintenance of open communication channels during all project phases
- Proper consultation and involvement of community representatives

Grievance redress mechanism (GRM) is presented in chapter 9, the GRM framework enables local communities and relevant stakeholders of a project to raise issues (including logging, tracking, and grievances resolution) about the project which are addressed efficiently and effectively while issues as regards implementation are resolved. The GRM will be communicated to all stakeholders in the course of project development and implementation and will make publicly available a log documenting the responses to all grievances received. The GRM shall be maintained throughout the project life cycle.

ES 10: Conclusion and Recommendation

The proposed project is designed to provide a reliable and sustainable electricity supply to the university campus, thereby enhancing academic activities, improving living and learning conditions, and reducing dependence on fossil fuel-based energy sources. In this regard, the project aligns with national energy development objectives and international commitments to sustainable development. Potential adverse impacts identified during the ESIA are largely site-specific, temporary, and manageable. During the construction phase, key impacts include dust generation, noise, soil disturbance, vegetation clearing, occupational health and safety risks, and minor social disturbances associated with labour influx and construction activities. During the operational phase, potential impacts are minimal and relate primarily to equipment maintenance, waste management (including e-waste), and occupational safety. Appropriate mitigation measures have been developed to address these impacts. The anticipated benefits of the project significantly outweigh the potential adverse impacts, all of which can be effectively mitigated through the implementation of the recommended measures.

CHAPTER ONE: INTRODUCTION

1.1 Background Information

The Federal Government of Nigeria (FGN), through the Rural Electrification Agency (REA), is implementing the Nigeria Electrification Project Phase II (Desert-to-Power) with financial support from the African Development Bank (AfDB). The project's primary objective is to accelerate Nigeria's electrification efforts by deploying sustainable, off-grid and grid-connected solar-powered renewable energy solutions. By leveraging Nigeria's vast solar energy resources, the initiative aims to provide clean, reliable, and long-lasting electricity to Federal Universities and their affiliated teaching hospitals. The broader goal is to enhance academic performance, support research initiatives, and improve healthcare service delivery.

As part of the Energizing Education Programme, the REA intends to electrify 24 Federal Universities and Teaching Hospitals, of which Federal University of Agriculture, Mubi is among the beneficiaries. The proposed project involves the installation of a solar-hybrid power system with a generation capacity exceeding 1 MW to provide reliable and sustainable electricity supply to the University.

This ESIA has been prepared for the proposed site in accordance with the African Development Bank's Integrated Safeguards System (ISS), the Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004, and other applicable Nigerian environmental and sectoral regulations, and international good practice standards.

1.2 Rationale for the ESIA

The project is rated as Category 2 (Medium Risk) in line with the Bank's Integrated Safeguards System (ISS) and Nigeria's Environmental Impact Assessment (EIA) Act, CAP E.12 LFN 2004 and the Environmental Impact Assessment Procedures and Charges Regulations (2021). The justification for the E&S categorization has been based on the nature, scale, sensitivity, and location of the proposed projects, with the likelihood to generate limited, site-specific (within existing university campuses, and in exceptional cases when there is land-related dispute in adjoining areas), and reversible E&S impacts such as: limited changes in environmental baseline due to pre-construction and construction activities (e.g., excavation, waste generation, etc.,); unsustainable waste management practices including management of solar e-wastes (spent batteries, broken panels and faulty electrical components); exposure of workers to occupational hazards and risks to health during construction activities, etc.

1.3 Objectives of the Assignment

The objective of this consultancy is to conduct site specific ESIA for the proposed power systems and associated infrastructure in Federal University of Agriculture, Mubi, to:

- Establish environmental and socio-economic baselines for each site;
- Identify, predict, and evaluate environmental, social, health, and safety impacts (positive and negative);
- Recommend mitigation and enhancement measures;
- Ensure compliance with AfDB and Nigerian E&S standards;
- Develop site-specific Environmental and Social Management Plans (ESMPs); and
- Facilitate environmental approvals, and stakeholder acceptance.
- Support REA in securing FMEnv ESIA certification and AfDB no-objection;
- Conduct inclusive stakeholder engagement (including women, youth, and persons with disabilities); and
- Build local institutional capacity for ESMP implementation.

This shall be in line with the requirements of the Federal Government of Nigeria and the African Development Bank's Integrated Safeguards System to ensure that any adverse effects on the environment and wellbeing of people are properly identified and mitigated.

1.4 Scope of Works

The scope of work for this assignment is to conduct an Environmental and Social Impact Assessment (ESIA) for the proposed Desert-to-Power (DtP) solar-hybrid power systems at the Federal University of Agriculture, Mubi Adamawa State. The assignment will include the preparation of a site-specific Environmental and Social Management Plan (ESMP) detailing mitigation measures, monitoring requirements, implementation responsibilities, and indicative costs, in line with applicable national regulations and the African Development Bank's Integrated Safeguards System.

To ensure a robust ESIA study, the following tasks were conducted:

Review of Project Information and Regulatory Requirements

- Review NEP documentation, feasibility studies, conceptual designs, layouts, and maps for each of the four universities.
- Identify applicable national regulations, FMEnv procedures, and AfDB safeguard requirements.
- Prepare ESIA registration documentation and liaise with FMEnv for project registration.

Scoping and Work Planning

- Conduct preliminary scoping and environmental and social risk screening.
- Identify key stakeholders and sensitive receptors within the project areas.
- Prepare detailed and site-specific ESIA work plans and schedules.

Baseline Data Collection (within defined area of influence)

- Undertake biophysical studies covering air quality, noise, water, soil, hydrology, flora, and fauna.
- Conduct socio-economic surveys addressing demography, livelihoods, gender issues, land use/tenure, cultural heritage, and traffic/transport conditions.
- Utilize GIS and remote sensing tools for spatial analysis and sensitivity mapping.
- Ensure laboratory analyses are performed by FMEnv-accredited laboratories.

Impact Identification and Evaluation

- Identify and assess direct, indirect, induced, and cumulative impacts.
- Evaluate pollution pathways, waste streams, and greenhouse gas emissions.
- Apply FMEnv and AfDB risk-rating methodologies (high, moderate, low).
- Develop mitigation hierarchy measures (avoid, minimize, mitigate, offset).

Stakeholder Engagement and Social Inclusion

- Conduct Free, Prior, and Informed Consultations (FPIC) with host communities, institutions, and relevant authorities around each university.
- Ensure inclusive participation of women, youth, and persons with disabilities.
- Maintain consultation records including attendance sheets, photographs, and feedback logs.
- Establish and operationalize a multi-tier Grievance Redress Mechanism (GRM).
- Prepare a costed Stakeholder Engagement Plan.

Development of Environmental and Social Management Plans (ESMPs)

- Define mitigation measures with clear performance indicators.
- Establish monitoring frameworks and reporting schedules.
- Specify roles, responsibilities, and institutional arrangements.

- Develop capacity-building plans for implementing entities.
- Provide cost estimates and financing considerations.
- Integrate ESMP provisions into EPC and operational contracts.

Reporting, Disclosure, and Approvals

- Prepare and submit inception, draft, and final ESIA reports in required formats.
- Facilitate statutory disclosure processes (public notices, hearings, gazette publications).
- Support disclosure through AfDB channels via the PMU.
- Facilitate issuance of ESIA approval letters and certificates.
- Cover statutory obligations including payment of access charges and IMM fees as required.

1.5 Study Approach/ Methodology in Details

The ESIA of the proposed Project of the Federal University of Agriculture, Mubi, Adamawa State has been carried out in line with the Federal Ministry of Environment (FMEnv) approved EIA process for mini-grid / off-grid projects being implemented under the Nigeria Electrification Project (NEP) Desert to Power (DtP) project. It also considers the requirements of relevant and applicable international standards and best practices such as the AfDB Integrated Safeguard system. The approach and methodology applied for undertaking the environmental and social impact assessment is as provided in the flowchart below.

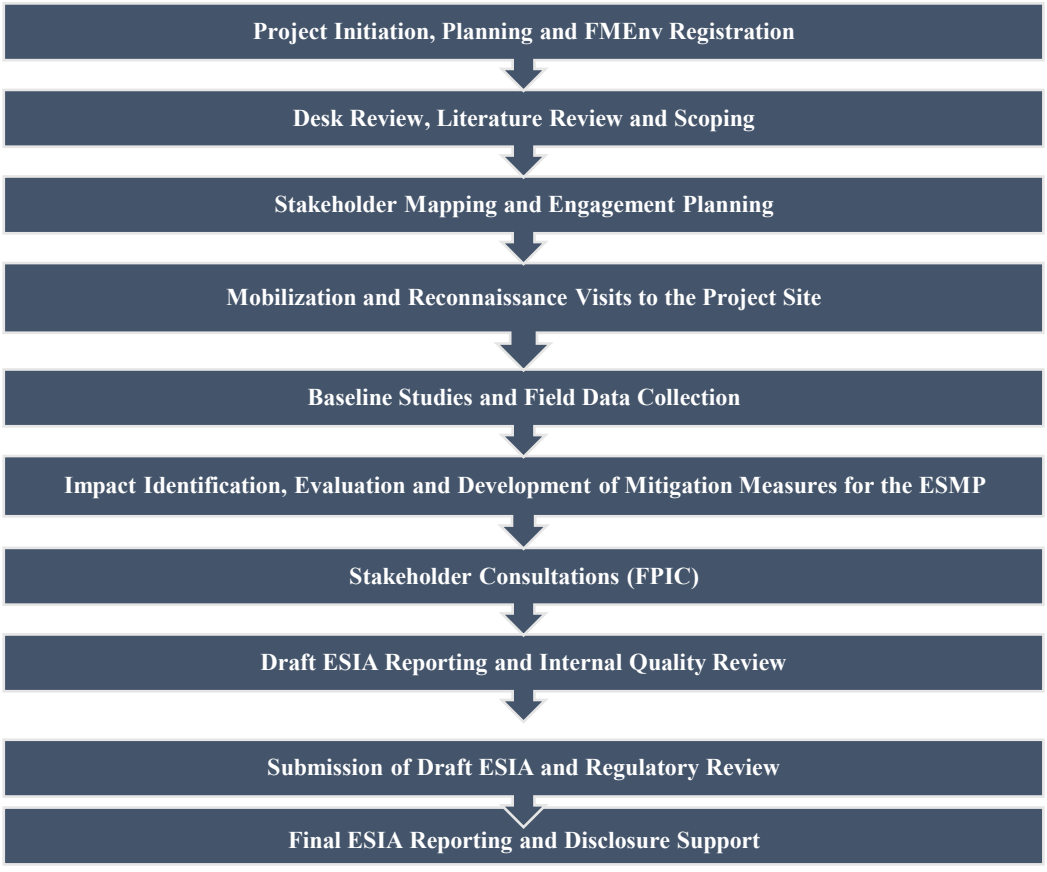

Figure 1: ESIA Methodology Flowchart

1.6 Policy, Legal and Administrative Framework

The proposed Project forms part of the Federal Government of Nigeria's Energizing Education Programme under the Nigeria Electrification Project, with the Desert-to-Power initiative representing the current scale-up phase. Several national laws and sectoral regulations govern the power and environmental sectors in Nigeria, alongside policies and guidelines that direct environmental and social assessment processes.

This section therefore outlines the relevant statutory, regulatory, and policy framework applicable to the proposed Project, noting that the ESIA will be conducted in compliance with applicable national and international standards throughout the project lifecycle.

1.6.1 Policy Framework

1.6.1.1 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.

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

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.

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).

1.6.1.3 The National Electric Power Policy (NEPP), 2001

In order 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: establishment of the electric power sector regulator and the privatisation 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 privatisation of the power sector.

1.6.1.4 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.

1.6.1.5 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.

1.6.1.6 National Occupational Health and Safety Policy 2020

The National Occupational Health and Safety Policy 2020 provides the overarching framework for the protection of workers and the working environment in Nigeria. The Policy establishes principles for the prevention of occupational accidents, diseases, and hazardous exposures, and places obligations on employers to maintain safe working conditions. Its provisions are directly relevant to this project during the construction phase, where workers will be exposed to excavation hazards, working at height, electrical installation risks, and heavy equipment operation.

1.6.1.7 National Gender Policy 2021 to 2026

The National Gender Policy 2021 to 2026 provides the strategic framework for mainstreaming gender equality and women's empowerment across all sectors of national development in Nigeria. The Policy promotes equal participation of women in economic, social, and political life and seeks to eliminate gender-based discrimination. Its provisions are relevant to this project in respect of gender-responsive stakeholder engagement, equitable local employment practices during construction, and the prevention of gender-based violence and sexual exploitation and abuse associated with labour influx.

1.6.1.8 National Policy on Solid Waste Management 2020

The National Policy on Solid Waste Management 2020 establishes the framework for environmentally sound management of solid waste generated from domestic, commercial, industrial, and construction activities in Nigeria. The Policy promotes waste minimization, segregation at source, recycling, and the polluter pays principle. Its provisions are relevant to this project in respect of construction waste, general operational waste streams, and the management of spent materials arising from the solar hybrid mini-grid system.

1.6.1.9 National Policy on Plastic Waste Management 2020

The National Policy on Plastic Waste Management 2020 addresses the growing challenge of plastic pollution in Nigeria and establishes principles for the reduction, reuse, recycling, and responsible disposal

of plastic waste. The Policy is relevant to this project given the plastic components associated with solar PV module packaging, cable insulation, and ancillary construction materials, all of which must be managed in accordance with the Policy's waste minimization and responsible disposal requirements.

1.6.2 National Legal Framework

1.6.2.1 Environmental Impact Assessment Act Cap E12 LFN 2004 and EIA Procedures and Charges Regulations 2021

The EIA Act makes it mandatory for any person, authority, corporate body private or public, to conduct EIA prior to 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 consideration of EIA of certain public or private projects.

The programme is considered to be a minor development, which is expected to have minimum impact on the environment. Hence, the programme is categorised 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.

The EIA Procedures and Charges Regulations 2021, made pursuant to the EIA Act Cap E12 LFN 2004, prescribe the procedural requirements and applicable fees governing the conduct and administration of environmental impact assessments in Nigeria. The Regulations establish the mandatory steps for EIA registration, scoping, review, public participation, and approval, and specify the access charges and Interim Management and Monitoring (IMM) fees payable at defined stages of the EIA clearance process. Compliance with these Regulations is required for the issuance of the EIA approval certificate and environmental compliance certificate for this project.

1.6.2.2 The Electricity Act 2023.

The Electricity Act 2023 is the principal legislation governing the Nigerian electricity sector, enacted to modernise the regulatory framework and consolidate all electricity sector laws in Nigeria. The Act devolves significant regulatory powers to states, establishes a liberalised electricity market, and provides for the licensing, regulation, and operation of electricity generation, transmission, distribution, and retail activities including off-grid and embedded generation systems such as solar hybrid mini-grids. The provisions of the Electricity Act 2023 are directly applicable to this project as the primary sector legislation governing its development, operation, and regulatory compliance

1.6.2.3 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 the 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.

1.6.2.4 Land Use Act Cap 5 LFN 2004

The Land Use Act, Cap L5, Laws of the Federation of Nigeria (LFN) 2004**, vests** all land within each State of the Federation in the Governor, who holds and administers such land in trust for the use and common benefit of all Nigerians. The Act empowers the Governor to grant statutory rights of occupancy in urban areas, while Local Governments administer customary rights of occupancy in rural areas for agricultural and residential purposes. It also provides for the revocation of land rights for overriding public interest, including public infrastructure and development projects, subject to payment of compensation for unexhausted improvements such as buildings, crops, and economic trees. Furthermore,

the Act requires the Governor's consent for land transfers or assignments and serves as the principal legal framework guiding land acquisition, compensation, and resettlement processes in Nigeria.

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

The Urban and Regional Planning Act is aimed at overseeing a 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.

1.6.2.6 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 persons who have suffered injury as a result of his offending act.

1.6.2.7 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 as a result of over exploitation. These sections are noteworthy:

- **Section 1** prohibits, except under a valid license, the 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 programme locations are on virgin land that serve as wildlife habitats which will be impacted by the programme. Hence, the programme activities shall be carried out to comply with the relevant provisions.

1.6.2.8 The Factories Act (Cap F1, Laws of the Federation of Nigeria, 2004)

The Factories Act (Cap F1, Laws of the Federation of Nigeria, 2004) provides the legal framework for safeguarding the health, safety, and welfare of workers in factories and other designated workplaces. The Act prescribes requirements relating to workplace safety, the use and maintenance of machinery, fire prevention, welfare facilities, accident reporting, and the protection of workers from occupational hazards. The Act is relevant to the proposed project during the construction and operational phases, where contractors shall implement appropriate occupational health and safety measures to ensure a safe working environment and compliance with applicable statutory requirements.

This Act deals with working conditions at work sites, including construction sites, such as the type to be undertaken under this proposed project. Hence, the occupational requirements applicable to construction sites, as well as other work sites to be used by the programme shall be subjected to the provisions of this Act.

1.6.2.9 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.

1.6.2.10 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 monitory 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.

1.6.2.11 Employee Compensation Act 2010

The Employee Compensation Act 2010 establishes a comprehensive framework for the payment of compensation to employees who suffer from occupational diseases, sustain injuries, or die in the course of employment in Nigeria. The Act replaces the Workmen's Compensation Act and provides for a contributory scheme administered by the Nigeria Social Insurance Trust Fund (NSITF). Its provisions are directly relevant to this project during the construction phase, where workers will be exposed to occupational hazards including excavation risks, working at height, electrical installation, and heavy equipment operation, and where the contractor bears statutory obligations to ensure compensation coverage for all site personnel.

1.6.2.12 Violence Against Persons (Prohibition) Act 2015

The Violence Against Persons (Prohibition) Act 2015 prohibits all forms of violence against persons in private and public life and provides for the protection of victims and punishment of offenders in Nigeria. The Act criminalizes physical, sexual, psychological, and socio-economic violence including sexual harassment, exploitation, and abuse. Its provisions are relevant to this project in the context of labour influx during construction, which carries an inherent risk of gender-based violence and sexual exploitation and abuse affecting the host community, and imposes obligations on the project to implement preventive measures and reporting mechanisms.

1.6.2.13 Child Rights Act 2003

The Child Rights Act 2003 domesticates the provisions of the United Nations Convention on the Rights of the Child in Nigeria and establishes a comprehensive legal framework for the protection of children from all forms of exploitation, abuse, and hazardous labour. The Act prohibits the engagement of children in any form of work that is harmful to their health, education, or development. This legislation is directly applicable to the project given the risk of child labour associated with labour influx during project implementation. Compliance with the Act requires that the EPC Contractor implement a robust labour screening mechanism to verify the age of all workers prior to engagement and maintain records confirming that no person under the age of 18 is employed on the project site.

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 minster 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 (Battery Control) Regulations, 2024.
- National Environmental (Permitting and Licensing System) Regulations, S. I. No. 29, 2009.
- National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, S. I. No. 20, 2011.
- National Environmental (Plastic Waste Control) Regulations, 2026
- National Environmental (Electrical/Electronic Sector) Regulations, 2011, S.I. No. 23
- National Environmental (Wetlands, River Banks 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 Catchments 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.

1.6.3 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, in order to ensure that the programme is implemented with maximum consideration of environmental factors. This ESIA study will be conducted in compliance with this guideline.

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 optimize the mini-grid projects EIA timeline and the cost of development.

1.6.4 Other Relevant Guidelines, Regulations and Policies

- Nigerian Electricity Supply and Installation Standards Regulations, 2015.
- The Renewable Energy Master Plan (REMP) - Policy
- National Renewable Energy and Energy Efficiency Policy, 2015
- National Renewable Energy Action Plans(NREAP), (2015-2030)
- Sustainable Energy for All Action Agenda (SE4ALL-AA)
- Nigerian Nationally Determined Contributions (Revised), 2021
- The Penal Code (Northern States) Federal Provisions Act (Cap. P3, Laws of the Federation of Nigeria, 2004)
- Public Health Law Cap 103 LFN 1990
- Fire and Rescue Service Act 2004;
- Abandonment Guidelines 1995;
- National Guidelines on Environmental Management System 1999 □
- REA's HSE Policy.

1.6.5 International Legislations

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 (2003):** This Convention is applicable as the project involves land clearing and vegetation removal within a savannah ecosystem, requiring that natural resources are managed sustainably in accordance with Africa-wide conservation commitments.
- **Convention on Biological Diversity (1992):** This Convention is relevant given that project activities, including site clearing and soil disturbance, have the potential to affect local flora and fauna within the project footprint, necessitating measures to avoid biodiversity loss and protect ecosystem integrity.
- **Convention on International Trade in Endangered Species of Wild Fauna and Flora, CITES (1973:** Although no CITES-listed species were identified within the project area, this Convention remains applicable as a precautionary reference to ensure that no project activities inadvertently affect protected species or facilitate illegal wildlife trade during construction.
- **Conservation of Migratory Species of Wild Animals 1973:** This Convention is applicable as the project site lies within the Sudan Savannah ecological zone, which provides habitat for migratory bird and animal species whose movement patterns and habitats must be considered during project implementation.
- **UN Framework Convention on Climate Change 1992**: This Convention is directly relevant as the project involves the deployment of solar photovoltaic technology as a clean energy alternative to fossil fuel-based generation, contributing to Nigeria's nationally determined contributions and global greenhouse gas reduction commitments.
- **Convention to Combat Desertification 1994:** This Convention is applicable given that the project is located in Adamawa State within the broader Sahel region, where land degradation, soil erosion, and desertification pressures are present and must be addressed through appropriate land management and erosion control measures during construction.
- **Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) (1979):** This Convention is relevant as the project involves labour engagement and community interactions, requiring that gender equality principles are upheld throughout recruitment, occupational health and safety, and stakeholder engagement processes.
- **Human and Peoples' Rights on the Rights of Women in Africa 2005**: This instrument is applicable as it reinforces CEDAW obligations within an African context, requiring that the project

avoids and mitigates risks of gender-based violence, sexual exploitation and abuse, and unequal access to project benefits by women in the host community.

- **Civil and Political Rights Covenant (1966):** This Covenant is relevant as it underpins the right of affected communities and workers to information, participation, and redress, which are operationalized through the project's stakeholder engagement and grievance redress mechanisms.
- **Economic, Social and Cultural Rights Covenant (1966):** This Covenant is applicable as the project has implications for the right to safe working conditions, adequate living standards, and access to energy as a socioeconomic enabler for the university community and surrounding population.
- **Convention on the Rights of the Child (1989):** This Convention is relevant as the project involves labour influx into a community that includes children, requiring that child labour is strictly prohibited and that construction activities do not expose children within or near the university campus to safety risks.

1.6.6 Institutional Framework

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

1.6.6.1 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.

1.6.6.2 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 mini-grid project complies with national environmental standards and regulations.

1.6.6.3 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

1.6.6.4 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 its supervision

1.6.6.5 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, 2005 was the legislation that led to the establishment of NERC.
The Commission is mandated 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.

In order 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.

1.6.6.6 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.

1.6.6.7 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 electrification of rural and unserved communities. The mission is 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 reasonable return on investment through appropriate tariff that is economically responsive and supportive of the average rural customer.

1.6.6.8 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 among others:

- Eliminate cultural/ religions gender-based biases and harmful cultural and religious practices which rise to inequalities in gender-role relations in the Nigerian society. A culture which is amendable 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 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.

1.6.6.9 Nigerian Electricity Management Services Authority

The Nigerian Electricity Management Services Authority (NEMSA), established by the NEMSA Act 2015, is the technical regulatory agency responsible for the enforcement of technical standards, metering regulations, and safety requirements for electrical installations and equipment in Nigeria. NEMSA is mandated to inspect, test, and certify all categories of electrical equipment and installations, including renewable energy systems, prior to commissioning and operation. The Authority's technical oversight is directly applicable to this project, as all electrical components of the solar hybrid mini-grid including the PV array, inverters, battery energy storage system, transformers, switchgear, and the 11 kV campus distribution network will be subject to NEMSA inspection and certification before energization.

1.6.7 State Institutions

1.6.7.1 Adamawa State Ministry of Environment

The Ministry of Environment is currently responsible for environmental service matter 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 Adamawa State Environmental Law 2021.

1.6.7.2 Adamawa 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 economic self-reliance of women, create awareness and campaign against gender-based violence etc.

1.6.7.3 Adamawa State Lands and Survey

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

1.6.8 Funding Agency Requirements

This programme is funded by the African Development Bank (AfDB). Therefore, the AfDB safeguard systems will be integrated in the project cycle as well as other national and international environmental and social protection requirements, in order to comply with international best practices. Both main environmental and social requirements that the project needs to comply with are described in the following sections.

1.6.8.1 The African Development Bank's Integrated Safeguards System

The proposed project has been classified as a Category 2 project under the African Development Bank's Integrated Safeguards System (ISS, effective May 2024). Category 2 projects are those with site-specific environmental and social risks and impacts that are generally reversible and can be effectively mitigated through appropriate management measures.

Under the ISS framework, the Operational Safeguards (OS1–OS10) have been considered during preliminary screening of the project. Given the nature of the proposed solar-hybrid mini-grid development, including civil works, electrical installations, labour engagement, community interface, climate considerations, and stakeholder interactions, all Operational Safeguards are considered applicable at this stage, with the exception of OS9 (Financial Institutions).

The Operational Safeguards considered include:

- OS 1 (OS1): Assessment and Management of Environmental and Social Risks and Impacts
- OS 2 (OS2): Labour and Working Conditions
- OS 3 (OS3): Resource Efficiency and Pollution Prevention and Management
- OS 4 (OS4): Community Health, Safety and Security
- OS 5 (OS5): Land Acquisition, Restrictions on Access to Land and Land use, and Involuntary Resettlement
- OS 6 (OS6): Habitat and Biodiversity Conservation and Sustainable Management of Living Natural Resources
- OS 7 (OS7): Vulnerable Groups
- OS 8 (OS8): Cultural Heritage
- OS 10 (OS10): Stakeholder Engagement and Information Disclosure.

In addition to the Operational Safeguards, the African Development Bank has published Borrowers' Guidance Notes corresponding to each Operational Safeguard. These Guidance Notes provide detailed technical and procedural guidance to borrowers on the practical implementation of the safeguard requirements and have been consulted in the preparation of this ESIA alongside the Operational Safeguards themselves. The Guidance Notes are publicly available on the AfDB website and constitute an integral reference within the AfDB Integrated Safeguards System[1]

The ESIA report provides comprehensive evaluation of the relevance and level of applicability of each Operational Safeguard and outlines corresponding mitigation and management measures in compliance with AfDB ISS requirements.

1.7 Report Structure

In line with the FMEnv guidelines and requirements of the Terms of Reference, this report is structured as follows:

- Preliminary Sections
- 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 Justification containing a rationale for the proposed Project as well as the Technical, Environmental, Social and Economical sustainability of the project
- 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 three also discusses Project Alternatives.
- 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.

[1] African Development Bank Group (AfDB), Borrowers' Guidance Notes for the Integrated Safeguards System (ISS), available at:*https://www.afdb.org/en/documents/borrower-guidance-note*

- 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.
- 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: Presents an overview of remediation / decommissioning plan after Project closure.
- Chapter Ten: Conclusion and Recommendations
- The report also includes references and Annexes.

CHAPTER TWO: PROJECT JUSTIFICATION

2.1 Need for the Project

Public tertiary institutions in Nigeria continue to experience inadequate and unreliable electricity supply from the national grid, which constrains effective teaching, research activities, and institutional operations. Federal universities, in particular, depend largely on diesel powered generators to supplement electricity needs, resulting in high operational costs, frequent power interruptions, and associated environmental impacts.

In response to these challenges, the Federal Government of Nigeria initiated the Nigeria Electrification Project (NEP) to improve electricity access through deployment of sustainable and renewable energy solutions. Building on lessons from NEP, the Desert to Power (DtP) initiative is being implemented by the Rural Electrification Agency with support from the African Development Bank to expand reliable electricity supply to public institutions and underserved areas using solar based hybrid systems.

The proposed intervention at the Federal University of Agriculture, Mubi forms part of the Energizing Education Programme under the DtP initiative, aimed at providing dedicated, clean, and reliable electricity to federal universities. The project is intended to address existing power supply limitations at the University, support academic and research activities, reduce dependence on fossil fuel-based generation, and enhance overall institutional efficiency. The intervention also contributes to Nigeria's commitment to climate change mitigation and sustainable energy transition in line with national development objectives and international obligations.

2.2 Project Benefits

The proposed solar hybrid mini grid project at the Federal University of Agriculture, Mubi is expected to deliver significant environmental, institutional, and socioeconomic benefits. Key anticipated benefits include:

- Provision of reliable and sustainable electricity supply to support academic, research, administrative, and residential activities within the University.
- Enhancement of teaching, laboratory operations, ICT services, and research productivity through improved power reliability.
- Reduction in dependence on diesel powered generators, resulting in lower operational costs, decreased fuel consumption, and reduced greenhouse gas emissions.
- Improvement in campus safety and security through enhanced outdoor lighting and increased nighttime visibility.
- Promotion of renewable energy knowledge and technical capacity development through exposure to solar power technology and associated training opportunities.
- Creation of direct and indirect employment opportunities during construction and operational phases, with associated skills transfer and local economic stimulation.
- Support for institutional expansion and improved living and learning conditions for students and staff within the permanent campus.
- Contribution to national renewable energy deployment and climate change mitigation objectives consistent with Nigeria's Nationally Determined Contributions under the Paris Agreement.

Overall, the project is expected to strengthen energy reliability, improve institutional efficiency, and promote environmentally sustainable development within the University and its surrounding community.

2.3 Envisaged Sustainability

2.3.1 Technical Sustainability

Technical sustainability of the proposed solar hybrid mini grid project will be ensured through implementation by qualified Engineering, Procurement and Construction contractors selected by the Rural Electrification Agency through a competitive process in accordance with established technical standards and procedures. Project design, installation, and commissioning activities will be supervised by competent technical personnel from the Rural Electrification Agency in collaboration with the Federal University of Agriculture, Mubi.

Standard operating procedures and operation and maintenance manuals will be developed to guide system management throughout the project lifecycle. Prior to commissioning, relevant University personnel will receive technical training to support effective system operation and routine maintenance.

Following completion of construction, an Operations and Maintenance contractor will be engaged to manage system performance and ensure continued functionality of the installation. Capacity building and knowledge transfer programmes will be implemented to enable designated University staff to progressively support day-to-day system operations. In addition, practical training opportunities will be provided for selected students in relevant science and engineering disciplines to enhance technical skills in renewable energy systems.

2.3.2 Environmental Sustainability

Environmental sustainability of the proposed project is supported by the adoption of solar energy as a renewable power source, thereby reducing reliance on fossil fuel-based electricity generation and associated greenhouse gas emissions. The project is designed to promote clean energy utilization while minimizing adverse environmental impacts throughout its lifecycle.

Oversight of environmental and social performance will be undertaken by the Rural Electrification Agency through its Project Management Unit, which includes qualified Environmental and Social Safeguards Specialists responsible for monitoring compliance with applicable standards and safeguards requirements. Furthermore, the conduct of this Environmental and Social Impact Assessment at the early stage of project development enables identification of potential impacts and incorporation of appropriate mitigation measures through the Environmental and Social Management Plan to ensure environmentally responsible project implementation.

2.3.3 Economic Sustainability

Economic sustainability of the proposed solar hybrid mini grid project will be achieved through reduced dependence on diesel-powered generation and conventional grid electricity, thereby lowering recurring expenditure on diesel procurement, generator servicing, lubricants, spare parts, emergency repairs, grid electricity bills, and productivity losses associated with power outages. Although the initial capital cost of solar-hybrid infrastructure is higher than the short-term cost of operating existing diesel generators, the operational cost profile of renewable energy systems is generally more favourable over the project life cycle because solar generation has no fuel cost, lower routine maintenance requirements, reduced exposure to fuel price volatility, and improved electricity reliability.

Comparative evidence from similar university energy audits under the NEP/Energizing Education Programme shows that public universities relying on diesel generators and unstable grid supply incur significant recurrent electricity costs. For instance, available NEP/EEP energy audit information for a comparable federal university indicates monthly diesel consumption of about 100,000 litres, monthly

diesel expenditure of approximately ₦45–50 million, monthly grid electricity payments of about ₦20–25 million, and monthly diesel generator maintenance expenditure of approximately ₦5–7 million. These figures are not presented as FUAMB-specific baseline data, but they demonstrate the types and magnitude of recurrent energy costs that the proposed solar-hybrid intervention is designed to reduce.

For FUAMB, the project is expected to reduce diesel generator runtime, diesel fuel consumption, generator maintenance frequency, expenditure on lubricants and spare parts, emergency generator repairs, and dependence on unreliable grid electricity. The project will also reduce indirect economic losses associated with power interruptions, including disruption of academic activities, ICT services, laboratory operations, administrative work, security lighting, and campus development activities at the permanent site.
Since FUAMB-specific records on current diesel consumption, fuel expenditure, grid electricity payments, generator runtime, and generator maintenance costs were not available to the ESIA team at this stage, the ESIA does not present speculative cost savings figures. Instead, REA and FUAMB shall undertake a pre-construction energy expenditure audit at this planning phase. The audit shall establish the actual FUAMB baseline for diesel consumption, diesel expenditure, grid electricity expenditure, generator maintenance costs, generator runtime, and existing power reliability. These data shall be used to quantify the actual cost reduction and cost-benefit performance of the solar-hybrid mini-grid during operation.

The economic sustainability of the project shall therefore be tracked using measurable indicators, including reduction in litres of diesel consumed per month, reduction in monthly diesel expenditure, reduction in generator maintenance cost, reduction in generator runtime, reduction in grid electricity dependence, improvement in daily hours of reliable electricity supply, and reduction in electricity-related operational disruptions. The results of this monitoring shall inform long-term operation and maintenance planning, including budgeting for battery replacement, inverter replacement, preventive maintenance, and lifecycle asset management.

To ensure continued financial sustainability, appropriate energy service arrangements may be adopted within the University, including metered electricity supply to campus facilities and commercial establishments. Revenue generated through such mechanisms will contribute to operational costs, system maintenance, and periodic replacement of major components such as batteries and electrical equipment. The project is therefore expected to improve the University's energy reliability while reducing long-term operating costs and enhancing institutional financial efficiency while also strengthening the University’s internally generated revenue while reducing dependence on conventional energy sources and recurrent government funding for electricity supply.

2.3.4 Social Sustainability

Social sustainability of the proposed project is supported through inclusive stakeholder engagement conducted as part of the ESIA process, ensuring that relevant stakeholders are informed and provided opportunities to contribute to project planning at an early stage. This process has facilitated transparency and strengthened relationships between the project implementing agency, the University, and surrounding communities.

A Stakeholder Engagement Plan has been developed to guide continuous consultation and information disclosure throughout the project lifecycle. In addition, a Grievance Redress Mechanism established by the Rural Electrification Agency will provide accessible channels for stakeholders, affected persons, and community members to submit concerns or complaints related to project activities. The mechanism ensures timely review, documentation, and resolution of grievances, thereby promoting accountability and minimizing potential social conflicts during project implementation and operation.

CHAPTER THREE: PROJECT DESCRIPTION

3.1 Project Overview

The Desert-to-Power (DtP) intervention at the Federal University of Agriculture, Mubi in Adamawa State forms part of the Energizing Education Programme component, which aims to provide reliable and sustainable electricity supply to federal universities through the deployment of solar-hybrid mini-grid systems with generation capacities exceeding 1 MW per site.

The proposed project will involve the development of a solar photovoltaic (PV) power plant which will convert solar radiation into usable electrical power for distribution within the University campus and will be supported by appropriate operation and maintenance arrangements to ensure long-term performance and sustainability.

The key project components will include:

- Ground-mounted and/or rooftop polycrystalline solar PV modules installed in regular arrays
- Battery energy storage systems for load balancing and energy reliability
- Inverters, step-up transformers, marshalling switchgear, and associated power conditioning and control systems
- Overhead and/or underground electrical conduits and cabling for internal power distribution
- Interconnection infrastructure linking the solar plant to the University's internal grid (and, where applicable, the national grid)
- A supervisory control and monitoring system
- Site office and maintenance building
- Limited backup generation facilities to enhance system reliability

Power produced by the plant would be converted to AC through inverters. Transformers would be installed to step up voltage so that it is compatible with the national grid.

3.2 Proposed Project Site and Location

3.2.1 Overview of the Federal University of Agriculture, Mubi

The Federal University of Agriculture, Mubi (FUAMB) is a federal tertiary institution located in Mayo Bani, Mubi North Local Government Area of Adamawa State, within the North-Eastern geopolitical zone of Nigeria. Established by the Federal Government of Nigeria in 2023, the University operates within a semi-rural savannah environment on the outskirts of Mubi town, at an approximate geographic position of latitude 10.44°N and longitude 13.24°E. Academic and administrative activities are currently conducted from a temporary campus, where teaching, research, and institutional operations are ongoing within a modest but functional infrastructure setting.

As the University is still in its formative phase, student and staff population levels remain moderate but are expected to grow steadily with the expansion of academic programmes and research activities, leading to increased demand for reliable electricity to support teaching, laboratories, ICT, residential, and institutional operations. In line with its long-term development strategy, the University is transitioning to a permanent campus located approximately Ten (10km) kilometers from the current temporary site. The permanent campus is being developed in phases and includes the construction of lecture halls, academic complexes, and supporting infrastructure designed to accommodate future institutional expansion. The proposed solar hybrid power intervention under the Desert-to-Power initiative is therefore intended to

enhance energy reliability and sustainability at the permanent campus, supporting the University's growth trajectory and long-term operational objectives.

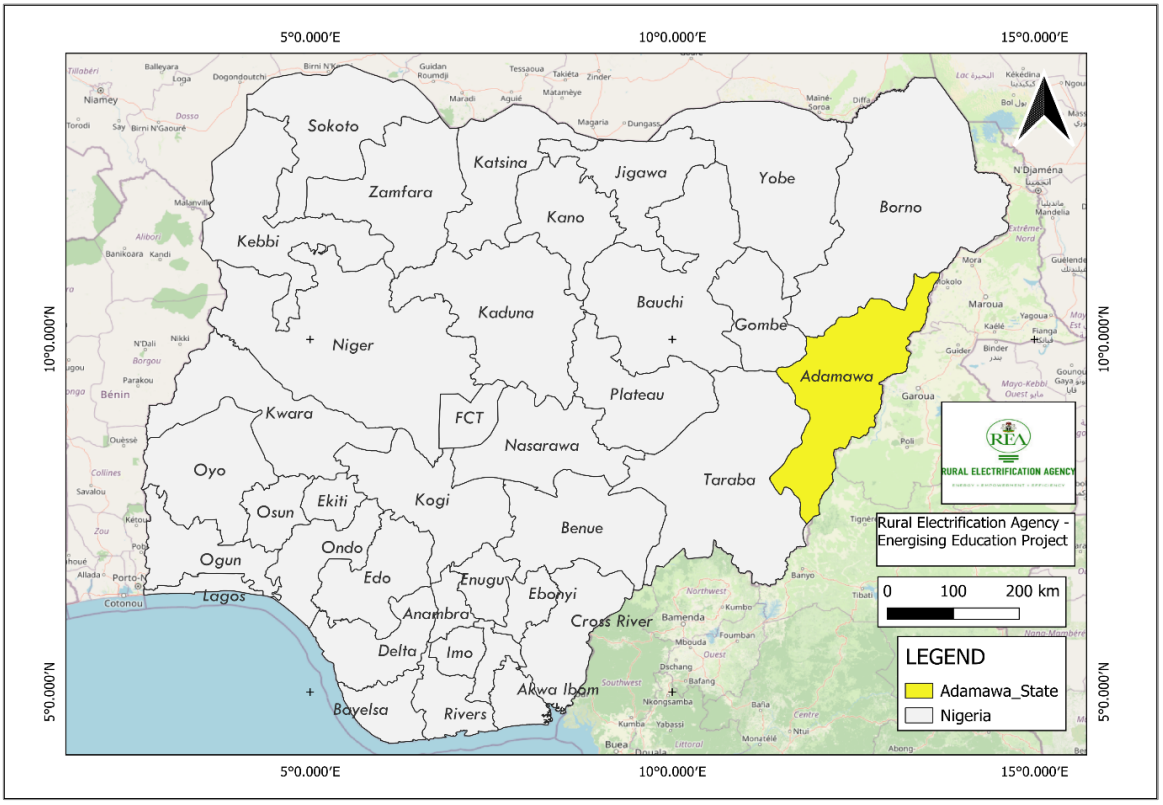

Figure 2: Map of Nigeria showing the project State, Adamawa.

3.2.2 Survey Assessment of the Proposed Site

The proposed project is to be located within the permanent campus of the University in Mayo Bani community, Mubi North LGA of Adamawa State, North-Eastern Nigeria. The specific project footprint

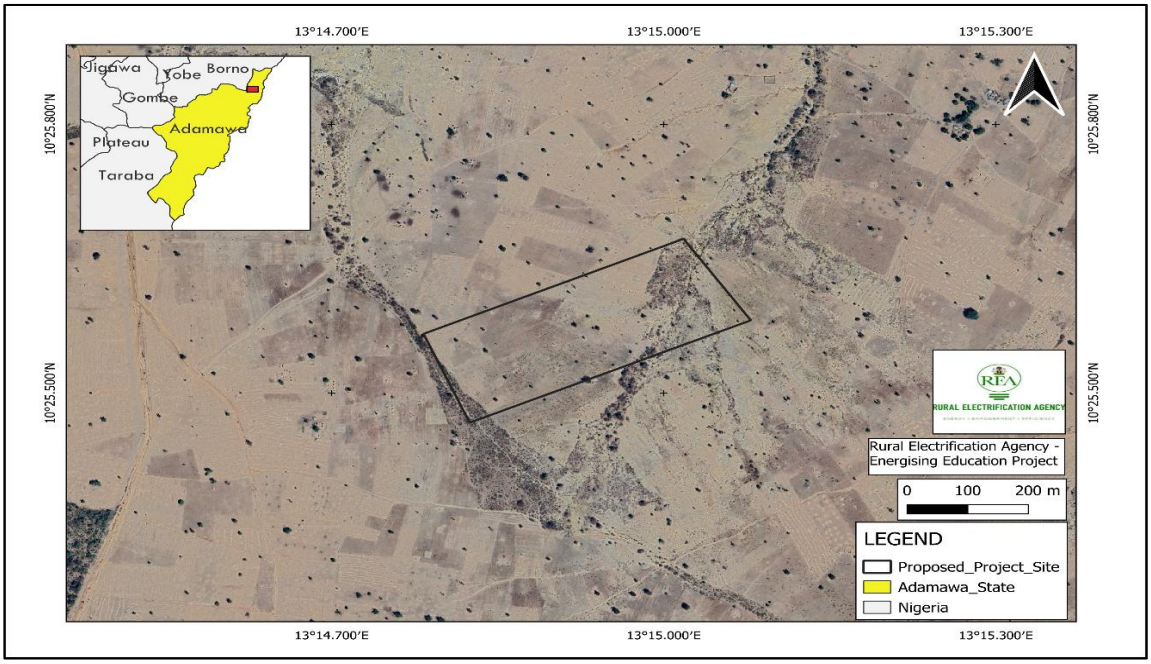

Figure 3: Location Map Showing the Proposed Site at the University

falls within the coordinate range of approximately 10°25′27″N to 10°25′40″N and 13°14′47″E to 13°15′04″E.

Existing Infrastructure

The proposed project site, located within the permanent campus of the Federal University of Agriculture, Mubi, currently does not contain any electrical or utility infrastructure. Field observations confirmed the absence of transmission lines, transformers, substations, generators, or internal power distribution facilities within the designated project footprint. The broader premises are characterized by ongoing institutional development, with lecture halls and theatre buildings presently under construction as part of the University's transition to its permanent campus.

Figure 4: Ongoing Construction Activities at the Broader Premises of the Project Site.

3.2.3 Site Suitability for the Proposed Project

The proposed site within the permanent campus of the Federal University of Agriculture, Mubi is technically suitable for the development of the planned solar hybrid mini-grid system. The allocated land is sufficient to accommodate the photovoltaic arrays, battery storage, and associated infrastructure without affecting existing buildings or institutional activities. The generally flat terrain with gentle undulations minimizes the need for major earthworks and supports efficient installation.

The site lies entirely within university-designated land, eliminating risks of land acquisition, displacement, or land use conflict. No farming, grazing, residential occupation, or economic activities were observed within the footprint. Environmental conditions indicate low sensitivity, as the area is sparsely vegetated and does not contain protected habitats, surface water bodies, or flood-prone zones. Potential impacts are therefore expected to be localized and manageable through standard mitigation measures.

The site is accessible through the existing road network connecting Mubi town to Mayo Bani and the University. Although portions of the access road are untarred, the route remains motorable and suitable for construction logistics with proper planning. While electricity distribution infrastructure exists within the wider Mubi area, the proposed solar hybrid mini-grid is designed to primarily provide dedicated power supply to the university, independent of the existing grid network

3.3 Project Requirements

Land:

As shown in figure 3, the allocated land for the proposed solar facilities installation covers approximately 10,000 square metres and comprises three contiguous parcels within the designated permanent campus development area. The land is under institutional ownership and control of the University and is currently undeveloped. Field assessment confirmed that the site is free from existing structures, competing land uses, or encumbrances, thereby providing adequate space for installation of the proposed solar infrastructure without the need for land acquisition or displacement.

Water Use and Supply

Water demand for the proposed solar hybrid mini grid project is expected to be minimal. During construction, limited quantities of water may be required for minor civil works, equipment installation activities, and domestic use by construction personnel, as cement intensive construction activities are anticipated to be limited. Based on standard construction water consumption rates, total construction phase water demand is estimated at approximately 8,250 litres per day.

During operation, water will primarily be required for periodic cleaning of photovoltaic panels to remove dust accumulation, particularly during the dry season when airborne particles may reduce panel efficiency. Cleaning activities will be undertaken manually and regulated to minimize water consumption. Based on experience from similar solar power installations, each photovoltaic panel may require approximately 5 litres of water per cleaning cycle. giving a total estimated water consumption of approximately 12,500 litres per cleaning cycle for the full panel array. Where practicable, wash water will be collected and reused to minimise freshwater abstraction.

Water for construction and operational activities will be sourced from existing groundwater facilities within the University or other approved local supply sources. Considering the relatively low and intermittent water demand associated with panel cleaning, abstraction for the project is not expected to adversely affect local groundwater resources. Wastewater generated from panel cleaning may carry trace metallic particles from panel frames and support structures as well as micro-plastic residues from aged panel components. Uncontrolled infiltration of such wastewater into the surrounding soil over the operational lifecycle presents a potential contamination risk. Mitigation measures addressing the management of panel cleaning wastewater, including collection, controlled disposal arrangements, and soil quality monitoring provisions, are detailed in the Environmental and Social Management Plan

Health and Safety

Occupational health and safety (OHS) is an issue that needs to be properly managed during all project phases in order to minimize the risk of preventable accidents leading to injuries and/or fatalities. Proper OHS risk identification and management measures should be incorporated in every project's management plan and standard EPC contractual clauses.

The contractor shall engage dedicated personnel competent on the basis of appropriate education, training, and experience to manage and oversee the Health, Safety and Environment (HSE) aspects of the Project.

The HSE personnel shall ensure that the Project and subcontractors operate in accordance with the applicable regulatory HSE requirements and plans; and also monitor implementation of environmental and social protection measures. Occupational health and safety (OHS) plans shall be developed and maintained by all contractors involved in the implementation of the proposed Project particularly in the following aspects:

Occupational Health and Safety:

- General Facility design and operation.
- Communication and Training.

- Physical Hazards.
- Chemical Hazards.
- Biological Hazards.
- Personal Protective Equipment (PPE).
- Special Hazard Environments.
- Monitoring.

Community Health and Safety:

- Water Quality and Availability.
- Structural Safety of Project Infrastructure.
- Life and Fire Safety (L&FS).
- Traffic Safety.
- Transport of Hazardous Materials.
- Disease Prevention.

Waste Management

Waste generation associated with the proposed solar hybrid mini grid project is expected to be limited and will occur mainly during construction, operation, and eventual decommissioning phases. Construction activities may generate typical solid wastes such as packaging materials, scrap metals, cable offcuts, and minor construction debris, while operational waste streams are expected to be minimal and largely associated with routine maintenance activities. Based on the proposed project scale, waste generation during the construction phase is expected to be estimated at approximately 1–3 tonnes over the construction period

Although solar photovoltaic systems generate negligible emissions during operation, some project components may require periodic replacement over their service life. These materials will be handled, stored, recycled, or disposed of in accordance with applicable environmental regulations, manufacturer recommendations, and approved waste management procedures.

During the operation and maintenance phase, waste generation is expected to be minimal, consisting primarily of packaging materials, spent consumables, and occasional electrical or electronic components, with quantities estimated at less than 0.2 tonnes per year. At the decommissioning stage, higher waste volumes are anticipated from the dismantling of solar panels, mounting structures, electrical systems, energy storage units, and associated infrastructure. Total waste generation is estimated at approximately 15–25 tonnes, a substantial proportion of which is expected to be reusable or recyclable through licensed recovery and waste management facilities.

The University maintains an existing waste management system which will support collection and management of non-hazardous wastes generated during project implementation. Specialized wastes arising from electrical or electronic components will be managed through approved vendors and licensed waste handlers in the state, to ensure environmentally sound disposal practices. A summary of anticipated waste streams across project phases is presented in Table 1.

Table 1: Typical waste Streams across Project Phases

Waste Stream	Sources	Waste Generation Phase		
		Construction (C)	Operation (O)	Decommissioning (D)
General rubbish, refuse, and putrescible wastes (Food wastes)	Wood splinter, domestic waste, food packs used bottles	X	X	X
Cleared vegetation	During site clearing and preparation	X	X	X
Scrap metals	Used tubular and casings, used iron rods	X	X	X
Excavated materials	Foundation works	X		X

Damaged/expired PV panels	PV modules	X	X	X
Expired inverters	Electrical installation		X	X
Damaged/expired Batteries	Power generation		X	X
Sanitary waste	Training centre	X	X	X

Solar Photovoltaic Installation Standards

Design, installation, and operation of the proposed solar photovoltaic hybrid system will comply with applicable national and international standards governing electrical safety, construction practices, and renewable energy installations. The project will adhere to relevant International Electro-Technical Commission standards for photovoltaic systems and mini grid development, including IEC 62257 guidelines covering system design, installation, operation, and maintenance.

Implementation will also conform to recognized engineering and construction codes relating to building safety, fire prevention, and electrical system protection. Compliance with these standards will ensure safe installation, reliable system performance, and long-term operational integrity of the solar power infrastructure throughout the project lifecycle.

3.4 Project Components

The proposed project consists of integrated infrastructure designed for electricity generation, storage, control, and distribution within the permanent campus of the Federal University of Agriculture, Mubi. This section provides a description of the major system components and their functions within the overall project configuration.

Solar Power Generation System

The solar power generation system constitutes the primary energy producing component of the proposed project. Electricity will be generated through ground mounted photovoltaic (PV) arrays installed in organized rows within the designated project footprint. The PV modules will be mounted on engineered support structures designed to ensure structural stability, optimal panel orientation, and resistance to prevailing environmental conditions such as wind and rainfall.

The photovoltaic modules will be configured in interconnected strings and arrays to maximize solar energy capture and overall system efficiency. Through the photovoltaic effect, solar radiation incident on the modules will be converted directly into direct current electricity, which will subsequently be transmitted to inverters for conversion into usable alternating current for distribution within the University's electrical network.

The system will utilize polycrystalline silicon photovoltaic technology with an expected operational lifespan of approximately 25 to 30 years under normal operating conditions, providing a reliable and renewable source of energy throughout the project lifecycle.

Figure 5: Example of a Monofacial Si-poly photovoltaic module

Table 2: Photovoltaic module characteristics

Main characteristics	
Technology	Si-poly
Type of module	Monofacial
Maximum voltage	1500 V
Standard test conditions (STC)	
Peak power	415.0 W
Efficiency	18.79 %
MPP voltage	39.3 V
MPP current	10.55 A
Open circuit voltage	47.8 V
Short circuit current	11.14 A
Temperature coefficients	
Power coefficient	-0.370 %/°C
Voltage coefficient	-0.291 %/°C
Current coefficient	0.050 %/°C
Mechanical characteristics	
Length	2108.0 mm
Width	1048.0 mm
Thickness	0.04 mm
Weight	24.9 kg

Energy Storage System

The project will incorporate a Battery Energy Storage System to enhance reliability and stability of electricity supply within the campus. The storage system will retain excess energy generated by the photovoltaic arrays during periods of peak solar production for use when solar generation is reduced or unavailable.

The Battery Energy Storage System will support load balancing and energy stabilization by regulating fluctuations in power output and maintaining consistent voltage supply. Stored energy will primarily be

utilized during nighttime operations, low solar irradiation periods, or temporary demand surges, thereby ensuring continuous electricity availability to critical university facilities.

Power Conversion and Control System

The power conversion and control system will regulate and manage electricity generated from the solar photovoltaic arrays to ensure safe, efficient, and reliable utilization within the University's electrical network. Direct current electricity produced by the PV modules will be converted into alternating current through grid compliant inverters designed for institutional power applications. The inverters will incorporate Maximum Power Point Tracking technology to optimize energy extraction from photovoltaic strings under varying solar irradiation conditions.

Table 3: Inverter characteristics

Inverter characteristics	
Main characteristics	
Inverter type	STRING
Maximum DC to AC conversion efficiency	98.79 %
Input side (DC)	
MPPT search range	880- 1300 V
Maximum input voltage	1500 V
Output side (AC)	
Rated power	110.0 kVA
Power at 30 C (datasheet)	110.0 kVA
Power at 50 C (datasheet)	100.0 kVA
Output voltage	800 V
Output frequency	50 Hz

Converted power will be transmitted through step up transformers to increase voltage levels suitable for integration into the campus medium voltage distribution system. Power evacuation and system integration will be supported through dedicated transformer or power stations configured as enclosed or containerized units housing transformers and associated medium voltage equipment.

Medium voltage switchgear assemblies and protection systems will be installed to provide system isolation, fault detection, operational safety, and controlled power flow. Power conditioning equipment will further stabilize voltage and frequency to maintain consistent power quality and safeguard connected electrical installations. Collectively, these components ensure efficient energy conversion, secure transmission, and stable operation of the solar hybrid system under varying load and generation conditions.

Figure 6: Example of string photovoltaic inverter

Figure 7: A transformer

Figure 8: Example of a Power Station

Electrical Distribution and Interconnection Infrastructure

The electrical distribution and interconnection infrastructure will facilitate transmission of electricity from the solar hybrid generation facility to designated load centres within the University's permanent campus. Power evacuation will be achieved primarily through medium voltage distribution lines operating at approximately 11 kV, with underground cabling installed along designated utility corridors and campus road alignments to minimize surface disturbance and ensure maintenance accessibility.

The distribution network will integrate with the University's internal electrical system to enable efficient and controlled supply to academic buildings, residential facilities, research centres, and essential service infrastructure. Provision will also be incorporated for coordinated operation with existing or future grid infrastructure where applicable, allowing system flexibility and reliable interface between the solar hybrid installation and external electricity supply sources.

Monitoring and Supervisory Control System

The project will incorporate an integrated monitoring and supervisory control system to ensure efficient operation and management of the solar hybrid power installation. The system will utilize Supervisory Control and Data Acquisition technology to enable real time monitoring of energy generation, battery storage performance, and electricity distribution across the facility.

The platform will support remote supervision, system diagnostics, performance analysis, and early fault detection, enabling timely corrective actions and optimized power flow regulation. These functions will enhance operational reliability, system safety, and overall efficiency of the installation.

As part of the monitoring framework, a solar weather station will be installed to capture real time meteorological and performance data. The station will include sensors for solar irradiation, ambient

temperature, relative humidity, wind speed, wind direction, and photovoltaic module temperature. Data collected will inform system performance evaluation, preventive maintenance planning, and operational optimization.

Supporting Infrastructure

Supporting infrastructure will be provided to facilitate effective operation, maintenance, and security of the proposed solar hybrid power facility. This will include construction of a site office and maintenance building to accommodate operational personnel, equipment storage, and routine system management activities.

Internal access tracks will be developed within the project area to enable movement of personnel and maintenance equipment during installation and operational phases. Security installations, including perimeter fencing and controlled access points, will be provided to safeguard project infrastructure against unauthorized access, vandalism, and theft, thereby ensuring safe and sustained operation of the facility.

Internal access tracks will be developed within the solar facility to provide connectivity between major project components and facilitate movement of personnel, equipment, and maintenance vehicles during construction and operational phases. These access routes will support routine inspection, operation, and maintenance activities within the project area and will connect the various installation units to existing campus circulation routes.

The access tracks will be designed with appropriate surface finishing and basic drainage provisions to manage stormwater runoff and minimize localized erosion within the facility. These internal roads are distinct from the external access routes to the University previously described under the site accessibility section.

To ensure operational safety and infrastructure protection, the project area will be secured through installation of perimeter fencing with controlled access points. Additional security measures, including perimeter lighting and surveillance systems, will be provided to prevent unauthorized access and safeguard installed equipment.

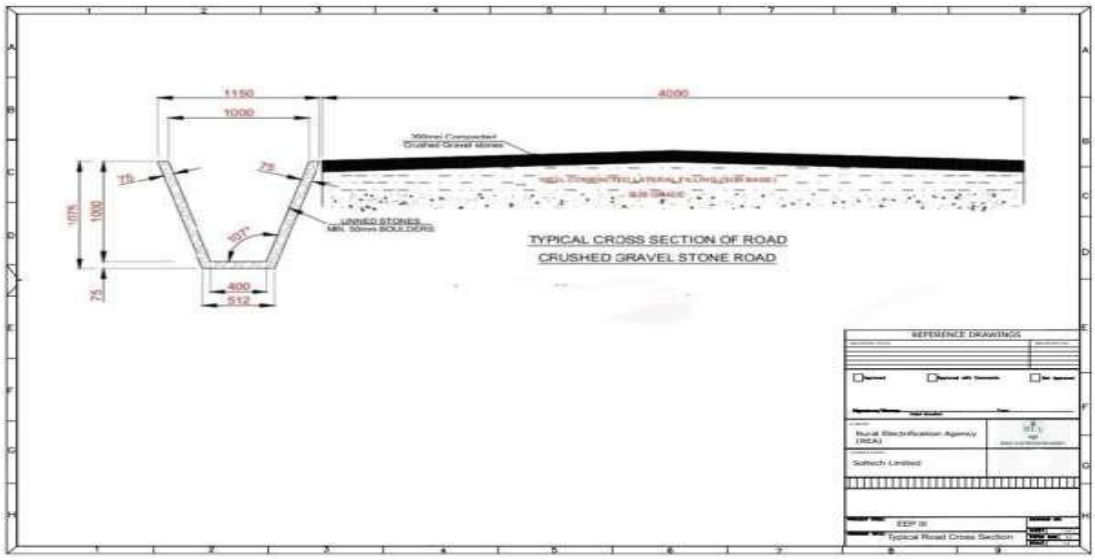

Figure 9: Typical Road Cross Section

Backup Power System

The proposed solar hybrid mini grid will incorporate limited backup generation facilities to enhance reliability and continuity of electricity supply within the University campus. The backup system, typically comprising diesel powered generators, will operate as a supplementary power source during periods of prolonged low solar generation, battery depletion, system maintenance, or emergency conditions.

The backup generators will be integrated into the hybrid control system to enable automatic synchronization and controlled operation alongside the solar photovoltaic and battery storage systems. This arrangement ensures uninterrupted power supply to critical facilities while maintaining overall system stability and operational flexibility.

3.5 Operation and Maintenance

Operation and maintenance of the system would be expected to occur on a limited basis at certain points during the system's estimated 25-year life cycle. To enhance the performance and reliability of the plant, the following types of maintenance will be carried out:

Preventive Maintenance: which involves routine inspection and servicing of plant equipment to prevent breakdowns. This includes panel cleaning, vegetation management, wildlife prevention, water drainage, monitoring of electrical components. It also involves retro- commissioning to improve the efficiency of the PV plant by detecting and solving problems in the system.

Corrective Maintenance: which involves repair of broken-down equipment. This includes on-site monitoring and mitigation, and critical and non-critical repairs of plant components.

Condition-based maintenance: which involves monitoring equipment and plant operations real- time and addressing potential problems early on in order to prevent plant downtime. This includes continuous monitoring via remote and on-site methods, warranty enforcement, and planned and unplanned equipment replacement.
Maintenance activities will be carried out by skilled manpower with backgrounds in electrical/electronic engineering and unskilled local labour where applicable. Specific maintenance activities include the following:

PV Modules

PV modules need to be cleaned weekly in the dry season manually using water and monthly in the wet season to prevent accumulation of dust. Also, the cabling around the modules need to be checked regularly for damages. Panels need to be checked regularly for cracks and breaks. Panel testing needs to be conducted annually to ensure they live up to the manufacturer’s warranty.

Electrical System

- Inverter components need to be checked to prevent breakdowns which can occur during very hot weather conditions.
- Electrical wiring and earthing protection need to be checked for wear and tear. Also, the underground cabling needs to be monitored regularly for damages from pests.
- Infrared technology may be employed to identify spots where there are electricity leaks.

Civil Structures

- Mounting structures need to be checked regularly for bending damage which can affect the PV modules

- Access roads, drainage works, plant foundation and array structures need to be checked by visual inspection for water damage during the rainy season

Vegetation

- Growth of shrubs and other vegetation needs to be curtailed to prevent shadowing effect on the solar panels leading to a decrease in the output from the plant. Weeds also need to be eliminated as they present a fire hazard.
- Vegetation around the transmission line RoW needs to be cleared quarterly to maintain a vegetation height at less than 2 ft (0.61 m).

A stockpile of spare parts will be kept on-site to facilitate replacement of broken-down or out- dated solar panels and inverters. On-site security and inventory management will be implemented to prevent theft of spare parts and installed plant components.

Monitoring of the PV system components needs to be conducted to ensure increased system output and to reduce down-time. Traditional monitoring methods that compare actual energy generation against predicted energy generation will help to track the system's relative health.

3.6 Project Implementation Phase Activities

3.6.1 Preconstruction

Preconstruction works is proposed to last for 1-2 months. The works at this stage will entail activities such as site selection and preparation, completion of engineering design for the Project and receipt of relevant approvals, mobilization of personnel, equipment and materials to site, site preparation and installation of temporary structures for material storage.

3.6.2 Construction

Construction activities would last about 12-18 months. The major facilities to be constructed will include:

- ❖ Towers;
- ❖ Transformers;
- ❖ Control building;
- ❖ Weather station; and
- ❖ Transmission lines;

The proposed construction programme would be as follows:

- ❖ Construct the site access roads with gates and temporary fencing;
- ❖ Erect weather station;
- ❖ Excavate the foundations
- ❖ Construct the panel foundations;
- ❖ Erect and connect the panels;
- ❖ Lay power and instrumentation cables;
- ❖ Construct the control station;
- ❖ Construct the transformer and install the grid connection;
- ❖ Commission the panels and transmission lines; and
- ❖ Carry out land reinstatement, remove temporary compounds and clear the site

The construction will normally be completed during daytime hours; however, there will be requirements for extended hours during major concrete pours or other installations that cannot be interrupted.

3.6.3 Commissioning and Operation

Following the completion of all works at the construction phase, the power plant will be commissioned for operations. The commission phase will involve 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. Standard operating procedures (SOPs) shall be developed by the EPS Contractor for the operation and maintenance of the solar panels, inverters, batteries, and other associated components of the Project.

Upon completion of the commissioning of the power plant and other ancillary infrastructures, the EPC contractor will hand over the power plant to the Operation and Maintenance (O&M) Consultant who will be charged with the responsibility of operating and maintaining the plant for a period of 1 year. At this period, the O&M Consultant will also train the technical unit staff of university for ease of handover at the end of the O&M period. Activities under this phase will include:

- Power generation and distribution to various sections of the University
- The preventative, corrective and predictive maintenance of the power plant and associated facilities.

Also, the training centre will be utilized in enhancing learning in renewable energy.

3.6.4 Decommissioning

Upon completion of the power plant, the project site area will be cleared up for proper housekeeping. This is different from the decommission of the site which will be undertaken at the end of life of the power plant. The plant has a life cycle of at least 25years, which is expected to be extended with proper and timely maintenance of the plant. Upon the end-of-life of the power plant, the decommissioning activities will include:

- 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).
- Removal of PV panels and equipment, demolition of structures and evacuation as well as site remediation.
- Waste management – recycling, disposal of unusable parts etc.
- Restoring the environment to allowable baseline conditions and monitoring of the process.
- Assessing the residual impacts, if any, that the project has on the environment.

Table 4: Project Implementation Phase Activities and Staff Requirement.

Project Phases	Activities	Staff Requirement	Employment Type
Pre-construction Phase Activities	• Land identification and confirmation of project site • Completion of detailed engineering design • Obtaining regulatory approvals and permits • Mobilization of personnel, equipment and materials to site • Site preparation and demarcation • Installation of temporary facilities for material storage and site operations	15–25 persons: project engineers/ design specialists, E&S officers, surveyors, security personnel, and limited support workers	Temporary / short-term professional assignment
Construction Phase Activities	• Construction of internal access roads, gates and temporary fencing. • Excavation and preparation of foundations • Installation of panel mounting structures and PV arrays • Installation of transformers and grid connection	50–70 persons at peak construction: skilled technicians, electricians, civil workers, equipment operators, HSE/ safeguard	Temporary, mainly construction-period employment

	• Infrastructure. • Laying of power and instrumentation cables • Construction of control station and supporting facilities • Installation of weather monitoring station • Erection and electrical connection of solar panels • Testing and commissioning of solar panels and transmission lines • Site reinstatement and removal of temporary structures after construction	personnel, supervisors, security personnel, and unskilled local labour	
Commissioning and Operation Phase Activities	• Testing and verification of installed equipment and systems • Commissioning of solar power plant and associated infrastructure • Development and implementation of standard operating procedures (SOPs) • Electricity generation and distribution across the university campus • Preventive, corrective and predictive maintenance of plant components • System monitoring and performance management • Training of university technical personnel for system operation and maintenance	10–15 persons: commissioning engineers, electrical specialists, HSE officer, REA/ FUAMB representatives, EPC technical personnel O&M manager/ engineer, electrical technicians, BESS technician, HSE/support officer, security personnel, cleaner/ site attendants,	Temporary / short-term technical assignment for commissioning phase & Long-term O&M contract / permanent operational support for operation and maintenance phase
Decommissioning	• Dismantling and removal of photovoltaic panels and mounting structures • Removal of electrical components including inverters, transformers, batteries and cables • Removal of underground installations • Demolition of supporting structures and evacuation of materials • Waste management including recycling and disposal of unusable components • Site remediation and restoration to baseline conditions • Post-decommissioning environmental monitoring and impact assessment	25–35 persons: decommissioning contractor, electricians, waste handlers, HSE officer, environmental officer, security and manual workers	Temporary / end-of-life decommissioning employment

3.7 Analysis of Project Alternatives

The proposed solar hybrid mini grid system for the Federal University of Agriculture, Mubi has been designed to provide a reliable and sustainable electricity supply to support the development of the University's permanent campus. In line with good environmental and social assessment practice, consideration was given to feasible alternatives during project planning in order to identify an option that meets the project objectives while minimizing potential environmental and social impacts.

The alternatives analysis focused primarily on the suitability of the selected project site within the University premises, the availability of land, proximity to electricity demand centres, accessibility, environmental sensitivity of the surrounding area, and compatibility with the campus development master plan. Technology options were also considered, particularly the suitability of renewable energy based electricity generation compared to continued reliance on conventional fossil fuel-based power supply.

Thus, this sub-section specifically focuses on the alternatives considered within the proposed solar-hybrid power plant.

3.7.1 Site Alternatives

Several potential locations within the permanent campus of the Federal University of Agriculture, Mubi were reviewed during preliminary site assessments. The evaluation considered key criteria including land availability, accessibility, proximity to electricity demand centres, environmental sensitivity, and potential social impacts.

Field verification was undertaken through site walk through surveys, GPS mapping, and consultation with university management. Based on these assessments, the selected site was considered the most suitable option due to the following factors:

- The land is already designated for institutional development within the university master plan and is under the control of the University.
- The site is presently undeveloped and free from physical structures, agricultural use, or other encumbrances that could require relocation or displacement.
- The terrain is generally flat with stable sandy soil conditions, making it technically suitable for installation of ground mounted photovoltaic systems.
- The site is located close to the anticipated campus load centres, thereby minimizing transmission losses and reducing the need for extensive distribution infrastructure.
- The location is accessible through existing campus road networks, which will facilitate construction logistics and future maintenance activities.
- Vegetation within the footprint is sparse and typical of the Sudan Savannah ecological zone, with no evidence of protected plant species, ecologically sensitive habitats, or cultural heritage resources.

Alternative locations considered within the university premises were not selected due to constraints such as proximity to existing or planned infrastructure, presence of institutional facilities, less favorable terrain conditions, or limited accessibility for construction activities.

3.7.2 Solar Power Technology Alternatives

The solar technologies options available for the proposed power plant in the University are:

- Concentrated Solar Power (CSP) Systems
- Photovoltaic (PV) Solar Panels

Concentrated Solar Power (CSP) Systems

Concentrated solar power (CSP) technologies harness thermal energy from the sun to drive a thermodynamic cycle. Thermal energy storage (TES) is realized through the addition of tanks, which allows CSP systems to generate electricity at times of little or no solar irradiance. This includes operating 24-h a day (baseline generation) or adjusting electricity generation during times of increased demand and high prices.

There are four different types of solar collector designs indicated in figure 10 parabolic troughs, heliostats (for power towers), linear Fresnel lenses, and dish receivers.

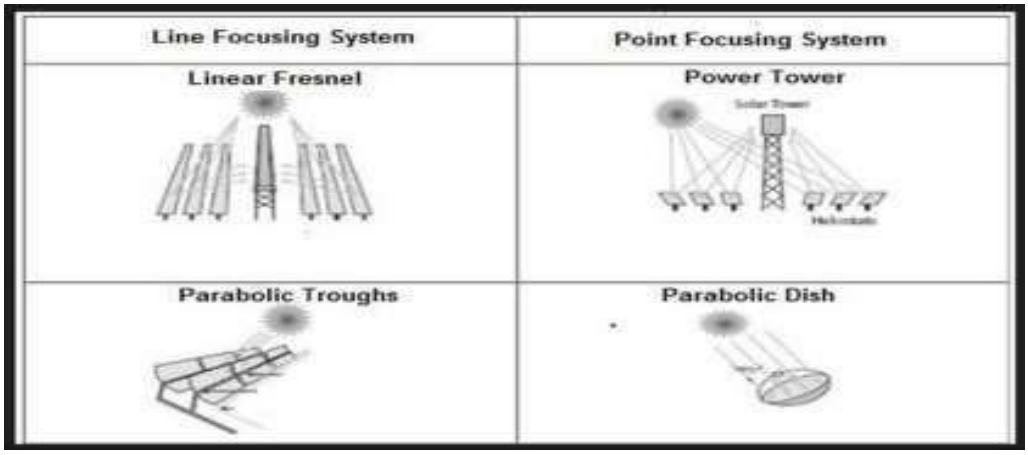

Figure 10: Four different types of solar collector designs

Solar Photovoltaic Power Systems

SPV systems utilize semiconductor-based materials (solar cells) which directly convert solar energy into electricity. SPV systems have many attractive features, including modularity, no fuel requirements, zero emissions, no noise and no need for grid connection. SPV systems can be classified according to three principal applications.

- Stand-alone solar devices purpose-built for a particular end use, such as solar HF radios, solar home lighting systems, or solar coolers. These dedicated SPV systems can either be configured to include some energy storage capacity or directly power electrical or mechanical loads, such as pumping or refrigeration;
- Stand-alone solar power plants, basically small power plants designed to provide electricity from a centralized SPV power plant to a small locality like village or a building; and
- Grid-connected SPV power plants, which are equivalent to any other generator supplying power to the electricity grid.

Comparison of solar power technologies

Parameter	Concentrated Solar Power (CSP)	Solar Photovoltaic (SPV)
Energy Conversion	Thermal (Heat to Steam to Electricity)	Direct (Semiconductor/Light to Electricity)
Mechanical Parts	High (Requires turbines, tracking mirrors)	Minimal (Solid-state, no moving parts)
Scalability	Best for large-scale utility projects	Highly scalable (from small devices to utility)
Operational Flexibility	Good (Thermal storage allows baseload)	Modular (Easy to expand/configure)
Maintenance	High (Complexity of thermal/mechanical systems)	Low (No fuel, no moving parts, simple upkeep)
Noise/Emissions	Low (Steam cycle may have some noise)	Zero (Silent, no emissions during operation)
Infrastructure Needs	Grid connection usually required	Can operate standalone or grid-tied

The final design preference is for Solar Photovoltaic Power Systems.

3.7.3 Solar Batteries Alternatives

Solar batteries are mainly categorized by manufacturing material. There are four main types of solar batteries available on the market:

Lead-Acid Batteries

Lead-acid batteries are the oldest form of battery with technology dating back more than a century. As a result, lead-acid batteries are a tried-and-true when it comes to storage. Lead acid batteries are categorized into two types: flooded lead-acid and sealed lead-acid batteries. The lead-acid variety are considerably more inexpensive than other solar batteries. These batteries come with some challenges: shorter lifespan and lower depth of discharge. Lead-acid battery capacity is also comparatively lower than other batteries. These limitations can complicate the installation process.

Figure 11: Illustrative Photo of a Lead Acid Battery

Lithium-Ion Batteries

Lithium-ion batteries are relatively new. Their advanced technology has updated features. Many portable devices, such as mobile phones and laptops, use lithium-ion batteries. They are efficient, compact and lightweight. If not properly installed, lithium-ion batteries could experience thermal runaway and catch fire.

Figure 12: Illustrative Photo of a Lithium-Ion Battery

Nickel Cadmium Batteries

Nickle Cadmium (Ni-Cd) batteries are not as common as lead-acid or lithium-ion batteries. These batteries are also a century old. They were popular in the aircraft industry. Because of their sturdiness, Ni-Cd batteries are useful for large-scale applications, such as utility solar energy storage.

Known for durability, Ni-Cd batteries can operate at higher temperatures. They also don't need complicated battery management systems and are almost maintenance-free. Ni-Cd batteries' biggest drawback is that they are toxic. Even when recycled, they can become a major environmental concern.

Figure 13: Illustrative Photo of a Nickel Cadmium Battery

Flow Batteries

Flow batteries are still in the development phase, and it may take some time before they are widely available in the market. Knowing about them now is worthwhile because this variety is expected to be a game changer in future solar panel storage methods. Within these batteries, water-based electrolyte liquid circulates between two different chambers. The chemical reaction of the charging process allows the battery to store and release electrical energy.

The biggest advantage of flow batteries is that they offer 100% depth-of-discharge capability. This means you can utilize all the energy stored in the battery without damaging it.

Table 5: Comparison of the Battery Technologies

Parameter	**Lead-Acid (VRLA/AGM)**	**Nickel-Cadmium (Ni-Cd)**	**Lithium Iron Phosphate (LiFePO4)**
Energy Density	Low	Low to Moderate	High
Cycle Life	Short (300–800 cycles)	Long (1,500–3,000+ cycles)	Very Long (3,000–6,000+ cycles)
Depth of Discharge	Shallow (50% recommended)	High (up to 80%)	Very High (up to 95%+)
Thermal Stability	Moderate	Very High	Excellent
Maintenance	Regular (depending on type)	Moderate	Low (Maintenance-free)
Environmental Risk	High (Lead/Acid)	Very High (Cadmium)	Low (No heavy metals)

N.B. The final design option is in preference of lithium battery. As illustrated in table 5 above, the Lithium-Ion Batteries technology is the preferred option. Its superior cycle life, high depth-of-discharge capability, and significantly lower environmental risk profile align with international best practices for modern, sustainable energy storage systems.

3.7.4 Climate Change Considerations

The following climate change considerations formed an explicit criterion in the evaluation of project alternatives.

Climate Risk: The selected site in northern Adamawa State is exposed to climate-related risks including high temperatures, harmattan conditions, seasonal wind loading, intense rainfall events, and lightning associated with seasonal thunderstorms. Among the site alternatives assessed, the selected location presents the lowest climate vulnerability due to its relatively flat and stable terrain and open aspect, which maximizes solar irradiance. Appropriate climate resilience measures, including lightning protection, surge protection, and adequate earthing of electrical installations, will be incorporated into

the project design to minimize the risk of equipment damage, service interruption, and fire hazards associated with extreme weather events.

Climate Impact on Project**:** The selected solar PV technology and lithium-ion battery storage system were evaluated against their susceptibility to climate-related impacts including heat stress on panels and batteries, dust accumulation on PV surfaces during harmattan conditions, and wind exposure. Lithium-ion batteries were preferred over lead-acid and nickel-cadmium alternatives in part due to superior thermal performance under the high ambient temperatures characteristic of the project environment. Panel cleaning provisions were incorporated to address dust-related efficiency losses.

Project GHG Contribution: Among the alternatives considered, solar photovoltaic technology generates negligible operational greenhouse gas emissions compared to continued diesel generation, which is estimated to contribute approximately 1,300 to 2,100 tonnes of CO_2 equivalent per year. The preferred alternative therefore directly supports Nigeria's mitigation commitments under the National Climate Change Policy 2021 to 2030.

3.7.5 Project Options

No Project Option

The "No Project" option refers to the scenario in which the proposed solar hybrid mini grid project is not implemented at the Federal University of Agriculture, Mubi. Under this scenario, the University would continue to rely largely on diesel powered generators and limited grid supply from surrounding distribution networks to meet its electricity needs. Existing electricity supply to the University and surrounding communities is characterized by severe limitations, as the transmission and distribution infrastructure serving the area was destroyed during insurgent activity and has not been rehabilitated or reconnected to the national grid. The community currently relies entirely on privately owned petrol and diesel generators and a small proportion of solar home systems, resulting in costly, unreliable, and environmentally burdensome energy supply conditions.

Continued reliance on these sources would result in higher operational costs, with FUAMB estimated to expend approximately NGN 15 to 25 million annually on diesel procurement, increased greenhouse gas emissions, estimated at approximately 1,300 to 2,100 tonnes of CO2 equivalent per year, and persistent energy reliability challenges, particularly as the University expands its permanent campus and academic activities.

Failure to implement the project would also prevent the realization of the expected benefits of the Energizing Education Programme under the Desert to Power initiative, including provision of clean and reliable electricity, reduction in fossil fuel dependence, improved learning and research conditions, and enhanced institutional development.

For these reasons, the No Project option is considered neither technically nor environmentally desirable and was therefore not selected as a viable alternative for meeting the long-term electricity demand of the Federal University of Agriculture, Mubi.

Delayed Option

The delayed project option refers to a scenario where implementation of the proposed solar hybrid mini grid project is postponed to a later date. Under this option, the University would continue to experience inadequate and unreliable electricity supply while development of the permanent campus progresses.

Delaying the project would prolong dependence on diesel powered generators and limited grid supply, resulting in continued operational costs, energy insecurity, and associated environmental impacts from fossil fuel-based electricity generation. In addition, postponement of the project could lead to increased implementation costs due to inflationary pressures on equipment, materials, and construction services.

A delay would also slow the realization of the expected benefits of the Energizing Education Programme under the Desert to Power initiative, including improved electricity reliability for academic activities, enhanced research capacity, and reduced greenhouse gas emissions.

For these reasons, the delayed project option is considered undesirable and was not retained as a practical alternative for meeting the immediate and long-term energy needs of the Federal University of Agriculture, Mubi.

Go Ahead Option

The "Go Ahead" option refers to the implementation of the proposed solar hybrid mini grid project at the Federal University of Agriculture, Mubi as planned under the Energizing Education Programme of the Desert to Power initiative. Implementation of the project will provide reliable, sustainable, and cleaner electricity supply to support the development and operation of the University's permanent campus.

The project is expected to enhance teaching, research, and innovation activities by providing stable electricity for academic buildings, laboratories, ICT facilities, and residential areas. In addition, improved lighting and power availability will contribute to better campus security and operational efficiency.

The project will also generate employment opportunities during construction and operational phases for skilled professionals, technicians, and local labour. Furthermore, the use of solar photovoltaic technology will reduce reliance on diesel powered generators, lower greenhouse gas emissions, and contribute to Nigeria's renewable energy and climate commitments.

Considering the technical feasibility, environmental compatibility, and socio-economic benefits associated with the project, the option to proceed with implementation represents the most appropriate and sustainable alternative when compared with the "No Project" and "Delayed Project" options.

CHAPTER FOUR: DESCRIPTION OF THE ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

4.1 Introduction

This chapter presents the baseline environmental and social conditions of the project area prior to the implementation of the proposed Project. The assessment provides an understanding of the existing physical, biological, and socio-economic characteristics of the project environment, which serves as a reference point for identifying and evaluating potential environmental and social impacts associated with the project.

4.2 Methodology for Baseline Data Collection

The baseline environmental and social conditions of the proposed Project at the University site were established through a combination of primary field investigations and secondary data review. The methodology adopted ensured that adequate information was obtained on the physical, biological, and socio-economic characteristics of the project site and its surrounding environment.

Baseline data collection activities were conducted between 22nd and 31st January 2026, and involved reconnaissance surveys, field observations, stakeholder consultations, environmental sampling, and socio-economic surveys. Baseline data collection was conducted during the dry season period of January 2026, when the project area experiences minimal rainfall, elevated dust levels, and reduced surface water flow.

These methods provided the basis for describing the existing environmental and social conditions within the project area prior to project implementation.

4.2.1 Study Area and Project Area of Influence

The assessment covered the proposed project site and its surrounding environment defined as the Project Area of Influence (AoI). For this study, the AoI encompasses the immediate project footprint and the surrounding environment within an approximate 2 km radius from the centre of the proposed solar hybrid mini-grid installation site located within the permanent campus of the Federal University of Agriculture, Mubi (FUAMB). This spatial boundary was considered appropriate for capturing environmental and social conditions that may potentially interact with the proposed project through construction activities, movement of personnel and equipment, drainage patterns, utility connections, and community interactions.

In delineating the AoI, consideration was given to the proximity of nearby receptors and facilities, including sections of the FUAMB permanent campus, and the Mayo Bani community located about 400 m away. Access routes, water sources, and areas undergoing institutional development within the university environment were also taken into account.

Baseline environmental sampling, field observations, and socio-economic surveys were therefore conducted within the defined AoI to ensure that the existing environmental and social conditions of the project environment were adequately characterized.

4.2.2 Field Observations

Detailed field observations were carried out across the project site and its immediate surroundings during the baseline study period. The purpose of these observations was to document the prevailing physical and biological conditions of the area.

Field observations focused on key environmental parameters including:

- Topography and drainage characteristics
- Soil conditions and surface stability
- Existing vegetation cover and habitat conditions
- Presence or absence of wildlife and ecological sensitivity
- Current land use and human activities within the project vicinity

Observations were conducted within the proposed project footprint and along the surrounding area extending approximately 300 - 500 m from the site boundary**,** including sections of the FUAMB campus and the direction of nearby settlements. Information obtained from field observations was recorded through field notes, geo-referenced photographs, and direct visual inspection.

4.2.3 Secondary Data Review

Secondary environmental and socio-economic data relevant to the project area were obtained through a review of existing literature and institutional sources. This review provided contextual information on the broader environmental and socio-economic conditions of Adamawa State and Mubi North Local Government Area**.** The reviewed materials included:

- Project documentation provided by the Rural Electrification Agency, including the Terms of Reference (TOR) for the ESIA.
- Technical planning documents and infrastructure information provided by the Federal University of Agriculture, Mubi, including the campus development framework and electrical planning information for the permanent campus.
- Environmental and Social Impact Assessment: Proposed Energizing Education Programme Phase III Project at Modibbo Adama University Yola, Adamawa State. Final Report, February 2024.
- National and regional environmental datasets including climatic and meteorological information for Adamawa State
- Relevant national environmental policies, legislation, and guidelines including the Environmental Impact Assessment Act (Cap E12 LFN 2004) and the Federal Ministry of Environment Environmental Impact Assessment Procedural Guidelines (2017).
- Applicable international environmental and social safeguard frameworks including the African Development Bank Integrated Safeguards System (ISS) and other international good practice guidance relevant to environmental and social assessment.

4.2.4 Environmental Sampling and Laboratory Analysis

Environmental sampling was conducted as part of the baseline study to establish the existing quality of key environmental media within the project area. Sampling focused on soil, air quality, and water resources within and around the project site.

Sampling activities were conducted on 29th January 2026 at representative locations within the project footprint and along the surrounding environment at distances ranging between approximately 100 m and 500 m from the proposed site boundary.

Soil Sampling

Soil sampling was undertaken at representative locations within the proposed project footprint and surrounding Area of Influence to establish the general baseline quality of the soil environment prior to project implementation. Samples were collected within the shallow soil horizon likely to be affected by project activities, particularly site clearing, grading, trenching, foundation works, vehicle movement and temporary stockpiling of materials.

The soil samples analysed for this ESIA represent composite shallow soil samples within the 0–30 cm interval at each sampling location. The results therefore provide an indicative baseline of the general soil quality within the project footprint and immediate surroundings. They should not be interpreted as separate analytical results for topsoil, 0–15 cm, and subsoil, 15–30 cm. This limitation has been taken into account in the impact assessment and in the development of soil management measures under the ESMP.

The purpose of the soil baseline was to identify existing evidence of contamination, soil chemical constraints, erosion susceptibility, and general soil conditions relevant to the proposed solar-hybrid mini-grid development. Given the nature of the project, its limited footprint, the absence of known industrial activity or waste disposal within the project site, and the baseline results indicating no significant soil contamination, the composite sampling approach is considered adequate for general environmental screening at ESIA stage. However, because the results do not provide depth-specific topsoil and subsoil information, the ESMP adopts a conservative soil management approach requiring separate handling, stockpiling and reuse of topsoil and subsoil during construction.

Prior to commencement of intrusive works, the EPC Contractor, under the supervision of REA/NEP-PMU and the environmental safeguard officer, shall undertake a pre-construction soil verification and site preparation exercise. This shall include visual inspection of soil horizons during stripping, separate management of topsoil and subsoil, documentation of any unusual staining, odour, waste material or suspected contamination, and targeted confirmatory sampling where such conditions are encountered. Where confirmatory sampling is required, topsoil and subsoil shall be sampled and analysed separately, and the results shall be used to update site-specific soil management measures before continuation of works in the affected area.

The samples were collected randomly using grab and composite techniques to achieve an even spread from the project site, and the sampling points were adequately captured by the use of a GPS and photo recognizable geographies on satellite imagery of the location. The dominant considerations in the selection of sampling points included accessibility, ecological features and geographical location of settlement. All the soil samples collected were packed and preserved for onward transmission to the laboratory where they would be analyzed. Laboratory analyses were conducted by the Pollution Control Laboratory, Ministry of Environment, Kano State, an FMEnv-accredited environmental laboratory, to determine parameters including soil pH, organic matter content, particle size distribution, and selected heavy metals, as presented in Table 6. The laboratory applied established analytical procedures and quality assurance/quality control (QA/QC) protocols to ensure the reliability of the analytical results. Supporting laboratory documentation is provided in the Annex Eight.

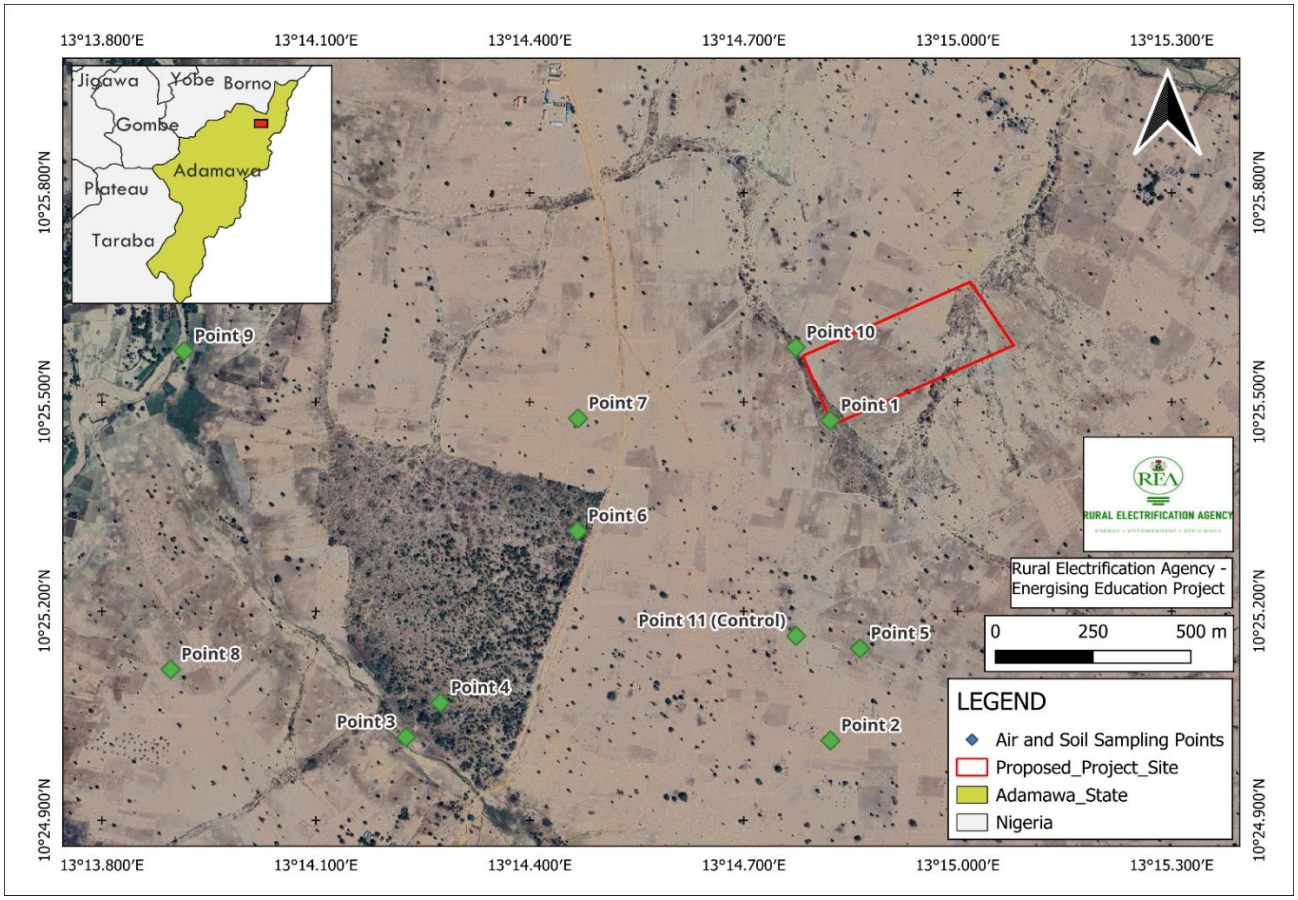

Figure 14: Map showing soil sampling points and Air / Noise quality sampling

Air Quality Monitoring and Noise measurement

Ambient air quality measurements were carried out at selected locations within the project area using pre-calibrated digital handheld Air Quality Monitoring Equipment such as pre-calibrated Crowcon [TETRA3] Pro Environmental Test Meter. Measurements focused on key parameters such as particulate matter (PM), carbon monoxide (CO), and other relevant indicators of air quality, carried out at Twelve (12) different points including control within and around the proposed project site. Air quality monitoring points were established within the project site and at nearby receptor locations to capture representative baseline conditions prior to project implementation.

Noise measurements were taken with a digital, battery-powered, sound pressure level meter (EXTEC Instruments, US Model 407735). The meter has both A and C weighting and 0.1 dB resolution with fast/slow responses. Its high- and low-metering ranges were 35 – 100 dB and 65 – 130 dB, respectively. The meter is also equipped with a building calibration check (94 dB), tripod mount, and analogue DC/AC conditioned outputs of 10mV/dB and utilized a 0.49 “(12.3 mm) condenser microphone.

Water Sampling

Water samples were collected from representative water sources within the study area to establish baseline water quality conditions. A total of eight water samples were obtained, comprising six groundwater samples (four boreholes and two wells) and two surface water samples (an irrigation stream and a pond).

Samples were collected using pre-cleaned and sterilized sampling bottles and preserved in accordance with standard sampling and preservation protocols prior to transportation for laboratory analysis. The collected samples were analyzed for selected physicochemical and microbiological parameters, including

indicators of water quality such as pH, turbidity, total dissolved solids (TDS), electrical conductivity (EC), and other relevant parameters as discussed in subsection 4.3.3.

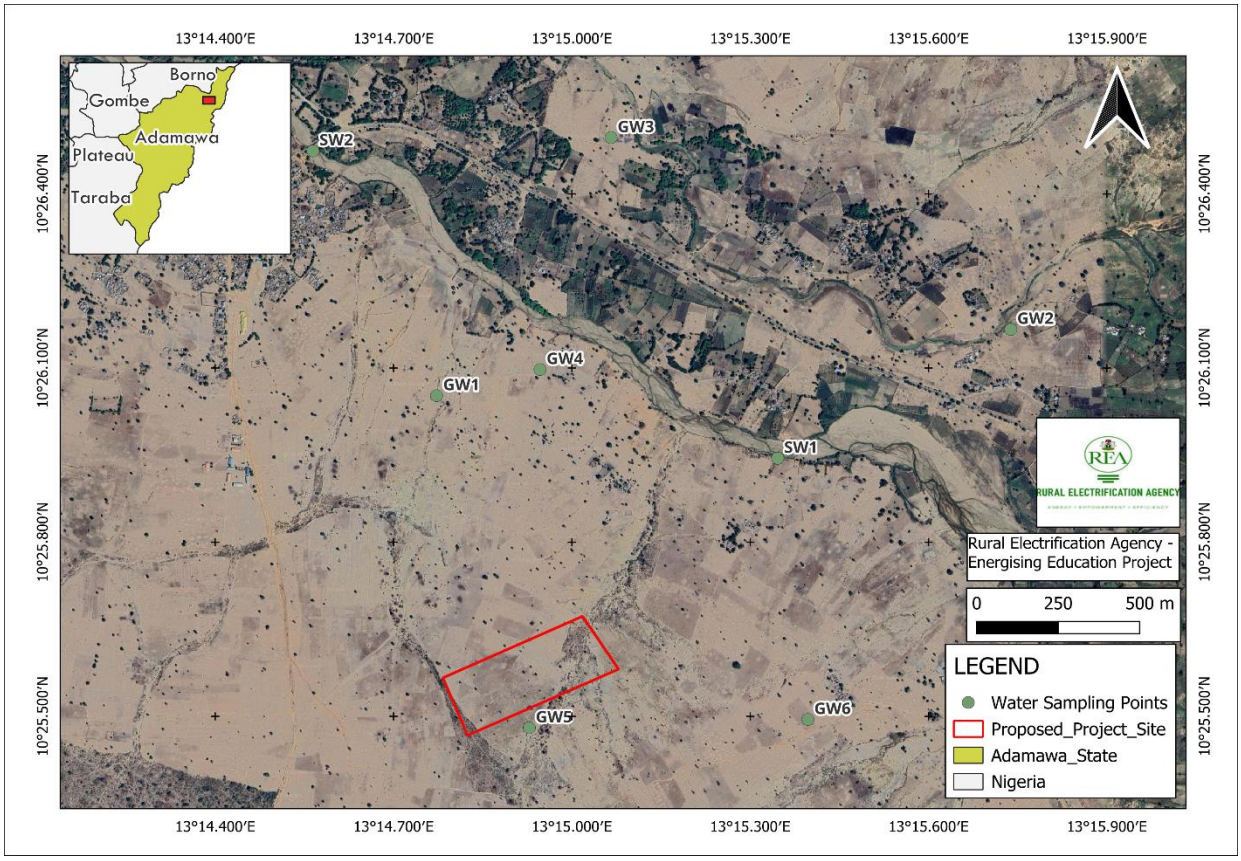

Figure 15: Water sampling Map

Quality Assurance and Control

Quality Assurance/ Quality Control (QA/QC) procedures covered all aspects of the study, including sample collection, handling, laboratory analyses, data coding and manipulation, statistical analyses, presentation and communication of results. The methods of analyses used in this study were those specified in Federal Ministry of Environment Guidelines, EGASPIN 2002 and other internationally accepted analytical procedures, in order to ensure the reliability and integrity of the data obtained.

Sample Collection and Handling

Sample collection and handling procedures to maintain the integrity of samples and enhance the quality of the results, were in accordance with Federal Ministry of Environment. Following procurement, all samples were immediately labelled indelibly, giving details of sampling point, location of sampling, date and time of sampling, name of personnel sampling, etc. To reduce sampling error, measurements were replicated and a number of spatially distributed samples were composited before sub sampling for analysis. The sample collection and handling procedures are summarized as follow:

- Standard field procedures and methods approved FMEnv were adopted.
- All sampling equipment was maintained in excellent condition, calibrated against international standards and adequate steps were taken to ensure that they function normally.
- Only new and thoroughly washed, rinsed and sterilized sampling containers were used.
- For heavy metal determination, sampling bottles were used and were rinsed with a solution of one-part nitric acid to four parts water, followed by copious amounts of distilled water. Water

samples for BOD_5 determination were collected in black oxygen bottles and kept away from light source.

- ❖ All parameters without holding time were measured *in situ* on the field.
- ❖ Samples for other parameters were preserved as soon as they were collected.
- ❖ All samples were safely packed and transported to the laboratory base

Sample contamination and deterioration were avoided by pre-sterilizing sampling tools and containers, pre-treating and preserving samples in transit in ice-cooled chest (<4^{o}C) to the laboratory and storing samples at that temperature in refrigerators pending subsequent analysis especially for attributes having short-holding time such as total hydrocarbon, heavy metals and microbiology.

Sample Preservation

Sample contamination and deterioration were avoided by pre-sterilizing sampling tools and containers, pre-treating and preserving samples in transit in ice-cooled chests to the laboratory and stored at that temperature in refrigerators pending subsequent analysis. All parameters with short holding time such as pH and temperature were measured *in situ* on the field, while samples for delayed analyses were preserved by refrigeration (for general water chemistry), pH adjustment or chemical pre-treatment (for heavy metals, Total Hydrocarbon, Dissolved oxygen). Dissolved oxygen samples were acidified to a pH 2 with concentrated H_2SO_4 and NHO_3 respectively and samples for microbiology were stored immediately in ice cooled chest (at 4^{o}C) in transit to the laboratory base where they were stored in refrigerators.

4.2.5 Socio-Economic Survey Methods

Socio-economic baseline information was obtained through a combination of community consultations, key informant interviews, field observations, and questionnaire surveys conducted within the project area and surrounding communities. The study employed a sequential mixed-methods research design, integrating both quantitative and qualitative approaches for data collection, analysis, and reporting.

The socio-economic survey was conducted between 27th and 29th January, 2026 within the project area and the nearby Mayo Bani community. Quantitative data were collected using structured questionnaires administered to selected respondents, while qualitative information was obtained through Key Informant Interviews (KII), Focus Group Discussions (FGDs), and stakeholder consultations with university representatives, community leaders, and other relevant stakeholders.

The assessment focused on gathering information on key socio-economic indicators including population characteristics and settlement patterns, livelihood activities and sources of income, access to education, healthcare and other basic services, existing infrastructure and community facilities, as well as community perceptions regarding development projects.

Information obtained from the various survey methods was triangulated to ensure reliability and to distinguish community perceptions from verifiable conditions within the project area. The results of the socio-economic assessment provided the basis for understanding the existing social conditions of the project environment and for evaluating potential project-related impacts on surrounding communities.

4.3 Physical Environment

4.3.1 Climate and Meteorology

The study area is located in the semi-arid climatic zone of Nigeria and characterized by two distinct seasons which are the hot dry season and a cool rainy season. Generally, Nigeria's climate is characterized by the dry and wet conditions associated with the movement of the Inter-Tropical

Convergence Zone (ITCZ) north and south of the equator. The Inter-Tropical Convergence Zone (ITCZ) appears as a band of clouds, usually thunderstorms that circle the globe near the equator and Nigeria is located just north of the equator. When the ITCZ is to the south of the equator, the north-east winds prevail producing the dry-season and whenever it moves into the Northern Hemisphere, the south westerly wind prevails to bring rainfall and the rainy (wet) season.

Air Temperature

Due to the latitudinal location of the region within the tropics, the temperature in the study area is generally high with mean monthly minimum and maximum ranges of 14.4ºC–23.6ºC and 29.5ºC – 37.3ºC respectively (Figure 16). Usually, the highest maximum temperature occurs in February and March, the peak of the dry season, while the lowest temperature occurs in August, the peak of the wet season.

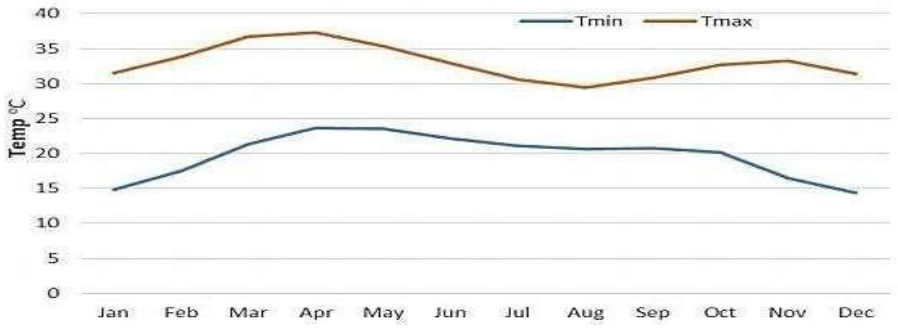

Figure 16: Monthly mean Temperature for Adamawa 1999 – 2021 (Source: NIMET, 2021)

Rainfall

The study area receives little or no rainfall from November to February, but significant rainfall from May onwards. The mean monthly rainfall (mm) for the period 1999 to 2021 (Figure 17), shows that August has the highest mean rainfall (624.7 mm), while from September, the average rainfall reduces. There was no rainfall during field due to the dry season period.

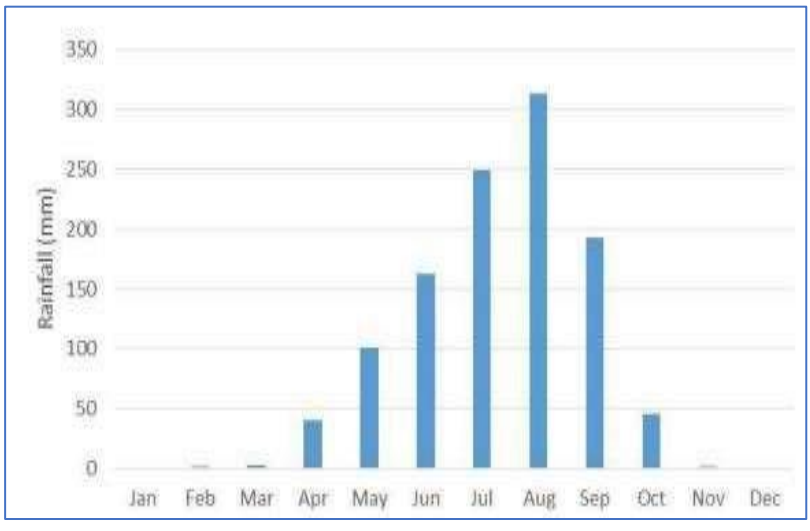

Figure 17: Monthly Average Rainfall for the Period of Twenty-five Years (*Source:* NiMET, 2021)

Sunshine

Data obtained from NiMET for Yola shows that the mean monthly sunshine period is between 4.8 hours to 7.6 hours per day (Figure 18). This is suitable for harnessing solar energy during day-time hours to generate electricity. Between July and October, the lowest sunshine period is recorded, while the

maximum period is in November. The shortest period is in July, when there is a greater amount of cloudiness and rainfall. In November, the sunshine periods are higher due to the prevalent clear skies when the ITCZ has started its northward migration. The duration reflects the double maxima feature of the rainfall pattern.

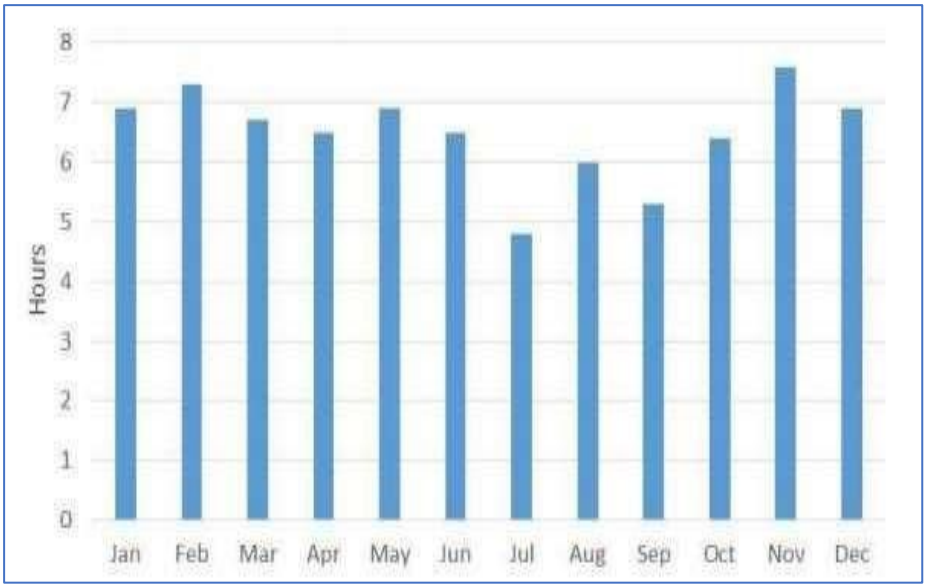

Figure 18: Mean sunshine hours in Adamawa 1999 – 2021 (Source: NiMet)

Geology of the Project Area

The project area is regionally concealed within Gongola basin of the upper Benue trough of Nigeria. The Benue Trough is a rift basin in central West Africa that extends NNESSW for about 800 km in length and 150 km in width. The trough contains up to 6000 m of Cretaceous–Tertiary sediments of which those pre-dating the mid-Santonian have been compressionally deformed, faulted, and uplifted in several places. Compressional folding during the mid-Santonian tectonic episode affected the whole of the Benue Trough and was quite intense, producing over 100 anticlines and synclines (Benkhelil, 1989). Following mid-santonian tectonism and magmatism, depositional axis in the Benue Trough was displaced westward resulting in subsidence of the Anambra Basin.

Topography and Land Use

The terrain across the project site is generally flat with gentle natural undulations, providing favourable conditions for the installation of ground-mounted solar infrastructure. However, field observations indicate the presence of localized surface erosion features, including shallow gullies and exposed sandy-silty soils, suggesting moderate susceptibility to erosion, particularly during rainfall events.
The project site is presently undeveloped and characterized as open land designated for future university expansion. No evidence of formal or informal land use such as farming, grazing, or established footpaths was observed within the project footprint. Similarly, no permanent or temporary structures were identified within the allocated site.

The current level of disturbance is low and primarily associated with natural processes, including weathering and erosion, as well as minimal human movement. There was no indication of significant prior land modification, excavation, waste disposal, or industrial activity within the site.

Figure 19: Evidence of Surface Erosion within the Proposed Project Site, FUAMB, Mubi

4.3.2 Soil Physico-Chemical Characteristics

The soil profile is predominantly silt-rich with varying proportions of loam, sand, and clay, indicating a generally silty to silty loam texture**.** Surface conditions appear moderately compacted and relatively stable under dry weather. Some early signs of developing surface erosion were observed within portions of the project footprint, likely associated with seasonal runoff acting on the exposed soils.

Analysis of Soil Sample Results

Physical Parameters

The physical characteristics of the soil were determined to understand the general soil condition and chemical environment of the project area. Parameters analyzed include soil colour, pH, electrical conductivity (EC), temperature, oxidation–reduction potential (ORP), and salinity, which provide information on soil reaction, ionic concentration, and general soil stability within the study area.

The soil pH across the sampling locations ranges from 5.83 to 6.99, indicating slightly acidic to near neutral soil conditions. These conditions are generally favourable for soil stability and do not indicate any chemical constraints that would affect civil works for the proposed solar installation. Electrical conductivity values range from 1557 µS/cm to 1741 µS/cm, while salinity values remain consistently low at approximately 0.07–0.08%, with a recorded lower value of 0.02%

These results indicate low salinity levels, suggesting that the soil environment is not saline and therefore unlikely to present corrosion risks to underground infrastructure or foundations. Soil temperatures recorded during sampling range between 30.0°C and 33.2°C, reflecting typical ambient conditions for the study area. Overall, the physical parameters indicate chemically stable soil conditions suitable for the proposed solar mini-grid infrastructure.

Exchangeable Cations

Exchangeable cations represent essential base elements present in the soil and influence soil fertility, structure, and chemical balance. The parameters analyzed under this category include calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), and ammonium (NH_4^{+}).

The concentrations of exchangeable cations show moderate variability across the sampling locations. Calcium concentrations range from 0.08 mg/kg to 0.74 mg/kg, while magnesium ranges between 0.01

mg/kg and 2.05 mg/kg. These values indicate the presence of essential base cations which contribute to soil structural stability.

Sodium concentrations range from 3 mg/kg to 42 mg/kg, with the control sample recording 56 mg/kg. Although sodium is present, the concentrations are not excessively high and therefore do not indicate sodic soil conditions that could lead to soil dispersion or structural instability. Potassium levels range from 0.1 mg/kg to 2.4 mg/kg, with a higher value of 10.7 mg/kg recorded in the control sample. Ammonium concentrations remain very low across all samples, ranging between 0.000 mg/kg and 0.051 mg/kg, with 0.066 mg/kg recorded in the control sample.

Overall, the exchangeable cation profile indicates low to moderate nutrient presence with no evidence of chemical imbalance or contamination, suggesting that the soil environment is stable and suitable for construction activities associated with the project.

Exchangeable Anions

Exchangeable anions were analyzed to determine the presence of soluble nutrient ions and possible chemical accumulation within the soil environment. The parameters assessed include sulphate (SO_4^{2-}), phosphate (PO_4^{2-}), nitrate (NO_3^-), and chloride (Cl^-).

Sulphate concentrations across the sampling locations range between 27 mg/kg and 61 mg/kg, with the control sample recording 12 mg/kg. Phosphate levels are generally low, ranging from 0.0 mg/kg to 1.7 mg/kg, while nitrate concentrations range between 5.6 mg/kg and 33.6 mg/kg, with the control value recorded at 4.0 mg/kg. Chloride concentrations vary from 3.1 mg/kg to 34.4 mg/kg, with the highest value recorded at Point 4.

These concentrations indicate low nutrient enrichment and absence of significant chemical accumulation, suggesting that the soil has not been impacted by industrial or agricultural contamination. For the proposed solar installation, these conditions indicate minimal risk of chemical corrosion or soil-related environmental constraints.

Organic Matters

Organic parameters were analyzed to determine the presence of organic compounds and potential hydrocarbon contamination within the soil. The parameters evaluated include phenols, calcium carbonate, oil and grease**.**

Phenol concentrations are generally absent or extremely low, ranging from 0.000 mg/kg to 0.053 mg/kg, with 0.201 mg/kg recorded in the control sample. These values indicate no significant organic contamination within the project footprint. Calcium carbonate concentrations range from 33 mg/kg to 202 mg/kg, reflecting natural mineral presence within the soil. Oil and grease were not detected in any of the samples (0 mg/kg).

This confirms that the soil environment is free from hydrocarbon contamination, indicating that the site has not been previously subjected to petroleum-related activities. For the proposed project, the absence of hydrocarbon contamination indicates low environmental risk during site preparation and excavation activities.

Heavy Metals

Heavy metals were analyzed to determine the presence of potentially toxic metallic elements within the soil environment that may indicate contamination. The parameters assessed include iron (Fe), copper (Cu), chromium (Cr), zinc (Zn), cobalt (Co), nickel (Ni), mercury (Hg), and lead (Pb).

The heavy metal concentrations recorded in the soil samples are generally very low. Iron concentrations range between 0.006 mg/kg and 1.347 mg/kg, while copper ranges from 0.03 mg/kg to 1.02 mg/kg. Zinc concentrations range between 0.05 mg/kg and 0.43 mg/kg. Chromium, cobalt, and mercury were not detected in any of the samples, while nickel was recorded only at very low concentrations ranging from 0.000 mg/kg to 0.010 mg/kg. Lead was also not detected in most samples, with only 0.006 µg/kg recorded in Point 5. These results indicate very low heavy metal presence and no evidence of metal contamination, confirming that the soil environment is within acceptable environmental quality levels for infrastructure development.

Soil Texture Characteristics

The soil texture analysis indicates that silt is the dominant soil fraction across most sampling locations, with values ranging from 17% to 73%. Loam content ranges between 3% and 42%, sand between 1% and 37%, while clay ranges from 0% to 49% across the sampling points. This distribution indicates that the soils within the project area are generally silty to silty-loam in texture.

Soils with relatively high silt content may be susceptible to surface erosion when exposed, particularly in areas with sparse vegetation and seasonal rainfall. This observation is consistent with the developing surface erosion observed within portions of the project footprint during field investigations. For the proposed project, appropriate site preparation, drainage management, and erosion control measures should be implemented during construction to minimize potential soil displacement.

Microbiological Parameters

Microbiological analysis was conducted to assess the presence of microbial organisms within the soil environment. The parameters evaluated include Escherichia coli (E. coli) and fungal counts**,** which indicate microbial activity within the soil.

Microbiological analysis shows the presence of E. coli concentrations ranging from 0 to 10 cfu/ml across the samples. Fungal counts range between 77 cfu/ml and 251 cfu/ml. These results reflect natural microbial activity typical of surface soils and do not indicate any abnormal contamination.

4.3.3 Water Quality Assessment

Water quality assessment was conducted to establish the baseline condition of water resources within the project area prior to project implementation. The samples were analyzed for selected physicochemical, chemical, and microbiological parameters to determine the existing water quality conditions within the study area.

Analysis of Water Sample Results

Physicochemical Characteristics

The physicochemical characteristics of the sampled water sources show generally acceptable baseline conditions within the study area.

The pH values range from 5.93 to 6.82 across all sampling locations, which falls within or close to the FME recommended range of 6.5–8.5. Slightly lower values such as 5.93 (WTS V) and 6.05 (WTS VIII – pond) indicate mildly acidic conditions but do not represent significant water quality concerns.

The surface water sources recorded higher turbidity values of 14 NTU (irrigation stream) and 38 NTU (Mayo Boni pond) compared with the FME limit of 50 NTU. The elevated turbidity in surface water reflects the presence of suspended particles typical of natural surface water bodies.

Total Dissolved Solids (TDS) range between 49 mg/L and 215 mg/L, well below the FME limit of 500 mg/L, indicating low dissolved mineral content. Electrical conductivity values range from 100 µS/cm (irrigation stream) to 442 µS/cm (community borehole), which are below the FME limit of 1000 µS/cm and reflect moderate ionic concentrations.

Overall, the physicochemical characteristics indicate that the groundwater sources exhibit good baseline quality, while the surface waters show slightly higher turbidity consistent with natural environmental conditions. For the proposed project, these conditions indicate no existing water quality stress within the project environment. However, erosion control and sediment management during construction should be implemented to prevent sediment runoff into nearby surface water bodies.

Chemical Characteristics

The concentrations of major ions in the sampled water sources are generally low and within acceptable limits. Ammonium concentrations vary from 0.0004 mg/L to 0.9371 mg/L, with the highest values recorded in WTS VIII (0.9371 mg/L) and WTS VII (0.8662 mg/L) representing the surface water sources. Calcium levels range between 0.06 mg/L and 3.19 mg/L, significantly lower than the FME limit of 200 mg/L, indicating low mineral hardness contribution. Nitrate concentrations vary from 0.4 mg/L to 37.5 mg/L, with the highest value recorded in the Mayo Boni pond (37.5 mg/L) but still below the FME limit of 50 mg/L.

Overall, the chemical characteristics indicate low mineral and nutrient concentrations, suggesting minimal anthropogenic contamination within the study area. The results indicate no chemical limitations for groundwater abstraction or local water use during construction activities.

Heavy Metals

Heavy metal concentrations in the sampled water sources are generally low; however, a few parameters such as iron and copper which exceeded the FME guideline values. Iron concentrations range from 0.046 mg/L to 1.24 mg/L, with the highest value recorded in WTS VIII (Mayo Boni pond) exceeding the FME limit of 0.3 mg/L. Copper concentrations range from 0.14 mg/L to 1.55 mg/L, with the highest value in WTS VIII (1.55 mg/L) slightly exceeding the FME limit of 1.5 mg/L. These elevated heavy metal concentrations may be associated with natural geologic sources or localized environmental inputs. For the proposed project, it is recommended that surface water sources should not be relied upon for potable use without treatment, and groundwater used for construction activities should be periodically monitored for metal concentrations.

Organic Parameters

Organic compounds were generally not detected in the sampled water sources which suggest that the project area has not been impacted by petroleum-related contamination.

Microbiological Characteristics

Microbiological analysis indicates no E. coli contamination in groundwater samples, with values recorded as 0 cfu/ml. However, E. coli was detected in surface water sources, with 7 cfu/ml recorded in the irrigation stream and 13 cfu/ml in the Mayo Boni pond. Similarly, faecal coliform was recorded at 2 cfu/ml in the irrigation stream and 4 cfu/ml in the pond, while total coliform levels reached 15 cfu/ml and 28 cfu/ml respectively. These results indicate microbial contamination typical of open surface water bodies influenced by environmental and human activities. For the proposed project, groundwater sources appear microbiologically safer for potential water use, while surface waters should not be used for potable purposes without adequate treatment.

Environmental Safeguard Consideration

The water analysis results therefore establish the existing environmental condition of water resources within the project area, which should be maintained during the construction and operational phases of the proposed project. Project activities such as site clearing, earthworks, material storage, and equipment maintenance should be properly managed to prevent contamination of nearby groundwater and surface water sources.

Other appropriate measures including erosion control, proper drainage management, prevention of fuel or chemical spills, and routine monitoring of nearby water sources should be implemented to ensure that project activities do not adversely alter the existing water quality conditions but rather sustain the environmental integrity of the area.

4.3.4 Air Quality and Noise Measurement

Ambient air quality measurements across the monitoring locations indicate generally good air quality conditions within the project area. Concentrations of Nitrogen (IV) Oxide (NO_2) range between 0.0 ppm and 0.2 ppm, while Sulphur (IV) Oxide (SO_2) was not detected in the sampled locations (0.00 ppm), except in the control value of 0.10 ppm. Carbon monoxide (CO) was not detected in most locations, with only 1 ppm recorded at AQ10, indicating minimal combustion-related emissions within the study area. Carbon dioxide (CO_2) concentrations range from 311 ppm to 376 ppm, reflecting normal atmospheric background levels. Particulate matter concentrations show PM2.5 values ranging from 120 µg/m³ to 140 µg/m³, while PM10 concentrations range from 144 µg/m³ to 184 µg/m³ across the sampling points. These levels exceed the ambient limit of 25 µg/m³ for PM2.5 and 150 µg/m³ for PM10. However, these exceedances are attributable to the combined influence of prevailing dry season harmattan dust conditions typical of the project area and fugitive dust emissions from ongoing civil construction activities at the FUAMB permanent campus at the time of measurement.

Other gaseous pollutants such as ammonia, hydrogen cyanide, hydrogen sulphide, methane, and phosphine were not detected during the monitoring exercise. Total Volatile Organic Compounds (TVOC) remain low, ranging from 0.011 mg/m³ to 0.019 mg/m³, while formaldehyde (HCOH) concentrations range between 0.001 mg/m³ and 0.006 mg/m³.

The Air Quality Index (AQI) for all monitoring points was classified as “Excellent”, indicating that ambient air quality within the project area is currently in a good environmental condition.

Ambient noise levels recorded across the monitoring locations range from 51.4 dB to 60.4 dB, reflecting relatively low background noise typical of institutional and semi-rural environments.

Overall, the baseline results indicate that the project environment currently maintains good air quality and relatively low ambient noise levels. During project implementation, activities such as site clearing, equipment operation, and vehicular movement should be properly managed to prevent deterioration of the existing air quality and noise conditions. Measures including dust suppression, proper equipment maintenance, and controlled construction scheduling should be implemented to maintain the existing environmental quality of the area.

Table 6: Results of Soil Sampling

S/N	Parameters	Unit	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Control 11
a)	**Coordinates**												
1	Latitude	N	10.42456	10.41691	10.41699	10.41781	10.41911	10.42192	10.42461	10.41861	10.42622	10.42631	10.41941
2	Longitude	E	13.24702	13.24703	13.23711	13.23791	13.24772	13.24112	13.24113	13.23161	13.23192	13.24622	13.24623
3	Elevation	M	-	-	-	-	-	-	-	-	-	-	-
b)	**Physical Test**												
4	Colour	TCU	Grayish Ash	Reddish Brown	Grayish Black	Brown	Reddish	Pale Brown	Grayish Black	Very Pale Brown	Dark Brown	Brown	Pale Brown
5	pH	-	5.83	6.83	6.37	5.98	6.49	6.24	6.56	6.02	5.95	6.99	6.08
6	Electrical Conductivity	µs/cm	1603	1557	1654	1666	1597	1688	1597	1620	1589	1741	1684
7	Temperature	^{0}C	31.8	31.9	30.0	32.8	30.0	31.0	32.3	31.9	31.5	32.3	33.2
8	ORP	MV	248	193	227	239	231	23	214	245	202	266	195
9	Salinity	%	0.08	0.07	0.08	0.08	0.08	0.08	0.07	0.08	0.08	0.02	0.08
c)	**Exchangeable Cation**												
10	Calcium (Ca^{2+})	mg/kg	0.11	0.46	0.08	0.34	0.19	0.36	0.29	0.18	0.74	0.55	0.12
11	Magnesium (mg^{2+})	mg/kg	0.29	0.54	0.17	0.48	0.47	0.30	0.01	0.27	0.05	0.73	2.05
12	Sodium (Na^{+})	mg/kg	42	18	11	3	15	37	23	36	9	21	56
13	Potassium (K^{+})	mg/kg	0.8	0.1	0.1	0.7	1.2	0.6	1.7	1.2	2.4	0.5	10.7
14	Ammonium (NH_4^{+})	mg/kg	0.006	0.013	0.000	0.000	0.011	0.034	0.019	0.043	0.022	0.051	0.066
d)	**Exchangeable Anion**												
15	Sulphate (SO_4^{2+})	mg/kg	61	37	30	28	54	61	55	27	43	51	12
16	Phosphate (PO_4^{2-})	mg/kg	0.1	0.0	0.3	0.6	0.1	0.2	1.7	0.3	0.5	1.3	0.7
17	Nitrate (NO_3^{2-})	mg/kg	21.0	33.6	14.7	20.7	16.3	21.9	13.3	5.6	11.0	9.7	4.0
18	Chloride (Cl^{-})	mg/kg	4.6	4.2	9.9	34.4	5.6	4.1	19.6	18.2	4.2	3.1	15.6
	Organics												
19	Phenols	mg/kg	0.000	0.000	0.017	0.000	0.000	0.003	0.016	0.011	0.053	0.000	0.201
20	Calcium Carbon	mg/kg	137	113	105	65	102	202	94	54	33	135	102
21	Oil & Grease	mg/kg	0	0	0	0	0	0	0	0	0	0	0
f)	**Heavy Metals**												
22	Iron	mg/kg	1.347	0.741	0.336	0.071	0.044	0.051	0.113	0.035	0.371	0.006	0.001
23	Cupper	mg/kg	0.05	0.06	0.09	1.02	0.36	0.18	0.04	0.17	0.08	0.12	0.03
24	Chromium	mg/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	Zinc	mg/kg	0.43	0.05	0.11	0.24	0.07	0.16	0.09	0.13	0.26	0.18	0.05
26	Cobalt	mg/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	Nickel	mg/kg	0.000	0.004	0.004	0.000	0.004	0.003	0.001	0.006	0.010	0.000	0.006

28	Mercury	µg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	Lead	µg/kg	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.000
g)	**Soil Characteristic**												
30	Loam	%	23	19	12	30	22	13	11	12	9	3	42
31	Sandy	%	9	8	37	1	7	5	4	21	14	14	30
32	Clay	%	3	0	25	16	21	49	19	16	24	18	11
33	Silt	%	65	73	26	53	50	33	66	51	53	65	17
h)	**Microbiological Test**												
34	E. Coli	Cfu/ml	3	2	0	5	7	3	2	2	5	10	6
35	Fungal	Cfu/ml	109	154	77	109	143	206	79	105	194	251	136

Table 7: Results of Water Sampling

S/N	Parameters	Unit	WTS I Faculty of Sci.	WTS II Admin Block	WTS III Police Station	WTS IV GDSS	WTS V Comm. Mosque	WTS VI Comm. Borehole	WTS VII Irrigation Stream	WTS VIII Mayo Boni Pond	FMENT Limit
	Coordinates										
1	Latitude	N	10.43421	10.43611	10.44162	10.43496	10.42467	10.42491	10.49492	10.51431	-
2	Longitude	E	13.24621	13.26231	13.25110	13.24911	13.24881	13.25662	13.30123	13.21623	-
3	Altitude	M	-	-	-	-	-	-	-	-	-
a)	**Physicochemical Test**										
4	Colour	TCU	Clear	Clear	Clear	Clear	Clear	Clear	Pale Brownish	Brownish	Clear
5	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Unobjectionable
6	Taste	-	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Unobjectionable
7	Turbidity	NTU	0	0	0	3	0	0	14	38	50
8	pH	-	6.82	6.81	6.13	6.37	5.93	6.81	6.43	6.05	6.5 – 8.5
9	Temperature	^{0}C	29.2	29.3	28.4	29.0	29.0	29.3	29.3	29.1	Ambient
10	Dissolve Oxygen	mg/L	4.6	4.2	4.5	3.8	3.5	2.8	2.5	2.9	2 – 8
11	Total Dissolve Solid	mg/L	207	213	93	85	106	215	49	95	500
12	Electrical Conductivity	µs/cm	416	420	190	172	213	442	100	190	1000
13	Total Suspended solid	mg/L	2	1	0	0	5	2	3	11	20
14	Salinity	mg/L	0.02	0.02	0.00	0.00	0.01	0.02	0.00	0.00	<1000
15	ORP (MV)	(MV)	123	98	125	154	101	109	89	123	200-600
16	B.O.D	mg/L	0.8	1.0	0.7	0.5	0.9	0.8	1.7	2.0	NS

17	Total Hardness	mg/L	24.6	23.4	34.1	46.1	42.1	47.5	27.1	27.5	-
18	Total Suspend Solid	mg/L	0	0	0	5	6	0	19	55	-
19	Dissolve Oxygen	mg/L	3.6	4.1	4.0	3.8	3.7	4.1	3.5	3.0	-
b)	**Chemical Test**										
20	Ammonium (NH_4^+)	mg/L	0.0004	0.0030	0.0010	0.8492	0.0052	0.0031	0.8662	0.9371	NS
21	Potassium (K^+)	mg/L	0.3	0.1	0.6	0.7	0.4	0.1	1.0	2.8	20
22	Calcium (Ca^{2+})	mg/L	0.13	0.10	0.17	0.71	0.32	0.06	1.29	3.19	200
23	Sodium (Na^+)	mg/L	5	8	3	14	6	3	0	0	20
24	Magnesium (mg^{2+})	mg/L	0.03	0.02	0.05	0.30	0.12	0.02	0.45	1.35	20
25	Sulphate (SO_4^{2+})	mg/L	5	0	3	10	5	1	13	30	100
26	Nitrate (NO_3^{2-})	mg/L	1.4	0.4	1.9	5.9	2.9	1.3	10.5	37.5	50
27	Chloride (Cl^-)	mg/L	0.0	0.00	0.1	2.1	0.5	0.0	3.9	17.3	150
28	Phosphate (PO_4^{2-})	mg/L	0.80	0.38	2.19	1.32	0.89	0.41	0.93	2.92	NS
29	Nitrite (NO_2^-)	mg/L	0.002	0.003	0.002	0.029	0.012	0.000	0.044	0.112	0.2
c)	**Heavy Metal**										
30	Zinc (Zn^{2+})	mg/L	0.19	0.17	0.27	0.29	0.27	0.17	0.30	0.48	3.0
31	Iron (Fe^{2+})	mg/L	0.153	0.046	0.152	0.400	0.252	0.139	0.546	1.24	0.3
32	Copper (Cu^{2+})	mg/L	0.24	0.14	0.30	0.56	0.41	0.18	0.65	1.55	1.5
33	Chromium (Cr^{3+})	mg/L	0.01	0.01	0.014	0.02	0.016	0.03	0.05	0.01	0.05
34	Lead (Pb^{2+})	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01
35	Cobalt (CO^{2+})	mg/L	0.02	0.09	0.08	0.02	0.04	0.01	0.05	0.10	0.2
36	Mercury (Hg^+)	µg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	Nickel (Ni^{2+})	mg/L	0.001	0.001	0.006	0.007	0.100	0.002	0.018	0.015	0.070
d)	**Organics**										
38	Oil and Grease	mg/L	0	0	0	0	0	0	0	0	10
39	Benzene	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
40	Toluene	mg/L	0	0	0	0	0	0	0	0	0.7
41	Ethylbenzene	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.30
42	Xylene	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
43	Phenols	mg/L	0.000	0.008	0.002	0.000	0.000	0.000	0.000	0.000	0.05
e)	**Microbiological Test**										
44	E. Coli	Cfu/ml	0	0	0	0	0	0	7	13	Nil
45	Feacal Coliform	Cfu/ml	0	0	0	1	0	0	2	4	Nil
46	Total Coliform	Cfu/ml	0	0	0	2	0	0	15	28	10

Table 8: Air Quality and Noise Measurements

S/N	Parameters	Unit	AQ_1	AQ_2	AQ_3	AQ_4	AQ_5	AQ_6	AQ_7	AQ_8	AQ_9	AQ_{10}	AQ_{11}	AQ_{12}	$AQ_{Control}$	FMEnv Limit
1	Latitude	N	10.42456	10.41691	10.41699	10.41781	10.41911	10.42192	10.42461	10.41861	10.42622	10.42631	10.41941	10.42955	10.42951	
2	Longitude	E	13.24702	13.24703	13.23711	13.23791	13.24772	13.24112	13.24113	13.23161	13.23192	13.24622	13.24623	13.24511	13.24512	
3	Nitrogen (iv) Oxide	ppm	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.3	0.4
4	Sulphur (iv) Oxide	ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.02
5	Carbon (ii) Oxide	ppm	0	0	0	0	0	0	0	0	0	1	0	0	0	10
6	Carbon (iv) Oxide	ppm	371	371	371	376	371	369	355	341	341	331	311	361	316	-
7	EX	% /e/	0	0	0	0	0	0	0	0	0	0	0	0	0	-
8	Ammonia Gas	ppm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02
9	Hydrogen Cyanide	ppm	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01
10	Hydrogen Sulphite	ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
11	Chlorine gas	ppm	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.02
12	Methane gas	ppm	0	0	0	0	0	0	0	0	0	0	0	0	0	-
13	Phosphine gas	ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
14	$PM_{2.5}$	$\mu g/m^3$	139	133	124	120	131	140	125	132	132	133	136	132	121	25
15	PM_{10}	$\mu g/m^3$	158	160	153	156	160	184	159	144	150	149	150	153	148	150
16	$PM_{1.0}$	$\mu g/m^3$	82	82	74	71	81	82	74	80	81	82	83	81	72	-
17	TVOC	mg/m^3	0.019	0.019	0.018	0.011	0.011	0.018	0.011	0.019	0.011	0.017	0.018	0.019	0.016	-
18	HCOH	mg/m^3	0.003	0.003	0.006	0.001	0.001	0.006	0.001	0.001	0.003	0.001	0.004	0.006	0.001	-
19	Temperature	^OC	32.3	32.1	32.6	32.4	32.4	32.6	32.5	32.5	32.3	32.5	32.5	32.2	32.2	-
20	R/Humidity	%	29.2	29.3	29.6	29.2	29.2	29.3	29.4	29.6	29.2	29.3	29.2	28.4	28.6	-
21	Ozone	Ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
22	A Q	-	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	
23	**Sound Level**	**dB**	**53.1**	**54.3**	**51.4**	**51.6**	**53.6**	**58.2**	**55.6**	**60.4**	**59.4**	**55.2**	**53.6**	**51.8**	**52.6**	**85**

4.4 Biological Environment

The biological environment assessment was conducted through systematic transect walks within and around the project footprint, covering the defined Area of Influence. Field observations were recorded at designated observation points along each transect, with species identified through direct sighting, physical evidence such as tracks and burrows, and auditory identification for bird species. Flora species were identified using morphological characteristics and cross-referenced against standard botanical references for the Sudan Savannah ecological zone. Fauna occurrence was assessed through direct observation and habitat suitability assessment. The determination of critical habitat status was made by screening identified species and habitat types against the IUCN Red List of Threatened Species, the IUCN Habitat Classification Scheme, and the AfDB Integrated Safeguards System critical habitat screening criteria. No species of conservation concern and no habitat features meeting the threshold for critical habitat designation were identified through either field observation or technical reference screening.

Vegetation

Vegetation within the project footprint is sparse and characteristic of the Sudan Savannah ecological zone, consisting mainly of low grasses, scattered shrubs, and occasional small trees. Dominant ground vegetation observed during the site inspection includes common savannah grasses such as *Andropogon gayanus* and *Hyparrhenia rufa*, interspersed with shrubs such as *Calotropis procera* and *Sida acuta*. Occasional small trees typical of the savannah landscape, including *Azadirachta indica* (Neem) and *Parkia clappertonia* (African locust bean), were observed in the surrounding areas. However, No protected plant species, economic plantations, or areas of ecological conservation significance were identified within the project footprint during the site inspection.

Figure 20: The Project Site Showing Surrounding Land Cover and Vegetation Conditions

Beyond the immediate project footprint, the broader Area of Influence (AoI) and surrounding landscape exhibits similar Sudan Savannah vegetation characteristics, though with relatively higher vegetation density in some sections. Vegetation in these surrounding areas consists of a mosaic of savannah grasses, shrubs, and scattered medium-sized trees, including species such as *Faidherbia albida*, *Acacia senegal*, *Ziziphus mauritiana*, and *Adansonia digitata*. These vegetation types are typical of the natural savannah ecosystem in the Mubi area and are generally adapted to seasonal rainfall patterns and dry climatic conditions.

The vegetation and land cover within the project area of influence provide limited ecosystem services, primarily the supply of fuel wood and livestock fodder.

Fauna

The fauna within the project footprint and surrounding area is typical of disturbed savannah environments influenced by human activities. No endangered species, critical habitats, migratory corridors, or wildlife breeding grounds were identified within the project footprint during the field survey. Consequently, the proposed project is not expected to significantly affect wildlife populations, provided that construction activities are properly managed to minimize unnecessary disturbance to local fauna. Below are highlights of identified faunas.

Mammals

Wildlife occurrence within the immediate project area is relatively limited due to the open savannah landscape and the presence of human activities within the university environment. During field observations, only small and adaptable mammal species typical of savannah environments were considered likely to occur within the broader area.

Such species include small rodents such as grasscutters (*Thryonomys swinderianus*), rats (*Rattus rattus*), squirrels (*Xerus erythropus*), and mice species. Domestic animals such as cattle (*Bos taurus*), goats (*Capra aegagrus hircus*), and occasionally sheep are also commonly observed within surrounding communities and grazing areas.

Reptiles

Reptiles commonly associated with savannah environments are expected to occur within the broader area of influence. These include monitor lizards (*Varanus albigularis*), agamas (*Agama agama*), and various snake species such as puff adder (*Bitis arietans*), African rock python (*Python sebae*), and African bush snake (*Philothamnus irregularis*). These reptiles typically inhabit open grasslands, shrubs, and rocky areas where they utilize vegetation cover and soil crevices for shelter.

Insects

A wide variety of insects typical of savannah ecosystems are also present in the area. Common insect groups observed or expected within the project area include ants (*Formicidae*), termites (*Termitidae*), grasshoppers (*Caelifera*), dragonflies (*Anisoptera*), mantises (*Sphodromantis viridis*), bees (*Anthophila*), wasps (*Polistes spp.*), and various spider species including tarantulas (*Hysterocrates spp.*). These organisms play important ecological roles in pollination, decomposition, and nutrient cycling within the ecosystem.

Amphibians

Amphibian species expected in the broader project area are typically associated with seasonal water bodies and moist environments during the rainy season. Species likely to occur include African toads (*Amietophrynus spp.*) and grass frogs such as *Ptychadena spp.*. These species are generally abundant during wet seasons when temporary pools and wetlands form within the savannah landscape.

Birds

Bird species are among the most visible fauna within the savannah ecosystem of the study area. Common bird species observed or expected include Village Weaver (*Ploceus cucullatus*), Red-eyed Dove (*Streptopelia semitorquata*), Cattle Egret (*Bubulcus ibis*), Helmeted Guinea Fowl (*Numida meleagris*), and various passerine birds such as finches and shrikes.

Table 9 below presents a summary of identified flora and fauna species within the project Area of Influence, including their economic uses and IUCN conservation status. All species recorded are of Least Concern or Not Evaluated status, confirming the absence of threatened, near-threatened, or endemic species within the Area of Influence.

Table 9: Identified Flora and Fauna Species, Economic Uses and IUCN Status

Group	Common Name	Scientific Name	Economic Use	IUCN Status
Flora	Sudan Savannah Grass	*Andropogon gayanus*	Livestock fodder, thatching material	Least Concern
	Guinea Grass	*Hyparrhenia rufa*	Livestock fodder, erosion control	Least Concern
	Sodom Apple	*Calotropis procera*	Traditional medicine, fibre	Least Concern
	Devil's Horsewhip	*Sida acuta*	Traditional medicine, fuelwood	Least Concern
	Neem	*Azadirachta indica*	Medicinal, timber, biopesticide	Least Concern
	African Locust Bean	*Parkia biglobosa*	Food, condiment, timber, fodder	Least Concern
	Winter Thorn	*Faidherbia albida*	Fodder, soil nitrogen fixation, timber	Least Concern
	Gum Arabic Tree	*Acacia senegal*	Gum arabic production, fodder, fuelwood	Least Concern
	Jujube	*Ziziphus mauritiana*	Edible fruit, fodder, timber, medicine	Least Concern
	Baobab	*Adansonia digitata*	Food, medicine, fibre, water storage	Least Concern
Mammals	Grasscutter	*Thryonomys swinderianus*	Bushmeat, income source	Least Concern
	Black Rat	*Rattus rattus*	None of significance	Least Concern
	African Ground Squirrel	*Xerus erythropus*	Bushmeat	Least Concern
	Cattle	*Bos taurus*	Livestock, draught power, income	Not Evaluated
	Domestic Goat	*Capra aegagrus hircus*	Livestock, income, meat	Not Evaluated
Reptiles	Rock Monitor Lizard	*Varanus albigularis*	Traditional medicine, bushmeat	Least Concern
	Red-headed Agama	*Agama agama*	None of significance	Least Concern
	Puff Adder	*Bitis arietans*	Traditional medicine	Least Concern
	African Rock Python	*Python sebae*	Traditional medicine, skin trade	Least Concern
	African Bush Snake	*Philothamnus irregularis*	None of significance	Least Concern
Insects	Termites	*Termitidae spp.*	Soil aeration, decomposition	Not Evaluated
	Grasshoppers	*Caelifera spp.*	Food source in some communities	Not Evaluated
	Bees	*Anthophila spp.*	Pollination, honey production	Not Evaluated
	Tarantula	*Hysterocrates spp.*	None of significance	Not Evaluated
Amphibians	African Toad	*Amietophrynus spp.*	Pest control, ecological indicator	Least Concern
	Grass Frog	*Ptychadena spp.*	Ecological indicator	Least Concern
Birds	Village Weaver	*Ploceus cucullatus*	Aesthetic, ecological indicator	Least Concern

	Red-eyed Dove	*Streptopelia semitorquata*	Aesthetic, bushmeat	Least Concern
	Cattle Egret	*Bubulcus ibis*	Pest control, ecological indicator	Least Concern
	Helmeted Guinea Fowl	*Numida meleagris*	Bushmeat, income	Least Concern

4.5 Socio-Economic Assessment

This section covers the socio-economic and health assessment of the identified community within the project's area of influence. The assessment provides a description of existing conditions which is essential to the identification of the potential impacts of the proposed project. The socioeconomic environment around the project area is shaped by the presence of the Federal University of Agriculture, Mubi and the adjoining Mayo Bani community. Other key community facilities within the broader environment include schools, a local market, and a police station.

Target Population for the Study and Sample Size

The target populations and stakeholders for this study are Mayo Bani community members above the age of 18 years, community leaders, healthcare practitioners, youths, and women. The study employed a sequential mixed methods research design, combining structured questionnaires for quantitative data gathering with Focus Group Discussions, Key Informant Interviews, and stakeholder consultations for qualitative data gathering. A total of three (3) FGDs were conducted comprising 2 male groups covering elderly men and youths, and 1 female group, with each FGD including a minimum of 15 and a maximum of 52 participants. Different categories of respondents including youths, adults, males, females, people living with disabilities, and educated and non-educated persons were included in each session.

Specific population figures for the Mayo Bani community are not available in recent official publications. However, Mubi North LGA, within which Mayo Bani is located, had an estimated population of approximately 244,800 by 2025. Given the relatively small size of the Mayo Bani community, a sample size of 100 respondents was determined using the Cochran Formula at a 95% confidence level and a 5% margin of error, with a 10% non-response rate adjustment. Respondents were selected using a systematic sampling technique to ensure fair representation across gender, age, and community categories.

It is important to note that at the time of the field survey, the Federal University of Agriculture, Mubi was operating from its temporary campus located approximately 10 km from the proposed project site. Consequently, students and most academic staff were not physically present within the immediate project environment during the survey period. The socio-economic survey therefore focused primarily on the host community and other stakeholders within the project's immediate area of influence, while consultations with university management provided institutional perspectives regarding the anticipated benefits and implications of the proposed solar hybrid mini-grid project.

Ethical Considerations

All interviews were undertaken with the informed written consent of participants. Confidentiality and anonymity were maintained through secure storage of data in password protected computers and under lock and key. Participation was voluntary and respondents were allowed to withdraw at any point they feel uncomfortable to continue with the study.

Socio-Economic Characteristics of Respondents

Gender Distribution

During the questionnaire administration, 72% of the respondents were males while 28 % were females. It was observed that there is a smooth relationship between the genders and no socio-cultural belief affecting their interaction and relationship.

Age Distribution

Analysis of the baseline data shows the age distribution among the gender; 70% of respondents within the age group of 18-50 years, while 30% of the respondents are from age 50-70 years.

Marital Status

Findings from the survey indicate that:

- 57% of respondents are single
- 41% are married
- 2% are divorced

The relatively high proportion of single respondents may reflect the youthful demographic structure of the community. However, marriage remains an important social institution in the area, consistent with broader socio-cultural practices in Adamawa State, particularly within rural communities of Mubi North LGA.

Educational Profile

Education levels within Mayo Bani community are generally low. Findings from the field survey showed that only 2% of respondents possess a National Certificate in Education (NCE) or its equivalent. About 15% have attained primary education, while 10% completed secondary education.

This implies that over 70% of the respondents have either no formal education or did not complete basic education, indicating limited access to educational opportunities and a generally low literacy level within the community.

The low educational attainment may be attributed to several factors common in rural parts of Mubi North LGA, including;

- Economic constraints
- Early marriage practices
- Limited access to higher educational institutions within immediate reach

The generally low literacy level has implications for employment opportunities, income generation capacity, and the ability of residents to fully engage in technical or skilled employment sectors. It also suggests the need for simplified communication strategies during project implementation to ensure effective stakeholder engagement.

Economic Engagement / Occupation

Economic activities in Mayo Bani community are predominantly informal and self-driven. The survey revealed that:

i. 52.5% of respondents are self-employed, primarily engaged in petty trading, small-scale retail businesses, artisanship (such as tailoring, carpentry, and welding), motorcycle transport services (commercial bike riding), barbing salons, and small household-based enterprises.
ii. 6% of respondents are farmers, mostly subsistence farmers cultivating crops such as maize, beans, sorghum, and groundnuts.
iii. 22.5% are students, many of whom combine schooling with minor economic activities.
iv. 5% are unemployed but actively seeking employment opportunities.

The dominance of self-employment reflects limited access to formal sector jobs and highlights the community's dependence on small-scale commerce and informal economic activities for survival.

Income Levels

The survey data reveals the income differences in the study area. Respondents were allowed to provide an estimate of their income per month in their respective livelihood activities. Respondents who earn below N10, 000 per month are 15%; 45% earn between N10, 000 – N50, 000 and 40% earn between N50, 000 – N100, 000. The survey data was further analysed to show the distribution of income among the gender. It was evident that men earn more than women in the community. There are 65% of men in the community who earn between N50, 000 – N100, 000 while only 35% of women earn such income. There are 75% of men who earn between N10, 000 – N50, 000 per month while only 25% of women earn such income.

Table 10: Income Levels of Respondents

Monthly Income Range (₦)	Percentage of Respondents (%)
Below 10,000	15
10,000 – 50,000	45
50,000 – 100,000	40
Total	**100**

Waste management

The Mayo Bani project community is rural in nature and lack access to the services of waste management system in the state. Hence, waste management practice is characterized by open dumping (25%) in their neighbourhood, burning and application to farmlands as manure (68%). Others dump their waste indiscriminately (7%) in open unauthorized places. Although the nature of wastes is largely domestic and biodegradable, these practices cannot be adopted during project implementation. Therefore, contractors should liaise with the waste management authority in the state for proper management of all construction wastes.

Access to Water:

The primary source of domestic water supply in Mayo Bani community is hand-pump boreholes, which serve as the main and relatively reliable source of potable water. However, a proportion of households still depend on alternative sources such as rivers and hand-dug wells, particularly during periods of high demand or when boreholes are non-functional. This pattern indicates partial access to improved water infrastructure, with continued reliance on unimproved surface water sources in some cases.

Healthcare Facilities and Access to Healthcare Services

Findings from the field survey confirm that only one functional healthcare facility exists within Mayo Bani community, a Primary Healthcare Centre (PHC) constructed by the State Government. This facility serves the entire population of the community. No additional public or private hospitals were identified within the community at the time of the survey.

Baseline survey data indicate that 71% of respondents reported having access to medical services, primarily through the existing Primary Healthcare Centre and pharmaceutical outlets located outside the immediate community. However, 29% reported limited or no access to formal healthcare services, which may be attributed to distance, affordability, or preference for traditional medicine.

In terms of healthcare utilization patterns:

- 63.38% of respondents patronize the public Primary Healthcare Centre.
- 31.69% obtain medications or medical advice from pharmaceutical outlets (largely outside the community).

4.93% seek care from private hospitals or clinics located in neighboring areas.

Energy Source

The Mayo Bani community in Mubi North was previously connected to the national electricity grid. However, the transmission and distribution infrastructure serving the community was destroyed during insurgent attacks that affected the area in previous years. Since the incident, the damaged power lines have

not been rehabilitated or reconnected to the national grid. Consequently, the community currently relies largely on privately owned petrol or diesel generators for electricity supply, while a small proportion of households utilize solar energy systems as an alternative power source. This limited and irregular access to electricity has implications for household welfare, local businesses, and overall socio-economic development within the community.

Socio-Cultural and Institutional Characteristics

Ethnicity, Language and Culture

Mubi North LGA, including Mayo Bani, is ethnically diverse. Major ethnic groups in the area include Gude Nzanyi, Fali, Kilba, Marghi, Kamwe (Higgi), Fulani, and Mundang (Godo-godo). The Gude Nzanyi language and other indigenous languages are widely spoken alongside Hausa as a lingua franca for inter-group communication. Both Christianity and Islam are practiced by residents. The cultural fabric of Mayo Bani reflects the broader inland Adamawa context, with community life strongly influenced by agricultural cycles, local governance through traditional structures, and inter-ethnic relations that support social cohesion.

Religion

The dominant religions in Mubi North are Islam and Christianity, both of which coexist peacefully within the community. Religious celebrations are prominent social events. Christians celebrate festivals such as Christmas and Easter, while Muslims observe Eid-el-Fitr and Eid-el-Kabir. These religious events often foster communal interaction and social cohesion.

Traditional Leadership Patterns and Representations

The traditional leadership in the project area remains an important part of local governance and social organization. In Mayo Bani, traditional rulers are recognized as custodians of culture, conflict resolution, and community mobilization. These leaders, often drawn from local ethnic groups such as Hausa-Fulani, Bata, or Margi, play advisory and ceremonial roles alongside the formal LGA administration.
Key traditional structures in Mayo Bani include:

- District Heads (Hakimi) and Village Chiefs – oversee the affairs of their communities, settle disputes, and represent the people in negotiations with government authorities.
- Emirs and Lamidos – in some parts of Adamawa, including Mubi, the Mubi Emirate has historical authority and cultural influence, providing guidance on customary matters.
- Traditional leadership operates in tandem with statutory governance, ensuring that project planning and implementation respect both legal and cultural norms.

The Hakimi of Mayo Bani, is regarded as Angunwa (leader) in the community. He has been ruling for more than 5 years, and he inherited the position from his father. The leadership position is by election. The community elders consider tolerance, courage and endurance as a test of character for any man who wants to rule or lead the community. The position is lifetime except if the incumbent dies. The Hakimi is widely respected by the community members because of his leadership qualities and elderliness. He is assisted by other chiefs who are significant members of the community. They assisted in overseeing the day-to-day administration of the community. The community leader ensures that everybody is well-represented in the decision- making process, although women are not represented among the council of chiefs. Women, however have the freedom to form associations, make decisions among themselves and elect leaders among themselves.

Land Tenure and Ownership

Land tenure is the legal regime in which a parcel of land is possessed or occupied. In other words, the principal methods on land acquisition in Nigeria are inheritance, purchase, lease, pledge, exchange, and gift. Rights to land can only be exercised over when the piece of land must have been acquired in one way or another.

The proposed Project site has been acquired by the state government for the establishment of the university. The University management has the authority to use the land for development projects to the benefit of the University. The site was allocated for the Project by the management and physical planning department of the University.

Conflict Resolution

During interactions with the survey team, the community leader emphasized that Mayo Bani has had no recent record of significant conflicts. Minor disputes within households are typically resolved internally. For disputes that extend beyond the household, the District Head—as the recognized traditional authority which serves as the primary mediator and intervenes to resolve conflicts amicably.

When a conflict exceeds the mediation capacity of the traditional leadership, the Nigeria Police Force is involved to ensure resolution and prevent recurrence. The community maintains a positive working relationship with the Mayo Bani Police Command, reflecting mutual trust and cooperation. This dual system of traditional mediation and police support has contributed to the overall peace and social cohesion in Mayo Bani, reinforcing both customary norms and statutory law in conflict management.

Gender Relations and Involvement

Findings from the field assessment indicate that Mayo Bani community operates largely under a patriarchal social structure, where men predominantly make major decisions at both household and community levels. Although a community-based Women's Association exists within the community, women's decision-making authority is generally limited to matters concerning their immediate household, such as childcare, food management, and minor domestic issues. When decisions extend beyond the household particularly those relating to land, community development, dispute resolution, or public affairs, the involvement and approval of male household heads and, in some cases, the community leadership, are required.

With respect to property rights, it is culturally acceptable for women to inherit property in Mayo Bani. However, inheritance practices are gender-differentiated, with men typically receiving a larger share of family property. Nonetheless, women who possess the financial capacity to acquire land independently are permitted to do so without significant social resistance or institutional barriers.

Overall, while women participate in social and economic activities, decision-making power remains predominantly male-controlled, reflecting entrenched cultural norms within the community.

University Community Administrative Structure

The Federal University of Agriculture, Mubi operates under a structured administrative system consistent with federal universities in Nigeria. The university is headed by a Vice-Chancellor who oversees academic, administrative, and development activities within the institution. Supporting the Vice-Chancellor are principal officers including the Deputy Vice-Chancellor(s), Registrar, Bursar, and Librarian, as well as Deans and Heads of Departments responsible for academic units. This administrative structure provides the institutional framework through which infrastructure development projects, including the proposed solar hybrid mini-grid, are coordinated and managed within the university environment.

Governing Council

The Governing Council is the highest decision-making body of the Federal University of Agriculture, Mubi. The Council is headed by a Chairman (Pro-Chancellor) appointed by the Federal Government of Nigeria through the Federal Ministry of Education. Other members of the Council include the Vice-Chancellor, representatives of the University Senate, external members, and a representative of the Federal Ministry of Education, in accordance with the provisions guiding federal universities in Nigeria.

The Governing Council is responsible for the overall governance, policy formulation, and strategic direction of the University. Key decisions relating to institutional development, including approval of major infrastructure projects, budgetary allocations, and the appointment of principal officers, are taken at this level.

The Council operates on a tenure basis, with members serving for a specified term as stipulated by relevant regulations. Decisions of the Council provide the institutional framework within which projects such as the proposed solar hybrid mini-grid are implemented within the University.

CHAPTER FIVE: POTENTIAL AND ASSOCIATED IMPACTS

5.1 Introduction

This chapter presents the assessment of the potential environmental and social impacts associated with the proposed Project at the permanent campus of the Federal University of Agriculture, Mubi (FUAMB), Adamawa State. The assessment identifies and evaluates the likely impacts that may arise from project activities across the different phases of implementation, namely pre-construction, construction, operation, and decommissioning.

The impact assessment is based on the interaction between project activities described in Chapter Three and the baseline environmental and social conditions established in Chapter Four. It considers both adverse and beneficial impacts, with particular emphasis on identifying potential risks to environmental components such as soil, water, air quality, and biological resources, as well as social aspects including community health and safety, livelihoods, and institutional dynamics.

In line with the requirements of the African Development Bank (AfDB), the assessment evaluates impacts in terms of their magnitude, spatial extent, duration, reversibility, and overall significance. The chapter also highlights potential cumulative impacts that may arise from the interaction of the proposed project with other activities within the area of influence.

The outcome of this assessment provides the basis for the development of appropriate mitigation and enhancement measures, which are presented in subsequent chapters to ensure that the project is implemented in an environmentally and socially sustainable manner.

5.2 Impact Assessment Methodology

The assessment of potential environmental and social impacts associated with the proposed Solar Hybrid Mini-Grid Project was carried out through a systematic evaluation of the interactions between project activities and environmental and social receptors within the defined Area of Influence.
Potential impacts were identified by linking specific project activities (e.g., site clearing, civil works, equipment installation, operation and maintenance) with environmental and social components such as soil, water, air quality, biological resources, and community / socio-economic receptors**.**

5.2.1 Impact Characterization Criteria

Each identified impact was characterized using defined criteria to ensure a consistent and objective evaluation. The criteria applied in this assessment are presented in Table 11.

Table 11: Impact Characterization Criteria

Criteria	Description	Classification
Nature	Type of impact	Positive / Negative
Extent	Spatial coverage of impact	Site-specific / Local / Regional
Duration	Time scale of impact	Short-term (less than 1 year) / Medium-term (1 to 5 years) / Long-term (greater than 5 years)
Reversibility	Ability of environment to recover	Reversible / Irreversible
Likelihood	Probability of occurrence	Unlikely / Likely / Highly Likely

5.2.2 Magnitude of Impact

The magnitude (or intensity) of each identified impact was assessed based on the degree of change it is likely to cause to the baseline environmental or social conditions within the project area. This considers the scale, intensity, and extent of the impact on the affected receptor. The criteria used for determining impact magnitude are presented in Table 12.

Table 12: Criteria for Determining Impact Magnitude

Magnitude	Description
Negligible	No measurable change to baseline conditions; impact is insignificant and does not affect the function or value of the receptor
Low	Minimal change to baseline conditions; impact is localized and of low intensity with no significant alteration to receptor function
Moderate	Noticeable change to baseline conditions; impact may alter the function or quality of the receptor but remains manageable with mitigation
High	Significant change to baseline conditions; impact substantially alters the function, integrity, or value of the receptor

5.2.3 Receptor Sensitivity

Receptor sensitivity refers to the degree to which an environmental or social component may be affected by project-related activities. It reflects the importance, vulnerability, and capacity of the receptor to withstand or recover from impacts**.** The classification of receptor sensitivity used in this assessment is presented in Table 13.

Table 13: Receptor Sensitivity Classification

Sensitivity	Description
Low	Receptors with low environmental or social value and high resilience (e.g., already disturbed land or modified environments)
Medium	Receptors of moderate value or sensitivity (e.g., vegetation, local infrastructure, institutional facilities)
High	Receptors of high importance or vulnerability (e.g., groundwater resources, human population, sensitive ecosystems)

5.2.3 Impact Significance Evaluation

The significance of identified environmental and social impacts was determined as a function of impact magnitude and receptor sensitivity. Receptor sensitivity reflects the importance, vulnerability, and resilience of the affected environmental or social component within the project's area of influence.

The combination of these parameters provides a structured basis for evaluating the overall significance of each impact. A matrix approach was adopted to ensure a systematic and consistent assessment, as presented in Table 14.

Table 14: Impact Significance Matrix

Impact Magnitude ↓	Receptor Sensitivity →		
	Low	**Medium**	**High**
High	**Minor**	**Moderate**	**Major**
Medium	**Minor**	**Moderate**	**Major**
Low	**Negligible**	**Minor**	**Moderate**
Negligible	**Negligible**	**Negligible**	**Minor**

The resulting impact significance levels were classified as follows:

Table 15: Impact Significance Classification

Significance Level	Description
Negligible	No measurable change to baseline conditions
Minor	Low-level impact requiring minimal mitigation
Moderate	Noticeable impact requiring mitigation measures
Major	Significant impact requiring detailed mitigation and management

5.2.4 Quantitative Expression of Impact Significance

As part of the impact evaluation process, each identified impact has been assigned a quantitative significance value expressed as a percentage. This percentage represents the estimated proportion of the receptor affected by the identified impact, taking into account the magnitude of the impact and the sensitivity of the affected receptor as assessed in this chapter (*see tables 18 – 20)*).

The percentage ranges adopted correspond directly to the qualitative significance ratings applied throughout the impact evaluation, as presented in Table 16 below.

Table 16: Significance Rating and Corresponding Percentage Range

Significance Rating	Percentage Range	Representative Value
Negligible	0 - 10%	5%
Minor	11 - 30%	20%
Moderate	31 - 60%	45%
Major	61 - 100%	75%

5.2.5 Assessment of Cumulative Impacts

Cumulative impacts were assessed by considering the combined effects of the proposed project and other existing or planned activities within the project's area of influence. This includes ongoing and future developments within the university and surrounding communities. The assessment focused on determining whether the project could contribute to incremental environmental or social changes when considered alongside other activities, particularly in relation to land use, air quality, water resources, and community wellbeing**.**

5.2.6 Risk Assessment Approach

In addition to the impact assessment, a risk-based approach was adopted to evaluate potential environmental, health, and safety risks associated with the proposed project. Risk assessment was conducted using a Risk Assessment Matrix (RAM)**,** which evaluates risks based on the likelihood of occurrence and the severity of potential consequences.

The RAM provides a structured framework for identifying, analyzing, and prioritizing risks associated with project activities, particularly those related to occupational health and safety, accidental events, and environmental hazards. The likelihood of occurrence was categorized as rare, unlikely, possible, likely, or almost certain**,** while consequence severity was classified as insignificant, minor, moderate, major, or severe**,** as presented in Table 17.

Table 17: Risk Assessment Matrix (RAM)

Consequence ↓	Likelihood →				
	Rare	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
Insignificant	Low	Low	Low	Low	Low
Minor	Low	Low	Medium	Medium	Medium
Moderate	Low	Medium	Medium	High	High
Major	Medium	Medium	High	High	Extreme
Severe	Medium	High	High	Extreme	Extreme

5.3 Positive Impacts of the Proposed Project

The anticipated positive impacts include:

- Improved reliability and stability of electricity supply for academic buildings, laboratories, ICT centres, student hostels, and administrative facilities.
- Enhanced research capacity, particularly for laboratory-based and technology-driven programmes that depend on uninterrupted power supply.
- Improved learning conditions and academic performance through access to lighting, digital resources, and extended study hours.
- Strengthening of agricultural research, innovation, and agro-technology development, thereby supporting regional food security and knowledge dissemination.
- Reduction in dependence on diesel generators, leading to lower greenhouse gas emissions, reduced noise pollution, and improved campus air quality.
- Decrease in operational and energy costs over time, allowing the University to redirect resources to core academic and developmental priorities.
- Creation of temporary employment opportunities during construction and installation phases for skilled and unskilled labour, including technicians, electricians, and support workers.
- Indirect economic opportunities for local suppliers, service providers, transport operators, and small-scale businesses supporting project implementation.
- Strengthening of local technical capacity in renewable energy installation and maintenance through skills transfer and training opportunities.
- Contribution to national renewable energy targets and improved energy resilience in the North-Eastern region.

5.4 Potential Negative Impacts

The potential adverse environmental and social impacts associated with the proposed Solar Hybrid Mini-Grid Project were identified based on the interaction between project activities and environmental and social receptors within the project's area of influence. These impacts are assessed across the different phases of project implementation, namely pre-construction, construction, operation, and decommissioning. The identified impacts are grouped according to key environmental and social components, including: Land use and soil conditions; Air quality; Noise and vibration; Water resources; Biological environment (flora and fauna); Waste generation and management; Traffic and access; Socio-economic conditions; Community health and safety; and Occupational health and safety.
The impacts under each of these components are discussed with emphasis on their nature, magnitude, sensitivity of affected receptors, and overall significance.

Preconstruction Phase

The pre-construction phase of the proposed Project will involve activities such as site preparation, limited vegetation clearing, and mobilization of personnel, equipment, and materials to the project site. Although

these activities are relatively low in intensity, they may result in localized environmental and social interactions within the project area.

Site preparation activities will lead to the minor removal of sparse Sudan savannah vegetation, consisting mainly of grasses and shrubs within the project footprint. Given the absence of protected or economically important plant species, the impact on terrestrial flora is expected to be minimal. Faunal species within the area are largely common and mobile and are therefore likely to relocate temporarily during site disturbance.

Disturbance of the sandy-silty soil profile, coupled with existing signs of developing surface erosion within parts of the project site, may increase susceptibility to erosion, particularly during rainfall events. However, such impacts are expected to remain localized and of low intensity.

Mobilization of personnel, equipment, and materials may result in minor air quality impacts due to dust generation along campus access routes, as well as a temporary increase in traffic movement within the university environment. Increased human and vehicular activity may also pose minor safety risks to road users and nearby receptors within the site.

The procurement of solar photovoltaic modules, batteries, inverters, transformers, and other electrical components also presents potential environmental and social risks within the project supply chain. These include the potential procurement of equipment from manufacturers associated with allegations of forced labour, modern slavery, child labour, or other human rights abuses. Failure to undertake appropriate supply chain due diligence may expose the project to reputational, legal, and sustainability risks.

Overall, impacts associated with the pre-construction phase are expected to be short-term, site-specific, and of low significance. The identified adverse impacts arising from pre-construction activities, together with their corresponding magnitude, receptor sensitivity, and significance ratings, are presented in Table 18.

Construction Phase

The construction phase of the proposed Project will involve activities such as excavation for mounting structures, foundation works, installation of solar panels and associated infrastructure, trenching and laying of distribution cables within the university campus, movement of construction machinery, and handling of materials. These activities represent the most intensive stage of project implementation and will result in a range of interactions with environmental and social receptors within the project area.

The construction activities will interact with soil, air quality, water resources, and the biological environment. Given the sandy-silty soil conditions and existing signs of developing surface erosion within the project site, there is potential for increased susceptibility to erosion, particularly during earthworks and trenching activities. In addition, dust generation from excavation and vehicle movement may affect ambient air quality within the site and along campus access routes. However, considering the sparse vegetation and absence of ecologically sensitive habitats, impacts on flora and fauna are expected to be minimal and localized. Also, the construction phase will involve the presence of construction workers and increased movement of equipment and materials, which may interact with nearby Mayo Bani communities, located approximately 400 m from the project site. These interactions may result in temporary disruptions to movement and access within the campus, as well as minor community-related impacts such as expectations regarding employment opportunities and potential grievances. Nevertheless, given that the project is located within the permanent university campus with no displacement or land use conflicts, social impacts are expected to be localized and manageable.

In addition, construction activities present potential occupational health and safety (OHS) and community safety risks, particularly in relation to excavation works, operation of machinery, electrical installations, and movement of vehicles within the project environment. These risks may affect both construction workers and nearby community if not adequately controlled.

The impacts associated with the construction phase are expected to be site-specific, requiring effective management to minimize potential adverse effects. The identified adverse impacts arising from construction activities, together with their corresponding magnitude, receptor sensitivity, and significance ratings, are presented in Table 19.

Operation Phase

During the operation phase, activities will primarily involve the generation of electricity through the solar PV system, operation of inverters and battery storage systems, routine monitoring, inspection, and periodic maintenance of project infrastructure. These activities are less intensive and do not involve significant physical disturbance of the project site.

Identified Impacts during the operational impacts are expected to be minimal, as solar PV systems do not generate emissions during normal operation. However, certain risks may arise from the operation and maintenance of battery storage systems and handling of electrical components, particularly in relation to potential leakage, improper disposal of damaged components, and generation of e-waste. In addition, minor impacts may be associated with low-level noise from inverters and periodic maintenance activities, as well as the presence of installed infrastructure within the project area. There are also occupational health and safety (OHS) and community safety considerations, particularly in relation to electrical hazards, battery-related risks, fire hazards, and unauthorized access to energized components. These risks require appropriate control measures to ensure the safety of both facility operators and nearby users within the FUAMB campus. Overall, impacts associated with the operation phase are expected to be long-term but of low to moderate significance, and largely manageable with standard operational and safety procedures.

The identified adverse impacts arising from operation activities, together with their corresponding magnitude, receptor sensitivity, and significance ratings, are presented in Table 20.

5.4.1 Negative Impacts: Pre-Construction Phase

Table 18: Preconstruction Phase Negative Impacts

Activity	Receptor	Potential Impact	Magnitude	Sensitivity	Significance	Impact Quantification (%)
Environmental Component						
Mobilization of construction materials and equipment to proposed university site	Air quality and Noise	Generation of dust along the university's access roads and within the project site due to movement of delivery trucks	Low	Medium	Minor	15%
		Exhaust fumes from vehicles resulting to environmental pollution and respiratory discomfort to project community	Low	Medium	Minor	15%
		Increase in ambient noise levels	Low	Medium	Minor	15%
Site clearing	Soil	Localized soil compaction and disturbance within areas designated for temporary material storage	Low	Medium	Minor	20%
		Minor disturbance of the sandy-silty topsoil within the designated project area may increase susceptibility to surface erosion and could potentially accelerate existing erosion processes, particularly during early rainfall events.	Low	Medium	Minor	25%
	Biological (Flora & Fauna)	Removal of sparse vegetation and temporary disturbance to local fauna within the project footprint	Low	Low	Negligible	5%
Social Component						
Procurement of solar equipment	Workers within the supply chain / Project reputation	Potential procurement of equipment from OEMs or suppliers associated with forced labour, modern slavery, child labour or other human rights abuses within the supply chain.	Low	Medium	Minor	15%
Movement of vehicles and equipment	Traffic / Access	Temporary increase in vehicular movement within the university access routes, with minor disruption to movement	Low	Medium	Minor	15%
		Minor disturbance to nearby university users and surrounding areas due to increased human activity	Low	Medium	Minor	15%

Handling and movement of equipment	OHS	Risk of minor accidents or injuries to workers during loading, unloading, and movement of equipment on site	Low	Medium	Minor	20%
		Influx of people (migrant workers, sub-contractors and suppliers) and increased pressure on existing social infrastructure	Low	Medium	Minor	20%
Project mobilization and initial engagement	Community	Minor safety risks to pedestrians and road users within campus access routes	Low	Medium	Minor	15%
	Security	Risk of unauthorized access to project site leading to potential theft of equipment and accidents	Low	Medium	Minor	20%

5.4.2 Negative Impacts: Construction Phase

Table 19: Construction Phase Negative Impacts

Activity	Receptor	Potential Impact	Magnitude	Sensitivity	Significance	Impact Quantification (%)
Environmental Component						
Excavation and foundation works for mounting structures	Soil	Disturbance of soil leading to increased susceptibility to erosion and potential acceleration of existing erosion features within the project footprint.	Moderate	Medium	Moderate	45%
Movement of construction vehicles and equipment within site	Soil	Soil compaction reducing permeability and affecting soil structure within frequently trafficked areas	Low	Medium	Minor	20%
Site grading and leveling for panel installation	Soil / Drainage	Alteration of natural surface runoff patterns, leading to localized water concentration and erosion	Moderate	Medium	Moderate	45%
Trenching for underground distribution cables	Soil	Creation of exposed and loosely compacted soil zones along cable routes, increasing erosion potential, especially during rainfall	Moderate	Medium	Moderate	45%

Trenching and cable laying across site	Soil / Drainage	Temporary disruption of natural drainage paths and potential formation of preferential runoff channels	Moderate	Medium	Moderate	40%
Movement of vehicles and earthworks	Air quality	Generation of dust (TSP) due to disturbance of dry sandy soil and vehicle movement within site and access roads	Moderate	Medium	Moderate	45%
Movement of construction equipment	Air quality	Emission of exhaust gases (NOx, CO, SO_2) from diesel-powered machinery	Low	Medium	Minor	20%
Operation of machinery and installation activities	Noise	Increased noise levels within the project area affecting nearby communities	Moderate	Medium	Moderate	40%
Installation of mounting structures and cable works	Flora	Removal of sparse grasses and shrubs within footprint and along cable routes	Low	Low	Negligible	5%
Construction activities and human presence	Fauna	Temporary disturbance and displacement of small terrestrial fauna species	Low	Low	Negligible	5%
Storage and handling of fuel, oil, and materials	Soil / Water	Risk of localized contamination from accidental spills affecting soil and potentially infiltrating groundwater located around the project footprint Potential pollution of the irrigation stream and ponds identified 450 m away from the project site	Low	High	Moderate	35%
Construction activities and material storage	Waste	Generation of construction waste (scrap materials, packaging, excavated soil) with potential for improper disposal and consequent environmental pollution.	Low	Medium	Minor	20%
Installation of mounting structures and foundations	Visual aesthetics	Temporary visual disturbance due to presence of equipment, materials, and exposed surfaces	Low	Medium	Minor	15%
Social Component						
Mobilization and presence of construction workers	University / premises	Temporary disruption to ongoing activities within the university environment due to increased human presence	Low	Medium	Minor	15%

Engagement of labour	Community	Potential for unmet expectations regarding employment opportunities among local residents, causing grievances	Low	Medium	Minor	15%
Movement of construction vehicles and materials	Access / Mobility	Temporary restriction or disruption of movement along campus roads and access routes	Moderate	Medium	Moderate	40%
Trenching and cable laying across campus	Access / Infrastructure	Temporary obstruction of walkways and internal access routes within the university.	Moderate	Medium	Moderate	40%
Presence of workforce	Public Health	Increased risk of communicable diseases and social vices due to interaction between workers and host community	Low	Medium	Minor	20%
Labour dynamics	Social (Gender)	Potential for unequal access to employment opportunities, particularly for women as well as risks of sexual exploitation, abuse and harassment (SEAH) and gender-based violence (GBV) associated with labour influx during the construction phase.	Low	Medium	Minor	20%
Influx of workers	Local Services	Minor pressure on existing social amenities and services within the university and surrounding areas	Low	Medium	Minor	15%
Project activities and expectations	Community Grievance	Potential for complaints arising from perceived impacts or unmet expectations	Low	Medium	Minor	15%
OHS and Community Safety						
Excavation and trenching works	OHS (Workers)	Risk of injuries from trench collapse, slips, trips, and falls within excavation areas	Moderate	High	Major	75%
Installation of mounting structures and panels	OHS (Workers)	Risk of falls, cuts, and musculoskeletal injuries during installation activities	Moderate	High	Major	75%
Handling of construction materials and equipment	OHS (Workers)	Risk of injuries from improper lifting, falling objects, or equipment misuse	Moderate	High	Major	70%
Electrical installation works (cabling, connections)	OHS (Workers)	Risk of electric shock, burns, or electrocution during installation of electrical components	Moderate	High	Major	75%

Operation of machinery and equipment	OHS (Workers)	Exposure to noise, vibration, and mechanical hazards	Moderate	Medium	Moderate	45%
Movement of construction vehicles within site and access roads	Community Safety	Risk of accidents involving pedestrians, workers, or other road users within the campus	Moderate	High	Major	75%
Open trenches and excavation areas	Community Safety	Risk of unauthorized access leading to falls or injuries	Moderate	High	Major	75%
Storage of fuel and hazardous materials	OHS / Community Safety	Risk of fire outbreak, explosion, or exposure to hazardous substances	Low	High	Moderate	35%
Dust and emissions from activities	OHS (Workers)	Respiratory discomfort or health effects due to prolonged exposure to dust	Moderate	Medium	Moderate	40%
Presence of construction workforce	Community Safety	Risk of unsafe interactions, including minor conflicts or security concerns	Low	Medium	Minor	20%

5.4.3 Negative Impacts: Operation Phase

Table 20: Operation Phase Negative Impacts

Activity	Receptor	Potential Impact	Magnitude	Sensitivity	Significance	Impact Quantification (%)
Battery storage and operation	Soil / Water	Risk of contamination from battery leakage or improper handling of electrolyte materials	Low	High	Moderate	35%
Operation of equipment (inverters, transformers)	Noise	Low-level noise generation from operational equipment	Low	Medium	Minor	15%
Surface structures and installations	Soil / Hydrology	Reduced infiltration due to presence of mounting structures and associated infrastructure	Low	Medium	Minor	20%
Cleaning of solar panels	Water resources	Use of water for panel cleaning leading to minimal water demand	Negligible	Medium	Negligible	5%

Maintenance activities	Waste generation	Generation of minor waste such as damaged components, packaging, and maintenance residues	Low	Medium	Minor	20%
End-of-life components (batteries, panels)	Soil / Environment	Potential environmental risk from improper disposal of hazardous components (e-waste)	Low	High	Moderate	40%
Operation of electrical systems (inverters, cables, connections)	OHS (Workers)	Risk of electric shock, burns, or electrocution during operation and maintenance	Moderate	High	Major	75%
Battery storage and management	OHS (Workers)	Risk of chemical exposure, fire, or explosion in case of battery failure or improper handling	Moderate	High	Major	75%
Operation of facility within campus	Community Safety	Risk of unauthorized access to energized equipment or restricted areas leading to injury	Moderate	High	Major	70%

5.5 Cumulative Impacts

Cumulative impacts refer to the combined effects of the proposed project together with other existing or reasonably foreseeable activities within the project's area of influence. These impacts may result from the incremental addition of project-related activities over time and space**,** even where individual impacts may be minor. Within the Federal University of Agriculture, Mubi (FUAMB) permanent campus**,** there is an ongoing construction of academic buildings funded by another agency**.** The simultaneous implementation of this development alongside the proposed Solar Hybrid Mini-Grid Project presents the potential for overlapping environmental and social interactions**,** particularly during the construction phase.

The cumulative impacts identified are primarily associated with the simultaneous construction of the proposed mini-grid project and ongoing building development within the FUAMB permanent campus. The most notable combined effects relate to dust generation, noise levels, traffic increase, and soil disturbance, all of which are influenced by the overlapping nature of construction activities.

Given the sandy soil conditions and existing signs of developing erosion within the project area, the combined disturbance of multiple construction sites may increase the potential for localized erosion and sediment movement, particularly during rainfall events. In addition, the presence of multiple construction teams and equipment within the campus environment may lead to increased pressure on access routes, waste management systems, and overall safety conditions. However, these impacts are expected to be temporary, localized, and manageable through coordinated planning and implementation of mitigation measures. Table 21 below highlights identified cumulative impact associated with the proposed project.

Table 21: Identified cumulative Impacts

Component	Source of Cumulative Interaction	Potential Cumulative Impact	Significance
Air Quality	Simultaneous construction activities (mini-grid + building project)	Increased dust (TSP) levels due to combined earthworks and vehicle movement	Moderate
Noise	Concurrent operation of construction equipment	Elevated ambient noise levels within campus environment	Moderate
Traffic & Access	Combined movement of construction vehicles	Increased traffic volume, congestion, and accident risk within campus roads	Moderate
Soil / Erosion	Multiple disturbed surfaces across project areas	Increased risk of soil erosion and runoff, especially due to sandy soil conditions	Moderate
Waste Management	Waste generation from both projects	Increased pressure on campus waste handling and disposal systems	Minor–Moderate
Institutional Environment	Multiple construction activities within campus	Prolonged disturbance to academic and administrative activities	Moderate
Community & Occupational Safety	Increased number of workers, equipment, and vehicles.	Elevated risk of accidents and safety incidents within campus.	Moderate

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

Project Specific Risks and Hazards

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

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. In addition, lightning strikes during extreme weather events may damage solar photovoltaic panels, inverters, transformers, and other electrical equipment, potentially resulting in electrical surges, equipment failure, fire, or service interruption if adequate protection systems are not provided. 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 runaway, which commonly leads to battery damage, fire, and, in severe cases, explosions. Deep discharging may also compromise battery integrity and increase fire risk. These risks will be minimized through the incorporation of appropriate lightning protection systems, surge protection devices, and adequate earthing of electrical installations as part of the project design. Any outbreak of uncontrolled fire within the facility could escalate to dangerous dimensions and is therefore classified as Severe.

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.

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 and is thus classified as Moderate.

Gender-Based Violence, Harassment and Sexual Exploitation and Abuse (GBVH/SEAH)

The influx of construction workers into the Mayo Bani host community during the construction phase creates an elevated risk of gender-based violence, harassment, and sexual exploitation and abuse. Women and girls in the host community are particularly vulnerable to these risks given the patriarchal social structure of the community and its limited access to formal justice and support mechanisms. This risk is classified as Major.

Child Labour

The construction phase carries a risk of child labour, particularly given the low formal educational attainment and income levels within the Mayo Bani community, where economic pressure may drive households to present underage members for employment opportunities. The absence of a robust contractor labour screening mechanism increases this risk. This risk is classified as Moderate.

Security Risks

The project is located in Adamawa State within the North-East geopolitical zone, which has experienced insurgent activity in recent years. The destruction of community infrastructure including electricity distribution networks in Mayo Bani is directly attributable to this history. During the construction and operational phases, the project infrastructure and personnel may be exposed to security threats including theft, vandalism, and broader insecurity in the region. This risk is classified as Major.

Contamination from Improper Management of Solar E-Waste

The operational and decommissioning phases of the project will generate electronic waste including spent lithium-ion battery modules, photovoltaic panels, inverters, cables, and associated electrical components. Improper handling, storage, or disposal of these materials poses a risk of soil and groundwater contamination from hazardous substances including heavy metals and chemical electrolytes. Given the 25-year operational lifecycle and the volume of end-of-life components anticipated, this risk is classified as Major**.**

CHAPTER SIX: MITIGATION MEASURES

6.1 Introduction

This chapter outlines the measures proposed to prevent, reduce, and manage the environmental and social impacts associated with the Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB), Adamawa State. The measures are based on the significance of impacts identified in Chapter Five and are designed to ensure that potential adverse effects are effectively controlled throughout the project lifecycle.

The development of mitigation measures follows the principles of the mitigation hierarchy as recommended by the African Development Bank, ensuring a systematic approach to impact management. These measures are tailored to the specific conditions of the project site, including its soil characteristics, vegetation cover, ongoing construction activities, and proximity to nearby communities.

In addition to addressing environmental concerns, the mitigation measures also incorporate occupational health and safety considerations, community safety, and resource efficiency. The measures have been developed in line with applicable national regulations, including those of the Federal Ministry of Environment, as well as international best practices.

6.2 Strategy and Principles

The selection of mitigation measures for the proposed project is guided by a structured approach aimed at managing risks in a practical and effective manner. This approach is based on the following principles:

- **Impact Avoidance:** Integration of environmental and social considerations into project design and planning to prevent adverse impacts where feasible;
- **Impact Reduction:** Application of appropriate construction methods and operational controls to limit the extent and intensity of unavoidable impacts;
- **Impact Control:** Implementation of site-specific measures to manage residual impacts during project execution;
- **Remediation and Compensation:** Restoration or compensation for significant residual impacts, where necessary and feasible.

Mitigation measures have also been designed with consideration for:

- the nature and scale of project activities;
- site-specific environmental sensitivities, including erosion-prone soils;
- interactions with ongoing construction within the university campus; and
- potential concerns of nearby communities.

This approach ensures that all identified risks are managed to acceptable levels while maintaining compliance with regulatory and institutional requirements.

6.3 Mitigation Measures by Project Phase

Pre-Construction Phase

Activity	Receptor	Potential Impact	Mitigation Measures	Significance
Environmental Component				
Mobilization of construction materials and equipment to proposed university site	Air quality and Noise	Generation of dust along the university's access roads and within the project site due to movement of delivery trucks	• All access roads and active work areas shall be regularly watered, particularly during dry and windy conditions, to suppress dust generation. • Delivery trucks transporting fine materials (e.g., sand, laterite) should be covered with tarpaulin to prevent dust dispersion. • Vehicle movement within the site shall be restricted to designated routes to minimize surface disturbance.- Speed limits (e.g., ≤ 30 km/h) shall be enforced for all construction vehicles within campus roads.	Minor
		Exhaust fumes from vehicles resulting to environmental pollution and respiratory discomfort to project community	• All vehicles and machinery should undergo routine maintenance and servicing to ensure efficient fuel combustion and reduced emissions. • switch off engines when not in use	Minor
		Increase in ambient noise levels	• Vehicles and equipment shall be fitted with functional silencers/mufflers • Mobilization activities shall be restricted to daytime hours (e.g., 8:00 am – 6:00 pm) to avoid nuisance	Minor
Site clearing	Soil	Localized soil compaction and disturbance within areas designated for temporary material storage	• Prior to construction, the Contractor shall prepare and implement a Soil Handling and Erosion Control Procedure. The procedure shall require: i. demarcation of the approved work area before clearing; ii. stripping of topsoil separately from subsoil where excavation or grading is required; iii. separate stockpiling of topsoil and subsoil to prevent mixing; iv. protection of stockpiles from erosion using covering, compaction control, silt traps, diversion drains or other suitable measures; v. reuse of topsoil as the final surface layer during reinstatement; vi. avoidance of stockpiling within drainage lines or areas prone to runoff; vii. immediate backfilling and compaction of trenches after cable laying; viii. stabilization of disturbed areas through grading, revegetation or erosion-control measures; and	Minor

			ix. targeted confirmatory soil testing if visual inspection identifies unusual staining, odour, buried waste, oil residue or other evidence of possible contamination. • Movement of heavy equipment shall be limited to designated areas to prevent widespread soil compaction • Where compaction occurs, affected soils shall be loosened/ripped after use to restore permeability	
		Minor disturbance of the sandy-silty topsoil within the designated project area may increase susceptibility to surface erosion and could potentially accelerate existing erosion processes, particularly during early rainfall events.	• Vegetation clearing shall be restricted strictly to the project footprint to preserve natural ground cover. • Topsoil shall be carefully stripped, stockpiled, and protected for later reinstatement. • Land clearing shall be scheduled, where possible, to avoid peak rainfall periods. • Exposed surfaces shall be stabilized promptly after clearing activities.	Minor
	Biological (Flora & Fauna)	Removal of sparse vegetation and temporary disturbance to local fauna within the project footprint	• Clearing shall be limited to only required areas - avoiding unnecessary vegetation removal • Post-construction, disturbed areas shall be rehabilitated/re-vegetated using native species.	Negligible
Social Component				
Procurement of solar equipment	Workers within the supply chain / Project reputation	Potential procurement of equipment from OEMs or suppliers associated with forced labour, modern slavery, child labour or other human rights abuses within the supply chain.	Conduct due diligence on OEMs and suppliers to exclude those linked to forced labour, modern slavery, child labour, or other human rights abuses. REA shall implement a Solar PV OEM Supply Chain Due Diligence Procedure for supplier screening prior to procurement	Minor
Movement of vehicles and equipment	Traffic / Access	Temporary increase in vehicular movement within the university access routes, with minor disruption to movement	• Movement of delivery vehicles should be scheduled during off-peak hours to minimize interference with campus traffic and nearby community movement. • Temporary traffic control measures (signage, flagmen) should be deployed at critical points along access roads. • Coordination should be maintained with university management to align with ongoing construction activities within the campus.	Minor
		Minor disturbance to nearby university users and surrounding areas due to increased human activity.	Mobilization activities should be properly planned and coordinated to reduce unnecessary movement and congestion	Minor

Handling and movement of equipment	OHS	Risk of minor accidents or injuries to workers during loading, unloading, and movement of equipment on site	• Conduct a Job Hazard Analysis (JHA) or Job Safety Analysis (JSA) before commencement of work activities. • Establish and enforce administrative controls including safe work method statements and worker induction training • Workers involved should be provided with appropriate Personal Protective Equipment (PPE) such as gloves, helmets, and safety boots. • Equipment handling procedures should be clearly communicated and enforced.	Minor
		Influx of people (migrant workers, sub-contractors and suppliers) and increased pressure on existing social infrastructure	• Preference should be given to local labour recruitment from Mubi and surrounding communities where skills are available. • Engagement with community leaders should be carried out to manage expectations regarding employment opportunities. • Workers should be provided with basic on-site facilities (e.g., sanitation, water) to reduce pressure on local infrastructure.	Minor
Project mobilization and initial engagement	Community	Minor safety risks to pedestrians and road users within campus access routes	• Warning signs and temporary safety signage should be installed along access routes to the site. • Traffic marshals/flagmen should be positioned at key crossing points during peak movement periods	Minor
Project mobilization and initial engagement		Grievances from poor recruitment of local labour for semi- and unskilled jobs	• A transparent and documented recruitment process should be adopted. • Job opportunities for unskilled roles should be publicly communicated within nearby communities. • Selection criteria should be clearly defined and consistently applied. • A simple grievance redress mechanism (GRM) should be established to address complaints related to employment.	Minor
Project mobilization and initial engagement		Increase in sexual activities and potential spread of STDs/STIs due to labour influx	• Awareness programs on HIV/AIDS and STDs/STIs prevention should be conducted for workers. • Information materials (posters, briefings) should be provided at site and worker gathering points	Minor
Project mobilization and initial engagement		Induced SEA/SH and other GBV risks due to labour influx	• A strict Code of Conduct addressing SEA/SH and GBV should be developed and enforced for all workers. • Workers should undergo mandatory induction and sensitization on acceptable behavior and consequences of violations • A confidential reporting mechanism should be established for GBV-related complaints • Sanctions for violations should be clearly defined and enforced.	Minor

Project mobilization and initial engagement	Security	Risk of unauthorized access to project site leading to potential theft of equipment and accidents	• The project site should be properly secured using temporary fencing or barriers. • Security personnel should be engaged to control access to the site • Warning signs such as *"No Unauthorized Access"* should be installed at visible locations.	Minor

Construction Phase

Activity	Receptor	Potential Impact	Mitigation Measures	Significance
Environmental Component				
Excavation and foundation works for mounting structures	Soil	Disturbance of soil leading to increased susceptibility to erosion and potential acceleration of existing erosion features within the project footprint.	• Excavation activities should be limited strictly to designated foundation areas to minimize unnecessary soil exposure. • Excavated areas should be backfilled and compacted promptly after installation works to reduce exposure duration. • Temporary erosion control measures such as sandbags, silt fences, or berms should be installed around disturbed areas • Excavation works should, where feasible, be scheduled outside peak rainfall periods to reduce erosion risk	Moderate
Movement of construction vehicles and equipment within site	Soil	Soil compaction reducing permeability and affecting soil structure within frequently trafficked areas	• Movement of heavy-duty vehicles should be restricted to clearly defined access routes within the site • Areas not required for construction activities should be cordoned off to prevent unnecessary movement. • Compacted areas should be ripped/loosened after construction to restore soil permeability.	Minor
Site grading and leveling for panel installation	Soil / Drainage	Alteration of natural surface runoff patterns, leading to localized water concentration and erosion	• Gentle slopes and proper leveling techniques should be adopted to prevent water accumulation • Regular inspection of graded areas should be conducted, especially after rainfall events	Moderate
Trenching for underground distribution cables	Soil	Creation of exposed and loosely compacted soil zones along cable routes, increasing erosion potential, especially during rainfall	• Trenching activities should be planned in sections (progressive trenching) to limit the length of open trenches at any time. • Excavated materials should be placed on one side of the trench and protected from runoff. • Trenches should be backfilled and compacted immediately after cable laying	Moderate

			• Temporary barriers or coverings (e.g., tarpaulin) should be used to protect open trenches during rainfall .	
Movement of vehicles and earthworks	Air quality	Generation of dust (TSP) due to disturbance of dry sandy soil and vehicle movement within site and access roads	• Active work areas and access roads should be regularly watered, especially during dry and windy conditions. • Vehicle speeds within the site should be strictly controlled (≤ 30 km/h) to reduce dust generation • Loading and unloading activities should be conducted in a manner that minimizes dust generation • Workers in high-dust areas should be provided with dust masks	Moderate
Movement of construction equipment	Air quality	Emission of exhaust gases (NOx, CO, SO_2) from diesel-powered machinery	• All construction equipment should undergo regular maintenance and servicing to ensure efficient combustion • Equipment emitting excessive smoke should be withdrawn from use and repaired immediately • Idling of machinery should be minimized; engines should be switched off when not in use	Minor
Operation of machinery and installation activities	Noise	Increased noise levels within the project area affecting nearby communities	• Construction activities should be restricted to daytime hours to minimize disturbance • Equipment should be fitted with functional silencers/mufflers	Moderate
Installation of mounting structures and cable works	Flora / Fauna	Removal of sparse grasses and shrubs within footprint and along cable routes	• Vegetation clearing should be restricted strictly to the required project footprint and cable routes to avoid unnecessary loss • Disturbed areas should be progressively rehabilitated after installation works using native grass species • Awareness briefings on biodiversity protection should be conducted during worker induction	Negligible
Storage and handling of fuel, oil, and materials	Soil / Water	Risk of localized contamination from accidental spills affecting soil and potentially infiltrating groundwater located around the project footprint Potential pollution of the irrigation stream and ponds identified 450 m away from the project site	• Storage areas should be equipped with impermeable flooring and secondary containment (bund walls) to prevent seepage. • Refueling and maintenance activities should be conducted in controlled areas with spill containment measures • Spill kits (absorbent materials, sand, etc.) should be available on site at all times. • Any spills should be immediately contained, cleaned up, and contaminated soil properly disposed. • Regular inspection of storage areas should be conducted to detect leaks early	Moderate

Construction activities and material storage	Waste	Generation of construction waste (scrap materials, packaging, excavated soil) with potential for improper disposal and consequent environmental pollution.	• A waste management plan should be implemented for proper segregation, storage, and disposal of waste. • Waste should be stored in designated areas with appropriate containment to prevent scattering • Disposal should be carried out through approved waste handlers or designated disposal sites. • Open dumping and burning of waste should be strictly prohibited	Minor
Installation of mounting structures and foundations	Visual aesthetics	Temporary visual disturbance due to presence of equipment, materials, and exposed surfaces	• Construction materials and equipment should be neatly arranged and stored in designated areas. • Progressive site cleanup should be carried out as work advances • Disturbed areas should be restored promptly after completion of installation works	Minor
Social Component				
Mobilization and presence of construction workers	University / premises	Temporary disruption to ongoing activities within the university environment due to increased human presence	• Workers should be restricted to designated work zones and not allowed to roam freely within university premises. • Engagement should be maintained with university authorities to coordinate activities with ongoing campus developments	Minor
Engagement of labour	Community	Potential for unmet expectations regarding employment opportunities among local residents, causing grievances	• A grievance redress mechanism (GRM) should be established to handle employment-related complaints • A transparent and well-documented recruitment process should be implemented • Priority should be given to qualified local labour from Mubi and surrounding communities • Selection criteria should be clearly defined and consistently applied	Minor
Trenching and cable laying across campus	Access / Infrastructure	Temporary obstruction of walkways and internal access routes within the university	• Trenching activities should be carried out in phases to limit the extent of open excavations at any time • Work schedules should be coordinated to minimize disruption to key access routes	Moderate
Presence of workforce	Public Health	Increased risk of communicable diseases and social vices due to interaction between workers and host community	• Workers should undergo health and safety induction, including awareness on communicable diseases • A code of conduct addressing worker-community interactions should be strictly enforced	Minor
Labour dynamics	Social (Gender)	Potential for unequal access to employment opportunities, particularly for women, as well as risks of sexual exploitation, abuse and harassment (SEAH) and gender-based violence (GBV)	• Equal opportunity principles should be integrated into recruitment processes • Women should be encouraged to apply for suitable roles, especially in unskilled and semi-skilled categories	Minor

		associated with labour influx during the construction phase.	• Recruitment processes should be free from discrimination based on gender or social status • Awareness should be created among contractors on the importance of gender inclusion in the workforce	
Influx of workers	Local Services	Minor pressure on existing social amenities and services within the university and surrounding areas	• Basic facilities (water, sanitation) should be provided on-site for workers • Workers should be discouraged from using community's amenities without proper consent	Minor
Project activities and expectations	Community Grievance	Potential for complaints arising from perceived impacts or unmet expectations	• A functional grievance redress mechanism (GRM) should be established and communicated to stakeholders • Complaints should be promptly recorded, assessed, and resolved within defined timelines • Regular engagement should be maintained with university authorities and nearby communities • Clear communication should be provided on project scope, timelines, and limitations to manage expectations • Records of grievances and resolutions should be maintained for accountability	Minor
OHS and Community Safety				
Excavation and trenching works	OHS /Workers)	Risk of injuries from trench collapse, slips, trips, and falls within excavation areas	• Excavations should be properly designed with stable side slopes or shoring systems to prevent collapse • Open trenches should be clearly barricaded and fitted with warning signage • Excavation areas should be kept free of loose materials and obstructions • Workers should be provided with appropriate PPE (helmets, safety boots, reflective vests) • Daily inspection of trenches should be conducted, especially after rainfall	Major
Installation of mounting structures and panels	OHS (Workers)	Risk of falls, cuts, and musculoskeletal injuries during installation activities	• Workers should be trained on safe installation techniques and manual handling practice • Use of appropriate lifting equipment and tools should be ensured • Work at height should be supported with fall protection systems (harnesses, guardrails) • PPE such as gloves and helmets should be mandatory at all times	Major

Electrical installation works (cabling, connections)	OHS (Workers)	Risk of electric shock, burns, or electrocution during installation of electrical components	• Electrical works should be carried out only by qualified and certified personnel • All electrical systems should be properly isolated and de-energized before work begins • Use of insulated tools and equipment should be enforced • Workers should wear appropriate PPE (insulated gloves, boots) • Warning signs should be installed around live or high-risk electrical areas.	Major
Operation of machinery and equipment	OHS (Workers)	Exposure to noise, vibration, and mechanical hazards	• Workers should be provided with hearing protection (earplugs/earmuffs) • Only trained personnel should operate machinery • Safe working distances should be maintained around operating equipment. • Work schedules should include rest breaks to reduce exposure to vibration and noise.	Moderate
Movement of construction vehicles within site and access roads	Community Safety	Risk of accidents involving pedestrians, workers, or other road users within the campus	• Clearly defined vehicle routes and pedestrian walkways should be established • Speed limits should be strictly enforced within the project site • Traffic marshals/flagmen should be deployed at high-risk crossing points. • Drivers should be trained on defensive driving and campus safety requirements	Major
Open trenches and excavation areas	Community Safety	Risk of unauthorized access leading to falls or injuries	• Open excavations should be securely barricaded and signposted at all times • Temporary fencing or covers should be installed where necessary • Access to excavation areas should be restricted to authorized personnel only • Night-time visibility should be enhanced using warning lights or reflective markers	Major
Storage of fuel and hazardous materials	OHS / Community Safety	Risk of fire outbreak, explosion, or exposure to hazardous substances	• Fuel and hazardous materials should be stored in designated, well-ventilated areas with proper containment systems • Fire extinguishers should be provided and strategically located • Workers should be trained on fire safety and emergency response procedures • Smoking should be strictly prohibited near fuel storage areas • Emergency response plans should be developed and communicated.	Moderate

Presence of construction workforce	Community Safety	Risk of unsafe interactions, including minor conflicts or security concerns	• A worker code of conduct should be enforced to guide behavior • Workers should undergo induction on community relations and acceptable conduct • Security personnel should be engaged to monitor site access and activities • Grievance mechanisms should be available to report and address conflicts promptly • Workers should be restricted from unauthorized interaction in sensitive areas	Minor

Operation Phase

Activity	Receptor	Potential Impact	Mitigation Measures	Significance
Battery storage and operation.	Soil / Water	Risk of contamination from battery leakage or improper handling of electrolyte materials	• Battery procurement specifications should include OEM safety, storage, and handling requirements as contractual obligations • Suppliers should demonstrate compliance with Extended Producer Responsibility (EPR) obligations for end-of-life battery collection, recycling, and disposal • Batteries should be stored in a secure, well-ventilated, and impermeable containment area to prevent leakage into soil • Secondary containment systems (e.g., bunds) should be provided to capture any accidental spills • Routine inspection of battery units should be conducted to detect leaks or damage early • Handling of batteries should follow manufacturer guidelines and safety procedures • Spill response materials should be readily available at battery storage locations	Moderate
Operation of equipment (inverters, transformers)	Noise	Low-level noise generation from operational equipment	• Equipment should be properly installed and maintained to minimize noise emissions • Noise-generating equipment should be housed or shielded where necessary • Routine maintenance should be conducted to prevent abnormal noise levels • Monitoring should be carried out periodically to ensure noise remains within acceptable limits	Minor

Cleaning of solar panels	Water resources	Use of water for panel cleaning leading to minimal water demand	• Water use for cleaning should be optimized through efficient cleaning methods (e.g., controlled spraying) • Cleaning activities should be scheduled to avoid unnecessary frequency. • Where feasible, non-potable water sources should be utilized • Water use should be monitored to ensure efficiency	Negligible
Maintenance activities	Waste generation	Generation of minor waste such as damaged components, packaging, and maintenance residues	• Waste should be segregated and stored in designated areas • Recyclable materials (e.g., metals, packaging) should be recovered and reused where possible • Waste should be disposed through approved waste management facilities. • Open dumping or burning of waste should be strictly prohibited • Maintenance records should include waste tracking and disposal logs.	Minor
End-of-life components (batteries, panels)	Soil / Environment	Potential environmental risk from improper disposal of hazardous components (e-waste)	• A formal e-waste management plan should be implemented for end-of-life components • Used batteries and panels should be returned to manufacturers or certified recyclers • Temporary storage of decommissioned components should be in secure and controlled conditions • Handling of hazardous waste should comply with national environmental regulations • Records of disposal and recycling should be maintained for accountability.	Moderate
Operation of electrical systems (inverters, cables, connections)	OHS (Workers)	Risk of electric shock, burns, or electrocution during operation and maintenance	• Electrical systems should be regularly inspected and maintained by qualified personnel • Access to electrical installations should be restricted to authorized personnel only • Warning signage should be installed in high-risk electrical areas • Lockout/tag-out procedures should be implemented during maintenance • Workers should use appropriate PPE (insulated gloves, boots) during maintenance	Major
Battery storage and management	OHS (Workers)	Risk of chemical exposure, fire, or explosion in case of battery failure or improper handling	• Battery storage areas should be equipped with fire detection and suppression systems • Adequate ventilation should be maintained to prevent accumulation of hazardous gases	Major

			• Emergency response procedures should be developed and regularly tested. • Staff should be trained on battery handling and emergency response • Storage conditions should comply with manufacturer specifications	
Operation of facility within campus	Community Safety	Risk of unauthorized access to energized equipment or restricted areas leading to injury	• The facility should be properly fenced and secured to prevent unauthorized access • Security personnel should be engaged to monitor and control site access. • Warning signs such as *"Danger: High Voltage"* should be installed at visible locations • Access control measures (e.g., locked gates, ID systems) should be implemented • Regular inspection of security systems should be conducted	Major

CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 Overview

The Environmental and Social Management Plan (ESMP) provides a structured framework for implementing, monitoring, and managing the mitigation measures identified in this ESIA. It is designed to ensure that potential environmental and social impacts associated with the Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB) are effectively controlled throughout the project lifecycle.

The ESMP also provides for periodic reporting, supervision, and adaptive management. Monitoring results will be documented and used to inform corrective actions where necessary, ensuring continuous improvement in environmental and social performance throughout the project lifecycle.

7.2 Objectives of the ESMP

The key objectives of the ESMP are to:

- Ensure the effective implementation of all mitigation measures identified in this ESIA;
- Promote compliance with applicable national environmental regulations and relevant international standards, including those of the Federal Ministry of Environment and the African Development Bank;
- Establish a monitoring framework to track environmental and social performance using clearly defined and measurable indicators;
- Promote community health and safety through effective management of project-related risks;
- Ensure transparent stakeholder engagement and provide mechanisms for addressing grievances;
- Promote fair and inclusive employment practices, including equal opportunity for qualified individuals;
- Facilitate capacity building through training, awareness, and continuous supervision of project personnel; and
- Provide a basis for corrective actions and continuous improvement in project implementation.

7.3 Scope and Content of the ESMP

The ESMP outlines the specific measures required to manage identified environmental and social impacts across the pre-construction, construction, and operation phases of the project. For each identified impact, the ESMP specifies:

- the proposed mitigation measures;
- monitoring indicators for assessing performance;
- frequency of monitoring and reporting;
- institutional responsibilities for implementation and supervision; and
- estimated costs associated with mitigation and monitoring measures.

The mitigation and monitoring measures are presented in a structured matrix format, covering environmental, social, occupational health, and community safety aspects of the project. These matrices provide a practical tool for guiding day-to-day implementation and ensuring accountability throughout the project lifecycle.

7.4 ESMP Matrix: Pre-Construction Phase

Table 22: ESMP Matrix for Pre-construction Phase

Project Activity	Receptor	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (In Naira)	
								Mitigation	Monitoring
Environmental Component									
Mobilization of construction materials and equipment to proposed university site	Air quality and Noise	Generation of dust along the university's access roads and within the project site due to movement of delivery trucks	Minor	• All access roads and active work areas shall be regularly watered, particularly during dry and windy conditions, to suppress dust generation. • Delivery trucks transporting fine materials (e.g., sand, laterite) should be covered with tarpaulin to prevent dust dispersion. • Vehicle movement within the site should be restricted to designated routes to minimize surface disturbance.- Speed limits (e.g., ≤ 30 km/h) shall be enforced for all construction vehicles within campus roads.	Regular watering observed; low visible dust; covered trucks; compliance with routes/speed limits	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU). Site Engineer.	500,000.000	200,000.00
		Exhaust fumes from vehicles resulting to environmental pollution and respiratory discomfort to project community	Minor	• All vehicles and machinery should undergo routine maintenance and servicing to ensure efficient fuel combustion and reduced emissions. • switch off engines when not in use.	Maintenance logs; no excessive smoke; engines off when idle	Weekly / Continuous	**Mitigation** Contractor **Monitoring** NEP (PMU) . Site Engineer.	500,000.00	100,000.00
		Increase in ambient noise levels	Minor	• Vehicles and equipment should be fitted with functional silencers/mufflers. • Mobilization activities should be restricted to daytime hours (e.g., 8:00 am – 6:00 pm) to avoid nuisance	Silencers installed; compliance with work hours; complaints record	Weekly			

Project Activity	Receptor	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (In Naira)	
								Mitigation	Monitoring
Site clearing	Soil	Localized soil compaction and disturbance within areas designated for temporary material storage	Minor	• Movement of heavy equipment should be limited to designated areas to prevent widespread soil compaction • Where compaction occurs, affected soils should be loosened/ripped after use to restore permeability	Designated routes used; compacted areas restored	weekly			
		Minor disturbance of the sandy-silty topsoil within the designated project area may increase susceptibility to surface erosion and could potentially accelerate existing erosion processes, particularly during early rainfall events.	Minor	• Vegetation clearing should be restricted strictly to the project footprint to preserve natural ground cover. • Topsoil should be carefully stripped, stockpiled, and protected for later reinstatement. • Land clearing should be scheduled, where possible, to avoid peak rainfall periods. • Exposed surfaces should be stabilized promptly after clearing activities.	Topsoil stockpiled; erosion signs monitored; stabilization applied	Weekly / After rainfall	**Mitigation** Contractor **Monitoring** NEP (PMU). Site Engineer.	700,000.00	200,000.00
	Biological (Flora & Fauna)	Removal of sparse vegetation and temporary disturbance to local fauna within the project footprint	Negligible	• Clearing should be limited to only required areas - avoiding unnecessary vegetation removal • Post-construction, disturbed areas should be rehabilitated/re-vegetated using native species.	Clearing within footprint; no unnecessary removal; evidence of rehabilitation	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU). Site Engineer.	1,000,000.00	100,000.00
Social Component									
Procurement of solar equipment	Workers within the supply chain / Project reputation	Potential procurement of equipment from OEMs or suppliers associated with forced labour, modern slavery, child labour or other human rights abuses within the supply chain.	Minor	• Undertake due diligence on OEMs and suppliers prior to procurement. • REA shall implement a Solar PV OEM Supply Chain Due Diligence Procedure.	• Due diligence procedure developed and implemented. • Supplier screening	Prior to procurement and throughout procurement	**Mitigation:** EPC Contractor; Procurement Unit **Monitoring:** REA PIU	*Included in project cost*	*Included in project cost*

Project Activity	Receptor	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (In Naira)	
								Mitigation	Monitoring
				• Procure equipment only from suppliers that demonstrate compliance with applicable labour and human rights standards.	records available. • Procurement records demonstrate compliance.				
Movement of vehicles and equipment	Traffic / Access	Temporary increase in vehicular movement within the university access routes, with minor disruption to movement	Minor	• Movement of delivery vehicles should be scheduled during off-peak hours to minimize interference with campus traffic and nearby community movement. • Temporary traffic control measures (signage, flagmen) should be deployed at critical points along access roads. • Coordination should be maintained with university management to align with ongoing construction activities within the campus.	Traffic signs/flagmen present; complaints record	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) . Site Engineer.	500,000.00	100,000.00
		Minor disturbance to nearby university users and surrounding areas due to increased human activity	Minor	Mobilization activities should be properly planned and coordinated to reduce unnecessary movement and congestion	Complaints record; coordination evidence	Daily / Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) . Site Engineer.	N/A	N/A
Handling and movement of equipment	OHS	Risk of minor accidents or injuries to workers during loading, unloading, and movement of equipment on site	Minor	• Workers involved should be provided with appropriate Personal Protective Equipment (PPE) such as gloves, helmets, and safety boots. • Equipment handling procedures should be clearly communicated and enforced.	PPE usage rate; safety briefings; incident records	Monthly	**Mitigation** Contractor **Monitoring** NEP (PMU). Site Engineer.	500,000.00	200,000.00

Project Activity	Receptor	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (In Naira)	
								Mitigation	Monitoring
		Influx of people (migrant workers, sub-contractors and suppliers) and increased pressure on existing social infrastructure	Minor	• Preference should be given to local labour recruitment from Mubi and surrounding communities where skills are available. • Engagement with community leaders should be carried out to manage expectations regarding employment opportunities. • Workers should be provided with basic on-site facilities (e.g., sanitation, water) to reduce pressure on local infrastructure.	Local labou percentage; facilities available; complaints recorded	Monthly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer.	1,000,000.00	200,000.00
Project mobilization and initial engagement	Community	Minor safety risks to pedestrians and road users within campus access routes	Minor	• Warning signs and temporary safety signage should be installed along access routes to the site. • Traffic marshals/flagmen should be positioned at key crossing points during peak movement periods	Signage present; marshals deployed; incident records	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer		
Project mobilization and initial engagement		Grievances from poor recruitment of local labour for semi- and unskilled jobs	Minor	• A transparent and documented recruitment process should be adopted. • Job opportunities for unskilled roles should be publicly communicated within nearby communities. • Selection criteria should be clearly defined and consistently applied. • Grievance redress mechanism (GRM) should be established to address complaints related to employment.	GRM records; complaints resolved	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	100,000.00
Project mobilization and		Increase in sexual activities and potential	Minor	• Awareness programs on HIV/AIDS and STDs/STIs	Awareness sessions; materials	Monthly	**Mitigation** Contractor	500,000.00	100,000.00

Project Activity	Receptor	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (In Naira)	
								Mitigation	Monitoring
initial engagement		spread of STDs/STIs due to labour influx		prevention should be conducted for workers. • Information materials (posters, briefings) should be provided at site and worker gathering points	available; attendance		**Monitoring** NEP (PMU) Site Engineer		
Project mobilization and initial engagement		Induced SEA/SH and other GBV risks due to labour influx	Minor	• A strict Code of Conduct addressing SEA/SH and GBV should be developed and enforced for all workers. • Workers should undergo mandatory induction and sensitization on acceptable behavior and consequences of violations • A confidential reporting mechanism should be established for GBV-related complaints • Sanctions for violations should be clearly defined and enforced.	Code of conduct; trainings; reporting cases.	Continuous	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	100,000.00
Project mobilization and initial engagement	Security	Risk of unauthorized access to project site leading to potential theft of equipment and accidents	Minor	• The project site should be properly secured using temporary fencing or barriers. • Security personnel should be engaged to control access to the site • Warning signs such as *"No Unauthorized Access"* should be installed at visible locations.	Fencing; security staff; access logs.	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	800,000.00	100,000.00
						Total Costs		**7,000,000.00**	**1,500,000.00**

ESMP: Construction Phase

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
Environmental Component									
Excavation and foundation works for mounting structures	Soil	Disturbance of soil leading to increased susceptibility to erosion and potential acceleration of existing erosion features within the project footprint.	Moderate	• Excavation activities should be limited strictly to designated foundation areas to minimize unnecessary soil exposure. • Excavated areas should be backfilled and compacted promptly after installation works to reduce exposure duration. • Temporary erosion control measures such as sandbags, silt fences, or berms should be installed around disturbed areas • Excavation works should, where feasible, be scheduled outside peak rainfall periods to reduce erosion risk	Presence of erosion control measures; exposed soil areas minimized; backfilled areas	Weekly / After rain	**Mitigation** Contractor **Monitoring** REA (PMU) Site Engineer	1,500,000.00	300,000.00
Movement of construction vehicles and equipment within site	Soil	Soil compaction reducing permeability and affecting soil structure within frequently trafficked areas	Minor	• Movement of heavy-duty vehicles should be restricted to clearly defined access routes within the site • Areas not required for construction activities should be cordoned off to prevent unnecessary movement. • Compacted areas should be ripped/loosened after construction to restore soil permeability.	Use of designated routes; evidence of soil restoration	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A	200,000.00
Site grading and leveling for panel installation	Soil / Drainage	Alteration of natural surface runoff patterns, leading to localized	Moderate	• Gentle slopes and proper leveling techniques should be adopted to prevent water accumulation	Absence of water pooling	Weekly / After rain	**Mitigation** Contractor **Monitoring**	N/A	100,000.00

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
		water concentration and erosion		• Regular inspection of graded areas should be conducted, especially after rainfall events			NEP (PMU) Site Engineer		
Trenching for underground distribution cables	Soil	Creation of exposed and loosely compacted soil zones along cable routes, increasing erosion potential, especially during rainfall	Moderate	• Trenching activities should be planned in sections (progressive trenching) to limit the length of open trenches at any time. • Excavated materials should be placed on one side of the trench and protected from runoff. • Trenches should be backfilled and compacted immediately after cable laying • Temporary barriers or coverings (e.g., tarpaulin) should be used to protect open trenches during rainfall .	Length of open trenches; backfilling compliance	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	1,000,000.00	300,000.00
Movement of vehicles and earthworks	Air quality	Generation of dust (TSP) due to disturbance of dry sandy soil and vehicle movement within site and access roads	Moderate	• Active work areas and access roads should be regularly watered, especially during dry and windy conditions. • Vehicle speeds within the site should be strictly controlled (≤ 30 km/h) to reduce dust generation • Loading and unloading activities should be conducted in a manner that minimizes dust generation • Workers in high-dust areas should be provided with dust masks	Watering records; visible dust levels; PPE use	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	200,000.00

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
Movement of construction equipment	Air quality	Emission of exhaust gases (NOx, CO, SO_2) from diesel-powered machinery	Minor	• All construction equipment should undergo regular maintenance and servicing to ensure efficient combustion • Equipment emitting excessive smoke should be withdrawn from use and repaired immediately • Idling of machinery should be minimized; engines should be switched off when not in use	Maintenance logs; absence of excessive smoke	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A *Activities costed under pre-construction*	100,000.00
Operation of machinery and installation activities	Noise	Increased noise levels within the project area affecting nearby communities	Moderate	• Construction activities should be restricted to daytime hours to minimize disturbance • Equipment should be fitted with functional silencers/mufflers	Work hours compliance; complaints record	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer		
Installation of mounting structures and cable works	Flora / Fauna	Removal of sparse grasses and shrubs within footprint and along cable routes	Negligible	• Vegetation clearing should be restricted strictly to the required project footprint and cable routes to avoid unnecessary loss • Disturbed areas should be progressively rehabilitated after installation works using native grass species • Awareness briefings on biodiversity protection should be conducted during worker induction	Clearing within footprint; rehabilitation evidence	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	200,000.00
Storage and handling of fuel, oil, and materials	Soil / Water	Risk of localized contamination from accidental spills affecting soil and potentially infiltrating	Moderate	• Storage areas should be equipped with impermeable flooring and secondary containment (bund walls) to prevent seepage.	Bunds present; spill kits available; no contamination signs	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU)	1,000,000.00	200,000.00

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
		groundwater located around the project footprint Potential pollution of the irrigation stream and ponds identified 450 m away from the project site		• Refueling and maintenance activities should be conducted in controlled areas with spill containment measures • Spill kits (absorbent materials, sand, etc.) should be available on site at all times. • Any spills should be immediately contained, cleaned up, and contaminated soil properly disposed. • Regular inspection of storage areas should be conducted to detect leaks early			Site Engineer		
Construction activities and material storage	Waste	Generation of construction waste (scrap materials, packaging, excavated soil) with potential for improper disposal and consequent environmental pollution.	Minor	• A waste management plan should be implemented for proper segregation, storage, and disposal of waste. • Waste should be stored in designated areas with appropriate containment to prevent scattering • Disposal should be carried out through approved waste handlers or designated disposal sites. • Open dumping and burning of waste should be strictly prohibited.	Waste segregation; disposal records	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	1,500,000.00	300,000.00
Installation of mounting structures and foundations	Visual aesthetics	Temporary visual. disturbance due to presence of equipment, materials, and exposed surfaces	Minor	• Construction materials and equipment should be neatly arranged and stored in designated areas. • Progressive site cleanup should be carried out as work advances	Site tidiness; organized work materials	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	300,000.00	100,000.00

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
				• Disturbed areas should be restored promptly after completion of installation works					
Mobilization and presence of construction workers	University / premises	Temporary disruption to ongoing activities within the university environment due to increased human presence	Minor	• Workers should be restricted to designated work zones and not allowed to roam freely within university premises. • Engagement should be maintained with university authorities to coordinate activities with ongoing campus developments	Complaints record; coordination evidence	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A	200,000.00
Engagement of labour	Community	Potential for unmet expectations regarding employment opportunities among local residents, causing grievances	Minor	• A grievance redress mechanism (GRM) should be implemented to handle employment-related complaints • A transparent and well-documented recruitment process should be implemented • Priority should be given to qualified local labour from Mubi and surrounding communities • Selection criteria should be clearly defined and consistently applied	GRM records; resolved complaints	Monthly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A	200,000.00
Trenching and cable laying across campus	Access / Infrastructure	Temporary obstruction of walkways and internal access routes within the university	Moderate	• Trenching activities should be carried out in phases to limit the extent of open excavations at any time • Work schedules should be coordinated to minimize disruption to key access routes	Barricades / signage; alternative routes	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A	200,000.00

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
Presence of workforce	Public Health	Increased risk of communicable diseases and social vices due to interaction between workers and host community	Minor	• Workers should undergo health and safety induction, including awareness on communicable diseases • A code of conduct addressing worker-community interactions should be strictly enforced	Awareness records; sanitation availability	Monthly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	200,000.00
Labour dynamics	Social (Gender)	Potential for unequal access to employment opportunities, particularly for women	Minor	• Equal opportunity principles should be integrated into recruitment processes • Women should be encouraged to apply for suitable roles, especially in unskilled and semi-skilled categories • Recruitment processes should be free from discrimination based on gender or social status • Awareness should be created among contractors on the importance of gender inclusion in the workforce.	Female participation; recruitment records	Monthly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A	200,000.00
Influx of workers	Local Services	Minor pressure on existing social amenities and services within the university and surrounding areas	Minor	• Basic facilities (water, sanitation) should be provided on-site for workers • Workers should be discouraged from using community's amenities without proper consent	Facilities availability; complaints recorded	Monthly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A	N/A
Project activities and expectations	Community Grievance	Potential for complaints arising from perceived impacts or unmet expectations	Minor	• A functional grievance redress mechanism (GRM) should be established and communicated to stakeholders • Complaints should be promptly recorded, assessed, and resolved within defined timelines	GRM logs; resolution time	Monthly	**Mitigation** Contractor	N/A	N/A

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
				• Regular engagement should be maintained with university authorities and nearby communities • Records of grievances and resolutions should be maintained for accountability			**Monitoring** NEP (PMU) Site Engineer		
OHS and Community Safety									
Excavation and trenching works	OHS /Workers)	Risk of injuries from trench collapse, slips, trips, and falls within excavation areas	Major	• Excavations should be properly designed with stable side slopes or shoring systems to prevent collapse • Open trenches should be clearly barricaded and fitted with warning signage • Excavation areas should be kept free of loose materials and obstructions • Workers should be provided with appropriate PPE (helmets, safety boots, reflective vests) • Daily inspection of trenches should be conducted, especially after rainfall	PPE use; barricades; inspection logs	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	800,000.00	200,000.00
Installation of mounting structures and panels	OHS (Workers)	Risk of falls, cuts, and musculoskeletal injuries during installation activities	Major	• Workers should be trained on safe installation techniques and manual handling practice • Use of appropriate lifting equipment and tools should be ensured • Work at height should be supported with fall protection systems (harnesses, guardrails)	Training records; PPE compliance	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	100,000.00

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
				• PPE such as gloves and helmets should be mandatory at all times					
Electrical installation works (cabling, connections)	OHS (Workers)	Risk of electric shock, burns, or electrocution during installation of electrical components	Major	• Electrical works should be carried out only by qualified and certified personnel • All electrical systems should be properly isolated and de-energized before work begins • Use of insulated tools and equipment should be enforced • Workers should wear appropriate PPE (insulated gloves, boots) • Warning signs should be installed around live or high-risk electrical areas.	Presence of qualified staff; lockout use; signage	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	200,000.00
Operation of machinery and equipment	OHS (Workers)	Exposure to noise, vibration, and mechanical hazards	Moderate	• Workers should be provided with hearing protection (earplugs/earmuffs) • Only trained personnel should operate machinery • Safe working distances should be maintained around operating equipment. • Work schedules should include rest breaks to reduce exposure to vibration and noise.	PPE use; operator certification	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A	N/A
Movement of construction vehicles within site and access roads	Community Safety	Risk of accidents involving pedestrians, workers, or other	Major	• Clearly defined vehicle routes and pedestrian walkways should be established	Speed compliance; marshals present	Daily	**Mitigation** Contractor **Monitoring**	N/A	200,000.00

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
		road users within the campus		• Speed limits should be strictly enforced within the project site • Traffic marshals/flagmen should be deployed at high-risk crossing points. • Drivers should be trained on defensive driving and campus safety requirements			NEP (PMU) Site Engineer		
Open trenches and excavation areas	Community Safety	Risk of unauthorized access leading to falls or injuries	Major	• Open excavations should be securely barricaded and signposted at all times • Temporary fencing or covers should be installed where necessary • Access to excavation areas should be restricted to authorized personnel only • Night-time visibility should be enhanced using warning lights or reflective markers	Presence of barricades; warning lights	Daily	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	N/A	N/A
Storage of fuel and hazardous materials	OHS / Community Safety	Risk of fire outbreak, explosion, or exposure to hazardous substances	Moderate	• Fuel and hazardous materials should be stored in designated, well-ventilated areas with proper containment systems • Fire extinguishers should be provided and strategically located • Workers should be trained on fire safety and emergency response procedures • Smoking should be strictly prohibited near fuel storage areas • Emergency response plans should be developed and communicated.	Presence of fire Extinguishers; training records	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	100,000.00

Project Activities	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Costs (Naira)	
								Mitigation	Monitoring
Presence of construction workforce	Community Safety	Risk of unsafe interactions, including minor conflicts or security concerns	Minor	• A worker code of conduct should be enforced to guide behavior • Workers should undergo induction on community relations and acceptable conduct • Security personnel should be engaged to monitor site access and activities • Grievance mechanisms should be available to report and address conflicts promptly • Workers should be restricted from unauthorized interaction in sensitive areas.	Incident records; code of conduct enforcement	Weekly	**Mitigation** Contractor **Monitoring** NEP (PMU) Site Engineer	500,000.00	100,000.00
TOTAL CONSTRUCTION COST								**9,100,000.00**	**3,900,000.00**

ESMP: Operation Phase

Project Activity	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsivity	Cost (Naira)	
								Mitigation	Monitoring
Battery storage and operation.	Soil / Water	Risk of contamination from battery leakage or improper handling of electrolyte materials	Moderate	• Batteries should be stored in a secure, well-ventilated, and impermeable containment area to prevent leakage into soil • Secondary containment systems (e.g., bunds) should be provided to capture any accidental spills • Routine inspection of battery units should be conducted to detect leaks or damage early	No leakage observed; bunds intact; spill kits available; inspection records	Weekly	**Mitigation** Facility Operator **Monitoring** NEP (PMU) Site Engineer	1,500,000.00	200,000.00

Project Activity	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsivity	Cost (Naira)	
								Mitigation	Monitoring
				• Handling of batteries should follow manufacturer guidelines and safety procedures • Spill response materials should be readily available at battery storage locations					
Operation of equipment (inverters, transformers)	Noise	Low-level noise generation from operational equipment	Minor	• Equipment should be properly installed and maintained to minimize noise emissions • Noise-generating equipment should be housed or shielded where necessary • Routine maintenance should be conducted to prevent abnormal noise levels • Monitoring should be carried out periodically to ensure noise remains within acceptable limits	No abnormal noise; maintenance records; no complaints	Quarterly	**Mitigation** Operator **Monitoring** NEP (PMU) Site Engineer	500,000.00	100,000.00
Cleaning of solar panels	Water resources	Use of water for panel cleaning leading to minimal water demand	Negligible	• Water use for cleaning should be optimized through efficient cleaning methods (e.g., controlled spraying) • Cleaning activities should be scheduled to avoid unnecessary frequency. • Where feasible, non-potable water sources should be utilized • Water use should be monitored to ensure efficiency	Water use records; efficient methods used; no excessive use	Monthly	**Mitigation** Operator **Monitoring** NEP (PMU) Site Engineer	N/A	100,000.00
Maintenance activities	Waste generation	Generation of minor waste such as damaged components, packaging, and maintenance residues	Minor	• Waste should be segregated and stored in designated areas • Recyclable materials (e.g., metals, packaging) should be recovered and reused where possible • Waste should be disposed through approved waste management facilities in Adamawa state • Open dumping or burning of waste should be strictly prohibited • Maintenance records should include waste tracking and disposal logs.	Waste segregated; disposal records; no dumping	Monthly	**Mitigation** Operator **Monitoring** NEP (PMU) Site Engineer	1,000,000.00	200,000.00
End-of-life components	Soil / Environment	Potential environmental risk from	Moderate	• A formal e-waste management plan should be implemented for end-of-life components	E-waste records; recycler	Annually	**Mitigation** Operator	1,000,000.00	200,000.00

Project Activity	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsivity	Cost (Naira)	
								Mitigation	Monitoring
(batteries, panels)		improper disposal of hazardous components (e-waste)		• Used batteries and panels should be returned to manufacturers or certified recyclers • Temporary storage of decommissioned components should be in secure and controlled conditions • Handling of hazardous waste should comply with national environmental regulations • Records of disposal and recycling should be maintained for accountability.	receipts; secure storage		**Monitoring** NEP (PMU) Site Engineer		
Operation of electrical systems (inverters, cables, connections)	OHS (Workers)	Risk of electric shock, burns, or electrocution during operation and maintenance	Major	• Electrical systems should be regularly inspected and maintained by qualified personnel • Access to electrical installations should be restricted to authorized personnel only • Warning signage should be installed in high-risk electrical areas • Lockout/tag-out procedures should be implemented during maintenance • Workers should use appropriate PPE (insulated gloves, boots) during maintenance	Qualified personnel; PPE use; lockout applied; signage present	Monthly	**Mitigation** Operator **Monitoring** NEP (PMU) Site Engineer	500,000.00	100,000.00
Battery storage and management	OHS (Workers)	Risk of chemical exposure, fire, or explosion in case of battery failure or improper handling	Major	• Battery storage areas should be equipped with fire detection and suppression systems • Adequate ventilation should be maintained to prevent accumulation of hazardous gases • Emergency response procedures should be developed and regularly tested. • Staff should be trained on battery handling and emergency response • Storage conditions should comply with manufacturer specifications	Fire systems functional; ventilation adequate; training records.	Monthly	**Mitigation** Operator **Monitoring** NEP (PMU) Site Engineer	500,000.00	100,000.00
Operation of facility within campus	Community Safety	Risk of unauthorized access to energized equipment or restricted areas leading to injury	Major	• The facility should be properly fenced and secured to prevent unauthorized access • Security personnel should be engaged to monitor and control site access. • Warning signs such as *"Danger: High Voltage"* should be installed at visible locations	Fencing intact; security present; access logs maintained	Weekly	**Mitigation** Operator **Monitoring** NEP (PMU)	N/A	200,000.00

Project Activity	Receptors	Potential Negative Impact	Impact Significance	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsivity	Cost (Naira)	
								Mitigation	Monitoring
				• Access control measures (e.g., locked gates, ID systems) should be implemented • Regular inspection of security systems should be conducted.			Site Engineer, Security.		
						TOTAL OPERATION COST		**5,000,000.00**	**1,200,000.00**

7.5 Roles, Responsibilities and Accountabilities

The Rural Electrification Agency Project Management Unit (NEP-PMU) supervises the implementation of the 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 23 indicates the Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP

Table 23: Institutional Roles & Responsibilities for ESMP Implementation

S/N	Stakeholder	Roles and Responsibilities
1.	FUAMB Director Physical Planning:	**Pre-Construction Phase** • Earmark the areas for the project development from the survey land • Appoint a Site Engineer • Arrange and ensure adequate training is carried out for the Site Engineer • Review the ESMP from the consultant • Ensure the University's commitment to the ESMP implementation • Implement the restoration of livelihood to affected persons before mobilization to site **Operational Phase** • Supervise the activities of the Site Engineer by reviewing reports on ESMP issues • Suggest ESMP improvements to O&M Contractor and PMU to address noncompliance and upcoming issues
2.	NEP-PMU	**Pre-Construction Phase** • Provide technical support to the University in the final selection of sufficient and suitable land for construction of power plant and training centre • Appoint an EPC contractor • Supervise the activities of the EPC contractor • Review the ESMP from the consultant • Ensure REA's commitment to the ESMP implementation **Construction phase** • Supervise the activities of the EPC contractor by reviewing reports on ESMP issues • Discuss ESMP improvements with FUAMB Director of Physical Planning to address non-compliance and upcoming issues • Monitor the implementation of the ESMP • Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures • Report to FUAMB Director of Physical Planning on ESMP compliance and noncompliance issues **Operational** • Appoint an O&M Contractor • Supervise the activities of the O&M Contractor by reviewing reports on ESMP issues • Discuss ESMP improvements with FUAMB Director of Physical Planning to address non-compliance and upcoming issues
3.	Site Engineer	**Pre-Construction Phase** • Attend adequate training on ESMP implementation • Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures • Report to FUAMB Director of Physical Planning on ESMP compliance and noncompliance issues **Operational phase**

		• Appoint a O&M Contractor • Supervise the activities of the O&M Contractor by reviewing reports on ESMP issues • Discuss ESMP improvements with FUAMB Director of Physical Planning to address non-compliance and upcoming issues
4. 4	EPC Contractor	• Familiarize with ESMP requirements • Ensure that all personnel are made aware of the management measures/plans that are to be implemented • Report to the NEP-PMU, POE and FUAMB Site Engineer on ESMP compliance and noncompliance issues • Implement ESMP requirements relevant to work being undertaken **Construction phase** • Implement ESMP requirements relevant to work being undertaken • Hire a Gender/GBV officer • Report to the REA-PMU, POE and FUAMB Site Engineer on ESMP compliance and noncompliance issue
5.	O&M Contractor	• Implement ESMP requirements relevant to work being undertaken • Hire a Gender/ GBV officer • Report to the NEP-PMU, POE and FUAMB Site Engineer on ESMP compliance and non-compliance issue
6.	FMEnv Representatives	• Monitor the implementation of ESMP requirements (impact mitigation monitoring) relevant to work being undertaken • Discuss ESMP improvements with FUAMB Director of Physical Planning and NEP-PMU to address non-compliance and upcoming issues • Operational phase • Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUAMB Director of Physical Planning, and NEP-PMU to address non-compliance and upcoming issues
7.	NESREA Representatives	• Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUAMB Director of Physical Planning, and NEP-PMU to address non-compliance and upcoming issues
8.	Adamawa State Ministry of Women Affairs and Social Development (GBV/SEA service provider)	• Monitor the implementation of Gender mitigation measures relevant to work being undertaken • Discuss ESMP improvements with the Gender/GBV officer, FUAMB Director of Physical Planning, and NEP-PMU to address non-compliance and upcoming issues **Operational** • Monitor the implementation of Gender mitigation measures relevant to work being undertaken • Discuss ESMP improvements with the Gender/GBV officer, FUAMB Director of • Physical Planning, and NEP-PMU to address non-compliance and upcoming issues
9.	Adamawa State Ministry of Environment Representatives	• Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken • Discuss ESMP improvements with FUAMB Director of Physical Planning and NEP-PMU to address non-compliance and upcoming issue
10.	Adamawa State Ministry of Environment Representatives	• Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken • Discuss ESMP improvements with FUAMB • Director of Physical Planning and NEP-PMU to address non-compliance and upcoming issues **Operational**

		• Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUAMB Director of Physical Planning, and NEP-PMU to address non-compliance and upcoming issues
11.	Safeguards Unit	**Environmental Aspects** • Analyze potential community/individual sub-projects and their environmental impacts; • Ensure that project activities are implemented in accordance to best practices and guidelines set out in the site specifics; • Identify and liaise with all stakeholders involved in environment related issues in the project; and • Be responsible for the overall monitoring of mitigation measures and the impacts of the project during implementation. **Social Aspects** • Develop, coordinate and ensures the implementation of the social aspects of the ESMP; • Implement the grievance mechanism on the project • Identify and liaise with all stakeholders involved in social related issues in the project; • Conduct impact evaluation and beneficiaries' assessment; and • Establish partnerships and liaise with organizations, Community Based Organizations (CBOs) and Civil Society Organizations (CSOs).
12.	EPC and Works Contractor	• After receiving and committing to the environmental procedures and Management Plans, • Contractors must fully carry out the measures of the environmental protection, health and safety procedure as indicated; • Any changes related to Environment, health and safety procedure must be referred to PMU for approval • In case of any violations on arising works either detected by Environmental consultant, Safeguard Specialists, or new arising works proposed by contractors, they must be reported to PMU for further actions. • If contractors decided to not follow instruction from PMU, construction activities will be halted until necessary actions are taken. • Contractors must assign at site, personnel in charge of Environment, health and safety procedure. • Compliance to BOQ specification in procurement of material and construction Provide oversight function during construction and decommissioning

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7.6 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:

- ❖ Labour Management Plan (LMP) (Annex 6)
- ❖ Waste Management Plan (WMP) (Annex 4)
- ❖ Grievance Redress Mechanism (GRM) (chapter 9)
- ❖ Stakeholder Engagement Plan (SEP) (chapter 9)
- ❖ Health and Safety Plan (H&S Plan) (Annex 7)
- ❖ Climate Change Adaptation and Mitigation Plan (Annex 5)

7.7 Monitoring and Evaluation Plan

The monitoring plan (Internal and External Monitoring) for the ESMP is presented in the Table 24 below. Monitoring results shall be documented with preventive/corrective actions to be implemented.

Table 24: Monitoring Plan for the ESMP

Monitoring	Action	Responsibility	Period	Performance Indicator
Internal Monitoring	Regular site visit to ensure that the mitigation measures and actions specified in the ESMP are implemented and as bound by the contract is satisfactorily implemented.	E&S team of the NEP PMU	During Preconstruction, Construction and Operation Phases	Monitoring Reports and documentation as described below
	Daily monitoring of the contractor performance and adherence to GBV/SEA/SH obligations	Supervision Consultant, GBV Specialist	During Preconstruction and Construction phases	Monitoring Reports presented to the PMU.
	Site visits for supervision and inspection to ensure contractor adhere strictly to the E&S requirements of the project	Supervising Consultant Environmental, Social, GBV specialists	During Preconstruction and Construction phases	Observations and Monitoring Reports presented to the PMU.
External Monitoring	Periodic site visit to ensure project is implemented in an environmentally & socially sustainable manner using the monitoring indicators specified in the ESMP Matrix and other national and international environmental & social requirements	FMEnv, NESREA, Adamawa State Ministry of Environment, Representatives of the project community, Mubi, and other relevant MDAs.	During Preconstruction, Construction and Operation Phases	Inspect monitoring reports from the PMU Provide feedback on observations. Enforce corrective actions where necessary.
	Periodic monitoring of timely, mandatory and confidential reporting for E&S activities	Third Party Monitors	During Preconstruction, Construction and Operation Phases	Monitoring Reports presented to the AfDB

7.8 Training, Awareness and Capacity Building for Zonal Offices

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 appointment;
- Specialist training (as required for specific job role); and
- Refresher training as required.

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

7.8.1 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 25.

Table 25: Proposed Capacity Building Plan

	Training Content	Participants	Delivery	Cost (Naira)
1.	Specific training on Environmental & Social Safeguards	Environmental & Social Safeguard Officer	PMU Consultant	2,000,000.00
2.	Training on ESMP Implementation: mitigation, roles & responsibilities	Project Team	PMU Consultant	1,000,000.00
3.	Training for contractors on ESMP mitigation measures, Code of Conduct, OHS requirements	Contractors' management and workers	PMU Consultant	1,000,000.00
4.	Training of Contractor Drivers, fleet management, traffic control within FUAMB etc.	Contractor, contractor drivers, HSE officer, ESO	School of Transport, FUAMB / Security Management	2,000,000.00
5.	GBV/SEA/SH Prevention and Response Mechanisms	Project team Environmental & Safeguard Officer, Contractors	PMU Consultant	2,000,000.00
6.	Grievance Redress Mechanism	Grievance Redress Committees: project level and management level GRCs , Contractors	PMU Consultant	2,000,000.00
			Total	**10,000,000.00**

The capacity-building cost estimate is an all-inclusive budget. It covers facilitator/resource person fees, venue and logistics, participant transportation or local travel support, training materials and printing, audio-visual/technology support, refreshments, documentation, reporting, and post-training follow-up. The final cost breakdown shall be confirmed during implementation planning, but the estimate has been included to ensure that all key training-related expenditures required for ESMP implementation are budgeted.

7.9 Implementation Schedule and Reporting

The project has an estimated completion period of 12-18months as outlined in activities related to the ESMP Matrix as seen above should to be integrated into the overall construction schedule.

Implementation will be in line with the finalized overall project schedule, as all activities are integrated into the project design. This will take place from the planning stages to ensure quality equipment and support services are sourced, through construction, commissioning, operation to decommissioning phases. Once monitoring begins, any observation of an environmental problem, such as non-compliance or adverse impacts will be reported immediately by the officers responsible to respective authorities in

REA and corrective/ remedial actions will be taken without delay to ensure optimal performance of the project while promoting environmental sustainability.

Also, REA shall keep the regulatory authorities (FMEnv, NESREA, Adamawa State Ministry of Environment) informed of the project performance through reports that will be made available to the regulators when required. REA will provide appropriate documentation of HSE related activities, including internal inspection records, training records, and reports to the relevant authorities. These periodic HSE reports summarizing the status of the environment in the plant will be submitted to FMEnv. Any values exceeding regulatory limits will be specifically identified, together with an explanation of the circumstances involved and corrective measures to ensure compliance in the future.

Table 26: ESMP Implementation Schedule

S/No	Activity	Responsibility	Months											
			1	2	3	4	5	6	7	8	9	10	11	12 – 18
1	ESMP Disclosure	Project Team												
2	Develop Environmental/Social Requirements in Bid Documents	Project Team												
3	Finalization and Approval of Engineering Designs	Design Consultant/ Project Team												
4	Allocate budget for ESMP Monitoring	Project Team												
5	Appoint Support Staff for ESMP	Project Team												
6	Review and Approval of Contractor's HSE, WMP, TMP etc	ESO/SSO												
7	Capacity building	Project Team												
8	Implementation of Environmental and Social Mitigation Measures	Contractor												
9	Supervision of pre-Construction and Construction activities	Project Team												
10	Supervision of ESMP Implementation	ESO/SSO and Engineering Consultant												
11	Environmental and Social Monitoring and Auditing	FMEnv, SMEnv,												
12	Reporting on ESMP Implementation	ESO/SSO												

7.10 ESMP Disclosure

Following the ESMP clearance by the Bank, the PIU shall disclose the ESIA in line with the Nigerian EIA laws. This will include a formal registration of the ESIA with the FMEnv and receipt of guidelines for the disclosure from the EA department including the locations to disclose the documents. At a minimum, this will include the following:

Table 27: ESMP Disclosure

s/n	Entity	Disclosure Requirements
1	Federal Ministry of Environment (FMEnv). Disclosure according to Country System in line with Nigeria EIA Act Cap E12 LFN, 2004	The PMU will disclose the ESIA for 21 days as required by the Nigeria EIA public notice and review procedures in the following offices: - FMEnv Office, - Adamawa State Ministry of Environment - Mubi North LGAs - NEP-PMU Office Disclosure will also include advert in 2 newspapers: one national and one local (state) newspapers and Radio Jingles. The purpose will be to inform stakeholders about the project activities; environmental and social impacts anticipated and proposed environmental and social mitigation measures.
2	AfDB	Following clearance by the AfDB, the ESIA/ESMP shall be disclosed in accordance with the disclosure requirements applicable to the project's environmental and social categorization under the AfDB Integrated Safeguards System.

7.11 ESMP Budget

The total costs of the ESMP implementation including costs for mitigation, monitoring and capacity building is estimated as: **₦41,470,000.00** (Forty-One Million, Four Hundred and Seventy Thousand Naira, only.*)* which converts to **$30,094.34** (Thirty Thousand, and Ninety-Four Dollars, Thirty-Four Cents), as detailed in Table 28 below:

Table 28: ESMP Budget

ITEM	RESPONSIBILITY	COST ESTIMATE	
		NAIRA (₦)	USD ($)
Cost of Mitigation	Contractor	21,100,000.00	15,312.05
Cost of Monitoring	NEP-PMU, MDAs	6,600,000.00	4,789.55
Capacity Building	NEP- PMU/Contractor	10,000,000.00	7,256.89
Sub-total		37,700,000.00	27,358.49
Contingency (10% of sub-total)		3,770,000.00	2,735.85
TOTAL		**41,470,000.00**	**30,094.34**

Exchange Rate $1.00(USD) = ₦1,378 (NGN) – CBN rate as at May, 2026

CHAPTER EIGHT: REMEDIATION PLAN AFTER DECOMMISIONING/ CLOSURE

8.1 Introduction

The proposed solar-hybrid mini-grid is expected to have an operational design life of approximately twenty-five (25) years, subject to proper operation, maintenance and replacement of major components such as batteries and inverters. At the end of the project's operational life, or where major components are permanently taken out of service, decommissioning shall be planned and implemented in accordance with applicable Nigerian regulatory requirements, the AfDB Integrated Safeguards System, the FMEnv National Guidelines for Decommissioning of Facilities in Nigeria, and good international industry practice.

8.2 Decommissioning Activities

A detailed decommissioning and closure plan shall be prepared before decommissioning activities commence and submitted to the relevant regulatory authorities for review and approval. The plan shall define the scope of decommissioning, the components to be removed, the method of dismantling, waste streams to be generated, handling and recycling arrangements, occupational and community health and safety measures, site rehabilitation requirements, implementation schedule, institutional responsibilities and estimated costs.

Decommissioning activities shall include:

i. Dismantling and removal of photovoltaic panels, mounting structures, inverters, transformers, batteries, switchgear, control equipment, cables and associated infrastructure;
ii. Removal or safe abandonment of underground cables and subsurface installations, where applicable;
iii. Segregation, inventory and management of decommissioned materials, including reusable components, scrap metal, electrical and electronic waste, batteries and general demolition waste;
iv. Transportation of spent batteries and e-waste through licensed handlers to approved recycling, take-back or disposal facilities in accordance with applicable NESREA regulations and Extended Producer Responsibility requirements;
v. Restoration and stabilization of disturbed areas, including erosion control, backfilling, grading and revegetation where required;
vi. Consultation with FUAMB, Mayo Bani community, regulatory authorities and other relevant stakeholders before commencement of decommissioning; and
vii. Post-decommissioning inspection and monitoring to confirm that the site has been left in a safe, environmentally sound and socially acceptable condition.

8.3 Management of Decommissioning Activities

In the event of decommissioning, NEP, in conjunction with the leadership of the FUAMB, 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
  - 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 shall 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 operational phase) and the measures to minimize the effects by:
- 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.

8.4 Abandonment Plan

Prior to site abandonment, NEP 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 NEP-Project Management Unit, the Department of Works and Physical Planning in FUAMB, the Federal Ministry of Environment and the Adamawa State Ministry of Environment. 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.

8.5 Roles, Responsibilities and Accountabilities

The key personnel and institutions with major roles in the implementation and monitoring of environmental and social measures for the Project decommissioning/closure are as follows:

A. Contractor(s) Engaged for Decommissioning Activities

- Implement environmental and social measures and management actions put in place for the decommissioning activities.

B. NEP-PMU

- Supervise the activities of the contractor(s) engaged for decommissioning purpose by ensuring that the recommended environmental and social and management actions are implemented.
- Discuss environmental and social management plan improvements with the Director of Works and Physical Planning Department in FUAMB to address noncompliance and upcoming issues.

C. FUAMB University Site Manager

- Directly monitor the activities of the contractor(s) engaged for decommissioning and ensure compliance to the implementation of environmental and social measures and management actions put in place to address potential impacts and risks associated with the decommissioning activities.
- Report to the Director of Works and Physical Planning Department in FUAMB on contractor's performance regarding the implementation of environmental and social measures.

D. Director of Works and Physical Planning Department in FUAMB

- Jointly supervise the activities of the contractor(s) engaged for decommissioning
- Suggest environmental and social management plan improvements to NEP-PMU to address non-compliance issues and upcoming issues.

E. FMEnv/Adamawa State Ministry of Environment Representatives

- Approve the decommissioning plan for the Project
- Monitor the implementation of environmental and social measures and management actions documented in the decommissioning plan.
- Discuss environmental and social management plan improvements to NEP-PMU to address non-compliance issues and upcoming issues.

CHAPTER NINE: STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

9.1 Stakeholder Engagement

Stakeholders are defined as individuals, groups, or institutions that may be directly or indirectly affected by the proposed Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB), or that have an interest in its planning and implementation. These stakeholders play an important role in providing relevant information, local knowledge, and feedback that can influence project design and decision-making. In line with national ESIA requirements and international best practices, including those of the African Development Bank, stakeholder engagement was carried out as an integral part of the ESIA process. The engagement process commenced at the early stage of project planning and continued throughout the assessment phase.

Consultations were conducted using a combination of approaches, including stakeholder meetings, site visits, key informant interviews, and administration of questionnaires. These engagements provided an opportunity to inform stakeholders about the project, obtain their views and concerns, and incorporate relevant inputs into the assessment and project design.

9.1.1 Objectives of Stakeholder Engagement

The objectives of public participation in an ESIA are to provide sufficient and accessible information to potentially interested and affected parties/stakeholders in an objective manner to assist them identify issues of concern, and provide suggestions for enhanced benefits and alternatives. The stakeholder engagement process was designed to conform to the Nigerian EIA Act and international standards. For this Project, the key objectives for stakeholder engagement are:

- 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.

9.1.2 Stakeholder Analysis and Identification

Stakeholder analysis was undertaken to identify relevant stakeholders, understand their roles, and assess their level of influence and interest in relation to the proposed project. This process is important for determining stakeholder capacities, concerns, and potential contributions to project planning, decision-making, and implementation.

The analysis recognizes that different stakeholders exert varying degrees of influence on project outcomes. While some institutions and regulatory bodies may have significant authority in policy formulation and approvals, other groups such as local communities and end-users may have limited formal influence but play a critical role in day-to-day interactions that can affect project implementation and sustainability. To better understand these dynamics, stakeholders were assessed based on their level

of influence and interest in the project. This approach provides useful insight into how different stakeholder groups should be engaged, ensuring that appropriate strategies are adopted to enhance participation, address concerns, and support effective project implementation.

Table 29: Stakeholder Identification and Categorization

Stakeholder Category	Stakeholders
Primary Stakeholders (Directly Affected / Beneficiaries)	• Federal University of Agriculture, Mubi (FUAMB) Management • University Staff and Students (End Users) • On-campus Facilities and Departments • Host Community (Residents within ~400 m radius) • Traditional Rulers and Community Leaders • Youth and Women Groups within Host Community • Local Labour (Skilled and Unskilled Workers) • Contractors and Sub-contractors
Implementing Agency	National Electrification Project (NEP)
Regulatory Institutions	• Federal Ministry of Power • Federal Ministry of Environment • Adamawa State Ministry of Environment • Nigerian Electricity Regulatory Commission (NERC) • Mubi North Local Government Authority • Rural Electrification Agency (REA)
Financing / Oversight Institution	African Development Bank

9.1.3 Stakeholder Engagement Plan

Stakeholder engagement is a continuous and essential process for the successful and sustainable implementation of the proposed Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB). In this regard, a Stakeholder Engagement Plan (SEP) has been developed to guide interactions with all relevant stakeholders throughout the project lifecycle. The SEP provides a structured approach for ensuring that stakeholders are adequately informed, consulted, and involved at appropriate stages of project planning, construction, and operation. It outlines mechanisms for effective communication, stakeholder consultation, and grievance redress, with the aim of promoting transparency, inclusiveness, and accountability.

The plan also ensures that stakeholder concerns, expectations, and feedback are systematically identified, documented, and integrated into project decision-making processes. This approach is consistent with national regulatory requirements and international best practices, including those of the African Development Bank.

Table 30: Proposed Stakeholder Engagement Plan

Project Phase	Key Activities	Target Stakeholders	Method of Engagement
Design / Preparation Phase	• Disclosure of ESIA findings- • Stakeholder identification and consultation • Integration of stakeholder inputs into project design	• Federal University of Agriculture, • Mubi (FUAMB) Management- • University Staff and Students • Rural Electrification Agency (REA) • Federal Ministry of Environment-	• Formal stakeholder meetings- • Key informant interviews- • Site visits- • ESIA disclosure sessions-

		• Adamawa State Ministry of Environment- • Mubi North Local Government Authority- • Host Community (nearby residents) • Traditional Leaders and Community Representatives	• Emails and official correspondence- • Public notices (where applicable)
Construction Phase	• Implementation of ESMP and mitigation measures • Environmental and social monitoring- • Labour management and community relations- • OHS supervision and compliance- • Ongoing stakeholder engagement and grievance management	• Host Community (residents within project area) • Youth and Women Groups • Local Labour and Workers • Contractors and Sub-contractors- FUAMB Management- • NEP - Adamawa State Ministry of Environment • Project Owner's Engineer (POE) / Supervising Engineer	• Community meetings and sensitization sessions- • Toolbox meetings (for workers)- • Grievance Redress Mechanism (GRM)- • Site inspections and monitoring visits- • Posters, signage, and notices on site- • Regular progress meetings
Operation Phase	• Operation and maintenance of the mini grid system • Monitoring of environmental and social performance- • Continued stakeholder engagement- • Management of grievances and feedback- • Periodic audits and reporting	• FUAMB Management and Facility Operators- • University Staff and Students (users)- • Host Community- • NEP • Federal Ministry of Environment (as applicable)- • Adamawa State Ministry of Environment	• Periodic stakeholder meetings- • Feedback and complaint channels (GRM)- • Routine inspections and audits- • Reports and official communication- • Continuous engagement through university channels

9.2 Grievance Redress Mechanism

This section shall describe the grievance redress mechanism for general grievances and GBV/SEA related grievances (including a GBV action Plan). The standard GRM of REA-NEP will support but not replace the site-specific grievance mechanisms established at subproject level.

Grievance redress mechanism (GRM) is a framework which enables local communities and relevant stakeholders of a project to raise issues (including logging, tracking, and grievances resolution) about the project which are addressed efficiently and effectively while issues as regards implementation are resolved. The GRM will be communicated to all stakeholders in the course of project development and implementation and will make publicly available a record documenting the responses to all grievances received. The GRM shall be maintained throughout the project life cycle.

9.2.1 Grievance Redress Mechanism: Reporting Channels and Process

The Grievance Redress Mechanism process as presented in figure 21 below, has been adopted to provide a structured and transparent process for receiving, addressing, and resolving complaints or concerns from stakeholders. This process is designed to ensure that all grievances are handled in a timely, fair, and consistent manner, thereby enhancing trust, accountability, and effective stakeholder engagement throughout the project lifecycle.

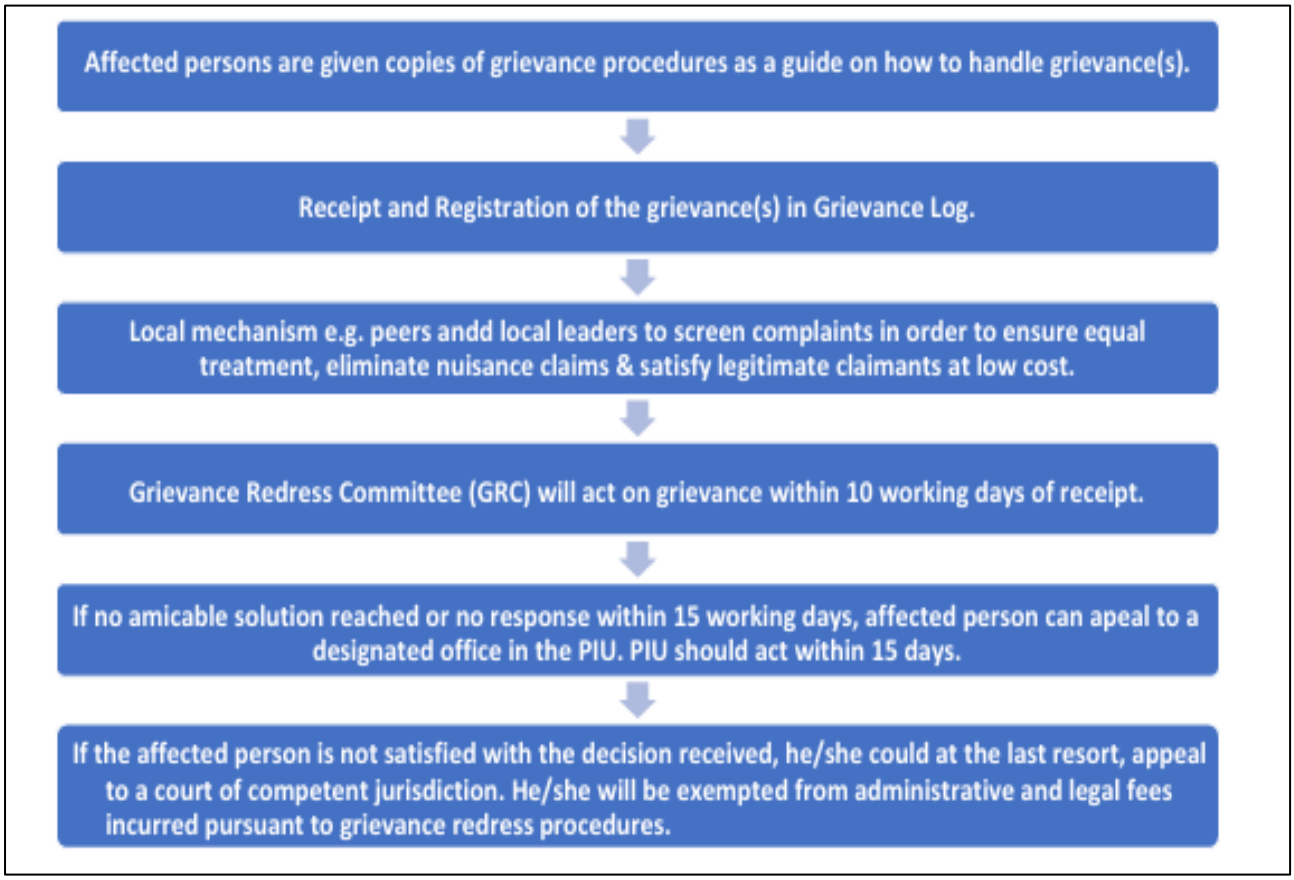

Figure 21: GRM process

9.2.2 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.

9.2.3 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 (in the format given in Table 31) to the project representatives or to the designated Grievance Officer (GO) directly. If the 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. A sample grievance form is presented in the table below:

Table 31: Grievance Recording Form

Grievance Registration	
Case No.:	Date:
Name:	
Office Location: Unit:	
Phone no:	
Details of grievance:	
Name of person recording grievances:	
Designation of recording person:	

Proposed date of response to grievance:	
Signature of recording person	Signature of complainant
Grievance Redressal Response	
Decision of GO (give full details):	
Claimant accepts the outcome:	
Accepted	Not accepted
Signature of claimant:	
Signature of GO:	

All project staff will be informed that they must pass all grievances, communications to the Grievance Officer (discussed in the following section) on site as soon as possible after they are received. Details of the person lodging the grievance shall be noted and passed along with the grievance. The Grievance Officer in turn will communicate all grievances to the Social Standard Officer/Manager for the project. For assisting the communication of grievances, a Register will be maintained at the project office and site camp, at which any individual/group can come have their complaint registered.

9.2.4 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.

9.2.5 Acknowledgment of Grievance

Upon the completion of the recording of the grievance, the stakeholder will be provided with an acknowledgment of the receipt, along with a summary of the grievance. In case the grievance is assessed to be out of the scope of the GRM, a communication towards the same shall be made to the grievant, and an alternative mode of redressal shall be suggested.

This receipt is acknowledgement of grievance registration by_____, resident of -community/staff of -------- department _____ on date _____. His/her case number is _____ and the date for response is _____.

Full name & signature of recording person

9.2.6 Site Inspection and Resolution

For the purpose of verifying and resolving the grievances received, site inspection may not be required in all the cases. Depending upon the sensitivity of the issue, requirement of a site inspection will be identified.

A site inspection will be undertaken by the site level community liaison officers or the project member assigned by the Social Safeguard Officer/ Manager. The purpose of the site inspection will be to check the validity and severity of the grievance. For this purpose, the personnel may also undertake discussions with the concerned external stakeholder. The inspection will be undertaken within ten days of receiving the grievance. The assigned individual will then work with other relevant members of the Project team to investigate the problem and identify measures to resolve the grievance as appropriate. The personnel to be involved in the grievance resolution shall be dependent upon the nature of the grievance, as discussed in the table 32.

Table 32: Classification and Categorization of External Grievances

S/N	Nature of Grievance	Categorization
1.	Compensation	Environmental and Social Safeguard Officer
2.	Resettlement implementation related	Project Management, Social Safeguard Officer and Contractor,
3.	Compensation on account of damage to community forest / property/.	Contractor, Social and Environmental Safeguard Officer
4.	Environmental impact, Community health, culture and customs /access to site etc	Project Management, Environmental and Social Safeguard Officer
5.	Migrant worker related issues	Contractor, Social Safeguard Officer
6.	Sexual harassment / GBV	Human Resource Executive of Contractor/ Social Safeguard Officer of PMU
7.	Others	Contractor, Environmental and Social Safeguard Officers, Project Manager

9.2.7 Resolution, Escalation, and Closure

Based on the understanding thus developed, the social safeguard officer/ manager, in consultation with the concerned departments, shall identify a suitable resolution to the issue. This could involve provision of information to clarify the situation, undertaking measures to remedy actual problems or compensate for any damage that has been caused either by financial compensation or compensation in-kind, and introduction of mitigation measures to prevent recurrence of the problem in the future. This resolution shall be accordingly communicated to the grievant within 10 working days of completing the site investigation.

In case the issue is beyond the purview of the social safeguard officer/ manager, it should be escalated to the Head PMU of NEP (as appropriate). A communication regarding the same shall be provided to the grievant. The Head PMU of the NEP shall in turn endeavour to resolve the grievance within 10 working days of the escalation.

If, however, the grievance remains unsettled, and the Head PMU of NEP is not able to identify an adequate resolution for the grievance, then an adequate response shall be given to the grievant along with a suggested alternative resolution to the grievance including to take the matter to the citizens' rights mediation-centre for the settlement before a law court is considered.

If at any stage, the grievant is not satisfied with the solution, s/he may choose to ask for an escalation of the grievance to the next level. Where a grievance is found to be not a real problem a clear explanation will be provided to the complainant.

9.2.8 Update of Records

The records of the grievance register shall be updated every working week with the present status of the grievance. Once the grievance is resolved, and the same has been communicated to the grievant, the grievance shall be closed in the grievance register. The grievance register should also provide an understanding of the manner in which the grievance was resolved. These instances shall then serve as references for any future grievances of similar nature. Where there is evidence of recurring issues or grievance coming up on the project, it is necessary to flag this up to Head PMU of the NEP in order to assess if the project design requires updating.

9.3 Summary of Public Consultations.

The proposed Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB) is expected to generate both positive and adverse environmental and socio-economic impacts during its construction and operation phases. These impacts may affect various stakeholders directly or indirectly, including the university community and nearby residents. As such, stakeholder consultations were undertaken to ensure that the views, concerns, and expectations of relevant stakeholders were adequately captured and considered in the ESIA process.

The consultation process focused on providing information about the project scope, planned activities, and implementation approach, as well as clarifying the roles of key stakeholders. It also provided an opportunity to obtain feedback, identify potential concerns, and incorporate stakeholder inputs into project planning and impact assessment. Engagement methods included stakeholder meetings, key informant interviews, site visits, and interactive discussions with community representatives and relevant institutions.

The specific objectives of the public consultations were to:

- Inform stakeholders about the proposed project and its components;
- Raise awareness within the university environment and surrounding communities;
- Obtain stakeholder views, concerns, and expectations regarding the project; and
- Ensure that the concerns of potentially affected groups are identified and addressed.

As part of the ESIA study, consultation activities were conducted at different stages of the assessment process. The sections that follow present a summary of the key issues raised by stakeholders and how these have been addressed in the project design and mitigation measures.

Table 33: Consultation with University Administration

Consultation at the Vice Chancellor's Office	
Date	28th January 2026
Location	Temporary Site, Federal University of Agriculture, Mayo Bani (Mubi)
Attendees:	The Consultant team, Vice Chancelor of FUAM

Summary of consultation

The meeting started with formal introduction by the Consultants, introduction the purpose of assignment. The consultant clarified that the ESIA process would include environmental baseline studies, social assessments, stakeholder consultations, and risk identification, culminating in mitigation planning and reporting in compliance with regulatory and international best practices.

The Vice Chancellor expressed profound appreciation for the visit and described the electrification project as a long-awaited milestone for the institution. He emphasized that electricity supply has been a major challenge in Mubi, particularly for a growing academic institution with increasing infrastructure and research demands. He explained that unreliable grid power had significantly affected teaching, laboratory research, administrative efficiency, and overall institutional development. Therefore, the proposed solar farm was viewed not merely as an infrastructure project, but as a transformational intervention that would stabilize academic productivity and enhance institutional reputation.

He reassured the team that the host community was aware of the project and had expressed receptiveness, particularly because of the potential benefit of improved electricity supply that could extend to surrounding communities.

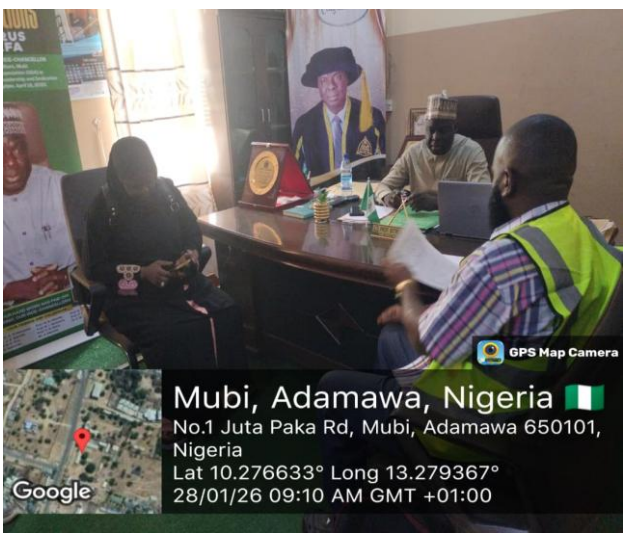

Figure 22: Consultation with University Administration

Table 34: Consultation with the Traditional Leadership

Consultation with the Traditional Ruler	
Date	28th January 2026
Location	Hakimi's Palace Mayo Bani
Attendees:	The Consultant team, The Hakimi and members of the cabinet

The Hakimi expressed gratitude to the Vice Chancellor for maintaining strong ties with the traditional institution. He welcomed the consultants and assured them of full community cooperation. He emphasized that development initiatives that benefit both the university and the host community are always encouraged.

He highlighted the need for inclusive participation in socio-economic surveys, noting that the assessment required inputs from women, youths, elders, and persons with disabilities to ensure that all demographic perspectives were captured. The Hakimi agreed to mobilize at least one hundred respondents for questionnaire administration the following day.

Figure 23: Consultation with the Traditional Leadership

Table 35: Community-Wide Consultation

Consultation with Mayo Bani Community	
Date	30th January 2026
Location	Mayo Bani Community

Attendees:	The Consultant team, Community members representing women, men, youths, elderly persons, and persons with disabilities were present in significant numbers.

Summary of consultation

The consultant explained the purpose of the visit, the nature of the proposed solar project, and the importance of collecting socio-economic data to understand potential impacts and benefits. He emphasized that the ESIA process aims to identify both positive outcomes and possible risks, while recommending mitigation measures to safeguard community welfare.

A representative of the men welcomed the initiative, highlighting that youth unemployment had contributed to social vices such as idleness and petty crime. They expressed hope that job opportunities during construction and operation would redirect youthful energy toward productive engagement. Some raised concerns regarding land boundaries and requested that the university ensure no encroachment on community farmland.

Youth representatives expressed enthusiasm about improved electricity access, noting its potential to support digital learning, entrepreneurship, and income generation. They requested skill acquisition opportunities and transparency in recruitment processes.

Elderly participants focused on peaceful coexistence and urged that communication channels remain open throughout project implementation. Persons with disabilities requested inclusive considerations, particularly in employment opportunities and benefit distribution.

Women

Women participants expressed strong support for the project, noting that improved electricity could enhance small-scale businesses such as food vending, tailoring, phone charging services, and petty trading. They also emphasized employment opportunities for their children and hoped that women would not be excluded from indirect economic benefits. Some requested that preference be given to local labor where feasible

Figure 24: Community-Wide Consultation

Table 36: Consultation with the Executive Secretary, Mubi North

Consultation with the Executive Secretary, Mubi North	
Date	29th January 2026
Location	Office of the Executive Secretary, Mubi North LGA

Attendees:	Consultant team, the Executive Secretary

Summary of consultation

The ESIA team visited the Office of the Executive Secretary of Mubi North Local Government to formally notify the local authority of their assignment. The team explained that stakeholder consultation is integral to the ESIA process and that informing the Local Government was both procedural and strategic.

The Executive Secretary Alh. Danladi Musa expressed appreciation, noting that many projects commence without prior notification to local authorities. He welcomed the proactive approach and assured the team of administrative support. He further stated that he would brief the Executive Chairman upon his return and encouraged sustained collaboration.

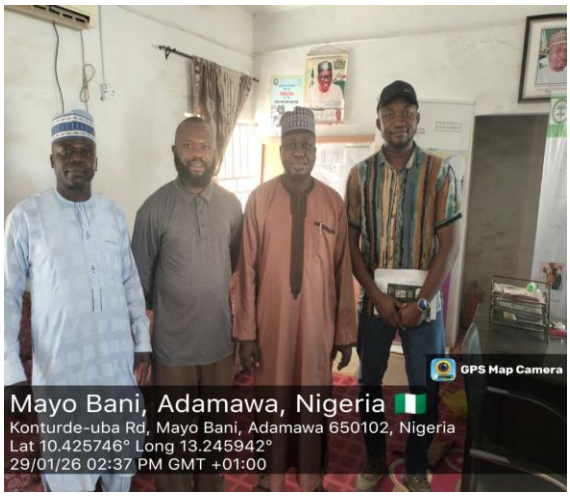

Figure 25: Consultation with the Executive Secretary, Mubi North

Table 37: Consultation with State Ministries

Consultation with the State Ministry of Education	
Date	3rd February 2026
Location	State Secretariat
Attendees:	Consultant team, the Permanent Secretary and the Director of Tertiary Education

Summary of consultation

At the State Ministry of Education, the ESIA team met with the Permanent Secretary and the Director of Tertiary Education. The team explained that the proposed solar project directly concerned a tertiary institution within the state and that it was necessary to formally inform the Ministry.

The Permanent Secretary expressed appreciation and acknowledged the potential positive impact on educational delivery. She promised to communicate the development to the Honourable Commissioner and expressed optimism that the project would strengthen academic performance in the state. Photographs were taken with the Permanent Secretary and Director of Tertiary Education.

Consultation with the State Ministry of Environment	
Date	3rd February 2026
Location	State Secretariat
Attendees:	Consultant team, the Permanent Secretary

Summary of consultation

The ESIA team visited the State Ministry of Environment to inform the Permanent Secretary of the ongoing ESIA assignment. The team emphasized that environmental impact assessment requires regulatory awareness and institutional alignment at the state level.

The Permanent Secretary welcomed the engagement and underscored the importance of environmental compliance and sustainable development. She expressed satisfaction that proper procedures were being followed and wished the team success in executing a thorough and objective ESIA. A group photograph was taken to document the visit.

Figure 26: Consultation with State Ministries of Education and Environment

CHAPTER TEN: CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

The Environmental and Social Impact Assessment (ESIA) conducted for the proposed Solar Hybrid Mini-Grid Project at the Permanent site of Federal University of Agriculture, Mubi (FUAMB), Adamawa State, has evaluated the potential environmental, social, and occupational health and safety implications associated with the project across its pre-construction, construction, and operational phases.

The proposed project is designed to provide a reliable and sustainable electricity supply to the university campus, thereby enhancing academic activities, improving living and learning conditions, and reducing dependence on fossil fuel-based energy sources. In this regard, the project aligns with national energy development objectives and international commitments to sustainable development.

The baseline assessment indicates that the project site is located within the university's permanent campus, characterized by relatively flat terrain, sandy-silty soils with signs of surface erosion, and sparse Sudan savannah vegetation. The site is currently not under active academic use, and no significant ecological or culturally sensitive resources were identified within the project footprint. The nearest community is located approximately 400 metres from the site, suggesting limited direct social disruption. Potential adverse impacts identified during the ESIA are largely site-specific, temporary, and manageable. During the construction phase, key impacts include dust generation, noise, soil disturbance, vegetation clearing, occupational health and safety risks, and minor social disturbances associated with labour influx and construction activities. During the operational phase, potential impacts are minimal and relate primarily to equipment maintenance, waste management (including e-waste), and occupational safety.

Appropriate mitigation measures have been developed to address these impacts and have been presented in Chapter Six, while a comprehensive Environmental and Social Management Plan (ESMP) has been provided in Chapter Seven to guide implementation, monitoring, and reporting. The ESMP outlines clear responsibilities, monitoring indicators, and institutional arrangements to ensure effective environmental and social management throughout the project lifecycle.
Stakeholder consultations conducted as part of the ESIA process indicate general support for the project, particularly due to its expected benefits in improving electricity supply and supporting academic activities. Concerns raised such as safety, environmental management, and community interaction have been duly considered and incorporated into the project design and mitigation measures.

Based on the findings of this ESIA, the proposed project is considered environmentally and socially viable. The anticipated benefits of the project significantly outweigh the potential adverse impacts, all of which can be effectively mitigated through the implementation of the recommended measures.

10.2 Recommendations

In order to ensure the successful and sustainable implementation of the project, the following recommendations are provided:

Environmental Management

- All mitigation measures identified in Chapter Six should be fully implemented.
- Site-specific measures should be adopted to control dust, soil erosion, and surface runoff during construction activities.
- Vegetation clearing should be limited strictly to the project footprint, and disturbed areas should be rehabilitated where necessary.

- ❖ Proper waste management practices, including segregation and disposal of solid waste and e-waste, should be strictly enforced.

Occupational Health and Safety (OHS)

- ❖ A comprehensive Health, Safety, and Environment (HSE) plan should be implemented by the contractor.
- ❖ All workers should be provided with appropriate Personal Protective Equipment (PPE) and trained on its proper use.
- ❖ Regular safety training, toolbox talks, and site inspections should be conducted.
- ❖ Adequate safety signage and restricted access controls should be maintained at all times.

Social Management

- ❖ The project should prioritize the engagement of local labour where feasible to enhance socio-economic benefits.
- ❖ A functional Grievance Redress Mechanism (GRM) should be established and maintained throughout the project lifecycle.
- ❖ Continuous stakeholder engagement should be ensured, particularly with FUAMB management, campus users, and nearby communities.
- ❖ Measures should be implemented to prevent and address risks related to gender-based violence (GBV), sexual exploitation and abuse (SEA), and sexual harassment (SH).

Institutional and Regulatory Compliance

- ❖ The project should comply with all applicable national environmental regulations and standards, including those of the Federal Ministry of Environment.
- ❖ Implementation of the ESMP should be supervised by the Rural Electrification Agency (REA) and relevant regulatory authorities.
- ❖ The project should adhere to the environmental and social safeguard requirements of the African Development Bank.

Monitoring and Reporting

- ❖ Environmental and social monitoring should be carried out in accordance with the ESMP, using the defined indicators and frequency.
- ❖ Regular monitoring reports should be prepared and submitted to relevant authorities.
- ❖ Corrective actions should be taken promptly where non-compliance or unforeseen impacts are identified.

Operation and Maintenance

- ❖ Routine inspection and maintenance of the mini-grid system should be conducted to ensure optimal performance.
- ❖ Battery storage systems should be properly managed to prevent leakage, fire risks, and environmental contamination.
- ❖ End-of-life management plans should be established for solar panels, batteries, and other components.

REFERENCES

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ANNEX ONE: TERMS OF REFERENCE

1 INTRODUCTION/ BACKGROUND

The Federal Government of Nigeria (FGN), through the Rural Electrification Agency (REA), is implementing the Nigeria Electrification Project Phase II (Desert-to-Power) with financial support from the African Development Bank (AfDB). The project's primary objective is to accelerate Nigeria's electrification efforts by deploying sustainable, off-grid and grid-connected solar-powered renewable energy solutions. By leveraging Nigeria's vast solar energy resources, the initiative aims to provide clean, reliable, and long-lasting electricity to Federal Universities and their affiliated teaching hospitals. The broader goal is to enhance academic performance, support research initiatives, and improve healthcare service delivery.

As part of the Energizing Education Programme, the REA intends to electrify 24 Federal Universities and Teaching Hospitals through solar-hybrid mini-grid systems exceeding 1 MW per site. The Government intends to apply part of the proceeds toward engaging a qualified Environmental and Social Consulting Firm to prepare Environmental and Social Impact Assessments (ESIAs) for 13 universities proposed under the AfDB-financed component.

The ESIAs shall be prepared in accordance with the African Development Bank's Integrated Safeguards System (ISS, effective 31 May 2024), the Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004, relevant FMEnv Procedural Guidelines (2017), Nigerian Climate Change Act (2021), other relevant and associated Nigerian regulations, and international good practice (IFC Performance Standards, ISO 14001, ISO 45001).

Table 1: List of Federal Universities Under the AfDB Desert-to-Power Programme for ESIA Study

S/N	NAME OF INSTITUTION	STATE	GEO-POLITICAL ZONE	CATEGORIZATION INTO LOT
1	Federal University, Birnin-Kebbi	Kebbi	North West	LOT 1
2	Federal University of Education, Kano	Kano	North West	
3	Federal University of Education, Zaria	Kaduna	North West	
4	Federal University of Health Sciences, Azare	Bauchi	North East	LOT 2
5	Federal University of Agriculture, Mubi	Adamawa	North East	
6	Federal University of Technology, Minna	Niger	North Central	
7	University of Jos	Plataeu	North Central	
8	Adeyemi Federal University of Education	Ondo	South West	LOT 3
9	Federal University of Health Sciences, Ila Orangun	Osun	South West	
10	Federal University of Agriculture and Technology, Okeho	Oyo	South West	
11	Federal University Otuoke	Bayelsa	South-South	LOT 4
12	Federal University of Technology, Ikot Abasi	Akwa-Ibom	South-South	
13	Federal University of Health Sciences Kwale	Delta	South-South	

2 DESCRIPTION OF THE PROJECT

The Desert-to-Power (DtP) project builds on lessons from NEP-I, focusing on three main components:

1. Energizing Education Programme: Electrification of 24 Federal Universities and Teaching Hospitals with solar-hybrid mini-grids exceeding 1 MW capacity per site.

2. Energizing Healthcare Facilities: Deployment of reliable energy to health centres in underserved regions.

3. Interconnected Mini-Grids for Cooperatives: Supporting local electricity cooperatives via Minimum Subsidy Tenders and Performance-Based Grants.

Each university system will include solar PV arrays, battery energy storage systems, control systems, distribution infrastructure, and backup generation, with appropriate operation and maintenance plans.
The ESIA will consider the full lifecycle — design, construction, operation, and decommissioning — including waste management (solar panels, batteries, oils, packaging, etc.), community safety, and resilience to climate risks.

3 STATUTORY LEGAL AND ADMINISTRATIVE FRAMEWORK

The statutory (legal and administrative) frameworks within which the consultancy activities shall be executed are provided in the following regulations, guidelines and standards (Note: these regulations are not exhaustive):

- African Development Bank's Integrated Safeguards System (2023)
- The regulations, guidelines and standards of the Federal Ministry of Power as it concerns high voltage power transmission in Nigeria.
- Environmental Impact Assessment Act Cap E12 LFN 2004
- FMEnv EIA Procedural Guidelines (2017)
- The regulations, guidelines and standards of the Federal Ministry of Environment concerning power generation and transmission activities in Nigeria.
- National Environmental (Solar Energy) Regulations (2017)
- NESREA Act (2007) and sectoral guidelines
- Labour Act (2004) and Employee Compensation Act (2010)
- Land Use Act (1978) and Urban and Regional Planning Act
- Climate Change Act (2021);
- Occupational Safety and Health (Factories) Regulations (2010)
- National Gender Policy (2006) and Discrimination Against Persons with Disabilities Act (2018)
- All International Conventions/Treaties on Environmental Protection/Social Welfare to which Nigeria is a party: Paris Agreement (2015), Convention on Biological Diversity, ILO Conventions, and the UN Guiding Principles on Business and Human Rights
- The regulations, guidelines and standards of the various State Ministries of Environment and Social Welfare.

The Consultant shall ensure all studies align with FMEnv, relevant State Environmental Protection Agencies, and Local Government Authorities.

4 OBJECTIVES OF THE ASSIGNMENT

The objective of this consultancy is to conduct site specific ESIAs for the proposed power systems and associated infrastructure to:

- Establish environmental and socio-economic baselines for each site;
- Identify, predict, and evaluate environmental, social, health, and safety impacts (positive and negative);
- Recommend mitigation and enhancement measures;
- Ensure compliance with AfDB and Nigerian E&S standards;
- Develop site-specific Environmental and Social Management Plans (ESMPs); and
- Facilitate environmental approvals, and stakeholder acceptance.
- Support REA in securing FMEnv ESIA certification and AfDB no-objection;
- Conduct inclusive stakeholder engagement (including women, youth, and persons with disabilities); and

- Build local institutional capacity for ESMP implementation.

Special attention shall be given to vulnerable groups, gender equality, disability inclusion, resettlement risks, occupational health and safety, and climate resilience.

This must be in line with the requirements of the Federal Government of Nigeria and the African Development Bank's Integrated Safeguards System to ensure that any adverse effects on the environment and wellbeing of people are properly identified and mitigated.

Each university represents a unique ecological, social, and institutional context — from arid North-West terrains to humid South-South coastal areas. Therefore, individual (modular) ESIA studies are required to capture site-specific risks, localized stakeholder concerns, and regulatory obligations under Nigeria's Environmental Impact Assessment Act (Cap E12 LFN 2004).

This modular approach ensures:

- Tailored mitigation and management measures suitable for each region and site;
- Independent FMEnv certification and public disclosure;
- Alignment with AfDB Category 2 project requirements under the Integrated Safeguards System (ISS);
- Easier monitoring and adaptive management during implementation.

5 SCOPE OF THE ASSIGNMENT – METHODOLOGY AND GENERAL APPROACH

The Consultant, who shall be duly registered with the Federal Ministry of Environment, towards achieving the objectives noted under section 4 above, shall carry out the following activities:

Phase 1 – Desk Review and Scoping

- Review prior NEP documentation, feasibility studies, conceptual project design and maps.
- Conduct preliminary stakeholder identification and risk screening.
- Prepare forms and register the project with the FMEnv.
- Prepare and submit detailed work plans

Phase 2 – Baseline Studies (within at least 5km radius)

- Biophysical: Air, water, soil, noise, flora, fauna, hydrology.
- Socio-economic: Demography, livelihoods, gender, land tenure, cultural heritage, transport/traffic studies.
- Laboratory analysis shall be performed by FMEnv-accredited laboratories.
- GIS and remote sensing tools shall be used for mapping and sensitivity analysis.

Phase 3 – Impact Assessment

- Identify and evaluate direct, indirect, and cumulative impacts.
- Assess greenhouse gas emissions and pollution pathways.
- Use AfDB's and FMEnv's risk rating methodology (high, moderate, low).
- Develop mitigation hierarchy (avoid, minimize, mitigate, offset).

Phase 4 – Stakeholder Engagement

- Conduct Free, Prior, and Informed Consultations (FPIC) with communities, institutions, and Federal/ state agencies.
- Ensure inclusive participation of women, youth, and persons with disabilities.

- Maintain engagement logbooks with signatures, photos, and feedback.
- Establish and operationalize a multi-tier costed Grievance Redress Mechanism (GRM).
- Develop a costed stakeholder engagement plan.

Phase 5 – ESMP Development: Each ESMP shall include:

- Mitigation measures and performance indicators;
- Roles, responsibilities, and institutional arrangements;
- Monitoring framework and schedule;
- Capacity-building plan;
- Estimated costs and financing sources;
- Integration strategy into EPC contracts.

Phase 6 – Reporting and Disclosure

- Submit inception, draft, and final ESIA reports all in soft and hard copies
- Facilitate public disclosure in line with FMEnv procedures (public notice, hearing, gazette publication).
- Ensure AfDB disclosure on its website and InfoShop portal via the PMU E&S Unit.
- Payment of Final access charge and IMM fees.
- Issuance of ESIA Approval Letters and certificates by the FMEnv

NOTE: The successful consultant for this assignment is responsible for the payment of Federal Ministry of Environment's regulatory fees. Hence, all costs related to this should be factored as part of reimbursable expense in its financial submission.

6 DELIVERABLES AND PAYMENT SCHEDULE

The successful consultant shall work closely and report to the Head, Project Management Unit (HPMU) of the Nigeria Electrification Project through the Environmental & Social (E&S) team of the NEP Project Management Unit (PMU). The Consultant is expected to work closely with the E&S unit of the PMU towards successfully executing the assignment.

Schedule: The following reports shall be submitted by the Consultant to the Rural Electrification Agency and FMEnv:

#	Deliverables	Timeline *(After contract signing in weeks)*
1.	**A. Inception Report:** - This should include methodology and work plan with clearly defined strategy for carrying out the assignment with timelines for the various outputs. The report should include: • Detailed Project including plan for the on-site activities • Complete Work plan document • Draft Survey Tools • Evidence of registration of project sites (by state) with the Federal Ministry of Environment. The Consultant must submit (3) hard copies and a soft copy of the inception report. **B. Progress Report:** An update on the progress of the Baseline survey and plans for completion of the survey and next activities. The consultant must submit electronic copies of this progress report	2 weeks

2.	**Draft ESIA Report:** - A draft report containing detailed assessment and survey information in line with the approved reporting outline of the FMEnv to be reviewed by the AfDB and PMU. The consultant shall submit electronic copies of the draft ESIA report to the PMU and Bank for internal reviews.	Week 2-14
3	**Resubmission of Draft ESIA Report:** Upon completion of review by the PMU and incorporation/finalization of recommended changes, the revised Draft Report shall be resubmitted to the REA, Bank and FMEnv for review and disclosure	Week 14-16
4.	**A. In house Panel Review:** - Presentation of the ESIA at a Panel to be held by the Federal Ministry of Environment (as required) **B. Review of the draft report** in line with the comments from the FMEnv. **C. Draft Final ESIA report** as approved by the FMEnv will be produced for each of the institutions as covered in the TOR. The consultant shall submit the required number of copies to the FMEnv, and one hard copy and one soft copy (in a flash drive) of each final ESIA reports D. ESIA approval letters and certification from the FMEnv for each of the project sites shall be obtained by the Consultant	Week 16-20

Note: Each site must be registered separately, and standalone reports must be prepared for each of the sites.

Report Structure: The Environmental and Social Impact Assessment (ESIA) report for the project will be structured in line with FMEnv and AfDB guidelines, including all necessary management plans and supplementary documentation. The report must include detailed analysis, mitigation measures, and management strategies for addressing environmental and social impacts. Below is a sample structure for the ESIA report, to be considered, and improved on as necessary.

1. Executive Summary

- Purpose of the Project: A concise overview of the project, its objectives, scope, and alignment with sustainable development goals.
- Key Findings: Summary of the significant environmental and social impacts identified, including proposed mitigation measures.
- Recommendations: A summary of the recommended actions for project implementation and ongoing compliance with environmental and social safeguards. In addition, the consultant shall provide summary of cost of the measures and the institutional arrangements for implementation.

2. Introduction

- Project Background: Description of the project's goals, location, and key stakeholders.
- ESIA Purpose and Scope: The specific objectives of the ESIA, focusing on identifying, assessing, and mitigating the environmental and social impacts of the project.
- Regulatory Framework: Reference to the relevant Nigerian regulations (e.g., EIA Act Cap E12 LFN 2004), AfDB's Integrated Safeguards System (ISS), Nigerian Climate Change Act (2021), and international standards (e.g., IFC Performance Standards, ISO 14001, ISO 45001).

3.1 Project Description

- Project Components: A detailed description of the project components, including all infrastructure and technologies (e.g., solar-hybrid mini-grid systems, energy storage, etc.). Also, the consultant shall describe the proposed project and its geographic, environmental, social, and temporal context, including associated facilities, third parties, and any offsite investments that may be required.
- Project Phases: Explanation of all phases of the project lifecycle, including planning, construction, operation, and decommissioning.

- Project Activities: A breakdown of project activities and their potential environmental and social implications.
- Includes a map of sufficient detail showing the project site and the area that may be affected by the project's direct, indirect, and cumulative impacts.
- Presents the basis for selecting the project design proposed, including for applying the mitigation hierarchy.

3.2 Analysis of Project Alternatives

- Evaluates a reasonable range of feasible project alternatives to meet the project's purpose and needs (e.g. location, technology options, or timing) and their E&S implications, including a no project alternative.
- During the project scoping process, Borrowers shall consult stakeholders and the public and allow for their participation in the identification of feasible project alternatives through public consultation meetings and the opportunity to comment.
- Assesses the alternatives' feasibility of mitigating the E&S impacts, the capital and recurrent costs of alternative mitigation measures, and their suitability under local conditions, and the institutional, training, and monitoring requirements for the alternative mitigation measures.
- Evaluates a reasonable range of feasible project alternatives to meet the project's purpose and needs (e.g. location, technology options, or timing) and their E&S implications, including a no project alternative.
- During the project scoping process, Borrowers shall consult stakeholders and the public and allow for their participation in the identification of feasible project alternatives through public consultation meetings and the opportunity to comment.
- Assesses the alternatives' feasibility of mitigating the E&S impacts, the capital and recurrent costs of alternative mitigation measures, and their suitability under local conditions, and the institutional, training, and monitoring requirements for the alternative mitigation measures.

4. Legal and Institutional Framework

- National Legislation: Overview of Nigerian laws, including the EIA Act, Nigerian Climate Change Act (2021), and other FMEnv regulations. In addition, the E&S institutional and regulatory framework is comprehensively analyzed, not focusing only on environmental and land laws but including social protection policies/strategies, and the project's sector relevant standards/norms related to E&S health and safety.
- AfDB Safeguard Policies: Summary of the AfDB's Integrated Safeguards System (ISS), including the environmental and social safeguard policies that must be adhered to.
- International Standards: Reference to IFC Performance Standards, ISO 14001, and ISO 45001, which guide the ESIA process.
- Permits and Approvals: A list of the necessary permits and clearances required by local authorities and the relevant ministries for the project.
- Analyses the legal and institutional framework for the project within which the ESA is carried out, consisting of:
    - the host country's applicable policy framework, national and local laws and regulations, and the respective institutional capabilities (including implementation) concerning E&S issues;
    - national environmental or social action plans or strategies, and obligations of the country directly applicable to the project under relevant international and regional treaties and agreements;

- applicable requirements under the OSs and the African Development Bank's Integrated Safeguards System (ISS) Guidance Notes;
- the identification of differences between the Borrower's existing Environmental and Social Framework, and requirements relating to the project that may affect how the project is carried out in a manner consistent with the OSs;
- a description of how any deficiencies in the host framework can be addressed through administrative, legislative or regulatory change, institutional strengthening, and capacity building.

5. Baseline Environmental and Social Conditions

- Environmental Baseline: The environmental baseline should:
  - Describe how climate change is affecting or likely to be affecting the project area and how this may influence the nature of project risks and impacts.
  - Describe how the project may be affecting or contributing to climate change and its associated risks and impacts.
  - Overview of climate, topography, hydrology, land use, and vegetation.
  - Assessment of biodiversity, water quality, and air quality.
  - Identification of sensitive environmental receptors (e.g., protected areas, species of concern).
- Social Baseline:
  - Overview of local communities, demographics, socio-economic conditions, and existing infrastructure.
  - Description of land tenure, livelihoods, cultural heritage, and public health.

6. Stakeholder Engagement

The consultant shall identify and characterize individuals and groups that are, due to circumstances, vulnerable, discriminated against, and underserved in, or excluded from, mainstream society. Disaggregated data on all such social groups should be provided to the extent that personal and group safety and data confidentiality and privacy are not compromised.

In addition, the consultant shall describe contextual risks (e.g. the political economy) that may affect the ability of the project to be carried out in a manner consistent with the AfDB OSs and other requirements such as international human rights obligations.

Other aspect to consider include:

- Stakeholder Identification: A comprehensive list of key stakeholders, including local communities, governmental bodies, NGOs, and other interested parties.
- Stakeholder Consultation Process: Description of consultation methods (e.g., meetings, surveys, public hearings), frequency, and topics discussed.
- Stakeholder Concerns: Summary of key concerns raised by stakeholders and how these concerns have been addressed in the ESIA process.

7. Impact Assessment

To the extent demonstrable, characterize residual impacts in terms of their magnitude, extent, duration, reversibility, and significance. The levels of impacts will be assessed using the following key tools:

- Methodology: A thorough impact analysis (***quantitative NOT generic***) and identification of feasible measures addressing each significant and moderate impact and risk.
- Environmental Impacts: Analysis of potential environmental impacts (e.g., land degradation, water and air quality, noise, waste generation, etc.).

- Social Impacts: Evaluation of potential social impacts, including displacement, changes to local livelihoods, public health, and community wellbeing.
- Cumulative Impacts: Assessment of how the project may interact with other projects or activities in the region, and the cumulative impacts on the environment and society.

8. Environmental and Social Risks and Opportunities

- Risk Assessment: Identification of key risks to the environment and local communities, including legal, environmental, social, and economic risks.
    - Potential environmental risks (e.g., habitat destruction, resource depletion)
    - Social risks (e.g., community resistance, displacement, health impacts)
    - Legal and regulatory non-compliance risks
    - Economic risks, including project delays or cost overruns
- Opportunities: Identification of potential benefits arising from the project, such as:
    - Job creation and local employment
    - Community development (e.g., infrastructure, healthcare, education)
    - Improved energy access and sustainability
    - Contribution to local and national economic growth

9. Mitigation and Management Plans

- **Mitigation Measures:** Identify avoidance, minimization and mitigation measures and significant residual impacts that cannot be mitigated and, to the extent possible, assesses the acceptability of these residual impacts. This should also include specific actions to mitigate the identified environmental and social impacts, including design modifications, operational best practices, and technological solutions. Other measures to note are thus:

  • Identify measures to enhance positive impacts and opportunities.
  • Identify differentiated measures so that adverse impacts do not fall disproportionately on the vulnerable.
  • Assess the feasibility of mitigating the E&S impacts, the capital and recurrent costs of proposed mitigation measures, and their suitability under local conditions, and the institutional, training, and monitoring requirements for the proposed mitigation measures.
  Specify issues that do not require further attention, providing the basis for this determination.

- Environmental and Social Management Plan (ESMP): A detailed plan to monitor and manage the implementation of mitigation measures, including roles and responsibilities, timelines, and resources.
- Climate Change Mitigation and Adaptation: Address the project's approach to mitigating climate change impacts and adapting to potential climate risks.

10. Monitoring and Evaluation

- Monitoring Plan: Framework for monitoring the implementation of the mitigation measures and ESMP, including frequency, parameters, and responsible entities.
- Performance Indicators: Identification of key performance indicators (KPIs) to track the effectiveness of the mitigation measures and the overall environmental and social performance of the project.
- Adaptive Management: Plans for adjusting project activities based on monitoring results and feedback from stakeholders.

11. Conclusions and Recommendations

- Summary of Findings: A concise summary of the key environmental and social impacts, along with the proposed mitigation measures.

- Project Justification: Justification for the project's viability and positive outcomes relative to its environmental and social risks.
- Further Actions: Recommendations for additional studies, monitoring, or mitigation measures that may be necessary.

Appendix: Detailed Management Plans and Supporting Documentation

The following plans and documents must be included as part of the ESIA report to ensure comprehensive environmental and social management throughout the project lifecycle:

- **Labour Management Plan (LMP)**: A detailed plan for managing labor-related impacts, including workforce accommodation, health and safety, working conditions, and grievance mechanisms for workers.
- **Waste Management Plan (WMP)**: A strategy to manage waste generated by the project, detailing waste minimization, segregation, storage, transportation, and disposal procedures.
- **Grievance Redress Mechanism (GRM)**: A clear culturally appropriate and accessible process for receiving, addressing, and resolving grievances from local communities and other stakeholders throughout the project.
- **Stakeholder Engagement Plan (SEP)**: A plan outlining how stakeholder engagement will be carried out throughout the project lifecycle, including consultation methods and feedback loops.
- **Biodiversity Management Plan (BMP)**: A strategy for managing impacts on biodiversity, including mitigation measures for habitat loss, species protection, and ecosystem restoration.
- **Health and Safety Plan (H&S Plan)**: A plan to ensure the health and safety of workers, local communities, and other stakeholders, covering site safety procedures, emergency response protocols, and health monitoring.
- **Climate Change Adaptation and Mitigation Plan**: A plan for assessing and addressing climate risks, reducing the project's carbon footprint, and enhancing resilience to climate change.

In addition, the following supporting documentation shall be included in the report:

- A list of the individuals or organizations that prepared or contributed to the ESA.
- References listing the written materials, both published and unpublished, that have been used.
- A record of meetings, consultations, and surveys with stakeholders, including those with affected people and other interested parties. The record specifies the means of stakeholder engagement that were used to obtain the views of affected people and other interested parties.
- Tables presenting the relevant data referred to or summarized in the main text.
- A list of associated reports or plans.

7 DURATION OF THE ASSIGNMENT

The Consultant shall prepare time schedules to be submitted to the E&S unit of the PMU in accordance to this TOR. The time frame for the entire consultancy services is within four (4) months of contract signing.

ANNEX TWO: ENVIRONMNETAL AND SOCIAL ASSESSMENT CHECKLIST

Project Alternatives – On-Site Checklist

Item	What to Verify on Site	Method / Evidence	Daily Check (✓)	Remarks
Alternative Location	Other feasible locations within FUAM identified	Walk-through, GPS points, maps		
Land Availability	Alternative sites free of encumbrance	Physical inspection, interviews		
Proximity to Sensitive Receptors	Distance to hostels, labs, water bodies	GPS, mapping		
Technology Options	Other renewable/energy options considered	Engineer input, design notes		
Battery Technology	Alternative battery types assessed	Vendor info, safety review		
Timing Option	Construction timing alternatives assessed	Academic calendar review		
E&S Implications	Environmental & social pros/cons documented	Field notes		

2. BASELINE ENVIRONMENTAL CONDITIONS – DAILY FIELD CHECKLIST

2.1 Climate Change Considerations

Item	What to Check	Method	Daily check ✓	Remarks
Climate Risk	Flooding, heat, wind exposure	Community interview, observation		
Climate Impact on Project	Effect on PV, batteries, access roads	Engineer + climate expert		
Project GHG Contribution	Diesel backup, logistics emissions	Inventory checklist		
Climate Adaptation Measures	Drainage, elevation. ventilation.	Design review		

2.2 Physical Environment

Parameter	What to Verify	Method	Daily Check	Remarks
Climate	Rainfall pattern, temperature	Local data, observation		
Topography	Slope, elevation, flood risk	GPS, visual survey		
Land Use	Academic, residential, open land	Mapping, inspection		
Vegetation	Type and density	Transect walk		

2.3 Environmental Quality

Parameter	What to Verify	Method	Daily Check	Remarks

Biodiversity	Flora/fauna presence	Ecological survey		
Water Quality	Surface & groundwater condition	Sampling + visual inspection		
Air Quality	Dust, emissions	Instrument + observation		
Noise	Ambient noise levels	Sound meter		

2.4 Sensitive Environmental Receptors

Item	What to verify	Method	Daily check	Remarks
Protected Areas	Nearby protected sites	GIS, authority consultation/GPS Cordinates		
Flora of Concern	Threatened species	Ecologist input		
Fauna of Concern	Wildlife presence/movement	Observation, interviews		

3. SOCIAL BASELINE – DAILY CHECKLIST

Item	What to verify	Method	Daily check	Remarks
Local Communities around the project sites	Host & adjacent communities	Mapping, interviews		
Demographics	Population structure	Surveys, records		
Socio-Economic Conditions	Livelihoods, income sources	FGDs, questionnaires		
Existing Infrastructure	Roads, power, water, health	Physical inspection		

4. STAKEHOLDER ENGAGEMENT

4.1 Vulnerable Groups & Context

Item	What to verify	Method	Daily check	Remarks
Vulnerable Groups	Widows, elderly, PWDs identified	Community mapping		
Inclusion Measures	Separate or assisted sessions	Observation		
Political Economy	Power dynamics, conflicts	Key informant interviews		

4.2 Stakeholder Identification & Engagement

Item	What to verify	Method	Daily check	Remarks
Stakeholder List	Communities, NGOs, institutions	Stakeholder register		
Consultation Technique	Meeting, survey, hearing	Engagement log		
Frequency	Adequate & documented	Attendance sheets		

5. STAKEHOLDER CONCERNS – ISSUE-BASED CHECKLIST

Concern area	What to check	Evidence	Daily Check	Remarks
Water Quality	Boreholes, streams condition	Physical inspection		
Air Quality	Dust, fumes	Observation, monitoring		
Noise	Disturbance risk	Measurement		
Waste Generation	Type & volume of waste	Site inspection		

6. DAILY SUMMARY OF FINDINGS

Items	Summary
Key Environmental Issues	
Key Social Issues	
Stakeholder Concerns Raised	
Immediate Mitigation Actions	
Issues for ESMP	

ANNEX THREE: STAKEHOLDERS CONSULTATION ATTENDANCE SHEET

RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION: FUAMB DATE: 28-01-2026

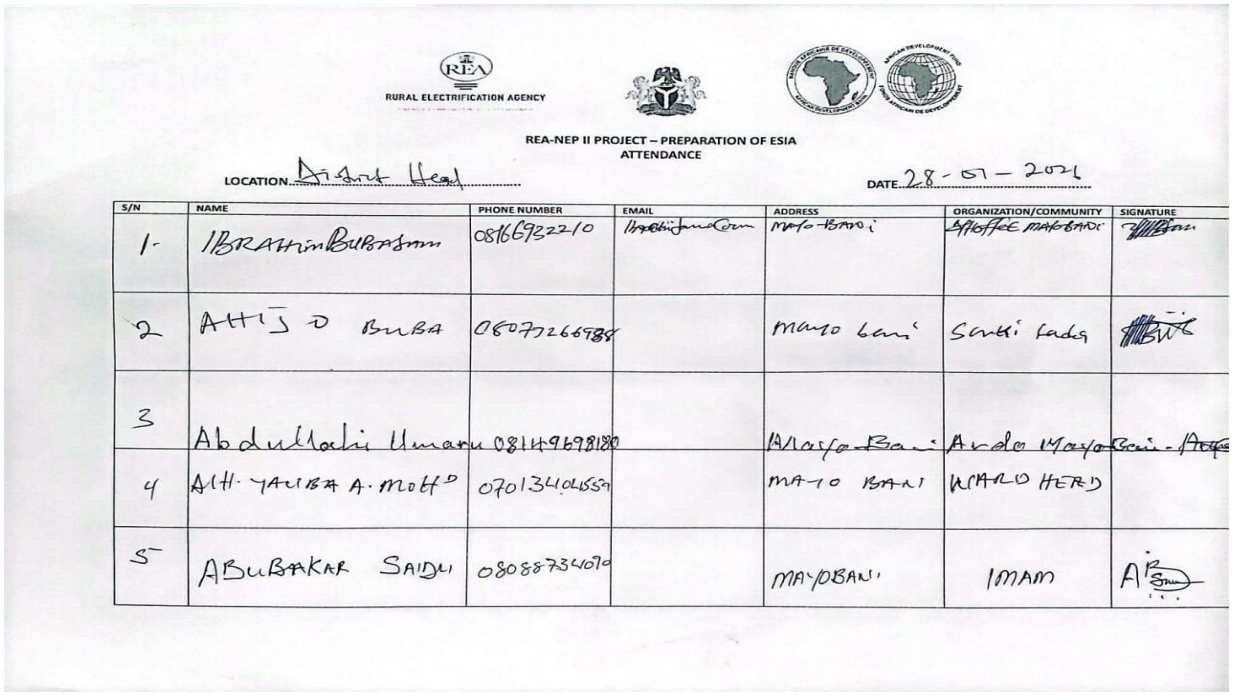
S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
6.	Col DS Gurin (rtd)	07089990999	dsthinegurin@gmail.com	Security Dept FUAMB	FUAMB	[signature]
7	Oladeinde Babatunde	08154116404	oladeinde babatunde @gmail.com	Ecofield Consult / Abuja	ECOFIELD	[signature]
8.	Ar. MB Sajo	08163618126				
9	Engr. Ayuba B. H	08064786368	leokabra01@gmail.com	"	"	[signature]
10	Henry Okoye	07033738795	henryokoye555@gmail.com	Ecofield Consult Abj.	Ecofield	[signature]

RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION: FUAMB DATE: 28-01-2026

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
1.	Prof. Bitrus D. Tarfa	08037033166	vc@fuamb.edu.ng	FUAMB	FUAMB	[signature]
2	Fatima Bashir (Mrs)	08069719910	reg@fuamb.edu.ng	FUAMB	"	[signature]
3	Isiaka Taofiq	08039285692	t.ladi53@gmail.com	FUAMB	"	[signature]
4	Dr Yakubu Abuga	08030956679	Yakuzonas@gmail.com	FUAMB	"	[signature]
5	Arc. Suleiman Hamma	08034701536	shawdecon-sult@yahoo.com	FUAMB	"	[signature]

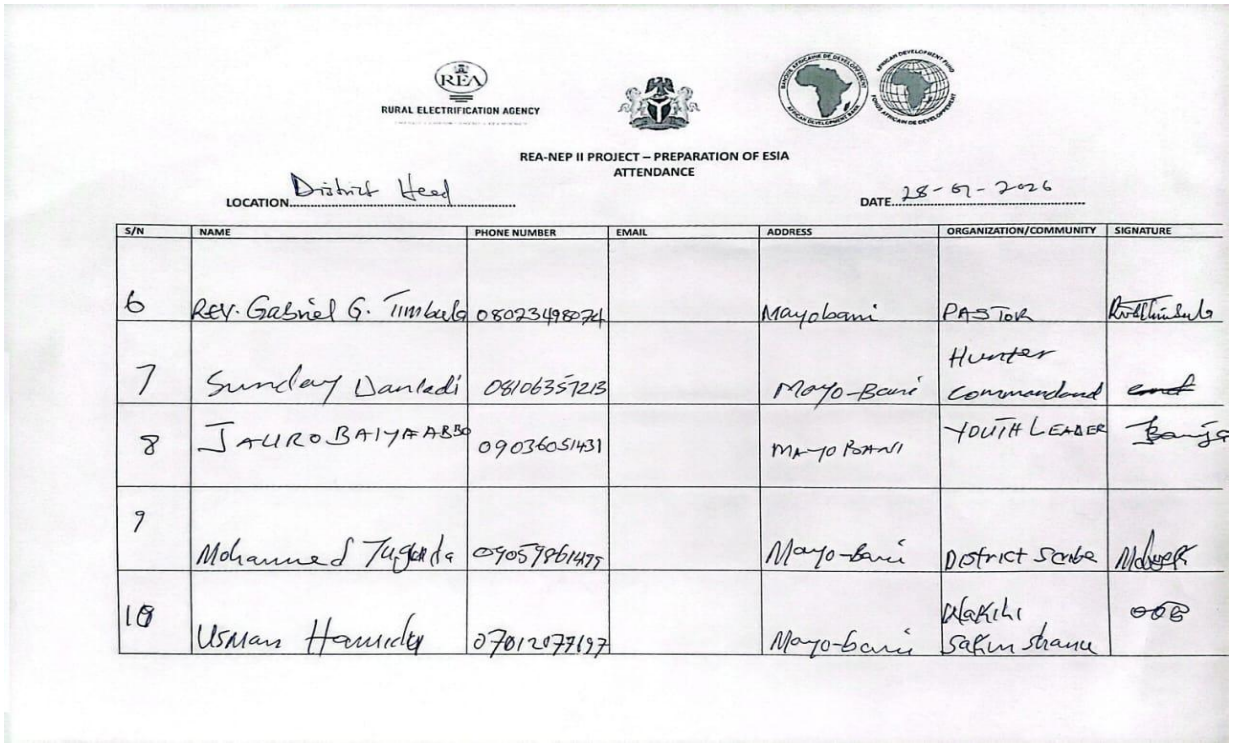


RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION District Head DATE 28-07-2026

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
1	IBRAHIM BUBA	08166932210		Mayo-Bani	SAHOFFEE MAYOBANI	
2	AHIJO BUBA	08073266988		Mayo Bani	Sarki Fada	
3	Abdullahi Umaru	08149698180		Mayo-Bani	Arabic Mayo-Bani	
4	AIH. YALIBA A. MOH'D	07013404659		MAYO BANI	WARD HEAD	
5	ABUBAKAR SAIDU	08088734070		MAYOBANI	IMAM	



RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION District Head DATE 28-07-2026

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
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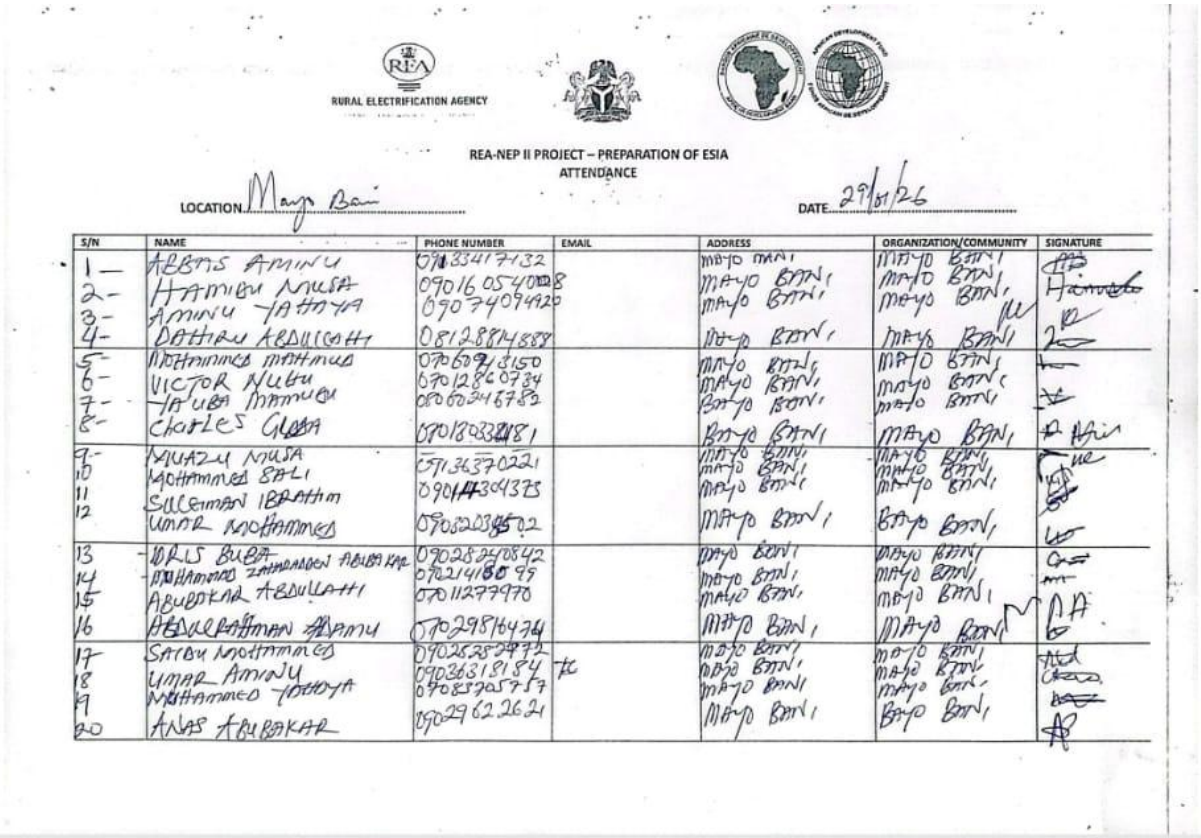
8	JAURO BAIYA ABBO	09036051431		MAYO BANI	YOUTH LEADER	
9	Mohammed Tukura	09057961477		Mayo-Bani	District Scribe	
10	Usman Hamidu	07012077197		Mayo-Bani	Wakili Sakin Shanu	



RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION: Mayo Bani DATE: 29/01/26

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
1	ABBAS AMINU	0813341 7132		MAYO BANI	MAYO BANI	
2	HAMIDU MUSA	0901605408		MAYO BANI	MAYO BANI	
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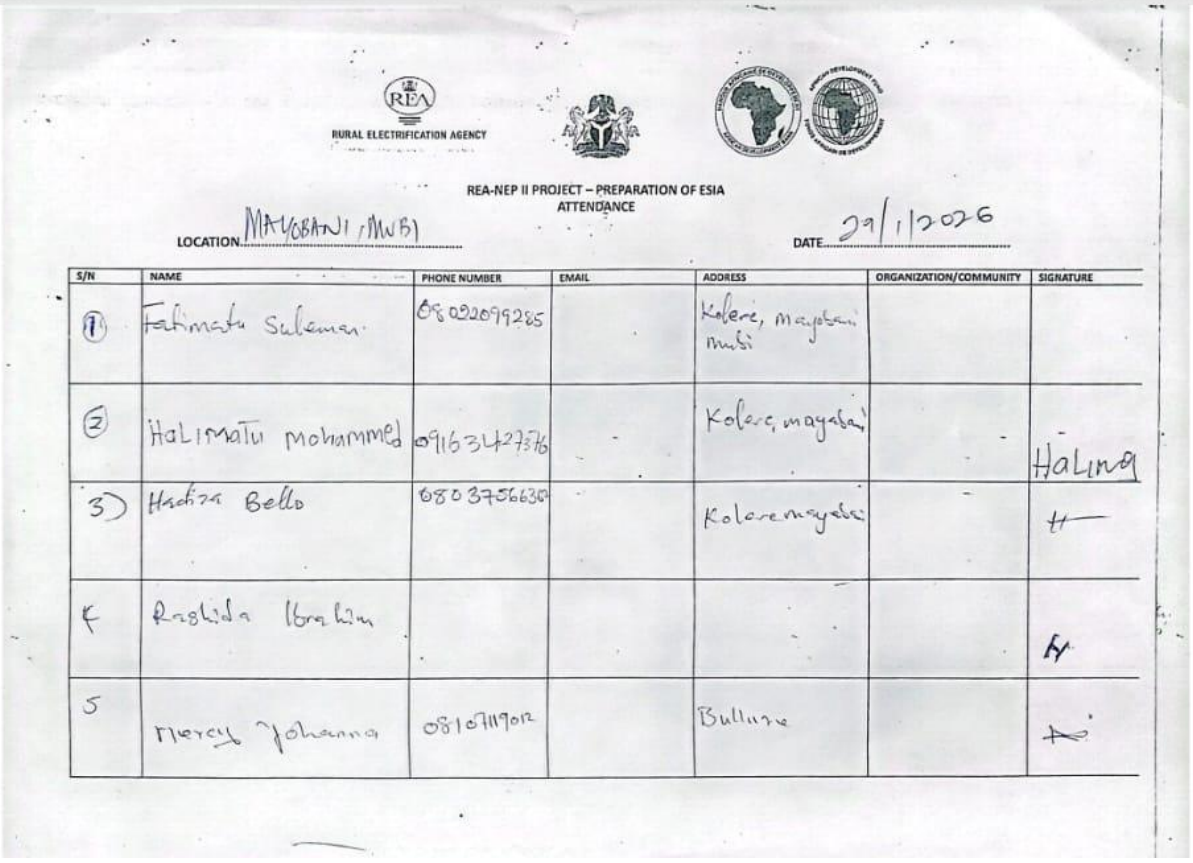
4	DAHIRU ABDULLAHI	08128814888		MAYO BANI	MAYO BANI	
5	MOHAMMED MAHMUD	07060978150		MAYO BANI	MAYO BANI	
6	VICTOR MUHU	07012860734		MAYO BANI	MAYO BANI	
7	YAUBA MAMUDU	08060346783		MAYO BANI	MAYO BANI	
8	CHARLES GLADA	07018033481		MAYO BANI	MAYO BANI	
9	MUAZU MUSA	07136370221		MAYO BANI	MAYO BANI	
10	MOHAMMED SALI	09014304375		MAYO BANI	MAYO BANI	
11	SULEIMAN IBRAHIM			MAYO BANI	MAYO BANI	
12	UMAR MOHAMMED	07032038502		MAYO BANI	MAYO BANI	
13	IDRIS BUBA	09028240842		MAYO BANI	MAYO BANI	
14	MUHAMMED ZAHARADEEN ABUBAKAR	07021418095		MAYO BANI	MAYO BANI	
15	ABUBAKAR ABDULLAHI	07011277970		MAYO BANI	MAYO BANI	
16	ABDULRAHMAN ADAMU	07029816474		MAYO BANI	MAYO BANI	
17	SAIDU MOHAMMED	09025252472		MAYO BANI	MAYO BANI	
18	UMAR AMINU	09036318184		MAYO BANI	MAYO BANI	
19	MUHAMMED YAHAYA	09085705757		MAYO BANI	MAYO BANI	
20	ANAS ABUBAKAR	09029622621		MAYO BANI	MAYO BANI	



RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION: MAYOBANI, MWB DATE: 29/1/2026

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
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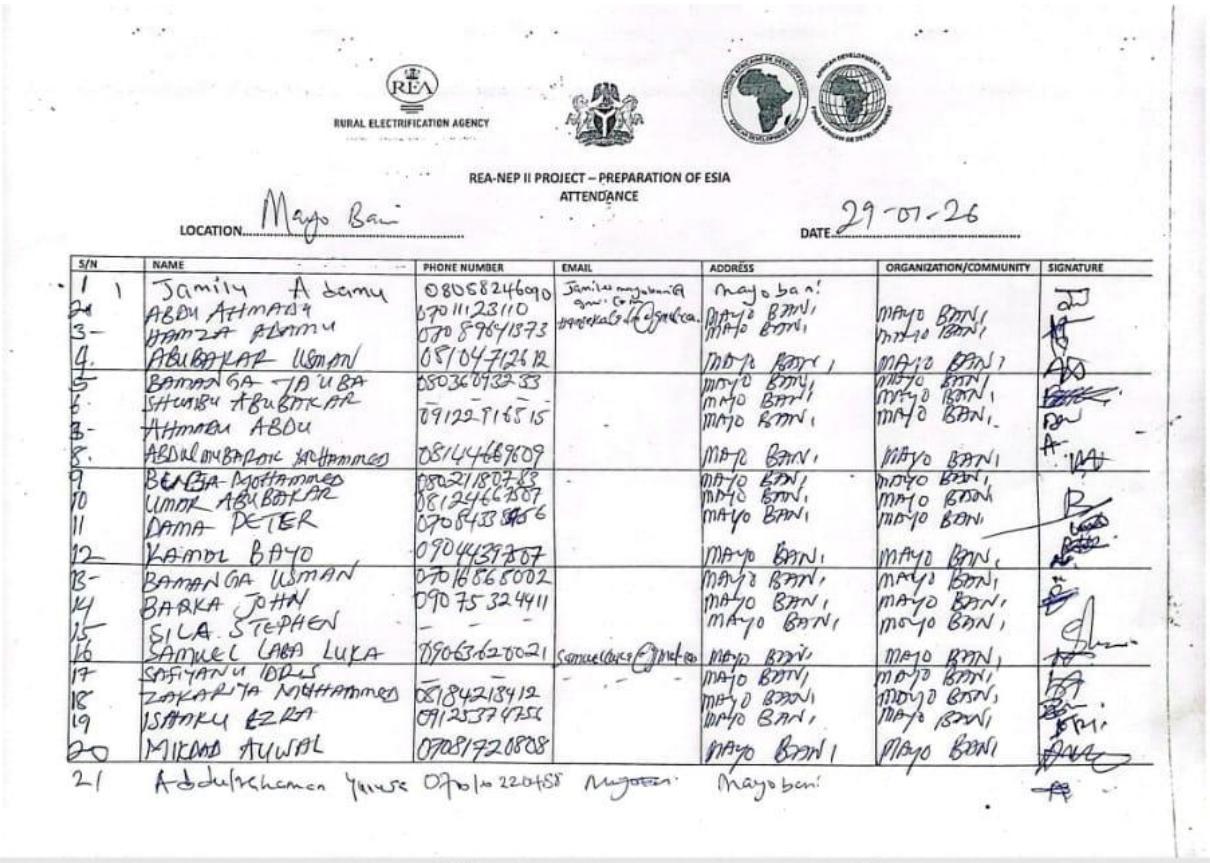
3	Hadiza Bello	08037566360		Kolere mayobi		
4	Rashida Ibrahim					
5	Mercy Johanna	08107119012		Bulluwe		



REA
RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION: Mayo Bani DATE: 29-01-26

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
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3	HAMZA ALIYU	07089641873		MAYO BANI,	MAYO BANI,	
4	ABUBAKAR USMAN	08104712512		MAYO BANI,	MAYO BANI,	
5	BAMANGA TIJUBA	08036032353		MAYO BANI,	MAYO BANI,	
6	SHUAIBU ABUBAKAR	09122716515		MAYO BANI,	MAYO BANI,	
7	AHMADU ABDU			MAYO BANI,	MAYO BANI,	
8	ABDULMUMINI MUHAMMED	08144689609		MAYO BANI,	MAYO BANI,	
9	BELGA MUHAMMED	08021807283		MAYO BANI,	MAYO BANI,	
10	UMAR ABUBAKAR	08124667807		MAYO BANI,	MAYO BANI,	
11	DAMA PETER	07084338966		MAYO BANI,	MAYO BANI,	
12	KAMDL BAYO	07044237807		MAYO BANI,	MAYO BANI,	
13	BAMANGA USMAN	07016868002		MAYO BANI,	MAYO BANI,	
14	BARKA JOHN	09075324411		MAYO BANI,	MAYO BANI,	
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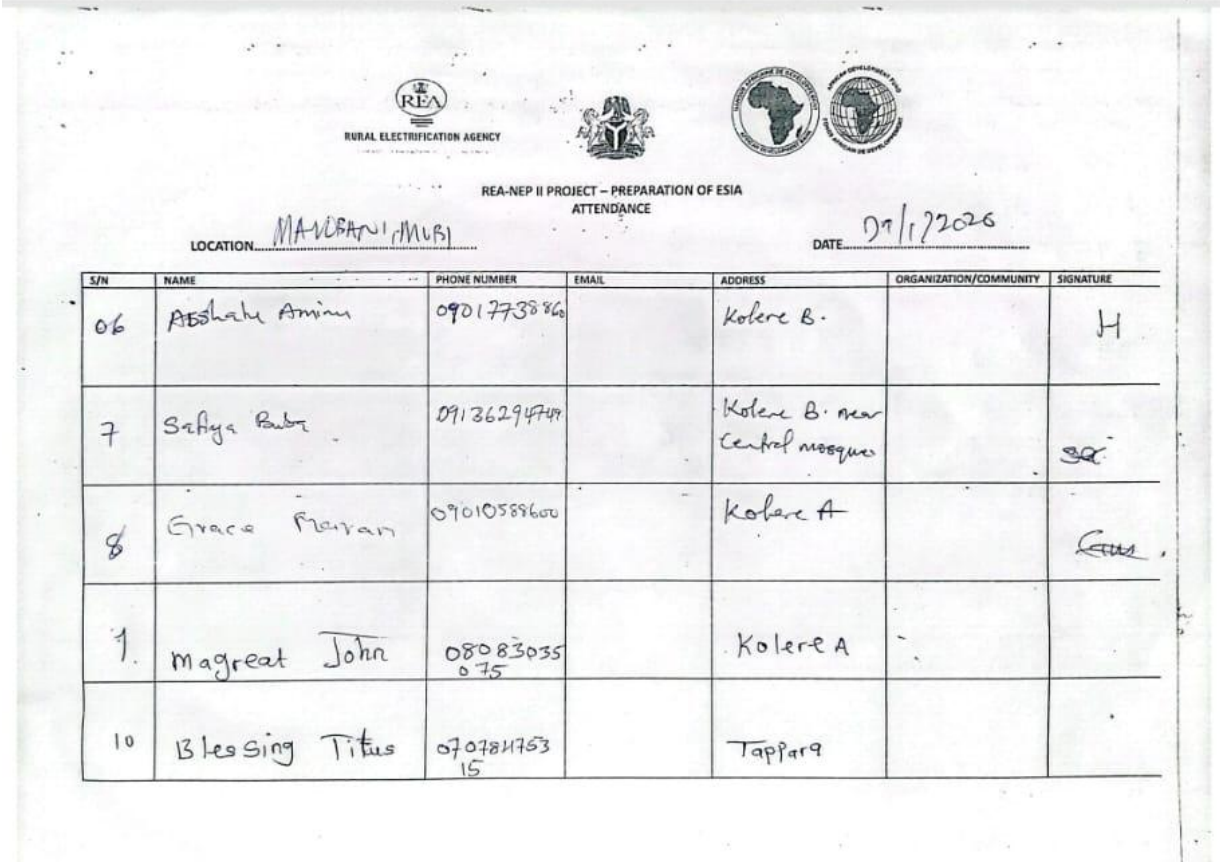
18	ZAKARIYA MUHAMMED	08184218412		MAYO BANI,	MAYO BANI,	
19	ISAMKU EZRA	09125374751		MAYO BANI,	MAYO BANI,	
20	MIKAD AUWAL	07081720808		MAYO BANI	MAYO BANI	
21	Abdulrahaman Yerwa	07010220458	Nigeria	Mayobani		



REA
RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION: MAVERANI, MUBI DATE: 27/1/2026

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
06	Abdulahi Aminu	09017738866		Kolere B.		
7	Safya Baba	09136294749		Kolere B. near Central mosque		
8	Grace Maryam	09010588600		Kolere A		
9	Magreat John	08083035075		Kolere A		
10	Blessing Titus	07078417531 5		Tappara		

ANNEX FOUR: WASTE MANAGEMENT PLAN

BACKGROUND

This Waste Management Plan (WMP) has been developed as part of the Environmental and Social Impact Assessment (ESIA) for the proposed solar hybrid mini-grid at the Federal University of Agriculture, Mubi (FUAMB), Adamawa State, under the Energizing Education Programme III of the Nigeria Electrification Project Phase II (Desert-to-Power), financed by the African Development Bank (AfDB).

The purpose of this plan is to ensure that effective procedures are implemented for the generation, handling, storage, transportation, and disposal of all waste streams arising from project activities across all phases. The plan prescribes measures for waste collection, temporary storage, safe management, and disposal, and includes provisions for recovery, reuse, and recycling in accordance with the waste management hierarchy.

This WMP has been prepared with due cognizance of the AfDB Integrated Safeguards System 2023, the World Bank Environmental, Health and Safety (EHS) Guidelines on Waste Management, the NESREA Act 2018 and applicable subsidiary regulations, and the National Environmental (Sanitation and Wastes Control) Regulations 2009. It shall be reviewed and updated as further detail on waste quantities and categorisation becomes available during construction and operational stages.

2.0 Regulatory and Policy Framework

The preparation and implementation of this Waste Management Plan is guided by the following regulatory instruments:

- AfDB Integrated Safeguards System 2023, Operational Safeguard 3 on Pollution Prevention and Control
- World Bank Environmental, Health and Safety General Guidelines on Waste Management
- National Environmental Standards and Regulations Enforcement Agency (NESREA) Act 2018
- National Environmental (Sanitation and Wastes Control) Regulations 2009
- NESREA National Environmental Regulations on the Electrical and Electronic Sector 2011
- Federal Ministry of Environment (FMEnv) Guidelines on Hazardous Waste Management
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, to which Nigeria is a signatory
- Adamawa State Environmental Law 2021

3.0 General Waste Management Strategy

An integrated approach to waste management is required across all phases of this project. Waste management is premised on the principle of a management hierarchy, ranging from the most desirable to the least desirable option, as follows:

- Reduce: Avoid waste generation by minimising the quantity of materials used. This is the most preferred and cost-effective option.
- Reuse: Use products or materials again for the same or similar purpose without reprocessing, thereby reducing waste generation and energy consumption.
- Recycle: Process waste into a usable non-waste product, conserving energy and reducing landfill pressure.
- Dispose: Where reduction, reuse, and recycling are not feasible, waste shall be removed and disposed of at a licensed landfill or appropriately approved facility.

The following overarching good management practices shall apply across all project phases:

- Waste generation shall be limited to the lowest practicable level at all times.
- Non-hazardous wastes shall be segregated from hazardous wastes at source.
- Wastes destined for recycling shall be segregated by type.
- Hazardous materials use shall be minimised; personnel handling hazardous waste shall be trained accordingly.
- Spills of hazardous materials shall be prevented through sensible materials management and regular equipment inspections.
- Waste storage areas shall have secondary containment or spill trays.
- Under no circumstances shall waste be burnt or disposed of on site.

4.0 Classification of Wastes

Project activities will generate both non-hazardous and hazardous waste streams, as described below.

Non-Hazardous Wastes

Non-hazardous wastes expected from project activities include domestic waste, recyclable materials such as paper, glass, metals, wooden waste, and tin cans, packaging waste, waste tyres, and excavation and concrete waste generated from civil works and foundations.

Hazardous Wastes

Hazardous wastes expected from project activities include electrical wastes such as damaged or expired batteries, accumulators, inverters, and PV panels, waste oil from equipment and vehicle maintenance, waste paint and chemical residues, and other hazardous waste related to operation, maintenance, and decommissioning activities. These wastes require dedicated management given their potential to cause significant environmental and human health harm if improperly handled.

5.0 Waste Streams by Project Phase and Management Method

The tables below present the expected waste streams for each project phase, their classification, and the prescribed management method.

5.1 Pre-Construction Phase

Project Phase	Activity / Waste Aspect	Waste Type	Classification	Management Method
Pre-Construction	Vegetation clearing	Vegetation, logs, mulched timber, weeds	General Solid (Non-putrescible)	Reuse as compost, soil conditioner, or woodchip mulch on site
	Site clearing and preparation	Excavated materials and topsoil	General Waste	Beneficial reuse on site; balance cut and fill earthworks to optimise reuse
	Site clearing and preparation	Potentially contaminated soils	Hazardous Waste	Off-site disposal at an approved FMEnv or NESREA-licensed facility
	Site clearing and preparation	Scrap metal from site preparation	General Solid (Non-putrescible)	Off-site recycling
	Mobilization of equipment	Packaging materials (wood, plastic, cardboard)	General Solid (Non-putrescible)	Off-site disposal at an approved facility
	Mobilization of equipment	Domestic waste from workers (food packs, cans, bottles)	General Solid (Putrescible)	Off-site disposal at an approved facility

5.2 Construction Phase

Project Phase	Activity / Waste Aspect	Waste Type	Classification	Management Method
Construction	Civil works and foundations	Concrete, brick, asphalt and gravel	General Solid (Non-putrescible)	Crushed and used as backfill or road base
	Civil works and foundations	Steel reinforcing and scrap metal	General Solid (Non-putrescible)	Off-site recycling
	Civil works and foundations	Timber formwork	General Solid (Non-putrescible)	Reuse on site where possible; off-site recycling otherwise
	Civil works and foundations	Sediment from earthworks and excavations	General Solid (Non-putrescible)	Beneficial reuse on site as fill material

Project Phase	Activity / Waste Aspect	Waste Type	Classification	Management Method
	Electrical and cabling works	Conduits, pipes and bulk electrical cabling	General Solid (Non-putrescible)	Off-site recycling
	Electrical and cabling works	Packaging materials (wood, plastic, cardboard, metals)	General Solid (Non-putrescible)	Off-site disposal at an approved facility
	Electrical and cabling works	Empty oil and chemical drums	General Solid (Non-putrescible)	Off-site recycling by licensed contractor
	Electrical and cabling works	Spill clean-ups, waste paint and chemicals	Hazardous Waste	Off-site disposal at an approved FMEnv or NESREA-licensed facility
	Equipment maintenance	Waste oil, grease, fuel and other fluids	Liquid Hazardous Waste	Off-site disposal at an approved facility; no discharge to ground or water
	Equipment maintenance	Used air and oil filters, worn components and rags	General Solid (Non-putrescible)	Off-site disposal at an approved facility
	General site operations	Domestic waste from workers (food packs, cans, bottles)	General Solid (Putrescible)	Off-site disposal at an approved facility
	General site operations	Sanitary waste and sewage	General Solid (Putrescible)	Off-site disposal at approved facility or on-site sewer system
	General site operations	Wastewater and stormwater	Liquid	Off-site disposal or on-site sewer system; no uncontrolled discharge
	Office operations	Paper, cardboard and plastic	General Solid (Non-putrescible)	Off-site recycling
	Office operations	Glass bottles and aluminium cans	General Solid (Non-putrescible)	Off-site recycling
	Office operations	Ink cartridges and toner	General Solid (Non-putrescible)	Off-site recycling by licensed contractor

5.3 Operation and Maintenance Phase

Project Phase	Activity / Waste Aspect	Waste Type	Classification	Management Method
Operation and Maintenance	Routine O&M activities	Waste oil and lubricants from equipment servicing	Liquid Hazardous Waste	Off-site disposal at an approved facility; no discharge to ground or water
	Routine O&M activities	Used filters, worn mechanical components and rags	General Solid (Non-putrescible)	Off-site disposal at an approved facility
	Routine O&M activities	General site waste (cardboard, paper, plastic, tins)	General Solid (Non-putrescible)	Off-site recycling or disposal at approved facility
	Battery and e-waste	Damaged or expired batteries and battery accumulators	Hazardous Waste (E-waste)	Stored in dedicated bonded containment; handed to NESREA-licensed e-waste handler or returned to supplier under EPR arrangement
	Battery and e-waste	End-of-life or damaged inverters	Hazardous Waste (E-waste)	Managed under EPR plan; handed to NESREA-licensed e-waste handler

Project Phase	Activity / Waste Aspect	Waste Type	Classification	Management Method
	Battery and e-waste	Damaged or degraded PV panels	Hazardous Waste (E-waste)	Managed under EPR plan in accordance with NESREA Electrical and Electronic Sector Regulations 2011
	Battery and e-waste	Waste electrical and electronic components	Hazardous Waste (E-waste)	Off-site disposal through certified e-waste management facility in compliance with Basel Convention
	General site operations	Domestic waste from operational staff	General Solid (Putrescible)	Off-site disposal at an approved facility
	General site operations	Sanitary waste and sewage	General Solid (Putrescible)	Off-site disposal at approved facility or on-site sewer system

5.4 Decommissioning Phase

Project Phase	Activity / Waste Aspect	Waste Type	Classification	Management Method
Decommissioning	Dismantling of solar arrays	PV panels and mounting structures	Hazardous Waste (E-waste)	Inventoried; reusable components redirected for refurbishment; remainder disposed through certified e-waste facility in compliance with Basel Convention
	Dismantling of electrical systems	Battery banks, inverters and transformers	Hazardous Waste (E-waste)	Inventoried; managed under EPR and NESREA Electrical and Electronic Sector Regulations 2011
	Dismantling of electrical systems	Electrical cabling and conduits	General Solid (Non-putrescible)	Off-site recycling by licensed contractor
	Demolition of structures	Concrete, brick and rubble	General Solid (Non-putrescible)	Crushed for reuse as fill or road base; remainder to licensed landfill
	Demolition of structures	Scrap metal from structural components	General Solid (Non-putrescible)	Off-site recycling
	Site remediation	Contaminated soils (if any)	Hazardous Waste	Off-site disposal at approved FMEnv or NESREA-licensed facility
	Site remediation	General demolition waste and debris	General Waste	Off-site disposal at a licensed landfill by certified contractor

6.0 Phase-Specific Waste Management Requirements

6. Pre-Construction and Construction Phase

6.1.1 Waste Assessment and Inventory

The Environmental Officer shall develop, implement, and maintain a waste inventory reflecting all waste generated during pre-construction and construction, covering both general and hazardous waste streams. Construction methods and materials shall be carefully considered to maximise opportunities for waste reduction, reuse, and recycling. Targets for waste recovery shall be established once the inventory is in place.

6.1.2 Waste Collection, Handling, and Storage

Each contractor and subcontractor shall implement a waste segregation system using separate bins for food waste, plastics, paper, wood, glass, cardboard, and metals. Waste collection bins and hazardous waste containers shall be provided by the principal contractor and placed at designated locations across the site. A dedicated waste storage area shall be established on site for the temporary storage of all waste streams prior to removal.

Colour coding and signage shall be used to differentiate disposal bins by waste stream type. Hazardous waste shall be stored within a bonded containment area constructed in accordance with FMEnv requirements, and the volume of waste stored shall not exceed 110 percent of the bund capacity. Waste storage areas shall be positioned away from water courses and covered with tarpaulins or roofing to prevent water ingress. Portable sanitation facilities shall be monitored and maintained daily. Under no circumstances shall waste be burnt on site.

6.1.3 Disposal

Waste shall be removed from site on a regular basis as determined by the Environmental Officer, taking into account the volumes generated at different stages of construction. All waste removal shall be undertaken by a registered and licensed contractor, who shall provide waste manifests for all removals at least once a month and supply proof of appropriate disposal at a licensed landfill or approved facility.

6.1.4 Record Keeping

Documentation including waste manifests and certificates of safe disposal shall be maintained, detailing the quantity, nature, and fate of all regulated waste for audit purposes. Waste management shall form part of monthly reporting requirements, covering volumes generated, waste types, storage arrangements, and final disposal.

6.1.5 Training

Training and awareness on waste management shall be provided to all employees and contractors as part of on-site induction and periodic awareness sessions.

6.2 Operation and Maintenance Phase

During the operational phase, waste generation is expected to be limited, consisting primarily of general waste such as cardboard, paper, plastic, tins, metals, and vegetation materials. Limited hazardous waste from end-of-life electrical and electronic equipment may also arise during maintenance activities.

The O&M Contractor and Site Manager shall develop and maintain a waste inventory covering all general and hazardous waste streams generated during operations. Separate bins shall be provided for general and hazardous waste, and recyclable materials shall be removed from the waste stream and stored separately. All waste shall be removed regularly by a licensed contractor and disposed of at an appropriately licensed landfill, with proof of disposal retained.

6.3 Battery and Electronic Waste (E-Waste) Management

The solar hybrid mini-grid involves the installation and long-term operation of battery energy storage systems, inverters, PV panels, and associated electrical and electronic equipment. These components are a significant source of hazardous e-waste over the project lifecycle, particularly at end of life or upon damage during operation. Their management requires dedicated attention given the toxic constituents they may contain, including lead, cadmium, lithium, and other heavy metals.

Battery waste and e-waste generated across all project phases shall be managed in accordance with the NESREA National Environmental Regulations on the Electrical and Electronic Sector 2011, the FMEnv guidelines on hazardous waste management, and the Extended Producer Responsibility (EPR) framework. At the point of procurement, the EPC Contractor shall confirm and document the EPR obligations of all equipment suppliers, including take-back and end-of-life management arrangements for batteries, inverters, and PV modules.

During the operational phase, damaged, expired, or end-of-life batteries and inverters shall be classified as hazardous waste and stored separately in a dedicated, covered, and bonded containment area prior to collection and disposal. No battery or electronic component shall be dismantled, buried, or disposed of on site under any circumstances. All such waste shall be handed over to a NESREA-licensed e-waste handler or returned to the equipment supplier under the applicable EPR arrangement, with waste transfer documentation retained for audit purposes.

During the decommissioning phase, all PV panels, battery banks, inverters, transformers, and electrical cabling removed from the site shall be inventoried and categorised by waste type prior to disposal. Reusable components shall be identified and redirected for reuse or refurbishment where feasible. All remaining e-waste shall be disposed of through certified and licensed e-waste management facilities in compliance with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.
The Environmental Officer shall maintain a dedicated e-waste register recording the type, quantity, storage location, collection date, and final disposal destination of all battery and electronic waste generated throughout the project.

6.4 Decommissioning Phase
The project is expected to operate for a minimum of 25 years and potentially up to 40 years with proper maintenance. Waste management during decommissioning shall include notifying the appropriate ministries including FMEnv and NESREA prior to commencement of decommissioning activities, applying best practices in demolition and dismantling to prevent pollution or contamination from improper waste handling, managing all associated e-wastes under the EPR framework and NESREA Electrical and Electronic Sector Regulations 2011, and disposing of all other waste types through certified waste managers at appropriately licensed landfills.

7.0 Monitoring of Waste Management Activities
Records shall be kept of the volumes and mass of the different waste streams collected from the site throughout the project lifecycle. The appointed waste contractor shall provide monthly reports to the operator containing the following information:
- Monthly volumes and mass of the different waste streams collected
- Monthly volumes and mass of waste disposed of at a landfill site
- Monthly volumes and mass of waste recycled
- Data illustrating progress compared to previous months

These reports will aid in monitoring the effectiveness of the waste management procedures in place and identify any need for revision or corrective action.

8.0 Waste Management Cost
Finances have been allocated for proper waste management across all project phases. The cost of mitigation and monitoring for waste management from pre-construction through to operations and maintenance has been factored into the respective phase budgets in the ESMP, covering training, personal protective equipment, receptacles, containment areas, and disposal costs. The cost of waste management during the decommissioning phase shall be developed at that stage, reflecting the specific quantities and types of waste to be managed at that time.

9.0 Conclusion
This Waste Management Plan has been prepared to ensure that all wastes generated from the proposed solar hybrid mini-grid project at FUAMB are effectively managed, minimised, and disposed of in an environmentally responsible manner consistent with applicable Nigerian regulations and AfDB safeguard requirements. The effectiveness of the plan depends on prompt and systematic waste management practices, the use of appropriately licensed contractors, and adequate supervision by the REA-PMU and relevant regulatory authorities throughout the project lifecycle.

ANNEX FIVE: CLIMATE CHANGE ADAPTATION AND MITIGATION PLAN

Introduction

This Climate Change Adaptation and Mitigation Plan has been developed for the proposed Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB), Adamawa State. The plan outlines measures to enhance the project's resilience to climate variability and change, while also contributing to climate change mitigation through reduced greenhouse gas (GHG) emissions.

The plan is prepared in line with national climate policies and international best practices, including the requirements of the African Development Bank.

Climate Context of the Project Area

Mubi, located in Adamawa State, lies within the Sudan Savannah ecological zone and is characterized by:

- High temperatures, particularly during the dry season
- Seasonal rainfall with increasing variability
- Occasional intense rainfall events leading to localized erosion and flooding
- Increasing risk of prolonged dry periods

These conditions present potential risks to infrastructure performance and environmental sustainability.

Climate Change Risks to the Project

Climate Risk	Potential Impact on Project
Increased temperature	Reduced efficiency of solar panels and battery systems
Intense rainfall events	Soil erosion, flooding of trenches, damage to infrastructure
Strong winds	Damage to solar panel mounting structures
Prolonged dry periods	Increased dust generation affecting panel efficiency
Extreme weather events	Disruption of construction and operation activities
Lightning strike	Damage to solar PV panels, inverters, transformers, and other electrical equipment, resulting in service interruption, fire hazards, and increased maintenance requirements.

Climate Change Mitigation Measures

The project inherently contributes to climate change mitigation through the use of renewable energy. Additional measures include:

Reduction of Greenhouse Gas Emissions

- Deployment of solar photovoltaic (PV) systems to reduce reliance on diesel generators
- Optimization of hybrid system design to minimize fossil fuel backup usage
- Promotion of energy efficiency within the university facilities

Sustainable Construction Practices

- Use of well-maintained equipment to reduce emissions
- Minimization of material wastage during construction
- Efficient logistics planning to reduce fuel consumption

Waste Management

- Proper handling and disposal of construction waste
- Safe management of hazardous materials (e.g., batteries)
- Promotion of recycling where feasible

Protection Against Lightning and Extreme Weather Events

- Incorporation of lightning protection systems for solar PV arrays and associated electrical infrastructure.
- Installation of surge protection devices (SPDs) to safeguard electrical equipment against transient overvoltages.
- Provision of adequate earthing and grounding systems for all PV installations and electrical equipment.
- Routine inspection and maintenance of lightning protection and earthing systems to ensure continued effectiveness.

Climate Change Adaptation Measures

Infrastructure Design and Siting

- Elevation of critical equipment (e.g., inverters, batteries) to prevent flood damage
- Design of adequate drainage systems to manage stormwater runoff
- Use of corrosion-resistant and heat-tolerant materials

Erosion and Soil Management

- Stabilization of exposed soils through compaction and vegetation where applicable
- Installation of erosion control measures (e.g., sandbags, drainage channels)

Solar Panel Efficiency Management

- Regular cleaning of solar panels to reduce dust accumulation
- Proper spacing and orientation to optimize airflow and reduce overheating

Structural Stability

- Design and installation of mounting structures to withstand local wind conditions
- Regular inspection and maintenance of structural components

Operational Resilience

- Development of maintenance schedules to ensure system reliability
- Training of personnel on climate-related risks and response measures

Institutional Responsibilities

Activity	Responsible Party
Implementation of mitigation measures	Contractor / Operator
Monitoring of climate risks	REA- NEP / Supervising Engineer
Compliance with standards	Federal Ministry of Environment
Oversight and reporting	African Development Bank / REA

Monitoring Indicators

Aspect	Indicator	Frequency
Solar efficiency	Energy output vs expected performance	Monthly
Erosion control	Presence of erosion features	After rainfall
Drainage performance	Absence of flooding or waterlogging	During rainy season
Structural integrity	Condition of mounting structures	Quarterly
Waste management	Proper disposal records	Monthly

Capacity Building and Awareness

- Training of workers on climate-resilient construction practices
- Awareness programs for facility operators on system maintenance under varying climatic conditions
- Integration of climate considerations into routine operational procedures
- reducing greenhouse gas emissions while ensuring reliable and climate-resilient energy supply.

ANNEX SIX: LABOUR MANAGEMENT PLAN

1.0 Introduction

This Labour Management Plan (LMP) has been developed for the proposed Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB), Adamawa State. The LMP outlines the approach to managing labour and working conditions in a manner that promotes fair treatment, non-discrimination, and safe working environments throughout the project lifecycle.

The plan is prepared in line with national labour laws and international best practices, including the requirements of the African Development Bank.

2.0 Types of Project Workers

The project is expected to engage the following categories of workers:

Direct Workers

- Personnel engaged by the Rural Electrification Agency (REA) and project consultants
- Supervising engineers (including Project Owner's Engineer – POE)

Contracted Workers

- Workers employed by contractors and sub-contractors for construction and installation activities
- Skilled and unskilled labour for civil, electrical, and mechanical works

Community Workers (Where Applicable)

- Local labour engaged for minor site activities (e.g., clearing, logistics support)

3.0 Key Labour Risks

Risk Category	Potential Issues
Occupational Health and Safety (OHS)	Injuries from equipment, electrical hazards, falls, trenching risks
Labour influx	Pressure on local resources, potential community tension
Worker misconduct	Conflict with host community, inappropriate behaviour
Child labour	Engagement of underage workers
Forced labour	Unfair or coercive employment practices
Gender-based risks	Sexual Exploitation and Abuse (SEA), Sexual Harassment (SH)
Poor working conditions	Lack of PPE, inadequate welfare facilities

4.0 Labour Management Measures

- **Employment Principles**
  - Equal opportunity employment based on qualifications and competence
  - No discrimination based on gender, religion, ethnicity, or social status
  - Preference for local labour where feasible

- **Working Conditions**
  - Clear terms of employment (contracts, wages, working hours)
  - Compliance with national labour regulations
  - Provision of adequate welfare facilities (water, sanitation, rest areas)

- **Occupational Health and Safety (OHS)**
  - Development and implementation of a site-specific Health, Safety and Environment (HSE) Plan
  - Mandatory use of appropriate Personal Protective Equipment (PPE)
  - Regular toolbox talks and safety briefings
  - Provision of first aid kits and emergency response procedures
  - Safe handling of equipment and electrical systems

- **Code of Conduct**

All workers shall sign and adhere to a Code of Conduct that includes:

- Respect for local communities and cultural norms
- Prohibition of SEA/SH and gender-based violence (GBV)
- Prohibition of child labour and forced labour
- Compliance with safety rules and regulations

- **Prevention of Child and Forced Labour**
  - Minimum employment age of 18 years for hazardous work
  - Verification of worker age through valid identification
  - Voluntary employment without coercion

- **Gender and Social Inclusion**
  - Promotion of women participation where feasible
  - Awareness programs on GBV, SEA, and SH
  - Safe and inclusive working environment for all workers

5.0 Worker Grievance Redress Mechanism (GRM)

A dedicated grievance mechanism shall be established for workers to raise concerns related to:

- Working conditions
- Wages and benefits
- Harassment or discrimination
- Safety concerns
- **GRM Features:**
- Accessible and confidential
- Timely response and resolution
- Proper documentation of grievances
- No retaliation against complainants

6.0 Roles and Responsibilities

Entity	Responsibilities
Contractor	Implementation of LMP, worker management, OHS compliance
Supervising Engineer / POE	Monitoring compliance with labour and safety requirements
Rural Electrification Agency (REA)	Oversight and enforcement of labour standards
African Development Bank	Monitoring compliance with safeguard requirements

7.0 Monitoring Indicators

Aspect	Indicator	Frequency
PPE usage	% of workers using PPE correctly	Daily
Safety training	Number of toolbox talks conducted	Weekly
Incidents	Number of accidents/incidents recorded	Monthly
Labour conditions	Availability of contracts and welfare facilities	Monthly
GRM	Number of grievances received and resolved	Monthly
Gender inclusion	% of female workers (where applicable)	Monthly

ANNEX SEVEN: HSE PLAN

1.0 INTRODUCTION

All projects present inherent health, safety, and environmental (HSE) risks that must be effectively managed to prevent accidents, injuries, and environmental harm. This HSE Plan has been developed for the proposed Solar Hybrid Mini-Grid Project at the Federal University of Agriculture, Mubi (FUAMB), Adamawa State, to ensure compliance with applicable Occupational Health and Safety (OHS) standards and best practices.

The plan provides a structured framework for identifying, assessing, and managing HSE risks associated with the project. The project team shall ensure high performance standards and full compliance with contractual and regulatory requirements by implementing HSE measures in a systematic, proactive, and continuous manner throughout the project lifecycle.

2.0 PROJECT DESCRIPTION

The proposed project involves the installation and operation of a Solar Hybrid Mini-Grid system within the permanent campus of the Federal University of Agriculture, Mubi (FUAMB). The project components include site preparation, installation of solar photovoltaic (PV) panels, battery energy storage systems, inverters, and associated electrical infrastructure, as well as trenching and cabling for power distribution within the campus.

Construction activities will include site clearing, civil works, equipment installation, and electrical connections, while the operational phase will involve routine maintenance, system monitoring, and facility management.

2.1 Purpose

The purpose of this HSE Plan is to outline the occupational health, safety, and environmental management requirements for the project, and to define the procedures, control measures, and responsibilities necessary to prevent incidents and ensure a safe working environment.

Specifically, this plan aims to:

- Identify potential HSE risks associated with project activities;
- Establish appropriate risk control and mitigation measures;
- Ensure compliance with applicable national OHS laws and international best practices, including those of the African Development Bank;
- Promote a strong safety culture among all project personnel; and
- Provide guidelines for safe work practices throughout the project lifecycle.

2.2 HSE Objectives

The Objectives for this plan are to:

- Adopt a positive Health & Safety Culture.
- Adopt the principles of prevention to avoid risk.
- Complete the project without incident (Zero fatalities, Zero Lost Time Injury (LTI) or occupational illness).

2.3 Scope of Work

The Project Occupational Health and Safety (OHS) plan covers the scope of works defined in the contract. This includes Preconstruction, Construction, Operation & Maintenance and decommissioning phases.

2.4 Policy Statement

In addition to the existing HSE policy, other policies shall be developed which includes:

- Substance Abuse Policy – Prohibiting the consumption or possession of narcotics, drugs, alcohol and other banned substances
- Emergency Response Policy – Stating commitment to ensure adequate resources and arrangement are in place in the case an emergency.
- Community Affairs Policy – Stating commitment to foster healthy relationships with communities through observance of the highest standard of conduct.
- Road Safety Policy–Stating commitment to complying with Road Traffic regulations and continuously improving its road safety performance by implementing a Road Safety Management Plan (RSMP)

3.0 KEY RESPONSIBILITIES

Involvement of all in implementing, maintaining and continually improving OHS processes is the key to successful completion and achievement of quality objectives set by the management. All project personnel shall therefore be required to be familiar with the content of this OHS plan and shall participate in implementing, maintaining and improving the management system.

It is the responsibility of the project manager and all key personnel to ensure that the requirements for quality are fulfilled for works under their responsibility.

All new staff and staff who are given new responsibilities are to be inducted into the requirements set out in this plan in general and into their function and responsibilities in particular.

3.1 Project Manager Responsibilities

- Set good example in HSE issues.
- Ensure the availability of resources essential to establish, implement, maintain and improve the OHS Management System.
- Define, document and communicate roles, allocate responsibilities and accountabilities, delegating authorities, to facilitate effective OHS management.
- Ensure that all of the activities undertaken in the Project conform to Nigerian legislation, client requirements or international standards when applicable.
    - Review objectives achievements throughout the year.

3.2 Project Supervisors Responsibilities

- Enforcing all phases of the established HSE plan.
- Set good example in HSE issues.
- Preparing Job Hazard Analysis when required.
- Ensuring the safety of all workers associated with the site.
- Conducting HSE inspections.
- Ensuring workers are competent for their allocated tasks.
- Attending and participating in HSE meetings.
    - Participating in accident investigations.

3.3 HSE Manager/Supervisor Responsibilities

- Prepare relevant OHS documentation and procedures.
- Monitor the efficient implementation of OHS requirements.
- Participate and organize the OHS risk assessments.
- Advise management of compliance and of conditions requiring attention.
- Conduct regular HSE inspections.
- Make thorough analysis of statistical data and inspections; delineates problem areas; and makes recommendation for solutions.
- Take part in the review of all OHS incidents and assist in investigating incident.

- Monitor the efficient implementation of the Project's OHS requirements.
- Organize the Project's OHS risk assessment exercises.
- Check on the use of all types of personal protective equipment specifies the use of appropriate PPE for the various work activities. Evaluates their effectiveness and suggests improvements where indicated.

3.4 HSE Advisor Responsibilities

- Check on the use of all types of personal protective equipment specifies the use of appropriate PPE for the various work activities. Evaluates their effectiveness and suggests improvements.
- Conduct independent inspections to observe conformance with established OHS Plan and determines the effectiveness of individual elements of the plan (pre-task briefing, weekly toolbox talk, etc)
- Establish contact with Subcontractors with the objective of maintaining good relations and coordination of accident prevention activities and compliance with the established OHS plan.
- Correct unsafe acts and unsafe conditions.
- Deliver HSE induction/orientation course to all employees, including subcontractors.
- Deliver HSE awareness course and toolbox talk.
- Advise employees on OHS matters.

3.5 All employees Responsibilities

- Take all reasonable and practical steps to care for their own health and safety and avoid affecting the health and safety of co-workers and the general public.
- Follow all instructions and use the equipment properly
- Not interfere with any safety arrangements.
- Report any circumstances which may not comply with the project's OHS management system.

4.0 Competency

All personnel required to operate or work with any equipment or machine must be competent, be tested for each equipment that he/she shall be operating. All personnel who as part of their profession require licensing or certification must obtain the necessary certification before he/she shall be allowed to work on the site.

5.0 Fitness

All personnel working on site shall be required to be certified medically fit to do so by an approved medical facility or Medical Doctor (pre-employment medical examination)

6.0 HSE Training

6.1 Induction/Orientation

Every new or rehired employee and Subcontractors employees must undergo mandatory OHS orientation / induction. The purpose of the Induction is to educate workers and make them aware of the major potential hazards he or she shall come into contact with while working on the site; also, it is one more opportunity to stress the importance of HSE being the first priority in the operations.

The content of the HSE orientation / induction shall cover the following subjects:

- Site safety rules.
- Personnel protective equipment requirements (PPE).
- Environmental sensitivity and protection.
- Preparation and planning of the job (Daily Pre-task talk).
- Emergency plan and muster points.

6.2 Project Specific HSE Training

In addition to the HSE orientation /induction, there shall be specific site HSE trainings which shall cover the following topics:

- Manual handling.

- Electrical Safety
- Emergency Prevention, Preparedness and Response
- Work at height training
- First Aid training (for site First Aiders)
- Lifting and Rigging
- Safe Driving techniques (for drivers)

7.0 Hazard identification & HSE risk assessment

7.1 Project HSE Risk Assessment

The project HSE risk assessment shall be developed and recorded. The Project's HSE risk assessment shall be conducted by a team consisting of HSE Manager/ Supervisor and technical managers/supervisors. It must be approved by the Project manager.

7.2 Fire Risk Assessment

A fire risk assessment shall be developed and recorded. A fire safety plan shall be in place in the site.

7.3 Job Hazard Analysis

Job hazard analysis is required when the hazards and risks associated with a specific task is to be identified so as to implement control measures. The HSE department together with the technical managers/supervisors shall develop a job hazard analysis when applicable.

8.0 EMERGENCY PREPAREDNESS AND RESPONSE

Emergency procedures and evacuation plan shall be developed by the HSE Department and displayed on the notice board. These procedures shall be communicated to all staff. Also each section/department shall have at least a trained first aider at all times.

9.0 HSE IMPLEMENTATION AND PERFORMANCE MONITORING

9.1 HSE Meetings

HSE management meetings shall be held once a month. The meeting is to help identify safety problems, develop solutions, review incident reports, provide training and evaluate the effectiveness of our safety program. Some of the meetings shall be:

- Project/Site Management HSE Meeting for management and supervision (Monthly).
- Tool box talk meetings for all workforce (Weekly).
- Pre-task briefing for all workforces (Daily).
- Special situation meeting (As required).

9.2 HSE Reporting

All incidents and illnesses must be reported to site supervisor after which investigation shall commence and recorded so that appropriate corrective actions shall be implemented to prevent any re-occurrence and report findings shall be forwarded to management for review. Reporting requirements shall include notification of incident, investigation report, and monthly report. Notification of Incident form shall be developed which shall be filled and submitted to HSE department for investigation.

9.3 HSE Inspection and Audits

For continual improvement of HSE management system, HSE inspection and audit shall be conducted. An inspection checklist shall be developed. This is to ensure that the HSE management system is being adhered to. The inspection shall be conducted by the HSE department together with site management.

9.4 Corrective and Preventive Actions and Non-Conformities

During the cause of inspections, concerns raised shall be addressed and closed out. It is expected that in a period of two weeks, a close out inspection shall take place to verify that the corrective actions have been closed.

10.0 PROJECT HSE RULES

The project HSE rules shall be developed and supervision shall develop specific rules and procedures when necessary.

The following site rules shall be implemented at all times. The Site Manager shall draw these rules to the attention of their own workmen or staff. All sub-contractors must ensure that these rules are drawn to the attention of their workmen and staff.

The Principal Contractor may implement additional site rules during the contract programme. Any such additional rules shall be notified to all personnel engaged on the project prior to their implementation. The HSE rules shall include but not limited to:

1. Personal Protective Equipment must be worn at all times.
2. All instructions issued by the Site Manager regarding the storage, handling or cleaning of materials, plant and equipment must be followed.
3. All vehicles must be parked in the designated areas.
4. Any workman suffering from a medical condition that might affect his work and/or that could require specific Medical treatment must inform the supervisor before commencing work.
5. All site tools shall either be battery operated or 110 volts.
6. No one shall be permitted on site if it is believed that they are under the influence of alcohol or drugs.
7. Vehicles must not reverse without a banksman in attendance.
8. All visitors to site must undergo a site-specific induction and operative Identity badges must be worn at all times.
9. All excavations must be secured.
10. Smoking and eating shall only be permitted in the designated area. This area shall be identified during induction.
11. No hot works operations are permitted without a hot work permit in place.
12. There shall be no radios or other music playing devices on site.
13. Good housekeeping practices to be adopted**.**
14. Compliance with all Ethical Power Permit to Work systems
15. The site keyed access procedure must be strictly adhered to.
16. All Contractors must comply with Site Health & Safety Guidelines / Site Safety Method Statement
17. No untrained worker shall be permitted to operate heavy machineries.

11.0 SAFE WORK PRACTICES

Implementing safe work practices is one of the keys to achieving our HSE objectives and some of these safe work practices include:

11.1 Personal Protective Equipment (PPE)

The basic PPE required for the project shall be Safety Glasses, Safety Boots, Hand Gloves, Hard Hat and Coverall. Any other PPE shall be used as applicable. Management is responsible for the provision of PPE and usage shall be enforced at all time. PPE shall be provided in circumstances where exposure to hazards cannot be avoided by other means or to supplement existing control measures identified by a risk assessment. An assessment shall be made to ensure that the PPE is suitable for purpose and is appropriate to the risk involved. Information, instruction & training shall be given to all employees on safe use, maintenance and storage of PPE. Employees shall, in accordance with instructions given, make full use of all PPE provided and maintain it in a serviceable condition and report its loss or defect immediately to the maintenance department where it shall be replaced. PPE shall be replaced when it is no longer serviceable and returned on a new for old basis. Employees shall sign to state that they have received PPE when issued.

12.0 WELFARE FACILITIES

The provision of welfare facilities on the site shall be communicated to all operatives at site induction.

A cleaning regime shall be implemented and maintained for the duration of the construction phase to ensure the site welfare facilities remain in a clean and tidy condition.

If mains drinking water becomes unavailable during the construction phase bottled water shall be brought to site for all operatives for the necessary period.

13.0 SIGNAGE

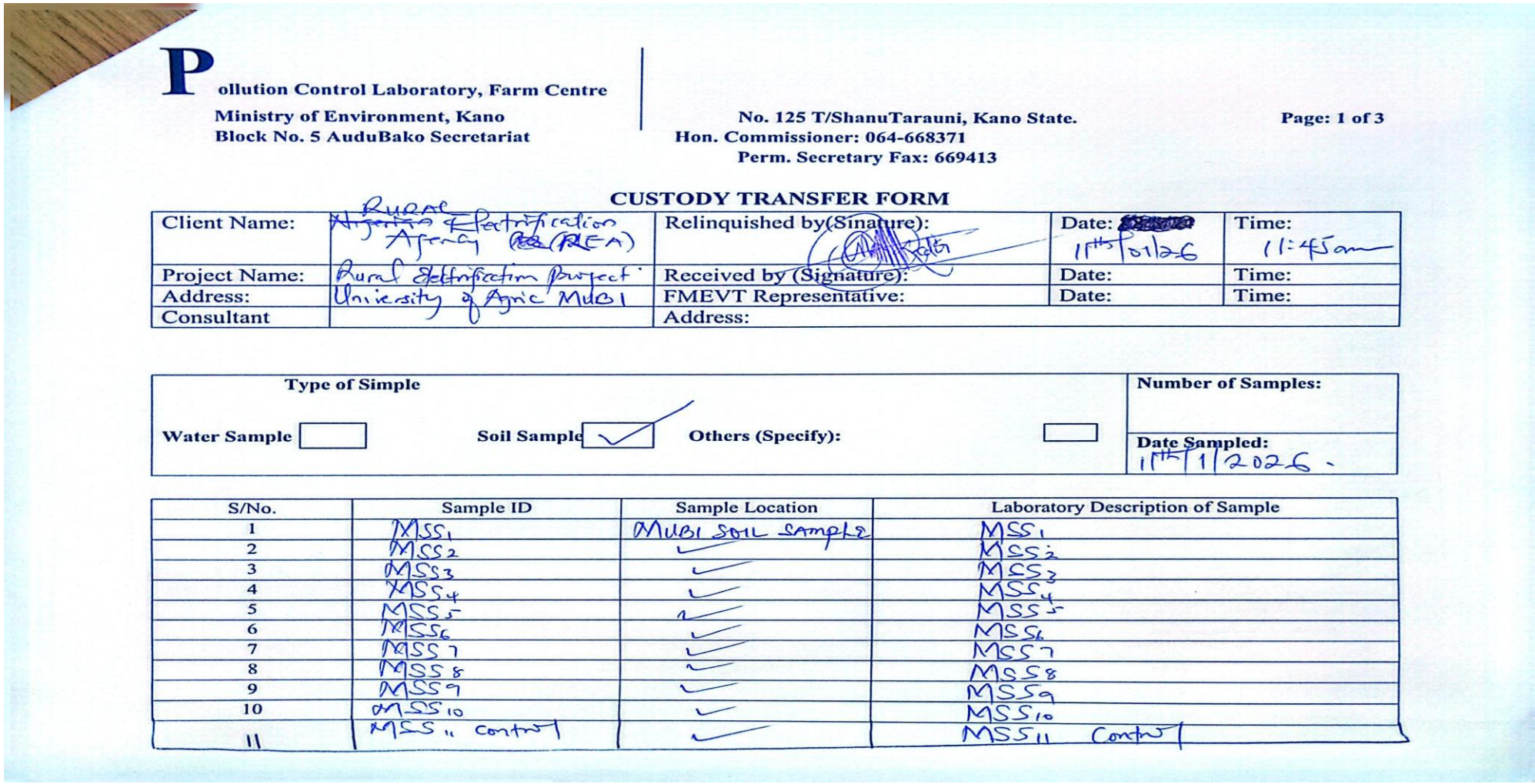
Adequate provision for warning and directional signs shall be made.

14.0 PROJECT HSE PROCEDURES

OHS procedures shall be developed. Project activities shall generally be controlled in accordance with OHS Procedures. These procedures shall include:

- Lifting and Rigging Procedure
- HSE Reporting Procedure
- Working at Height Procedure.
- Emergency Procedure.

ANNEX EIGHT: LABORATORY ANALYTICAL REPORTS AND CHAIN OF CUSTODY DOCUMENTATION.



Pollution Control Laboratory, Farm Centre
Ministry of Environment, Kano
Block No. 5 AuduBako Secretariat

No. 125 T/ShanuTarauni, Kano State.
Hon. Commissioner: 064-668371
Perm. Secretary Fax: 669413

Page: 1 of 3

CUSTODY TRANSFER FORM

Client Name:	~~Nigerian Electrification~~ Rural Electrification Agency (REA)	Relinquished by(Sinature):	Date: 11th/01/26	Time: 11:45am
Project Name:	Rural Electrification Project	Received by (Signature):	Date:	Time:
Address:	University of Agric Mubi	FMEVT Representative:	Date:	Time:
Consultant		Address:		

Type of Simple				Number of Samples:
Water Sample ☐	Soil Sample ☑	Others (Specify):	☐	Date Sampled: 11th/1/2026.

S/No.	Sample ID	Sample Location	Laboratory Description of Sample
1	MSS1	MUBI SOIL SAMPLE	MSS1
2	MSS2	✓	MSS2
3	MSS3	✓	MSS3
4	MSS4	✓	MSS4
5	MSS5	✓	MSS5
6	MSS6	✓	MSS6
7	MSS7	✓	MSS7
8	MSS8	✓	MSS8
9	MSS9	✓	MSS9
10	MSS10	✓	MSS10
11	MSS11 Contd	✓	MSS11 Contd

Project: Rural Electrification Agency (REA), 1
Site Address: Federal University of Agriculture (MUBI) Adamawa State
Date: 11th/01/2026.

Ambient Air Quality Measurements

Station Code	Stations	Latitude	Longitude	Elevation	Parameters									
	MUBI	10.42192	13.24112		HCL (ppm)	TVOC (ppm)	O_3 (ppm)	C_2H_4 (ppm)	PH_3 (ppm)	PM1.0 (ppm)	HCHO (ppm)	Temp (^{0}C)	HUM (%)	Noise (dB)
1	AQ1				1.8	0.019	0.00	0.000	0.00	82	0.003	32.3	29.2	53.1
2	AQ2				2.3	0.015	0.00	0.000	0.00	82	0.003	32.1	29.3	54.3
3	AQ3				1.4	0.018	0.00	0.000	0.00	74	0.006	32.6	29.6	51.4
4	AQ4				1.3	0.011	0.00	0.000	0.00	71	0.001	32.4	29.2	51.6
5	AQ5				1.8	0.011	0.00	0.000	0.00	81	0.001	32.4	29.2	53.6
6	AQ6				1.5	0.018	0.00	0.000	0.00	82	0.006	32.6	29.3	58.2
7	AQ7				2.2	0.011	0.00	0.000	0.00	74	0.001	32.5	29.4	55.6
8	AQ8				2.4	0.019	0.00	0.000	0.00	80	0.001	32.5	29.6	60.4
9	AQ9				2.7	0.011	0.00	0.000	0.00	81	0.003	32.3	29.2	59.4
10	AQ10				2.8	0.017	0.00	0.000	0.00	82	0.001	32.5	29.3	55.2
11	AQ11				2.3	0.018	0.00	0.000	0.00	83	0.004	32.5	29.2	53.6
12	AQ12				1.4	0.019	0.00	0.000	0.00	81	0.006	32.2	28.4	51.8
13	AQ13 control				2.3	0.016	0.00	0.000	0.00	72	0.001	32.2	28.6	52.6

FMEVT REPRESENTATIVE
DATE

CONSULTANT REPRESENTATIVE
DATE

FMEVT ACCREDITED LABORATORY REPRESENTATIVE
11/01/2026.
DATE

Project: Nigerian Electrification Agency (REA).
Site Address: Federal University of Agriculture (MUBI) Adamawa State.
Date: 11th January 2026.

Ambient Air Quality Measurements

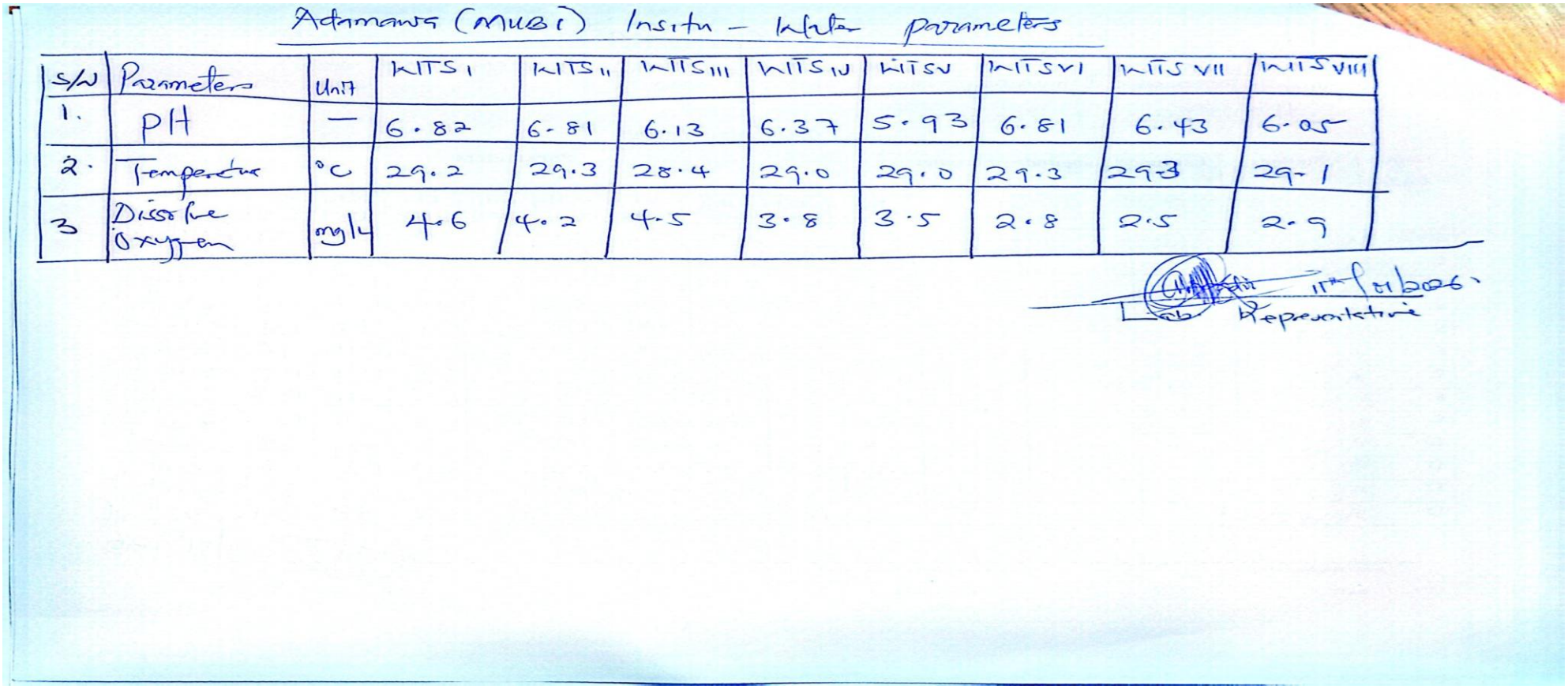
Station Code	Stations	Latitude	Longitude	Elevation	Parameters									
					NO_2 (ppm)	CO (ppm)	H_2S (ppm)	SO_2 (ppm)	HCN (ppm)	NH_3 (ppm)	CL_2 (ppm)	PM_{10} (ppm)	$PM_{2.5}$ (ppm)	(AQI)
1	AQ1				0.0	0	0.000	0.00	0.000	0	0.0	158	139	Excellent
2	AQ2				0.2	0	0.000	0.00	0.000	0	0.0	160	133	Excellent
3	AQ3				0.0	0	0.000	0.00	0.000	0	0.1	153	124	Excellent
4	AQ4				0.0	0	0.000	0.00	0.000	0	0.1	156	120	Excellent
5	AQ5				0.1	0	0.000	0.00	0.000	0	0.1	160	131	Excellent
6	AQ6				0.0	0	0.000	0.00	0.000	0	0.0	184	140	Excellent
7	AQ7				0.0	0	0.000	0.00	0.000	0	0.0	159	125	Excellent
8	AQ8				0.0	0	0.000	0.00	0.000	0	0.0	144	132	Excellent
9	AQ9				0.0	0	0.000	0.00	0.000	0	0.0	150	132	Excellent
10	AQ10				0.2	1	0.000	0.00	0.000	0	0.2	149	133	Excellent
11	AQ11				0.1	0	0.000	0.00	0.000	0	0.1	150	136	Excellent
12	AQ12				0.1	0	0.000	0.00	0.000	0	0.1	153	132	Excellent
13	AQ13 Control				0.3	0	0.000	0.10	0.000	0	0.0	148	121	Excellent

11/01/2026.

FMEVT REPRESENTATIVE — DATE

CONSULTANT REPRESENTATIVE — DATE

FMEVT ACCREDITED LABORATORY — DATE



Adamawa (MUBI) Insitu – Water parameters

S/N	Parameters	Unit	WTS I	WTS II	WTS III	WTS IV	WTS V	WTS VI	WTS VII	WTS VIII
1.	PH	—	6.82	6.81	6.13	6.37	5.93	6.81	6.43	6.05
2.	Temperature	°C	29.2	29.3	28.4	29.0	29.0	29.3	29.3	29.1
3	Dissolve Oxygen	mg/L	4.6	4.2	4.5	3.8	3.5	2.8	2.5	2.9

17th Feb 2026.
Representative