ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT

FOR THE

THE PROPOSED SOLAR-HYBRID POWER PLANT AND ASSOCIATED INFRASTRUCTURE IN FEDERAL UNIVERSITY OF HEALTH SCIENCES (FUHSA), AZARE, BAUCHI STATE.

BY

NIGERIA ELECTRIFICATION PROJECT
DESERT TO POWER (DtP)
PHASE II, ENERGIZING EDUCATION PROGRAMME (EEP)

PREPARED FOR
RURAL ELECTRIFICATON AGENCY (REA), FEDERAL MINISTRY OF POWER

SUBMITTED TO

THE FEDERAL MINISTRY OF ENVIRONMENT, MABUSHI, ABUJA

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	-	Alternating Current
ALARP	-	As Low as Reasonably Practicable
AoI	-	Area of Influence
a-S	-	Amorphous silicon
ASTM	-	American Standards for Testing and Materials
BOD	-	Biological Oxygen Demand
B.Sc.	-	Bachelor of Science
Cd	-	Cadmium
CdTe	-	Cadmium telluride
CH_4	-	Methane
CO	-	Carbon monoxide
CoC	-	Code of Conducts
Cr	-	Chromium
CSP	-	Concentrated Solar Power
Cu	-	Copper
DC	-	Direct Current
E&S	-	Environmental and Social
EA	-	Environmental Assessment
EEP	-	Energizing Education Programme
EHS	-	Environmental, Health and Safety
EMF	-	Electromagnetic Field
EMP	-	Environmental Management Plan
ESIA	-	Environmental and Social Impact Assessment
ESMF	-	Environmental and Social Management Framework
ESMP	-	Environmental and Social Management Plan
EPC	-	Engineering, Procurement and Construction
EPR	-	Extended Producer Responsibility
ESAs	-	Environmentally Sensitive Areas
Fe	-	Iron
FEC	-	Federal Executive Council
FGD	-	Focus Group Discussion
FGN	-	Federal Government of Nigeria
FMEnv	-	Federal Ministry of Environment
FUHSA	-	Federal University of Health Sciences, Azare
GBV	-	Gender Based Violence
GHG	-	Greenhouse Gas
GPS	-	Global Positioning System
H&S	-	Health and safety
H_2S	-	Hydrogen Sulphide
HSE	-	Health, Safety and Environment

IDI	-	In-depth Interview
IEC	-	International Electro technical Commission
IGR	-	Internally Generated Revenue IHR
IHR	-	International Health Regulations
ILO	-	International Labour Organisation
IPAN	-	Institute of Public Analysts of Nigeria
ITCZ	-	Inter-Tropical Convergence Zone
IUCN	-	International Union for Conservation of Nature
KII	-	Key Informant Interview
LEMP	-	Labour and Employment Management Plan
LGA	-	Local Government Area
mono-Si	-	Mono-crystalline silicon
M.Sc.	-	Master of Science
MW	-	Megawatt
NAAQS	-	Nigerian Ambient Air Quality Standards
NBS	-	National Bureau of Statistics
NDC	-	Nationally Determined Contributions
NEPP	-	National Electric Power Policy
NERC	-	Nigerian Electricity Regulatory Commission
NESREA	-	National Environmental Standards and Regulations Enforcement Agency
Ni	-	Nickel
NiCd	-	Nickel cadmium
NiNAS	-	Nigeria National Accreditation Service
NiMet	-	Nigerian Meteorological Agency
NO_2	-	Nitrogen dioxide
NPC	-	National Population Commission
O&M	-	Operations and Maintenance
OP	-	Operational Policy
OPC	-	Organic Photovoltaic Cells
OHS	-	Occupational Health and Safety
Pb	-	Lead
PHCN	-	Power Holding Company of Nigeria
PM	-	Particulate Matter
PMT	-	Project Management Team
poly-Si	-	Polycrystalline silicon
PPE	-	Personal Protective Equipment
PEPSA	-	Plateau State Environmental Protection and Sanitation Agency
PV	-	Photovoltaic
QA/QC	-	Quality Assurance and Quality Control
REA	-	Rural Electrification Agency
RH	-	Relative Humidity

SEA	-	Sexual Exploitation and Abuse
SMEs	-	Small Medium Enterprises
SO_2	-	Sulphur dioxide
SOP	-	Standard Operating Procedure
TDS	-	Total Dissolved Solids
TFSC	-	Thin-film solar cell
TMP	-	Traffic Management Plan
TOC	-	Total Organic Carbon
TSP	-	Total Suspended Particulate
V	-	Vanadium
VOC	-	Volatile Organic Compounds
VRFB	-	Vanadium Redox Flow Battery
AfDB	-	African Development Bank Group
WHO	-	World Health Organisation
WMP	-	Waste Management Plan
Zn	-	Zinc

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

This report documents the Environmental and Social Impact Assessment (ESIA) for the solar-hybrid power plant and associated infrastructure in Federal University of Health Sciences (FUHSA), Bauchi State Government, under the Federal Government's Energizing Education Programme (EEP) Phase III.

The EEP is one of the key components of the Nigeria Electrification Project (NEP). NEP is a Federal Government initiative that is private sector driven and seeks to provide electricity access to off grid communities across the country through renewable power sources. NEP is being implemented by the Rural Electrification Agency (REA) in collaboration with the African Development Bank (AfDB).

The objective of the EEP is to provide dedicated, clean and reliable power supply to Federal Universities and affiliated Teaching Hospitals across the country. The scope of the EEP includes provision of off-grid, dedicated and independent power plant, rehabilitation of existing electricity distribution infrastructure, and provision of street lighting (for illumination and improved security) as well as a world class renewable energy training center for each of the beneficiary universities. FUHSA is one of the beneficiary universities under the EEP Phase III.

In compliance with the relevant requirements of the Federal Ministry of Environment (FMEnv.) and other relevant regulatory agencies in Nigeria, as well as the applicable requirements of the African Development Bank Safeguard Policies, the ESIA of the proposed Project in FUHSA has been conducted.

The ESIA study covers all the various phases of the project and throughout the entire life cycle of the Project (i.e., pre-construction, construction, commissioning, operation, decommissioning, and closure) and it involves key issues identification, baseline environmental and socio-economic data gathering, stakeholder consultation, identification and evaluation of impacts, development of mitigation measures and environmental and social management plan.

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

- EIA Act CAP E12 LFN 2004
- National Policy on the Environment, 1989 (revised in 1999 and 2017)
- African Development Bank Integrated Safeguard Systems Operational safeguards OS1- OS10.
- National Environmental (Energy Sector) Regulations, 2014

- National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991
- National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991
- National Environmental (Sanitation and Wastes Control) Regulations, 2009
- National Environmental (Noise Standards and Control) Regulations, 2009
- Bauchi State Environmental Protection and Sanitation Agency laws on Environmental Protection
- Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal
- The United Nations Framework Convention on Climate Change
- Declaration of the United Nations Conference on Human Environment
- International Labor Organization (ILO): ILO-OSH 2001 - Guidelines on Occupational Safety and Health (OSH) Management Systems.

2.0 PROJECT JUSTIFICATION

Need for the Project and Benefits

The Project is justified primarily based on the need for power for Nigeria's federal universities as an essential element for research and educational development. The EEP is also part of measures in ensuring that Nigeria achieves its carbon emission targets (20 % - 30 % carbon emission reduction by the year 2030) as contained in its Nationally Determined Contributions (NDC), under the Paris Agreement.

The potential Project benefits include, amongst others:

- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Reduction in fossil fuel consumption by the University thereby leading to reduction in carbon emissions and improvement in eco-balance.
- Significant reduction in the cost of power generation by the University through diesel-fuel generators.
- Increase in social interactions within the University. There will be enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.
- Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the Project.
- Improvement in livelihood enhancing activities within the University.
- Direct and indirect employment opportunities during Project development and operation.
- Increase in local and regional economy through award of contracts and purchase of supplies for Project development.

- Increase in financial and technical collaborations between the FGN, the University, REA, African Development Bank and other relevant Ministries, Departments and Agencies (MDAs).
- The project will contribute to Nigeria's nationally determined contributions for the Paris agreement to cut carbon emission by 20 % - 30 % by 2030.

Envisaged Sustainability of the Project

Technical Sustainability: The Project development shall be handled by qualified and experienced EPC contractor (to be selected by REA through a competitive process) according to pre-established standards and procedures. The design and construction phase of the Project shall be overseen by qualified engineers from REA and the Department of Works and Physical Planning in FUHSA. Upon completion of the construction phase, an operation and Maintenance(O&M)contractor will be engaged to operate and maintain the Project, in conjunction with the team from FUHSA's Works and Physical Planning Department. Knowledge and skills will also be transferred to young Nigerians on the project design, construction, implementation and maintenance. This will ensure technical sustainability of the project.

Environmental Sustainability: The environmental sustainability measures for the Project include the use of renewable source of energy (solar) for electricity generation (with negligible greenhouse gas emissions compared to fossil fuel power plants). In addition, the establishment of REA Project Management Unit (PMU) which includes experienced Environmental and Social Safeguards Specialists to oversee the implementation of the Project will contribute to environmental sustainability of the Project. The implementation of the site, and project specific Environmental and Social Management Plan (ESMP) will ensure the Environmental Sustainability of the project.

Economic Sustainability: The Project is co-financed by the African Development Bank (AfDB) through a loan facility of approximately US$200 million, of which US$123 million has been earmarked for the implementation of Energizing Education Programme (EEP) Phase III. The proposed Project in FUHSA, as part of the EEP Phase III, will be financed from the NEP fund. Upon completion, the Project will significantly reduce the use of diesel generators in the University thereby saving costs on diesel fuel and generator maintenance, amongst others. Also, monthly expenditures to the local power distribution company for power consumption from the national grid would be saved. Part of such savings will be used for the maintenance of the Project facilities in the long run.

Social Sustainability: Stakeholder consultation has been carried out as part of the ESIA process in ensuring that all relevant stakeholders are presented with the opportunity to provide input into the Project at the early stage. This has also assisted in laying a good foundation for building relationship with the stakeholders. In addition, a Stakeholder Engagement Plan (SEP) has been developed as part of the ESIA study to ensure continuous engagement with relevant stakeholders throughout the Project life cycle. In addition, a grievance redress mechanism (GRM) has been developed by REA for the Project. Lastly, the implementation of the site, and project specific Environmental and Social Management Plan (ESMP) will ensure the Social Sustainability of the project.

Project Alternatives

Within the context of the Solar Project, various alternatives were considered based on environmental, economic and operational factors. These included solar technology, energy source, PV module, and battery type alternatives. The preferred option is the use of Photovoltaic panels (polycrystalline silicon) and Lithium-ion batteries for the Project.

3.0 PROJECT DESCRIPTION

An approximately 7.06 hectares (ha) of land within FUHSA main campus has been allocated for the proposed solar power plant and training center. The Project site lies geographically within Latitude 11.668143 and Longitude 10.221234. Azare community is the host community for FUHSA, surrounded by neighboring communities (Fatara and Gursoli Community) that are also indirectly impacted as a result of the intervention. No cultural/heritage sites are however located within the Project site and its immediate surroundings. The topography of the site can be described as undulating with a few rocky outcrops and a seasonal stream onsite. The stream flows mostly during the rainy season.

The proposed solar power plant will involve the use of PV technology for power generation. PV panels will be installed on the site using piling foundations and the power generated will be evacuated via an 11 kV underground armoured cable to the existing power house (also the switch yard) and distributed within the University. The exact number of the panels is yet to be finalized.

Storage facilities will be constructed for batteries and inverters to be installed for the Project. Power distribution within the University will be via the existing power infrastructure (mostly wooden poles and overhead cables), which will be rehabilitated where required. Additional streetlights will be installed within the University while existing streetlights will be retrofitted for energy efficiency purposes and powered by the proposed Project.

The pre-construction phase activities for the Project will include site clearing, and mobilization of equipment and construction materials to site. The construction phase activities will include civil, mechanical and electrical works; installation of PV panels and associated components such as mounting structures, inverters, batteries, and switchgear. The exact number of PV panels, batteries and inverters to be installed is yet to be finalized. Also, the construction of renewable energy training centre as well as installation of additional streetlights will be carried out during the construction phase.

Following the construction phase, the facility will be tested and commissioned before operational phase. Activities during the operational phase will include power generation and distribution, and routine maintenance such as periodic cleaning of the PV panels.

The envisaged life span of the power plant is 25 years which could be extended with proper and regular maintenance. In the event of decommissioning, the PV panels and associated infrastructure will be removed from the Project site and recycled as appropriate. The site will be rehabilitated with native plant species afterwards.

It is estimated that about 100 people would be employed during the construction phase. Occupational health and safety (OHS) plans shall be developed and maintained by all contractors involved in the implementation of the proposed Project. The contractors shall provide OHS training which will include hazard awareness, safe work practices and emergency preparedness. Worker activities will be managed through appropriate planning and the application of Permit-to-Work system, Job Hazard/Safety Analysis, Personal Protective Equipment (PPE) requirements and other safety-based protocols.

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

A. Pre-construction and construction phase: cleared vegetation, excavated soil, general refuse, garbage, inert construction materials, metal scraps, concrete waste, food waste, and used packaging materials.
B. Operational phase: paper waste, food packaging, e-wastes (damaged/discarded batteries, panels, inverters, cables, equipment, etc.).

In line with NEP ESMF, the University shall be encouraged to prepare e-waste management plans that account for safe end-of-life disposal of equipment from the solar power plant. The Extended Producer Responsibility program (EPR) will be implemented for solar panels, inverters, batteries and other electrical components to be installed for the Project.

The proposed Solar Power Project is planned to be commissioned in the fourth quarter (Q4) of 2026

4.0 DESCRIPTION OF THE BASELINE ENVIRONMENTAL AND SOCIAL CONDITIONS

The description of the environmental and social conditions of the Project's area of influence is based on desktop studies and field investigations. Field sampling for baseline data acquisition was conducted from 25th – 31st January 2026 by a team of environmental and social specialists.

A 1km radius from the center of the Project site was selected as the spatial boundary for biophysical sampling while a 3km radius from the centre of the Project site was selected as the spatial boundary for socio-economic survey. The rationale for the spatial boundary was based on the consideration of potential environmental and social aspects of the proposed Project as well as observations noted during the reconnaissance survey.

The environmental and social condition of the Project's Area of Influence (AoI) is summarized as follows:

Climate and Meteorology: climate of the study area is that of a tropical environment characterised by high relative humidity and moderate rainfall. Based on the review of long term (1990-2020) climatic data of the study area obtained from the Nigerian Meteorological Agency (NiMet), the total annual rainfall in the area is approximately 1600 mm. The rainy season begins from April and ends in October. The temperature of the Project area is relatively high and stable all over the year. The overall annual average daily temperature is 21.8^{o}C . The region is characterized by low relative humidity (RH) as a result making it feel dry and comfortable despite the high temperature. Relative humidity measured in the morning ranged between 22% % in February and 93 % in August while at night the value ranged from 22% to approximately 68.2%.

Geology: The study/project area is located within the Central Nigeria Precambrian Basement Complex, the rocks as comprising mostly granite, gneisses, mica schists, hornblende and feldspathic schists and migmatites. The rocks are highly fractured and jointed showing essentially two fracture patterns, NE – SW and NW – SE. These fractures control the drainage and flow patterns of rivers in the area.

Air Quality and Ambient Noise Level: A total number of eight (8) sampling locations were established in the study area for ambient air quality and noise study. The concentrations of air quality parameters recorded within the Project site were generally below the National Ambient Air Quality Standards and the World Health Organization (WHO) Air Quality Guidelines. The noise levels recorded within the Project site were also within acceptable limits (African Development Bank limit of 55 dB(A) for educational institution and FMEnv limit of 90 dB(A). In summary, the ambient air quality and noise within the Project site and the surrounding environment is considered to be satisfactory.

Soil Quality: in general, the dominant soils samples within the project site is clay for both topsoil and subsoil based on particle size analysis. No heavy metal was recorded in the soil samples from the Project site and AoI. The concentrations of Iron in the soil samples ranged from
24.37 to 77.23mg/kg and a mean value of 53.92 mg/kg. This was followed by Zinc which recorded concentrations of 0.01 to 0.91mg/kg prescribed for unpolluted soil. Mercury, Chromium, Lead and Nickel were undetected in the soil samples from the Project site and AoI.

Groundwater Quality: Groundwater samples were collected from two (2) different boreholes in the Project area during the field sampling. The concentrations of parameters analyzed in the groundwater samples were generally within the FMEnv and WHO limits for substances and characteristics affecting the acceptability of groundwater for domestic use, except for pH which had a range of 6.14 to 6.33 and iron which had a ranged of 2.17 to 3.13 mg/l outside the FMEnv limit of 6.5-8.5 and 1.0 mg/l respectively.

Surface water Quality: Surface water samples were collected from three (3) locations around the project area. The concentrations of parameters analyzed in the water samples were generally within the FMEnv limits for substances and characteristics affecting the acceptability of surface water for aquatic and recreational use. Except for parameters such as Iron and dissolved Oxygen.

Terrestrial Flora: The natural ecosystem of the study area was observed to have been substantially modified by human activities (primarily farming activities). The physiognomy of the entire study area is characterized by open vegetation of shrubs, grasses, and trees. Based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species classification, no endangered species were recorded within the Project site. The plants species noted include Maize (*Zea Mays*) Melon (Egusi) (*Cucumeropsis mannii)* Pawpaw (*Carica papaya*), White yam (*Dioscorea rotundata*), Cucumber (*Cucumis sativus*), and Mint Weed (*Mesosphaerum suaveolens*).

Terrestrial Fauna: The fauna species observed at the site were generally few and mostly small invertebrates such as earthworms, insects, Grasshoppers, Butterflies, spiders. Also, vertebrates such as Lizards, birds and rodents were sighted within the

Project site and AoI. Based on the IUCN, no threatened or endangered fauna species were recorded in the study area.

Socio-economic and Health: the identified local community located within 3 km AoI of the site is Azare community. The socio-economic characteristics of the community based on information gathered through focus group discussions, key informant interviews, direct observations, and surveys are summarized as follows:

- Azare community is relatively homogenous in terms of ethnicity and language.
- Islam is the most prevalent religion in the community
- Agriculture (over 80%) and trading (about 15%) are the common livelihood activities in the community.
- There is a central market within the community where traders sell goods such as farm produce, cooked food, etc.
- Self-employment is the prominent form of occupation in the community.
- There are government hospitals, private hospital and pharmaceutical outlets.
- Malaria, measles, skin rashes and fever are common health problem reported in the community.
- Women play the domestic and economic roles within the community
- Women are allowed to own property, trade, and work but they are not allowed to hold major leadership roles.
- Most of the female respondents stated that the community was peaceful and Gender Based Violence (GBV) incidents were not common. GBV cases are usually reported to the community heads or police depending on the severity.
- Based on interviews with the community leaders and respondents in the community, there are local residents who own farms within FUHSA main campus.
- Members of the community were positively disposed to the proposed Project. They believe that the Project will improve the economic values of the communities, impact positively on entrepreneurship and create job opportunity for community members.

Stakeholder Engagement

Stakeholder engagement was conducted as part of the ESIA for the proposed project. This included a review of the legal and administrative framework, stakeholder identification and analysis, and initial consultation with stakeholders. Comments and issues raised by relevant stakeholders consulted during the ESIA study were provided in the report. The consultations were carried out between 25th – 31st January, 2026 with the following:

- Bauchi State Environmental Protection Agency
- Federal Ministry of Women Affairs and Social Development

- Federal Ministry of Youth and Sports
- FUHSA Vice Chancellor
- FUHSA Director of works and Physical Planning
- FUHSA Student Union Government President
- Katagum Local Government Area
- Azare Community Leader
- Civil Society Organizations
- Nigerian Women Trust Fund

The consultations served to provide stakeholders with information about the proposed Project and to gather information important to the ESIA. Consultation with the identified stakeholders (including regulators and potentially affected communities) showed general acceptance of the proposed Project.

Stakeholder Engagement and Key Outcomes

Stakeholder consultation formed a critical component of the ESIA process for the proposed solar-hybrid power project at the Federal University of Health Sciences. Consultations were conducted between 25th – 31st January, 2026 and involved a wide range of stakeholders including government agencies, university management, students, host communities, civil society organizations, and potentially affected persons.

The engagement process aimed to disclose project information, gather stakeholder inputs, and incorporate concerns into project design and mitigation measures.

Key concerns raised during consultations included:

- Potential loss of farmland and livelihood among local farmers
- Need for employment opportunities for host community members
- Proper management of waste, including electronic waste
- Reliability and adequacy of power supply to meet university demand
- Inclusion of vulnerable groups, including women and youths
- Risks related to gender-based violence (GBV) and community safety

In response to these concerns, the ESIA incorporated several mitigation and enhancement measures, including:

- Development of a Livelihood Restoration Plan (LRP) for affected farmers
- Commitment to local employment, with a significant proportion of the workforce drawn from host communities
- Preparation and implementation of a comprehensive Waste Management Plan, including e-waste handling
- Conduct of an energy demand audit to ensure adequate power supply design
- Integration of a Gender-Based Violence (GBV) Action Plan and gender-sensitive grievance redress mechanism
- Establishment of a Stakeholder Engagement Plan (SEP) and Grievance Redress Mechanism (GRM) to ensure continuous consultation throughout the project lifecycle

Overall, stakeholders expressed general acceptance and strong support for the proposed project, citing its potential to improve electricity supply, create employment opportunities, and enhance socio-economic development within the University and surrounding communities.

5.0 ASSOCIATED AND POTENTIAL RISKS AND IMPACTS

The potential environmental and social (E&S) risks and impacts associated with the proposed Project were identified and ranked across each phase of the Project development. In the pre-construction phase, the significant impacts identified are: economic displacement due to loss of local farmlands onsite, increase in vehicular movement and traffic including potential for road accident, and soil degradation as a result of site clearing. For construction phase, the potential impacts identified include: soil degradation, decrease in ambient air quality, increased noise emission, GBV risks, community health and safety due to influx of workers and construction activities, and occupational health and safety hazards.

During the commissioning phase, the proposed Project is presumed to have minor noise impact and Occupational Health and Safety (OHS) hazards which may arise from injuries and electrocution. The operational phase will have significant risks such as electric shock and injuries to workers, GBV risks, and work-related issues (poor working conditions and discrimination). The decommissioning phase will have significant impacts on the soil and road traffic of the Project area. Some of the potential positive impacts associated with the proposed Project include: employment opportunity, promotion of clean energy source, reduction of GHG emissions, and skill acquisition and transfer of knowledge through training and retraining.

6.0 MITIGATION MEASURES

Recommended mitigation measures required to complement those incorporated in the Project design for the identified negative impacts were proffered while enhancement measures for the positive impacts were similarly presented and documented in this report. The summary of the recommended mitigation measures for the identified significant negative impacts is provided as follows:

<u>Pre-construction Phase</u>

The proffered mitigation measures for the potential impacts associated with the pre-construction phase of the Project include, amongst others:

- Livelihood Restoration Plan (LRP) shall be developed and implemented if applicable (in consistent with the requirements of OP 4.12, Annex A - Involuntary Resettlement Instruments) for the affected persons.
- Only the portion of the site required for Project development shall be cleared for construction.
- The affected farmers shall be given time to harvest their crops before commencement of construction activities.

- FUHSA Management shall collaborate with the community leaders to identify the affected farmers if applicable.
- The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited.
- Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas.
- Disturbed areas will be rehabilitated with native plants as soon as possible to prevent erosion.
- Site clearing equipment / machinery shall be operated and maintained under optimum fuel-efficient conditions.
- Site clearing activities shall be carried out only during the daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).
- A traffic management plan (TMP) shall be developed and implemented by the EPC Contractor.
- Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided.
- Drivers' competency shall be assessed and where required; appropriate training shall be provided. This will include training on safe driving measures such as adherence to speed limits (of less than 10 km/h) in the Project area.
- Provision of adequate PPE especially gloves, safety boots, and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.
- Unregistered labourers and touts shall not be patronized for off-loading materials.
- The site shall be secured with perimeter fencing and/or security.

<u>Construction Phase</u>

Mitigation measures for the potential impacts associated with the construction phase of the Project include:

- Excavation works shall not be executed under aggressive weather conditions.
- Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion.
- Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.
- Construction machinery shall be turned off when not in use.
- Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities.
- All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimize introduction of alien species.
- Employment of workers for construction activities shall be open and fair.
- The GBV Action Plan for EEP shall be implemented for the Project.
- All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA).

- GBV sensitive channels for reporting in GRM shall be implemented for the Project.
- The EPC Contractor shall be required to hire a Gender/GBV officer.
- Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured.
- All workers shall be required to undergo regular training and refreshers on GBV
- The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site.
- All gender-based violence incidents shall be reported and dealt with as per the law.
- Health and Safety Plan shall be developed and implemented. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence.
- Daily toolbox talks prior to commencement of work activities shall be carried out.
- Construction activities shall be limited to daytime as much as possible.
- Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.
- Proper safety signs and signage shall be placed at strategic locations within the site.
- PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored.
- Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers.
- The NEP Grievance Redress Mechanism (GRM) for receiving complaints arising from damage to infrastructure and private property during construction activities shall be developed.
- Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible.
- Public access shall be restricted to construction area via security fencing and appropriate signage.

Commissioning Phase

Mitigation measures for the potential impacts associated with the commissioning phase of the Project include:

- The Project components shall be installed in line with the pre-established standards and as per manufacturer recommendations.
- The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation.
- Plant testing shall be carried out by experienced personnel.

Operation Phase

Mitigation measures for the potential impacts associated with the operation phase of the Project include:

- All lighting will be kept to a minimum within the requirements of safety and efficiency. Where such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage will be used.
- Appropriate PPE shall be provided for workers.
- Training shall be provided to employees on emergency preparedness and responses.
- Provision of medical insurance scheme for employees shall be ensured.
- Appropriate safety signage shall be placed at strategic locations within the site.
- Strict compliance to the SOPs shall be ensured.
- A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.
- Continuous implementation of the GBV Action Plan for EEP shall be sustained for the Project.
- All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA).
- GBV sensitive channels for reporting in GRM shall be implemented for the Project.
- The O&M Contractor shall be required to hire a Gender/GBV officer.
- Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained.
- The O&M Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site.
- All gender-based violence incidents shall be reported and dealt with as per the law.
- A Waste Management Plan shall be developed and implemented
- Training shall be provided for workers on safe storage, use and handling of e-waste on site.
- Damaged/expired Lithium-ion batteries, solar panels, inverters and electric components shall be returned to the manufacturer based on the Extended Producer Responsibility (EPR) model. Prior to returning them to the manufacturers, they will be stored on impermeable surfaces within the site.
- Burning of waste shall be prohibited.

7.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

An Environmental and Social Management Plan (ESMP) has been developed as part of the key elements of the ESIA study to satisfy long term objectives of managing and monitoring the environmental and social impacts of the proposed Project. It covers the entire life cycle of the Project and also includes desired outcomes; performance indicators; monitoring (parameters to be monitored and frequency); timing for actions; responsibilities and cost estimates required for implementation.

REA-PMU is committed to the implementation of the ESMP and shall work with relevant agencies at local, state and national levels to ensure full compliance. REA shall have principal responsibility for all measures outlined in the ESMP, but may delegate responsibility to its contractors, where appropriate and monitor the implementation. The relevant regulatory authorities at Federal, State and Local Government levels shall also be involved in the monitoring of the ESMP implementation. An environmental monitoring programme, which outlines specific environmental/social components to be measured, methodology, parameters/requirements, frequency of monitoring, timelines and estimated budget, has also been developed as part of the ESMP. The total costs of the ESMP implementation including costs for mitigation, monitoring and capacity building is estimated as: **₦58,820,000.00** (Fifty Eight Million, Eight Hundred and twenty Thousand Naira, only.*)* See the table below:

ESMP Costing

S/N	Fundamental ESMP Activities	Cost Estimates (NAIRA)	Cost Estimate (US$
	ESMP Implementation Cost	30,600,000	21,103.45
	Monitoring Cost	4,100,000	2,827.59
	Capacity Building	2,000,000	1,379.31
	GRM Implementation Cost	18,720,00	12,910.34
	Additional Management Cost	3,400,000	2,344.83
Total		**58,8200,000**	**40,565.52**

The USD equivalent was calculated using an exchange rate of **US$1 = ₦1,450** (June 2026 exchange rate adopted for this ESIA)

8.0 REMEDIATION PLAN AFTER DECOMMISSIONING/CLOSURE

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

In the event of decommissioning, REA, in conjunction with the leadership of FUHSA, 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;
- Restoration of the Project site to baseline conditions (as much as practicable) in line with legislative and regulatory requirements.
- Assessing the residual impact, if any, the project has on the environment.
- Monitoring the abandoned project environment as necessary.

Decommissioning activities will only begin after due consultation with the relevant stakeholders including the regulatory authorities.

9.0 CONCLUSION AND RECOMMENDATIONS

The ESIA of the proposed Project has been conducted in accordance with the relevant requirements of the FMEnv. and other relevant regulatory agencies in Nigeria, as well as the applicable requirements of the African Development Bank Safeguard Policies, specifically the Operational Policy 4.01 and Involuntary Resettlement Policy 4.12 triggered by the proposed Project. Consistent with the regulatory standards, the assessment of the environmental status and the socio-economic aspects of the proposed Project's area of influence have been carefully carried out using accepted scientific methodology. Evaluation of associated and potential impacts of the proposed Project identified both positive and negative interactions with the receiving biophysical and socio-economic environment.

Based on the nature and extent of the proposed Project and the findings of the ESIA study, it is believed that the potential negative impacts associated with the proposed Project can be mitigated to as low as reasonably practicable through the implementation of the proffered mitigation measures documented in Chapter 6 of this report, while the positive impacts can also be enhanced. In addition, an ESMP has been established (Chapter 7) to assess the efficiency and effectiveness of the recommended mitigation measures and ensure long-term monitoring of the Project.

The ESIA study recommends the following:

- The REA, through its Project Management Unit (PMU), as well as the management of the FUHSA, through its Department of Works and Physical Planning, shall ensure that the proposed Project is developed and operated in an environmentally sustainable manner by properly managing the processes/activities that may bring about disturbances to the environment through the implementation of the recommended mitigation measures and the ESMP.
- Continuous monitoring of environmental and social performance of the Project shall be ensured, including periodic consultation with the relevant regulatory authorities, the potentially affected community,and other relevant stakeholders throughout the Project life cycle.
- Implementation of the Project's Stakeholder Engagement Plan (including grievance redress mechanism) shall be maintained.

CHAPTER ONE:

INTRODUCTION

CHAPTER ONE INTRODUCTION

1.1 Background Information

The purpose of this assignment is to prepare a site-specific Environmental and Social Impact Assessment (ESIA) for the Solar Power Plant Project at the Federal University of Health Sciences Azare (FUHSA). The ESIA will establish the environmental and social baseline conditions of the project area within the University's Permanent Site, identify and evaluate potential impacts associated with the project activities, and proffer appropriate mitigation and management measures in accordance with national regulatory requirements and international best practice and the Integrated Safeguards System (ISS) of the African Development Bank (AfDB).

The assignment is intended to generate reliable biophysical and socio-economic baseline indicators that will serve as reference benchmarks for assessing project-related impacts during the construction, operation, and decommissioning phases. These baseline indicators will also support informed decision-making, refinement of project design, and monitoring of environmental and social performance throughout the project lifecycle.

The biophysical baseline studies will involve site reconnaissance and field investigations to characterize the physical environment of the proposed project location, including landform and topography, soil characteristics, surface and groundwater conditions, climate and meteorology, air quality, Ambient noise environment, and biological resources within the project area and its Area of Influence (AoI).

The socio-economic baseline assessment will include stakeholder identification and engagement, community consultations, focus group discussions (FGDs), and key informant interviews, implemented in line with the Stakeholder Engagement Plan (SEP). These activities will seek to understand existing socio-economic conditions, livelihood patterns, institutional arrangements, vulnerability profiles, and stakeholder perceptions relevant to the proposed project.

Overall, the ESIA will provide technical guidance to the project proponent on environmental and social risk management, monitoring, and compliance with applicable regulatory, institutional, and lender safeguard requirements, thereby supporting the sustainable implementation of the proposed FUHSA solar power project.

1.2 Objectives of the ESIA Study

The specific objectives of the ESIA assignment are to:

- Provide a clear and comprehensive description of the proposed Federal University of Health Sciences Solar Power Project, including its key components, activities, design features, and implementation phases, within the context of the receiving environment at the University's Permanent Site.
- Establish and document baseline physical, biological, and socio-economic conditions within the project site and the defined Area of Potential Project Influence (APPI).
- Identify, predict, and assess potential positive and adverse environmental and social impacts that may arise during the construction, operation, and decommissioning phases of the project.
- Propose practicable, cost-effective, and sustainable mitigation and enhancement measures to prevent, minimize, or offset identified adverse impacts while maximizing positive project outcomes.
- Develop a site, and project specific Environmental and Social Management Plan (ESMP) detailing mitigation measures, monitoring indicators, institutional responsibilities, implementation timelines, and indicative costs.
- Identify institutional, organizational, and individual capacity-building requirements necessary for the effective implementation of environmental and social management measures.
- Prepare outline environmental and social management instruments, including Labour Management Procedures (LMP), Waste Management Plan, Traffic Management Plan, Occupational Health and Safety (OHS) Plan, Community Health and Safety Plan, Gender-Based Violence/Sexual Exploitation and Abuse and Sexual Harassment (GBV/SEAH) Prevention and Response Plan, and a Grievance Redress Mechanism (GRM).
- Develop a decommissioning and site closure framework to guide environmentally sound and socially responsible end-of-life management of the project infrastructure.

1.3 Scope of the ESIA Study

The ESIA Consultant's scope of work shall include, but not be limited to, the following:

i. Review relevant project documentation, including project designs, feasibility studies, and applicable environmental and social safeguard instruments.

ii. Review applicable environmental and social policies, legal, and institutional frameworks, including Federal Ministry of Environment regulations, relevant state environmental laws, and African Development Bank Policies.

iii. Describe the proposed project in detail, including its components, layout, activities, and implementation schedule, supported by maps, drawings, and schematic representations.

iv. Analyze the policy, legal, and administrative framework relevant to the project.

v. Define and justify the project study area and Area of Potential Project Influence (APPI).

vi. Describe and analyze baseline physical, biological, and socio-economic conditions within the study area using literature review, field surveys, in-situ measurements, and laboratory analyses, as appropriate. Biophysical considerations shall include,: climate and meteorology; air quality and noise; geology, topography, and hydrogeology; surface and groundwater quality; soils; drainage; flora and fauna, including sensitive or protected species.

vii. Undertake socio-economic assessments covering population characteristics, livelihoods, health and safety conditions, land use, gender dynamics, vulnerable groups, service availability, and potential project-induced risks.

viii. Analyze project alternatives, including site, technology, and the "no-project" option, based on technical, economic, environmental, and social criteria.

ix. Identify and assess potential direct, indirect, cumulative, short-term, long-term, temporary, and permanent impacts, with particular attention to vulnerable and marginalized groups.

x. Assess risks related to labour influx, GBV/SEAH, child labour, occupational and community health and safety, and propose appropriate mitigation measures, including a GBV Action Plan.

xi. Define mitigation, compensation, and enhancement measures, assign responsibilities, and estimate associated costs.

xii. Develop an environmental and social monitoring programme with indicators, frequency, institutional responsibilities, and cost estimates.

xiii. Assess institutional capacity for ESMP implementation and propose capacity-building measures, including training on ESHS, GBV prevention, emergency response, and stakeholder engagement.

xiv. Conduct stakeholder consultations at inception and draft ESIA stages and document stakeholder concerns and responses.

xv. Prepare a Stakeholder Engagement Plan (SEP) and an accessible and inclusive Grievance Redress Mechanism (GRM).

xvi. Define Environmental, Social, Health and Safety (ESHS) requirements for incorporation into bidding and contract documents.

xvii. Prepare a comprehensive Environmental and Social Management Plan (ESMP) that includes identified impacts, mitigation measures, monitoring indicators, institutional responsibilities, costs, and implementation schedule.

1.4 ESIA Study Approach / Methodology

The ESIA of the proposed Project has been carried out in line with the FMEnv.-approved EIA process for mini-grid / off-grid projects being implemented under NEP. It also takes into consideration the requirements of relevant international standards and guidelines, such as the African Development Bank Integrated Safeguard Systems Operational Safeguards OS1-10.

The illustration of general methodology adopted for the ESIA study is provided in Figure 1.1. Detailed information on each of the activities is provided in the subsequent chapters of this report.

Figure 1.1: Schematic presentation of the general methodology for the ESIA

1.5 Limitations of the ESIA Study

The ESIA study has been carried out in line with the relevant local and international guidelines and regulations to identify and assess the potential environmental and social impacts of the proposed Project, and also to put in place appropriate mitigation measures to address the identified impacts. However, the inherent limitations in the ESIA process require that a few assumptions have to be made. Hence, there may be some degree of uncertainty as to the exact nature and magnitude of the environmental impacts. These uncertainties could arise from issues such as the level of available information on the proposed development at the time of the environmental assessment and limitations of the impact assessment prediction process. In view of these limitations, a robust ESMP has been put in place to ensure that the environmental and social performance of the project is monitored throughout the project's life cycle.

1.6 Legal and Administrative Framework

The proposed Project is part of the FGN's EEP, a component of NEP. Several laws and regulations apply to the energy sector in Nigeria. In addition, a number of laws, policies and instruments have been established to support environmental management and the ESIA process in Nigeria. In this section, an overview of the relevant statutory regulations, legislations and guidelines to the proposed Project and the ESIA study is provided. The Project shall ensure compliance with the applicable local and international regulations and standards throughout its life cycle.

1.6.1 National Policy, Guidelines and Regulations

1.6.1.1 Federal Ministry of Environment (FMEnv.)

The FMEnv. is the principal authority for the regulation and enforcement of environmental laws in Nigeria. The Act establishing the Ministry places on it the responsibilities of ensuring that all development and industry activity, operations and emissions are within the limits prescribed in the national guidelines and standards, and comply with relevant regulations for environmental pollution management in Nigeria as may be released by the Ministry. In furtherance of her mandate, the FMEnv. developed laws/guidelines on various sectors of the national economy. The specific policies, acts, guidelines enforced by FMEnv. that are applicable to the Project are summarized as follows:

❖ National *Policy on the Environment, 2017*

The National Policy on the Environment, 2017 provides for "a viable national mechanism for cooperation, coordination and regular consultation, as well as harmonious management of the policy formulation and implementation process which requires the establishment of effective institutions and linkages within and among the various tiers of government that is, federal, state and local government". The objective of the policy is to achieve sustainable development in Nigeria pertaining to:

- Securing a quality environment adequate for good health and wellbeing;
- Conserving the environment and natural resources for the benefit of present and future generations;
- Raising public awareness and promoting understanding of the essential linkages between the environmental resources and developments and encouraging individual and community participations in environmental improvement efforts;
- Maintaining and enhancing the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity; and
- Co-operating with other countries, international organizations and agencies to achieve optimal use and effective prevention or abatement of trans- boundary environmental degradation.

❖ **National Policy on Solid Waste Management (2020)**

This policy serves as an overarching framework to govern the collection, treatment, and disposal of all municipal, industrial, and institutional solid waste across the country.

Key Objectives & Frameworks

- **Transition to a Circular Economy:** Shifting the national focus from mere waste dumping to material recovery, recycling, and re-manufacturing.
- **Institutional Waste-to-Energy (WtE) Agenda:** Encouraging the conversion of unrecyclable municipal solid waste into reusable energy (such as electricity or fuel oil) to simultaneously combat Nigeria's municipal waste crisis and energy deficit.

  Federal University Gusau Faculty of Education Journal - Faculty of Education, Federal University Gusau.
- **Decentralized and Inclusive Governance:** Promoting strategic alignment between Federal, State, and Local Government Area (LGA) environmental authorities, while actively engaging community leadership and the informal sector (such as waste pickers and scavengers) to standardize safe collection practices.

  The Nigerian Economic Summit Group (NESG)

- **Private Sector & Infrastructure Investment:** Incentivizing private participation in the establishment of Material Recovery Facilities (MRFs), integrated waste management centers, briquetting plants, and modernized sanitary landfills to phase out open dumpsites.

  IKENGA International Journal of the Institute of African Studies

❖ **National Policy on Plastic Waste Management (2020)**

Approved alongside the broader solid waste framework, this specialized policy specifically addresses the massive surge in plastic pollution, driven heavily by single-use plastics like "pure water" sachets and Polyethylene Terephthalate (PET) bottles.

Key Objectives & Core Pillars

- **Phasing Out Single-Use Plastics (SUPs):** Establishing gradual bans and reduction targets for certain single-use plastics and non-biodegradable polymer packaging that cannot easily be integrated into recycling streams.

  The Nigerian Economic Summit Group (NESG)
- **Extended Producer Responsibility (EPR):** Mandating that plastic manufacturers, importers, and brand owners take operational and financial responsibility for the entire lifecycle of their products, including post-consumer collection and recycling schemes.

  The Nigerian Economic Summit Group (NESG)
- **Setting National Recycling Targets:** Creating explicit quantitative benchmarks for plastic recycling at local, municipal, state, and federal tiers, aiming to ensure that the vast majority of plastic packaging introduced into the market becomes recyclable.

  The Nigerian Economic Summit Group (NESG)
- **Resource Efficiency & Cleaner Production:** Driving local industrial modifications to lower the consumption of virgin plastic resins (which are heavily imported) and expanding domestic plastic recycling plants.

❖ National *Guidelines and Standards for Environmental Pollution Control in Nigeria, 1991*

This represents the basic instrument for monitoring and controlling industrial and urban pollution.

❖ *S.I. 9 National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991*

This imposes restrictions on the release of toxic substances into the environment and stipulates requirements for pollution monitoring, machinery for combating pollution and contingency plan.

- *S.I. 15 National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991*

This instrument regulates the collection, treatment and disposal of solid and hazardous wastes from municipal and industrial sources.

- *EIA Act No. 86 of 1992 (now codified as the EIA Act Cap E12 LFN 2004*

The EIA Act is the primary Act governing the environmental and social assessment of developmental project or activity in Nigeria. Section 2(2) of the Act requires that where the extent, nature or location of a proposed project or activity is such that it is likely to significantly affect the environment, an EIA must be undertaken in accordance with the provisions of the Act.

- *National Environmental Impact Assessment Procedural and Sectoral Guidelines*

In response to the promulgation of the EIA Act, the FMEnv developed National EIA Procedural Guidelines and other set of guidelines on various sectors of the National economy. Applicable to the proposed Project is the EIA Guidelines for Power Sector, 2013. However, in line with the request by REA, an abridged EIA process has been approved by the FMEnv for proposed mini-grid/off-grid projects to be implemented under NEP. This ESIA study ensures compliance with the approved EIA process.

1.6.1.2 National Environmental Standards and Regulations Enforcement Agency

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the Federal Government of Nigeria as a parastatal of the FMEnv. The Agency is charged with the responsibility of enforcing the environmental laws, guidelines, standards and regulations in Nigeria, specifically during the operational phase of developmental projects. The NESREA's regulations applicable to the proposed Project include:

- *S.I. 28 National Environmental (Sanitation and Wastes Control) Regulations, 2009*

The purpose of this regulation is the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution.

- *S.I. 35 National Environmental (Noise Standards and Control) Regulations, 2009*

This regulation highlights the permissible noise levels to which a person may be exposed; control and mitigation of noise; permits for noise emissions in excess of permissible levels; and enforcement. The NESREA's permissible noise level for ambient environment is 85 dB(A).

- ❖ *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 (Electrical/Electronic Sector) Regulations, S.I No 79, 2022.*
- ❖ *National Environmental (Battery Control) regulations, 2024*

- ❖ *S.I. 22 National Environmental (Surface and Groundwater Quality Control) Regulations, 2010*

The purpose of this regulation is to enhance and preserve the physical, chemical and biological integrity of the groundwater and surface water resources.

- ❖ *S.I. 63 National Environmental (Energy Sector) Regulations, 2014*

The purpose of this regulation is to prevent or minimize pollution and encourage energy efficiency in all operations and ancillary activities of the energy sector in achieving sustainable economic development in Nigeria.

Other NESREA regulations relevant to the proposed Project are:

- *National Environmental (Ozone Layer Protection) Regulations, 2009, S.I.32*: The provisions of this regulation seek to prohibit the importation, manufacture, sale and the use of ozone-depleting substances.

- *National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, 2011, S.I.15*: The principal thrust of this regulation is to prevent and minimize the destruction of ecosystem through fire outbreak and burning of any materials that may affect the health of the ecosystem through the emission of hazardous air pollutants.

- *National Environmental (Electrical/Electronic Sector) Regulations, 2011, S.I.23*: The main purpose of this regulation is to ensure that best practices are applied and maintained in the operation of electrical and electronic equipment in order to safeguard the Nigerian environment against pollution hazards.

- *National Environmental (Soil Erosion and Flood Control) Regulations 2011, S. I. 12*: The overall objective of this regulation is to regulate all earthing-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.

- *National Environmental (Protection of Endangered Species in International Trade) Regulations, S. I. 11, 2011*: The major objective of this regulation is to protect species of endangered wildlife from extinction through the prohibition of trade, importation, etc.

- *National Environmental (Control of Alien and Invasive Species) Regulations, S. I. 32, 2013*: This regulation seeks to prevent the decline, minimize the modification and destruction of ecosystem, and human health caused by alien and invasive species.

- *National Environmental (Air Quality Control) Regulations, S. I. 64, 2013*: The objective of this regulation is to ensure the control of air pollutants that may affect the ambient environment.

1.6.1.3 Federal Ministry of Power, Works and Housing

The Federal Ministry of Power, Works and Housing 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. These policies are briefly described below:

❖ *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 privatization of the electric power sector.

❖ *Electric Power Sector Reform Act 2005*

The Electric Power Sector Reform Act No. 6 of 2005 provides for the licensing and the regulation of the generation, transmission, distribution and supply of electricity. Part IV of the Act contains requirements for licensing and stipulates that no person may construct, own or undertake any of the following activities without a license, unless the generating capacity and distribution capacity is below 1 MW and 100 kilowatts (KW) respectively for electricity generation, excluding captive generation, electricity transmission, system operation, electricity distribution and trading in electricity.

❖ *The National Energy Policy (NEP) 2013*

The National Energy Policy (NEP) 2013, 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.

❖ *The National Energy Efficiency Action Plans (NEEAP) 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, Works, and Housing.

❖ *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.

1.6.1.4 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency inaugurated on October 31, 2005. 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; iii) ensure compliance with market rules and operating guidelines.

1.6.1.5 Endangered Species Act 1985

The FGN enacted the Endangered Species (Control of International Trade and Traffic) Act 11, 1985 which makes, amongst others, the provisions for the conservation, management and protection of the country's endangered species. Section 1 of the Act prohibits the hunting, capture and trade of endangered species.

1.6.1.6 Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN 2004

The Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN 2004 prohibits and declares unlawful all activities relating to the purchase, sale, importation, transit, transportation, deposit, storage of harmful wastes. Appropriate penalties for contravention are prescribed.

1.6.1.7 Nigerian Urban and Regional Planning Act CAP N138 LFN, 2004

This Act establishes a Development Control Department (DCD) charged with the responsibility for matters relating to development control and implementation of physical development plans at Federal, State and Local Government levels within their respective jurisdiction.

1.6.1.8 Penal Code (Northern States) Federal Provisions Act, CAP P3 LFN 2004

The Act contains the basic criminal law offences relating to endangering the life of people from various activities in the Northern region of Nigeria. These include offences relating the public health and safety, amongst others.

1.6.1.9 Labour Act CAP L1, LFN 2004

The Labour Act is the primary law protecting the employment rights of individual workers. The Act covers protection of wages, contracts, employment terms and conditions, and recruitment; and classifies types of workers and special workers.

1.6.1.10 National Policy on Occupational Safety and Health, 2020

Section 17(3c) of the constitution of the Federal Republic of Nigeria (1999) stipulates that the health, safety and welfare of all persons in employment must be safeguarded and not endangered or abused.

1.6.1.11 Land Use Act CAP L5 LFN 2004

Section 1 of the Act vests the entire land in any state in the Governor of the State. The Act also stipulates the procedures the State must follow to clear the land, and define the compensatory measures the State must implement in order to compensate any affected person. The proposed solar-hybrid power plant and associated infrastructure will be sited within the land property owned by FUHSA. No additional land outside the University campus will be expropriated for the Project.

1.6.1.12 Violence Against Persons (Prohibition) Act, 2015

The Violence Against Persons (Prohibition) Act (VAPP) was passed into law in May, 2015. The Act was necessitated as a result of agitations for protection of persons against different forms of violence. The Act has strengthened advocacy against rape, female genital mutilation, partner battery, stalking, harmful widowhood practices while prohibiting all forms of violence, including physical, sexual, psychological, domestic, harmful traditional practices and discrimination against persons. It also provides maximum protection and effective remedies for victims and punishment of offenders. The Act is a key instrument for addressing GBV in Nigeria.

1.6.1.13 Employees Compensation Act, 2010

The Employee's Compensation Act, 2010 was passed into law to provide comprehensive compensation to employees who suffer from occupational diseases or sustain injuries arising from accidents at workplace or in the course of employment. The Act repeals the Workmen's Compensation Act Cap. W6 Laws of the Federation of Nigeria, 2004.

1.6.1.14 National Guidelines for Decommissioning of Facilities in Nigeria (2017)

The purpose of this guideline is to provide clear directions and guidance on the step-by-step process involved in decommissioning a facility in Nigeria. The guideline is to aid in achieving an effective and environmentally sustainable decommissioning process that shall be compatible with intended future land use on health concerns and environmental impacts.

1.6.1.15 Natural Resources Conservation Act CAP 349 LFN 1990

The Natural Resources Conservation Act CAP 268 LFN 1990 is the most direct existing piece of legislation on natural resources conservation. The Act establishes the Natural Resources Conservation Council, which is empowered to address soil, water, forestry, fisheries and wildlife conservation by formulating and implementing policies, programmes and projects on conservation of the country's natural resources.

1.6.1.16 Public Health Law Cap 103 LFN 1990

Public Health Law examines the authority of the government at various jurisdictional levels to improve the health of the general population within societal limits and norms. The State is empowered to protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria. The law prohibits the public or private sector of the economy not to undertake or embark on or authorize projects or activities without prior consideration of the effect on the environment.

1.6.1.17 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 State Laws

The proposed Project site is in FUHSA, Azare, Bauchi State. The key State administrative authorities and legal instruments that are relevant to the Project are briefly described below:

❖ *Bauchi Environmental Protection Agency*

The Bauchi Environmental Protection and Sanitation Agency (BASEPA) was established under the Bauchi State Environmental Protection Law of 1994, with amendments in 1997. The agency operates under the Bauchi State Ministry of Housing and Environment. The Board's functions shall cover, but not limited to:

- The control of removal and disposal of liquid wastes
- The control and disposal of solid wastes. The control of vector pests, rodents, and reptiles; water and waste water effluent discharges; noise which constitute a nuisance; the use of septic tanks and sewage maintenance; bush burning, poaching and indiscriminate felling of trees; stray and wandering animals; public conveniences and cemeteries; the use of residential areas for prohibited purposes; walking or driving on prohibited areas.

❖ *Katagum Local Government Area*

The proposed Project falls within the jurisdiction of Katagum Local Government Area. The Council has an Environmental Health Department which ensures compliance with environmental sanitation law.

1.6.3 International Guidelines, Conventions and Industry Codes

An overview of international guidelines, conventions and industry codes that are relevant to the proposed Project is provided in the sub-sections below:

1.6.3.1 International Guidelines and Standards

- *The African Development Bank Integrated Safeguards System (ISS)*

The environmental and social safeguard policies of the African Development Bank are the fulcrum of its support towards sustainable poverty reduction, particularly in developing countries. The policies aimed at preventing and mitigating undue harm to the people and the environment in the development process. As indicated in Table 1.1, there are a total of ten (10) environmental and social safeguard policies of the African Development Bank, of which only Operational Policy (OP) 4.01 – Environmental Assessment- is triggered by the proposed Project, and its requirements have been taken into consideration in the ESIA study.

Table 1.1: Applicability of the African Development Bank Safeguard Policies to the proposed Project

AfDB ISS 2023 Operational Standard (OS)	Objective	Triggered / Applicability to the Project
OS1: Environmental and Social Assessment	To ensure that projects are environmentally and socially sound and sustainable through the identification, assessment, management, and monitoring of environmental and social risks and impacts throughout the project lifecycle.	**Triggered – Applicable.** The proposed solar hybrid mini-grid project involves land acquisition (approximately 2.01 ha), site preparation, civil works, installation of solar infrastructure, and operational activities which may result in environmental and social impacts such as vegetation clearance, soil disturbance, waste generation, occupational risks, and community interactions. Consequently, an Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) are required in line with AfDB ISS 2023 requirements.
OS2: Labour and Working Conditions	To protect workers' rights, promote fair treatment, non-discrimination and equal opportunity, and ensure safe and healthy working conditions for project workers.	**Triggered – Applicable.** The project will engage direct and contracted workers during the construction and operational phases. Potential risks include occupational accidents, exposure to electrical hazards, inadequate use of PPE, labor disputes, and worker welfare concerns. Labor Management Procedures (LMP), Occupational Health and Safety (OHS) measures, grievance mechanisms, and worker codes of conduct will be implemented in compliance with national labour laws and AfDB requirements.
OS3: Resource Efficiency and Pollution Prevention	To promote the sustainable use of resources, avoid or minimize pollution arising from project activities, and manage hazardous and non-hazardous wastes effectively.	**Triggered – Applicable.** Construction and operational activities may generate solid waste, used oil, packaging materials, wastewater, dust, noise emissions, and hazardous wastes including spent batteries and damaged solar components. The project will incorporate pollution prevention measures, waste management procedures, resource efficiency strategies, and safe handling/storage of hazardous materials in accordance with the ESMP and applicable environmental standards.

OS4: Community Health, Safety and Security	To anticipate, avoid, and minimize adverse impacts on the health, safety, and security of project-affected communities during the project lifecycle.	**Triggered – Applicable.** Construction activities, movement of equipment and vehicles, excavation works, and electrical installations may expose nearby communities to safety risks such as accidents, dust, noise, electrocution hazards, and restricted access. Community Health, Safety and Security measures including traffic management, emergency response procedures, public awareness, and stakeholder communication will be implemented to mitigate these risks.
OS5: Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement	To avoid involuntary resettlement where feasible and minimize adverse social and economic impacts arising from land acquisition or restrictions on land use.	**Triggered – Applicable.** The project requires acquisition of approximately 2.01 hectares of land for the mini-grid infrastructure. Although physical displacement may not occur, economic displacement, loss of access, or livelihood impacts may arise. Appropriate land acquisition procedures, compensation arrangements, and livelihood restoration measures will be implemented where necessary. A Resettlement Action Plan (RAP) or Abbreviated RAP may be prepared depending on the extent of impacts identified.
OS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	To protect and conserve biodiversity, maintain ecosystem services, and promote sustainable management of living natural resources.	**Triggered – Applicable (Low to Moderate).** Minor vegetation clearing and habitat disturbance may occur during site preparation and construction activities. Although the project area is not expected to contain critical habitats or protected biodiversity areas, mitigation measures will be implemented to minimize impacts on local flora, fauna, and ecosystem functions, including controlled vegetation clearing and site restoration measures.
OS7: Vulnerable Groups	To ensure that vulnerable and disadvantaged groups are identified and that project impacts do not disproportionately affect them, while promoting inclusive participation and equitable access to project benefits.	**Triggered – Applicable.** Vulnerable groups within the project area, including women, elderly persons, low-income households, persons with disabilities, and marginalized community members, may be affected differently by project activities or may face barriers to accessing project benefits and consultation processes. Inclusive stakeholder engagement, equitable compensation processes, and targeted mitigation measures will be implemented to ensure their meaningful participation and protection.

OS8: Cultural Heritage	To protect tangible and intangible cultural heritage from adverse impacts of project activities and support its preservation.	**Triggered – Applicable (Precautionary Basis).** Excavation and construction activities may result in accidental discovery of archaeological materials or culturally significant resources. Although no known cultural heritage sites have been identified within the project area, a Chance Find Procedure will be included in the ESMP to ensure proper management of any unexpected discoveries during project implementation.
OS9: Financial Intermediaries	To ensure that financial intermediaries appropriately assess and manage environmental and social risks associated with subprojects they finance.	**Not Triggered – Not Applicable.** The project is not being implemented through a financial intermediary arrangement and does not involve on-lending or subproject financing through financial institutions. Therefore, this Operational Standard is not applicable to the proposed project.
OS10: Stakeholder Engagement and Information Disclosure	To establish a systematic approach for effective stakeholder engagement, information disclosure, and management of grievances throughout the project lifecycle.	**Triggered – Applicable.** The project involves multiple stakeholders including host communities, local authorities, regulatory agencies, and potentially affected persons. Continuous stakeholder consultations, disclosure of project information, and implementation of a Grievance Redress Mechanism (GRM) are required to ensure transparency, community participation, and effective management of concerns throughout the project lifecycle.

❖ African Development Bank *Group Environmental, Health and Safety (EHS) Guidelines*

The African Development Bank Group EHS Guidelines are technical reference documents that include the African Development Bank Group expectations regarding industrial pollution management performance. The EHS Guidelines are designed to assist managers and decision makers with relevant industry background and technical information. This information supports actions aimed at avoiding, reducing, and controlling potential EHS impacts during the construction, operation, and decommissioning phase of a project. The EHS Guidelines serve as a technical reference source to support the implementation of the African Development Bank policies and procedures, particularly in those aspects related to pollution prevention and occupational and community health and safety.

The African Development Bank EHS Guidelines relevant to the proposed Project are:

- The African Development Bank Group EHS General Guidelines; and
- The African Development Bank Group EHS Guidelines for Electric Power Transmission and Distribution

The General EHS Guidelines provide guidance to users on common EHS issues potentially applicable to all industry sectors. It contains management measures for the following EHS issues associated with a project under the following headings:

- Air emissions
- Noise
- Ambient water quality
- Water conservation
- Energy conservation
- Hazardous materials management
- Waste management
- Occupational health and safety
- Community health and safety
- Construction and decommissioning.

The EHS Guideline for Electric Power Transmission and Distribution provides guidance applicable to the power project facilities that will involve power transmission and distribution.

The E&S management measures documented in the relevant African Development Bank EHS Guideline form part of the recommended mitigation measures to address the identified impacts of the proposed Project, as detailed in Chapters 6 and 7.

1.6.3.2 <u>International Conventions</u>

The Nigerian Government is an important player in the International support for the protection of the environment. As such, the country is a signatory to some International laws and conventions, which are targeted towards conservation and protection of the environment in order to ensure sustainable development. Some International conventions and regulations that are applicable to the proposed Project include:

❖ *African Convention on the Conservation of Nature and Natural Resources*

The African Convention on the Conservation of Nature and Natural Resources was adopted in Algiers, Algeria, on September 15, 1968 and entered into force on June 16, 1969. The Convention stipulates that the contracting States shall undertake to adopt the measures necessary to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interest of the people.

❖ *Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (Maputo Protocol)*

This calls on states to protect rights of women and girls, such as property rights, rights to a consensual marriage, protection against child marriage, widows' rights, inheritance rights, and protection against all forms of violence. Nigeria ratified this protocol in 2004 to address the historical discrimination and marginalization of women and girls, including GBV.

❖ *Basel Convention on the Control of Trans-Boundary Movement of Hazardous Wastes and their Disposal*

The Convention was adopted on March 22, 1989 and entered into force on May, 1989. It focuses attention on the hazards of the generation and disposal of hazardous wastes. The Convention defines the wastes to be regulated and controlled in order to protect human and environmental health against their adverse effects.

❖ *The United Nations Convention on Biological Diversity*

The Convention was adopted in 1994. The objectives of the Convention include the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

❖ *The Minamata Convention on Mercury*

The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury. The Minamata Convention was adopted in 2013 and entered into force in 2017. The international treaty is designed to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds by member countries.

❖ *The United Nations Framework Convention on Climate Change*

The Convention on Climate Change was adopted in 1992 during the Rio Earth Summit in Rio De Janeiro, Brazil, and entered into force in 1994 to limit Greenhouse Gas (GHG) emissions which cause global warming.

❖ *International Health Regulations (2005)*

The International Health Regulations (IHR) is an international legal instrument that is binding on 196 countries across the globe, including all the Member States of World Health Organisation (WHO). This binding instrument of international law entered into force on 15 June 2007. The purpose and scope is "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks and which avoid unnecessary interference with international traffic and trade".

❖ *Declaration of the United Nations Conference on Human Environment*

United Nations Conference on the Human Environment proclaims that "a point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences."

The principles of this Declaration relevant to the proposed Project are summarized below:
Principle 2: The natural resources of the earth, including the air, water, land, flora and fauna especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate.

Principle 3: The capacity of the earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved.

Principle 4: Nature conservation, including wildlife, must receive importance in planning for economic development.

Principle 15: Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all.

Principle 18: Science and technology, as part of their contribution to economic and social development, must be applied to the identification, avoidance and control of environmental risks and the solution of environmental problems and for the common good of mankind.

- *International Labour Organisation (ILO): ILO-OSH 2001 – Guidelines on Occupational Safety and Health (OSH) Management Systems*

These guidelines call for coherent policies to protect workers from occupational hazards and risks while improving productivity. The guidelines present practical approaches and tools for assisting organizations, competent national institutions, employers, workers and other social partners in establishing, implementing and improving occupational safety and health management systems, with the aim of reducing work-related injuries, ill health, diseases, incidents and deaths.

At the organizational level, the guidelines encourage the integration of OSH management system elements as an important component of overall policy and management arrangements. Organizations, employers, owners, managerial staff, workers and their representatives are motivated in applying appropriate OSH management principles and methods to improve OSH performance. Nigeria ratified the guidelines in 2001.

1.6.3.3 Industry Codes and Standards

- *International Electrochemical Commission (IEC)*

The IEC Technical Specification 62257 series contains recommendations for small renewable energy and hybrid systems for rural electrification Projects. It outlines international best practice solutions to support energy access in developing countries across a range of technologies. The purpose of this series is to assist renewable energy project managers, engineers and system designers as well as operators to choose the right system for the right place and to design, operate and maintain the system.

1.7 Institutional Arrangements for Environmental and Social Management

The proposed Project is under the FGN's EEP Phase III, being implemented by REA. REA was set up by Section 88 of the Electric Power Sector Reform Act 2005, and its Board and Management were inaugurated on March 16, 2006.

REA will lead the design, installation, operation, and maintenance of the Project while FUHSA, through its Department of Works and Physical Planning, is responsible for land allocation for the Project. REA is responsible for selecting Engineering, Procurement and Construction (EPC) contractor (through competitive process) to build, operate and maintain the proposed power plant, and also build and equip the associated training center. The selected EPC will also be considered for a ten-year operation and maintenance (O&M) contract for the power plant. In the long run, the University will be responsible for operating and maintaining the Project.

REA has established a Project Management Unit (PMU) which includes experienced Environmental and Social Safeguard Specialists. The REA-PMU will provide oversight functions for the management of potential environmental and social issues associated with the Project throughout its life cycle. The PMU, in conjunction with the University's Department of Works and Physical Planning, will monitor the hired contractor's E&S performance.

The implementation of mitigation measures for potential environmental and social impacts associated with the Project (at various stages) will also be monitored by FMEnv., NESREA, Bauchi State Environmental Protection and Sanitation Agency and other relevant regulatory agencies, as part of their statutory responsibilities.

In addition, the African Development Bank will provide overall supervision, facilitation and co- ordination of the Project, and monitor Project performance indicators. Further information on E&S risk management process for the Project is provided in Chapter 7 of this report.

1.8 Report Structure

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

- **Preliminary Sections:** containing table of contents, lists of ESIA preparers, Executive Summary, amongst others.
- **Chapter One**: Introduction containing an overview of the proposed Project, the ESIA objectives and study approach and applicable legal and administrative framework.
- **Chapter Two**: Project Justification containing a rationale for the proposed Project as well as the analysis of Project alternatives and development options.
- **Chapter Three**: Project Description containing the technical elements of the Project. It concisely describes the proposed Project and its geographic and temporal context, including the Project's associated infrastructure.

- **Chapter Four**: Description of the Environment. It details the baseline data that is relevant to decisions about the Project location, design, development and operation.

- **Chapter Five**: Potential and Associated Impacts. This takes into account all relevant environmental and social risks and impacts of the proposed Project, including cumulative impacts.

- **Chapter Six**: Mitigation measures for the identified negative environmental and social impacts, as well as the enhancement measures for the identified positive impacts.

- **Chapter Seven**: is the ESMP. It summarizes the key environmental and social measures and actions and the timeframe including responsibility for the implementation of the recommended measures.

- **Chapter Eight**: presents an overview of remediation / decommissioning plan after Project closure.

- **Chapter Nine**: Conclusion and Recommendations

The report also includes references and appendices.

CHAPTER TWO:

PROJECT JUSTIFICATION

CHAPTER TWO

PROJECT JUSTIFICATION

This chapter presents the justification for the proposed solar-hybrid power plant and associated infrastructure in Federal University of Health Sciences, Bauchi State Government, Nigeria, as part of the Federal Government of Nigeria (FGN) Energizing Education Programme (EEP) Phase II. It also includes the description of alternatives and development options considered for the proposed Project.

2.1 Need for the Project

Public tertiary institutions in Nigeria, particularly Federal Universities, continue to attract a significant proportion of candidates seeking higher education due to their affordability, academic credibility, and national spread. Despite this demand, many of these institutions face persistent challenges associated with inadequate and unreliable electricity supply from the national grid. These power constraints have direct implications for academic delivery, research activities, ICT systems, laboratory operations, security, water supply, and overall campus functionality.

At present, Federal University of Health Sciences (FUHSA) relies largely on a mix of intermittent grid supply and diesel-powered generators to meet its electricity needs. This arrangement is not only financially burdensome due to high fuel and maintenance costs, but also environmentally unsustainable, contributing to greenhouse gas emissions, noise pollution, and localized air quality degradation. As a specialised health sciences institution with energy-intensive facilities such as laboratories, simulation centres, ICT infrastructure, and medical training equipment, FUHSA requires a stable, clean, and reliable power supply to effectively fulfil its academic and research mandate.

In response to Nigeria's broader electricity access challenges, the Federal Government of Nigeria (FGN) initiated the Nigeria Electrification Project (NEP), an innovative programme designed to expand electricity access through decentralized renewable energy solutions, particularly for underserved and off-grid populations and institutions. The NEP is implemented by the Rural Electrification Agency (REA) and co-financed by development partners, including the African Development Bank.

A key component of the NEP is the Energizing Education Programme (EEP), which aims to provide dedicated, reliable, and clean electricity to Federal Universities and their affiliated teaching hospitals across Nigeria through solar-hybrid power solutions. The EEP is also strategically aligned with Nigeria's commitments under the Paris Agreement, particularly the country's Nationally Determined Contributions (NDCs), which target a 20 per cent reduction in carbon emissions by 2030 through increased adoption of renewable energy and reduced reliance on fossil fuels.

The proposed solar-hybrid power project at FUHSA forms part of the EEP Phase IIII intervention. The Project is intended to address the University's current energy deficits by delivering a sustainable and resilient power solution capable of supporting present and future electricity demand. Beyond improving power reliability, the Project is expected to yield multiple ancillary benefits, including reduced operational costs, improved campus security through enhanced lighting, strengthened water supply systems, and an enabling environment for effective teaching, learning, and research.

Overall, the proposed Project is justified on technical, economic, environmental, and institutional grounds, and represents a critical infrastructure investment to support FUHSA's growth as a national centre of excellence in health sciences education and training.

2.2 Value of the Project

The Nigeria Electrification Project (NEP) is a flagship Federal Government initiative aimed at expanding access to electricity through decentralized renewable energy solutions. The Project is co-financed by the African Development Bank (AfDB) through a loan facility of approximately US$200 million, of which US$123 million has been earmarked for the implementation of Energizing Education Programme (EEP) Phase III.

Funding under EEP Phase IIII covers the full lifecycle delivery of solar-hybrid power plants at selected Federal Universities and Teaching Hospitals across Nigeria. This includes Engineering, Procurement and Construction (EPC) as well as Operations and Maintenance (O&M) arrangements. Under this framework, competitively selected EPC contractors are responsible for the design, construction, commissioning, operation, and maintenance of the power plants for an initial period, as well as the construction and equipping of renewable energy training centres to support capacity building for a minimum of one year.

The proposed solar-hybrid mini-grid project at the Federal University of Health Sciences, (FUHSA) constitutes a strategic investment under EEP Phase IIII. The Project represents a long-term value proposition by delivering clean, reliable, and cost-effective electricity supply to the University, while simultaneously reducing recurrent expenditure on diesel fuel, generator maintenance, and grid-related inefficiencies. In addition, the Project contributes to national development priorities in renewable energy deployment, climate change mitigation, and human capital development.

2.3 Project Benefits

The proposed Project is expected to generate substantial environmental, social, economic, and institutional benefits at the University, community, and national levels. Key anticipated benefits include, but are not limited to, the following:

- Improved Electricity Generation and Reliability

Upon full operation, the solar-hybrid system is expected to generate approximately 3,566 megawatt-hours (MWh) of clean electricity annually, providing a stable and dependable power supply to the University.

- Expanded Power Coverage

The electricity generated will be sufficient to support power needs for an estimated 180 additional facilities, including academic buildings, laboratories, student hostels, staff quarters, healthcare training facilities, and administrative offices.

- Enhanced Academic and Research Activities

Reliable power supply will significantly improve teaching, learning, research, ICT operations, laboratory functionality, and clinical training activities, thereby strengthening FUHSA's capacity to deliver high-quality health sciences education.

- Environmental benefits and Climate change mitigation

The Project will substantially reduce reliance on diesel-powered generators, resulting in lower fossil fuel consumption, reduced greenhouse gas emissions, improved local air quality, and overall enhancement of environmental sustainability within the campus.

- Improved Campus security and Social well-being

Increased availability of electricity will support expanded street lighting and surveillance systems, thereby improving campus security, reducing opportunistic crime risks, and contributing to safer learning and residential environments, including reduced risks of gender-based violence.

- Capacity Building and Skills development

The renewable energy training centre to be established as part of the Project will promote knowledge transfer, skills acquisition, and certification in solar and hybrid power technologies, benefiting students, staff, and selected members of the surrounding community.

- Livelihood and Economic Opportunities

The Project will create direct and indirect employment opportunities during construction, operation, and maintenance phases. These opportunities will foster skills development, income generation, and local economic stimulation through procurement of goods and services.

- Institutional and Intergovernmental Collaborations

Implementation of the Project will strengthen technical and financial collaboration between the Federal Government of Nigeria, FUHSA, the Rural Electrification Agency (REA), AfDB, and other relevant Ministries, Departments, and Agencies (MDAs).

- Contribution to National and International Climate Commitments

The Project supports Nigeria's Nationally Determined Contributions (NDCs) under the Paris Agreement by contributing towards the national target of at least 20 per cent reduction in carbon emissions by 2030 through increased deployment of renewable energy technologies.

Overall, the socio-economic and environmental benefits associated with the Energizing Education Programme are significant. The intervention not only strengthens electricity access within the education and health sectors but also contributes to broader national objectives, including climate resilience, energy sector reform, and sustainable development. The EEP is therefore a critical component of Nigeria's Power Sector Recovery

Programme (PSRP), approved by the Federal Executive Council (FEC) in March 2017, and remains central to the transformation of power supply in public tertiary institutions.

2.4 Envisaged Sustainability

2.4.1 Technical Sustainability

The Project development shall be handled by qualified and experienced EPC contractor (to be selected by REA through a competitive process) according to pre- established standards and procedures. The design and construction phase of the Project shall be overseen by qualified engineers from REA and the Department of Works and Physical Planning in FUHSA. In addition, standard operating manuals and appropriate documentation regarding the operation and maintenance of the Project shall be developed and put in place by the EPC Contractor. These documents will be used as the basis for providing facility-specific training to relevant personnel prior to start-up to further ensure technical sustainability of the Project.

Upon completion of the construction phase, an O&M contractor will be engaged to operate and maintain the Project, in conjunction with the team from FUHSA's Works and Physical Planning Department, knowledge and skills will also be transferred to young Nigerians on the project design, construction, implementation and maintenance. This will ensure technical sustainability of the project. In addition, adequate capacity building shall be provided to the University personnel that will work with the O&M Contractor for the day-to-day operations of the Project in the long run

2.4.2 Environmental Sustainability

The environmental sustainability measures for the Project include the use of renewable sources of energy (such as solar) for electricity generation (with negligible greenhouse gas (GHG) emissions compared to fossil fuel-burning power plants). Using data from Azura Edo 450 MW natural gas-fired thermal power plant project (Azura 2012), about 3.5-kilo tonnes (kt) of CO_2 equivalent per year will be saved from being emitted into the atmosphere as a result of the proposed 500KWA Solar PV plant. The CO_2 value would even be more if the proposed plant were to be diesel or coal-fired. The avoided emissions can also be used to earn carbon credits that can be traded in the voluntary carbon market.

The project is also in line with the FGN's efforts to keep GHG emissions at the barest minimum, as part of efforts towards climate change mitigation and adaptation. According to WRI CAIT, Nigeria's GHG emissions increased by 25% between 1990 and 2014, averaging 1% annually, while GDP grew 245%, averaging 5.5% annually.

Although GDP grew faster than GHG emissions, in 2014, Nigeria's emissions relative to GDP were 1.6 times the world average, indicating the potential for improvement (USAID, 2019). Thus, the adoption of renewable energy for power generation – a critical need for Nigeria's development, is a key policy direction of the FGN.

In addition, the establishment of REA-PMU (which includes experienced Environmental and Social Safeguards Specialists) to oversee the implementation of the Project will contribute to environmental sustainability of the Project. More so, this ESIA study undertaken at the early stage of the Project development phase (and the commitment to implement the recommended mitigation measures and the commitment of the proponent to the implementation of the ESMP and the diligent implementation of the ESMP shall ensure the environmental and social sustainability of the project.

the ESMP developed as part of the ESIA) is geared towards ensuring the environmental sustainability of the Project.

2.4.3 Economic Sustainability

The proposed Project is part of the FGN's EEP initiative, a component of NEP. The Project is co-financed by the African Development Bank (AfDB) through a loan facility of approximately US$200 million, of which US$123 million has been earmarked for the implementation of Energizing Education Programme (EEP) Phase II. The proposed Project in FUHSA, as part of the EEP Phase II, will be financed from the NEP fund. Upon completion, the Project will significantly reduce the use of diesel generators in the University thereby saving costs on diesel fuel and generator maintenance, amongst others. Also, the monthly payment to distribution company (Jos Electricity Distribution Company) for power consumption through the grid would stop (the University consumes an average of 60,045kWh monthly from the grid). Part of such savings will be used for the maintenance of the Project facilities in the long run.

A cost-reflective service charge (to be determined based on consultation with university management and users) shall be implemented for all facilities within the University campus. Private business establishments within the University campus shall be allowed to connect to the power Project and metered for billing to generate additional revenue to the University. The generated funds shall be used to sustain the operational costs of the project as well as for the procurement of project components that may be replaced (e.g. spent batteries, panels, etc.) in the future. Additionally, the Project will enhance the University's Internally Generated Revenue (IGR) for other development activities and minimize dependency on allocation from the Federal Government.

2.4.4 Social Sustainability

Stakeholder consultation has been carried out as part of the ESIA process in ensuring that all relevant stakeholders are presented with the opportunity to provide input into the Project at the early stage. This has also assisted in laying a good foundation for building relationship with the stakeholders.

In addition, initial stakeholder engagement activities carried out during the ESIA have been presented in the report. A Stakeholder Engagement Plan (SEP) shall be developed to ensure continuous engagement with relevant stakeholders throughout the Project life cycle. In addition, a grievance redress mechanism (GRM) has been developed by REA for the Project. The GRM provides the communication channel to receive any complaints from stakeholders on the proposed Project and ensures that they are timely and adequately addressed. Furthermore, the commitment of the proponent to the implementation of the ESMP and the diligent implementation of the ESMP shall ensure the environmental and social sustainability of the project. Details on stakeholder consultations carried out till date on the proposed Project are provided in this report.

2.5 Project Alternatives

2.5.1 Site Alternatives

An approximately 7.06 hectares of land within the FUHSA campus has been allocated by the University authority for the proposed Project. The Project site has been selected based on a number of considerations including: i) proximity to the existing switch yard which is located about 20 m away from the site; ii) accessibility - the Project site can easily be accessed through the existing road network within the campus; iii) security; iv) absence of any ecologically sensitive areas and/or cultural resources within and around the Project site. Other candidate sites considered within the University campus for the proposed Project were rejected due to some factors such as: i) far distance from the existing switch yard; ii) poor accessibility; iv) technical considerations for installation of solar panels, for example, topography.

2.5.2 Alternatives Considered within the Context of the proposed Solar-hybrid Power Plant

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

2.5.2.1 Overview

Solar power generation is currently one of the fastest growing areas in renewable energy. Beyond panel production, it does not emit any significant GHGs. Compared to alternative renewable generation technologies such as wind turbines or biofuel generators, solar energy is produced by converting the sun's radiation – a process void of any smoke, gas, or other chemical by-product, which makes this technology to meet the clean development mechanism of the Kyoto Protocol. This is the main driving force behind all green energy technology, as nations attempt to meet climate change obligations in curbing emissions. The use of solar energy for the proposed power plant in FUHSA will significantly avoid the generation of GHG emissions associated with fossil-fuel power plants. Thus, the proposed Project will help contribute to Nigeria's NDC on climate change. In addition, the high solar irradiation in Bauchi (as indicated in Figure 2.1) will be able to support the proposed power plant.

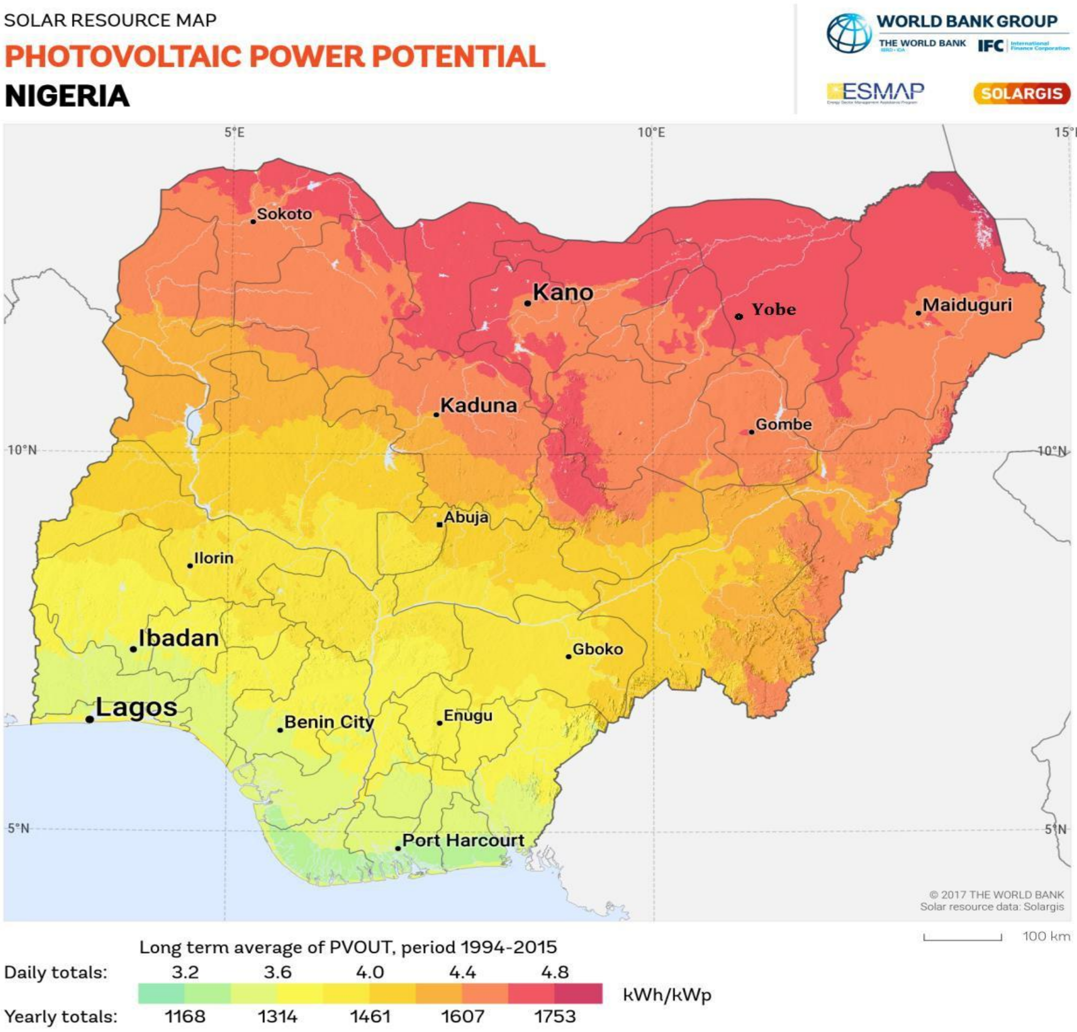


Figure 2.1: Photovoltaic power potential of Nigeria
Source: © 2017 The African Development Bank, Solar resource data: Solargis

2.5.2.2 <u>Solar Power Technology Alternatives</u>

The solar technologies considered for the proposed power plant in FUHSA are:

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

However, the preferred option for the proposed power plant is the use of PV Solar Panel, since it is highly flexible and requires low installation and maintenance cost in comparison to CSP technology. Water requirement for PV system is also low when compared to CSP system.

The comparison between CPS and PV Solar technologies considered for the Project is summarized in Table 2.1.

Table 2.1: Comparison between CSP and PV Solar Technology

Features	CSP Technology	PV Technology
Description	CSP technology uses concentrated radiation from the sun, to heat a liquid substance which is used to generate steam which in turn passes through a steam-turbine to generate electricity. CSP Technology produces electricity through indirect means. Energy output with CSP technology is of AC type.	PV technology uses sunlight through the 'photovoltaic effect' to generate direct electric current (DC). PV Technology produces electricity through direct means. Energy output with PV technology is of DC type but commonly converted to AC through an inverter.
Applications/Scale	CSP is used for utility scale power generation, mostly for Grid Connections, and also supporting conventional thermal power and desalination plants.	PV technology is suitable for off grid small and medium-sized applications, and for utility scale applications
Land requirement	CSP technology is best suited for areas of high direct normal solar radiation. CSP technology requires about 4 hectares of land per MW of capacity	PV technology has a wider geographical area of application. PV technology requires about 2 hectares of land per MW of capacity
Cost	CSP technology has an high installation and maintenance cost compared to PV	PV technology has a low installation and maintenance cost in comparison to CSP
Construction Time	CSP plant construction is technical more complex than PV	Utility scale PV plants are easier to install and require less time than CSP for Plant construction
Water Requirement	Water requirement is variable depending on the CSP technology option adopted. CSP may utilize wet, dry, and hybrid cooling techniques	Typically requires less water than CSP technology. Water is occasionally required for cleaning of dust from the panels.
Design Options	Less flexible in comparison to PV technology. Can be hybridized with fossil fuels like natural gas.	Highly flexible and adaptable to the project specific requirement
Average life span	25 years	25 years
Efficiency	Power production efficiency of CSP technology are as high as 45%	Power production fluctuates with the sunlight's intensity. For practical use this usually requires conversion to certain desired voltages or AC, through the use of inverters.
Environmental Risks	CSP systems have been recorded to pose environmental risks to bird species, which may be killed by the intense heat generated by the concentrated solar radiation which is reflected off the mirrors.	PV systems are considered to be generally benign.

Culled from different online sources

2.5.2.3 PV Panel Alternatives

Solar PV panel is an assembly of photovoltaic cells, also known as solar cells. It is an essential component of a PV system that converts sunlight directly into direct current (DC) electricity. To achieve a required voltage and current, a group of PV panels (also called PV modules) are wired into large array that called PV array. PV panels can be wired together in series and/or parallel to deliver voltage and current in a particular system requires.

The types of solar cells that are commonly used in PV technology are: i) mono- crystalline silicon; ii) poly-crystalline silicon; iii) thin film and iv) bifacial panels. The typical appearance of each of these PV panels is shown in Figures 2.2 to 2.5.

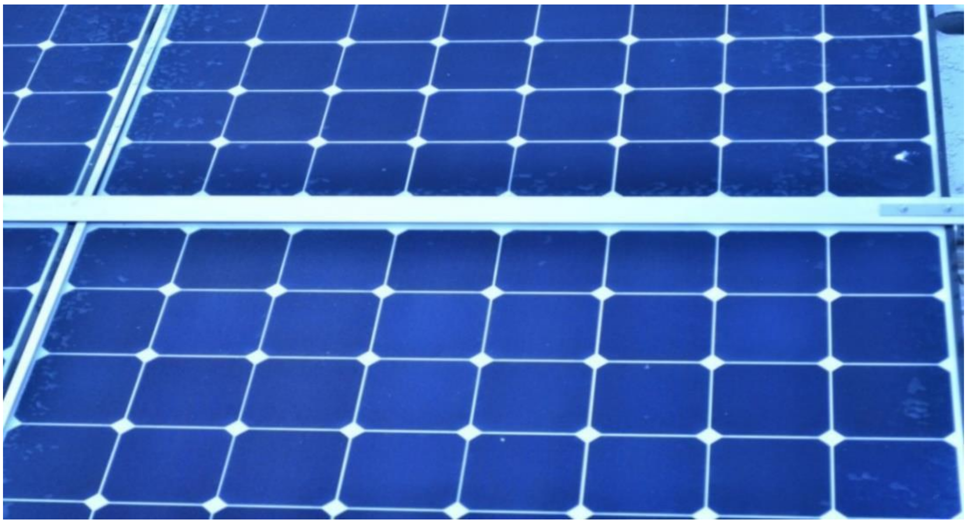


Figure 2.2: Typical appearance of mono-crystalline silicon PV panels

Figure 2.3: Typical Appearance of Polycrystalline Silicon PV panels

Figure 2.4: Typical appearance of Thin-Film CdTe panels

Figure 2.5: Bifacial Solar panels

2.5.3 Battery Types Alternative

The proposed solar power plant in FUHSA is an off-grid system, which will involve the storage of power. Storage allows the PV array to continue providing power even when the demand is down, instead of having to disconnect and refrain from generating power. The batteries for the proposed power plant would be required to meet the demands of heavy cycling (charging and discharging) and irregular full recharging. There are a variety of battery types fitted for these requirements; however, four (4) of these batteries are the best available technology for solar power plants. These are: lead-acid, lithium-ion, flow, and nickel-cadmium batteries.

Following the careful consideration of factors such as safety, charging cycles, depth of discharge and life span, lithium-ion batteries are envisioned to be used as the preferred battery for the proposed solar power plant.

An overview of the battery types considered for the Project is provided below:

- ***Lead-Acid Batteries***

These are the oldest and cheapest form of batteries used in solar systems. They are widely used in Solar PV installations due to their wide availability and ability to work in a wide range of conditions. They internally convert hydrogen and oxygen into water and do not require maintenance (Zhang *et al.,* 2016). However, proper disposal of end-of-life lead-acid batteries is important. The lead-acid battery life is typically 3-10 years (Sun *et al.,* 2017).

- ***Lithium-Ion Batteries***

Lithium-ion batteries can deliver more cycles in their lifetime than lead-acid. They can be lighter and more self-contained than lead-acid batteries. They are solid, and do not require refills or maintenance. The most important benefit lithium-ion provides for solar is its high charge and discharge efficiencies, which help harvest more energy. Lithium-ion batteries also lose less capacity when idle, which is useful in solar installations where energy is only used occasionally. Lithium ion batteries usually have longer lifespan when compared to the lead-acid batteries, average of 5 years.

- ***Flow Batteries***

The vanadium redox flow battery (VRFB) is the most common technology in this type of batteries. They are more expensive than the lithium-ion batteries but more environmentally friendly. In VRFB, the vanadium electrolyte does not degrade over time, so they can last much longer than other technologies. With other technologies, adding more batteries is the only way to increase hours of storage; however, adding more electrolyte (vanadium) can increase battery size in VRFB (Whitehead et al., 2017).

The VRFB has no cycling limitations, and batteries can be charged and discharged completely without impact on their lifespan. They can last up to 20 years. The recycled vanadium in flow batteries is not toxic and can be reused repeatedly for other purposes, such as in making steel (Whitehead *et al.,* 2017). However, the high cost of vanadium and ion selective membrane within the cell will lead to significant cost implications for the Project.

❖ ***Nickel-cadmium Batteries***

Nickel cadmium or NiCd batteries are as old as the lead-acid batteries. Though they may not have the energy density (the power) of other technologies, they provide long life and reliability without complex management systems. They are also as cheap as lead-acid batteries (Shukla and Hariprakash, 2009).

NiCd batteries are rugged batteries with a high life span of up to 20 years (Shukla and Hariprakash, 2009). However, the major disadvantage of NiCd batteries is the relatively low energy density and susceptibility to self-discharge. Thus, making NiCd batteries an unreliable alternative for the proposed Project

2.6 Project Options

2.6.1 No Project Option

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

2.6.2 Delayed Option

This option implies that the planned Project will be delayed until a much later date. Such option is usually taken when conditions are unfavourable to project implementation such as in war situation, or where the stakeholders are deeply resentful of the Project. Also, if the prevailing economic climate is not quite favourable to the Project, then delayed project option may be feasible. But none of these conditions is applicable.

Indeed, both the economic and the political environments are most favourably disposed towards the Project. The implication of delayed project option will mean that all the preliminary work and associated efforts/costs incurred would have come to nothing. Also, because of inflationary trends, such a delay may result in unanticipated increases in project costs, which may affect the final profit accruable from the Project. The delayed option is considered unviable for the Project.

2.6.3 G o Ahead Option

The inherent benefits of allowing the Project to go ahead as planned are multifarious. The quality of education, capacity for research and innovation, training opportunities, improved security within the University campus, job opportunities for Nigerian professionals, skilled and semi-skilled craftsmen will increase. Thus, the option to go ahead as planned does outweigh the other options as clearly highlighted above.

CHAPTER THREE:

PROJECT DESCRIPTION

CHAPTER THREE
PROJECT DESCRIPTION

3.1 Introduction

Solar-hybrid mini-grid is strategically important, as it supplies electricity not only to the Permanent Site but also to three other FUHSA campuses located in different parts of Bauchi, thereby facilitating efficient power integration and distribution.

The project site comprises two adjoining land parcels separated by a paved internal campus road, collectively designated for the proposed solar-hybrid power infrastructure. Parcel 1 covers approximately 2.704 hectares, while Parcel 2 measures about 2.049 hectares, resulting in a total combined land area of approximately 4.753 hectares. Both parcels lie entirely within the University's institutional boundary and have been formally earmarked for infrastructure development. Access to the site is provided through existing internal campus road networks.

The terrain of the proposed site is slightly rocky, with generally flat to gently undulating topography and no significant elevation changes or natural drainage constraints observed during site reconnaissance. The land is currently undeveloped, with no permanent buildings, utilities, or fixed structures within the project footprint at the time of assessment. This condition significantly reduces the need for demolition, relocation, or extensive site clearance prior to construction.

Vegetation cover within the project area is sparse and typical of institutional reserve land, consisting mainly of grasses and scattered shrubs. No evidence of permanent agricultural activities, residential occupation, or culturally significant features was identified within either parcel. As such, the proposed development is not expected to result in physical or economic displacement, and land tenure risks are minimal, given that ownership and control rest with the University.

The selection of the project site was informed by a combination of technical, environmental, and social considerations, including:

- Availability of adequate land within the FUHSA Permanent Site, eliminating the need for external land acquisition;
- Close proximity to the University's existing power injection substation, enabling efficient power evacuation and integration into the internal distribution network serving multiple campuses;
- Minimal resettlement, land-use conflict, and tenure risks, as the land is institutionally owned and free from third-party claims; and
- Suitability for solar photovoltaic development, based on open exposure, limited shading, and manageable terrain conditions.

The combined 4.753-hectare site area is adequate to accommodate the key components of the proposed solar-hybrid mini-grid system, including solar PV arrays, battery energy storage systems, inverter and control stations, internal access routes, security fencing, and ancillary facilities. The spatial arrangement of the two parcels also allows for appropriate safety setbacks, buffer zones, and operational flexibility in accordance with applicable design standards and environmental management requirements.

Overall, the physical characteristics, strategic location, and institutional setting of the proposed project site make it suitable for the planned development while limiting potential adverse environmental and social impacts, consistent with the mitigation hierarchy and best practice for renewable energy infrastructure siting.

Figure 3.1: Map of Nigeria Highlighting showing the Project State, Bauchi

Fig 3.2: Proposed Site showing bot location bisected with paved road as well as proximity to Injection Substation (Source: field work, 2026)

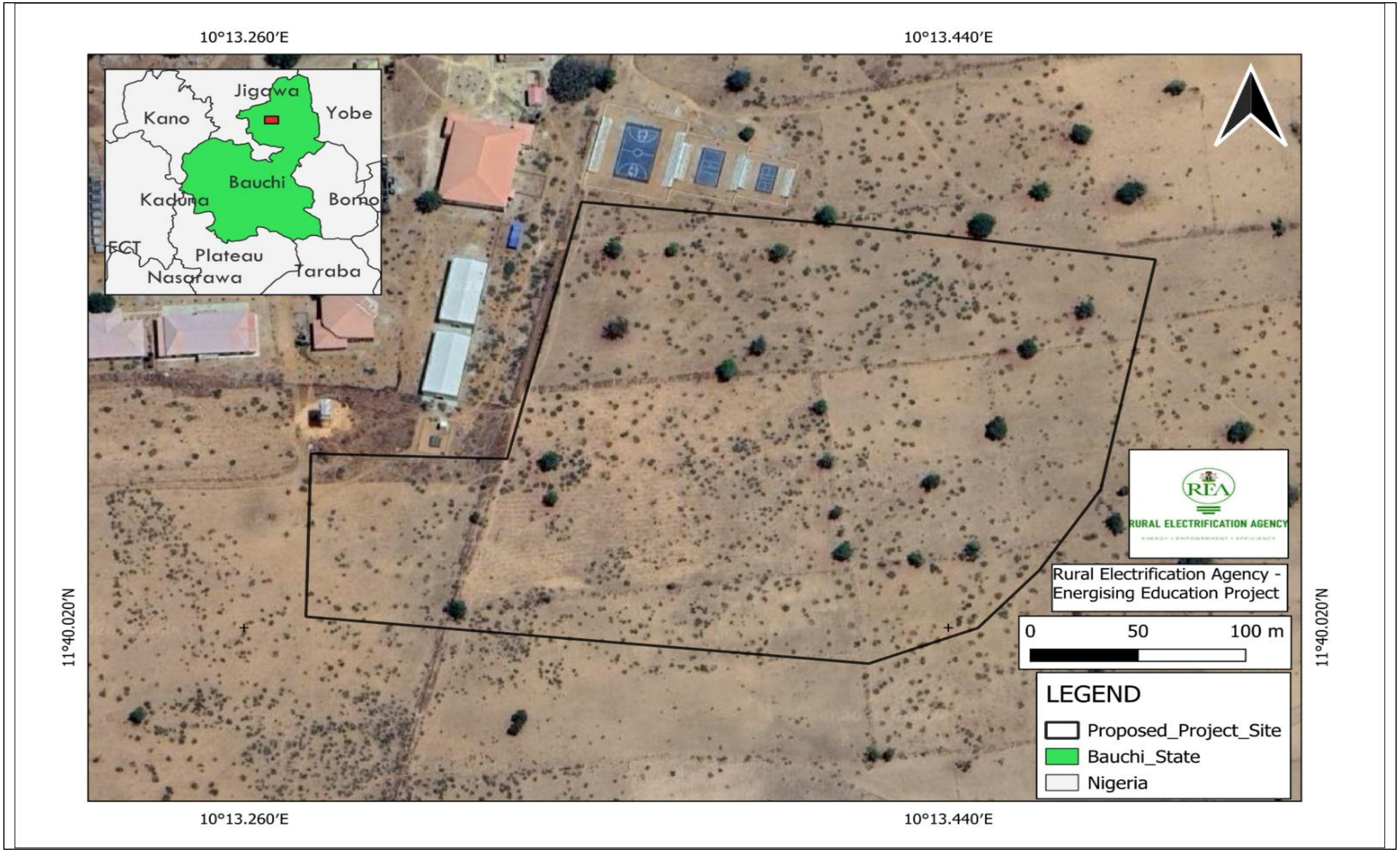


Figure 3.3: Satellite imagery of the site at FUHSA, Katagum LGA, Bauchi State, depicting the final survey of the agreed site in black line. (Source: Field Work 2026).

3.3 Project Components

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

3.3.1 Proposed Solar-Hybrid Power Plant

PV technology is a method of generating electricity through the use of solar panels which are composed of a number of solar cells. Such cells convert solar energy (radiation from the sun) into electricity using semiconductors such as silicon. One of the properties of semiconductors that makes them most useful is that their conductivity may be easily modified through the introduction of foreign materials into their crystal lattice, which in turn can lead to improved energy generation.

PV technology is basically comprised of:

PV Cell: This is the basic photovoltaic device which generates electricity when exposed to solar radiation due to its photo-electric effect. The absorbed solar energy excites electrons inside the cells into a higher state of energy, producing electrical energy. PV cells are commonly constructed from mono- or polycrystalline silicon or thin film technology. A number of solar (PV) cells electrically connected to each other and mounted in a single support structure or frame is called a PV panel.

PV panel or module: This is the smallest assembly of interconnected PV cells sold commercially. In the case of crystalline silicon cells, following testing and sorting to match the current and voltage, the cells are interconnected in series and encapsulated between a transparent, anti-reflective front, and a backing material to provide environmental protection to the cells. The panel is then typically mounted in an aluminum frame to provide mechanical strength to the assembly. PV panels are usually designed to supply electricity at a certain voltage, such as a 12V system. The current produced is directly dependent on the intensity of light reaching the panel. Several PV panels can be wired together to form an array. PV panels and arrays produce Direct Current (DC) electricity.

The most likely PV panels to be used for the proposed power plant in FUHSA are of poly-crystalline silicon as discussed in Chapter 2. However, the exact number of the panels is yet to be finalized. Based on the review of similar solar power projects, about 7,200

PV panels (for example, JKM340PP-72H-V) would be required to generate a power capacity that can sustain the energy demand of the University.

The PV panels to be installed will have following characteristics:

- All PV panels within a PV string will have equivalent Voc (voltage at open circuit) and Vmpp (voltage at maximum power point) values and will be of same type, with same design, from the same manufacturer.
- All PV strings within a PV sub-array connected in parallel will have similar rated electrical characteristics of open circuit voltage and maximum power voltage, and temperature coefficients.
- All PV panels that are electrically in the same string will have the same orientation (azimuth and tilt angle).
- PV structural components will be corrosion resistant.

Aside the PV panels, the power plant will typically consist of the following associated components:

Mounting structure: The PV panels will be secured on a fixed structure, made up of galvanized steel or aluminium. The majority of leg structures for the frames will be fixed into the earth. Driven piles and/or screwed system will be used and the depth of driven piles is 2m.

Inverter: An inverter converts the variable DC output of a PV panel into a utility frequency alternating current (AC) that can be used by a local, off-grid electrical network or fed into a commercial electrical grid. Solar inverters are usually designed to have in-built safety features required by PV cells as well as special functions adapted for use with PV arrays, including string current monitoring and anti- islanding protection.

The number and specification of inverters to be installed as part of the proposed solar power plant is yet to be finalized. The inverters shall however be acquired from the internationally recognized manufacturers such as WSTech, Ingeteam, Gamesa, Jema, Power Electronics, GPTech, and Helios Systems.

Battery: The number and capacity of lithium-ion batteries to be installed as part of the power plant is yet to be finalized. The batteries would be stored and operated under optimum conditions as specified by the manufacturers.

Backup Generator: Diesel-fuel generating sets (2 – 3 Nos) would be installed at the Project site for recharging the batteries during unfavorable weather conditions (e.g. at the peak of raining season). The capacity of the proposed generators is yet to be finalized. A diesel-storage tank with appropriate bund wall on a concertized floor will also be provided on site.

Combiner Boxes: A combiner box combines the output of several solar strings into one output. Solar combiner boxes also consolidate incoming power into one main feed that distributes to a solar inverter. They are engineered to provide overcurrent and overvoltage protection to enhance inverter protection and reliability.

Underground cable for power evacuation: The power generated from the proposed plant would be evacuated to the existing power house in the University through an 11 kV underground armoured cable. The distance between the Project site and the existing power house is approximately 50m. Information on the size of the evacuation cable is not available yet.

Low and medium voltage switchgear cabinets: Power generation and distribution during plant operation involves the use of various types of circuit breakers and surge protectors, which will be enclosed in low and medium voltage switchgear cabinets. The switch gear cabinets to be installed at the plant site will contain a combination of electrical disconnect switches, fuses and circuit breakers. These components will be used to control, protect and isolate power generation and distribution activities during operation. A typical low voltage switchgear cabinet is shown in Plate 3.2.

Plate 3.4 A typical low voltage switchgear cabinet
Source: bowerselec.co.uk/low-voltage-switchgear, 2018

3.3.2 Rehabilitation of Existing Distribution Infrastructure

The energy audit conducted at FUHSA indicates that the major power equipment in the University such as transformers, distribution network are in good condition. In addition, there are high level interconnection substations in place with installed distribution capacity of 12,320 kW. Where required, the existing distribution network will be upgraded to accommodate the generated power from the proposed solar-hybrid power plant.

3.3.3 Provision of Street Lighting

Information obtained from the report of energy demand audit conducted in FUHSA in April 2019 reveals that the University has 240 streetlights (solar and conventional) covering major roads within the campus. As part of proposed Project, new and additional streetlights will be installed (where required) to ensure that different areas within the University campus are well illuminated.

3.3.4 Renewable Energy Training Centre

Students from the University will be allowed to access the Project site for learning and training purposes. Therefore, a renewable energy training centre will be constructed within the 20.0 ha of land earmarked for the entire Project. The training centre will also include storage room, workshop and toilet facilities.

3.4 Engineering Codes and Standards

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

3.5 Project Implementation Phase

3.5.1 Pre-construction Phase Activities

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

3.5.2 Construction Phase Activities

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

It is envisaged that approximately 400 people would be required for construction activities. These are divided into low skilled workers (e.g. construction labour who will make up the majority of workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers and expatriates). Most of the unskilled and semi-skilled workers would be drawn from the nearby local community (located outside the University campus) to enhance the job opportunities associated with the proposed Project. Moderate level of migrant workers may also be associated with the construction phase activities (potential impacts associated with the migrant workers as well as the proffered mitigation measures are covered in Chapters 5 and 6). No worker's camp is planned to be established onsite during construction.

3.5.3 Commissioning Phase Activities

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

3.5.4 Operational Phase Activities

The operational phase of the Project will involve power generation and distribution to various sections of the University as well as the preventative, corrective and predictive maintenance of the power plant and associated facilities. In addition, the training centre will be put into use to enhance learning in renewable energy.

The EPC contractor shall develop standard operating procedures (SOPs) for the operation and maintenance of the solar panels, inverters, batteries, and other associated components of the Project. If need be, the SOPs shall be further reviewed and updated by the O&M contractor during operation. The day-to-day operations of the plant will involve both regular preventive and corrective maintenance carried out by the O&M Contractor in order to keep the power plant in optimal working condition throughout its operating life. The preventive maintenance follows a routine service schedule aimed at preventing faults from occurring and keeping the power plant operating at its optimum level. The frequency of the preventive maintenance would depend on a number of factors such as the technology selected, environmental conditions of the site, warranty terms and seasonal variances. It contains, for example, activities like PV panel cleaning, inverter servicing, and checks on structural integrity of the mounting structure.

Corrective maintenance will be carried out in response to failures, for example, the repair/exchange of damaged or faulty equipment. Maintenance will consist mostly of panel/battery replacement and other mechanical and electrical infrastructure repairs. Faulty components will be replaced as soon as the problems are identified.

The average life span of the PV power plant is 25 years which can be extended through regular maintenance. Even after the 25 years, the PV panels can still generate up to 90% of the design capacity. Overall, the approximate number of persons (skilled and Unskilled) that will be involved in the project from Preconstruction to operational and Mainteance phase is about 100 personnels.

Chapter 8 of this report contains detailed information on the activities associated with the decommissioning of the proposed solar power plant and its ancillary facilities (in the event of final decommissioning), including the environmental and social measures to be implemented to address potential impacts of the decommissioning activities.

3.6 Water Use and Supply

One of the key benefits of the power plant (to be provided as part of the proposed Project) in terms of resource use is the generation of electricity using freely available solar energy to produce electricity, reducing the dependence on fossil fuels; thus, reducing carbon emission.

The use of water for construction activities will be minimal approximately at about 20,000 litres because construction works requiring cement mixing will be few on site. Water is required majorly during the operational phase of the power plant for periodic cleaning of PV panels to prevent dust build-up (especially during the dry season), since dust can affect their performance by inhibiting the amount of irradiation that reaches the solar cells. The rate of build-up of dust on the PV panels is dependent on a number of factors including soil type, local wind speed and the mounting structure used for the panels.

Manual cleaning of the PV panels with water shall be regulated as much as practicable. During the periods of rainy, direct cleaning of the PV panels is estimated to occur not more than three times. However, during the dry, the frequency of cleaning will depend on the rate of dust accumulation, and it is envisaged to be more than three times due to high dust generation usually experienced in the Northern part of the country.

Based on the review of similar solar power projects, each PV panel would require approximately 5 litres of water per cleaning cycle. The water required for the cleaning purpose would be obtained from the borehole that will be installed within the Project site. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have significant effect on the existing groundwater aquifer of the Project area as well as the local water use. The recharge of the existing boreholes in the study area is largely due to direct precipitation. During the rainy season, the water reserve of the aquifer in the study area increases; thus, hand dug wells and boreholes yields improve significantly.

3.7 Health and Safety

The EPC 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. The contractors shall provide OHS training that may include hazard awareness, safe work practices and emergency preparedness to their workers to ensure they are appraised to project sites rules of work, personal protection and preventing injury to fellow workers. Worker activities will be managed through appropriate planning and the application of Permit-to-Work system, Job Hazard/Safety Analysis, Personal Protective Equipment (PPE) requirements and other safety-based protocols.

Also, all contractors, as a component of their contracts, will implement HSE plans which will outline procedures for avoiding health and safety incidents and for emergency medical treatment. Contractors will be required to carry our regular safety inspections to ensure measures to manage potential OHS hazards are implemented.

For example, during the construction phase, a Health and Safety (H&S) risk assessment-based approach will be taken to manage H&S risks to workers. This would involve assessing all the various risks that are involved in each aspect of the job and educating workers on how to manage these risks. The people working around the Project area shall also be warned of the risk involved i.e. warning signs shall be erected for people to see clearly. In addition, First-aid equipment and PPEs for workforce will be provided onsite throughout the construction activities.

All staff, workmen, supplier and sub-contractor working on site shall be informed on the need to ensure their safety and the safety of the people working around them. Every worker will be instructed to always put on PPE whilst on site. Appropriate warning signs will be erected and checked each day. Daily health and safety tool-box meetings among workforce will be ensured. The safety briefings will be led by the onsite HSE officers. Smoking, use of alcohol or hard drugs will be strictly forbidden.

3.8 Waste Management

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

3.8.1 Overview

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

Waste management principles shall be based on an integrated approach which involves a combination of techniques and programs to manage waste. Source reduction is at the top of the approach, followed by reuse and recycling as preferred options to disposal.

Generally, wastes associated with the proposed Project shall be managed using the following prioritized program:

- **Reduction at Source** – The elimination or minimization of waste generation through equipment modifications and installation of pollution abatement equipment.
- **Reuse** – Using an item for its original purpose, or similar purpose, in its original form. Wastes generated from one operation shall be put to use in other operations where they are found useful without compromising standards and safety.
- **Recycling** – conversion of waste materials into reusable objects. This will involve using FMEnv/NESREA approved companies involved in recycling business using best available technology that meet international standards.
- **Residue Disposal** - disposal of wastes in a government-approved dumpsite.

3.8.2 Associated Waste Streams

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

Pre-construction Phase

The waste streams associated with the pre-construction phase of the Project include cleared vegetation (during site preparation), food waste, and general rubbish. The cleared vegetation (mostly grasses) will be removed from the site and allow to biodegrade at a portion of the site while wood from felled trees will be made available to the local community. The general rubbish will be collected within the Project site and disposed of at a government-approved dumpsite through a third- party waste contractor accredited by the Bauchi State Environmental Protection and Sanitation Agency (BASEPA). Estimated waste generation during preconstruction stage is around 2-5kg per day.

Construction Phase

The planned activities during the construction phase include civil, mechanical and electrical works and installation of PV panels and associated components which will be carried out by a number of construction workers. The waste streams associated with the construction activities include excavated soil, general refuse, garbage, inert construction materials, metal scraps, concrete waste, food waste, and used packaging materials.

In line with the Environmental and Social Management Framework (ESMF) for the Nigeria Electrification Project (NEP), the EPC contractor shall put in place and comply with a site waste management plan. The plan shall be developed to address all waste streams associated with the construction activities and comply with relevant regulations. The contractor shall comply with the national requirements and Building rules on storage of construction materials.

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

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

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

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

<u>Operational Phase</u>

Solid wastes generated during the operational phase of the Project will be incorporated into the existing FUHSA waste management approach (there is a dedicated site within the University environment where solid wastes are collected for disposal).

Approximately 2.25 cm^{3} of solid waste (e.g. paper waste, food packaging, etc.) is estimated to be generated per week during the operational phase.

In line with NEP ESMF, the University shall be encouraged to prepare e-waste management plans that account for safe end-of-life disposal of equipment from the solar plant. The Extended Producer Responsibility program (EPR) will be implemented for solar panels, inverters, batteries and other electrical components to be installed for the Project.

Damaged or discarded PV panels and inverters will be collected and sent to the manufacturer for recycling (through a take-back scheme). Spent, damaged or expired batteries will also be returned to the manufacturer for recycling in line with NESREA Extended Producer Responsibility (EPR) programme. Alternatively, the spent batteries will be recycled by local and accredited battery recycling companies in Nigeria. REA will work closely with NESREA to identify these local recyclers. These batteries shall be stored in red coloured waste receptacles before they are transported to the accredited battery recycling companies. The quantity of waste batteries generated typically depends on a number of factors such as type, capacity and number of batteries installed and depth of discharge.

Storm water will be managed through a combination of open trenches and ditches. Storm water shall drain away to the natural environment via gravity. Paved and concreted areas will be sloped to allow for proper drainage.

Sanitary wastes (sewage) generated during the facility operation shall be channeled to a septic tank to be installed onsite. The septic tank shall be of reinforced concrete and will be located away from any groundwater source. As at when due, the contents of the septic shall be evacuated by an accredited waste contractor for treatment at a sewage treatment plant approved by BASEPA.

Decommissioning

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

The summary of wastes stream associated with the Project is provided in Table 3.2.

Table 3.2: Summary of Wastes Stream associated with the proposed Project and Handling Techniques

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

3.9 Project Schedule

The proposed Project is planned to be operational by the third quarter (Q4) of 2026. The tentative Project schedule is provided in Table 3.3.

Table 3.3: Tentative Project Schedule

Project Schedule	**2026**											
	April-June				July-Sept				Nove			
	Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Site allocation												
Energy demand audit												
ESIA study and Approval												
Selection of EPC Contractor and contract signing												
Civil, electrical, and mechanical design												
Procurement (Manufacturing and transportation)												
Preconstruction and construction Phase Activities												
Commissioning												
Commencement of operation												

CHAPTER FOUR:

DESCRIPTION OF THE ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

CHAPTER FOUR

DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction

This chapter provides a description of the existing environmental and socio- economic conditions of the Project's area of influence, which covers the Project site and its surrounding environment up to 3km, including the area where the cumulative impacts of the Project may be experienced. Data and information for the environmental description of the study area were based on field data gathering (primary data) as well as review of relevant literature (secondary data).

The field sampling was carried out from 25th – 31st January, 2026 by several Environmental and Social specialists. Based on the consideration of the potential environmental and social footprints of the proposed Project, the observations noted during the preliminary visit to the Project site as well as the need to ensure that all the sensitive receptors that could be potentially affected by the proposed Project have been captured, a 1km radius from the centre of the Project site was selected as the spatial boundary for biophysical sampling while the socio-economic survey was extended to approximately 3km radius from the centre of the Project site. The environmental components of the study area described in this chapter cover the following:

- Climate and meteorology;
- Geology and hydrogeology;
- Air quality and noise;
- Groundwater;
- Soil;
- Surface water;
- Terrestrial flora;
- Terrestrial fauna;
- Land use;
- Socio-economic and health.

4.2 Baseline Data Collection

Baseline data acquisition exercise involved a multi-disciplinary approach and was executed within the framework of Quality Health, Safety, and Environment (QHSE) management system. This approach assured that the required data and samples were collected in accordance with the approved scientific and regulatory requirements using appropriate equipment, materials and personnel.

The study approach includes the following:

- Desktop review of existing materials relevant to the Project environment;
- Designing and development of field sampling strategies to meet the scope of the ESIA study and regulatory requirements;
- Pre-mobilization activities (including calibration/pre-testing of field equipment, review of work plan with team members);
- Mobilization to site for fieldwork sampling (sample collection, in-situ measurements, sample handling, documentation, and storage);
- Demobilization from field; and
- Transfer of field samples to the laboratory for analysis.

4.2.1 Desktop Studies/Literature Review

Desktop studies involved the acquisition of relevant background information on the biophysical and socio-economic environment of the Project area. Information was sourced from the relevant government authorities including the Nigerian Meteorological Agency (NiMet), the National Bureau of Statistics (NBS) and the Federal Ministry of Environment (FMEnv). Other sources of information employed include online publications, textbooks, articles etc.

4.2.2 Field Sampling and Laboratory Analysis

4.2.2.1 <u>Field Sampling</u>

In order to effectively characterize the environment of the Project area, field sampling was conducted from 25th – 31st January, 2026. The objective of the field survey was to obtain the baseline data of the Project's area of influence and describe its environmental and social context. Sampling locations were identified using recent satellite imagery of the Project area. The basis of the sampling design was informed by a preliminary characterization of the Project area through desktop research and nearby sensitive receptors. Sampling locations for biophysical components were randomly selected to cover as much as possible the land area for the proposed Project as well as the surrounding environment, while the socio-economic survey focused on the potentially affected community (Low-Cost Community) identified within the Project's area of influence. All sampling locations were geo-referenced using Garmin Map-62 series Global

Positioning System (GPS) handsets. Plate 4.1 to 4.5 show sample photographs of field sampling activities in the Project area.

Plate 4.1: Air quality and noise measurements within the proposed project site

Source: EcoFields Field Survey, 2026

Plate 4.2: Soil sampling within the proposed project site

Source: EcoFields Field Survey, 2026

Plate 4.3: Focus group discussion with women in Azare community

Source: EcoFields Field Survey, 2026

Plate 4.4: Groundwater sampling close to the proposed project site
Source: EcoFields Field Survey, 2026

Plate 4.5: Surface water sampling within the project AoI
Source: EcoFields Field Survey, 2026

Quality assurance and quality control measures consistent with the relevant local and international guidelines and standards were implemented during the field sampling. These measures include,

- *In-situ* measurements of parameters with short holding time in water samples immediately after collection.
- Proper calibration of all portable meters used for in-situ measurements.
- Separate samples were collected for parameters requiring different treatment/preservation before analysis.
- Field samples were adequately preserved and labelled.
- The chemical reagents used for sample preservation were adequately labelled to avoid mix-up.

The summary of sample management program put in place to safeguard the integrity of the field samples collected during the baseline data gathering is provided in Figure 4.2.

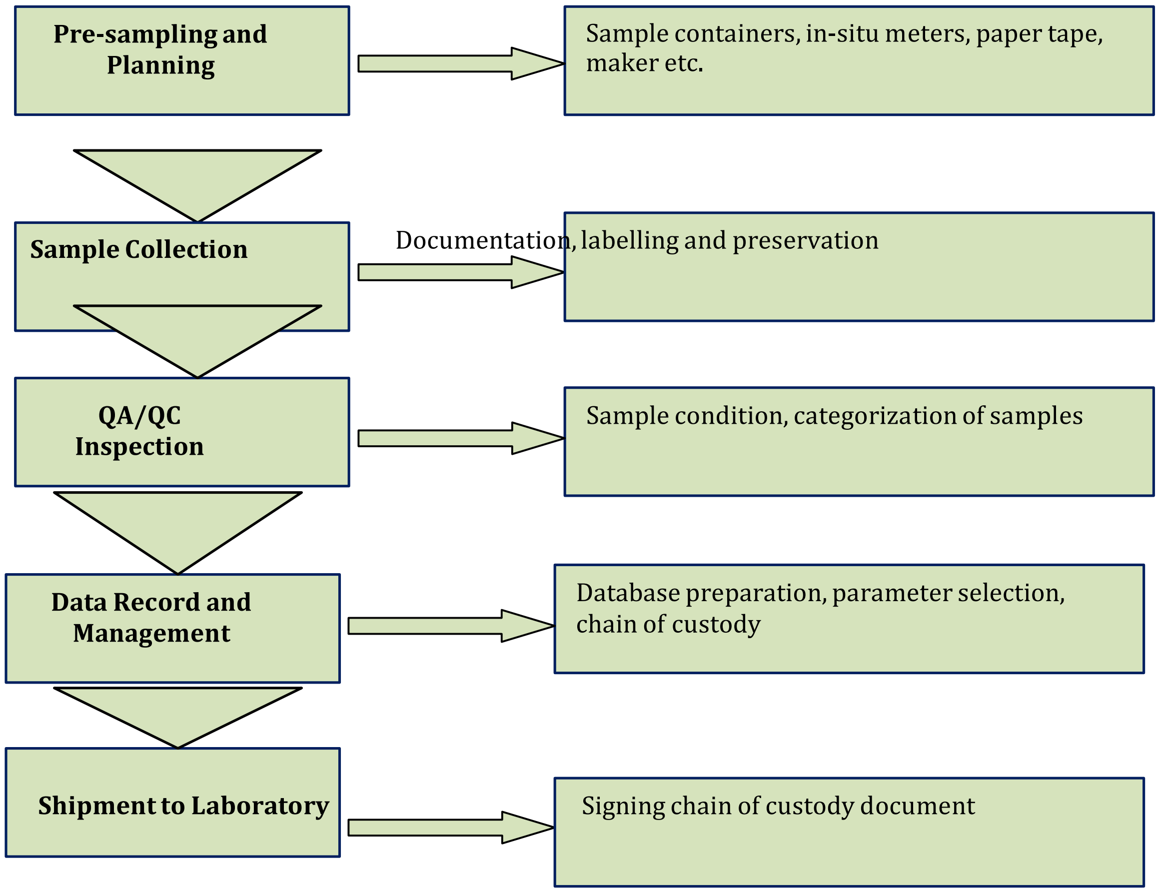


Figure 4.2: Management program employed for field sampling
Source: EcoFields Field Survey, 2026

4.2.2.2 <u>Laboratory Analysis of Field Samples</u>
Field samples collected during the baseline survey were conveyed to the laboratory for analysis, along with the completed chain of custody forms. The samples were preserved with appropriate reagents (such as nitric acid and sulphuric acid), and the recommended temperature of 4^0C for the samples was maintained in-transit with the use of ice-chest and ice chips in different insulating containers.
The field samples were analysed for physico-chemical and microbial parameters at Ministry of Environment and Climate Change Pollution Control Laboratory, Farm centre, Near Cool FM, Kano state. The Laboratory is accredited by FMEnv and other relevant regulatory agencies.
The laboratory analyses were undertaken in consistent with the approved standard methodologies such as those recommended by the American Society for Testing and Materials (ASTM) International, the American Public Health

Association (APHA) and the FMEnv. The summary of analytical methods employed is presented in Table 4.1.

Table 4.1: Analytical methods employed for field sample analysis

S/N	Parameters	Analytical Methods	Units	
			Water sample	Soil sample
1.	Total Suspended Solids	Gravimetric method	mg/l	-
2.	Biological Oxygen Demand	Dilution method	mg/l	-
3.	Chemical Oxygen Demand	Closed Reflux dichromate method	mg/l	-
4.	Oil and Grease	N-Hexane Extraction Method	mg/l	mg/kg
5.	Alkalinity	Titration method	mg/l	-
6.	Total Hardness	EDTA/Titration method	mg/l	-
7.	Nitrate	Spectrophotometric method	mg/l	mg/kg
8.	Sulphate	Spectrophotometric method	mg/l	mg/kg
9.	Phosphate	Spectrophotometric method	mg/l	mg/kg
10.	Nitrite	UV/VIS Spectrophotometry	mg/l	mg/kg
11.	Sodium	Flame photometric method	mg/l	mg/kg
12.	Potassium	Flame photometric method	mg/l	mg/kg
13.	Calcium	Titration with ethylenediamine tetra-acetic acid method	mg/l	mg/kg
14.	Magnesium	Titration with EDTA method	mg/l	mg/kg
15.	Lead	Atomic Absorption Spectrophotometry	mg/l	mg/kg
16.	Nickel	Atomic Absorption Spectrophotometry	mg/l	mg/kg
17.	Cadmium	Atomic Absorption Spectrophotometry	mg/l	mg/kg
18.	Zinc	Atomic Absorption Spectrophotometry	mg/l	mg/kg
19.	Copper	Atomic Absorption Spectrophotometry	mg/l	mg/kg
20.	Chromium	Atomic Absorption Spectrophotometry	mg/l	mg/kg
21.	Manganese	Atomic Absorption Spectrophotometry	mg/l	mg/kg
22.	Total Iron	Atomic Absorption Spectrophotometry	mg/l	mg/kg
23.	Mercury	Cold Vapour Atomic Absorption Spectrophotometry	mg/l	mg/kg

Source: EcoFields Field Survey, 2026

4.3 Description of Biophysical Environment of the Study Area

4.3.1 Climate and Meteorology

The climate of the study area is that of a tropical environment characterised by high relative humidity and moderate rainfall. Climate controls the natural forces that act on virtually all the components of the ecosystem. In addition to determining the components of the environment, it also modifies the structural differences between them in the process of maintaining equilibrium. In this section of the report, the dominant climatic elements and factors within the study area are discussed.

(a) *Rainfall*

The total annual rainfall in the area ranges from 1100 mm to 1600 mm. The rainy season begins from April and ends in October (Figure 4.3).

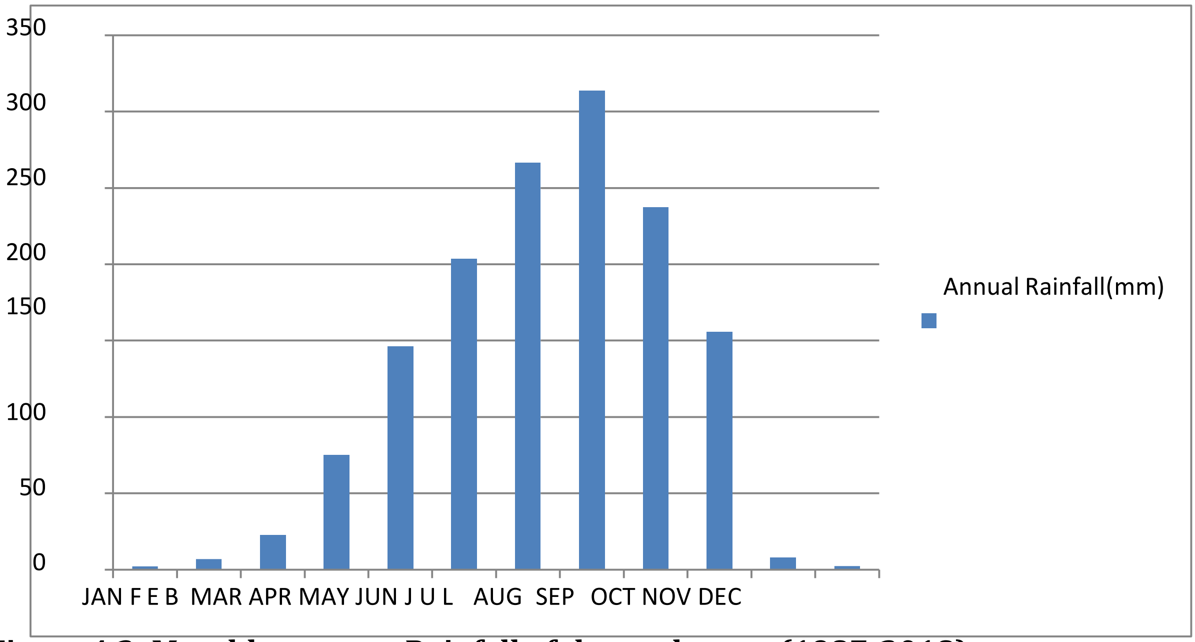


Figure 4.3: Monthly average Rainfall of the study area (1987-2018)
Source: NiMet, 2019

(b) Temperature

The temperature of the study area is relatively high and stable all over the year. Figure 4.4 shows the temperature characteristics of the area.

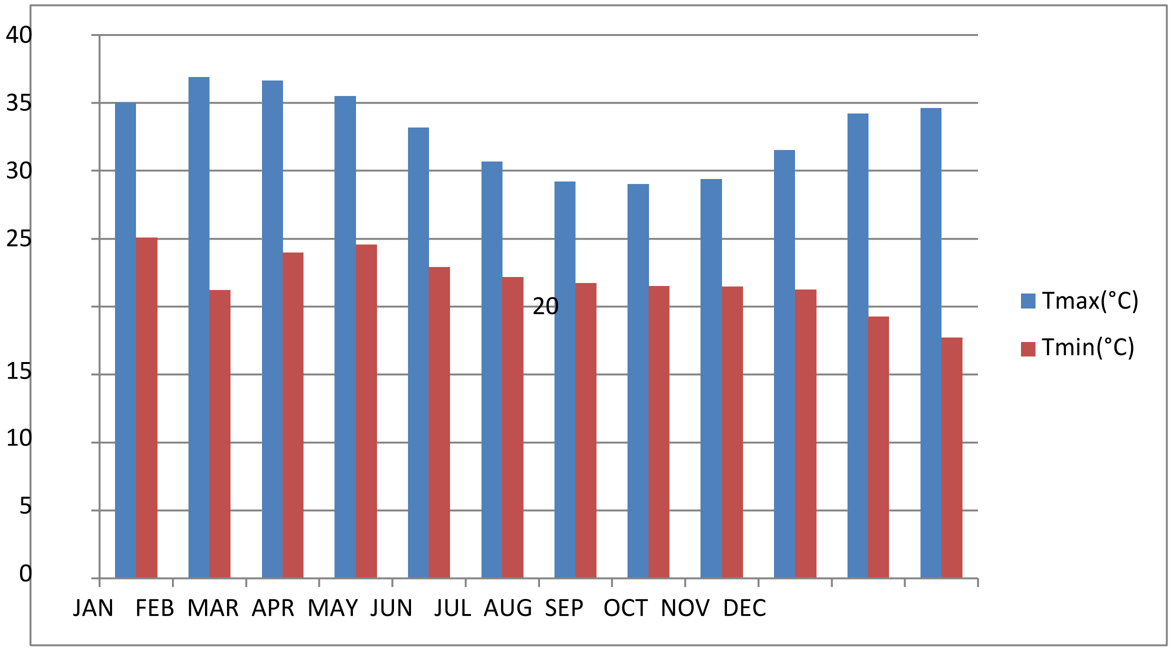


Figure 4.4: Average Minimum and Maximum Temperature of the study area (1987-2018)
Source: NiMet, 2019

(c) Relative Humidity

Bauchi experiences high relative humidity as a result of the prevailing air masses that blow over the area almost all the year round. Long time climatic data for Bauchi indicate that relative humidity measured in the morning ranged between 35.1 % in February and 86.3 % in August while at night the value ranged from 23.5 % to approximately 73.5 % as shown in Figure 4.5.

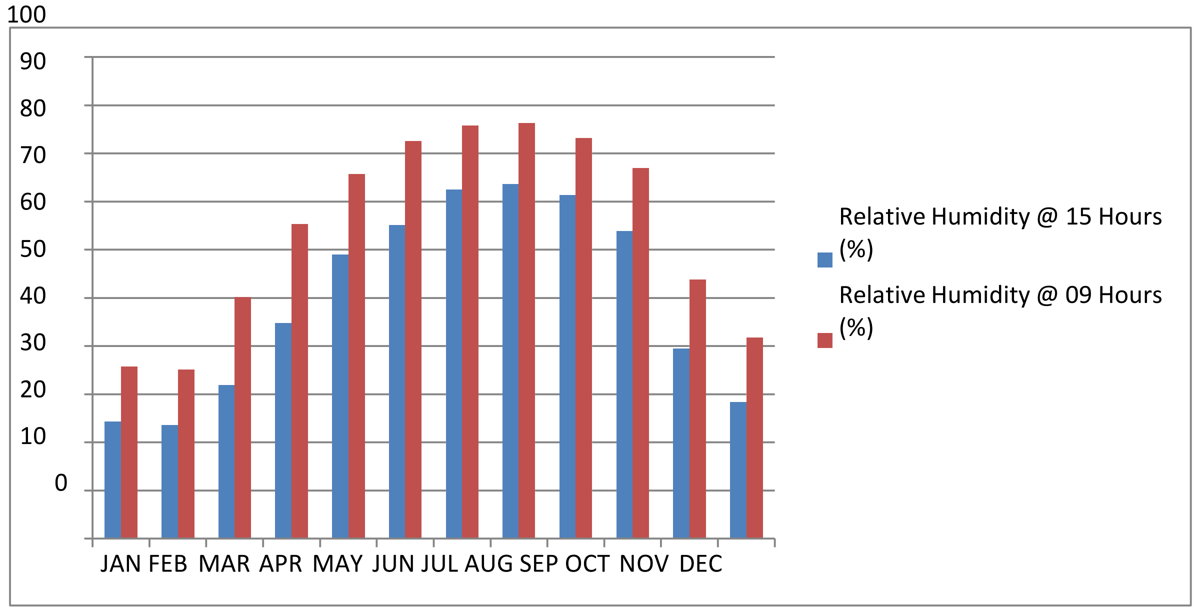


Figure 4.5: Monthly Relative Humidity characteristics of the study area (1987-2018) **Source: NiMet, 2019**

(d) Wind Speed

Seasonal observations revealed appreciable variability. Wind speed variability is more pronounced during the wet season. The lowest wind speed value was obtained in the month of December.

(e) Sunshine Hours

Based on the information gathered from NiMet (1987-2018), the mean monthly sunshine hours range between a low value of 4.6 hours in August and a high value of 8.6 hours in November.

4.3.2 Geology and Hydrogeology

4.3.2.1 Geology

The study area is located within the Central Nigeria Precambrian Basement Complex. (Figure 4.6) The geology of the area has been studied and discussed by previous publications like Oyawoye (1972), McCurry (1976) etc. They described the rocks as comprising mostly granite, gneisses, mica schists, hornblende and feldspathic schists and migmatites. The rocks are highly fractured and jointed showing essentially two fracture patterns, NE – SW and NW – SE. These fractures control the drainage and flow patterns of rivers in the area. However, minor

Cretaceous deposits of Nupe sandstones occur in the southern part of BAUSG between Kwali and Abaji, extending to Rubochi and the border with Nassarawa State. Similarly, metasediments have also been mapped along a general NNE-SSW direction through the west of Kusaki (in the south) and east of Takushara (in the north) (USGS 1977). Mica schists and amphibolite schists occur around Kusaki and
Buze villages outside the study area.

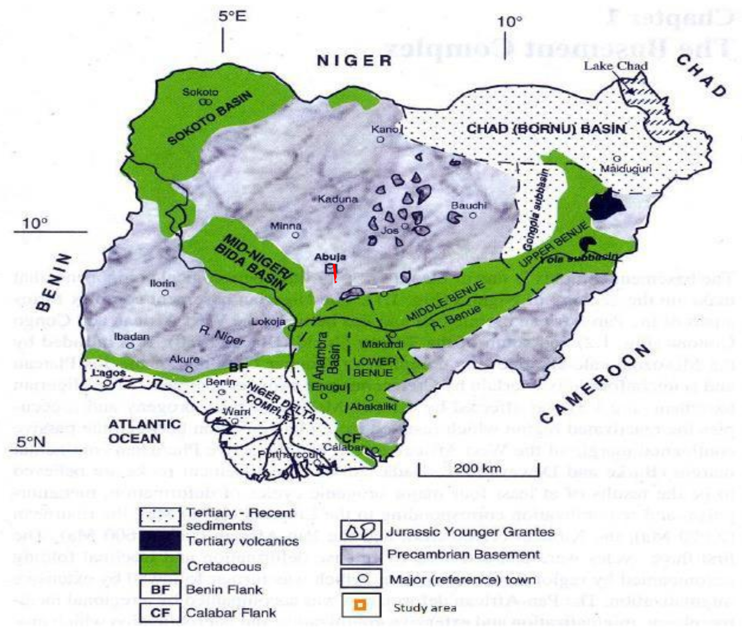


Figure 4.6: Sedimentary Map of Nigeria
Source: Obrike *et al.*, 2011

4.3.2.2 Hydrogeology

Bauchi State is characterized by a diverse hydrogeological setting controlled by two major geological provinces: the **Precambrian Basement Complex**, which underlies much of the central and western parts of the state, and the **sedimentary formations** of the Kerri-Kerri Formation and the Chad Basin, which occur predominantly in the eastern and northeastern areas. This geological diversity influences groundwater occurrence, availability, and aquifer productivity across the state.

Groundwater is the primary source of potable water for domestic, agricultural, and industrial uses in Bauchi State. Within the Basement Complex terrain, groundwater occurs mainly in the weathered regolith and fractured crystalline bedrock because the underlying igneous and metamorphic rocks possess negligible primary porosity. Aquifer productivity in these areas depends largely on the thickness of the weathered overburden, the degree of fracturing, and the connectivity of structural discontinuities. Productive boreholes are generally obtained where thick weathered layers coincide with fractured bedrock, with borehole depths typically ranging between **40 and 80 m**.

In contrast, the sedimentary terrain is underlain predominantly by the **Kerri-Kerri Formation**, comprising sandstone, siltstone, claystone, and lateritic deposits. The sandstone horizons provide aquifers with moderate to high primary porosity and permeability, resulting in relatively higher groundwater storage and yields compared to the Basement Complex aquifers. Boreholes in these formations are commonly drilled to depths of **60–150 m**, depending on local lithology and aquifer characteristics.

Groundwater recharge occurs principally through direct infiltration of seasonal rainfall, seepage from rivers and streams, and percolation through permeable soils and fractured zones. Annual rainfall ranging from approximately **800 mm in the northern areas to over 1,300 mm in the southern highlands** provides seasonal replenishment of shallow aquifers, although groundwater levels typically decline during the dry season due to reduced recharge and increased evapotranspiration.

4.3.3 Ambient Air Quality and Noise

Ambient Air Quality and Noise Monitoring Methodology

Primary baseline data were generated through field measurements undertaken within the Project Area of Influence (AoI), while secondary data were obtained from published environmental studies, meteorological records, and previous environmental assessments conducted within Imo State and the Niger Delta region to establish the seasonal representativeness of the baseline conditions.

In-situ ambient air quality measurements were conducted using pre-calibrated portable monitoring instruments, including the Aeroqual Series 500 Multi-Gas Monitor, Aerocet 531 Particle Mass Profiler, and GrayWolf Particle Counter. The monitoring programme covered the following parameters:

- Sulphur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Carbon Monoxide (CO)
- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Hydrogen Sulphide (H_2S)
- Volatile Organic Compounds (VOCs)
- Total Suspended Particulates (TSP)
- Particulate Matter (PM_{10} and $PM_{2.5}$)

Ambient environmental noise levels were measured using a calibrated Extech Integrated Sound Level Meter with a measurement range of 30–130 dB(A). Measurements were taken approximately 2 m above ground level, with the instrument configured to the A-weighting network and slow response mode in accordance with internationally accepted environmental noise monitoring procedures.

A total of eight (8) strategically selected monitoring locations were established across the Project Area of Influence to characterize existing ambient air quality and environmental noise conditions. The locations were selected to represent sensitive receptors, residential settlements, road corridors, and proposed project facilities.

Ambient Air Quality

Baseline ambient air quality monitoring was undertaken during the dry season, when atmospheric conditions in the Niger Delta are typically influenced by reduced rainfall, increased vehicular movement on unpaved roads, biomass burning, localized gas flaring activities within the region, and occasional Harmattan dust transport from northern Nigeria. These conditions generally result in relatively higher particulate matter concentrations and therefore represent conservative baseline conditions for air quality assessment.

To complement the field measurements, secondary information obtained from published environmental studies, historical air quality assessments, and meteorological data for Imo State and the Niger Delta region indicates that particulate matter concentrations (PM_{10}, $PM_{2.5}$ and TSP) generally reduce during the wet season due to rainfall-induced atmospheric cleansing (wet deposition) and suppression of fugitive dust emissions. Conversely, concentrations of gaseous pollutants such as SO_2, NO_2, CO, VOCs and H_2S are primarily influenced by localized anthropogenic sources, including vehicular traffic, domestic fuel combustion, artisanal activities, and industrial operations, and therefore exhibit relatively limited seasonal variability except near significant emission sources.

Accordingly, the combination of primary monitoring data and secondary environmental information indicates that the baseline air quality data generated during the study are representative of existing environmental conditions within the Project Area and provide a robust basis for assessing potential project-related air quality impacts during the construction, operation, and decommissioning phases of the proposed modular refinery.

Ambient Noise

Baseline environmental noise measurements were also conducted during the dry season using calibrated field instruments. Existing ambient noise within the Project Area is principally influenced by community activities, vehicular traffic, commercial operations, agricultural activities, operation of power generators, and localized industrial activities associated with oil and gas development in the wider Ohaji/Egbema area.

Secondary information obtained from previous environmental studies undertaken within the Niger Delta indicates that environmental noise levels are generally governed by human activities rather than seasonal climatic conditions. Although rainfall during the wet season may temporarily increase background sound levels through precipitation and vegetation interaction, seasonal variations in environmental noise are generally minimal and do not significantly alter the prevailing acoustic environment.

Consequently, the dry-season baseline measurements, supported by secondary environmental information, are considered representative of the existing ambient noise environment within the Project Area and provide an appropriate basis for evaluating potential project-induced noise impacts throughout the project lifecycle. The air quality and noise sampling locations map is presented in Figure 4.7.

4.3.3.1 Air Quality Standards

Due to the dangers of excessive release of air pollutants into the atmosphere from anthropogenic activities, attempts have been made to limit the volume of noxious gases and particulates, which are discharged indiscriminately into the atmosphere. In present times, air quality is being judged increasingly against legally adopted standards. The concentrations of air quality parameters recorded at the study area were compared to the Nigerian Ambient Air Quality Standards (NAAQS), World Health Organization (WHO) Air Quality Guidelines, and African Development Bank noise level guidelines. The summary of these limits are provided in Tables 4.2 – 4.4.

Table 4.2: Ambient Air Quality Standards

Parameter	Averaging Time	Nigeria Standards FMEnv Limit (µg/m³)	WHO Ambient Air Quality Guidelines (µg/m³)
CO	1-hour	11, 400	-
NO_2	1-hour	75-113	200
SO_2	1-hour	26	20 (24hr)
TSP	1-hour	250	-

Source: FMEnv, 1991 and African Development Bank General EHS 2007

Table 4.3: Noise Exposure Limits for Nigeria

Duration per Day, Hour	Permissible Exposure Limit dB(A)
8	90
6	92
1	105
0.5	110
0.25	115

Source: Guidelines and Standards for Environmental Pollution Control in Nigeria (FEPA {now FMEnv}, 1991)

Table 4.4: Noise Level Guidelines adopted by the African Development Bank

Receptor	One Hour Leq (dBA)	
	Daytime	Night time
Residential; institutional educational	55	45
Industrial; commercial	70	70

Source: The African Development Bank General EHS Guidelines, 2007

4.3.3.2 Air Quality of the Project Area

Table 4.5: Air quality and noise sampling locations

Sampling Location	Coordinates	
	Latitude (N)	Longitude (E)
Project Site		
AQ1	9.959338	8.880827
AQ2	9.959337	8.880796
AQ3	9.974096	8.881421
AQ4	9.972595	8.882335
1km Area of influence (AoI)		
AQ5	9.97585	8.879601
AQ6	9.987789	8.900376
Buffer (Control)		
AQ7	9.959628	8.880407
AQ8	9.959736	8.880152

Source: Eco-Fields Field Survey, 2026

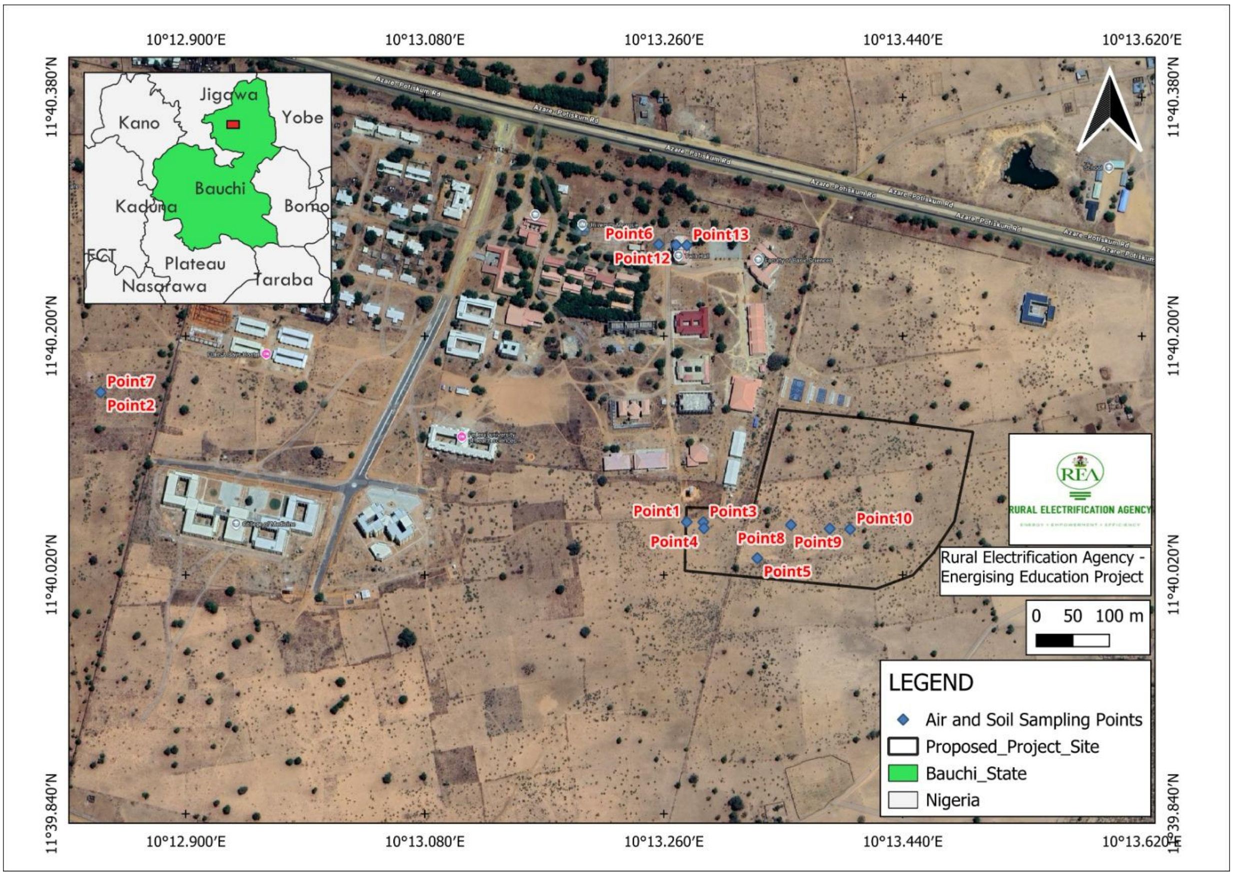


Figure 4.7: Air quality and noise sampling map of the Project area

Source: Google Earth 2026 and Eco-Fields Field Survey, 2026

The results of air quality study conducted in the Project's AoI are presented below in Table 4.6.

Table 4.6: Concentration of ambient air quality and noise level in the Project's AoI

S/N	Parameters	Unit	BP_1	BP_2	BP_3	BP_4	BP_5	BP_6	BP_7	BP_8	BP_9	BP_{10}	BP_{11}	BP_{12}	BP Control
1	Latitude	N	11.667667	11.669298	11.667665	11.667588	11.667212	11.671154	11.669298	11.66763	11.667583	11.667577	11.671142	11.671146	11.671142
2	Longitude	E	10.2212589	10.213932	10.221496	10.221505	10.222174	10.220938	10.213932	10.222597	10.223083	10.223339	10.221289	10.221156	10.221289
3	Nitrogen (iv) Oxide	ppm	0.1	0.00	0.2	0.1	0.1	0.0	0.2	0.1	0.1	0.8	0.1	0.2	0.1
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	0.00
5	Carbon (ii) Oxide	ppm	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Carbon (iv) Oxide	ppm	643	298	541	543	493	564	643	635	630	343	621	635	587
7	EX	% /e/	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Ammonia Gas	ppm	0.1	0.4	0.6	0.0	0.2	0.9	0.0	0.5	0.1	0.4	0.6	0.0	0.2
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
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
11	Chlorine gas	ppm	0.01	0.00	0.03	0.02	0.01	0.02	0.01	0.02	0.14	0.36	0.02	0.01	0.47
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	$PM_{2.5}$	$\mu g/m^3$	127	128	128	127	129	128	128	127	128	131	126	128	126
15	PM_{10}	$\mu g/m^3$	167	171	172	173	168	165	168	168	169	165	168	172	173
16	$PM_{1.0}$	$\mu g/m^3$	73	72	80	81	32	82	71	72	70	80	82	79	78
17	TVOC	mg/m^3	0.14	0.17	0.13	0.09	0.14	0.20	0.16	0.12	0.19	0.17	0.13	0.09	0.14
18	HCOH	mg/m^3	0.122	0.127	0.124	0.121	0.1322	0.148	0.103	0.153	0.197	0.142	0.147	0.107	0.147
19	Temperature	^oC	31.6	31.4	32.0	31.1	33.1	32.5	33.2	32.8	33.0	32.6	33.0	32.6	33.2
20	R/Humidity	%	43	48	44	50	49	53	58	43	47	51	43	54	53
21	Ozone	Ppm	0.01	0.01	0.00	0.00	0.0	0.00	0.03	0.00	0.03	0.03	0.00	0.00	0.03
22	A Q I	-	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
23	Sound Level	dB	54.1	61.6	57.1	53.9	55.5	62.7	62.1	50.5	51.0	58.6	55.1	54.3	59.9

Source: Eco-Fields Field Survey, 2026; BDL= Below Detection Limit (VOC = 0.1; CH_4, = 0.01; CO = 0.01; H_2S = 0.01)

Carbon Monoxide (CO): Carbon monoxide is a colourless, odourless and tasteless gas that is slightly less dense than air. It is produced from the partial oxidation of carbon containing compounds**.** The CO concentrations values recorded at the Project site, Project area of influence as well as the buffer points were below the detection limit of the equipment (0.01PPM). This implies that the CO values obtained are below the FMEnv limit of 11.4 PPM for 1hr averaging time.

Sulphur dioxide (SO_2): The concentrations of SO_2 recorded in the study area had a mean value of 0.0 PPM. Values recorded at the Project site, Project area of influence as well as the buffer points were below the FMEnv ambient air quality standards of 0.026 PPM for 1-hour averaging time and the WHO guideline value of 0.5 PPM for 10-minute averaging time.

Nitrogen dioxide (NO_2): The results of air quality measurement conducted in the study area show that the NO_2 values ranged from 0.1 -0.3 PPM with a mean concentration of 0.018 PPM. The values recorded at the Project site, Project area of influence as well as the buffer points were below the FMEnv threshold limit of 0.113 PPM and WHO guideline value of 0.2 PPM respectively for 1hr averaging time

Noise: The measured noise level ranged from 50.5 to 62.7dB (A) with a mean value of 56.6 dB (A). The noise levels recorded were below the FMEnv permissible Noise Exposure Limit of 90 dB (A) but higher than the African Development Bank limit of 55 dB (A), particularly at the Control/Buffer area.

4.3.4 Soil Quality

Soil is an important component of the ecosystem that serves as a footprint of impacts. The critical properties of soil that usually form the basis for impact evaluation include physical properties, fertility indices, and chemical composition.

4.3.4.1 Soil Sampling

Soil samples were collected from eight (8) different locations within and around the Project site, including the control points. At each of the sampling station, both top soil (0-15cm) and sub-soil (15-30cm) were collected. Soil sampling was carried out using a iron steel auger. The soil samples collected were homogenized in plastic bucket lined with aluminum foil sheet, and from the homogenized soil samples, sub samples were taken for physico-chemical analysis. All samples collected were preserved and transported to the laboratory for analysis. The geographical coordinates of the soil sampling locations are presented in Table 4.7 while the soil sampling locations map is shown in Figure 4.8.

Table 4.7: Soil Sampling Locations

Sampling Code	Latitude (N)	Longitude (E)
Within the Project Site		
S01	11.671142	10.221289
S02	11.667663	10.221311
S03	11.668895	10.224704
S04	11.667508	10.217643
1km AoI		
S05	11.667665	10.221496
S06	11.671146	10.221158
Buffer (Control)		
S07	11.667583	10.223083
S08	11.667667	10.221338

Source: EcoFields Field Survey, 2026

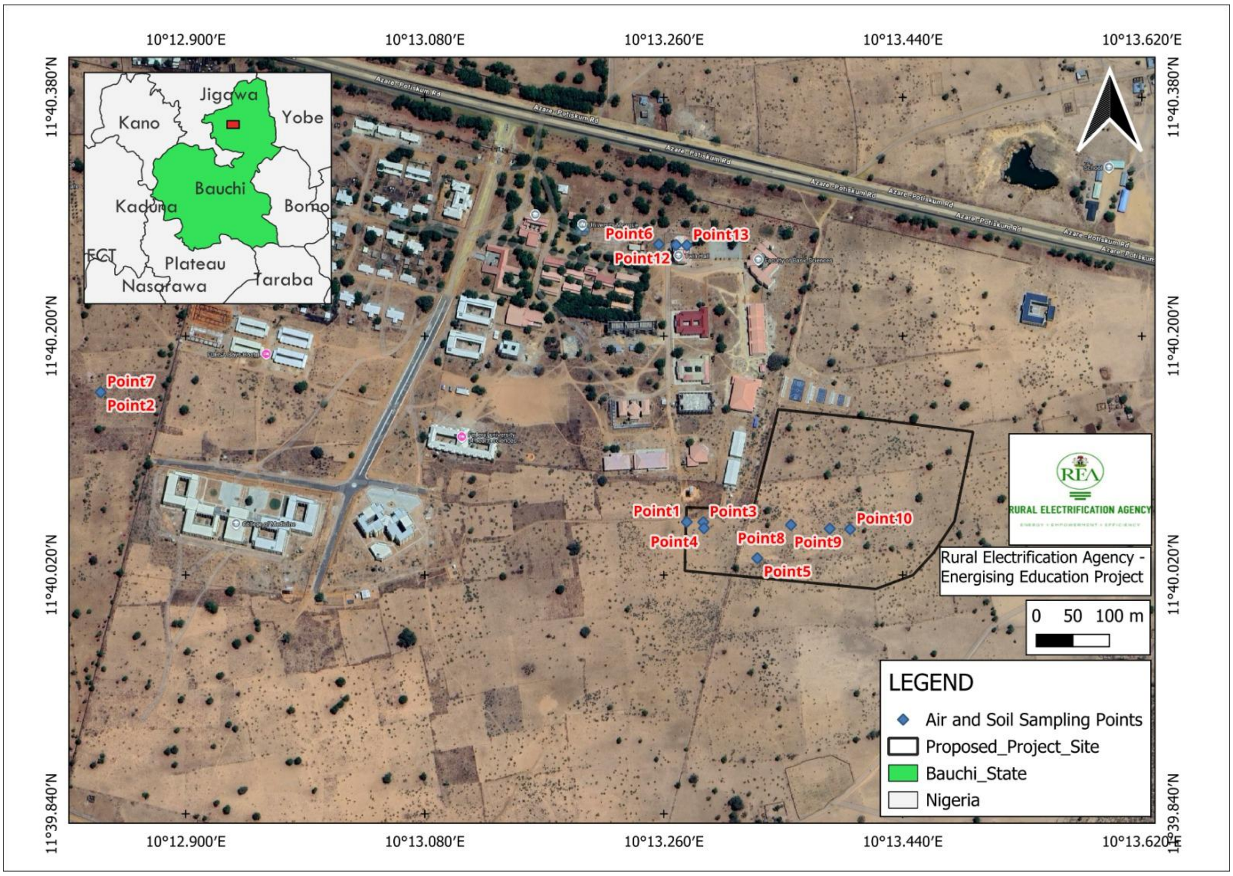


Figure 4.8: Soil sampling map of the Project area

Source: Google Earth 2026 and EcoFields Field Survey, 2026

The physico-chemical and microbial analysis results of soil samples from the study area are provided in Tables 4.8

Table 4.8: Physico-chemical properties of top soil samples

S/N	Parameters	Unit	BSS_1	BSS_2	BSS_3	BSS_4	BSS_5	BSS_6	BSS_7	BSS_8	BSS_9	BSS_{10}	BSS_{11}	BSS_{12}	BSS_{13} Control
a)	**Coordinates**														
1	Latitude	N	11.667667	11.669298	11.667665	11.667588	11.667212	11.671154	11.669298	11.66763	11.667583	11.667577	11.671142	11.671146	11.671142
2	Longitude	E	10.2212589	10.213932	10.221496	10.221505	10.222174	10.220938	10.213932	10.222597	10.223083	10.223339	10.221289	10.221156	10.221289
b)	**Physical Test**														
4	Colour	TCU	Reddish	Pale Reddish	Reddish	Brownish	Brownish	Dark Brownish	Dark Brownish	Dark Brownish	Pale Reddish	Brownish	Dark brownish	Brownish	Pale Brownish
5	pH	-	5.96	5.49	5.51	6.74	5.26	5.89	5.46	5.60	6.13	6.36	5.46	6.36	6.44
6	Electrical Conductivity	µs/cm	1652	1348	1551	1175	1376	1121	1159	1648	1161	1533	1616	1376	902
7	Temperature	^0C	32.0	31.1	32.4	31.9	31.5	30.9	32.3	32.4	32.8	30.8	32.3	31.5	31.4
8	ORP	MV	203	234	204	206	206	228	236	230	172	213	195	177	171
9	Salinity	%	0.08	0.07	0.07	0.05	0.04	0.05	0.06	0.05	0.08	0.05	0.07	0.08	0.07
c)	**Exchangeable Cation**														
8	Calcium (Ca^{2+})	mg/kg	0.27	0.30	1.01	0.07	0.07	0.23	0.65	0.44	0.39	0.25	0.10	1.05	0.07
9	Magnesium (mg^{2+})	mg/kg	0.14	0.12	0.57	0.06	0.09	0.06	0.31	0.16	0.21	0.09	0.11	0.59	0.08
10	Sodium (Na^+)	mg/kg	3	2	2	2	5	3	4	5	1	3	3	14	7
11	Potassium (K^+)	mg/kg	0.0	0.0	0.9	0.0	0.0	0.0	0.3	0.2	1.5	0.0	0.0	0.6	0.1
12	Ammonium (NH_4^+)	mg/kg	0.041	0.053	1.086	0.026	0.112	0.306	0.996	0.994	0.805	0.024	0.022	2.143	0.057
d)	**Exchangeable Anion**														
13	Sulphate (SO_4^{2+})	mg/kg	7	7	13	5	5	6	8	6	13	6	3	11	5
14	Phosphate (PO_4^{2-})	mg/kg	0.05	0.07	0.09	0.00	0.00	0.05	0.13	0.11	0.21	0.02	0.00	0.03	0.06
15	Nitrate (NO_3^{2-})	mg/kg	2.8	3.1	8.7	2.1	0.9	2.5	4.0	3.3	4.5	2.7	0.5	9.1	1.1
16	Chloride (Cl^-)	mg/kg	0.39	0.41	1.44	0.21	0.00	0.45	0.79	0.79	0.68	0.33	0.00	1.35	0.09
	Organics														
17	Phenols	mg/kg	0.026	0.029	0.059	0.021	0.024	0.027	0.030	0.028	0.064	0.024	0.015	0.059	0.026
18	Calcium Carbon	mg/kg	144	144	132	100	110	130	115	104	134	110	73	139	101
19	Oil & Grease	mg/kg	0	0	0	0	0	0	0	0	0	0	0	0	0
f)	**Heavy Metals**														

S/N	Parameters	Unit	BSS_1	BSS_2	BSS_3	BSS_4	BSS_5	BSS_6	BSS_7	BSS_8	BSS_9	BSS_{10}	BSS_{11}	BSS_{12}	BSS_{13} Control
20	Iron	mg/kg	0.133	0.177	0.546	0.108	0.057	0.144	0.281	0.198	0.319	0.166	0.122	0.054	0.103
21	Cupper	mg/kg	0.00	0.00	0.63	0.04	0.01	0.00	0.25	0.14	0.12	0.05	0.00	0.55	0.03
22	Chromium	mg/kg	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.01	0.00	0.00	0.09	0.00
23	Zinc	mg/kg	0.00	0.00	0.13	0.00	0.06	0.00	0.04	0.01	0.18	0.03	0.00	0.07	0.00
24	Cobalt	mg/kg	0.000	0.075	0.000	0.047	0.000	0.000	0.000	0.000	0.001	0.014	0.000	0.121	0.039
25	Nickel	mg/kg	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000	0.008	0.002	0.000	0.008
26	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	0.000	0.000
27	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	0.000	0.000
g)	**Soil Characteristic**														
28	Loam	%	0	2	3	3	1	0	2	3	18	2	6	3	31
29	Sandy	%	9	14	8	13	10	20	11	6	4	12	9	13	15
30	Clay	%	28	10	24	33	46	43	51	9	27	30	22	14	29
31	Silt	%	63	74	65	51	43	35	36	82	51	56	63	70	25
h)	**Microbiological Test**														
32	E. Coli	Cfu/g	3	0	1	1	8	6	2	0	0	0	0	0	
33	Fungal	Cfu/g	47	39	51	74	104	29	47	126	57	39	74	136	37

Soil Physical properties (Sand, Clay, and Silt): The soil texture is determined by the balance of clay, silt and sand particles and by the organic humus content of the soil. For practical considerations, soil texture and related soil structure influence soil workability, drainage and management.

The soils samples can be described as clay for both topsoil and subsoil based on the soil texture triangle (Figure 4.9). The soil profile had a sand fraction varying from (9-20%) while the proportion of other soil fractions in the soil were as follows; clay (10-51%) and silt (26-82%). Soil samples from the Project site, Project area of influence as well as the buffer points showed a similar composition.

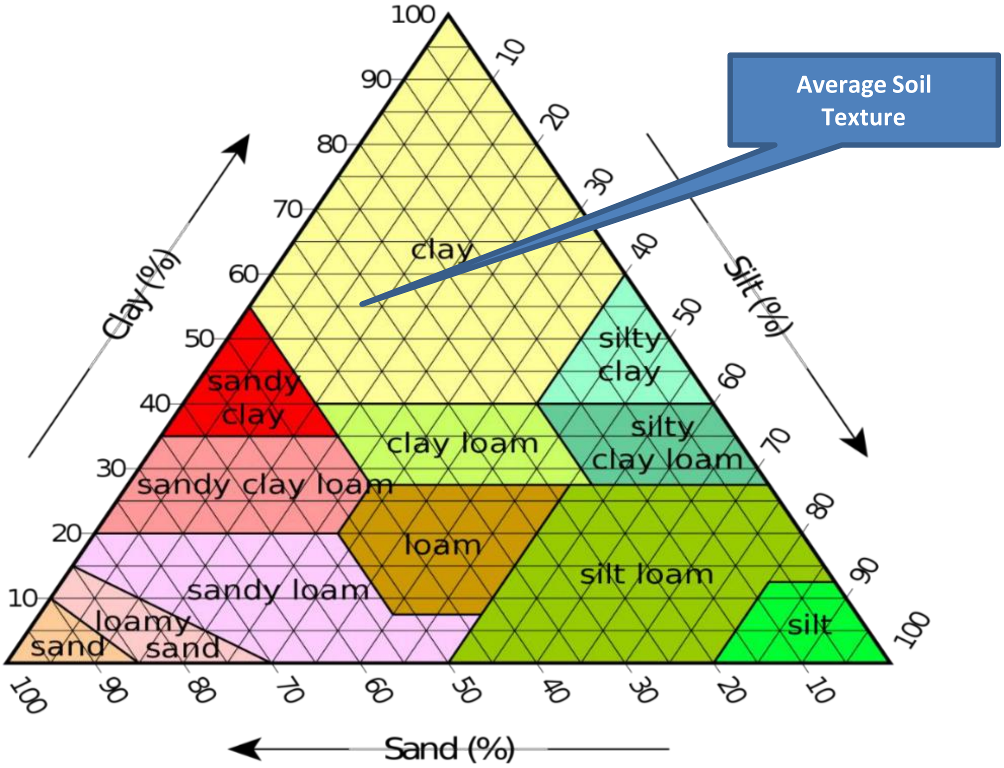


Figure 4.9: Soil texture triangle
Source: https://www.nrcs.usda.gov

Table 4.9: Surface Water Analysis

S/N	Parameters	Unit	GW Pt_1	GW Pt_2	GW Pt_3	GW Pt_4	GW Pt_5	Surface Water	Control	FMENT Limits
a)	**Coordinates**									
1	Latitude	N	11.669047	11.667588	11.671142	11.669047	11.66347	11.671142	11.671142	-
2	Longitude	E	10.220624	10.221389	10.220624	10.222624	10.221382	10.221382	10.221289	-
3	Altitude	M	503.6	511.2	543.6	531.0	498.1	537.1	5631.1	-
a)	**Physicochemical Test**									
4	Colour	TCU	Clear	Clear	Clear	Clear	Clear	Pale brown	Clear	Clear
5	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	unobjectionable
6	Taste	-	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	unobjectionable
7	Turbidity	NTU	1	1	0	0	2	9	1	50
8	pH	-	7.22	7.13	7.03	7.27	7.10	7.77	6.81	6.5-8.5
9	Temperature	^0C	28.0	27.0	27.6	27.0	28.0	28.4	29.0	Ambient
10	Dissolve Oxygen	mg/L	3.3	3.3	3.6	3.2	3.1	2.9	2.8	2 – 8
11	Total Dissolve Solid	mg/L	31	27	27	27	29	127	52	500
12	Electrical Conductivity	µs/cm	62	54	62	54	58	255	104	1000
13	Total Suspended solid	mg/L	3	2	2	3	1	14	8	20
14	Salinity	mg/L	0.00	0.00	0.00	0.00	0.00	0.01	0.00	<1000
15	ORP (MV)	(MV)	206	192	198	194	174	153	178	200-600
16	B.O.D	mg/L	0.4	2.1	1.6	0.8	1.1	2.6	2.0	NS
b)	**Chemical Test**									
17	Ammonium (NH_4^+)	mg/L	0.036	0.021	0.011	0.013	0.015	0.338	0.030	NS
18	Potassium (K^+)	mg/L	0.0	0.0	0.0	0.0	0.1	0.8	0.2	20
19	Calcium (Ca^{2+})	mg/L	0.8	3.0	3.1	2.1	2.0	2.1	0.6	200
20	Sodium (Na^+)	mg/L	2	7	6	6	4	19	8	20
21	Magnesium (mg^{2+})	mg/L	0.3	1.8	1.6	1.3	1.0	0.7	0.3	20
22	Sulphate (SO_4^{2+})	mg/L	32	18	11	9	8	13	10	100
23	Nitrate (NO_3^{2-})	mg/L	4.0	6.0	8.0	5.2	3.6	16.3	5.4	50
24	Chloride (Cl^-)	mg/L	2.1	3.2	3.2	1.8	1.6	1.2	1.1	150
25	Phosphate (PO_4^{2-})	mg/L	0.35	0.14	0.35	0.42	0.29	0.23	0.23	NS
26	Nitrite (NO_2^-)	mg/L	0.01	0.00	0.00	0.01	0.00	1.81	0.01	0.2

c)	**Heavy Metal**									
27	Zinc (Zn^{2+})	mg/L	0.03	0.01	0.02	0.01	0.01	0.01	0.01	3.0
28	Iron (Fe^{2+})	mg/L	0.023	0.037	0.019	0.066	0.048	0.084	0.000	0.3
29	Cupper (Cu^{2+})	mg/L	0.03	0.03	0.04	0.07	0.01	0.01	0.06	1.5
30	Chromium (Cr^{3+})	mg/L	0.02	0.02	0.02	0.06	0.04	0.05	0.02	0.05
31	Lead (Pb^{2+})	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01
32	Cobalt (CO^{2+})	mg/L	0.15	0.17	0.05	0.21	0.22	0.26	0.18	0.2
33	Mercury (Hg^{+})	µg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
34	Nickel (Ni^{2+})	mg/L	0.039	0.032	0.011	0.010	0.039	0.017	0.000	0.07
d)	**Organics**									
35	Oil and Grease	mg/L	BDL	BDL	BDL	BDL	BDL	1	BDL	10
36	Benzene	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01
37	Toluene	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.7
38	Ethylbenzene	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.30
39	Xylene	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
40	Phenols	mg/L	0.007	0.001	0.000	0.000	0.014	0.099	0.001	0.05
e)	**Microbiological Test**									
41	E. Coli	Cfu/ml	0	1	0	0	1	5	1	Nil
42	Feacal Coliform	Cfu/ml	0	0	0	0	0	4	0	Zero
43	Total Coliform	Cfu/ml	0	0	0	0	0	13	0	10

BOD Level in mg/liter	Water Quality
1 - 2	**Very Good:** There will not be much organic matter present in the water supply.
3 - 5	**Fair:** Moderately Clean
6 - 9	**Poor:** Somewhat Polluted - Usually indicates that organic matter present and microorganisms are decomposing that waste.
100 or more	**Very Poor:** Very Polluted - Contains organic matter.

Figure 4.10: BOD water quality chart

Source: www.pharmaguideline.com

4.3.5 Surface Water and Groundwater Quality Results Analysis

The assessment evaluated five Groundwater points (GW Pt1–Pt5) and one Surface Water sample against Federal Ministry of Environment (FMEnv) limits.

Physicochemical Parameters

- pH Levels: All groundwater samples (7.03–7.27) and the surface water (7.77) fall within the FMEnv. permissible range of 6.5–8.5, indicating a neutral to slightly alkaline nature.
- Turbidity: Most groundwater points showed very low turbidity (0–2 NTU), well below the 50 NTU limit. However, the Surface Water recorded 9 NTU, likely due to suspended organic or inorganic matter, though still within the regulatory limit.
- Total Dissolved Solids (TDS) & Conductivity: TDS values (27–127 mg/L) and Electrical Conductivity (54–255 µs/cm) are significantly below the limits (500 mg/L and 1000 µs/cm respectively), suggesting low mineralization and good freshwater quality.

Chemical & Heavy Metals

- Nutrients (Nitrates/Nitrites): Nitrate levels (3.6–16.3 mg/L) are well within the 50 mg/L limit. Surface water showed a higher Nitrite level (1.81 mg/L) exceeding the 0.2 mg/L limit, which may indicate recent organic pollution or runoff.
- Heavy Metals: Lead, Mercury, and Cadmium were largely undetected or at zero levels. Other metals like Zinc, Iron, and Copper are well below the FMEnv. thresholds, indicating no significant heavy metal contamination in the water sources.

Microbiological Status

- Groundwater: Most points are clean, though GW Pt2 and Pt5 showed minor E. Coli presence (1 Cfu/ml).

- Surface Water: Shows significant contamination with 13 Cfu/ml Total Coliform and 5 Cfu/ml E. Coli, rendering it unsafe for direct consumption without treatment.

Table 4.10 Typical Microbial Isolates in Community

Microbial Isolate	**Typical Count (CFU/g soil or CFU/mL water)**	**Environmental Significance**
Total Heterotrophic Bacteria (THB)	$1.5 \times 10^5 - 8.0 \times 10^6$	Indicates overall microbial abundance and soil biological activity.
Total Heterotrophic Fungi (THF)	$2.0 \times 10^3 - 7.0 \times 10^4$	Reflects fungal diversity and organic matter decomposition.
Total Coliform	10 – 200 CFU/100 mL	Indicator of environmental sanitation.
Faecal Coliform (***Escherichia coli***)	<1 – 50 CFU/100 mL	Indicates recent faecal contamination.
Bacillus spp.	$10^3 - 10^5$	Important decomposers and hydrocarbon degraders.
Micrococcus spp.	$10^2 - 10^4$	Common indigenous soil bacteria.
Aspergillus niger	$10^2–10^4$	Organic matter decomposition; hydrocarbon degradation
Aspergillus flavus	$10^2–10^4$	Natural soil fungus; some strains produce aflatoxins
Penicillium spp.	$10^2–10^4$	Organic matter decomposition

Importance of Microbial Isolates in Pollution Studies

Microbial investigations are an essential component of environmental baseline studies because microorganisms respond rapidly to changes in environmental quality and therefore serve as sensitive indicators of ecosystem health.

The significance of the various microbial groups includes:

Total Heterotrophic Bacteria (THB)

- Measure the overall biological activity of soil and water.
- Reflect the capacity of the environment to degrade organic matter.
- Declining THB following project activities may indicate toxic contamination.

Total Heterotrophic Fungi (THF)

- Participate in decomposition and nutrient cycling.
- Some fungal species degrade petroleum hydrocarbons.
- Sensitive to heavy metals and chemical pollution.

Coliform Bacteria

These organisms are widely used as indicators of sanitary quality.

High coliform counts may indicate:

- sewage contamination
- poor sanitation
- livestock waste
- surface runoff contamination

Escherichia coli

The presence of **E. coli** specifically indicates recent faecal contamination and possible presence of pathogenic microorganisms.

Hydrocarbon-Degrading Bacteria

Species such as

- ***Pseudomonas***
- ***Bacillus***
- ***Acinetobacter***
- ***Arthrobacter***
- ***Alcaligenes***

are particularly important for refinery projects because they naturally degrade:

- crude oil
- diesel
- gasoline
- lubricating oil
- polycyclic aromatic hydrocarbons (PAHs)

An increase in these organisms during operation may indicate adaptation to hydrocarbon contamination.

Hydrocarbon-Degrading Fungi

Common genera include:

- ***Aspergillus***
- ***Penicillium***
- ***Trichoderma***
- ***Mucor***

These fungi produce extracellular enzymes capable of degrading complex petroleum hydrocarbons.

Relevance of Microbial Counts in ESIA

Microbial counts are valuable because they:

- Establish baseline environmental quality before project commencement.
- Detect contamination from sewage, hydrocarbons, or industrial discharges.
- Assess the effectiveness of pollution prevention and remediation measures.
- Evaluate changes in soil fertility and ecological health.
- Provide early warning of environmental degradation.
- Support environmental monitoring and regulatory compliance.

- Assist in determining the natural attenuation potential of contaminated sites.
- Serve as indicators of ecosystem recovery following remediation.

4.3.6 Soil Quality Assessment

Results from 13 sampling points (BSS1–BSS13) characterize the pedology of the Azare site.

Physical & Chemical Properties

- Soil Texture: The soil is predominantly Silt (up to 82% at BSS8) and Clay (up to 51% at BSS7), with relatively low sandy content. This composition suggests a soil with high water retention but potentially low permeability.
- Acidity (pH): The soil is moderately acidic, ranging from 5.26 to 6.74. Most plants thrive in this range, though the lower end (5.26 at BSS5) may limit the availability of certain nutrients like Phosphorus.
- Conductivity: High Electrical Conductivity (902–1652 μs/cm) indicates a high concentration of soluble salts in the soil.

Nutrients & Heavy Metals

- Exchangeable Cations: Levels of Calcium and Magnesium are relatively low, while Sodium levels peaked at 14 mg/kg at BSS12.
- Heavy Metals: Iron (0.054–0.546 mg/kg) and Copper are present in trace amounts typical of natural soil backgrounds, with no evidence of industrial metal loading.

Air Quality & Noise Assessment

Data from 13 Bauchi Points (BP1–BP13) suggests an overall "Excellent" Air Quality Index (AQI).

Gaseous Emissions

- Carbon Oxides: CO2 levels fluctuate between 298 and 643 ppm. While CO2 is a greenhouse gas, these levels are typical for outdoor environments. Carbon Monoxide (CO) was 0 ppm across all points, indicating no immediate combustion-related pollution.
- Other Gases: Trace amounts of Nitrogen Dioxide (NO2) and Ammonia (NH3) were detected but remain well within safe environmental limits.

Particulate Matter (Dust)

- PM10 (165–173 μg/m^3) and PM2.5 (126–131 μg/m^3): These levels are relatively high. While common in Northern Nigeria due to harmattan dust or dry soil suspension, they exceed the WHO's strict 24-hour guidelines (PM2.5<15μg/m^3), though they may be typical for the regional baseline in January.

Noise Levels

- Sound Levels: Most points recorded between 50.5 and 62.7 dB. These are within the acceptable range for residential and educational zones (usually 55–60 dB during the day).
- Outlier: BP10 recorded an anomalous 586 dB, which is physically impossible (likely a typographical error in the lab sheet) and should be corrected to its likely intended value (perhaps 58.6 dB).

4.3.7 Terrestrial Flora and Fauna

4.3.7.1 Terrestrial Flora

Flora refers to all plant life forms that are found within a specific region at a particular period of time. Plants provide valuable information about site environmental conditions. By their occurrence and relative abundance, certain plant species serve as environmental indicators, through which inferences can be drawn about the state of the environment in that area. Thus, the physiological state and ecological response of plants provide evidence of changes in the environmental conditions of a Project site. The array of information derived from the flora composition and vegetation structure of a site is of importance for understanding the nature of the site, potential human health and ecological risk, and the feasibility of different mitigation approaches.

The field assessment of the Project site and surrounding area was done via site observations. The identification of flora specimen was done both in situ (field) and ex situ using appropriate manuals and monographs, photographs were taken during survey to record relevant plant species, habitat characteristics and other features.

The results of the vegetation assessment are presented as follows:

- Habitat characterization
- Physiognomy, Floristic composition, and Biodiversity assessment

❖ *Habitat characterization*

The general vegetation type of Bauchi, Nigeria is of Guinea Savannah type. It is characterized predominantly by trees, woodlands and shrubs. Grasses are subdominant while patches of rain forest are found in certain locations. Generally, rainfall and humidity are known to have a primary influence on the vegetation of Bauchi. The natural vegetation within the Project site was observed to have been modified habitat as a result of human interference. The dominant vegetation observed on the site can be classified as secondary vegetation dominated by grasses, shrubs, and a few trees.

❖ *Physiognomy, Floristic composition, and Biodiversity assessment*

Species composition, distribution and structure of the vegetation of Project as well as the physiognomic view show few trees, shrubs and grasses. A few plants and their families were identified and within and around the Project.

In terms of biodiversity assessment, the IUCN (International Union of Conservation of Nature) Red List of Threatened Species was employed. The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable).

Biodiversity Profile of the Study Area

The IUCN's (International Union of Conservation of Nature) Red List of threatened Species provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction (i.e., those listed as **Critically Endangered**, **Endangered** and **Vulnerable**).

The IUCN Red List also includes information on plants, fungi and animals that are categorized as **Extinct** or **Extinct in the Wild**; on taxa that cannot be evaluated because of insufficient information (i.e., are **Data Deficient**); and on plants, fungi and animals that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e., are **Near Threatened**). The ecological status of the species encountered was evaluated and classified appropriately according to the following threat categories (**IUCN Red List of Threatened Species Version 2018-1**) as shown in Figure 4.13 below.

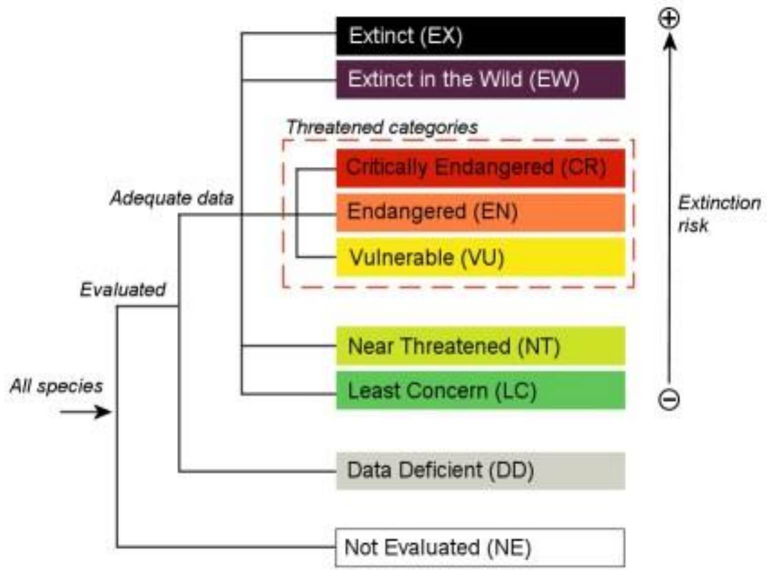


Figure 4.11: IUCN Red List Categories and Criteria

Source: Guidelines for Using the IUCN Red List, 2018

The plant species encountered in the study area fall under Not Evaluated. None of the recorded plant species in the study area is critically endangered or endangered. In addition, there are no known protected species on the Project site under the Nigerian legislation. The IUCN status of the plant species encountered in the study area is highlighted in Table 4.10 below while Plates 4.6 to 4.10 show some of the common flora species observed in the study area.

Table 4.10: Plant Species observed around proposed site and AoI

S/N	BOT NAME	COMMON NAME	FAMILY	HABIT	IUCN STATUS	USES/ IMPORTANCE
1.	*Ceiba pentandra* (L) Gaertn.	Kapok tree or silk cotton tree.	Malvaceae	Tree	Least concern (IUCN 3.1)	Fibre, Traditional medicinal uses, and seed oil
2.	*Jacanranda mimosifolia* D.Don	Blue Jacaranda or fern tree	Bignoniaceae	Tree	Vulnerable (IUCN 3.1)	Ornamental landscaping, shade, wood used for furniture and parts of the tree used in traditional medicine
3.	*Eucalyptus torelliana* Dehnh	River red gum	Myrtaceae	Tree	Near Threatened (IUCN 3.1)	Medicinal, industrial and environmental properties
4.	*Faidherbia albida* Delille) A Chev	Apple ring Acacia or WhitevAcacia or Winter Thorn Hausa Gargo	Fabaceae	Tree	Least Concern (IUCN 3.1	Feed for livestock, raising bees, wood used in making mortar and pistle, Agroforestry and medicinal uses.
5.	*Corymbia camaldulensis* (F Muell) K.D . Hill and L.A.S Johnson	Cadaghi or Cadaga	Myrtaceae	Tree	Least Concern (IUCN 3.1	Shade, windbreaks, and landscaping, with furniture occasionally used for furniture and construction.sd
6.	*Araucaria araucana* Pav	Monkey *araucana* puzzle tree	Araucariaceae	Tree	Primarily threatened, with many listed as endangered or critically endangered	Food, pharmacological and ornamental uses.
7.	*Delonix regia* (Boi. Ex Hook) Raf	Flamboyant or flame of the forest	Fabaceae	Tree	Least Concern (IUCN 3.1	Ornamental tree, medicinal uses, livestock fodder, agroforestry and as fuel wood.
8.	*Ficus* species (L)	Fig trees or Figs	Moraceae	Tree	Least Concern (IUCN 3.1	Useful latex , agriculture and medicinal uses.
9.	*Tithonia diversifolia* (Hemsl) A. Gray	Tree marigold or Mexican sunflower	Asteraceae	Shrub and tree	Not listed as threatened	Medicinal plant, organic green manure and livestock fodder

10.	*Gmelina arborea* (Roxb)	Beechwood	Lamiacea	Tree	Least concern	Durable wood, furniture, construction and paper pulp. Traditional medicine and food.
11.	*Borassus aethiopum* Mart	African Fan Palm	Arecacceae	Tree	Least Concern (IUCN 3.1	Fruit and roots are edible, produce fibres from the leaves and can be used for construction.
12.	*Vernonia amygdalina* Delile	Bitter leaf plant	Asteraceae	Perennial shrub	Least concern	Food and medicinal plan
13.	*Cascabela thevetia* (L) Lippoid	Yellow oleander	Apocynaceae	Shrub or small tree	Least concern	Medicinal and ornamental plant.
14.	*Bauhinia purpurea (*L)	Camel's feet, Purple Bauhinia or Orchid Tree	Fabaceae	Tree	Least Concern (IUCN 3.1	Edible leaves and flowers and medicinal uses
15.	*Amogeissus leiocarpa*	African birch	Combretaceae	Tree	Threatened	medicinal plant and durable wood.
16.	*Psidium guajava* L	Guava	Myrtaceae	Shrub or tree	Least concern	Food and medicinal plant
17.	*Adansonia digitata* (L)	African baobab	Malvaceae	Tree	Least Concern (IUCN 3.1)	Food, water, health remedies and or places of shelter
18.	*Senna siamea* (Lam) Irwin et Barneby	Cassod tree or cassia tree.	fabaceae	tree	Least concern	Medicinal, environmental and practical purposes
19.	*Dichrostachys cinerea* Wight et Arin	Sicklebush or Kalahari Christmas tree	fabaceae	Shrub and small tree	Least concern	Medicinal plant
20.	*Terminalia neotaliala* Capuron	Madagascar almond tree	combretaceae	Tree	Least concern	Ornamental plant, provides shade and medicinal plant
21.	*Magifera indica* L	Mango	Anacardiaceae	Tree	Least Concern (IUCN 3.1)	Food and medicinal purposes

SITE 2 ALTERNATIVE FOR THE PROJECT

S/N	BOT NAME	COMMON NAME	FAMILY	HABIT	IUCN STATUS	USES/IMPORTANCE
1.	*Tithonia diversifolia* (Hemsl) A. Gray	Tree marigold orMexican sunflower	Asteraceae	Shrub & tree	Not listed as threatened	Medicinal plant, organic green manure and livestock fodder
2.	*Lrucaena leucocephala (Lam) de Wit.*	White leadtree or horse tamarind	Fabaceae	Tree	Least concern	Forage production, animal feed, firewood or charcoal
3.	*Senegalia ataxacantha*	Flame thorn	fabaceae	Tree	Least concern	Root is used as aphrodisiac
4.	*Borassus aethiopum* Mart	African Fan Palm	Arecacceae	Tree	Least Concern (IUCN 3.1	Fruit and roots are edible, produce fibres from the leaves and can be used for construction.
5.	*Magifera indica* L	Mango	Anacardiaceae	Tree	Least Concern (IUCN 3.1)	Food and medicinal purposes
6.	*Ficus* species (L)	Fig trees or Figs	Moraceae	Tree	Least Concern (IUCN 3.1	Useful latex , agricultureand medicinal uses.
7.	*Faidherbia albida* (Delille) A Chev	Apple ring Acacia or WhitevAcacia or Winter Th orn Hausa Gargo	Fabaceae	Tree	Least Concern (IUCN 3.1	Feed for livestock, raising bees, wood used in making mortar and pistle, Agroforestry and medicinal uses.
8.	*Ficus exasperata* Vahl	Sandpaper tree or white fig	Moraceae	Tree	Threatened	Medicinal plant and practical application
9.	*Ziziphus spina-christi* (L) Desf	Christ's thorn jujube	Rhamnaceae	Tree/ Shrub	Least Concern (IUCN 3.1	Fruits edible, medicinal uses.
10.	*Lantana camara* L	Common lantana	Verbenaceae	Shrub/ small tree	Secure	Medicinal plant and ornamental plant
11.	*Eucalyptus torelliana* Dehnh	River red gum	Myrtaceae	Tree	Near Threatened (IUCN 3.1)	Medicinal,industrial and environmental properties
12.	*Corymbia camaldulensis* (F Muell) K.D . Hill and L.A.S Johnson	Cadaghi or Cadaga	Myrtaceae	Tree	Least Concern (IUCN 3.1	Shade, winbreaks, and landscaping, with furniture occasionally used for

						furniture and construction.sd
13.	*Senna siamea* (Lam) Irwin et Barneby	Cassod tree or cassia tree.	fabaceae	tree	Least concern	Medicinal, environmental and practical purposes
14.	*Psidium guajava* L	Guava	Myrtaceae	Shrub or tree	Least concern	Food and medicinal plant
15.	*Ficus* species (L)	Fig trees or Figs	Moraceae	Tree	Least Concern (IUCN 3.1	Useful latex, agricultureand medicinal uses.
16.	*Agave sisalana Perrine*	Sisal	Asparagaceae	shrub	Has not been assessed	It yields fibre used in making rope,clothes, footwear, hats, bags, carpets, geotextiles, and dartboards
17.	*Phoenix dactylifera* L	Date palm	Arecaceae	Tree	Not evaluated	Food, traditional medicine and industrial uses.
18.	*Euphorbia poisonii* Pax	Spurge	Euphorbiaceae	Shrub	Not listed	Fish poison, arrow poison, natural pesticide and medicinal uses.
19.	*Senna sengueana* (Dellile) Lock	Winter cassia or sticky pod	Fabceae	Shrub or a small tree	Lacks an official ranking	Food and medicine
20.	*Uvaria chamae P.Beauv*	Finger root or bush banana	Annonaceae	Shrub or small tree	Least concern	Food and medicinal uses
21.	*Adansonia digitata* (L)	African baobab	Malvaceae	Tree	Least Concern (IUCN 3.1)	Food, water, health remedies and or places of shelter
22.	*biglobosa* (Jacq) R.Br. ex *G Don*	African locust beans	Fabaceae	Tree	Least Concern (IUCN 3.1)	Food, animal feed, Ecomic activity and medicinal uses
23.	*Vitex doniana* (R.S)	Black Plum	Lamiaceae	Tree	Least Concern (IUCN 3.1	Food and medicinal values.
24.	Dichrostacys cinerea Wight et Arm	Sicklebush	fabaceae	Tree	Least concern	Feed for cattle, nectar for honey, hardwood and medicinal uses.

25.	*Annona senegalensis* Pers	African custard apple	Annonaceae	Shrub/small tree	Least Concern (IUCN 3.1	Food, spice, and animal feed.
26.	*Harungana madagascariensis* Lam. ex Poir	Dragon blood tree or orange milk tree	Hypericaceae	Shrub / small tree	Least Concern (IUCN 3.1	Medicinal plant and food.
27.	*Sarcocephalus latifolia* Sm	African peach	Rubiaceae	Shrub/ small tree	No official published IUCN conservation Status	Medicinal plant
28.	*Bombax costatum* Pellegr. And Vuill	Red-flowered silk cotton tree	Malvaceae	Tree	Threatened or endangered species	Food, medicine, fodder, and handicrafts.
29.	*Strophanthus hispidus* DC.	Poison arrow vine or hairy strophanthus	Apocynaceae	Liana or shrub	Endangered	Medicinal plant. Antidote for snake bite.
30.	*Euphorbia kamerunica* Pax,1905	Cactus	Euphorbiaceae	shrub	Least concern	Medicinal plant and use for fencing.
31.	*Carissa edulis* L	Conkerberry or bush plum	Aocynaceae	Shrub	Least Concern (IUCN 3.1	Food and medicinal uses.

Plate 4.6: *Jacaranda mimosifolia* vulnerable

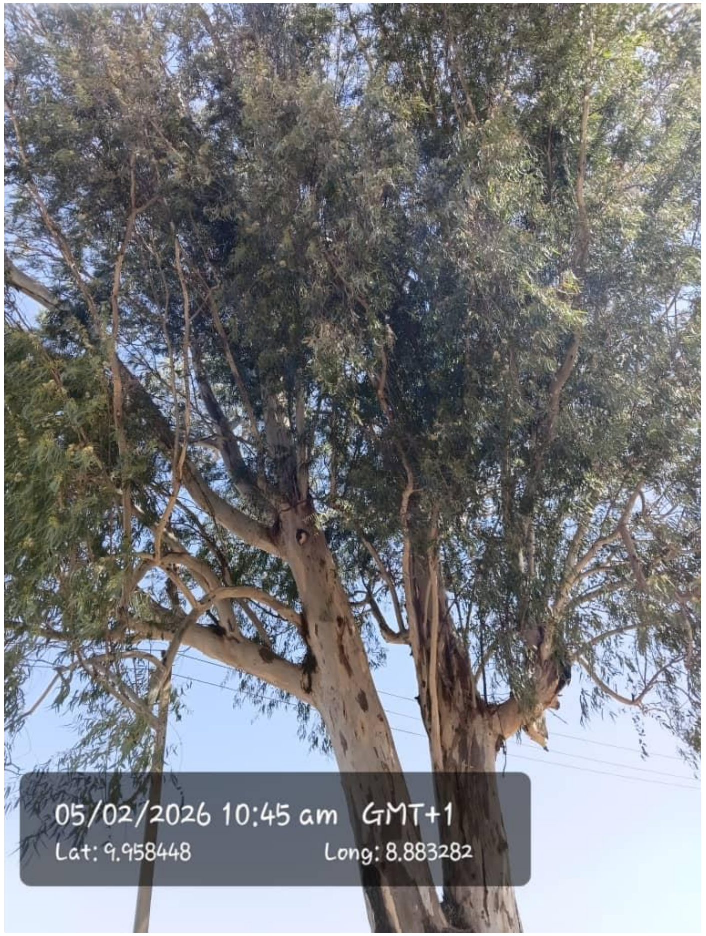


Plate 4.7: *Eucalyptus torelliana,* near threatened

Plate 4.8: *Araucaria araucana* some threatened, some endangered and some critically enjoyed

Plate 4.9: *Ficus exasperate,* threatened

Plate 4.10: *Stropathus hispidus* endangered

Plate 4.11: Tomato planted around the project side

Plate 4.12:*Cassava*

4.3.8 Land Use/Land Cover

This section discusses the existing land use / land cover type in the study area. The land use map was produced from a combination of ground truthing, aerial imagery (LandSat ETM+) and topographical maps covering the study area. The study covers the land use within the project site boundary and the wider study area (1km biophysical area of influence).

4.4 Socio-economic and Health Conditions of the Study Area

This section covers the socio-economic and health assessment of the identified community within the project's area of influence. This baseline provides a description of existing conditions which is essential to the identification and assessment of the potential impacts of the proposed project. From the social and health perspective, the assessment covers the pre-project human conditions in the identified community with a view to predicting and mitigating any possible adverse future impact of the project on the socio-economic and health conditions of the human inhabitants in the study area. The study furthered by assessing the gender-based issues, ranging from gender-specific activities to gender-based violence within the identified community.

4.4.1 Study Approach and Methodology

Study Area

The study was conducted in the surrounding community of Azare (host community), Katagum LGA, Bauchi State. Katagum LGA has an estimated population of 296,970 inhabitants, according to the National Population Census of 2006 and 2022 population projection of about 523,200 using the 3.2% (NBS, 2018) national population growth rate. Azare community is one of the oldest settlements and the capital of Katagum.

Study Population

The study population consists of residents of the Federal University of Health Sciences staff quarters and Azare community. Only population who gave informed consent were studied within the staff quarters and the Azare community.

Study Design

The study employed sequential mixed methods research design including quantitative and qualitative methods of data gathering, analysis and reporting. Information collected during the study was triangulated to separate perception from the reality. The study made use of questionnaire for quantitative data gathering and Key informant interview, Focus Group Discussions (FGD) and stakeholders' consultation for the qualitative data.

Target Population for the Study

The target populations and stakeholders for this study are Azare community members and residence of Federal University of Health Sciences staff quarters that are above the age of 18 years, community leaders, healthcare practitioners, youths and women.

Sample Size and Sampling Techniques

The study population is heterogeneous with respect to ethnicity and language. However, Federal University of Health Sciences Staff Quarters and the Azare community do not have a large population. The sample size would be calculated using the Cochran Formula

Where n is the sample size

p is the estimate of the proportion of interest (i.e. 0.29)
q is 1 – p (i.e. 0.71)
e is the desired level of precision (i.e. 0.07)

Hence, $n = 1.96^2 (0.29) (0.71) / 0.07$ n
$= 180$

A 10% non-response rate was added as a standard practice with the speculation that some respondents within the study area may refuse to participate or some may withdraw at the middle of the interview. Thus, the sample size was 200 respondents. The systematic sampling technique employed ensures a fair representation of both males and females among the respondents.

For the qualitative data, Focus Group Discussions (FGDs) were conducted (2 male groups, both men and youths, 1 female group) making a total of 3 FGDs. Each FGD includes a minimum of 6 and maximum of 15 participants. Different categories of respondents including youths, adults, males, females, people living with disabilities, educated and non-educated etc. were included in each FGD session. Key informant interviews were held with the local chief i.e. community leaders and in-depth interview was held with healthcare practitioner who has been in the community for more ten (10) years. A gender specialist was consulted to handle women's group discussion and study the gender issues within the community. The socio-economic data gathering records (attendance sheets) are presented in Appendix 4.1.

Data Collection, Analysis and Reporting

During data gathering, this study made use of Computer Assisted Personal Interviewing (CAPI), a Survey CTO Software using smartphone and assisted by competent survey enumerators.

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.

4.4.2 *The Socio-Economic Baseline Report Structure*

This study adopted the Social Framework Model for reporting its findings. In line with the social framework developed by Smyth and Vanclay in 2017, the socio- economic baseline report is structured as follows:

- Overview of key socio-economic indicators
- Demographic Profile;
- Administrative and socio-cultural institutions
- Livelihood Assets and Activities
- Infrastructure and Services
- Housing Structures/Settlement pattern
- Land Acquisition
- Health Profile
- Gender Assessment
- Project Affected Persons (PAPs)
- Waste management
- Community Concerns and Perceptions
- Stakeholders' Consultation

Socio-Economic Baseline Conditions of Survey Population

A comprehensive socio-economic survey was conducted as part of the Environmental and Social Impact Assessment (ESIA) for the proposed Solar Hybrid Mini-Grid Project at the Federal University of Health Sciences, Azare (FUHSA). The primary objective was to establish a reliable baseline of the existing community conditions and livelihood patterns within the university community and surrounding host communities that may be impacted by the project. The survey provided an in-depth understanding of the demographic characteristics, economic activities, and social structure of the survey population, including university staff, students, nearby residents and local stakeholders. It assessed sources of livelihood, employment patterns (including potential opportunities for local youths), access to infrastructure and basic services and community expectations regarding the project.

Furthermore, the assessment examined potential positive and adverse social impacts associated with land use (approximately 5–15 hectares under consideration), construction activities, and operational phases of the solar facility. The baseline information serves as a critical reference for impact prediction, stakeholder engagement and the development of appropriate mitigation and enhancement measures in line with applicable environmental and social safeguard requirements and national regulations.

The summary of the socio-economic survey findings is presented in Table 4.11below.

Table4.11 : Summary of Socio – economic Status of the Survey population

ITEM	CATEGORIES	DTP INITIATIVE	DTP INITIATIVE	DTP INITIATIVE	TOTAL	%
		FUHSA Students	**Fatara Community**	**Gursoli Community**		
Gender Distribution	Male	34	8	14	56	56%
	Female	26	12	6	44	44%
	TOTAL	**60**	**20**	**20**	**100**	**100%**
Age of Respondent	Below 20	20	2	0	22	22%
	20 – 29 years	24	2	8	34	34%
	30 – 39 years	0	6	6	12	12%
	40 – 49 years	8	2	2	12	12%
	50 – 59 years	8	6	2	16	16%
	Above 60 Years	0	2	2	4	4%
	TOTAL	**60**	**20**	**20**	**100**	**100%**
Household Composition	Children <18	36	16	20	72	40%
	Adults 18-59	40	20	20	80	44.44%
	Elderly	16	2	10	28	15.56%
	TOTAL	**92**	**38**	**50**	**180**	**100%**
Household Sizes	1-3	8	0	0	8	8%
	4-6	12	2	4	18	18%
	7-10	22	0	16	38	38%
	11-15	18	18	0	36	36%

	TOTAL	**60**	**20**	**20**	**100**	**100%**
Marital Status	Single / Never Married	38	6	2	46	46%
	Married	22	12	18	52	52%
	Separated	0	0	0	0	0%
	Divorced	0	0	0	0	0%
	Widowed	0	2	0	2	2%
	TOTAL	**60**	**20**	**20**	**100**	**100%**
Duration of Respondents residence in the community (years)	<1 yr	2	0	0	2	2%
	1 – 5 yrs	24	2	0	26	26%
	6 – 10 yrs	12	2	2	16	16%
	>10 yrs	22	16	18	56	56%
	TOTAL	**60**	**20**	**20**	**100**	**100%**
Religion	Christian	19	0	0	19	19%
	Muslim	41	20	20	81	81%
	TOTAL	**60**	**20**	**20**	**100**	**100%**
Education	Islamic Studies	0	6	10	16	16%
	Completed Primary School	0	2	2	4	4%
	Completed Secondary School	4	4	4	12	12%
	Vocational/ technical	4	0	0	4	4%
	Tertiary school	52	8	0	60	60%
	None	-	-	4	4	4%
	TOTAL	**60**	**20**	**20**	**100**	**100%**
Occupation	Crop Farming	2	12	16	30	30%

	Livestock rearing	2	4	4	10	10%
	Fishing	0	0	0	0	0%
	Trading	0	4	0	4	4%
	Civil Servants	22	0	0	22	22%
	Student	26	0	0	26	26%
	Artisan	0	0	0	0	0%
	Unemployed	8	0	0	8	8%
	TOTAL	**60**	**20**	**20**	**100**	**100.00 %**
Vulnerability Description	Elderly>60yrs	32	8	2	42	61.76%
	Persons with disabilities	0	0	0	0	0%
	Chronically ill persons	2	8	4	14	20.59%
	Female-headed household	2	0	0	2	2.94%
	Orphans	4	4	2	10	14.71%
	TOTAL	**40**	**20**	**8**	**68**	**100%**
Monthly Income	0-70,000	10	16	12	38	38%
	71,000-100,000	16	2	0	18	18%
	101,000-200,000	8	2	8	18	18%
	Above 200,000	26	0	0	26	26%
	TOTAL	**60**	**20**	**20**	**100**	**100%**

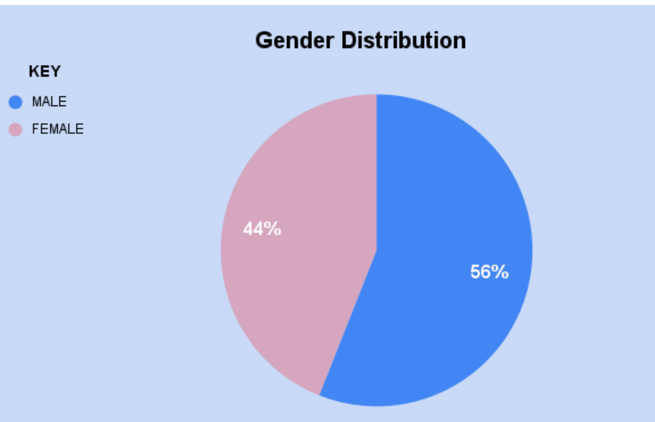
Age

Findings from the socio-economic survey conducted within the project's Area of Influence indicate that 22% of respondents are below 20 years of age, while 34% fall within the 20–29 age group. Additionally, 12% of respondents are aged 30–39 years and another 12% fall within the 40–49 age category. A further 16% belong to the 50–59 age group, while 4% are aged 60 years and above. Overall, a significant 96% of the survey population falls within the economically active age bracket of 20–59 years.

This distribution indicates a predominantly youthful and productive population engaged in academic, administrative and small-scale economic activities within the university and adjoining host communities. The proposed solar installation is expected to provide reliable power to support teaching, research, healthcare services and other socio-economic activities, while also stimulating small businesses and improving livelihoods within the state. Furthermore, a reliable and stable electricity supply is expected to enhance learning outcomes, improve healthcare service delivery and strengthen security within the university and adjoining host communities through improved lighting and related infrastructure. It will also boost overall socio-economic productivity. The high proportion of working-age individuals provides a potential labor pool for temporary employment during construction as well as limited skilled and semi-skilled roles during the operational phase.

Gender

The gender distribution of respondents indicates that 56% are male and 44% are female, indicating a slight male majority within the project Area of Influence. This reflects the general demographic composition of the area and highlights the need to consider the different roles and responsibilities of men and women when assessing potential project impacts and benefits. Appropriate attention to gender considerations will help ensure fair access to employment opportunities, consultations, and other benefits associated with the proposed solar installation.



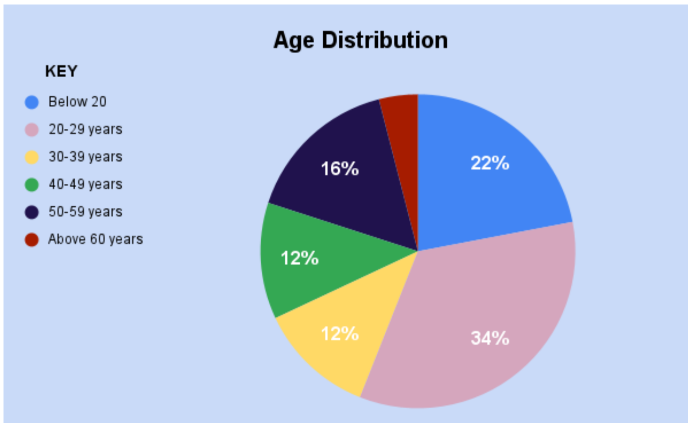


Figure 4.12: Age and Gender Distribution of survey population

Household Composition and Household Sizes of Survey Population

Household Composition

The age profile of respondents indicates that 40% are children (<18 years), 44.4% are adults (18–59 years), and 15.56% are elderly (60 years and above). This distribution reflects a moderately youthful population with a significant proportion of economically active individuals; alongside dependent and elderly groups within the project Area of Influence (AOL).

The presence of children and elderly persons identifies potentially vulnerable groups that require consideration in impact assessment and mitigation planning. Accordingly, the design and implementation of the proposed solar project will incorporate inclusive measures to safeguard vulnerable populations while enhancing reliable electricity supply to support education, healthcare services, security and overall socio-economic well-being within the university and adjoining host communities.

Household Sizes

Household size analysis shows that 8% of households have 1 to 3 members, 18% have 4 to 6 members, 38% have 7 to 10 members and 36% have 11 to 15 members. Large households are common, reflecting extended family structures with multiple dependents. Project planning and mitigation measures will consider household size to ensure that all members, including children, women and the elderly benefit equitably from the reliable electricity supply and socio-economic improvements provided by the solar installation.

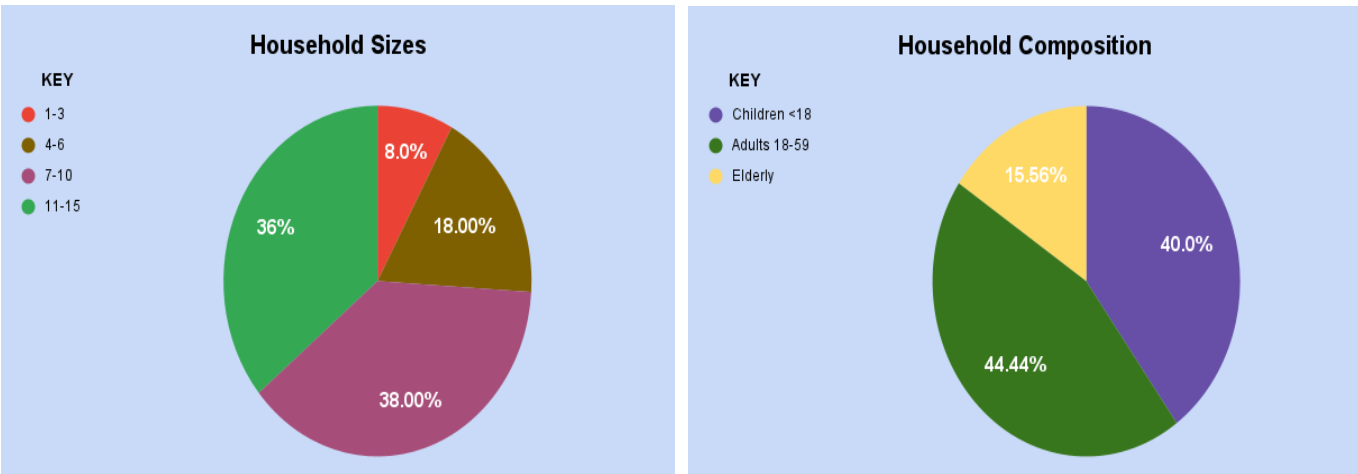


Figure 4.13: Household Composition and Household Sizes of survey population

Religion of Survey Population

Religion

The survey findings indicate that 81% of respondents within the project Area of Influence are Muslim, while 19% are Christian. No respondents reported adherence to traditional religions. This reflects the predominantly Muslim character of the area, with a smaller Christian population also present. The religious composition of the communities is an important consideration in understanding social dynamics and ensuring that project activities are sensitive to local cultural and religious practices.

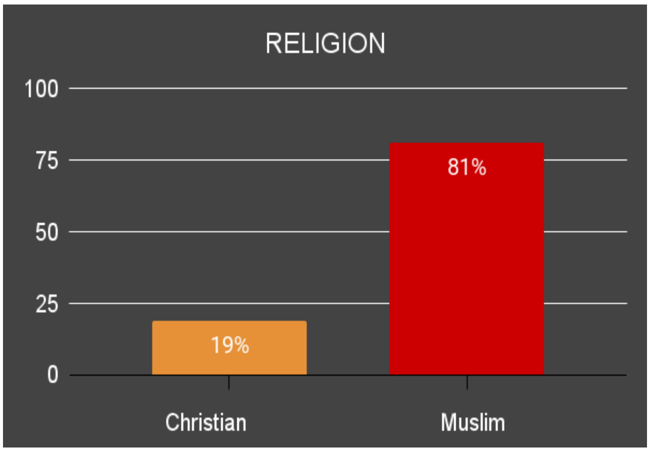


Figure 4.14: Religion of Survey Population

Marital Status and Monthly Income of Survey Population

Marital Status

The baseline survey shows that 52% of respondents are married, 46% are single or never married and 2% are widowed. No respondents reported being separated or divorced. This distribution reflects a relatively balanced population structure, with a slight majority of married individuals. Married respondents are likely to have greater household responsibilities, including dependents, while single respondents may have different socio-economic priorities. The presence of a small widowed population, representing 2%, is also noteworthy, as widowed individuals may face distinct social or economic challenges depending on household support structures. Understanding the marital composition of the population provides context for assessing household dynamics, dependency levels, and potential variations in how project benefits may be experienced across different social groups.

Monthly Income

The income distribution within the project Area of Influence reflects varying levels of economic resilience among the university and surrounding communities. Survey data indicate that at the lower end of the spectrum, 38% of respondents earn ₦0–₦70,000 per month, which is at or below the national minimum wage, 18% earn ₦71,000–₦100,000, another 18% earn ₦101,000–₦200,000 and 26% earn above ₦200,000. Lower-income groups may have limited financial capacity to adapt to changes in daily routines or economic activities; whereas higher-income groups generally demonstrate greater economic stability and flexibility. Understanding these income patterns is critical for assessing socio-economic vulnerability and potential disparities in how communities may experience the benefits of the proposed solar installation, particularly in relation to access to electricity, household activities and small-scale economic opportunities.

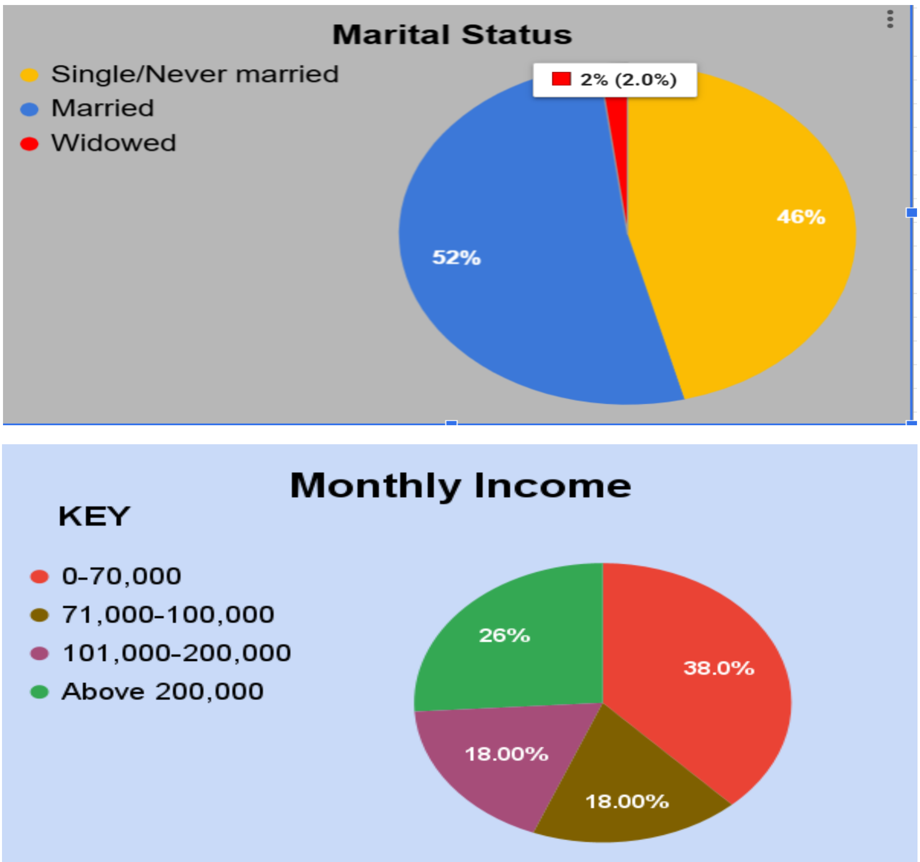


Figure 4.15: Marital Status and Monthly Income of survey population

Education and Occupation of Survey Population

Education

Educational attainment within the project Area of Influence reflects the university setting, with the university population largely tertiary-educated, while host communities show lower levels of formal education: 16% have Islamic education, 4% completed primary school, 12% completed secondary school, 4% possess vocational or technical training and the remaining 4% has no educational background. This diverse human capital, combined with a workforce comprising students, civil servants and small-scale entrepreneurs provides a strong foundation for engaging with and benefiting from the proposed solar installation. Skilled and educated individuals in both the university and surrounding communities can support technical activities, knowledge transfer, and capacity-building initiatives, maximizing project benefits.

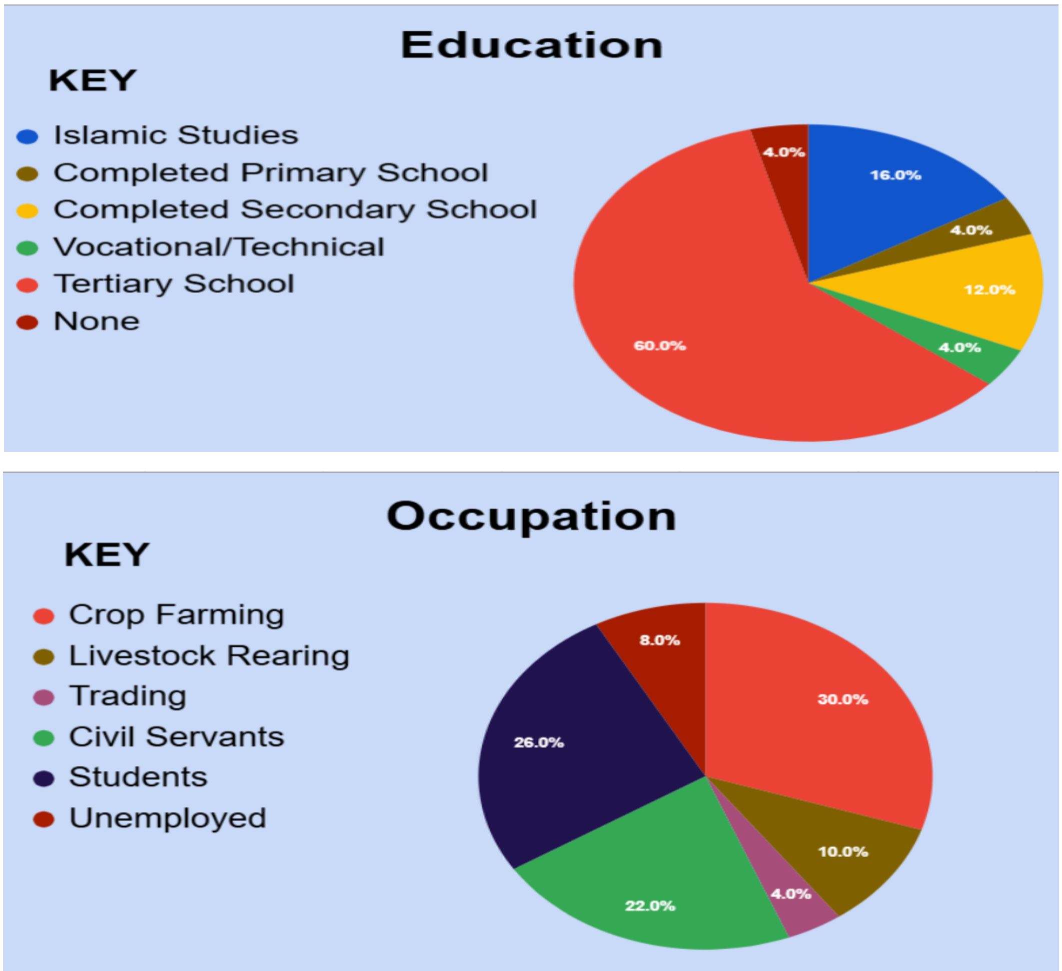


Figure 4.16: Education and Occupation of Survey Population

Vulnerability Criteria

The socio-economic survey conducted in the project Area of Influence identified vulnerable groups, with the elderly constituting the largest proportion at 61.76 percent, followed by chronically ill persons (20.59%), orphans (14.71%), and female-headed households (2.94%). These groups may have limited capacity to fully engage in or benefit from socio-economic activities due to age, health, or household circumstances. Recognizing these groups in the baseline underscores the need for project design and interventions, such as reliable electricity supply, improved access to university services, and inclusive community engagement, to ensure that benefits are equitably experienced across all social categories.

The breakdown of the groups is as follows:

- **Elderly (aged 60 and above): 61.76%** – Representing the largest vulnerable group, the elderly may face mobility limitations, health challenges, and reduced capacity to engage in livelihood or community activities.
- **Chronically ill persons: 20.59%** – Individuals with ongoing health conditions may have restricted participation in work or educational activities.
- **Orphans: 14.71%** – Children without parental support may be vulnerable to disruptions in education, care, and social protection.
- **Female-headed households: 2.94%** – Women heading households may face economic and social vulnerabilities, including limited access to income and household decision-making.
- **Persons with physical disabilities: 0%** – No respondents were recorded, though consideration for accessibility remains important.

This demographic profile underscores the need for project planning, engagement, and interventions such as reliable electricity, access to university and community services, and inclusive programs to ensure that benefits are equitably experienced across all social groups, including the most vulnerable.

Existing Infrastructures & Utilities

Electricity Supply

Electricity supply across the Federal University of Health Sciences (FUHSA) and surrounding communities is currently intermittent and inadequate. According to the Director of Works and Planning at the Federal University of Health Sciences Azare (FUHSA), power is available for approximately four hours at a time, followed by four hours of no supply, rotated over a 24-hour period. This rationing limit academic, administrative, and residential activities within the university. The inconsistent electricity supply affects teaching and research laboratories, ICT facilities, cold storage for medical and pharmaceutical materials, and student and staff residences. In the adjoining communities, erratic power reduces productivity for small businesses, constrains income-generating activities and affects household welfare.

The proposed solar hybrid mini-grid is expected to significantly improve energy security for FUHSA and support surrounding communities. By providing stable and reliable electricity, the project will enhance learning and research outcomes, strengthen healthcare training functions, improve living conditions, and contribute to local economic resilience, aligning with sustainable infrastructure and socio-economic development objectives.

Household Energy use

Electricity supply across the project area of influence is characterized by erratic and unreliable service from the national grid. Power is distributed on a load rotation basis, typically four hours on and four hours off within a twenty-four-hour cycle, as shared during consultations. This limited and inconsistent supply constrains economic activities, affects small businesses, disrupts healthcare services, and reduces overall quality of life. In many instances, households and businesses rely on petrol and diesel generators to bridge supply gaps, increasing energy costs and environmental pollution.

In Fatara, Gursoli and surrounding rural communities, limited and unreliable electricity has also contributed to continued dependence on firewood and charcoal for cooking and other domestic energy needs. The high cost of liquefied petroleum gas and inconsistent power supply further reinforce reliance on traditional biomass fuels. This practice has environmental implications, including deforestation and land degradation, as well as public health concerns arising from prolonged exposure to indoor smoke. FUHSA, while connected to the grid, is similarly affected by unstable supply, which disrupts academic activities, laboratory operations, administrative functions and healthcare related training services. The institution relies significantly on backup generators to maintain critical operations, leading to high operational costs and greenhouse gas emissions.

The proposed 4-megawatt solar hybrid power project at FUHSA is of significant environmental and social relevance. It will provide a stable, clean, and reliable source of electricity for the university, reduce reliance on fossil fuel generators, lower carbon emissions, and enhance the quality of teaching, research, and healthcare training. While primarily intended to serve FUHSA, improved institutional energy stability may also ease demand on the local grid, contributing to broader energy resilience in Azare and Katagum. The project thus supports the objectives of the ESIA by promoting sustainable infrastructure, environmental protection and long-term socio-economic benefits for both the university and surrounding communities.

Plate 4. 13 Firewood in Fatara Community along the community market road as Source of Energy

Water for Domestic Use and Drinking

Findings from baseline surveys, site inspections and stakeholder consultations indicate varying levels of access to potable water across Federal University of Health Sciences Azare (FUHSA) and its host communities.

In **Fatara and Gursoli**, residents primarily depend on hand pump boreholes and shallow wells for domestic water supply. A limited number of motorized or solar powered boreholes exist, but coverage remains inadequate for the growing population. During the dry season, water scarcity becomes more pronounced as shallow wells dry up and groundwater levels decline. Households often resort to purchasing water from vendors or collecting water from distant sources, which increases household expenditure and exposes users to potential contamination risks. These conditions present public health concerns, particularly where water treatment practices are limited.

At **FUHSA**, water supply is relatively more structured, with reliance on boreholes and storage facilities to support academic, administrative and residential functions. However, like electricity supply, water infrastructure is under pressure due to increasing institutional demand. Ensuring sustainable water availability is critical for laboratory activities, sanitation, student accommodation and healthcare related training services.

Overall, water access in the project area of influence remains moderately constrained and subject to seasonal fluctuations, particularly during the dry season, while FUHSA maintains a more organized but demand sensitive system. This context underscores the importance of integrating sustainable resource management considerations into project planning to avoid additional pressure on existing community water infrastructure and to promote improved ***environmental health outcomes.***

Plate 4.14: Water Tanker supported by Tertiarty Education Trust Fund

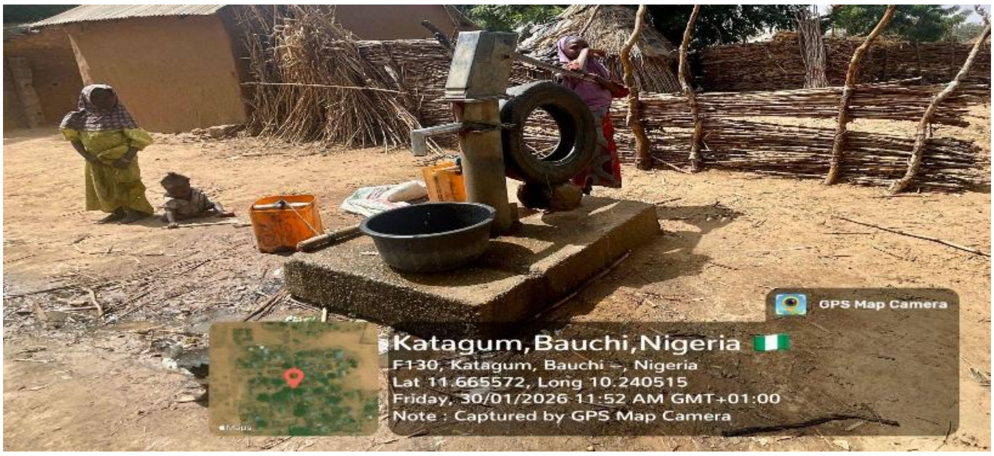


Plate 4.15: Mechanical Hand Pump Borehole in the project AoI

Educational Facilities

Educational infrastructure in the project area reflects the semi urban character of Azare and its adjoining communities of Fatara and Gursoli. The presence of the Federal University of Health Sciences Azare significantly strengthens tertiary level access within the area. However, access to basic education facilities varies at the community level.

In Rijia Alhaji, Yairi Primary School serves as a key public education facility for children within the settlement and nearby areas. Similarly, Fatara Nursery and Primary School provide foundational education services to residents of Fatara and surrounding households. These schools play an important role in improving literacy and early childhood development within the host communities.

Despite their presence, consultations indicate that infrastructure maintenance, learning materials and classroom capacity remain areas of concern, particularly as population growth increases enrollment pressure. Road conditions and seasonal accessibility also influence attendance, especially during the rainy season.

At the tertiary level, FUHSA represents a major educational asset not only to Azare and Katagum but to the wider region, contributing to human capital development in the health sciences sector. The proposed Solar Hybrid Project is expected to enhance reliable electricity supply to the university, thereby supporting uninterrupted teaching, laboratory research, healthcare training and administrative services.

The project is not expected to cause direct impacts on existing educational facilities. Instead, improved energy reliability at FUHSA and overall infrastructure enhancement in Fatara and Gursoli are anticipated to strengthen educational service delivery and create broader socio-economic benefits for the host communities.

Plate 4.16: Nursery and Primary School facilities in Fatara community.

Security and Conflict Situation

The broader security context in Northern Nigeria remains dynamic, with documented concerns relating to banditry, communal disputes, and youth related unrest in some parts of the region. However, findings from stakeholder consultations, field assessments, and engagement with community leaders indicate that the environment along the project corridors currently experiences a relatively stable security environment.

No recent incidents of armed conflict, terrorism, or widespread violence were reported within the immediate project Area of Influence. The university environment at FUHSA benefits from structured institutional security arrangements, while surrounding communities such as Fatara and Gursoli rely on traditional leadership structures and community-based conflict resolution mechanisms to maintain social order.

That said, underlying socio-economic stressors such as youth unemployment, limited infrastructure services, and periodic resource-based tensions remain potential risk factors if not properly managed. The improved electricity supply expected from the Solar Hybrid Project at FUHSA may contribute indirectly to social stability by enhancing institutional functionality, supporting employment opportunities, improving service delivery, and strengthening community university relations.

In line with ESIA good practice, the project will apply conflict sensitive implementation measures, maintain continuous stakeholder engagement with host communities, and operate a transparent grievance redress mechanism to promptly address concerns. Ongoing monitoring will be undertaken to ensure that project activities do not exacerbate existing vulnerabilities and that social cohesion within Fatara, Gursoli, and the wider Azare area is maintained.

Community Administration

The project Area of Influence covering FUHSA, Fatara, and Gursoli in Azare, Katagum LGA operates within a well-established traditional governance system that complements formal local government structures. Community administration follows a hierarchical model that remains central to local decision making, land administration, and dispute resolution.

At the community level, leadership is vested in the Mai Anguwa or Village Head, who oversees day to day affairs, maintains social order, and serves as the first point of engagement for households and external stakeholders. The Village Heads report to the District Head Hakimi, who supervises multiple communities and provides oversight on broader traditional and land related matters.

At the apex of the structure is the Emir of Katagum, who exercises cultural and traditional authority across the Emirate, including Azare and surrounding settlements such as Fatara and Gursoli. The Emirate Council plays a significant role in community mobilization, conflict mediation, and facilitating engagement between government institutions and host communities.

This governance framework remains functional and influential within the project area. It provides an established platform for stakeholder consultation, information disclosure, grievance resolution, and social mobilization during implementation of the Project at FUHSA. Engagement through these traditional structures enhances legitimacy, promotes social cohesion, and supports smooth project implementation in accordance with ESIA good practice.

Community Conflict Resolution Mechanism

Grievances in the project area, FUHSA host communities are primarily addressed through established community-based and traditional conflict resolution structures. These mechanisms are critical for maintaining social cohesion, preventing disputes, and ensuring orderly community interactions. At the grassroots level, concerns are typically raised with the **Village Head or Mai Anguwa**, who mediates disputes through dialogue and local consultation. Where issues cannot be resolved at this level, they are escalated to the **District Head or Hakimi**, who oversees multiple communities and facilitates broader discussions to achieve amicable settlements. Only in exceptional or complex cases are matters referred to formal judicial systems.

These processes are embedded within the **Emirate governance system**, with the **Emir of Katagum** and palace chiefs providing oversight and ensuring alignment with cultural norms and customary laws. This traditional framework complements formal institutions, reinforcing peace, stability, and accountability across the project area.

For the Solar Hybrid Project at FUHSA, integrating these community grievance pathways into project planning and engagement is essential. Collaboration with traditional leaders and local authorities will ensure culturally appropriate dispute resolution, promote timely and fair handling of complaints, and support sustainable project outcomes in both the university and surrounding host communities.

Telecommunication Facilities

Communities in Azare currently access mobile network services from major providers including MTN, Airtel, and Globacom. While coverage in these semi-urban and rural areas is less extensive than in larger towns, most residents have at least one available service provider, enabling basic social communication, mobile banking, and small-scale business activities.

Field observations confirm the presence of telecommunications infrastructure, including network masts, in and around the university and adjoining communities, reflecting ongoing private sector investment in digital connectivity. However, network reliability and service quality remain variable, with stronger performance closer to Azare town and weaker signals in more remote settlements.

The proposed Solar Hybrid Project at FUHSA is expected to indirectly support telecommunication growth. Reliable electricity supply and improved infrastructure within the university and surrounding communities will facilitate maintenance and operation of network equipment, reduce operational challenges for service providers and encourage further investment in digital infrastructure. Over time, this is likely to enhance network reliability, promote digital inclusion, support women, youth and students who increasingly rely on mobile connectivity for education, healthcare information, and income-generating activities.

Transportation and Mobility

In the project area covering FUHSA, Fatara and Gursoli, the predominant mode of local transport is commercial motorcycles, commonly known as Achaba, which are widely used for conveying passengers and goods. Other transport options include cars, trucks, and limited traditional carts, but poor road conditions often make these less practical.

Road accessibility challenges are particularly pronounced during the rainy season, when many rural routes become impassable, disrupting mobility, access to markets, and the movement of goods. Farmers and traders frequently face difficulties transporting produce, often walking long distances to reach motorable roads, which increases post-harvest losses and reduces household income. Transportation costs along key routes are also relatively high due to poor road conditions.

The proposed Solar Hybrid Project at FUHSA, while primarily an energy initiative, is complemented by ongoing infrastructure improvements in the area. Reliable electricity and potential support for local service provision are expected to enhance mobility indirectly by facilitating maintenance of equipment and operations dependent on power. More broadly, improving road connectivity in Fatara and Gursoli will reduce transport costs, improve access to markets and social services, strengthen local livelihoods and support economic opportunities for youth, women and small-scale entrepreneurs. Enhanced mobility will also contribute to safer and more efficient access to FUHSA facilities, benefiting students, staff and surrounding communities.

Plate 4.17: Common Means of transportation along project communities

Healthcare Facilities and Access

The primary healthcare centers (PHCs) serve as the main point of care for residents. These facilities provide basic services such as maternal and child health, immunizations, and treatment of common illnesses, but staffing is often limited to Community Health Extension Workers (CHEWs) and auxiliary nurses. Specialist care or resident doctors are generally absent, restricting the capacity to manage complex medical conditions.

For serious or complicated cases, residents must travel to better-equipped hospitals in Azare or other larger towns. Many rely on local pharmacies or informal medicine vendors, which can delay effective treatment and increase health risks, particularly for vulnerable groups such as women, children and the elderly.

The proposed Solar Hybrid Project at FUHSA is expected to indirectly support healthcare improvements by providing reliable electricity for the university's facilities, including its teaching hospitals and laboratories. Improved power reliability will also benefit surrounding communities by enabling uninterrupted operation of health facilities, refrigeration of vaccines, and use of medical equipment. Additionally, enhanced road access will reduce travel times and transportation costs, improve delivery of medical supplies and encourage deployment of qualified healthcare personnel to underserved areas. Collectively, these improvements will strengthen health service delivery, reduce morbidity and mortality, and enhance overall community well-being.

Human Health Status within the Project Area

Health information for Azare Community and neighboring settlements was obtained through field surveys, consultations with healthcare personnel at Primary Health Centres (PHCs), Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), and secondary information obtained from the Bauchi State Ministry of Health, National Demographic and Health Survey (NDHS), and relevant public health literature.

Common Causes of Morbidity by Age Group

Age Group	Common Causes of Morbidity
Infants (<1 year)	Neonatal infections, malaria, diarrhoeal diseases, pneumonia, birth asphyxia, low birth weight, malnutrition.
Children (1–5 years)	Malaria, acute respiratory infections (ARI), diarrhoea, intestinal helminth infections, skin infections, malnutrition.
School-age Children (6–14 years)	Malaria, respiratory tract infections, typhoid fever, gastrointestinal infections, skin diseases, minor injuries.
Adolescents (15–24 years)	Malaria, respiratory infections, sexually transmitted infections (STIs), road traffic injuries, substance misuse, mental health concerns.
Adults (25–59 years)	Malaria, hypertension, diabetes mellitus, musculoskeletal disorders, peptic ulcer disease, occupational injuries, respiratory illnesses, gastrointestinal infections.
Elderly (>60 years)	Hypertension, stroke, diabetes mellitus, arthritis, chronic respiratory diseases, cardiovascular diseases, visual impairment, age-related degenerative conditions.

Common Causes of Mortality

Based on consultations with healthcare providers and available secondary health statistics, the leading causes of mortality within the Project Area include:

- Severe malaria
- Neonatal complications
- Pneumonia
- Complications of hypertension
- Stroke
- Diabetes-related complications
- Maternal complications
- Road traffic accidents
- Chronic respiratory diseases

- Septicaemia and severe infections

Among children under five years of age, malaria, diarrhoeal diseases, pneumonia, neonatal disorders, and malnutrition remain the leading contributors to mortality, while non-communicable diseases such as hypertension, stroke, and diabetes account for a significant proportion of adult and elderly deaths.

Overall, malaria remains the single most prevalent communicable disease affecting virtually all age groups within the Project Area.

Relationship between Baseline Health Conditions and Project Health Risks

The baseline health profile indicates that communicable diseases, particularly malaria, respiratory tract infections, diarrhoeal diseases, and non-communicable conditions such as hypertension and diabetes, constitute the major health concerns within the Project Area.

Potential health risks associated with the project include:

Existing Health Condition	Potential Project-Related Health Risk
Malaria	Creation of stagnant water during construction may increase mosquito breeding if drainage is poorly managed.
Respiratory infections	Dust emissions during site clearing and gaseous emissions may aggravate respiratory conditions among sensitive populations.
Cardiovascular diseases	Exposure to air pollutants such as particulate matter ($PM_{2.5}$ and PM_{10}), sulphur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO) may increase cardiovascular health risks among susceptible individuals.
Diarrhoeal diseases	Improper wastewater management or accidental contamination of surface and groundwater could increase waterborne disease risks.
Occupational injuries	Construction and refinery operations present risks of slips, trips, falls, burns, chemical exposure, machinery accidents, and confined-space incidents.
Traffic-related injuries	Increased movement of heavy-duty vehicles during construction and operation may elevate the risk of road traffic accidents within surrounding communities.
Noise-related health effects	Construction equipment and refinery operations may result in temporary noise exposure causing annoyance, sleep disturbance, stress, and hearing

	impairment among workers without adequate controls.
Chemical exposure	Potential exposure to hydrocarbons, volatile organic compounds (VOCs), hydrogen sulphide (H_2S), benzene, and other refinery chemicals may pose acute and chronic health risks if not adequately managed.
Fire and explosion	Handling and storage of flammable petroleum products present potential fire and explosion hazards affecting both workers and nearby communities.
Communicable diseases	Workforce influx may increase the transmission of communicable diseases, including STIs, HIV/AIDS, tuberculosis, and COVID-19-like respiratory infections, if preventive measures are not implemented.

Gender Issues

In FUHSA, the gender distribution is relatively balanced, with women representing 46% and men 56% of the population, reflecting the university environment where women are well represented in both academic and administrative roles. In surrounding communities such as Fatara and Gursoli, traditional gender roles remain more pronounced, with women primarily managing households, childcare, and small-scale income activities, while men dominate business, formal employment and larger-scale agriculture.

Gender Considerations

The Solar Hybrid Project at FUHSA offers opportunities to strengthen gender inclusion by providing reliable electricity that supports educational activities, research, and livelihood opportunities for both women and men. The project also creates potential for skills development, temporary employment, and participation in decision-making, particularly for female students and staff.

Potential social risks, such as gender-based violence (GBV) and exploitation, are recognized, especially for vulnerable groups in the surrounding communities. To mitigate these risks, the project will implement gender-sensitive measures:

- **Inclusion in benefits:** Women at FUHSA and in host communities will be actively engaged in project opportunities, training and decision-making.

- **Workplace protections:** Contractors will enforce a Code of Conduct prohibiting GBV, SEA, and harassment, and ensure gender-responsive facilities on site.
- **Awareness and capacity building:** Sensitization campaigns and gender training will be conducted for both staff and community members.
- **Monitoring and response:** The State Project Implementation Unit (SPIU) will track GBV/SEA risks, develop an Action Plan, and ensure prompt prevention, reporting and response.

These measures ensure that the project not only avoids adverse gender impacts but actively promotes equity, empowerment and participation for women and men in both the university and surrounding communities.

4.5 Stakeholder Engagement

This section describes the activities that were carried out to engage and consult with key stakeholders. It describes the process by which stakeholders were identified; the means by which they were consulted; and the outcomes of the consultations to date. It describes the actions that the Project took to disclose pertinent information to stakeholders. A Stakeholder Engagement Plan (SEP) and Grievance Redress Mechanism (GRM) for the proposed project are presented in Appendix 4.2. The SEP describes the plan that the Project will implement to ensure that stakeholders are continued to be engaged throughout the Project life cycle.

4.5.1 Defining Stakeholder Engagement

Stakeholder engagement is an ongoing process of sharing Project information, understanding stakeholder concerns, and building relationships based on collaboration. Stakeholder consultation is a key element of engagement and essential for effective Project delivery. Disclosure of information is equally as vital. If there are risks or adverse impacts from a Project, consultation must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views.

In line with current guidance from the International Finance Corporation (IFC), consultation should ensure *"free, prior and informed consultation of the affected communities."* In other words, effective consultation requires the prior disclosure of relevant and adequate Project information to enable stakeholders to understand the risks, impacts, and opportunities. The Project's consultation program was intended to ensure that stakeholder concerns are considered, addressed and incorporated in the development process, especially during the ESIA.

4.5.2 Objectives

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:

- 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;
- 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.

Table 4.12 is a summary of the process and stages of consultation for this ESIA study.

Table 4.12: Summary of the process and stages of consultation for the ESIA

Stage Process	Activity	Key Stakeholders	Expected outcome
Stakeholder Identification and Mapping	Identification of individuals, groups, institutions, and communities that may be affected by or have interest in the project. Stakeholders are categorized as primary, secondary, and vulnerable groups.	Host communities, government agencies, NGOs, community leaders, project developers, vulnerable groups.	To understand who the stakeholders are and ensure that all relevant parties are included in the consultation process.
Stakeholder Engagement Planning	Development of a stakeholder engagement plan outlining consultation methods, timelines, communication	Project proponents, ESIA consultants, regulatory authorities.	To provide a structured framework for engaging stakeholders effectively throughout the ESIA process.

	strategies, and responsibilities.		
Initial Consultation / Project Introduction	Early engagement with key stakeholders to introduce the proposed project, discuss objectives, and gather preliminary concerns or expectations.	Community leaders, local government officials, regulatory agencies, community members.	To inform stakeholders about the proposed project and obtain initial feedback before detailed studies commence.
Scoping Consultation	Meetings and discussions to identify key environmental and social issues, potential impacts, and areas of concern that should be considered in the ESIA study.	Host communities, environmental regulators, civil society organizations, subject experts.	To define the scope of the ESIA and ensure that stakeholders' concerns are incorporated into the assessment.
Data Collection and Community Consultation	Field surveys, focus group discussions, key informant interviews, and community meetings conducted during baseline data collection.	Local residents, traditional leaders, women groups, youth groups, local businesses.	To obtain socio-economic information, community perceptions, and traditional knowledge relevant to the project area.
Public Consultation / Stakeholder Meetings	Formal meetings or public hearings to present findings of the ESIA study and discuss predicted impacts and proposed mitigation measures.	Host communities, regulatory agencies, NGOs, media, project proponents.	To ensure transparency, validate findings, and gather stakeholder opinions on proposed mitigation measures.
Disclosure of ESIA Findings	Sharing of ESIA reports or summaries with stakeholders through public displays, workshops, or online platforms.	Regulatory authorities, community representatives, NGOs, general public.	To allow stakeholders to review the ESIA findings and provide feedback before approval.
Integration of Stakeholder Feedback	Compilation and incorporation of stakeholder comments and concerns into the final ESIA report and Environmental and Social Management Plan (ESMP).	ESIA consultants, project developers, regulatory authorities.	To ensure stakeholder inputs are reflected in project design, mitigation measures, and management plans.
Continuous Engagement and	Establishment of a communication channel and grievance redress	Host communities, project	To maintain dialogue, address complaints, and ensure effective

Grievance Mechanism	mechanism throughout project implementation.	management team, government agencies.	implementation of mitigation measures.

The following sections describe the stakeholder engagement activities that have been carried out so far. The activities that are planned for later stages are also described.

4.5.3 Scoping Activities

At the scoping stage, Project stakeholders were identified in order to understand the individuals, groups, and organizations that may be affected by or may influence Project development positively or negatively. Initially, a broad list of potentially affected and interested parties (AIPs) was considered, such as:

- National, regional and local government;
- Local businesses/cooperatives and associations;
- Local communities and individuals; and
- Civil society organizations

4.5.3.1 Initial EIA Scoping Consultations

The initial consultations were carried out from 25th – 31st January, 2026 with the following:

- Bauchi State Environmental Protection Agency
- Federal Ministry of Women Affairs and Social Development
- Federal Ministry of Youth and Sports
- FUHSA Vice Chancellor
- FUHSA Director of works and Physical Planning
- FUHSA Student Union Government President
- Katagum Local Government Area
- Azare Community Leader
- Civil Society Organizations
- Nigerian Women Trust Fund

The consultations served to provide stakeholders with information about the proposed Project and to gather information important to the ESIA. The objective was to identify any key concerns or high-level issues that the stakeholders had at this early stage. Prior to the consultation, notification letters and Background Information Documents (BID) were sent to the stakeholders to provide high level information about the proposed Project.

Plate 4.18: Stakeholder Engagement with Vice Chancelor and Head of Department in FUHSA

Plate 4.19: Meeting with FUHSA Vice Chancellor and Director of Facilities
Source: EcoFields Field Survey, 2026

Plate 4.20: Meeting with FUHSA Students Union Government representatives
Source: EcoFields Field Survey, 2026

Table 4.13: Initial Stakeholder Consultation Findings

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
BASEPA	ESIA process and stakeholder consultation	• The ESIA should describe how waste generated from the Project would be managed • The percentage of locals that would be employed should be stated in the report • Alternatives should be considered for the Project (e.g. battery types) • The power generated must be able to meet the demand from the University	• A waste management plan that includes e-waste management will be developed and implemented for the Project • About 60% of the workforce during construction will be employed from the local communities • Alternative batteries, PV panels, etc. will be explored in the ESIA • An energy audit has been conducted to determine the power

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
		• The baseline data gathering for the Project should be carried out in line with best practice	demand for the university
FUHSA Vice Chancellor	ESIA process and stakeholder consultation, Sustainability of the Project,	• The Project is a welcome development to the University and they are ready to provide the necessary support • The University has a dedicated team to ensure sustainability of the Project. • Female students will not be marginalized from the Project • The University campus is secure and security would be provided for the Project	• The Project will serve all facilities and buildings within the University
FUHSA Director of Works and Physical Planning	Stakeholder consultation	• The land selected for the Project site has been approved by the University. The site was selected due to proximity to the injection substation, security, and availability of free land. • The building on the site was constructed a few years ago but it has not been used. • The affected farmers on the Project site will be adequately informed about the Project. Also, they will be provided with alternative land to continue their activities • There are no plans for any major developments close to the Project site in the near future. • Water supply within the University is from boreholes • Waste generated in the University is collected and disposed at dumpsites within the state • There are no facilities for e-waste	• A waste management plan that includes e-waste management will be developed and implemented for the Project

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
		management in the university	
President of FUHSA Students Union Government	ESIA process and stakeholder consultation	• Power supply in the University is erratic and they hope that the Project would fix it • The Project is a welcome development that will benefit the students. • Security within the school is satisfactory	• The power generated from the Project would be distributed to meet all the needs of students and staff of the University.
Azare leader	ESIA process and stakeholder consultation	• Some of the community members have farmlands within the Project site • They are aware that the land belongs to the university • They have a good relationship with the university and expect that they will be carried along • They would appreciate if the youths from their community will be employed to work on the Project	• The affected farmers will be consulted before the Project commences • A percentage of the workforce for the Project will be drawn from the host community

Engagement activities in the ESIA study stage included consultations designed to introduce the Project to stakeholders that could potentially be affected by the Project. This was intended to refine the ESIA scope by generating additional feedback on the ESIA approach, key issues and key stakeholders to be consulted, as well as to inform the development of mitigation for the Project.

Consultation with the identified stakeholders (including regulators and potentially affected communities) showed general acceptance of the proposed Project. Regulators such as the Bauchi State Environmental Protection and Sanitation Agency made suggestions relating to the proposed Project which were duly noted to be implemented accordingly. Community members also showed enthusiasm about the Project and shared their expectations from the Project including provision of jobs for the youth, skill acquisition opportunities for women and children, etc.

CHAPTER FIVE:

ASSOCIATED AND POTENTIAL IMPACTS

CHAPTER FIVE

ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

This chapter presents the potential environmental and social (E&S) impacts and risks associated with the proposed solar-hybrid power plant and associated infrastructure in Federal University of Health Sciences (FUHSA), Bauchi State Government, under the Federal Government's Energizing Education Programme (EEP), a component of the Nigeria Electrification Project (NEP). It also includes the methodology employed to assess the significance of the E&S impacts and risks.

5.2 Impact Assessment Overview

The potential for an E&S impact exists where an environmental aspect has been identified i.e. where a project activity has been determined to have the potential to interact with the biophysical and socio-economic environment. The significance of each impact is then determined. Figure 5.1 illustrates the general overview of the impact assessment process employed for this ESIA.

The primary objectives of the impact assessment process are to:

- Establish the significance of identified potential impacts that may occur as a result of the proposed Project activities;
- Differentiate between those impacts that are insignificant and those that are significant; and
- Apply mitigation hierarchy measures for the identified significant impacts and assess residual impacts, including periodic monitoring of the effectiveness of the proffered mitigation measures through the entire life cycle of the Project.

The assessment of impact significance is both in qualitative and quantitative terms. Qualitatively, the impact significance is ranked on four (4) widely accepted levels: **Major**, **Moderate**, **Minor** and **Negligible.**

The impact assessment covers the entire life cycle of the Project. i.e.: pre- construction; construction; commissioning; operation; and decommissioning. However, environmental and social issues including mitigation and management plans related to decommissioning activities are discussed in Chapter 8.

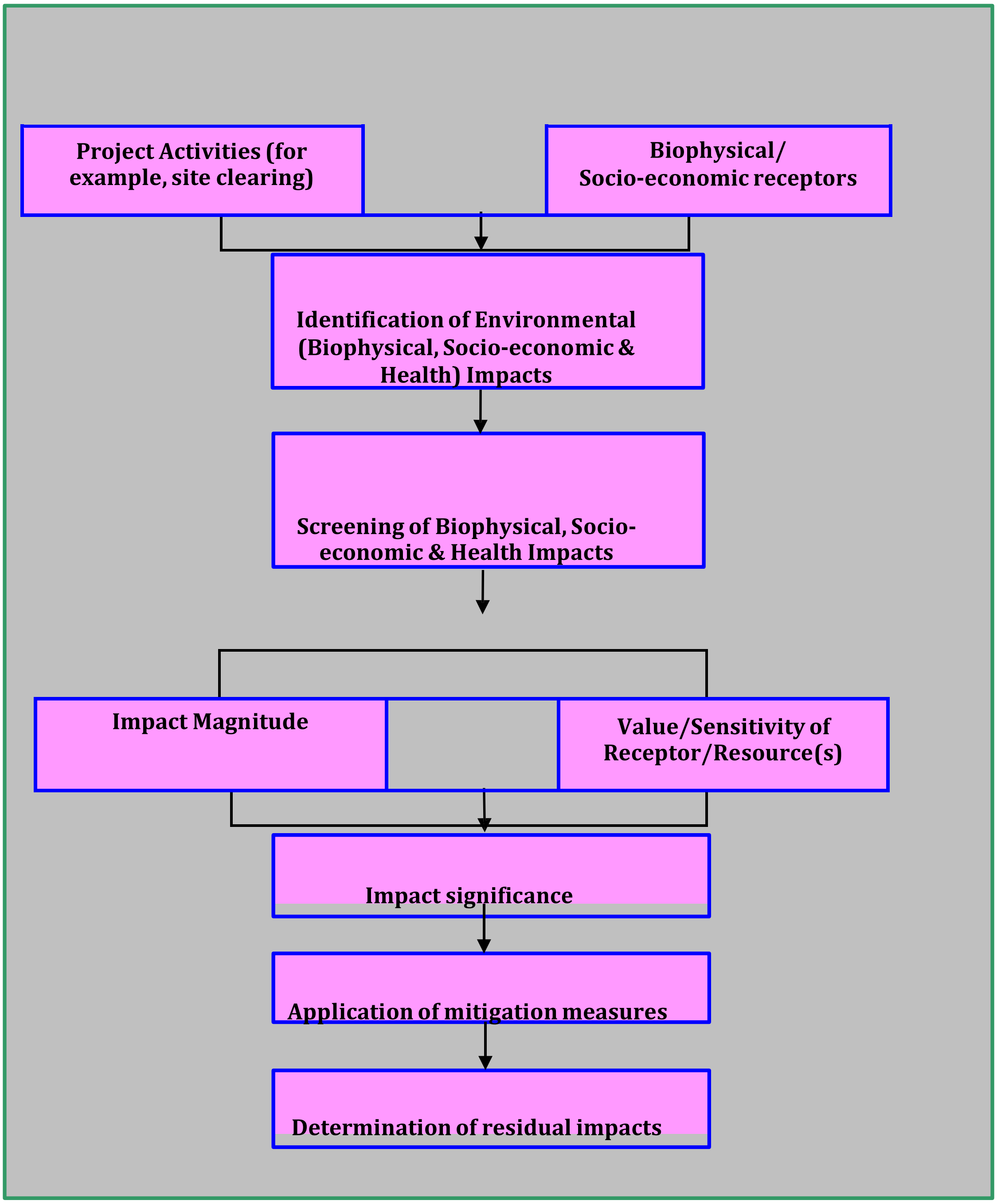


Figure 5.1: Overview of the Impact Assessment Process

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

5.3.1 Defining Environmental and Socio-economic Aspects and Impacts

The International Organization for Standardization's Environmental Management Systems (EMS), ISO 14001, defines an environmental aspect as: *"An element of an organization's activities, products or services that can interact with the environment." while an* environmental impact is defined as: *"Any change to the environment,* *whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services."*

To identify environmental and social aspects of the Project, the proposed Project activities were considered in terms of their direct or indirect potential to:

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

Activities assessed covered planned and non-planned events.

Table 5.1 illustrates the links between project activity, environmental aspect and potential impact.

Table 5.1: Example of a Link between Activities, Environmental Aspects and Impacts

Project Activity	Environmental Aspect	Potential Impact
Site clearing and grading	Removal of vegetation	Loss of biodiversity
Installation of PV panels	Soil excavation	Soil erosion and degradation
	Noise generation	Disturbance to surrounding environment and/or sensitive receptors

5.3.2 Potential Impact Characteristics

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

i. *Negative:* An impact that is considered to represent an adverse change from the baseline or to introduce a new undesirable factor.

ii. *Positive:* An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor.

iii. *Direct*: Impacts that result from the direct interaction between a planned project activity and the receiving bio-physical and socio-cultural environment.

iv. *Indirect:* Impacts that result from other activities that are encouraged to happen as a consequence of the project.

v. *Temporary:* Temporary impacts are predicted to be of short duration, reversible and intermittent/occasional in nature.

vi. *Short-term:* Short term impacts are predicted to last only for a limited period but will cease on completion of the activity, or as a result of mitigation measures and natural recovery.

vii. *Long-term:* Impacts that will continue for the life of the project, but cease when the project stops operating.

viii. *Permanent:* Potential impacts that may occur during the development of the project and cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime.

ix. *On-site:* Impact that is limited to the project site.

x. *Local:* Impacts that affect locally important environmental resources or are restricted to a single (local) administrative area or a single community.

xi. *Regional:* Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries.

xii. *National:* Impacts that affect nationally important environmental resources; affect an area that is nationally protected; or have macro-economic consequences.

xiii. *Reversible:* An impact that the environment can return to its natural state.

xiv. *Irreversible:* An impact that the environment cannot return to its original state, e.g. the extinction of an animal or plant species.

xv. *Cumulative/Synergistic*: Potential impacts that may result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project. This also includes synergy with other projects/infrastructure in the project area.

xvi. *Residual:* Both environmental and social impacts that will remain after the application of mitigation measures to project impacts during each of the project phases.

5.3.3 Screening and Scoping for Potential Impacts

A modified version of the Leopold Interaction-matrix technique was employed to screen and scope for the potential impacts of the proposed Project on the environment. The basis for the screening was derived from the following:

- Knowledge of the Project activities as summarized in Table 5.2.
- Detailed information on the environmental and socio-economic setting of the Project's area of influence as documented in Chapter 4. The potential environmental and social receptors/resources that could be affected by the proposed Project are summarized in Table 5.3.
- Consultation with relevant stakeholders including potentially affected community
- Review of other ESIA reports on similar projects/environments.
- Series of experts group discussions, meetings and experience on similar projects.

Table 5.2: Summary of the proposed Project Activities

S/N	Project Phase	Associated Activities
1.	Pre-Construction	Site selection
		Site clearing and preparation
		Mobilization of construction equipment and materials to site
2.	Construction/ Installation	Civil work activities including excavation, trenching, cable laying, foundation, construction of building (e.g. training centre)
		Installation of power plant facilities such as PV panels, mounting structures, inverters, power storage batteries; upgrade of existing distribution infrastructure; installation of streetlights
		Waste generation and disposal
3.	Commissioning	Testing of power plant and associated infrastructure
4.	Operation	Power generation (through PV panels) and distribution; provision of training on renewable energy
		Routine maintenance including occasional cleaning of PV panels; waste generation

Note: Activities related to decommissioning are discussed in Chapter 8

Table 5.3: Resource/Receptors and Impacts Indicators Considered

Environmental Receptor/Medium	Comment	Impact Indicators
	Physical	
Air	Ambient air quality within the Project site and its surrounding environment.	Increase in concentration of gaseous and particulate pollutants.
Noise	Ambient noise level within the Project site and its surrounding environment.	Increase in ambient noise level; day and night-time disturbance; communication impairment, etc.
Soil	Soil environment within the Project site and its AoI.	Changes in physical, chemical and biological properties of the soil; loss of soil ecology and fertility; soil erosion, etc.
Groundwater/aquifers	Underground water resources in the Project's AoI.	Decrease in underground water/aquifer reservoir level; groundwater contamination.

Environmental Receptor/Medium	Comment	Impact Indicators
Surface water	Surface water body within the Project's AoI	Decrease in surface water quality.
Landscape/topography	The geomorphological land forms and terrain of the Project site and its surrounding environment.	Alteration in drainage pattern; changes in landscape.
Biological		
Terrestrial flora and habitats	Plant species (vegetation) within the Project site and its AoI.	Loss of terrestrial flora; introduction of new species.
Terrestrial fauna	Terrestrial fauna within the Project site and its surrounding environment.	Loss of terrestrial fauna; involuntary migration.
Socio-economic Environment		
Land use	Existing land use within the Project site and its AoI.	Loss of existing land use.
Visual prominence	The aesthetic quality of the Power Plant on the surrounding visual catchment.	The compatibility of the Power Plant with the character of the locality; visual nuisance through reflection of panels.
Demography	Demography of community in the Project's AoI.	Changes in demography, gender ratio, age distribution, socio-economic structure, etc. of the local community.
Utilities	The existing utilities (e.g., power supply, water, sewer services, etc.) in the Project's AoI.	Changes in existing utilities; potential damage to public utilities.
Infrastructure	The existing infrastructure such as road, waste handling facilities, etc. within the Project's AoI.	Potential damage to road infrastructure; road traffic and accidents; increased pressure on waste management facilities.
Employment/income	The employment situation in the Project's AoI.	Opportunities for local employment; changes in income level.
Gender	Gender and disproportionate gender impacts	Potential for Gender based violence (GBV); marginalization of women; gender pay gaps;
Other (Health and Safety)		
Construction workers	Health and safety of construction workers.	Accident, injury, fatality, exposure to nuisance (dust, noise), fire, etc.
Workplace health and safety	Health and safety of employees involved in the Power Plant operation.	Accident, injury, fire, explosion, etc.
General public	Health and safety of the general public	Accident, fire, explosion, etc.

Identified Project activities, biophysical and socio-economic receptors were integrated into a matrix. The Project activities are on the y-axis while the biophysical and socio-economic receptors are on the x-axis. The matrix was completed for each of the Project elements. The Leopold's Interaction matrix was subsequently assessed to identify every possible case of activity-receptor interaction. Where it was considered that an activity-receptor interaction was possible, the cell was marked denoting an identified environmental aspect (denoted as "x" in Table 5.4).

Table 5.4: Activity-Receptor Interaction for Impact Screening

Summary of Project Activities at various Phases	Receptors																
	Physical						Biological		Socio-economic						Others (Health and Safety)		
	Air Quality	Ambient Noise	Soil	Groundwater and Aquifers	Surface water	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Gender	Construction workers	Workplace health and safety	General Public
Pre-construction Phase																	
Site selection									X								
Site clearing and preparation	X	X	X		X	X	X	X	X				X			X	
Mobilization of construction equipment and materials to site	X	X					X	X	X		X	X	X		X	X	X
Construction Phase																	
Civil work activities including excavation, trenching, cable laying, foundation, construction of building (e.g. training centre)	X	X	X		X			X		X	X		X	X	X	X	X
Installation of power plant facilities, upgrade of existing distribution infrastructure, installation of streetlights	X	X	X											X		X	
Waste generation and disposal			X	X	X							X	X			X	X
Commissioning Phase																	
Testing o f power plant and associated infrastructure		X								X		X				X	X
Operational Phase																	
Power generation and distribution and provision of training on renewable energy		X											X	X		X	X
Routine maintenance; waste generation and disposal	X		X	X		X					X	X	X	X		X	X

Note: Decommissioning is separately covered in Chapter 8

5.4 Determination of Impact Significance

Once all environmental aspects (and interactions between a receptor/resource and Project activity) were identified, the levels of impacts that may result from the proposed Project activities were assessed. Three (3) stages were utilized to establish significance of impacts as follows:

- **Impact Magnitude** which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency;
- **Value/Sensitivity/Fragility and importance of the relevant Receptor**;
- **Identification of the impact significance,** which is the "product" of a combination of the above two (2) key variables.

The magnitude of an effect is often quantifiable such as the extent of land take or predicted change in noise levels while the sensitivity, importance or value of the affected resource or receptor is derived from:

- Legislative controls;
- Designated status within the land use planning system;
- Number of affected individual receptors;
- An empirical assessment based on characteristics such as rarity or condition;
- Ability of the resource or receptor to absorb change; and
- Public perception about the criticality or sensitivity of the receptors.

The determination of significance also includes consideration of performance against environmental quality standards or other relevant pollution control thresholds, and compatibility with environmental policies.

Further details on the criteria used for determining the impacts significance are provided in the sub-sections below:

5.4.1 Impact Magnitude

The magnitude designations employed for potential negative impacts are: **Negligible**; Low; Medium; and **High**. In the case of a positive impact, it is considered sufficient for the purpose of the impact assessment to indicate that the Project is expected to result in a positive impact, thus no magnitude designation is assigned.

The magnitude of an impact takes into account the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum from Negligible to High. These criteria are discussed further as follows:

5.4.1.1 **Determining Magnitude for Biophysical Impacts**

For biophysical impacts, the quantitative definitions for the spatial and temporal dimension of the magnitude of impacts used are summarized in the following paragraphs:

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

A **Medium Magnitude Impact** affects a portion of an area, system, aspect (physical), population or species (biological) and at sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels (when compared with national or international limits and standards specific to the receptors) and may bring about a change in species abundance, but does not threaten the integrity of that population or any population dependent on it.

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

A Negligible Magnitude Impact: Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and are characterized as having a very low or negligible magnitude.

5.4.1.2 Determining Magnitude for Socio-economic Impacts

For socio-economic impacts, the magnitude considers the perspective of those affected by taking into account the likely perceived importance of the impact, the ability of people to manage and adapt to change and the extent to which a human receptor gains or loses access to, or control over socio-economic resources resulting in a positive or negative effect on their well-being. The quantitative elements are included into the assessment through the designation and consideration of scale and extent of the impact. Table 5.5 below presents the impact magnitude criteria for socio-economic and health impacts.

Table 5.5: Impact Magnitude Criteria for Socio-economic Impacts

Category	Ranking	Definition
High	4	▪ Major impacts on human health (e.g. serious injury). ▪ Significant impact on the livelihoods of individuals (i.e. access to income source restricted over lengthy period of time). ▪ Serious impact on access to community facilities and utilities ▪ Breach of economy social policy and/or regulation.
Medium	3	▪ Modest impact on human health and well-being. ▪ Moderate impact on individual livelihoods (e.g. restricted access to income source). ▪ Medium impact on access to community facilities and utilities (e.g. access to utilities restricted for long periods (weeks) of time). ▪ Potential breach of company social policy and/or legislation.
Low	2	▪ Limited impact on human health and well-being (e.g. occasional dust, odour, traffic noise). ▪ Some impact on the livelihoods of individuals (e.g. isolated incidents related to ethnic tensions and some restrictions on access to income source). ▪ Some impact on access to community facilities and utilities (e.g. access to cultural centers restricted to a limited extent, i.e. (days).
Negligible	1	▪ Possible nuisance to human health and well-being (e.g. occasional unpleasant odours) ▪ Inconvenience experienced in accessing community facilities and utilities (e.g. electricity supply disruption for short (hours) period of time). ▪ No impact on livelihood, community facilities and human health.
Positive	+	▪ Beneficial improvement to human health. ▪ Benefits to individual livelihoods (e.g. additional employment opportunities). ▪ Improvements to community facilities/utilities. ▪ Increased economy (e.g. local procurement, sourcing of supplies).

5.4.2 Determining Receptor Sensitivity

In addition to characterizing the magnitude of impact, the other principal variable necessary to assign significance for a given impact is the value, and sensitivity/fragility of the receptor. This refers to economic, social, and/or environmental/ecological importance of the receptor, including reliance on the receptor by people for sustenance, livelihood, or economic activity, and to the importance of direct impacts to persons associated with the resource.

Impacts that directly affect people or vital natural resources are deemed to be more important than impacts that indirectly affect people or vital resources. The sensitivity of the receptor criterion also refers to potential impacts to Environmentally Sensitive Areas (ESAs) and impacts to species, including loss of endangered species, effects of introduction of invasive species, and similar environmental/ecological impacts as well as the public perception about the criticality or sensitivity of the receptors.

There are a range of factors to be taken into account when defining the sensitivity of the receptor, which may be physical, biological, cultural or human:

- Where the receptor is physical (for example, soil environment) its current quality, sensitivity to change, and importance (on a local, national and international scale) are considered.
- Where the receptor is biological (for example, the aquatic environment), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered.
- Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

The receptors-sensitivity designations employed in this impact assessment process are **Low**, **Medium** and **High** which are universally acceptable.

The sensitivity/fragility/value/importance criteria for biophysical and socio-economic receptors are defined in Table 5.6.

Table 5.6: Bio-physical and Socio-economic Receptor-Sensitivity/ Fragility/ Value Criteria

Category	Ranking	Definition
Physical (for example, air quality)		
High	3	All ambient conditions/concentrations exceed guideline limits and are indicative of the resource being impacted or polluted. There is no (or very little) assimilation capacity for increased concentrations/ change in conditions.
Medium	2	Some ambient conditions/concentrations exceed guideline limits while others fall within the limits. There is some small assimilation capacity for increased concentrations/ change in conditions. Resource use does affect other users
Low	1	All ambient conditions/concentrations are significantly lower than guideline limits and there is capacity for assimilation for additional concentrations/ change in conditions. Resource use does not significantly affect other users.
Biological (for example, terrestrial ecology)		
High	3	Specifically protected under Nigerian legislation and/or international conventions such as International Union for Conservation of Nature (IUCN); considered to be of critical importance to the local use; and totally dependent on for livelihood or means of survival.
Medium	2	Not protected or listed but may be a species common globally but rare in Nigeria with little resilience to ecosystem changes, important to ecosystem functions, or one under threat or population decline; considered to be of moderate importance to the local use; and partially dependent on for livelihood or means of survival.
Low	1	Not protected or listed as common / abundant; or not critical to other ecosystem functions; considered to be of minor importance to the local use; and local communities do not depend on the resources for livelihood.
Socio-economic and Health		
High	3	Those affected will not be able to adapt to changes and continue to maintain pre-impact status.
Medium	2	Able to adapt with some difficulty and maintain pre-impact status but only with a degree of support.
Low	1	Those affected are able to adapt with relative ease and maintain pre-impact status.

5.4.3 Significance

The significance of the impact is determined by calculating the "product" of impact magnitude and severity/fragility/value/importance of the relevant receptor(s). Figure 5.2 illustrates the process for combining the impact magnitude with the receptor sensitivity.

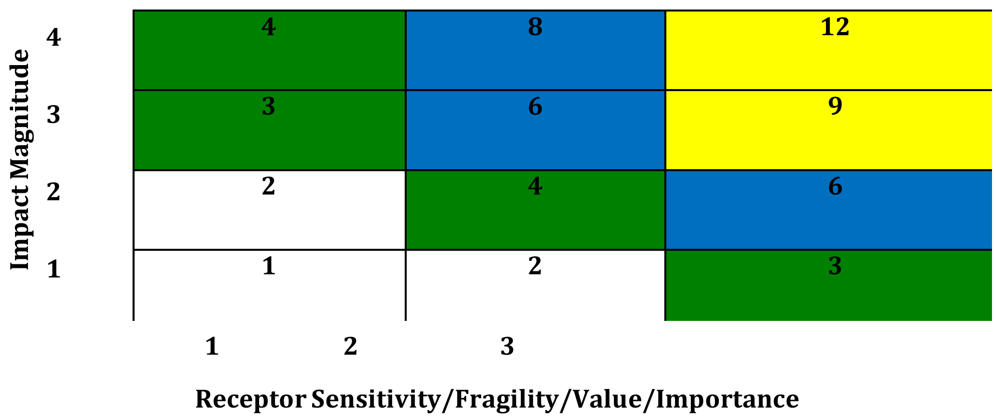


Figure 5.2: Impact Magnitude-Receptor Sensitivity Product Results

Based on its impact magnitude-receptor sensitivity/fragility/value score, each impact was again ranked into four (4) categories of significance as illustrated in Table 5.7 below.

Table 5.7: Environmental Impact Significance Rankings

Ranking (Impact Magnitude x Sensitivity of Receptor)	Significance
9 - 12	Major
6 - 8	Moderate
3 - 5	Minor
1 - 2	Negligible

Negligible Significant impacts are where a resource or receptor will not be affected in any way by a particular activity or the predicted effect is deemed to be 'negligible' or 'imperceptible' or is indistinguishable from natural background variations.

An impact of minor significance is one where an effect will be experienced, but the impact severity is sufficiently low (with or without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value.

An impact of moderate significance is one within accepted limits and standards. Moderate impacts may cover a broad range, from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP).

An impact of major significant is one where an accepted limit or standards may be exceeded, or high magnitude impact occurs to highly valued/sensitive receptors/resources.

5.4.3.1 Determining the Significance of Potentials Impacts of the Project

To assist in calculating the overall significance of each of the identified potential impacts, expert discussions were constituted. They employed extensive use of screening matrices and predefined criteria for impact magnitude and sensitivity/fragility/value/importance of resources/receptors. The significance was then developed as seen in Table 5.8.

Table 5.8: Leopold's Activity-Receptor Interaction Matrix (Impact Significance Matrix)

Summary of Project Activities at various Phases	R																
	Phy						Biological		Socio-economic						Others (Health and		
	Air Quality	Ambient Noise	Soil	Groundwater and Aquifers	Surface water	Landscape / Topograp	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Gender issues	Construction workers	Workplace health and safety	General Public
Pre-construction Phase																	
Site selection									3(2)								
Site clearing and preparation	2(2)	2(2)	3(2)		2(2)	2(1)	3(1)	3(1)	2(2)				+			2(2)	
Mobilization of construction equipment	2(2)	2(2)					2(1)	2(1)	2(1)		2(1)	2(2)	+		2(2)	2(2)	2(2)
Construction Phase																	
Civil work activities including excavation, trenching, cable laying, foundation, construction of building (e.g. training centre)	2(2)	2(2)	3(1)		2(2)			2(2)		2(1)		2(3)	++	2(3)	2(3)	2(3)	2(3)
Installation of power plant facilities, power storage batteries, upgrade of existing distribution infrastructure	2(2)	2(2)	3(1)											2(3)		2(3)	
Waste generation and disposal			2(2)	2(2)	2(2)							2(1)	+			2(2)	2(2)
Commissioning Phase																	
Testing of power plant and associated infrastructure		2(1)								1(1)		1(1)				2(3)	2(2)
Operational Phase																	
Power generation and distribution and provision of training on renewable energy		2(1)											++	2(3)		2(3)	3(2)
Routine maintenance; waste generation	2(2)		2(2)	2(2)		2(1)					2(2)	1(2)	+	2(3)		2(3)	2(2)

Note: Decommissioning is separately covered in Chapter 8

The value assigned to each cell in the matrix is in the form "x (y)": where "x" denotes the impact magnitude and "y" the sensitivity/fragility/importance of receptor

Impact magnitude ranking: 1 = Negligible; 2 = Low; 3 = Medium; 4 = High. Impact sensitivity raking: 1 = Low; 2 = Medium; 3 = High.

5.5 Impacts Discussion

5.5.1 Potential Positive Impacts

The Project seeks to provide uninterrupted power supply to the University environment through renewable (solar) energy source and thus, enhance learning and institutional operations. It also forms part of the measures in ensuring that Nigeria achieves its carbon emission reduction targets as contained in Nigeria's Nationally Determined Contributions (NDC) on climate change. In line with the Government's plans for Power Sector reform, the Project will assist to promote stronger relationship and collaboration between the FGN, Nigerian Universities, REA, and other relevant regulatory bodies.

A component of the proposed Project is the construction of a renewable energy training centre within the Project site. This component is particularly beneficial to the students of the University who are studying engineering courses. The renewable energy training centre will afford the students actual experience and skill acquisition in the construction and operation of a solar-hybrid power plant. Also, the installation of streetlights will boost safety and security within the University.

In addition, the Project will improve social economic activities within and around the University community and help to enhance internally generated revenue. Furthermore, there are employment opportunities associated with the proposed Project for skilled, semi-skilled and unskilled workforce. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects. For example, during the construction phase, about 400 workers (Nigerians) would be engaged. The larger portion (60%) of the workforce (especially semi-skilled and unskilled craftsmen) would be drawn from the immediate surroundings of the Project area.

Other potential benefits of the proposed Project include technology transfer and increase in local and regional economy through award of contracts for Project development and waste management.

5.5.2 Potential Negative Impacts

The potential negative impacts associated with the proposed Project are discussed under the following headings:

- Potential impact of the proposed solar-hybrid power plant and associated infrastructure
- Potential cumulative impacts

It is important to note that the significance of potential environmental and social impacts discussed in this section is without mitigation measures except those already built into the Project design. Implementation of additional mitigation measures (presented in Chapter 6 of this report) are expected to further reduce the impact rating as low as reasonably practicable.

5.2.1.1 Potential Impacts of the proposed Project

5.5.2.1.1 Pre-Construction Phase Activities

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

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

❖ ***Site Selection***

Approximately 4.753 Ha of land within FUHSA campus has been allocated by the University management for the proposed solar-hybrid power plant. Thus, no additional land from either private or public property outside the University will be appropriated for the proposed Project.

❖ ***Site Clearing and Preparation***

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

Potential Impact on Terrestrial Flora and Fauna

The site clearing activities will lead to loss of terrestrial vegetation. The impact magnitude on the terrestrial flora is considered to be moderate considering that not all the 20.0 ha of land allocated for the Project will be cleared while the sensitivity is low because the site is a modified habitat (no natural vegetation and endangered fauna species were observed during baseline gathering activities). The impact significance is considered to be **minor**.

With regard to the clearing of the Project site, the potential impact on terrestrial fauna species may include loss of individual or localized population of fauna species or disturbance to avifauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species (including avi- fauna) encountered or reported in the Project site belongs to the IUCN classification of threatened animal species.

The sensitivity of the fauna species recorded on the Project site is thus regarded as low. The impact magnitude is considered to be moderate given that the site clearing activities would cover approximately 20 ha of land. The impact significance is considered **minor**.

Potential Impact on Soil

The proposed site clearing activities would have direct negative impact on soil environment. The potential effects on soil include degradation due to site preparation e.g. compaction of soil as a result of the movement of earth moving equipment. Soil degradation is the removal, alteration, or damage to soil and associated soil forming processes, usually related to human activities. The stripping of vegetation or disturbance to the natural ground level will negatively affect soil formation, moisture levels, soil density, soil chemistry, and biological activity.

Uncontrolled site clearance of vegetation could lead to direct surface soil exposure and hence erosion of soil which could be significant. Soil erosion is a natural process whereby the ground level is lowered by wind or water action and may occur as a result of, *inter alia* chemical processes and/or physical transport on the land surface. Accelerated soil erosion induced or increased by human activity is generally considered the most geological impact in any development due to its potential impact on a local and regional scale and as a potential threat to agricultural production.

The impact magnitude is considered medium as the extent of soil erosion could be high especially if the site clearing activities are carried out in the wet season. However, based on the results of laboratory analysis conducted on soil samples from the study area, the Project site is not considered to be significantly prone to land- based erosion. The laboratory results indicate that the soil profile had a clay fraction varying from (55.05-67.82%) while the proportions of other soil fractions were sand (27.35- 36.47%) and silt (1.62-13.16%). Also, the topography of the project site was observed to be relatively flat. Thus, the impact significance of site clearing on soil environment of the study area is considered **moderate**.

Potential Impact on Air Quality and Ambient Noise

The pollutants which could impair air quality during site clearing activities are particulate matter in form of dust, and NO_x, TSP, CO, SO_x from combustion engines of the earth moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is considered to be low since the activities will be short-termed, intermittent, localized and reversible.

The site clearing activities will take less than 1 week. The sensitivity of the air shed of the Project area is also regarded as low based on the results of air quality measurements conducted in the area during the field data gathering; no elevated concentration of air pollutant criteria beyond the FMEnv, WHO, and the African Development Bank Ambient Air Emission Limits was recorded. The impact significance is considered to be **minor**.

Potential Impact on Workers Safety

Site clearing and preparation are potentially hazardous activities involving manual labour and the use of mechanized equipment. Accidents may occur when those involved are unskilled. Such accidents may result in loss of man-hours which may ultimately affect the scheduled date of completion of the site clearing activities. The site clearing activities should take less than one week, and the number of workers required would be less than fifty (50). Thus, the likelihood of the impact is considered low, and the significance of the impact is rated **minor**.

Moreover, there are potential health risks associated with the influx of workers who may be infected with various diseases (e.g. COVID-19) and spread it to other workers on site. An outbreak of infectious diseases during site clearing could significantly impact the project timelines and activities by causing disruptions and delays. For example, confirmed cases of the recent COVID-19 expand exponentially if health and safety controls are left unheeded. However, based on the low number of worker and the duration of the site clearing activities, the significance of the impact is rated **minor**.

- ***Mobilization of Construction Equipment and Materials to Site***

Potential Impact on Air Quality and Ambient Noise

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

The impacts could be more pronounced if the mobilization activities are carried out in the dry season due to the harsh weather conditions characterized by increased ambient air temperature and dry north-easterly winds blowing in the area. High noise levels from vehicular movement may also be pronounced during mobilization activities.

However, considering that the mobilization activities would be short-lived (less than 1 week); the impact magnitude is considered low. The sensitivity of the ambient air environment of the Project's AoI is adjudged to be low based on the results of air quality measurements carried out for parameters such as CO, SO_2, NO_2, and TSP. As documented in Chapter Four of this report, the measured concentrations of air quality parameters in the Project area were generally within FMEnv, WHO and African Development Bank Ambient Air Quality Guidelines. The noise levels recorded within the Project site and its surrounding environment were also below the FMEnv and African Development Bank recommended limits.

The capacity for assimilation of vehicular emissions and dust associated with the mobilization activities in the Project's AoI is considered to be high. The overall impact significance of mobilization activities on the ambient air quality and noise of the Project area is rated **minor**.

Potential Impact on Infrastructure (Road)

Regarding community health and safety, the mobilization activities during the pre-construction phase of the Project could increase the traffic volume in the Project area (and potential for road accident) as a result of movement of vehicles in and out of the Project site. The social aspects of these activities could lead to accidents, traffic congestion, and annoyance from other road users in the area. The magnitude of the impact is considered low since the mobilization activities would be less than 1 week. The sensitivity of the receptors is adjudged as medium given that the existing vehicular movement in the University environment is high. The prominent means of transportation are motorcycles; followed by cars, while buses/trucks were the least used. The impact significance is considered to be **minor**.

Potential Impact on Workers Safety

Mobilization of construction materials will involve off-loading of heavy consumables such as cement, gravel, etc. Injuries and accidents may occur especially when those involved are unskilled. Such accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. The mobilization activities will take less than 1 week and the number of workers required will be approximately ten (10). The impact significance is considered to be **minor**.

❖ ***Summary of Potential Negative Impacts Associated with Pre-Construction Phase***

Table 5.9 summarizes the potential impacts associated with the pre-construction phase of the proposed Project.

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

Activity	Receptor	Associated Impact	Significance
Site Selection	Land use	• Loss of farmlands • Impact on the existing land use	Moderate
	Existing building	• Possible demolition	Negligible
Site clearing and preparation	Terrestrial flora and fauna	• Vegetation loss • Direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project site	Minor
	Soil	• Loss of top soil • Soil compaction and degradation • Increased erosion potential • Reduction in structural stability and percolative ability of soil	Moderate
	Air Quality and Noise	• Air quality impacts due to emission from site clearing equipment • Increase in ambient noise levels	Minor
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation. • Outbreak of infectious diseases (e.g. COVID-19)	Minor
Mobilization of construction equipment and materials to site	Air Quality and Noise	• Air quality impacts from vehicular emissions (TSP, NO_x, CO, SO_x) • Increase in noise levels	Minor
	Infrastructure (road)	• Increase in vehicular movement and traffic including potential for road accident	Minor
	Workers Safety	• Injuries and accidents to workers during loading and offloading of construction materials.	Minor

5.5.2.1.2 Construction Phase

The construction phase of the proposed Project will include activities such as civil and electrical works (excavation, trenching, concrete mixing, etc.), installation of Plant facilities (mounting structures, PV panels, inverters, power storage batteries, underground cable, and associated components), and waste generation and disposal.

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

❖ ***Civil and Electrical Works, and Installation of Plant Facilities and Associated Infrastructure***

Potential Impact on Air Quality

Air quality could be impacted due to dust generation from earth moving equipment and emissions (like SO_2, CO, NO_x, VOC) from internal combustion of construction equipment. Dust is also likely to be generated during extraction and removal of overlying materials as well as a windblown dust generated from cleared land and exposed materials stockpiles.

It is proposed that the construction phase of the Project would take up to 12 months. Although emissions from the construction equipment and operations of construction vehicles could increase the existing concentrations of gaseous pollutants in the ambient air of the Project site beyond the permissible limit, the potential impact is considered to be infrequent, localized and reversible. The impact magnitude is considered to be medium. The sensitivity of the air shed of the Project site and its AoI is considered to be low judging by the results of in situ measurements obtained during the baseline data gathering. There are no heavy industrial activities in the Project area. The impact significance of construction activities on ambient air quality of the Project site and its surrounding environment is rated **minor**.

Potential Impact on Noise Levels

The planned activities during the construction phase of the Project have the potential to increase the ambient noise levels at the Project site and its surroundings. Based on in situ measurements, the day-time noise level recorded in the Project site and its immediate surroundings ranged between 42.5 to 65.9dB (A) with a mean value of 51.2 dB(A). The values were all below the FMEnv permissible Noise Exposure Limits of 90 dB(A) but some were above the African Development Bank daytime Noise Level limit of 55 dB(A), particularly samples collected at the buffer points.

The potential source of noise during the construction phase of the Project includes civil work and installation activities, vehicular movement and operation of construction equipment. The noise levels from construction activities would be intermittent and localized and are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location offsite (e.g. Azare community which is about 1.4m and the main campus which is about 800m away). The potential impact magnitude is regarded as low due to the envisaged low extent of its effect. The overall impact significance is considered **minor**.

Potential Impact on Soil

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

Soil environment of the Project site could be impacted in terms of removal of topsoil and soil compaction, reduction in structural stability and percolative ability of soil, loss of soil dwelling organisms resulting from compaction during excavation activities, installation of PV panels, mounting structures, and 11kv underground cable. These activities also have the potential to increase siltation as a result of accelerated erosion. The impact magnitude is considered to be low due to the short length of the proposed underground cable from the Power Plant to the switchyard. The sensitivity of the soil environment in the Project area is regarded low. No evidence of heavy metal and/or hydrocarbon pollution was recorded in soil samples from the study area based on the results of laboratory analysis. The impact significance is considered to be **minor**.

Potential Impact on Terrestrial Flora and Fauna

The construction activities may potentially cause disturbance to flora and fauna species as a result of increase in human activity, noise level, creation of areas of bare soil, etc. which may alter the composition and diversity of plant species around the Project site and drive many fauna species away from the area. In addition, the potential for plant species invasion is likely to increase as a result of increase in areas of bare soil around the Project site.

Also, the disturbance associated with noise and movement of construction equipment and personnel at the Project site may deter bird species from the area and disrupt the breeding of avifauna. It may also lead to increased risk to species such as snakes, rodents and mammals. The sensitivity of the receptor is adjudged to be low. The Project area is not known as a migratory route for avifauna species based on desktop reviews and field observation. Also, none of the organisms identified fall under the IUCN list of threatened species. The impact significance is regarded as **minor**.

Potential Impact on Groundwater Resources

Groundwater contamination during the construction phase may occur through accidental spills or leakages of diesel, lubricating oils, hydraulic fluids, and other petroleum products associated with construction equipment, fuel storage, and vehicle maintenance activities. However, the likelihood and significance of groundwater contamination are strongly influenced by the hydrogeological characteristics of the project area, including groundwater depth, soil profile, unsaturated zone thickness, aquifer type, and the attenuation capacity of the overlying strata.

Baseline hydrogeological investigations undertaken for the project indicate that groundwater within the Project Area occurs within the **Benin Formation (Coastal Plain**

Sands), which forms the principal regional aquifer across much of Imo State and the eastern Niger Delta. The aquifer is predominantly **unconfined to semi-confined**, comprising highly permeable medium- to coarse-grained sands interbedded with localized silty clay and clay horizons. During the hydrogeological investigation, the first groundwater was encountered at approximately **15m below ground level (bgl)**, while the principal water-bearing horizon was intercepted between 30m **bgl**, consistent with published hydrogeological information for the Niger Delta, where productive aquifers commonly occur between **15 and 40 m below ground level**.

The overlying stratigraphy within the project area comprises **lateritic topsoil**, underlain by **sandy clay and silty clay horizons**, followed by **fine- to medium-grained sands** of the Benin Formation. These finer-grained soil horizons possess relatively lower hydraulic conductivity than the underlying sands and therefore provide a degree of natural attenuation by retarding contaminant migration through adsorption, filtration, dispersion, and limited biodegradation before contaminants could potentially reach the groundwater table. Furthermore, naturally occurring microbial populations within the unsaturated zone may facilitate partial biodegradation of petroleum hydrocarbons.

Laboratory analysis of groundwater samples collected during the baseline study confirmed that groundwater quality within the Project Area is generally good, with concentrations of heavy metals and total petroleum hydrocarbons (TPH) below applicable Federal Ministry of Environment (FMEnv) and World Health Organization (WHO) guideline values, indicating that the aquifer has not been adversely affected by existing hydrocarbon contamination.

Considering the anticipated small quantities of fuels and lubricants to be handled during construction, the temporary nature of construction activities, the presence of an unsaturated soil profile capable of providing some attenuation, and the implementation of standard pollution prevention measures—including designated refuelling areas with impermeable surfaces, secondary containment for fuel storage, spill prevention procedures, spill response equipment, and proper equipment maintenance—the probability of contaminants migrating through the unsaturated zone to the underlying aquifer is considered **low**. Consequently, the residual impact on groundwater quality is assessed as **Minor (Low Significance)**.

Potential Impact on Groundwater Quantity

Construction activities will require relatively small quantities of water for concrete preparation, dust suppression, equipment washing, and domestic use by construction personnel. The estimated construction water demand is not expected to exceed the sustainable yield of available water sources and represents only a negligible proportion of the groundwater resources available within the Benin Formation aquifer, which is recognized as one of the most productive aquifer systems in southern Nigeria.

The regional aquifer is characterized by **high transmissivity, high recharge potential, and substantial groundwater storage**, primarily due to the highly permeable Coastal Plain Sands and the relatively high annual rainfall within the Niger Delta (approximately **2,000–2,500 mm/year**). These conditions facilitate rapid natural recharge and support sustainable groundwater abstraction for domestic, agricultural, and industrial uses.

Given the limited duration of construction activities, the relatively low construction water demand, and the high groundwater recharge potential of the area, groundwater abstraction during the construction phase is not expected to result in measurable drawdown of the water table, reduction in aquifer storage, or adverse impacts on neighbouring groundwater users. Therefore, the impact on groundwater quantity is assessed as **Negligible**.

Potential impact on Gender

Construction activities in Nigeria are typically dominated by males which presents a major challenge for equal opportunities for women. Generally, the Nigerian construction sector has a particularly low participation rate for women, both in industry and academia. Key Informant Interviews (KII) and Focus Group Discussions (FGD) conducted within the local communities revealed that although women are allowed to work and trade freely; they are underrepresented in leadership positions. During construction activities, women may experience discrimination as most employment and training opportunities may be provided to men, while women will be left with menial jobs. This may result in marginalization thereby reinforcing gender stereotypes and gender pay gaps. Furthermore, there is the possibility that the proposed Project may increase the risk of GBV, as a result of shifting existing power dynamics and financial relationships. However, this is considered a minor risk as many women in the community are engaged in economic activities.

However, FGD with the women in the local community revealed that there have been GBV incidents within the community (although not common). They also stated that there are systems (traditional, religious, and state) in place to address such cases. Also, FUHSA management expressed their commitment to providing a safe and conducive environment for all women within the institution. A GBV service provider (Adolescent & Youth Friendly Health Services centre) was identified within the community. Therefore, the impact significance is regarded as **moderate**.

Potential Impact on Socio-economic and Health

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

With regard to potential influx of workers to the community during the construction phase, the manner in which the workers conduct themselves can affect the local community in terms of disruption of existing family structures and demography. The potential behaviour of workers, most especially male construction workers, may lead to an increase in levels of crime and drug and alcohol abuse, and an increase in incidence of casual sexual relations, which may result in increase in sexually transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies. There are also potential risks of construction workers infected with diseases (e.g. COVID-19) moving to the community, and infecting the local population. Additional pressure may also be placed on existing social infrastructure. Considering that the proposed number of workers (approximately 400) for the construction phase of the Project is relatively high, the potential risk to local family structures is regarded as high. However, given that the majority of the construction workers, especially unskilled labour force would be drawn from the local community, the impact significance is considered to be **moderate**.

Potential Impact on Infrastructure (Road)

Regarding road infrastructure, the movement of construction vehicles in and out of the Project site during construction has the potential to increase road traffic and accidents. The impact magnitude is considered as low due to the minimal (about 2-3 daily) amount of Project vehicles and trucks to be used during the construction Phase. Also, traffic survey of the major road leading to the University indicated a moderate volume of vehicles (mostly motorcycles and cars) on the road during peak periods. The impact sensitivity is rated medium. Therefore, the impact significance is considered **minor**.

Potential Impact on Construction Workers Safety

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

Furthermore, there are potential health risks associated with the construction workers who may be infected with various diseases (e.g. COVID-19) and spread it to other workers on site. An outbreak of infectious diseases could significantly impact the project timelines and activities by causing disruptions and delays during construction. For example, during the COVID-19 pandemic lockdowns, many construction projects were affected as they were forced to shut down activities or work under restricted conditions. The impact significance is considered **moderate**.

❖ ***Waste Generation and Disposal***

Potential Impact on Soil

The proposed construction activities will lead to the generation of wastes. Waste streams if not properly handled will contaminate the soil within the Project site and AoI. The potential construction wastes to be generated include scrap metals, electrical cables, spent oils, damaged batteries, wood/planks, paper waste, leftover sand and gravel, etc. The impact magnitude of the wastes on the soil is considered to be low judging by the capacity of the Power Plant (3.0 MW). The impact sensitivity is low because the soil of the area is dominated by clay soil which has low percolative ability. Thus, the impact significance is considered to be **minor**.

Potential Impact on Groundwater

Groundwater may be impacted as a result of infiltration of contaminants associated with liquid wastes especially from damaged batteries and spent oils. The impact magnitude is considered low; assessment of ground water quality reveals that groundwater quality was within prescribed regulatory limit. The impact sensitivity is medium because the groundwater is a major source of potable water within the Project AoI. The potential for groundwater contamination as result of waste disposal is rated **minor**.

Potential Impacts on Surface Water and Aquatic Resources

Baseline studies confirmed the presence of surface water bodies within the Project Area of Influence (AoI), including seasonal drainage channels, streams, and associated wetlands that form part of the hydrological network of the Niger Delta. These water bodies provide important ecological functions and ecosystem services, including habitat for aquatic organisms, groundwater recharge, flood attenuation, and water supply for domestic and livelihood activities. Community consultations and socio-economic surveys further indicated that some households rely on these surface water resources for artisanal fishing, seasonal harvesting of aquatic organisms, livestock watering, and limited domestic uses, particularly during periods when alternative water sources are less accessible.

The aquatic ecosystem within the Project Area supports a variety of freshwater fish species, crustaceans, molluscs, amphibians, and aquatic vegetation typical of lowland freshwater ecosystems in southeastern Nigeria. These biological resources contribute to local food security, household income, and the cultural and traditional practices of surrounding communities.

During the construction phase, activities such as site clearing, excavation, earthworks, stockpiling of construction materials, movement of heavy machinery, and accidental spills of fuels, oils, lubricants, or chemicals may result in increased sediment loading and localized deterioration of surface water quality if not adequately controlled. Elevated suspended sediments may increase turbidity, reduce light penetration, smother fish spawning habitats, and impair benthic organisms. Accidental hydrocarbon spills could introduce toxic substances into adjacent watercourses, causing acute or chronic effects on fish, macroinvertebrates, amphibians, and aquatic plants.

Construction runoff containing suspended solids, cement residues, or improperly managed wastewater could also alter the physicochemical characteristics of receiving water bodies, including pH, dissolved oxygen, and nutrient concentrations. Such changes may temporarily reduce habitat quality and affect sensitive aquatic organisms.

During the operational phase, the principal risks to surface water and aquatic resources include accidental releases of hydrocarbons or process chemicals, leakage from fuel and chemical storage facilities, untreated or inadequately treated wastewater discharges, stormwater runoff from operational areas, and accidental firewater runoff during emergency situations. If uncontrolled, these releases could result in localized contamination of surface waters, bioaccumulation of contaminants in aquatic organisms, and reduced fisheries productivity.

Potential impacts on fisheries may include temporary avoidance of affected habitats by fish, reduced breeding success, decreased abundance of sensitive species, and diminished fish catches for artisanal fishers. Consequently, households that depend partly on fishing for income generation and household protein intake could experience temporary reductions in livelihood opportunities should significant contamination occur.

However, these impacts are considered **unlikely to be significant**, provided that internationally accepted pollution prevention and control measures are implemented. Such measures include:

- Establishment of appropriate buffer zones between construction activities and nearby water bodies.
- Installation of erosion and sediment control measures (e.g., silt fences, sediment traps, diversion drains, and stabilized stockpiles).
- Designated refuelling and equipment maintenance areas with impermeable surfaces and secondary containment.
- Proper storage and handling of fuels, lubricants, and hazardous materials.
- Immediate containment and clean-up of accidental spills through an approved Spill Prevention and Response Plan.
- Collection, treatment, and disposal of domestic and industrial wastewater in accordance with Federal Ministry of Environment (FMEnv) and National Environmental Standards and Regulations Enforcement Agency (NESREA) requirements.
- Routine monitoring of surface water quality upstream and downstream of the project site.
- Periodic monitoring of aquatic biodiversity and fisheries resources in collaboration with relevant regulatory agencies and local fishing communities.

With the implementation of these mitigation measures, the residual impacts on surface water quality, aquatic habitats, fisheries resources, and associated community livelihoods are expected to be **Minor to Low** and localized, with no long-term adverse effects anticipated on the ecological integrity of the receiving water bodies.

Potential Impact on Infrastructure (Waste Management Facility)

Construction waste can potentially have impact on the existing waste management facility of the Project area. Domestic wastes in FUHSA are collected by the Environmental Unit and taken to designated dumpsites outside the University. However, construction wastes such as scrap electrical components, batteries, damaged/defective panels and electrical cables (e-waste) cannot be disposed of in such manner. These wastes shall be returned to the manufacturers based on a take- back scheme or recycled as appropriate. The quantity of domestic wastes designated for the dumping site will thus be low. The impact of the waste on the waste management facility of the Project area is considered **negligible**.

Summary of Potential Negative Impacts Associated with Construction Phase

Table 5.10: Summary of Potential Negative Impacts Associated with the Construction Phase of the proposed Project

Project Activity	Environmental/Social Receptor	Potential Impact	Impact Significance
Civil and Electrical Works / Installation Activities	**Air Quality**	• Deterioration of ambient air quality due to emissions (SPM, PM_{10}, $PM_{2.5}$, NO_x, SO_2, CO and VOCs) from construction equipment and vehicles. • Generation of fugitive dust from land clearing, excavation, earthworks, movement of vehicles, and wind-blown stockpiles.	Minor
	Ambient Noise	• Temporary increase in ambient noise levels resulting from the operation of heavy machinery, construction equipment, and increased vehicular movement.	Minor
	Soil Resources	• Increased risk of soil erosion due to vegetation clearance and earthworks. • Soil compaction resulting from movement of heavy construction equipment, leading to reduced infiltration capacity and soil permeability. • Localized soil contamination from accidental spills or leakages of fuels, oils, lubricants, and chemicals.	Minor
	Surface Water Resources	• Increased sediment loading and turbidity from stormwater runoff carrying exposed soils. • Potential contamination of nearby surface water bodies from accidental spills of fuels, lubricants, cement washout, and construction runoff.	Minor
	Groundwater Resources	• Potential localized groundwater contamination from infiltration of hydrocarbons or hazardous substances following accidental spills.• Minor groundwater abstraction for construction activities (e.g., concrete mixing and equipment washing) with negligible impact on aquifer quantity.	Negligible
	Terrestrial Flora	• Loss of vegetation within the construction footprint. • Potential introduction and spread of invasive or alien plant species during construction activities.	Minor
	Terrestrial Fauna	• Temporary disturbance, displacement, or loss of wildlife due to habitat alteration, increased human presence, noise, and equipment operation.	Minor
	Gender and Vulnerable Groups	• Risk of unequal employment opportunities for women and vulnerable groups. • Potential increase in Gender-Based Violence (GBV), Sexual Exploitation and Abuse (SEA), and Sexual Harassment (SH) associated with workforce influx.	Moderate

	Socio-economic and Community Health	• Influx of workers may increase pressure on local services and infrastructure. • Increased risk of communicable diseases (including sexually transmitted infections and other infectious diseases) associated with workforce influx. • Temporary disturbance to community activities due to construction operations.	Moderate
	Road Infrastructure and Traffic	• Increased traffic volume, road deterioration, congestion, and elevated risk of traffic accidents arising from movement of construction vehicles and equipment.	Minor
	Occupational Health and Safety	• Risk of injuries and accidents to construction personnel arising from equipment operation, excavation, working at height, electrical works, manual handling, slips, trips, falls, and exposure to hazardous materials.	Moderate
Construction Waste Generation and Disposal	**Soil Resources**	• Soil contamination resulting from improper handling, storage, or disposal of construction waste, hazardous waste, and spill residues.	Minor
	Groundwater Resources	• Potential contamination of groundwater through leachate generation or infiltration from improperly managed waste storage or disposal areas.	Minor
	Surface Water Resources	• Pollution of nearby streams or drainage channels through runoff carrying construction waste, sediments, or improperly managed wastes.	Minor
	Waste Management Infrastructure	• Increased demand on existing waste management facilities due to the generation and disposal of construction wastes.	Negligible

5.5.2.1.3 Commissioning Phase

Once the construction phase of the solar-hybrid power plant is completed, the Plant will be tested to ensure that it has been installed according to the pre-design and operational requirements. During the Plant commissioning, there could be increase in noise level due to humming noise emission from the Plant components (inverters and batteries), vehicular movement (transportation of commissioning officials), public address system, crowd noise, and other ceremonial activities. The ambient noise levels recorded in the area during baseline data gathering were all below the FMEnv limits but some were above the World Bank recommended limits. The impact significance is rated **minor**.

Also, there is potential for occupational hazards during the Plant testing as a result of any wrong electrical connection. The impact significance is considered to be **moderate** on the workers' health and safety.

The commissioning phase will lead to an influx of guest and officials which will have an impact on the population and infrastructure (road). Due to the short duration (1-2 hrs) of the commissioning phase, the impacts are considered to be **negligible**. Table 5.11 below summarizes the potential negative impacts associated with the commissioning phase of the proposed Project.

Table 5.11: Summary of Potential Impact Associated with the Commissioning Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Plant testing	Ambient noise	Increase in ambient noise level	Minor
	Workers	Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Moderate
	Population influx	Increase in population during commissioning	Negligible
	Infrastructure (road)	Road traffic and risk of accidents	Negligible

5.5.2.4 Operational Phase

❖ ***Power Generation and Distribution***

Potential Impact on Air Quality

The operation of the backup diesel generators to be installed for charging the batteries will have associated gaseous emissions. The use of diesel as fuel has associated exhaust emissions containing Carbon monoxide (CO), Sulphur dioxide (SO_2), oxides of nitrogen (NO_X), and particulate matter (PM). However, since the generating sets are to be used only during unfavourable weather conditions (i.e. low sunlight) for charging the batteries, the associated air emissions will be minimal, localized and infrequent. Also, not all generators will be operated concurrently for backup charging purposes during operations to avoid general failures and reduce emissions. Thus, the significance of the impact is regarded as **minor**.

Furthermore, some potential factors that can impact negatively on the proposed project include the build-up of dust and cloud cover, which may reduce the efficiency of the solar panels during operations. Dust accumulation may increase during the dry season periods of harmattan (a period characterized by dry and dusty winds and relatively low temperatures). Heavy rainfalls and cloud cover associated with the wet season may also impact on the daily energy yields of the solar panels. The effect of cloud cover is immediate, leading to declining in solar irradiance, while the effects of dust accumulation may have long-term impacts if unmanaged. However, considering that these impacts are mainly reversible in nature and managed through the application of inherent operational controls, the impact significance is rated as **minor**.

Potential Impact on Noise

The potential sources of noise during the Solar Power project operations are inverters and the diesel generating sets. Typically, the designed noise level from an inverter is approximately 30-35 dB(A), while uncovered diesel generators produce up to 85 dB(A). The associated noise levels from the inverters are not envisaged to result in a maximum increase in background levels of 45dB(A) within the project area. The anticipated noise emission from the operation of diesel generators will not exceed 70-75 dB(A), since the generators will have soundproof covering. Also, the use of the diesel generator will not be continuous but mainly for backup purposes. Thus, the significance of the noise impact on the nearby receptors is regarded as **minor**.

Potential Impact on Gender

Women have conventionally been under-represented in the energy sector; they are often marginalized from many power sector employment and training opportunities. There is a potential that this situation may come to play during the operations phase of the Project as women may experience discrimination during employment and training opportunities. Also, GBV related issues such as sexual harassment, intimate partner violence, assault (physical and psychological), could potentially occur during operation. Although the number of personnel working at the Project site would be minimal, the likelihood of gender-based impacts predicted during the construction phase may exist. Therefore, the impact significance is regarded as **moderate**

Potential Impact on Socio-economic and Health

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

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

Scientists have not been able to prove that the ELF-EMF radiations generated from PV arrays or transmission line have an adverse impact on human health, as most studies show a weak association between magnetic field and adverse health effects. The World Health Organization (WHO) has designated ELF-EMF as a possible carcinogen (WHO, 2007). The use of the label “possible carcinogen” indicates that there is not enough evidence to designate ELF-EMF as a “probable carcinogen “or “human carcinogen,” the two indicators of higher potential for being carcinogenic in humans. Thus, the potential impact of EMF radiation from the proposed solar-hybrid power plant on community health and safety is considered to be **negligible**.

Potential Impact on Occupational Health, Safety and Welfare of Workers

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

❖ ***Routine Maintenance, Waste Generation and Disposal***

Potential Impact on Soil

Routine maintenance of the Project facilities has the potential for waste generation. The waste stream will be e-waste generated from spent/damaged components of the Project such as batteries, inverters and PV panels. Such wastes if not handled appropriately, could lead to soil contamination. The wastes will be stored within the Project site according to the manufacturer's instructions and with secondary containment. All components to be used for the project will incorporate buy-back agreements with the manufacturers as specified in the Extended Producer Responsibility Program (EPRP). The significance of the impact is considered **minor**.

Also, fuel spills and used oil from the backup diesel generators for the proposed project are potential sources of soil contamination. However, the solar hybrid power plant facility will be concretized, which will minimize the risk of soil contamination from leaks and spills. Thus, the significance of the impact is rated **minor.**

Potential Impact on Groundwater

Potential impacts may include decrease in amount of groundwater reservoir as a result of water abstraction for cleaning of the PV panels. Based on previous experience, each panel would require approximately 5 litres of water per cleaning cycle. With an estimated number of 11,280 panels for 3.0 MW generation, it is envisaged that the proposed Project would consume approximately 56,400 litres per cleaning cycle and 163,200 litres per year. A borehole will be installed on the Project site for water supply to the plant. Thus, the potential impact is considered **minor**. The water generated from the cleaning of PV panels will be discharged to nearby drains within the Project area. The impact magnitude is low because the frequency of cleaning is three (3) times a year. The impact sensitivity is low because environmentally friendly reagents will be used in the cleaning process. The impact significance is considered **negligible**.

Potential Impact on Infrastructure (Waste Management Facility)
Waste generated from operations and maintenance can potentially have impact on the existing waste management facility of the Project area. Waste in FUHSA is collected by the Environmental Unit and disposed designated dumpsites outside the university. However, e-wastes (panels, spent batteries, inverters, etc.) and hazardous wastes (spent oil, oily rags, etc.) cannot be disposed of in such manner. These wastes shall be returned to the manufacturers based on a take-back scheme or handles by licensed waste contractors.

Other categories of waste such as office and domestic wastes that will be generated during operations will be handled by FUHSA Environmental Unit. However, the quantity of office and domestic wastes designated for disposal from the power plant will thus be low. The impact of the waste on the waste management facility of the FUHSA is considered **negligible**.

Potential Impact on Occupational Health, and Safety of Workers
During routine maintenance, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries). The impact significance is considered to be **minor** primarily due to the low number of staff (approximately) required for maintenance activities and low frequency of maintenance.

- ***Summary of Potential Negative Impacts Associated with Operation Phase***

Table 5.12 summarizes the potential negative impacts associated with the operational phase of the proposed Project.

Table 5.12: Summary of Potential Negative Impacts Associated with Operational Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Power Generation and distribution	Air Quality	- Air emissions from the Diesel Generators - Effects of cloud cover and dust on the PV panels	Minor
	Noise	- Noise from diesel generators and inverters during power generation and evacuation	Minor
	Gender	- Discrimination of women during employment - GBV	Moderate
	Socio-economic (visual prominence)	- Landscape alterations resulting in unpleasant changes in the visual character of the area	Negligible
	Socio-economic (health issues)	- Community health and safety impact due to electromagnetic field (EMF) radiation from the Solar-hybrid Power Plant	Negligible
	Health, safety and welfare of staff during Plant operation	- Electric shock, injuries to personnel associated with the Power Plant operations, - Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions	Moderate
Routine Maintenance, Waste Generation and Disposal	Soil	- Soil contamination from spent batteries and inverters - Soil contamination from leaks and spills from the diesel generators	Minor
	Groundwater	- Groundwater abstraction from cleaning of PV panels	Minor
		- Groundwater and soil contamination	Minor
	Infrastructure (waste management facility)	- Waste disposal to existing waste management facility within the Project area	Negligible
	Health, safety and welfare of staff during maintenance	- Electric shock, injuries to personnel during maintenance	Minor

5.5.2.6 Potential Cumulative Impacts

Cumulative impacts are those impacts resulting from the combined effects of past, present or reasonably foreseeable actions owing to the project aspects and activities outside the project (GSI, 2003). The concept of cumulative effects is an important one. It holds that, while impacts may be small individually, the overall impact of all environmental changes affecting the receptors taken together can be significant. When a resource is nearing its tolerance threshold, a small change can push it over. The major existing activities within the Project area are farming though it wasn't occurring on the alloted portion of land. Given the nature of the activities associated with the proposed Project and the existing activities around the project area, the potential cumulative impacts of the Project on road traffic, ambient noise levels and groundwater availability is considered **low.**

5.6 Risk and Hazard Assessment

5.6.1 Overview

Risk assessment is the determination of quantitative or qualitative estimate of *risk* related to a concrete situation and a recognized threat (also called hazard). The assessment of the risks and hazards associated with the proposed Project involves the following steps:

- Identification of hazards/risks
- Likelihood of occurrence
- Consequence/severity of the hazards

The risk assessment matrix is then developed as presented in Figure 5.3.

0 – 5 = Low Risk 6 – 10 = Moderate Risk 11 – 15 = High Risk 16 – 25 = extremely high unacceptable risk		Severity of the potential injury/damage				
		Insignificant damage to Property, Equipment or Minor Injury 1	Non-Reportable Injury, minor loss of Process or slight damage to Property 2	Reportable Injury moderate loss of Process or limited damage to Property 3	Major Injury, Single Fatality critical loss of Process/damage to Property 4	Multiple Fatalities Catastrophic Loss of Business 5
Likelihood of the hazard happening	Almost Certain 5	5	10	15	20	25
	Will probably occur 4	4	8	12	16	20
	Possible occur 3	3	6	9	12	15
	Remote possibility 2	2	4	6	8	10
	Extremely Unlikely 1	1	2	3	4	5

Figure 5.3: Risk Assessment Matrix

5.6.2 Project Specific Risks and Hazards

The potential risks and hazards associated with the proposed Project are described below:

5.6.2.1 Fire and Explosion

The major risk associated with the Plant operation is fire and explosion. PV systems are subject to electrical faults like any other electrical installation such as short circuits, ground faults and reverse currents. These faults and other failures of the system, including cable insulation breakdowns, rupture of a module, and faulty connections, can result in hot spots that can ignite combustible material in their vicinity. Wrongly installed or defect DC/AC inverters have been the reason of several photovoltaic fires as well.

Fire could possibly occur during operation of the Power Plant. Overcharging, high temperatures and physical stress to Lithium ion battery cells can cause thermal runaway, which commonly leads to the destruction of the battery, fire and even explosions. In addition, deep discharging can also cause battery fires. Any outbreak of uncontrolled fire in the area can escalate to dangerous dimensions which could be critical. The hazard is classified as **high risk**.

5.6.2.2 Electrocution

Electrocution from direct contact with high-voltage electricity or from contact with tools, vehicles, ladders, or other devices that are in contact with high-voltage electricity could occur during the Plant operation. The likelihood of the hazard happening is remotely possible and its severity if occurs may result into severe consequence. The hazard is classified as **high risk**.

5.6.2.3 Occupational Hazards

Workers may be exposed to occupational hazards when working at elevation during construction. Also, there could be electrical hazards to workers. Common electrical accidents result in shocks and/or burns, muscle contractions, and traumatic injuries associated with falls after the shock. The likelihood of the hazards occurring is considered to be possible while its severity is considered to be marginal. The hazard is classified as **moderate risk**.

5.7 Summary

In summary, the key potential impacts and risks associated with the proposed Project have been evaluated in this chapter. From such, the significance of the identified negative impacts/risks will be minimized to as low as reasonably practicable with the implementation of appropriate mitigation measures presented in the next chapter of this report. Enhancement measures for the identified positive impacts are also contained in the chapter.

CHAPTER SIX:

MITIGATION MEASURES

CHAPTER SIX

MITIGATION MEASURES

6.1 Introduction

Following the detailed description of the associated and potential impacts of the proposed Project in Chapter 5, the recommended mitigation measures for the identified negative impacts are presented in this chapter as well as the enhancement measures for the potential positive impacts. The implementation of the mitigation measures shall be overseen by the Rural Electrification Agency's Project Management Unit (REA-PMU).

6.2 Mitigation Measures Approach

Mitigation refers to measures or interventions necessary to avoid, minimize, reduce or offset adverse impacts. Approach for selecting appropriate mitigation measures followed the framework stated by World Bank Environmental and Social Framework (2018):

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

In proffering mitigation measures for the various negative impacts identified in the previous chapter, preference was given to avoidance or prevention of adverse impacts and where not feasible, measures which are practicable and cost-effective using best available technology were suggested to reduce and/or minimize the impacts while rehabilitation, restoration or compensation was considered as the last resort.

6.3 Mitigation Measures for the Identified Significant Negative Impacts

The recommended mitigation measures for the identified negative impacts associated with the proposed Project are highlighted in Table 6.1. The unmitigated potential negative impacts ranked as negligible are not included in the table. The recommended mitigation measures are considered adequate to address the adverse impacts identified in the Chapter 5 of this report. There are no potential long-term impacts associated with the Project that cannot be mitigated to acceptable levels of residual impact. The residual impacts of the proposed Project, following the implementation of the proffered mitigation measures highlighted in Table 6.1, are of negligible to minor significance.

6.4 Mitigation Measures for the Identified Project Risks and Hazards

The mitigation measures for the identified Project risks and hazards are highlighted below:

Fire and Explosion

- Only PV modules which comply with international and local standards for electrical performance and safety shall be used.
- Only solar cables suitable for outdoor applications and severe weather conditions shall be used.
- Inverters shall not be mounted on combustible walls such as wood panels or combustible sandwich panels.
- Inverters shall be easily accessible and protected from severe weather conditions.
- The local fire department shall be informed of and familiarized with the photovoltaic installation.
- PV systems shall only be installed by qualified contractors.
- PV systems shall be inspected regularly by qualified professionals.
- PV systems shall be regularly checked for damage from rodents and other pests, which could compromise wiring or insulation.
- Batteries installed for the power plant shall be monitored regularly to prevent overcharging and deep discharging during operations.
- Protection devices (e.g. Current interrupt devices (CIDs), positive temperature coefficient (PTC) thermistors, current-limiting fuses, diodes, battery management systems (BMSs), etc.) shall be installed to protect the batteries
- The batteries shall be housed in well ventilated, dust free containers under optimal conditions.
- Emergency response plan shall be developed and implemented.
- Fire extinguishers, fire notices, warning signs) shall be installed at different locations within the Plant site.

Electrocution

- Use of signs, barriers and public outreach to prevent public contact with distribution cables shall be employed.
- Grounding conducting objects (e.g. fences or other metallic structures) shall be installed where required to prevent shock.

Occupational Hazards

- Provision of an adequate work-positioning device system for workers shall be ensured.
- Hoisting and lifting equipment shall be rated and maintained and operators trained in their use.
- Appropriate Personal Protective Equipment shall be worn.
- Electrical installation shall be carried out by trained personnel in line with the approved procedures.

6.5 Enhancement Measures for Identified Positive Impacts

6.5.1 Reduction in Carbon Emissions

The Project will enhance Nigeria's intention of reducing its carbon emissions by 20% in the year 2030 as contained in its NDC on climate change. To enhance this impact, the following measures shall be implemented:

- In cases where the power generated is insufficient to meet the power demands of the University in the next 10 to 20 years, power shall be distributed to high priority areas so as to reduce/eliminate the use of diesel- powered generators. In addition, The Project will be designed and constructed to allow for further expansion in power generation and distribution capacity to meet the University's demands
- The University shall implement energy conservation measures such as encouraging switching off appliances, use of energy-saving bulbs, purchase of low-energy appliances such as printers, computers, refrigerators, etc.
- The project shall explore opportunities for carbon credits trading in the voluntary carbon market.

6.5.2 Enhancement of Learning

The Project will help to overcome the barrier on research and learning posed by epileptic power supply to the University. To enhance this impact, the following measures shall be implemented:

- Power distribution priority shall be given to all classrooms, lecture theatres, research centers, libraries, laboratories, and other academic buildings especially during learning hours.
- Research centres, laboratories, and libraries shall have 24-hour power supply.

6.5.3 Direct Employment and Training

The Project will give rise to direct employment opportunities across different skill levels, from unskilled to highly skilled labour. It is estimated that during construction phase, at least 400 job opportunities would be created. Training for local people from skilled technicians shall also be carried out. The following measures shall be implemented to ensure that direct employment and training opportunities are maximized:

- A Labour and Employment Management Plan (LEMP) shall be developed prior to construction, detailing percentages and numbers of the workforce to be sourced from the local area and various demographics as well as influx management. The plan shall follow local and international employment guidelines.
- The EPC contractor shall provide notification to different groups in the community on specific jobs and skills required for the project, prior to the commencement of construction. Subsequently, the group leaders shall notify the local population prior to the commencement of construction of job opportunities and relevant skills/qualifications required to be employable on the Project.
- A Gender Management Plan (GMP) shall be developed and implemented to ensure that the Project does not increase women's burden and that women not only contribute, but also benefit from it.
- The EPC contractor shall initiate training and skills development programmes prior to the commencement of construction, as a means of ensuring that members of the local workforce are up-skilled and can be employed on the Project.

During the operational phase of the Project, job opportunities will also be created. About 15 people will be employed. This will be a mixture of skilled labour (such as electrical and mechanical technicians) and unskilled labour (such as PV module cleaners and security personnel). Periodic capacity building will be offered to the workforce.

6.5.4 Procurement and Indirect Employment

The construction and operation of the proposed Project will create opportunities for the supply of goods and services to the Project and in turn, indirect employment will be created in the supply chain. Other opportunities for local companies to provide catering, waste / recycling and landscaping facilities, etc. will also be created. Local and regional procurement targets shall be included in the Project's LEMP to enhance this potential opportunity.

6.5.5 Improvement in Power Supply

As part of the Corporate Social Responsibility (CSR) activities for the proposed project, there are plans to extend the power generation to the host communities in the near future. Thus, increasing their access to reliable power supply and leading to improved standard of living for the host communities.

Table 6.1: Mitigation Measures for the Potential Negative Impacts of the proposed Project

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Pre-construction Phase					
Site selection	Existing farmland on site	Livelihood /Economic displacement due to land selection Loss of economic crops	Moderate	▪ Livelihood Restoration Plan (LRP) shall be developed and implemented ▪ Only the portion of the site required for Project development shall be cleared for construction.	Negligible
	Existing building	Possible demolition of existing building on site	Minor	▪ The land take for the Project shall avoid the existing building on the site ▪ The site clearing activities shall be planned and executed such that there is no damage to the existing building on the Project site.	Negligible
Site clearing and preparation	Terrestrial flora and fauna	Vegetation loss Direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project site	Minor	▪ To avoid the direct impacts of vegetation loss, site clearing shall be limited to the areas within the Site needed for the Project. ▪ The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited. ▪ Bush burning shall be avoided. ▪ Use of herbicides for site clearing shall be avoided. ▪ Any cleared areas which are not used will be re- vegetated using plants or seeds of locally occurring species. ▪ Hunting or deliberate killing of animals by workers shall	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				be prohibited and monitored. Workers shall be sensitized on ecological protection.	
	Soil	- Removal of top soil and soil compaction associated with site clearing - Loss of top soil - Increased erosion potential - Reduction in structural stability and percolative ability of soil	Moderate	▪ Removal of vegetation and soil cover shall be restricted to the areas required for the Project. Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas. ▪ Disturbed areas will be rehabilitated as soon as possible to prevent erosion. ▪ The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited. ▪ Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	Minor
	Air quality and noise	- Air quality impacts due to emission from site clearing equipment - Increase in ambient noise levels	Minor	▪ Site clearing equipment / machinery shall be operated and maintained under optimum fuel efficient conditions. ▪ Noise suppression equipment shall be fitted on machinery (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). ▪ Site clearing equipment shall be turned off when not in use. ▪ Equipment/machinery with lower sound power levels shall be selected and used for site clearing. ▪ A procedure for receiving and addressing noise complaints shall be developed and implemented	Negligible
	Workers Safety	- Injuries and accidents to workers during site clearing and preparation.	Minor	▪ Site clearing shall be limited to the day time as much as possible. ▪ Unregistered labourers and touts shall not be engaged for off-loading materials ▪ Provision of adequate personal protective equipment	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				(PPE) such as nose masks shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties. ▪ The EPC contractor shall implement the Nigeria Centre for Disease Control (NCDC) safety Guidelines during operations. ▪ Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during site clearing works	
Mobilization of personnel, materials and equipment to site	Air quality and noise	‧ Air quality impacts from vehicular emissions ‧ Increase in ambient noise levels	Minor	▪ Construction vehicles with efficient engine performance and with minimal noise and air emissions shall be selected and used. This can be achieved through regular servicing and maintenance. ▪ All materials with potential to result in dust emissions shall be covered during transport. ▪ Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h so as to reduce dust generation.	Negligible
	Infrastructure (road)	‧ Increase in vehicular movement and traffic around the project site; ‧ Potential for road accident.	Minor	▪ A traffic management plan (TMP) shall be developed by the EPC Contractor and implemented. ▪ Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided. ▪ The local community shall be sensitized about the Project activities and the need to comply with the traffic management plan put in place. ▪ Project related vehicles shall be regularly serviced and maintained. ▪ Drivers' competency shall be assessed and where required, appropriate training shall be provided. This	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				will include training on safe driving measures such as adherence to speed limits (of less than 10 km/h) in the Project area. ▪ A procedure for recording traffic incidents/accidents associated with the Project shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc.	
Construction Phase					
Civil and Electrical Works/ Installation Activities	Soil	Increased erosion Minor potential as a result of construction activities such as excavation Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities		▪ Excavation works shall not be executed under aggressive Negligible weather conditions. ▪ Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion. ▪ Disturbed areas shall be rehabilitated as soon as possible to prevent erosion (using native plant species). ▪ Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.	
	Air Quality	Air quality impacts Minor due to emission from construction equipment Increase in dust from cleared land and windblown stockpiles		▪ Regular maintenance and servicing of construction Negligible equipment /machinery shall be ensured. ▪ Only modern and well maintained equipment and machinery shall be used for construction activities. ▪ Routine water sprinkling shall be carried out to minimize dust generation during construction.	

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Ambient Noise	- Increase in noise level due to construction activities; - Disturbance to neighbouring community and local ecology	Moderate	▪ Construction activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). In the event that noisy activities are undertaken outside of the specified working hours, all noise receptors in the Project area shall be informed of such activities in advance. ▪ Construction machinery shall be turned off when not in use. ▪ Machinery/equipment to be used for construction work shall meet industry best standard in relation to noise attenuation. ▪ Construction equipment shall be properly maintained and serviced. ▪ Major construction activities shall be limited to a particular area within the site. ▪ Construction-related vehicles shall be limited to access areas. ▪ Noise complaints related to the construction activities shall be assessed and appropriately addressed. ▪ Noise monitoring at locations with persistent noise complaints shall be maintained.	Minor
	Infrastructure (road)	- Road damage, traffic and safety impacts.	Minor	▪ A TMP shall be developed by the EPC contractor and implemented. ▪ Speed limits for all construction-related vehicles shall be established and enforced. ▪ Construction related vehicles shall be regularly serviced and maintained. ▪ Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active. Drivers' competency shall be assessed and where	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				required training shall be provided. ▪ A procedure for recording all construction related traffic incidents/accidents shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc. ▪ A Grievance Redress Mechanism (GRM) shall be implemented for receiving complaints arising from damage to infrastructure and private property during construction activities. The EPC contractor shall receive the complaints and repair damage as quickly as possible.	
	Groundwater and surface water	Groundwater and surface water contamination	Minor	▪ Training shall be provided for workers on safe storage and handling practices and rapid spill response and clean-up techniques during induction. ▪ Spill control and response plans to respond to spills and leaks shall be implemented. ▪ Waste receptacles shall be provided within a secured area within the project site for collection of solid waste. ▪ General wastes that cannot be reused shall be periodically evacuated by the government accredited waste contractor ▪ The NEP ESMF Grievance Redress Mechanism (GRM) shall be implemented for receiving complaints arising from damage to infrastructure and private property during construction activities shall be developed. The EPC contractor shall receive the complaints and repair damages as quickly as possible.	Negligible
	Terrestrial Flora and Fauna	Loss of plant species as a result of introduction of alien plants which may	Minor	▪ Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities. ▪ All construction equipment shall be cleaned (mud and	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		prevent the natural recovery of the natural vegetation on the site. - Loss of fauna as a result of increased human activity and associated noise.		soil removed) at source before being brought to site to minimise introduction of alien species. - If sand or other natural materials for building are required and brought onto site, the stored heaps will be monitored for the growth and germination of alien species and will be regularly cleared during construction. - Regular monitoring will be undertaken to ensure that alien plants are not increasing as a result of the disturbance that has taken place. - Hunting or deliberate killing of animals by construction workers shall be prohibited and monitored. - In order to reduce collision of vehicles with fauna, a 10 km/hr speed limit by construction-related vehicles shall be enforced in the Project area.	
	Gender	- Discrimination during employment and training opportunities - GBV (sexual harassment, intimate partner violence, poor working conditions)	Moderate	- Equal treatment of workers shall be ensured. - The GBV Action Plan for EEP shall be implemented for the Project - All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) - GBV sensitive channels for reporting in GRM shall be implemented for the Project - The EPC Contractor shall be required to hire a Gender/GBV officer. - Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured. - All workers shall be required to undergo regular training and refreshers on GBV	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site. ▪ All gender-based violence incidents shall be reported and dealt with as per the law.	
	Construction workers safety	▪ Injury to construction workers during construction activities. ▪ Exposure to infectious diseases (e.g. COVID-19)	Moderate	▪ Health and Safety Plan shall be developed and implemented. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence ▪ Construction workers shall be sensitized and monitored on the need to be safety conscious. ▪ Daily toolbox talks prior to commencement of work activities shall be carried out. ▪ Construction activities shall be limited to daytime as much as possible. ▪ Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules. ▪ Proper safety signs and signage shall be placed at strategic locations within the site. ▪ PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored. ▪ Safety training focused on safe working practices, information on specific hazards, first aid and fire- fighting shall be included in the induction programme for workers. ▪ A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented.	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ The site shall be secured with perimeter fencing and/or security. ▪ Sanitary amenities and potable water shall be provided for all workers. ▪ The EPC contractor shall implement the NCDC "Guidelines for employers and businesses in Nigeria" during construction works. ▪ A risk assessment of the occupational exposure to infectious diseases during construction shall be conducted, and appropriate control mechanisms shall be implemented. ▪ The EPC contractor shall develop policies and procedures for the identification and isolation of people with symptoms, as well as testing where appropriate. ▪ Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during construction.	
	Socio-economic and health	- Influx of migrant workers, increase in sexual transmitted diseases. - Influx of workers with infectious diseases (e.g. COVID-19)	Moderate	▪ Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible. ▪ No person under the age of 18 shall be engaged to work on the project. The EPC Contractor shall ensure that children and minors are not employed directly or indirectly on the project ▪ Any child dropout should be reported to the relevant government agency ▪ The local community shall be informed of the Project activities prior to commencement of work. ▪ An induction and sensitization programme, including a Code of Conduct, for all construction workers shall be	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				carried out prior to construction activities. increase sensitivity to local norms and customs, provide awareness to construction workers of appropriate and acceptable behaviours, and will govern worker interactions with the local community. ▪ Awareness education about GBV/SEA/HIV/AIDS and other sexually transmitted diseases shall be created among the workforce and extended to the local community. ▪ The CoC shall include provisions to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse by workers within the local community. ▪ Public access shall be restricted to construction area via security fencing and appropriate signage. ▪ Substance abuse prevention and management programs shall be implemented for workers. ▪ Sanctions (e.g., suspension and dismissal) shall be introduced for workers involved in criminal activities ▪ Procedure for receiving and addressing community concerns shall be developed and implemented. ▪ The EPC contractor shall implement the NCDC “Guidelines for employers and businesses in Nigeria” during construction works. ▪ Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during construction.	
Waste Disposal and Generation	Infrastructure (waste management facility)	▪ E-waste generation ▪ Disposal of construction wastes to existing waste	Minor	▪ A Waste Management Plan shall be developed by the EPC Contractor and implemented ▪ Training shall be provided for workers on safe storage, use and handling of e-waste on site.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		management facility in the Project area.		▪ E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal ▪ Waste receptacles shall be provided within a secured area for collection of solid waste. ▪ Construction vehicles and equipment shall be serviced regularly.	
	Soil	Soil contamination from solid and liquid construction waste streams.	Minor	▪ Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. ▪ Portable spill containment and clean-up kits shall be available onsite. ▪ Construction workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Negligible
	Groundwater	Groundwater contamination of liquid construction waste streams.	Minor	▪ Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site. ▪ Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. ▪ Portable spill containment and clean-up kits shall be available onsite. ▪ Waste management plan (WMP) shall be developed by the EPC Contractor and implemented. ▪ Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. ▪ Construction waste, as much as practicable, shall be reused or recycled.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Waste that cannot be reused or recycled shall be disposed of at an approved dumpsite.	
Commissioning Phase					
Plant Testing	Ambient noise	Increase in ambient noise level	Minor	▪ The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ▪ Strict compliance to the Standard Operating Procedures shall be ensured. ▪ The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation.	Negligible
	Workers	Occupational health safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Moderate and	▪ Plant testing shall be carried out by experienced personnel. ▪ Adequate PPE shall be worn. ▪ The Project components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ▪ The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project. Strict compliance to the Standard Operating Procedures (SOPs) shall be ensured. ▪ Prior to the Plant commissioning, appropriate emergency equipment (such as first aid box, fire extinguishers) shall be provided onsite. ▪ Plant testing shall be restricted to the daytime. ▪ The site shall be secured with perimeter fencing and/or security ▪ Sanitary amenities and potable water shall be provided.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Operational Phase					
Power Generation and Evacuation	Air Quality	- Air emissions from the diesel generators - Effects of cloud cover and dust on the PV panels	Minor	▪ Strict compliance to the standard operating procedures for the diesel generators shall be ensured. ▪ Regular maintenance of diesel generators shall be ensured as required by the manufacturer. ▪ A cleaning schedule shall be developed and implemented for cleaning the panels installed at the project site during operations. ▪ The solar panels shall be inspected regularly for dust and rain damages and maintained according to manufacturer's instructions.	Negligible
		- Noise from diesel generators and inverters during power generation and evacuation	Minor	▪ Inverters shall be maintained as per manufacturer's recommendations and operated as per original specifications. ▪ The diesel generators shall be operated with the sound proof covers at all times. ▪ Project personnel shall use appropriate PPE (e.g. ear muffs) to reduce exposure to noise impact. ▪ Periodic maintenance of the diesel generators shall be carried out.	Negligible
	Socio-economic (visual prominence)	- Landscape alterations resulting in unpleasant changes in the visual character of the area	Minor	▪ All lighting will be kept to a minimum within the requirements of safety and efficiency. Where suchm lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillagewill be used. ▪ Site fencing if required shall be implemented.	Negligible
	Health, safety and welfare of staff during Plant operation	- Electric shock, injuries to personnel associated with the	Moderate	▪ Appropriate PPE shall be provided for workers. ▪ Training shall be provided to employees on emergency preparedness and responses. ▪ Provision of medical insurance scheme for employees	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		Power Plant operations, - Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions - Exposure to infectious diseases (e.g. COVID-19)		shall be ensured. ▪ Appropriate safety signage shall be placed at strategic locations within the site. ▪ Strict compliance to the SOPs/ code of conduct shall be ensured. ▪ A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented. ▪ The O&M contractor shall implement the NCDC "Guidelines for employers and businesses in Nigeria" during operations at the power plant. ▪ A risk assessment of the occupational exposure to infectious diseases during construction shall be conducted, and appropriate control mechanisms shall be implemented. ▪ The O&M contractor shall develop policies and procedures for the identification and isolation of people with symptoms, as well as testing where appropriate. ▪ Provision of functional hygiene facilities and implementation of basic infection prevention measures during operations shall be ensured by the O&M contractor.	
	Gender	- Discrimination during employment and training opportunities - GBV (sexual harassment, intimate partner violence, poor	Moderate	▪ Equal treatment of workers shall be ensured. ▪ Continuous implementation of the GBV Action Plan for EEP shall be sustained for the Project ▪ All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) ▪ GBV sensitive channels for reporting in GRM shall be implemented for the Project	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		working conditions)		▪ The O&M Contractor shall be required to hire a Gender/GBV officer. ▪ Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained. ▪ All workers shall be required to undergo regular training and refreshers on GBV ▪ The O&M Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site. ▪ All gender-based violence incidents shall be reported and dealt with as per the law.	
Routine Maintenance, Waste Generation and Disposal	Soil	Soil contamination from spent batteries and inverters	Minor	▪ General housekeeping to ensure the site is not overgrown with grasses shall be maintained ▪ Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. ▪ General waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. ▪ WMP shall be implemented. ▪ Burning of waste shall be prohibited. ▪ Damaged/expired Lithium ion batteries, solar panels, inverters and electric components shall be returned to the manufacturer based on the Extended Producer Warranty (EPR) model. Prior to returning them to the manufacturers, they will be stored on impermeable surfaces within the site.	Negligible
	Health, safety and welfare of staff during maintenance	Electric shock, injuries to personnel during maintenance	Minor	▪ Appropriate PPE shall be provided for workers. ▪ Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. ▪ Strict compliance to the SOPs shall be ensured.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (After implementation of mitigation measures)
	Groundwater	- Groundwater abstraction from cleaning of PV panels	Minor	▪ Water conservation plan shall be implemented ▪ Manual cleaning of the PV panels with water shall be regulated as much as practicable. The frequency of cleaning of PV panels with water is dependent on the rainfall pattern in the project area. During rainy season, cleaning is estimated to occur not more than thrice; however, during dry season the interval shall depend on the rate of dust accumulation. ▪ Periodic monitoring of groundwater resources in the Project's area of influence shall be implemented.	Negligible

CHAPTER SEVEN:

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction

The potential and associated impacts of the proposed Solar-hybrid Power Project at the Federal University of Health Sciences as part of the Federal Government's Energizing Education Program, have been analyzed and documented in Chapter Five of this report. The results show that if the recommended mitigation measures (presented in Chapter 6) are implemented, the identified impacts of the Project are not severe and can be reduced to as low as reasonably practicable. It is thus important that those recommended mitigation measures be translated into practical management actions, which can be adequately resourced and integrated into the Project phases.

Hence, this chapter presents the management measures and actions required to address the potential environmental and social impacts of the proposed Project. It also includes monitoring program as well as performance indicators, responsible parties, timeframe and cost estimates for the implementation of recommended measures to address the associated impacts of the project throughout its life cycle. In addition, the framework for the contents of additional management plans to be developed and implemented as part of this ESMP is provided.

7.2 Objectives of the ESMP

The ESMP is essential for successfully implementing the Project's environmental and social performance throughout the life of the Project. Having this framework in place ensures a systematic approach to bringing environmental and social considerations into decision-making and day-to-day operations. It establishes a framework for tracking, evaluating and communicating environmental and social performance and helps ensure that environmental risks and liabilities are identified, minimized and managed including roles, responsibilities, and budget.

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

The specific objectives of the ESMP are to:

- Promote environmental and social management and communicate the aims and goals of the ESMP;
- Ensure that all workers, subcontractors and others involved in the Project meet legal and regulatory requirements with regard to environmental management;

- Incorporate environmental and social management into Project design and operating procedures;
- Serve as an action plan for environmental and social management for the Project;
- Provide a framework for implementing Project environmental and social commitments (i.e. mitigation measures identified in the ESIA);
- Prepare and maintain records of Project environmental and social performance (i.e. monitoring, audits and non-compliance tracking).

7.3 Environmental and Social Management Measures

Tables 7.1 to 7.4 present the recommended environmental and social management measures required to mitigate the identified impacts of the Project development and operation. Environmental and social measures for the decommissioning are documented in Chapter 8.

Table 7.1: Environmental and Social Management and Monitoring Plan

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
PRE-CONSTRUCTION PHASE											
A. Environmental Impacts											
Preparation of Campsite area, materials and equipment stacking Areas. **Mobilization of personnel, materials, heavy duty vehicles and equipment to the proposed project sites**	Deterioration of air Quality as a result of increase in amounts of fugitive dust, exhaust fumes and GHGs from movement of materials, heavy-duty vehicles and equipment into project areas.	Contractor shall ensure the sprinkling of water via spraying devices to limit dust at stipulated intervals. Materials such as sand, gravel etc. must be covered with tarpaulin during transportation. Train drivers/ workers on proper operation of vehicles & equipment to include fuel efficiency and anti- idling techniques Equipment and vehicles are to	Contractor	450,000.00	Fugitive dust and Air quality parameters (CO, NO2, SO2, CO2, SPM) Driver's training records Maintenance records	In-situ Measurement Visual Observation of records	FMEnv. permissible Limit Minimal dust within sites and environs	Within the Site	Daily	Supervising Consultant (SC) Contractor's Environmental Safeguard Specialist REA Environmental Safeguard Officer (REA-ESO)	Supervision Consultant costs are part of operational costs in the contract. Contractor costs are part of operational costs in the contract 150,000.00 (Monitoring activities during pre-construct ion phase. Part of routine REA monitoring)

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		be serviced before mobilizing to site.									
	Loss of Flora and Fauna as a result of Land clearing activities for campsite areas, materials and equipment stacking areas leading to loss of vegetation cover and increase soil erosion.	Selective removal of vegetation to the area of need only. Undertake quick re-vegetation of exposed soils with indigenous plant species. Protect all vegetation not required to be removed against damage; Sensitization of workers on the need to conserve the flora and fauna. .	Contractor	200,000.00	Vegetation cover Number of workers aware and sensitized on the need to conserve the flora and fauna Number or percentage of terrestrial flora and fauna unaffected by the sub projects	Visual observation of Vegetation Quadrant count ratio to estimate the number of flora & fauna species	Minimal vegetation clearing Site clearing Inspection records	Within the site green areas.	At the commencement of the project works and decommissioning	Supervising Consultant (SC) Contractor's Environmental Safeguard Specialist REA Environmental Safeguard Officer (REA-ESO)	

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	Vegetal waste from clearance can deface the environment	Implement site-specific waste management plan in Annex in conjunction with Kaduna State Environmental Protection Agency for effective waste management and safe handling/disposal of waste.	Contractor	150,000.00	Presence / amount of vegetal waste on-site	Site inspection	Compliance with the site waste management plan Good house keeping	project sites	Monthly	Kaduna State Environmental Protection Agency REA-ESO. Project Engineer	
	Distortion of soil due to movement of vehicles to site and mounting of building materials	Designate an area for parking and materials stacking	Contractor		Area of demarcated for vehicles and equipment limit/parking zone	Soil moisture Visual observation .	Satisfactory Soil Compaction test	Project camp sites and equipment packing zones	At the commencement of the project works and then Monthly	SC & REA-ESO	150,000.00
	Processing equipment installations Equipment Leakages and chemical substances into soil.	Install impermeable surface at the limit zone to contain potential leakages of chemicals from processing equipment	Contractor	180,000.00	Installed impermeable platform at limit zone. Level of pollution at vehicles and equipment		Absence of spillages Satisfactory Soil quality test	Project camp sites and equipment packing zones	Monthly	SC & REA-ESO	

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
					limit/parking zone						
	Construction material vehicle. Noise level above permissible noise level, (60dB and 50dB for day and night respectively) [1]during movement can disturb the community	Ensure transportation Scheduling for construction materials, equipment and vehicle. off peak hours/ weekends when it will cause least disturbance. Retrofit machines with sound proofing devices.	Contractor	NA	Noise Level and number of complaints in project area / host communities	In-situ measurement of noise level	Noise level test (Not to exceed 60dB(A) for 8 hours working period	Project host communities and environs	Weekly	REA-ESO	50,000.00 (Part of routine REA monitoring)
	Accidents and injuries from the use of scaffolds, over-tank installations and carpentry works	The contractor shall ensure the provision of (Personal Protective equipment) PPE to workers; Worker Education Incident/accident reporting;	Contractor	600,000.00	Contractors Compliance.	Routine inspection	Use of PPEs by Workers Training Records	Construction site	Daily	SC & REA-ESO	150,000.00

[1] The National Environment (Noise Standards and Control) Regulations, 2009 S.I No. 35. Maximum permissible noise levels for construction site as 60dB (A) and 50dB(A) for day and night respectively for Hospitals, SChools, institutions of higher learning, homes for the disabled, etc. and maximum permissible noise levels for construction site as 75dB (A) and 65dB(A) for day and night respectively for Buildings other than those mentioned previously. Maximum Permissible Noise Levels for Accelerating Vehicles as stated in Table VIII

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		Ensure provision of First Aid onsite Ensure that staging areas for contractor equipment are adequately demarcated and cordoned off with reflective tapes and barriers (See Annex 6 for OHS Plan)									
	Vehicle accidents or pedestrians during mobilization of materials and equipment to the site.	Training of drivers on safe driving practices Install safety signage Enforce speed limits. (see Annex 12)	Contractor	250,000.00	Community Affairs Safety Health, Environment & Security Plan (CASHES) Accident Report	Site Inspection Consultations	Training Report Accident/ Incident Report	Within the sites and environs	Every week	SC & REA-ESO/ SSO Traffic Control Team FRSC	(Part of routine REA monitoring)
Site Reconnaissance, Surveys	Slips, trips, falls, snake bites, insect bites, minor	Conduct site-specific risk assessment; provide	Contractor/Survey Team	300,000	Number of incidents and near misses; PPE	Site inspection; incident reports; PPE	Zero fatalities; 100% PPE compliance; no	Survey routes and project site	Weekly during surveys	REA-ESO, Project Engineer	150,000

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
and Investigations	injuries and exposure to difficult terrain	appropriate PPE (safety boots, reflective vests, gloves); ensure workers are briefed on hazards; maintain first aid kits on site; implement buddy system for fieldwork			availability and usage; number of safety briefings conducted	records; toolbox talk records	lost-time injuries				
Transportation of Personnel to and from Site	Road traffic accidents, injuries, fatalities	Use licensed drivers and roadworthy vehicles; enforce speed limits; prohibit use of mobile phones while driving; conduct defensive driving training; maintain journey management plan	Contractor	500,000	Number of vehicle incidents; driver training records; vehicle inspection reports	Vehicle inspection records; incident reports; driver competency records	Zero fatalities; zero major traffic accidents; 100% driver compliance	Access roads and project routes	Monthly	REA-ESO, Contractor HSE Officer	150,000
Mobilization of Equipment and Materials	Crush injuries, struck-by incidents, manual handling injuries	Develop lifting and handling procedures; use trained personnel; establish traffic management	Contractor	400,000	Number of lifting incidents; PPE compliance; equipment	Site inspection; lifting records; incident reports	Zero lifting-related injuries; 100% equipment certified and inspected	Project site and storage areas	Weekly	REA-ESO, Contractor HSE Officer	150,000

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		measures; inspect lifting equipment; provide PPE			inspection status						
Worker Induction and Pre-Mobilization Training	Poor awareness of site hazards leading to unsafe behaviours and accidents during subsequent phases	Conduct mandatory OHS induction; communicate emergency response procedures; train workers on hazard identification, reporting mechanisms, PPE use and incident response	Contractor	350,000	Number of workers trained; induction attendance records; competency assessment results	Training records; attendance registers; interviews	100% of workers inducted before site access; improved hazard awareness levels	Training venues and project site	Prior to mobilization and refresher quarterly	REA-ESO, Contractor HSE Officer	100,000
Establishment of Temporary Site Facilities and Offices	Fire hazards, electrical hazards, poor sanitation, occupational illnesses	Provide fire extinguishers and emergency equipment; ensure safe electrical installations; provide potable water and sanitation facilities; maintain housekeeping standards	Contractor	500,000	Number of fire extinguishers available; sanitation facilities provided; housekeeping inspection scores	Site inspections; maintenance records	Zero fire incidents; adequate sanitation facilities available at all times	Temporary offices, stores and camp facilities	Weekly	REA-ESO, Contractor HSE Officer	150,000
Sub-Total				**3,880,000.00**							**1,050,000.00**
B. Social Impacts											

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
Preparation of Campsite area, material and equipment stacking Areas and Mobilization of personnel, materials, heavy duty vehicles and equipment to the proposed project sites	Traffic congestion along road as a result of mobilization of personnel, materials, heavy duty vehicles and equipment or breakdown of heavy-duty vehicles and equipment	Movement of equipment and machinery should be limited during non-peak period and non-market days. Prepare & implement a Traffic Management Plan (TMP) in line with Annex 8. Equipment and vehicles are to be serviced before mobilizing to site	REA-SSO; REA Contractor Contractor	400,000.00	No of complaints received within the project area Traffic congestion	GRM Site visits and observation	GRM report and TMP report Traffic signs Availability of Market committee officials to control traffic	Within the site Routes through community to the sites	Before commencement of civil works During mobilization	REA Social Safeguard Officer (REA-SSO)	(Part of routine REA monitoring)
	Obstructions to nearby residential areas, through noise and movement	Mobilization of equipment at weekends. Laterite excavation sites should not be located near residential areas.	Contractor	NA	Number and frequency of complaints in project area	In-situ measurement of noise level	Noise level test (Not to exceed 60dB(A) for 8 hours working period	Residential areas, around the project corridors	Weekly	REA-SSO, and SC	150,000.00

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	Labor Influx which could lead to Increase in sexual activities and spread of STDs/STIs	Awareness campaign on sexual transmitted diseases, and implementation of labor influx plan (See Annex 11 for Labor Influx Plan)	Contractor, REA-SSS, REA Communications Officer	350,000.00	Level of Awareness and Education	Rapid health survey/ Primary Healthcare centres' report	Level of awareness and knowledge of preventive measures. % of reported STI/ STD cases among workforce	Nearby communities Health care facilities	During pre-construction	REA-SSO SC, ESO, GBVO	150,000.00
	Potential risk of harassment, Sexual Exploitation and Abuse (SEA)/ Gender Based Violence (GBV), including verbal insults, physical abuse, rape, and women and child trafficking.	Sourcing of local workforce All contractors' workers to sign and strictly comply with Code of Conduct (CoC) (see Annex 9 for sample CoC) and be sensitized on zero tolerance for sexual integration with students/ community Community leaders/ women	Supervision Consultant GBV Specialist Contractor Management, Resident engineers	500,000	Stakeholders concerns on risk of GBV	Consultations Third Party Monitor Report	Signed CoCs with the REA Conduct of sensitization campaigns and trainings Action plan for implementation of GBV activities internal "Reporting and Response Protocol"	Project host communities	During Pre-Construction/ Continuous	Project Coordinator REA-SSO, GBV Officer, ESO Supervising Consultant GBV Specialist GBV Focal Person at the project level Project Third Party monitor	120,000.00

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		group/youth group to sensitize the community on appropriate conduct with contractors Engagement of intermediary service provider Provide Referral centers for survivors of GBV/SEA									
	Child labour	No employment of children either directly or indirectly on the project. Communication on hiring criteria, minimum age. Enforcement of legislation prohibiting child labour	Contractor Supervision Consultant Social Specialist REA-SSS	50,000.00	Visual observation of child labour	Routine inspection	No. of cases observed & recorded	Project site	Daily	REA-ESO & SSO, Project Engineer (Supervision Consultant), FPMU SSO	(Part of routine monitoring costs)

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	Vulnerable groups (women, aged people, people living with disability) as identified will be at more disadvantage to social risks and disturbance to their movement	Implement SEA/SH/GBV prevention measures. Provide access slabs where required and should be considered in the project designs. Also, consult with these groups regularly to address any concerns relating to the project and educate them on the GRM channels	Contractor Supervision Consultant Social Specialist GRC	NA	Stakeholder/ vulnerable group Concerns	No of complaints via survey, GRM channels	Level of satisfaction of vulnerable groups	Project site and host communities	Daily	REA-ESO & SSO, GBVO Project Engineer SSC	Part of routine monitoring costs
	Physical and Economic displacement including temporary restriction within the perimeter of the site asides construction workers, suppliers.	Implement standalone RAP prepared for the project. Ensure all issues relating to compensation are handled in a transparent, equitable manner	REA-SSO; REA	Refer to the RAP for all compensation and livelihood assistance costs	Implementation of the compensation and livelihood assistance	Number of PAPs compensated or provided with livelihood assistance	Level of satisfaction of the PAPs	Project area of influence	Before implementation of civil works	FPMU-SSO, REA-SSO	Provided in the RAP report

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	Compensation for Economic trees on the Land	Ensure grievances over loss of sources of livelihood are handled in a transparent, equitable manner	Grievance Redress Committee (GRC)	NA	No of complaints received	Review Grievance redress Log	No of cases resolved by the GRC	Project area of influence	Continuous	GRC REA-SSO	150,000.00
	Additional Population may introduce menace to the community pressure on local resources.	Recommended that the contractor hire semi to unskilled labour locally. Contractor to provide amenities for workers	Contractor Supervising Consultant	Part of staff costs	Recruitment Process No. of locals hired.	Observation and Interview/ Records	Compliance with Mitigation	Camp Office Project Site	Monthly	REA-SSO FPMU-SSO	150,000.00
	Influx of workers could increase the risks of flus', common cold, tuberculosis, whooping cough, etc. and other infectious diseases in the proposed project area	Workers to adhere to airborne diseases prevention protocols (nose masks, frequent handwashing and regular health checks). See Annex 12	Contractor	150,000.00	Increase in airborne diseases cases/ Outbreak	Health survey reports	Absence of airborne diseases outbreak related to project workers	Primary Health Care Centre Project Site	Weekly	SSC SC REA-SSO ESO GBV Health care workers	100,000.00

Activities	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
All project activities	Security Risks	The REA to liaise with the Kaduna State Government and security forces to ensure adequate provision of security. Ensure compliance with the REA security focal person's security clearance	Contractor Security Supervising Consultant Security Imo State Government REA (site monitoring)	Part of contract costs for contractor and SC State Budget See monitoring costs	Availability of security personnel No of Incidents	Visual Observation Security Incident Report	Absence of security incidents associated with project workers and contractors	Project Site	Daily	SSC REA-SSO ESO GBV Nigeria Police Force (NPF), NSCDS and Community Vigilante Group	1,500,000.00 (Supplementary budget for REA monitoring visits security cost throughout the project implementation in addition to the state security arrangements)
Sub Total				**1,450,000.00**							**2,320,000.00**
Total (Pre-construction Phase)				**5,330,000.00**							**3,370,000.00**

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
					CONSTRUCTION PHASE						
Environmental Impacts											

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
Operation & movement of equipment , Waste management of debris and construction waste, Installation of borehole , parking lots, fencing and all the civil works .	Air Quality concerns. Fugitive dust Release of exhaust fumes, hazardous gases (NOx, CO, SOx, SPM,), Oxides from machinery GHG Emissions	Fuel switching from high- to low-carbon content fuels (where available) can be a relatively cost-effective means to mitigate GHG emissions during this phase. Use of Energy efficiency-Machines	Contractor	750,000.00	Fugitive dust Gaseous pollutants: SO2, NO2, CO2, CO, VOCs, H2S, TSP	Visual Observation In-situ Air Quality Measurement Vehicle emission testing (VET) and vehicle exhaust SCreening (VES Report	Minimal dust Permissible limit FMEnv air pollutants	On-site Project area	Monthly	REA-ESO Kaduna State Ministry of Environment Supervision Consultant	200,000.00 (Part of routine monitoring cost)
	Noise and vibration nuisance: noise level, (60dB) during construction activities can disturb communities	Adequate maintenance of equipment and machineries to reduce noise; Sound proof & Implement OHS Plan in Annex 12 Use of adequate PPEs	Contractor	250,000.00	Number and frequency of complaints in project area	In-situ measurement of noise level	Noise level test (Not to exceed 60dB(A) for 8 hours working period	Host communities and projects sites	Weekly	Supervising Consultant REA-ESO & SSO	
	Surface soil excavation for foundatio	Creation of limit zones Rip compacted areas to reduce runoff and re-	Contractor	NA	Visible demarcation of vehicles and	Visual observation Soil Compaction test	Visual observation	Project camp sites and equipmen	Monthly	Supervising Consultant REA-ESO	Part of routine maintenance

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	n from Movement of heavy vehicles/Stationary vehicles and equipment	vegetate where necessary (every affected tree/shrub should be replaced by two (2)			equipment limit zone		Soil Compaction test	t packing zones		Project Engineer	
	Pollution of soil and groundwater by oil and chemicals useful for the supply of portable water in the communities. Contamination by oil spills and lubricants.	Store fuel, oil, chemicals in bunded area capable of holding 110% of the volume of the largest container Install drip trays beneath generators and transformers The storage area should be far from all other water sources Provision of bunded storage area, impermeable base, drip trays under equipment, spill kits, emergency spill response procedure	Contractor	NA	Soil quality parameters (Especially hydrocarbon contaminants) Compliance with fuel storage procedures	In situ/ Laboratory Analysis Visual Observation	FMEnv. soil Pollutants Permissible limit	Project area	Twice during construction	REA-ESO	100,000.00
	Excessive vibrations from	Ensure construction trucks are well	Contractor	Built into Contractor's cost	Presence of affected buildings	Visual inspection	Machinery fitted with	Project areas	Monthly	Supervising Consultant	60,000.00

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	operations of construction trucks	maintained to prevent excessive vibrations caused by worn-out or malfunctioning parts.					acoustic shield			REA-ESO	
Construction works for foundation laying and civil works, including damp treatment	Presence of construction waste on-site which can pollute the environment	Implement site-specific waste management plan see Annex 5 Liaise with Kaduna State waste management authority for effective waste management and safe handling/disposal of waste.	Contractor	1,500,000.00	Presence/amount of construction waste on-site	Site inspection	Compliance with the site waste management plan Good house keeping	Project areas	Weekly	REA-ESO. Project Engineer	100,000.00
	Silt from drainages can pollute and deface the environment	Limit clearing to required designed layout	Contractor		Vegetation cover within the area	Visual Observation	vegetation at the appropriate outside the coverage of project design	Project design areas	Monthly	Supervising Consultant REA-ESO	
Material sourcing and laterite excavation sites	Material sourcing from borrow-pits may trigger erosion	Limit the need to dig excessive Laterite excavation sites Drainages and storm water management structures should be included in the project design, and should be	Contractor	950,000.00	Contractors' Compliance Reclaimed Laterite excavation sites	Inspections	Number of Laterite excavation sites incidents.	Borrow pit locations	Monthly	REA-ESO Supervising Engineer	150,000.00

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		adequately managed. Created Laterite excavation sites should have appropriate signage and protection around them; Borrow pit management plan (see Annex 7)									
Campsite management	Pollution of the environment from open defecation by workers Waste generation and disposal	Contractor to provide gender friendly mobile toilets and on-camp sanitary facilities for workers Implement the detailed Waste Management Plan (WMP) (See Annex 5 and Annex 10)	Contractor	1,500,000.00	Evidence of faecal waste within the project sites	Site inspection	Absence of faecal waste on-site	Camp sites and working zones	Weekly	Supervising Consultant REA-ESO	Part of Routine monitoring
Construction and final operational activities	Risk of occupational accidents (OHS), Injuries and diseases, life & fire safety Exposure to harmful chemicals	Implement project OHS Plan see Annex 6. Provide additional PPEs and enforce usage of appropriate PPEs. Demarcate/cordon off construction areas and, lit up adequately at night.	Contractor	1,200,000.00 (OHS Plan Implementation) 1,200,000.00 (PPEs) 450,000.00 (caution signs, tapes	OHS Plan Developed Compliance with OHS Plan First aid box	Consultations/ visual observation Accident Report	Decrease in Lost Time Injuries (LTI) Zero incident /accident report	Project area	Daily	Supervising Consultant REA-ESO	550,000.00

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		Develop and implement visitors' management protocol. Workers should get a daily induction/toolbox before going on the site Appropriate security measures Provide well-equipped first aid box Provide fire extinguisher at strategic locations Provide regular campsite fumigation		& barricades) 600,000.00 (first aid)			Well stocked first aid box				
Sub-Total:				**8,400,000.00**							**1,700,000.00**
Social Impacts											
Operation & movement of equipment	Temporary traffic build-up and delay in travel time along the proposed site	Prepare & Implement TMP (see framework see Annex 8) Movement of equipment and machinery should be limited during non-peak	Contractor Traffic Control Team	450,000.00	No of complaints received within the project area Contractors Compliance	Site visits and observation	Traffic signs Contractors' compliance Presence of flagmen and Traffic Control Team	Routes through community to the sites	Weekly	Supervising Consultant REA-SSO/ ESO Traffic Control Team FRSC ASTMCA	100,000.00

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		hours/days/period as identified such as non-market days									
	Grievances and negative perception by community members	Conduct stakeholders' consultation with the host community/market management at every phase of the project	Contractor GRC	NA	No of complaints by community persons/market users	Consultations Review grievance log	Minimal number of reported cases	Host community/market	Quaterly	GRC members REA-SSO FPMU	100,000.00
	Increase in sexual activities leading to possible spread of STDs/STIs from influx of workers to project location	Continuous awareness and sensitization campaign on sexual diseases. .	Contractor REA Local Healthcare centre	300,000.00	Level of Awareness and Education Increase in number of new STI cases	Rapid health survey	Awareness and knowledge of preventive measures. STI/ STD Cases.	Nearby communities Health care facilities	During Construction/ Continuous	REA-SSO, ESO & GBV Officer Supervising Consultant,	100, 000.00
	Potential risk of Sexual Exploitation and Abuse (SEA)/ Gender Based Violence (GBV) Influx of workers to project location	All contractors' workers to sign Code of Conduct (CoC) (See Annex 9 for sample CoC). Mapping of Service providers and establishment of GBV-GRM Compliance with the GBV Action Plan for RAAMP, Code of Conducts.	REA GBV Specialist, Contractor Supervision Consultant GBV Specialist GBV-GRC Focal person	150,000.00 (contractor)	Stakeholders concerns on risk of GBV GBV related grievances	Consultations GBV Prevention activities report	Signed CoCs with the REA Conduct of sensitization campaigns Satisfactory GBV Prevention activities report	Market/Communities along the project corridors	During Construction/ Continuous	REA-SSO, ESO & GBV Officer FPMU-GBV Specialist GBV Officer	100,000.00

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	Conflicts between contractor and community members	Good work enforcement program. Grievance Redress Mechanism (see Annex 11)	Contractor GRC	150,000.00	No of complaints received	Consultation Review Grievance redress Log	No of cases handled by the GRC	Project area of influence	Continuous	GRC REA SSO	100,000.00
	Increase demand on existing community health and sanitation infrastructure due to influx of temporary workers	Provide basic amenities (water, sanitation, etc. to workers) See Annex 4 General Environmental Conditions for Contract.	Contractor	Included in Contractor's cost	No of amenities in workers' camps	Visual observation	Availability of all essential amenities in workers' camps	Workers camp sites Host community	Monthly	REA-SSO REA ESO REA GBV Supervising Consultant	150,000.00
	Community and public health issues. (People within the project host communities may be exposed to vehicular or on-site accident)	Implement community health & safety plan: install caution signs, barricades, speed bumps, train drivers, avoid working at night and light up work areas. see Annex 10	Contractor	Same as in Env. Impacts	Accident /Incident Report	Reporting and feedback mechanism GRM	No of accidents reported	Project area of influence	Continuous	REA-ESO & SSO; Supervising Consultant	Captured in CASHES
	Child labour and SChool drop out	Ensure that children and minors are not employed directly or	Contractor, REA-SSS	NA	Visual observation	Routine inspection	No. of cases observed & recorded	Project site	Daily	REA-SSO Supervising Consultant	50,000.00

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		indirectly on the project.									
	Vulnerable groups as identified will be at more disadvantage to social risks and disturbance to their movement	Implement SEA/SH/GBV prevention measures. Provide access slabs where required and consult with these groups regularly to address any concerns relating to the project and educate them on the GRM channels	Contractor Supervision Consultant Social Specialist GRC	150,000.00	Stakeholder/ vulnerable group Concerns	No of complaints via survey, GRM channels	Level of satisfaction of vulnerable groups	Project corridor	Daily	REA-ESO & SSO, Project Engineer SSC	Part of routine monitoring costs
	Influx of workers could increase the risks of airborne diseases thus causing ill-health and potential airborne diseases outbreak in the project area	Workers to adhere to airborne diseases (such as flus', common cold, tuberculosis, whooping cough etc.) prevention protocols including use of nose masks, frequent handwashing. Comply with all airborne diseases regulations in Annex 12	Contractor	150,000.00	Increase in COVID-19 cases/ Outbreak	Health survey reports	Absence of COVID-19 outbreak related to project workers	Workers' campsite Primary Health Care Centre Project Site	Weekly	SSC SC REA-SSO ESO, GBV Health care workers	100,000.00
Sub Total				**1,350,000.00**							**800,000.00**
Total (Construction Phase)				**9,750,000.00**							**2,500,000.00**

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
OPERATION PHASE											
Environmental Impacts											
Operation of Solar PV System	Accumulation of dust and dirt on panels reducing efficiency; generation of wash water during panel cleaning	Implement routine preventive maintenance programme; use water-efficient cleaning methods; avoid use of hazardous cleaning chemicals; collect and properly channel wash water to prevent erosion and ponding	Mini-grid Operator	100,000	Clean panels; absence of erosion around panel arrays	Visual inspection and maintenance records	Implementation of the Mitigation	Solar PV Site	Monthly	REA-ESO, Project Engineer	300,000
Solar Panel Cleaning Activities	Excessive water consumption and localized runoff	Use controlled quantities of water; where feasible utilize harvested rainwater; ensure runoff is directed away from sensitive areas; maintain drainage channels	Mini-grid Operator	200,000	Water usage records; absence of stagnant water	Inspection and maintenance logs	Clean PV panels	Project Site	Monthly	REA-SSO	200,000
Operation of Diesel Generator (Backup System)	Air emissions (CO_2, NOx, SO_2, PM), noise generation and fuel consumption	Ensure routine servicing of generators; use low-sulphur diesel; limit generator operation to backup periods; install acoustic enclosures;	Mini-grid Operator	200,000	Generator maintenance records; noise and emission levels within standards	Equipment inspection; noise monitoring	Low Generator Noise and Little or no exhaust smoke	Power House	Quarterly	REA-ESO, Supervising Consultant	1,000,000

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
		maintain emission control systems									
Fuel Storage and Handling	Fuel leakage, soil contamination, groundwater pollution, fire risk	Store fuel in bunded areas with at least 110% containment capacity; provide spill kits; train personnel in spill response; conduct routine inspections; implement fire prevention measures	Mini-grid Operator	200,000	No evidence of spills; spill response equipment available	Site inspection	No visible Leakage on site	Generator /Fuel Storage Area	Monthly	REA-ESO	500,000
Operation of Battery Energy Storage System (BESS)	Thermal runaway, fire and explosion risk, release of toxic gases and electrolyte leakage	Install fire detection and suppression systems; maintain adequate ventilation; implement battery monitoring systems; establish emergency response procedures; provide secondary containment; conduct routine inspections and thermal monitoring	Mini-grid Operator	300,000	No fire incidents; battery operating within design parameters	Inspection and monitoring records		BESS Facility	Monthly	REA-ESO, HSE Officer	1,500,000
Operation of Electrical Infrastructure (Transformers,	Electrocution, electric shock, burns, public safety risks	Install warning signs; maintain fencing and restricted access; conduct routine inspections; implement Lock-	Mini-grid Operator	100,000	Number of incidents; safety signage availability	Inspection and safety audits	No incidents recorded	Entire Project Site	Monthly	REA-ESO	500,000

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
Inverters, Distribution Lines)		Out/Tag-Out (LOTO) procedures; train operators and technicians									
Emergency Situations (Fire, Explosion, Major Equipment Failure)	Injury, loss of assets, service interruption, environmental contamination	Develop and implement Emergency Response Plan; provide firefighting equipment; conduct drills; maintain emergency contacts and evacuation procedures	Mini-grid Operator	200,000	Number of drills conducted; emergency preparedness status	Inspection and emergency drills	No fire incidents recorded on site	Entire Project Site	Bi-annually	REA-ESO, HSE Officer	800,000
End-of-Life Solar Panels and Electronic Components	E-waste generation and potential release of hazardous materials	Develop E-Waste Management Plan; maintain inventory of obsolete equipment; engage licensed e-waste recyclers; prohibit open dumping or burning	Mini-grid Operator	500,000	E-waste inventory and disposal records	Audit and inspection	Implementation of E-waste Management Plan	Project Site	Annually	REA-ESO, State Environmental Agency	700,000
Sub-Total:				**1,800,000.00**							**5,500,000**
Social Impacts											
Community Electricity Access Monitoring	Unequal access to electricity services resulting in exclusion of low-income	Develop and implement an inclusive connection policy; conduct community sensitization on connection procedures;	Mini-grid Operator	500,000	Number of connected households; percentage of low-income households connected; percentage of female-	Review of customer records; household surveys; stakeholder consultations; grievance register review	≥80% of willing households connected within service area; ≥90% of access complaints	Project communities and service coverage area	Quarterly	REA-ESO, Mini-grid Operator, Community Energy Committee	250,000

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	households, female-headed households, persons with disabilities and other vulnerable groups	prioritize vulnerable households during connection rollout; maintain disaggregated customer database; establish grievance mechanism for access-related complaints			headed households connected; number of vulnerable households connected; access-related complaints received and resolved		resolved within specified timeframe; annual increase in vulnerable household connections				
Tariff Transparency and Affordability Monitoring	High tariffs may reduce affordability, increase energy poverty, and lead to community dissatisfaction or non-payment	Public disclosure of approved tariff structure; periodic stakeholder engagement on tariffs; provision of clear billing information; establish complaint resolution process; assess affordability impacts on vulnerable groups; implement approved lifeline or support measures where applicable	Mini-grid Operator	400,000	Tariff information publicly displayed; number of tariff-related complaints; average household expenditure on electricity; customer satisfaction levels; affordability concerns reported	Tariff audits; review of billing records; household expenditure surveys; customer satisfaction surveys; grievance log review	Tariff schedule publicly available at all times; >80% customer awareness of tariff structure; tariff-related complaints resolved within established timeframe; customer satisfaction ≥75%	Mini-grid office, customer households, community notice boards	Quarterly	NERC, REA-ESO, Mini-grid Operator	200,000
Monitoring of Equitable Distribution of Electricity Benefits	Elite capture of electricity benefits leading to unequal socioeconomic	Ensure transparent connection procedures; monitor distribution of productive-use connections;	Mini-grid Operator, Community Energy Committee	350,000	Distribution of customer categories; number of productive-use beneficiaries; proportion of	Customer database review; business beneficiary surveys; stakeholder consultations; grievance	No substantiated cases of discrimination; equitable representation of	Communities within mini-grid coverage area	Semi-annually	REA-ESO, Community Energy Committee, Mini-grid Operator	200,000

Activity	Potential Impact	Mitigation Measures	Responsibility for Mitigation	Mitigation Cost (NGN)	Parameters to be measured	Method of measurement	Performance indicator	Sampling Location	Monitoring Frequency	Institutional Responsibility (Monitoring)	Costs (NGN)
	opportunities and community tensions	support access for small businesses, women-led enterprises and vulnerable groups; periodically review beneficiary profile			women-owned and vulnerable-group enterprises benefiting; complaints relating to discrimination or preferential treatment	mechanism review	vulnerable groups among beneficiaries; reduction in complaints relating to unequal access				
Community Engagement on Service Delivery and Social Inclusion	Reduced trust in project operations due to inadequate information sharing and stakeholder participation	Conduct regular community meetings; disclose operational performance and tariff information; engage women, youth and vulnerable groups in consultations; maintain accessible grievance redress mechanism	Mini-grid Operator, Community Energy Committee	300,000	Number of stakeholder meetings held; participation rate of women and vulnerable groups; grievances received and resolved; level of stakeholder satisfaction	Meeting attendance records; consultation reports; grievance register; perception surveys	Minimum of 4 community engagement meetings annually; ≥40% participation by women; ≥90% grievance resolution rate	Project communities	Quarterly	REA-ESO, Mini-grid Operator	150,000
Sub Total				**1,550,000.00**							**800,000.00**
Total (Operation Phase)				**3,350,000**							**6,300,000**
Grand Total (Pre + Con. + Op.)				**18,430,000.00**							**12,170,000.00**

7.4 Roles, Responsibilities and Accountabilities

The main responsibility for overseeing the implementation of the ESMP lies with the REA PMU throughout the project life span. However, conformance with the specific environmental measures detailed in Chapter Six of this report will be ensured by the EPC contractor during the construction phase and Operations and Maintenance (O&M) Contractor at the operational phase of the Project.

7.4.1 P r e -construction Phase

The key personnel and institutions with major roles in the implementation of the ESMP during pre-construction phase are:

FUHSA Director of Physical Planning

- Select the land for the proposed Project
- 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

REA-PMU

- Assist the University in selecting sufficient and suitable land for construction of power plant and training center
- 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

FUHSA Site Engineer

- Attend adequate training on ESMP implementation
- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures
- Report to FUHSA Director of Physical Planning on ESMP compliance and non-compliance issues

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 REA-PMU and FUHSA Site Engineer on ESMP compliance and non-compliance issues
- Implement ESMP requirements relevant to work being undertaken

7.4.2 Construction Phase

The key personnel and institutions with major roles in the implementation of the ESMP during construction phase are:

<u>FUHSA Director of Physical Planning</u>

- Supervise the activities of the Site Engineer by reviewing reports on ESMP issues
- Suggest ESMP improvements to REA-PMU to address non-compliance and upcoming issues

<u>REA-PMU</u>

- Supervise the activities of the EPC contractor by reviewing reports on ESMP issues
- Discuss ESMP improvements with FUHSA Director of Physical Planning to address non-compliance and upcoming issues
- Monitors the implementation of the ESMP

<u>FUHSA Site Engineer</u>

- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures
- Report to FUHSA Director of Physical Planning on ESMP compliance and non-compliance issues

<u>EPC Contractor</u>

- Implement ESMP requirements relevant to work being undertaken
- Hire a Gender/GBV officer
- Report to the REA-PMU and FUHSA Site Engineer on ESMP compliance and non-compliance issues

<u>FMEnv Representatives</u>

- Monitor the implementation of ESMP requirements (impact mitigation monitoring) relevant to work being undertaken
- Discuss ESMP improvements with FUHSA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

<u>Ministry of Women Affairs and Social Development and GBV/SEA service provider</u>

- Monitor the implementation of Gender mitigation measures relevant to work being undertaken
- Discuss ESMP improvements with the Gender/GBV officer, FUHSA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

BASEPA Representatives

- Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken
- Discuss ESMP improvements with FUHSA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

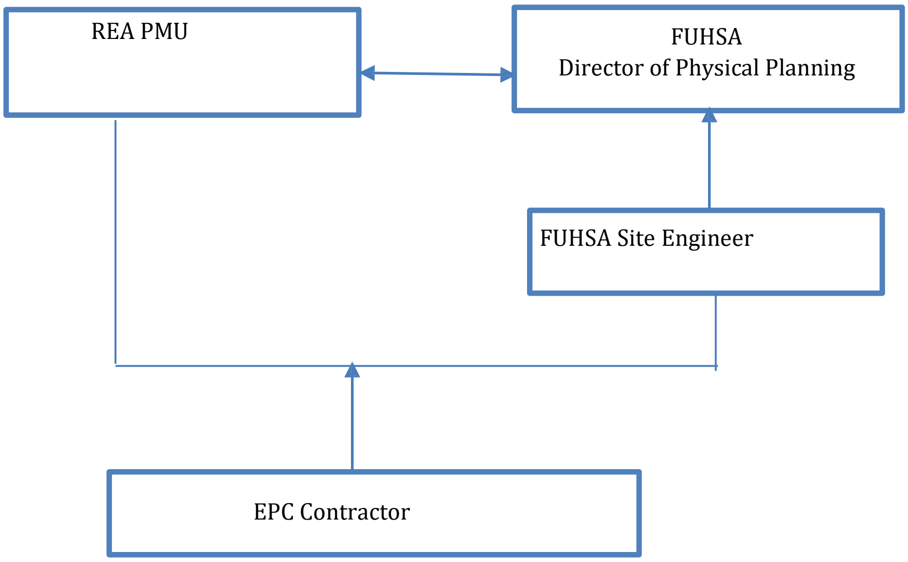


Figure 7.1: Roles and Responsibilities for the Pre-Construction and Construction Phase

7.4.3 Operational Phase

FUHSA Director of Physical Planning

- Supervise the activities of the Site Engineer by reviewing reports on ESMP issues
- Suggest ESMP improvements to O&M Contractor and PMU to address non-compliance and upcoming issues

REA PMU

- Appoint a O&M Contractor
- Supervise the activities of the O&M Contractor by reviewing reports on ESMP issues
- Discuss ESMP improvements with FUHSA Director of Physical Planning to address non-compliance and upcoming issues

FUHSA Site Engineer

- Supervise the activities of the O&M Contractor and ensure compliance ESMP with mitigation measures
- Report to FUHSA Director of Physical Planning on ESMP compliance and non-compliance issues

O&M Contractor

- Implement ESMP requirements relevant to work being undertaken
- Hire a Gender/GBV officer
- Report to the REA-PMU and FUHSA Site Engineer on ESMP compliance and non-compliance issues

FMEnv Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with O&M Contractor, FUHSA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

NESREA Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with FUHSA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

Ministry of Women Affairs and Social Development and GBV/SEA service provider

- Monitor the implementation of Gender mitigation measures relevant to work being undertaken
- Discuss ESMP improvements with the Gender/GBV officer, FUHSA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

BASEPA Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with FUHSA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

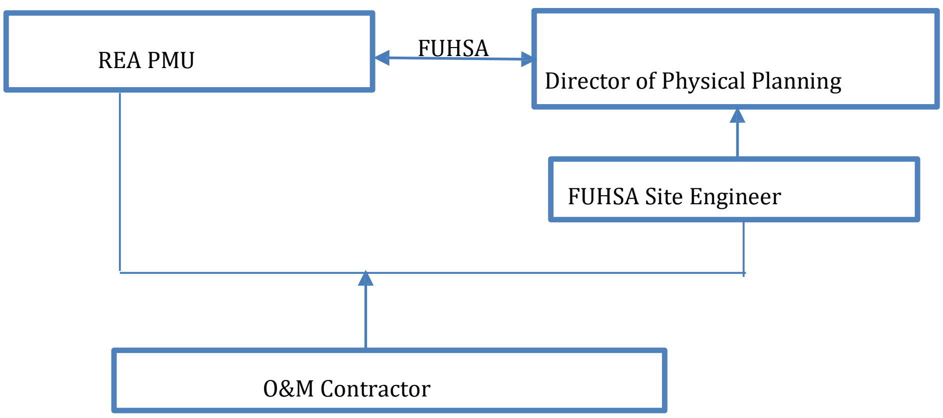


Figure 7.2: Roles and Responsibilities for the Operational Phase

Table 7.2: Role of African Development Bank

Area	AfDB Role
Environmental & Social Compliance	Monitor compliance with the ESIA, ESMP, ESF, ESSs, and Financing Agreement.
Technical Support	Provide guidance on environmental, social, health, and safety management.
Supervision	Conduct implementation support and supervision missions.
Monitoring	Review environmental and social performance reports and monitoring results.
Corrective Actions	Recommend and monitor implementation of corrective action plans where necessary.
Stakeholder Engagement	Ensure effective stakeholder engagement and functioning of the Grievance Redress Mechanism.
Capacity Building	Support strengthening of environmental and social management systems where required.
Audits	Review or require independent environmental and social audits to verify compliance and improve performance.

7.5 Additional Management Plans

This section provides a framework for the contents of additional management plans to be developed and implemented, in support of this ESMP, for the proposed Project. As the Project progresses, the management plans will be expanded to include specific procedures to guide implementation by the relevant Project personnel including contractor and subcontractors.

The documents will be prepared strictly in line with the requirements set out in the relevant international standards and guidelines such as the African Development Bank General EHS Guidelines as well as other applicable national and local regulations and guidelines.

7.5.1 Stakeholder Engagement Plan

A Stakeholder Engagement Plan (SEP) shall be developed and implemented throughout the lifecycle of the proposed Project. The objectives of developing SEP for the proposed Project include the following:

- Ensuring stakeholder inclusion and involvement across the various phases of the project;
- Ensuring clarity and understanding through an open, inclusive and transparent process of culturally appropriate engagement and communication undertaken to ensure that stakeholders are well informed about the proposed Project;

- Building and maintaining productive relationship between REA and its various stakeholders through supporting open dialogue;
- Engaging vulnerable groups through an open and inclusive approach to consultation, thereby increasing the opportunity for stakeholders to provide comment and voice their concerns on the proposed Project;
- Managing expectations to ensure that the proposed Project does not create or allow unrealistic expectations to develop amongst stakeholders about proposed Project benefits. The engagement process will serve as a mechanism for understanding and managing stakeholder and community expectations, where the latter will be achieved by disseminating accurate information in an accessible way.
- Ensuring compliance with both local regulatory requirements and international best practice.
- Ensuring stakeholders are free of external manipulation or coercion.

REA is committed to implementing stakeholder management as part of its operations. As such REA will ensure that the responsibility for implementing the SEP is duly assigned and all components of the plan are well-defined within its organizational processes. REA shall also commit to providing the necessary support to implement the SEP.

In line with the Environmental and Social Management framework (ESMF) for NEP, an effective SEP should:

- ❖ Describe regulatory, lender, company, and/or other requirements for consultation and disclosure.
- ❖ Identify and prioritize key stakeholder groups, focusing on Affected Communities.
- ❖ Provide a strategy and timetable for sharing information and consulting with each of these groups.
- ❖ Describe resources and responsibilities for implementing stakeholder engagement activities.
- ❖ Describe how stakeholder engagement activities will be incorporated into the company‘s management system.

A sample SEP is outlined in the Environmental and Social Management framework (ESMF) for NEP (NEP ESMF, 2019).

7.5.1.1 Grievance Redress Mechanism

A Grievance Redress Mechanism (GRM) has been developed for NEP. The proposed solar-hybrid power plant and associated infrastructure in FUHSA is part of the NEP. The GRM provides a framework for addressing Project-related complaints, including logging, tracking, and grievances resolution. 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.

7.5.2 Emergency Preparedness and Response Plan (EPRP)

An Emergency Preparedness and Response Plan (EPRP) shall be developed and implemented for the proposed Power Plant. As part of the EPRP, the fire protection system for the Project will be designed to meet the requirements of the local fire codes under the National Fire Protection Association. Also, the grounding and lightning strike protection systems for the Project shall be installed in a manner that will limit the effect of ground potential gradients to such voltage and current levels that will not endanger the safety of people or equipment under normal and fault conditions. Lightning arrestors and surge protectors shall also be installed with the grounding systems to protect electronic equipment by absorbing electrical surges in the event of lightning strikes. The EPRP shall include procedures for addressing all reasonably foreseeable and possible emergencies such as: fire, spill or release of hazardous wastes, medical and weather-related emergencies (e.g. lightning strikes). It shall address the following aspects, amongst others:

- Identification of the emergency scenarios and the development of appropriate and specific emergency response procedures for each scenario;
- Training of emergency response teams on the appropriate procedures and the use of emergency response equipment;
- Identification of emergency contacts and support services and the development of effective communication systems / protocols;
- Emergency equipment and facilities must be provided (e.g., first aid stations, fire-fighting equipment, personal protective equipment);
- Development of decontamination / clean-up procedures and identify critical remedial measures to contain, limit and reduce pollution;
- Identification of potential risk relating the uncontrolled release of hazardous materials and the preparation of a spill prevention, control, and response plans including:

- Training of operators on spill prevention.
- Implementation of inspection programmes to confirm the integrity of secondary containment structures and equipment.
- Development of standard operating procedures for filling containers or equipment and the transfer of hazardous materials.
- Identification and availability of the appropriate personal protective equipment and equipment.

7.5.3 Waste Management Plan (WMP)

The primary purpose of the WMP is to ensure that wastes (hazardous/non- hazardous) are avoided or minimized, and any wastes that are generated are properly managed and disposed in an environmentally sound manner

7.5.4 Occupational Health and Safety (OHS) Plan

The OHS plan must include the following elements, amongst others:

- Identification of potential hazards and development of responses to eliminate sources of risk or minimize workers' exposure to hazards;
- Provision of Personal Protective Equipment (PPE) to workers at no cost;
- Provision of training to all workers on all relevant aspects of occupational health and safety issues associated with their daily work, including emergency arrangements;
- Third parties (visitors and external service providers) must be briefed on the relevant aspects of health and safety and emergency response when accessing the site premises;
- Documentation and reporting of occupational injuries, illnesses and fatalities. It is recommended that a process for reporting near misses and unsafe behaviour be developed as a proactive approach to occupational health and safety risk management;
- Adequate access to first aid and medical assistance in cases of work related accidents or injuries must be provided;
- Designation of onsite Health and Safety officer with required experience;
- The overall site management system must be designed with adequate capacity for oversight of occupational health and safety matters.

7.5.5 Local and Employment Management Plan (LEMP)

The LEMP should aim to promote employment opportunities and training for local people in the Project's area of influence and include, amongst others:

- Targets for employing local labour;
- Targets for work experience opportunities;
- Notification of all employment and training opportunities prior to them being advertised elsewhere;
- Measures to provide verifiable monitoring information regarding training and employment. The training status for all workers must be recorded;
- Measures to provide training opportunities in respect of any new jobs created;
- Commitment to up-skilling existing employees;
- Measures to promote local procurement of goods and services;
- Recruitment and selection process for local employment;
- Measures to ensure the contractors work directly with local employment and training agencies;
- Measures to enhance and grow diversity in the workplace.

7.5.6 Erosion and Sediment Control Management Plan

This Plan should aim to control soil erosion and the transport of sediment in the Project area. The timing of works and the installation of control measures has a major influence on the management of storm water.

7.5.7 Water Conservation Plan

The Plan will address the appropriateness of water conservation, and efficient use of groundwater for construction activities and cleaning of PV panels during the operational phase of the Project.

7.5.8 EEP Gender-Based Violence (GBV) Action Plan

The GBV action plan shall be implemented throughout the project lifecycle. The components of the plan include:

- A GBV risk assessment; which has been conducted as part of the ESIA.
- Integration of GBV risk management in the ESMP.

- REA-PMU shall define GBV requirements in the contractor bid documents including the hiring of a Gender/GBV officer.
- REA-PMU shall evaluate GBV response protocol of the contractors before finalizing engagement contract.
- Contractors shall ensure that there are GBV-sensitive channels for reporting in GRM.
- Contractors shall inform Project affected communities about GBV risks.
- Contractors shall ensure code of conducts (CoC) forms are signed and understood by all workers. Workers shall be trained on CoC including regular training and refreshers
- Contractors shall ensure separate facilities for men and women and install GBV-free signage at the Project site.

Timely implementation of the EEP GBV action plan shall reduce GBV/SEA risks that may arise during Project development and operation.

7.5.9 Livelihood Restoration Plan (LRP)

The LRP will be developed and implemented to manage the potential impacts of the Project on the local farmers that will be economically displaced. The LRP will be prepared and implemented in line with the requirements of the African Development Bank. At a minimum, it LRP will provide:

- a census survey of displaced persons and valuation assets;
- description of compensation and other assistance to be provided;
- engagement with displaced people about acceptable alternatives;
- institutional responsibility for implementation and procedures for grievance redress;
- implementation schedule;
- costs and budget;
- monitoring, evaluation and reporting

The LRP will be developed and implemented prior to the commencement of construction activities.

7.5.10 Summary of Additional Management Plans

Table 7.5 summarizes the additional management plans required for the Project, including the cost estimate for developing each of the plans.

Table 7.2: Additional Management Plans and Timing for Development

S/N	Plan	Timing for Development	Cost Estimates (NAIRA)
1.	Emergency Preparedness and Response Plan	Pre-construction	500,000
2.	Waste Management Plan	Pre-construction	500,000
3.	Occupational Health and Safety	Pre-construction	200,000
4.	Local and Employment Management Plan	Pre-construction	200,000
5.	Erosion and Sediment Control Plan	Pre-construction	1,000,000
6.	Water Conservation Plan	Pre-construction	500,000
7.	EEP Gender Action Plan	Pre-construction	500,000
Total			3,400,000

7.6 Environmental Monitoring Program

Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Table 7.6 summarizes the environmental monitoring programme for the Project

Table 7.3: Environmental and Social Monitoring Programme for the proposed Project

Environmental Components/Matrix	Sampling Locations	Sampling Method	Environmental/Social Parameters to be Monitored	Compliance Requirement	Frequency of Monitoring	Responsible Party	Project Development Phase	Estimated Cost (NGN)
Atmosphere (Air Quality & Noise)	• Project Site • Power Evacuation Route	• Air Quality Monitoring Equipment • Sound Level Meter	TSP, CO, NOx, SOx, Noise Level (dBA)	FMEnv / WHO / AfDB	Monthly monitoring; Monthly reporting	ESC Contractor	Construction Phase	500,000
Groundwater Quality	Borehole within the Community	Thermometer, Water Sampler, Turbidity Meter, pH Meter, AAS, etc.	Temperature, pH, Salinity, TDS, Conductivity, DO, BOD, TOC, COD, NO_3, PO_4, Chloride, Sulphate, Microbiology, Heavy Metals, TSS and Turbidity	FMEnv / WHO	Quarterly monitoring and reporting	ESC Contractor	Construction Phase and Operations Phase	500,000
Soil	Unpaved Sections of the Plant	Composite Soil Samples Collection for Laboratory Analysis	pH, Moisture, TOC, THC, TPH, NO_3, PO_4, Chloride, Sulphate, Microbiology, Heavy Metals	NESREA / AfDB	Quarterly monitoring and reporting	ESC Contractor	Construction Phase and Operations Phase	500,000
Solid Waste	Operational Areas	Monitor the handling and disposal of solid wastes generated onsite; waste tracking documentation	Operational solid wastes including used packaging waste	FMEnv / NESREA / AfDB	Monthly monitoring; Quarterly reporting	ESC Contractor	Construction Phase and Operations Phase	500,000
Health and Safety	Workers and Operational Areas	Observe compliance to PPE and unsafe working conditions	Health and Safety Plan compliance	FMEnv / NESREA / AfDB	Daily monitoring; Quarterly reporting	ESC Contractor	Construction Phase and Operations Phase	500,000
Training	Workers	Observe compliance with existing training plan	Training Plan and Records	FMEnv / NESREA / AfDB	Quarterly monitoring and reporting	ESC Contractor	Construction Phase and Operations Phase	500,000
General Housekeeping	Construction Sheds and Operational Areas	Observe cleanliness and aesthetics of Plant	Cleanliness and aesthetics of Plant	FMEnv / NESREA / AfDB	Daily monitoring; Quarterly reporting	ESC Contractor	Construction Phase and Operations Phase	500,000
Stakeholder Engagement	• Local Community • Regulatory Agencies	Observe evidence of stakeholder consultations	Stakeholder Engagement Plan implementation	FMEnv / NESREA / AfDB	Quarterly monitoring and reporting	ESC Contractor	Construction Phase and Operations Phase	600,000

7.7 Training, Awareness and Capacity Building

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. The Project recognizes that it is important that employees at each relevant phase of the Project are aware of the potential impacts of their activities; and roles and responsibilities in achieving conformance with the management measures documented in this ESMP. This will be achieved through a formal training process.

In addition, training for local community on general environmental awareness and ESMP mitigation measures pertaining to community health, safety and security shall as be provided as indicated in Table 7.3 below.

Table 7.4: Institutional Capacity Strengthening Plan

Target Audience	Training Overview	Cost Estimates (Naira)
Site Engineer, ESC contractor and their sub-contractors, O&M Contractor	In-depth understanding of the mitigation measures proffered by the ESMP. Training on implementation of all emergency response procedures; training on Health, Environment, Safety, and Security Management Plan	1,000,000
Local community	General environmental awareness and mitigation measures proffered by the ESMP pertaining to community health, safety and security.	1,000,000
Total		**2,000,000**

7.8 Implementation Schedule and Reporting

The implementation of the ESMP will take place from the planning stages to ensure quality equipment and support services are sourced, through construction, commissioning to operation phases. Once monitoring of the ESMP begins the officers responsible will report all issues identified to respective authorities in REA and corrective/ remedial actions taken without delay to ensure optimal performance of the Project while promoting environmental sustainability.

Also, REA shall keep the regulatory authorities (FMEnv, NESREA, IMSEPA) informed of the Project performance with respect to E&S related matters 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

7.9 ESMP Costing

Table 7.5 below provides the summary of cost estimate required to effective and efficiently implement the recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed Project.

Table 7.5: ESMP Costing

Fundamental ESMP Activities	Cost Estimates (NAIRA)	Cost Estimates($)
ESMP Implementation Cost	30,600,000	21,103.45
Monitoring Cost	4,100,000	2,827.59
Capacity Building	2,000,000	1,379.31
SEP/GRM Implementation Cost	18,720,000	12,910.34
Additional Management Cost	3,400,000	2,344.83
Total	58,820,000	40,565.52

CHAPTER EIGHT:

REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

CHAPTER EIGHT: REMEDIATION PLAN AFTER DECOMMISIONING/ CLOSURE

8.1 Introduction

Upon the completion of useful life cycle of a project, there is a need to abandon and/or decommission such project if it no longer becomes economically viable either as a result of depleted feed stock or competing technology. The proposed solar project is expected to have a life span of 25 years. It is envisaged that technology and environmental policies could have changed so drastically by then, hence a definite decommissioning plan cannot be put in place for now. However, it is of importance that abandonment activities be planned in advance in accordance with the Nigerian regulatory requirements.

8.2 Decommissioning Activities

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

During decommissioning, NEP shall ensure that the project sites are returned to a safe and environmentally acceptable condition. The decommissioning activities will typically include the following:

- Dismantling and removal of PV panels and associated infrastructure (mounting structure, power evacuation cable, inverters, transformers, batteries, etc.);
- Removal of any sub-surface installations (e.g. underground cables);
- Waste generation and management;
- Restore the environment to allowable baseline conditions and monitor the process in line with legislative and regulatory requirements and best industry standards; and

8.3 Management of Decommissioning Activities

In the event of decommissioning, NEP, in conjunction with the leadership of the FAUMB, 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 FUHSA, the Federal Ministry of Environment and the Bauchi 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 FUHSA to address noncompliance and upcoming issues.

C. FUHSA 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 FAUMB on contractor's performance regarding the implementation of environmental and social measures.

D. Director of Works and Physical Planning Department in FAUMB

- ❖ 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/Bauchi 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.

Table 8.1: Environmental and Social Management Measures for Decommissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring		Responsible Party		Cost (US Dollars)
		Req/Freq Parameters	Performance Indicators	Implementation	Monitoring	
Removal of PV Panels, Batteries and inverters; demolition of buildings and associated facilities						
Soil Contamination due to waste generation; Soil Compaction	Excavation works shall not be executed under aggressive weather conditions.	Inspection	Daily	Contractor Engaged for facility decommissioning	FUHSA (site manager and Director of works and Physical Planning, Federal Ministry of Environment, BASEPA	3000
	Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion	Inspection	Daily			
	Hazardous substances and materials(e,g. Fuel, lubricating oil etc) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment (bund wall). Portable spill containment and clean up kits shall be made available onsite.	Inspection	Daily			
	PV panels, batteries and consignment notes inverters shall be for batteries collected and returne recycling plants to the manufacturer for recycling.	Inspection	Daily			
	All impacted soil area shall be revegetated with native plant species	Inspection	Daily			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	A decommissioning plan approved by the relevant regulatory authorities shall be developed and implemented.	Implementation records of decommissioning plan	Daily	Benchmarks in decommissioning plan			
Air quality impact; increase in dust level.	Dust suppression measures shall be implemented.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	FUHSA (Site Manager and Director of Works and Physical Planning) FMEnv BASEPA	1000
	Decommissioning equipment shall be properly serviced and maintained.	Inspection; Maintenance records	Before commencement of decommissioning activities	Adherence to measures			
Discomforting noise from decommissioning equipment and related activities	Noise suppression equipment (e.g. mufflers) shall be fitted on decommissioning equipment / machinery.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	FUHSA (Site Manager and Director of Works and Physical Planning) FMEnv BASEPA	2000
	Decommissioning activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Inspection	Daily	Adherence to measures			
	Equipment shall be turned off when not in use.	Inspection	Daily	Adherence to measures			
	Equipment shall be properly maintained	Inspection; Maintenance	Once before commence	Adherence to measures			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	and serviced.	records	ment				
	Noise complaints related to the construction activities shall be assessed and appropriately addressed.	Complaint records	Weekly	African Development Bank Good Practice Note on Addressing Grievances			
	Noise monitoring at locations with persistent noise complaints shall be maintained.	Noise monitoring records	Monthly	FMEnv Noise limit African Development Bank			
Groundwater and surface water contamination due to waste generation	Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site.	Training records	Once before commence ment	Certificates of completion of trainings	Contractor(s) engaged for facility decommissioning	FUHSA (Site Manager and Director of Works and Physical Planning) FMEnv BASEPA	1500
	Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment.	Inspection	Daily	Adherence to measures World Bank General EHS Guidelines			
	Portable spill containment and clean-up kits shall be available onsite.						
	Waste Management Plan shall be implemented.	WMP implementation	Daily	Benchmarks stated in WMP			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
		records		World Bank General EHS Guidelines			
Traffic due to transportation of dismantled equipment and materials from site including wastes	TMP shall be implemented.	TMP implementation records	Daily	Benchmarks stated in the TMP	Contractor(s) engaged for facility decommissioning	FUHSA (Site Manager and Director of Works and Physical Planning) FMEnv BASEPA	2500
	Appropriate barriers and signage shall be provided to demarcate areas in which traffic is active.	Safety signs and barriers	Once before commence ment	Adherence to measures			
	Drivers' competency shall be assessed and where required training shall be provided.	Drivers' competency assessments; training records	Once before commence ment	Passing of competency assessment or training completion certificates			
	A procedure for recording all decommissioning related traffic incidents/accidents shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc.	Incident forms	Daily	Completed incident forms			
	The EPC contractor shall promptly repair damage to public infrastructure	Incident forms, GRM	Daily during decommissio ning	Completed incident forms	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	and repair or compensate for damage to private property.		oning phase				
Exposure to injuries, electrical shock, slip, trip and fall	All workers involved in the decommissioning activities shall be sensitized and monitored on the need to be safety conscious. Daily toolbox talks prior to commencement of work activities shall be carried out.	Daily toolbox records	Daily	Benchmarks stated in Health and Safety Plan	Contractor(s) engaged for facility decommissioning	FUHSA (Site Manager and Director of Works and Physical Planning) FMEnv BASEPA	2500
	Appropriate PPE shall be provided for workers.	Availability of PPE	Daily	PPE compliance			
	Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.	Qualified a nd dedicated safety officer	Once before commence ment	Adherence to measures			
	Health and safety plans shall be implemented.	Health and Safety plan implementation records	Daily during constructio n phase	Benchmarks stated in Health and Safety Plan			

CHAPTER NINE: STAKEHOLDER ENGAGEMENT PLAN AND GRIEVANCE REDRESS MECHASNISM

STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

This section describes the Stakeholder engagement activities as well as the grievance mechanism to be implemented for the proposed solar power plant and associated infrastructure in Federal University of Health Sciences (FUHSA), under the Federal Government's Energizing Education Programme (EEP) Phase II.

9.1 Stakeholder Engagement

Stakeholder engagement is an ongoing process of sharing Project information, understanding stakeholder concerns, and building relationships based on collaboration. Stakeholder consultation is a key element of engagement and essential for effective Project delivery. Disclosure of information is equally as vital and must focus on informed consultation and participation with the local community and relevant stakeholders. If there are risks or adverse impacts from a Project, consultation must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views. In line with current guidance from the African Development Bank, consultation should ensure "*that appropriate project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible and appropriate manner and format*" In other words, effective consultation requires the prior disclosure of relevant and adequate Project information to enable stakeholders to understand the risks, impacts, and opportunities. The Project's consultation program was intended to ensure that stakeholder concerns are considered, addressed and incorporated in the development process, especially during the ESIA.

9.2 Legal and Administrative Framework Guiding Stakeholder Engagement

The stakeholder engagement was carried out to ensure compliance with both Nigerian legislative requirements, as well as international standards (as defined in the African Development Bank's Safeguard Policy – Operational Policy 4.01, Environmental Assessment). This section presents the relevant standards and legislation that relate directly to the public participation and stakeholder engagement requirements for the proposed Project.

9.2.1 Nigerian Legislative Requirements

1.2.1.1 EIA Act No. 86 of 1992 (as amended by the EIA Cap E12 LFN 2004)

The EIA Act is the primary Act governing the environmental and social assessment of developmental projects or activities in Nigeria. Section 2(2) of the Act requires that where the extent, nature or location of a proposed project or activity is such that it is likely to significantly affect the environment, an EIA must be undertaken in accordance with the provisions of the Act.

Section 55 of the EIA Act provides for the maintenance of a Public Registry to facilitate public access to records relating to environmental assessments. Public hearings to which interested members of the public are invited are a key part of the approval process for EIA reports by the Federal Ministry of Environment (FMEnv). However, this project shall not be subject to a public hearing but rather an in-house review to be conducted by the FMEnv. This arrangement was adopted based on the abridged EIA process for the Nigeria Electrification Projects (NEP), which has been approved by the FMEnv.

9.2.2 International Requirements

9.2.2.1 African Development Bank requirements for Stakeholder Engagement and Information Disclosure

The project will endeavour to meet standards and requirements set out by the African Development Bank safeguard policies as defined below:

 African Development Bank OP 4.01 - Environmental Assessment

If there are risks or adverse impacts from the Project, engagement must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views. Engagement should ensure ‘free, prior and informed engagement of the affected communities (1).’ The African Development Bank Operational Policy (OP) 4.01 requires at least one round of engagement early in the Environmental and Social Impact Assessment (ESIA) process, and again one on the final ESIA report before decision-making. In other words, effective engagement requires the prior disclosure of relevant and adequate project information to enable stakeholders to understand the risks, impacts, and opportunities.

9.3 Objectives of Stakeholder Engagement

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:

- 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;
- 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.

9.3.1 Stakeholder Identification and Analysis

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively (IFC, 2007). Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organizations and groups with special interests, the academic community, or other businesses.

Proper stakeholder identification forms the basis on which the stakeholder engagement was conducted for the Project as well as the development of the stakeholder engagement plan. It is necessary to determine who the stakeholders of a project are and understand their priorities and objectives. In addition, it is also essential that stakeholders are classified based on their position, influence, capacity and interests in order to develop a functional Stakeholder Engagement Plan (SEP) that is tailored to meet the individual and group needs of the identified stakeholders.

The EPC Contractor shall develop and implement an effective SEP which shall be maintained throughout the lifecycle of the project. A sample format for the SEP is outlined in the Environmental and Social Management framework (ESMF) for NEP. A list of identified stakeholders for the Project is shown in Table 2.1. This consists of individuals, groups, and organizations that may be affected by or may influence project development positively or negatively. The list was developed using international guidance and considered the following groups: national and local governments; Local community leaders; community members including potentially vulnerable sub-groups such as women, youth and elderly; international, national and local environmental and social Non-Government Organizations (NGOs); Potential contractors and service suppliers; and local businesses/cooperatives and associations.

Table 9.1: Identified Stakeholders Associated with the Proposed Project

Stakeholder Group / Interest in the Proposed Project	Stakeholder Name	International	National	State	Local	Connection to the Proposed Project
Project Sponsor	African Development Bank	✓				Provides financial and technical support for project development and operation.
Regulatory Authorities	Federal Ministry of Environment (FMEnv)		✓			Responsible for overseeing the Environmental Impact Assessment (EIA) process and

						ensuring compliance with relevant environmental laws and regulations.
	National Environmental Standards and Regulations Enforcement Agency (NESREA)		✓			Responsible for monitoring the project during the operational phase and ensuring compliance with national environmental laws and regulations.
	Federal Ministry of Power, Works and Housing (Department of Renewable Energy)		✓			Coordinates renewable energy and energy efficiency initiatives in Nigeria.
	Nigerian Electricity Regulatory Commission (NERC)		✓			Responsible for granting operational licences for solar power projects.
	Bauchi Environmental Protection and Sanitation Agency (BASEPA)			✓		Responsible for waste management and enforcement of state environmental laws in Bauchi State.
Social and Institutional Stakeholders	Federal Ministry of Women Affairs and Social Development		✓	✓		Promotes gender equality, women empowerment, and gender inclusion in development programmes.
	Federal Ministry of Youth and Sports Development		✓	✓		Responsible for youth development and inclusion in national development programmes and recreational activities.
Local Government Authorities	Katagum Local Government Area (LGA)				✓	Local government authority within which the project area is located.
Host Community	Azare Community				✓	Households, community members, and groups that may be directly or indirectly affected by the proposed project and its activities.
University Community	Federal University of				✓	Direct beneficiaries of

(Project Beneficiaries)	Health Sciences Management					the project through improved energy access and infrastructure.
	Physical Planning Office, Federal University of Health Sciences				✓	Responsible for planning, development coordination, and integration of the project within the university infrastructure.
	Federal University of Health Sciences Student Union Body				✓	Represents student interests and serves as a key stakeholder among the project beneficiaries.

9.3.2 Stakeholder Register

The project shall maintain a stakeholder engagement register for recording stakeholder information such as contact details, dates of engagement with comments and follow up requirements. A sample stakeholder engagement register is provided in Table 2.2.

9.2: Sample Stakeholder Engagement Register

Stakeholder category (choose from the list)	Individual or group (choose from list)	Stakeholder name	Organization	Position in their organization	Location	Contact addres	Contact	Contact email	Stakeholder interest	Stakeholder priority	Engagement	Method of engagemen	Date of engagemen	Issues raised	Follow-up

9.3.3. Stakeholder Engagement Process

REA shall adopt a proactive approach towards building and maintaining mutually beneficial relationships with all relevant stakeholders, throughout its operations. The engagement program shall be implemented to comply with national and international standards. The stakeholder engagement will be free of manipulation, interference, coercion, and intimidation. It shall be conducted on the basis of timely, relevant, understandable and accessible information.

Effective stakeholder engagement depends on mutual trust, respect and transparent communication between the Project and its stakeholders. It thereby improves REA's decision-making and performance by:

- **Managing costs:** Effective engagement can help project REA avoid costs, in terms of money and reputation;
- **Managing risk:** Engagement helps project REA and communities to identify, prevent, and mitigate environmental and social impacts that can threaten project viability;
- **Enhancing reputation:** By publicly recognising human rights and committing to environmental protection, REA and financial institutions (African Development Bank) involved in financing the project can boost their credibility and minimise risks;
- **Avoiding conflict:** Understanding current and potential issues such as land rights and proposed project activities;
- **Improving corporate policy:** Obtaining perceptions about a project, which can act as a catalyst for changes and improvements in REA corporate practices and policies;
- **Identifying, monitoring and reporting on impacts:** Understanding a project's impact on stakeholders, evaluating and reporting back on mechanisms to address these impacts; and
- **Managing stakeholder expectations:** Consultation also provides the opportunity for REA to become aware of and manage stakeholder attitudes and expectations.

Table 2.3 presents elements of the stakeholder engagement program to be implemented by REA.

Table 9.3: Stakeholder Engagement Process

Stakeholder Engagement Activity	Approach
Stakeholder Identification and Analysis	An initial stakeholder identification and analysis has been conducted as part of this ESIA. REA shall maintain a register of identified stakeholders and undertake periodic review on a need basis.

Information Disclosure	REA shall ensure that information is provided to relevant stakeholders on an on-going basis over the course of the Project lifecycle. REA shall maintain regular communication with its stakeholders throughout the project lifecycle.
Stakeholder	REA shall consult with its various stakeholders on mutual concerns to fulfil its compliance obligations in line with industry best practice. REA shall maintain records of its consultation with its various stakeholders.
Negotiation Partnership	REA shall adopt a stakeholder management process that fosters the mutual interest of all parties and adds value to its operation.
Grievance Management	REA shall provide appropriate channels for stakeholders to raise their concerns and grievances about its operations
Stakeholders Involvement	This entails procedures that allow the direct involvement of stakeholders in project related functions in order to foster
Reporting stakeholders	REA shall establish reporting procedure that allows information disclosure to stakeholders about the environmental social and economic performance of its operations.
Management Functions	REA shall build and maintain management capacity within the company to manage the process of stakeholder engagement, track commitments and report on progress.

9.3.4 Stakeholder Engagement Tool and Communication

REA recognizes the need to tailor its stakeholder engagement approach and information disclosure to suit the needs of each of its stakeholder. REA shall adopt a variety of communication and engagement methods to ensure continuous engagement, dialogue and feedback is established during its engagement activities. Table 9.4 presents various tools and methods to be adopted by REA during its stakeholder engagement process.

Table 9.4: Stakeholder Engagement Tools and Communication

Medium	Most Appropriate Application
Stakeholder meetings	
One-on-one consultations	• REA shall on a need basis hold consultation meetings with its individual • stakeholders. These meetings will be held to: • Solicit views and opinions; • Discuss freely and confidently about stakeholder concerns and provide feedback etc.; • Build personal relations with stakeholders.
Focus group discussions	REA shall on a need basis hold focus group discussions (FGDs) to pull together a small group of people with the same interest into a single meeting to engage them on common issues. FGDs would have specific objective and be aligned with the expectations and interest of the stakeholders present.
Workshops	REA shall on a need basis hold workshops with its various stakeholders. Workshops are ad-hoc outcomes-based meetings that seek to find solutions for specific issues facing the environment and social aspects. When conducting a workshop, REA shall use participatory exercises to facilitate group discussions, brainstorm issues, analyse information, and develop recommendations strategies.
Forum	REA shall on a need basis use forum to engage with various stakeholders. Participatory tools and methodologies such as workshops, town hall meetings, and FGDs will continue to be utilized, as they are more likely to increase stakeholder involvement in the process and elicit alternative responses, especially if there is controversy or complexity, or a need to build a consensus around possible solutions.

Written / visual/electronic communication	• Newsletter • Emails • Meetings • Executive Summary of the ESIA • Mass Media and Newspaper Print etc. • Survey

Table 9.5 presents a stakeholder analysis with respect to appropriate levels of consultation for each of the major stakeholder groups. REA shall determine the frequency of these interactions.

Table 9.5: Stakeholder Group Consultation Methods

STAKEHOLDER GROUP	CONSULTATION METHOD
Government and Regulators	Email exchanges and letters One-on-one consultations Formal meetings Print media Compliance reporting Performance report (Audits)
Project beneficiaries (FUHSA Management, Physical Planning, Students)	Formal meetings One-on-one consultations Print media Strategic collaboration Information Centre
Employees	Phone / email / text messaging/ WhatsApp Print media Workshops Focus group meetings Surveys Management/departmental meetings Performance appraisal Trainings
NGO's	Phone / email One-on-one interviews Town hall meetings Focus group meetings Information Centre

9.3.5 Principles for Effective Stakeholder Engagement

Stakeholder engagement is usually informed by a set of principles defining core values underpinning interactions with stakeholders. Common principles based on International Best Practice include the following:

- **Commitment** is demonstrated when the need to understand, engage and identify the key stakeholders is recognized and acted upon;
- **Integrity** occurs when engagement is conducted in a manner that fosters mutual respect and trust
- **Respect** is created when the rights, values and interests of stakeholders and neighbors are recognized;
- **Transparency** is demonstrated when stakeholder concerns are responded to in a timely, open and effective manner;
- **Inclusiveness** is achieved when broad participation is encouraged and supported by appropriate participation opportunities; and
- **Trust** is achieved through open and meaningful dialogue that respects stakeholder's values and opinions.

9.4 Summary of Previous Stakeholder Engagement Activities

This section describes the initial Stakeholder engagement activities carried out during the ESIA. The initial consultations were carried out from 25th -31st January, 2026 with the following:

- Bauchi State Environmental Protection Agency
- Federal Ministry of Women Affairs and Social Development
- Federal Ministry of Youth and Sports
- Federal Ministry of Environment
- FUHSA Vice Chancellor
- FUHSA Director of works and Physical Planning
- FUHSA Student Union Government President
- Katagum Local Government Area
- Azare Community Leader
- Civil Society Organizations
- Nigerian Women Trust Fund

The consultations served to provide stakeholders with information about the proposed Project and to gather information important to the ESIA. The objective was to identify any key concerns or high-level issues that the stakeholders had at this early stage.

Table 9.6 Stakeholders Concerns Raised

S/N	Stakeholder	Location	Date	Key Concerns / Issues Raised	Consultant's Response / How Addressed
1	Bauchi State Environmental Protection Agency (BASEPA)	Bauchi	25th -31st Jan, 2026	• Proper waste management including e-waste • Employment opportunities for locals • Consideration of project alternatives • Ability of project to meet energy demand • Need for standard baseline studies	• Waste Management Plan (including e-waste) will be developed and implemented • ~60% local employment during construction • Alternatives (battery types, PV options) assessed in ESIA • Energy audit conducted to determine demand • Baseline studies conducted using best practice
2	FUHSA Vice Chancellor	FUHSA Campus,	25th -31st Jan, 2026	• Project sustainability • Inclusiveness (e.g., female students) • Security concerns	• Project designed to serve entire university • Sustainability ensured via institutional support • No gender exclusion anticipated • Security arrangements incorporated

3	FUHSA Director of Works & Physical Planning	FUHSA	25th -31st Jan, 2026	• Site suitability and land use • Lack of e-waste facilities	• Site confirmed appropriate and approved • Waste management plan including e-waste proposed
4	FUHSA Student Union Government	FUHSA	25th -31st Jan, 2026	• Erratic power supply • Need for improved electricity • Student welfare benefits	• Project will provide stable electricity to meet university demand • Distribution designed to cover all facilities
5	Azare Community Leader	Azare Community (≈2 km from site)	25th -31st Jan, 2026	• Loss of farmlands • Inclusion in project decisions • Employment for community youths	• Farmers to be consulted prior to project commencement • Local employment prioritized • Continuous stakeholder engagement ensured
6	Civil Society Organizations / Nigerian Women Trust Fund	Bauchi	5th–12th Feb 2026	• Gender inclusion • GBV risks • Social safeguards	• GBV Action Plan included in ESMP • Gender-sensitive GRM to be implemented
7	Government MDAs (Women Affairs, Youth & Sports, LGA)	Bauchi	25th -31st Jan, 2026	• Youth employment • Social development benefits	• Local employment prioritized • Skill development and training integrated into project design

9.5 Management Function and Grievance Mechanism

9.5.1 *Management Commitment*

REA is committed to implementing stakeholder management as part of its operations. As such REA will ensure that the responsibility for implementing the SEP is duly assigned and all components of the plan are well-defined within its organizational processes. REA shall also commit to providing the necessary support to implement the SEP. The management structure for the SEP shall include the following elements.

Systems: REA will pursue its Stakeholder engagement activities as scheduled in a systematic manner that creates predictability in the eyes of the stakeholder in order to support and foster a relationship that is based on trust.

Structure: REA will establish a Stakeholder focused-structure within its organizational processes to provide the needed decision-making authority to enable quicker turnaround time on Stakeholder engagement activities and grievance feedback.

Skills: REA will ensure that the required internal capacity for effective Stakeholder engagement is provided for the implementation of the stakeholder engagement plan.

9.5.2 Roles and Responsibilities

REA shall assign the responsibilities of conducting and organizing stakeholder consultation and involvement to competent individuals. The individuals shall be qualified professionals with relevant skills and experience. The REA Project Management Unit shall have the overall responsibility of overseeing the implementation of the SEP. The role of managing stakeholder engagement shall be given to the University's Community Liaison Officer (CLO). The CLO shall monitor the implementation of the Project's stakeholder engagement program and report findings to the REA Project Management Unit.

9.5.3 Grievance Redress Mechanism (GRM)

A Project-specific Grievance Redress Mechanism (GRM) shall be established for the proposed mini-grid project to provide an accessible, transparent, culturally appropriate, and timely process through which project-affected persons (PAPs), host communities, workers, vulnerable groups, local authorities, and other stakeholders can raise concerns, complaints, or suggestions related to project activities. The GRM has been designed in accordance with the requirements of the African Development Bank (AfDB) Integrated Safeguards System (ISS, 2023), the National Environmental (Access to Environmental Justice) principles, and the Rural Electrification Agency (REA) stakeholder engagement framework under the Nigeria Electrification Programme (NEP). The mechanism shall operate throughout the project lifecycle, including the pre-construction, construction, operation, maintenance, and decommissioning phases.

The objectives of the GRM are to:

- Provide a predictable and transparent process for receiving and resolving grievances;
- Promote accountability and trust between project stakeholders and the project developer;
- Ensure early identification and resolution of concerns before they escalate into disputes;
- Provide special consideration for vulnerable and disadvantaged groups;
- Improve project performance through stakeholder feedback;
- Reduce social conflicts and project implementation delays;
- Ensure that complainants are not subjected to retaliation, discrimination, intimidation, or victimization.

Guiding Principles

The GRM shall be guided by the following principles:

- Accessibility;
- Inclusiveness;
- Fairness and impartiality;
- Transparency;

- Confidentiality;
- Cultural appropriateness
- Non-retaliation;
- Timeliness;
- Continuous improvement and learning.

Types of Grievances Covered
The GRM shall address grievances relating to:
- Land acquisition and access restrictions;
- Compensation and livelihood restoration issues;
- Employment and labour-related matters;
- Community health and safety concerns;
- Traffic and transportation impacts;
- Noise, dust, waste management, and environmental pollution;
- Damage to crops, property, or community assets;
- Gender-based violence (GBV), sexual exploitation and abuse (SEA), and sexual harassment (SH);
- Worker misconduct;
- Community-worker conflicts;
- Procurement and contractor-related complaints;
- Electricity access and service delivery concerns;
- Project benefit-sharing issues;
- Any other concern arising from project implementation.

Grievance Uptake Channels
Multiple grievance uptake channels shall be established to ensure accessibility to all stakeholders.
Stakeholders may submit grievances through:
1. Community Grievance Desk
    - Community Liaison Officer (CLO);
    - Village Head/Traditional Leader;
    - Community Grievance Committee representatives.
2. Written Complaints
    - Complaint forms available at community centres;
    - Project site offices;
    - Local government offices.
3. Telephone Hotline
    - Dedicated toll-free telephone number.
4. SMS Platform
    - Dedicated mobile number for text messages.
5. Email Submission
    - Dedicated project grievance email address.
6. Suggestion and Complaint Boxes
    - Located at strategic community locations.
7. Stakeholder Meetings
    - Community consultation meetings;
    - Town hall meetings;
    - Focus group discussions.
8. Project Website and Social Media Platforms

9. Direct Reporting to Project Staff
10. Anonymous Reporting Mechanism
    - Anonymous complaints shall be accepted and investigated where sufficient information is provided.

Accessibility Provisions
The GRM shall be designed to ensure equitable access for all stakeholders including vulnerable groups.
Accessibility measures shall include:
- Use of local languages during consultations and grievance handling;
- Oral complaint submission for illiterate complainants;
- Translation and interpretation services where necessary;
- Gender-sensitive reporting arrangements;
- Separate reporting pathways for women and girls;
- Support for persons living with disabilities;
- Home visits for elderly or mobility-constrained individuals;
- Confidential reporting options;
- Community-based grievance focal persons;
- No cost to complainants for filing grievances.

Institutional Arrangements
Community Grievance Redress Committee (CGRC)
The Community Grievance Redress Committee shall serve as the first level of grievance resolution.
- Traditional ruler or representative (Chairperson);
- Community Development Association representative;
- Women's representative;
- Youth representative;
- Vulnerable group representative;
- Community Liaison Officer;
- Religious leader;
- Project representative (Secretary).

Functions:
- Receive grievances;
- Register complaints;
- Conduct preliminary investigations;
- Facilitate mediation;
- Resolve grievances at community level;
- Maintain grievance records;
- Forward unresolved cases to the PMU.

Project Grievance Redress Committee (PGRC)
The Project Grievance Redress Committee shall serve as the second level of grievance management.
- Project Manager (Chairperson);
- Environmental Officer;
- Social Safeguards Officer;
- Community Liaison Officer;
- Contractor Representative;

- Local Government Representative;
- Legal Adviser;
- Gender Specialist.

Functions:

- Review unresolved grievances;
- Conduct investigations;
- Recommend corrective actions;
- Approve compensation where applicable;
- Monitor implementation of resolutions;
- Prepare quarterly grievance reports.

Special GBV/SEA/SH Response Committee

Sensitive complaints involving gender-based violence, sexual exploitation and abuse, or sexual harassment shall follow a survivor-centered approach.

Such cases shall:

- Be handled confidentially;
- Not be investigated by community committees;
- Be referred immediately to qualified GBV service providers
- Respect survivor consent;
- Protect survivor identity;
- Follow national referral pathways.

Grievance Resolution Process

Step 1: Receipt of Grievance

Timeline: Day 0

The grievance shall be received through any approved channel and entered into the Grievance Register.

Information recorded shall include:

- Date received;
- Complainant details;
- Nature of grievance;
- Location;
- Desired resolution;
- Supporting evidence.

Step 2: Acknowledgement

Timeline: Within 48 hours

The complainant shall receive acknowledgement through:

- Written communication;
- SMS;
- Email;
- Telephone call;
- Community focal person.

Step 3: Screening and Classification

Timeline: Within 3 working days

The grievance shall be categorized as:

- Environmental;
- Social;
- Labour;

- Health and safety;
- Compensation;
- GBV/SEA/SH;
- Operational/service-related.

Priority levels shall be assigned as:

- Low;
- Medium;
- High;
- Critical.

Step 4: Investigation
Timeline: Within 7 working days
Investigation activities may include:

- Site inspections;
- Interviews;
- Review of documentation;
- Stakeholder consultations;
- Technical assessments.

Step 5: Resolution Proposal
Timeline: Within 14 working days
Appropriate corrective actions shall be proposed and communicated to the complainant.

Step 6: Agreement and Implementation
Timeline: Within 21 working days
Upon acceptance of the proposed resolution, implementation shall commence immediately.

Step 7: Closure
Timeline: Within 30 working days
The grievance shall be closed only when:

- Resolution has been implemented;
- Complainant confirms satisfaction; or
- All reasonable efforts have been exhausted.

A closure form shall be signed and filed.

Grievance Escalation Procedure
Where grievances remain unresolved, the following escalation hierarchy shall apply:

Level Community Grievance Redress Committee	1
Level Project Grievance Redress Committee	2
Level REA Project Management Unit	3

Level Local Government Authority	4
Level Federal Ministry of Environment	5
Level Judicial System/Courts of Competent Jurisdiction	6

Monitoring and Reporting

The Social Safeguards Officer shall maintain a Grievance Database containing:

- Number of grievances received;
- Number resolved;
- Number pending;
- Average resolution time;
- Nature of grievances;
- Gender-disaggregated statistics;
- Vulnerable group statistics;
- Corrective actions implemented.

Quarterly reports shall be submitted to REA and relevant regulatory authorities.
Key performance indicators shall include:

- Percentage of grievances acknowledged within 48 hours;
- Percentage resolved within 30 days;
- Number of repeat grievances;
- Stakeholder satisfaction rate;
- Number of GBV cases referred appropriately.

Disclosure and Awareness

The GRM shall be publicly disclosed through:

- Community meetings;
- Posters and banners;
- Radio announcements;
- Project information leaflets;
- Local government offices;
- Traditional institutions;
- Project website.

Awareness campaigns shall be conducted before commencement of construction activities and periodically throughout project implementation.

Estimated Cost of GRM Implementation

The estimated budget for implementation of the GRM over the project lifecycle is Five Million Naira (₦18,720,000), disaggregated as follows:

Activity	Estimated Cost (₦)	**Estimated Cost ($)**
Establishment of Community Grievance Committees	3,000,000	2,069
GRM awareness and sensitization campaigns	3,000,000	2,069
Production of grievance forms, registers and IEC materials	1,000,000	689.7
Installation of grievance boxes and communication materials	1,500,000	1,034.5
Hotline, SMS and communication expenses	2,000,000	1,379.3
Committee meetings and mediation sessions	2,000,000	1,379.3
Capacity building and training of GRM personnel	2,000,000	1,379.3
Monitoring, reporting and database management	1,500,000	1,034.5
GBV/SEA/SH referral support and specialist services	2,000,000	1,379.3
Contingency (approximately 4%)	720,000	496.6
Total	₦18,720,000	12,910.5

The Project Developer shall be responsible for ensuring adequate financial resources are available for effective implementation, monitoring, and continuous improvement of the GRM throughout the project lifecycle.

CHAPTER TEN:

CONCLUSION AND RECOMMENDATIONS

CHAPTER TEN

CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

The ESIA of the proposed solar-hybrid power plant and associated infrastructure in FUHSA, BAUSG under the EEP Phase II has been conducted in accordance with the relevant requirements of the FMEnv guidelines and the applicable requirements of the African Development Bank Safeguard Policies, specifically the Operational Policy 4.01 and Involuntary Resettlement Policy 4.12 triggered by the proposed Project.

The ESIA study consists of a number of key steps including: desktop review, scoping, consultations with relevant stakeholders including relevant government authorities and potentially affected community in the Project's area of influence, field data gathering, laboratory analysis of field samples, potential impact identification and evaluation, development of mitigation measures and environmental management plan, report writing and disclosure.

The essence of the ESIA process is aimed at ensuring informed decision-making and environmental accountability, and to assist in achieving environmentally sound operation and social acceptance throughout the life cycle of the proposed Project.

Consistent with the regulatory standards, the assessment of the environmental status and the socio-economic aspects of the proposed Project's area of influence have been carefully carried out using accepted scientific methodology. Evaluation of associated and potential impacts of the proposed Project identified both positive and negative interactions with the receiving biophysical and socio-economic environment.

The positive impacts associated with the Project include:

- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Reduction in fossil fuel consumption by the University thereby leading to reduction in carbon emissions and improvement in eco-balance.
- Significant reduction in the cost of power generation by the University through diesel-fuelled generators. Such savings would be used for other undertakings that will benefit the University.

- Increase in social interactions within the University. There will be enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.
- Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the Project.
- Improvement in livelihood enhancing activities within the University.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects.
- Increase in local and regional economy through award of contracts and purchase of supplies for Project development.
- Increase in financial and technical collaborations between the FGN, the University, REA, African Development Bank and other relevant Ministries, Departments and Agencies (MDAs).
- Contribution to the Nigeria's NDC to cut carbon emission by 20 % to 30 % by the year 2030, under the Paris Agreement.

The identified negative impacts of the proposed Project were mostly of minor to moderate significance, and they are largely site-specific and localized. The identified potential negative impacts include:

- Economic displacement of local farmers from Azare community on site.
- Decreased in ambient air quality due to construction and decommissioning activities.
- Increase in ambient noise level due to construction and decommissioning activities.
- Decrease in soil quality due to improper management of generated wastes during construction, operation and decommissioning.
- Environmental nuisance due to improper disposal of e-waste including spent/damaged batteries.
- Influx of potential job seekers during construction which could pose indirect impacts on the nearby local community.
- Occupational health and safety issues during construction, operation and decommissioning.

Based on the nature and extent of the proposed Project and the findings of the ESIA study, it is believed that the potential negative impacts associated with the proposed Project can be mitigated to as low as reasonably practicable through the implementation of the proffered mitigation measures documented in Chapter 6 of this report, while the positive impacts can also be enhanced. In addition, an ESMP has been established (refer to Chapter 7 of this report) to assess the efficiency and effectiveness of the recommended mitigation measures and ensure long-term monitoring of the Project.

10.2 Recommendations

The ESIA study recommends the following:

1. The REA, through its Project Management Unit (PMU), as well as the leadership of FUHSA, through its Department of Works and Physical Planning, shall ensure that the proposed Project is developed and operated in an environmentally and socially sustainable manner by properly managing the processes/activities that may bring about disturbances to the environment through the implementation of the recommended mitigation measures and the ESMP.
2. Continuous monitoring of environmental and social performance of the Project shall be ensured, including periodic consultation with the relevant regulatory authorities, the potentially affected community, and other relevant stakeholders throughout the Project life cycle.
3. Implementation of the Project's Stakeholder Engagement Plan (including grievance redress mechanism) shall be maintained.

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APPENDICES

APPENDIX 4.1

Socio-Economic Data Gathering Records

Key Informant interview Attendance with Azare Community, Katagum

RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

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RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
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REA-NEP II PROJECT – PREPARATION OF ESIA

ATTENDANCE

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REA — RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
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REA-NEP II PROJECT – PREPARATION OF ESIA
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RURAL ELECTRIFICATION AGENCY

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RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION: FUHSA DATE: 29-01-2026

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RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION: District Head office Town Hall Azare DATE: 28-01-2026

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RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA

ATTENDANCE

LOCATION: Ministry of Housing and Environment Bauchi DATE: 02-02-2026

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RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA

ATTENDANCE

LOCATION: Gursoli Community DATE: 28-01-2026

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REA
RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION Gursoli Community DATE 28-01-2026

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
1	Safa musa	09068876344 ~~09068~~		Gursoli	Gursoli	
2	Umar Ahmad	07061831969		Gursoli	"	
3	Safiq Ahmad	09163216572		Gursoli	"	
4	Hafizu Minkaila	08108527242		Gursoli	"	
5	Ahmad Bello	07061372967	Amadu Bello932@gmail.com	Gursoli	"	

REA
RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA
ATTENDANCE

LOCATION Gursoli Community DATE 28-01-2026

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
1	Safa musa	09068876344 ~~09068~~		Gursoli	Gursoli	
2	Umar Ahmad	07061831969		Gursoli	"	
3	Safiq Ahmad	09163216572		Gursoli	"	
4	Hafizu Minkaila	08108527242		Gursoli	"	
5	Ahmad Bello	07061372967	Amadu Bello932@gmail.com	Gursoli	"	

RURAL ELECTRIFICATION AGENCY

REA-NEP II PROJECT – PREPARATION OF ESIA

ATTENDANCE

LOCATION: Bauchi State Environmental Protection Agency DATE: 02-02-2026

S/N	NAME	PHONE NUMBER	EMAIL	ADDRESS	ORGANIZATION/COMMUNITY	SIGNATURE
1	Dr Mahmud Mohd Bose	08036252013	Mahmudbose@gmail.com	BASEPA	BASEPA	[signature]
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Annex 1: Terms of Reference for the preparation of Environmental and Social Impact Assessment in Federal University of Health Sciences (FUHSA)

1. INTRODUCTION/ BACKGROUND

The Federal Government of Nigeria (FGN) has received financing from the African Development Bank for the Nigeria Electrification Project (NEP) and intends to apply part of the proceeds for Consultancy Services for the preparation of an Environmental & Social Impact Assessment (ESIA).

DESCRIPTION OF THE PROJECT

The Nigeria Electrification Project (NEP) is focused on practical, medium-term opportunities to significantly upscale electricity access through off-grid with different components. i.e., ***Component 1: Solar Hybrid Mini Grids for Rural Economic Development; Component 2: Productive Use Appliances and Equipment;*** and ***Component 3: Energizing Education Programme (EEP).***

Component 3: Energizing Education Programme (EEP)

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

- Energizing Education Programme: Electrification of 24 Federal Universities and Teaching Hospitals with solar-hybrid mini-grids exceeding 1 MW capacity per site.
- Energizing Healthcare Facilities: Deployment of reliable energy to health centres in underserved regions.
- 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.

STATUTORY LEGAL REQUIREMENT

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 (2024)
- 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.

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.

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

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)*	***Payment (%age of Total Remuneration)***
.	**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	2 weeks	20%

	for completion of the survey and next activities. The consultant must submit electronic copies of this progress report		
.	**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	30
	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	20
.	**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	30

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.

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.

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).

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.

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.

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.

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.

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.

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.

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

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.

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.

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.

CONSULTING FIRM QUALIFICATION / COMPETENCY AND EXPERTISE REQUIREMENT

The Consulting firm must have a minimum of 10 years of post-incorporation experience in the environmental and social sector. The firm must be duly registered with the Federal Ministry of Environment and have a valid certification for operating in Nigeria.

The firm must have:

- Demonstrated in-depth understanding of Nigeria's regulatory framework for environmental projects and experience working with relevant regulatory bodies involved in the review and approval of environmental projects.
- Experience with African Development Bank's Integrated Safeguards System (AfDB-ISS) or other MDAs Safeguard Systems, including compliance with environmental and social assessment requirements
- Proven experience in conducting environmental and social assessments, producing comprehensive reports that align with regulatory requirements and stakeholder needs.
- Capability to produce clear, detailed, and actionable reports that meet the expectations of both regulatory bodies and review processes.
- Deep understanding of resettlement and livelihood restoration issues in the Nigerian context.
- A track record of successfully engaging stakeholders, including affected communities, regulators, and other key groups through consultation processes.
- A proven record of successfully completing several environmental and social projects in Nigeria.
- Demonstrated ability to manage and execute projects in Nigeria, with experience working with industry, state, and federal government MDAs and relevant stakeholders.
- Experience in surveying projects, particularly in land surveys in Nigeria.
- Proven experience in collaborating with relevant regulatory bodies and government agencies in the context of surveying projects.
- Excellent written and verbal communication skills, with the ability to produce high-quality, clear documentation.

- Effective in presenting complex issues in an accessible manner to a variety of stakeholders.
- Demonstrated efficient and effective time management skills, ensuring timely delivery of project milestones and documentation.
- Evidence of completing similar assignments for the African Development Bank (AfDB) or other international donors will be considered an added advantage.

The Consulting Firm shall provide experienced personnel to carry out the assignment with the following minimum qualifications:

SN	Personnel – ESIA	Minimum Qualifications	Experience in years
1	Team Leader / Lead Environmental Specialist	MSc in Environmental Sciences, Natural Sciences or Similar Discipline	• Minimum 10 years post-graduation experience. • At least 8 years specific experience leading Environmental and Social Impact Assessments (ESIAs). • Proven record of serving as Team Leader on at least two (2) AfDB or other multilateral development bank (MDB)-funded ESIA projects within the last 5 years. • Demonstrated leadership, coordination, and stakeholder engagement skills.
2	Social Development / Safeguards Specialist	MSc in Sociology, Social Sciences, Environmental or Development Studies	• Minimum 7 years post-qualification experience. • At least 5 years specific experience in social assessment, stakeholder engagement, resettlement planning, and livelihood restoration. • Participation in at least one (1) MDB-funded ESIA or Resettlement Action Plan (RAP) projects within the last 5 years.
3	Air quality and Noise specialist	MSc in Environmental Sciences, Environmental Engineering, or a related discipline	• Minimum 7 years' post-graduation experience. • At least 5 years specific experience in air quality monitoring, emissions modelling, and noise assessment. • Participation in at least one (1) MDB-funded ESIA assignments (including AfDB) within the last 5 years.
4	Ecologist / Biodiversity Specialist	MSc in Ecology, Botany, Zoology, or Natural Resource Management	• Minimum 7 years post-graduation experience. • At least 5 years specific experience in biodiversity assessments, habitat mapping, and ecological baseline studies. • Experience in at least one (1) AfDB or equivalent MDB-funded ESIA projects in the last 5 years.
5	GIS and Mapping Specialist	MSc in GIS, Remote Sensing, Geography, or	• Minimum 7 years post-graduation experience. • At least 5 years hands-on experience in spatial

		Geospatial Science	data analysis, cartography, and environmental mapping. • Proficiency in ArcGIS, QGIS, AutoCAD, and other geospatial software. • Experience on at least one (1) MDB-funded ESIA in the last 5 years.
6	Soil and Land Resource Specialist	BSc in Soil Science, Environmental Chemistry, Agronomy, or related discipline	• Minimum 5 years post-graduation experience. • At least 3 years' experience in soil quality analysis and contamination studies. • Participation in at least one (1) MDB-funded ESIA project in the last 5 years.
7	Electrical / Renewable Energy Engineer	MSc in Electrical, Renewable Energy, or Power Systems Engineering	• Minimum 7 years post-graduation experience. • At least 5 years relevant experience in assessing electrical infrastructure and renewable energy systems under ESIAs. • Participation in at least one (1) MDB-funded ESIA within the last 5 years.
8	Senior Land Surveyor	MSc or BSc in Land Surveying or Geomatics, Licensed Surveyor	• Minimum 7 years post-graduation experience. • At least 5 years cognate experience in surveying and land demarcation in Nigeria. • Familiarity with land administration and regulatory frameworks. • Must be a qualified (licenced) Land Surveyor. Should also have a professional certification.
9	Climate Change and Sustainability Specialist	MSc in Climate Change, Environmental Management, or Sustainable Development	• Minimum 7 years post-graduation experience. • At least 5 years' experience in climate risk assessment, carbon footprint analysis, and adaptation planning. • Prior experience integrating climate considerations in ESIAs.
10	Socio-Economic Field Enumerators (4 positions): 2 each to support the social survey and land survey	BSc in Social Sciences, Geography, Statistics, or related discipline	• Minimum 3 years post-graduation experience. • Two (2) years specific experience in land Survey for survey assistants. • Two (2) years specific experience in social surveys for social assistants.

Towards, developing the land surveys required, the Senior Land Surveyor (K-8) who shall be a qualified surveyor, shall:

- Conduct site verification visits to determine current use to which the site/ land is being put to
- Conduct investigation by way of searching legal records, survey records, and land titles in order to obtain information about property boundaries and ownership in areas to be surveyed;

- Conduct investigation as to the current use of land and assets by communities, even if without a formal title;
- Conduct investigation as to how the project may affect access to assets, even though without a formal title;
- Commence surveys of the proposed DtP Project sites;
- Verify the accuracy of survey data, including measurements and calculations conducted at survey sites;
- Prepare and maintain sketches, maps, reports, and legal descriptions of surveys in order to describe, certify, and assume liability for work performed. Such maps, reports etc. should include but not be limited to information on the following:
  - Ownership/ title to land
  - How land is being currently used by communities, even though without a formal title
  - Information on the shape, contour, location, elevation, and dimensions of land or land features; heights, depths, relative positions, flooding history, property lines, and other characteristics of terrain; and
  - Baselines, elevations, and other geodetic measurements, longitudes and latitudes of important features and boundaries in survey areas using theodolites, transits, levels, and satellite-based global positioning systems (GPS).
- Apply to the National Institute of Surveyors (NIS) for a beacon or special number for the survey documentation.
  - Satisfy requirements of the NIS
  - Submit survey documentation to the Surveyor-General's office through the NIS

ONBOARDING OF CONSULTANT

In addition to the project supervisory and other responsibilities contained in this assignment, the client shall provide the Consultant with the following project documents:

- Relevant project documents, maps, route surveys.
- Support in interacting with relevant stakeholders

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.

REPORTING AND TRANSFER OF KNOWLEDGE

The Consultant shall report to the Head, Project Management Unit (HPMU) through the E&S Team of the REA PMU. The Consultant shall closely work with E&S unit of the PMU and other members of the REA PMU to transfer all relevant knowledge required.

SELECTION METHOD

Consultant will be selected in accordance with the Least Cost Selection (LCS) set out in the AFDB procurement framework for group funded operations, October 2015. www.afdb.org

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All materials, finished and unfinished, including the ESIA and certified Land Surveys, will be owned by the Rural Electrification Agency. The Consultant shall maintain confidentiality of all information received from the Rural Electrification Agency concerning all data and insights obtained during the course of the project.

Annex 2: Survey Questionnaire

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

1. Dear Respondent,

Thank you for taking the time to complete the following survey. The purpose of this survey is to gain valuable insight on proposed infrastructure intervention by Rural Electrification Agency (REA) under the Power Sector Recovery Program (PSRP). The survey provides you the opportunity to contribute to the environmental and social components of the project implementation.

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

SECTION A: Household data

Location/Name of SChool……………………………………..

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

(d) Tertiary (Excluding Community) € Community Graduate (f) Community Post Graduate

SECTION B: Health Status

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

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

7. Do you think your health condition will be affected by the proposed Infrastructure intervention? (a) Yes (b) No
8. If yes, how? ……………………………………………………………………..
9. Please suggest how this can be averted during construction and implementation………………………………………………………………..

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

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

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

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

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

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

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

( ) IUDs (intrauterine devices) or hormonal contraceptives

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

( ) Early abortion (in first trimester of pregnancy) at the pregnant woman's request ( ) Medically assisted reproduction (e.g., in vitro fertilization)

2. Are the following acts criminalized?

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

( ) adultery

( ) prostitution

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

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

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

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

in leadership of community-based organizations (d) Others specify…………………………………………...

SECTION D: Resources/ Cultural Property

1. Please indicate the environmental problems which your community experiences? (a) Soil infertility (b) Poor drainage system (c) Bad road (d) Bad lands (e) environmental degradation (f) Degraded land (i) Destruction of infrastructures (j) Others (specify) …………………………..
2. Please indicate the environmental problems which your community would likely experience and whose cause can be linked to the proposed Infrastructure intervention project during construction?
   (a) Soil infertility (b) Poor drainage system (c) Bad road (d) Low visibility
   (e) Erosion Problems (f) Flooding (g) Environmental degradation
   (h) Destruction of infrastructures (i) encroachment of land properties
   (j) Pollution (air, surface water, ground water, noise) (k) others (specify)
   ………………………..
3. Do you think the proposed Infrastructure intervention project will affect any valued resource/cultural/archaeological property in your area? (a) YES (b) NO
4. If yes mention the name(s) of the valued resource/cultural/archaeological property
   ………………………………
5. How will valued resource/cultural/archaeological property be affected? (a) Displacement of such valued cultural properties (b) Vandalisation of sacred items/locations (c) Possible theft of sacred/archaeological items (d) Others, specify:………………………………

SECTION E: Intervention Project Activities Impact Evaluation

1. Are you aware of the proposed Solar Power Project? (a) Yes (b) No
2. If yes, from which source (a) Community meetings (b) Media (TV, Radio, Newspaper, Internet) (c) Others specify…………………………..
3. Do you think the proposed Infrastructure intervention project can cause restiveness in your community? (a) YES (b) NO
4. If 3 is yes how will the proposed Infrastructure intervention result in restiveness? (a) Disrespect of norms and culture by contractors (b) loss of farmland / Property (c) Possible theft of sacred/archaeological items (d) local people not employed during construction (e) Others, specify: ……………………………

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

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

6. Can you name some of the animals and other habitat that may be affected by the proposed Infrastructure intervention project?
……………………………………..
7. What do you expect from the activities of solar power Infrastructure intervention? (a) employment of Locals during construction (b) compensation for those whose properties will be affected (c) capacity building for maintenance during implementation (d) community input into final engineering design (e) Others please specify……………………...

Section F: Grievance Redress Mechanism

1. Have you had grievances issue in this community in the last three years? (a) Yes (b) No
2. If 1 is yes, what was the cause of the grievance? (a) Land issue (b) theft of valuables
   (c) vandalization of property (d) Others, please specify…………………………….
3. Who do you report your grievances in this community to? (a) SChool authority/management (b) Law enforcement (c) My landlord/CDA (d) traditional/community leader (e) Others, please specify………………………………
4. Are grievances satisfactorily addressed or resolved by option(s) chosen in question 3 above? (a) Yes (b) No
5. Are there any other issue(s) of concerned as regards the proposed intervention project inyour area, please state clearly?...

Annex 3: Waste Management Plan

1.0 BACKGROUND

This waste management plan has been developed as part of the ESIA for the proposed project in the Community of Markarfi, Kaduna State. A Waste Management Plan (WMP) plays a key role in achieving sustainable waste management. The purpose of this plan is to ensure that effective procedures are implemented for the generation, handling, storage, transportation and disposal of waste that is generated from the activities on site. The plan prescribes measures for the collection, temporary storage and safe management/ disposal of the waste streams associated with the project and includes provisions for the recovery, re-use and recycling of waste.

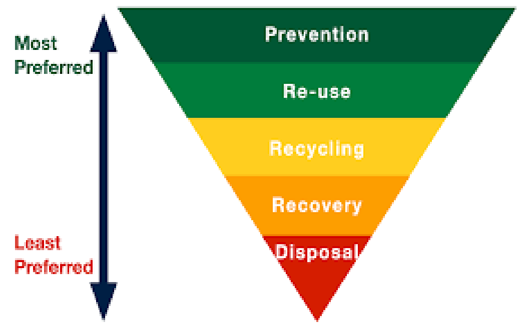
This WMP has been compiled as part of the project Environmental and Social Management Plan (ESMP) and includes potential waste stream information based of previous experiences in similar projects. Construction practices and operations must be measured and analyzed in order to determine the efficacy of the plan and whether further revision of the plan is required. This plan should be further updated should further detail regarding waste quantities and categorization become available, during the construction and/or operational stages.

The document examines the possible types of wastes to be generated during the various phases of the proposed project as well as details of how the wastes can be handled. In putting this document together, due cognizance has been taken of the AfDB Integrated Safeguard Systems and also World Bank EHS Guidelines on Environmental waste management, which requires, among others:

- Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences.
- Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.
- Avoiding or minimizing the generation waste materials, as far as practicable.
- Where waste generation cannot be avoided but has been minimized, recovering and reusing waste.
- Where waste cannot be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner

2.0 GENERAL WASTE MANAGEMENT STRATEGY

An integrated approach to waste management is needed on this sub-project. Waste management is premised on certain principles, which include avoidance or prevention, minimization or reduction reuse, recycle, recover and proper disposal. For the current project, waste generation shall be limited to the lowest possible.



Reducing volumes of waste is a priority; if reduction is not feasible, the maximum amount of waste is to be recycled; and wastes that cannot be recycled is to be disposed of in the most environmentally responsible manner as possible. The Waste Management Hierarchy, from most desirable to least desirable, is presented below:

- **Reduce**: Avoid waste by reducing the quantity of waste being generated. This is the simplest and most cost-effective way to minimize waste. It is the most preferred option.
- **Reuse**: Reuse is when a product is used again for the same or similar use, without reprocessing. Reusing a product more than once in its original form reduces the waste generation and energy consumption associated with recycling.
- **Recycle**: Recycling involves processing waste into a similar non-waste product, which consumes less energy than production from raw materials. Recycling prevents further environmental degradation, and saves landfill space and resources
- **Dispose**: Removing waste from worksites, compounds and offices, and diSCarding the material in a licensed landfill site, or other appropriately licensed facility.

In order to minimize and appropriately manage the waste generated on site, the following good management practices will be used:

i. Reduction of waste generation (through management practices, avoiding or decreasing materials use, etc.) is the primary goal of this plan.
ii. Non-hazardous wastes will be segregated from hazardous wastes.
iii. Wastes to be sent to licensed recycling/dumpsites will be segregated by type.
iv. Effort will be made to minimize the quantity of hazardous materials used.
v. Personnel that handle hazardous materials and wastes, will be trained for proper handling and management.
vi. Spills of hazardous materials will be prevented through careful and sensible management of the materials.

vii. Regular inspections of storage areas will be conducted. If damaged or leaking containers are detected, they will be replaced.
viii. Preventive maintenance will be performed on equipment to avoid potential spills.
ix. Waste storage areas will have secondary containment or spill trays.
x. Under no circumstances will waste be disposed on site.

2.1 *Classification of Wastes*

The Project activities will lead to the generation of various non-hazardous and hazardous wastes.

2.1.1 *Non-Hazardous Wastes*

- Typical non-hazardous wastes are given below:

- Domestic waste,
- Recyclable wastes (e.g. paper, glass, metals, wooden waste, trees, tin cans, textile, etc.),
- Packaging waste,
- Waste tires, and
- Excavation waste / Concrete waste generated from civil works and foundations.

2.1.2 *Hazardous Wastes*

Different type of hazardous wastes, that may potentially be generated as a result of the project activities, are given below:

- Electrical wastes including waste and/or damaged batteries and accumulators,
- Waste oil (from maintenance of equipment and vehicles, transformers, etc.),
- Waste paint, and
- Other hazardous waste related to operation and maintenance (O&M) and decommissioning activities.

2.2 *Potential Sources of Waste*

Avoiding the generation of waste remains of highest importance to (project) when considering waste minimization and management measures. Waste management and reuse strategies will be considered and implemented where practical and cost-effective as outlined in Table 1. On-site reuse opportunities will be maximized, with efforts made to implement reuse and off-site recycling initiatives.

Table 1 lists the waste generating aspects and identifies the range of solid, hazardous wastes that are likely to be generated by construction. It also outlines the proposed reuse, recycling or disposal method.

Table 1: Potential Waste Streams and Management Method

Activity / Waste Aspect	Types	Classification	Proposed Reuse / Recycling / Disposal Method
Site clearing and preparation	Vegetation (logs, mulched timber, weeds)	General Solid (non-putreSCible)	Native Vegetation – Reuse as biodiversity measures such as habitat enhancement, compost for topsoil or soil conditioner, or modify mulching equipment to create woodchip
	Concrete, brick asphalt and gravel	General Solid (non-putreSCible)	Crushed and used as backfill or as road base
	SCrap metal	General Solid (non-putreSCible)	Off-site recycling
	Excavated Materials	General Waste	Beneficial soil material - reuse onsite. Balance cut and fill earthworks, where possible, to optimise reuse on the Project
	Potentially contaminated soils	Hazardous waste	Off-site disposal at an approved facility
Construction Waste	Steel reinforcing	General Solid (non-putreSCible)	Off-site recycling
	Conduits and pipes	General Solid (non-putreSCible)	Off-site recycling
	Concrete (solids and washouts) and asphalt	General Solid (non-putreSCible)	Crushed and used as backfill or as road base
	Timber formwork	General Solid (non-putreSCible)	Reuse onsite where possible or Off-site recycling

	Packagingmaterials, including wood, plastic, cardboard and metals	General Solid (non-putreSCible)	Off-site disposal at an approved facility
	Empty oil and other drums	General Solid (non-putreSCible)	Off-site recycling

Activity / Waste Aspect	**Types**	**Classification**	**Proposed Reuse / Recycling / Disposal Method**
	spill clean ups, paints and other chemicals	Hazardous waste	Off-site disposal at an approved facility
	Metals and bulk electrical cabling	General Solid (non-putreSCible)	Off-site recycling
	Sediment basin diSCharge and solids (sediment)	General Solid (non-putreSCible)	Beneficial reuse onsite
General Waste from compounds during construction and operation	Waste generated by the maintenance of equipment including air and oil filters, worn components and rags	General Solid (non-putreSCible)	Off-site disposal at an approved facility
	Oil, grease, fuel, chemicals and other fluids	Liquid	Off-site disposal at an approved facility
	Damaged/ expire d Batteries/ Inverters	Hazardous waste	Off-site Management according to the EPR with the producer or an approved FMEnv facility
	Domestic wast e generated by workers including food packs, cans, bottles	General soli d (putreSCibles)	Off-site disposal at an approved facility

	Sanitary Waste/Sewage	General solid (putreSCibles)	Off-site disposal at an approved facility
	Waste water / recycled water / stormwater	Liquid	Off-site disposal at an approved facility, or use of onsite sewer system
Office Waste	Paper, cardboard and plastic	General Solid (non-putreSCible)	Off-site recycling
	Glass bottles and aluminium cans	General Solid (non-putreSCible)	Off-site recycling
	Ink cartridges	General Solid (non-putreSCible)	Off-site recycling
	Domestic waste including food waste generated by workers	General Solid (putreSCible)	Off-site disposal at an approved facility

3.0 PROJECT PHASE - WASTE MANAGEMENT PLAN

3.1 *Preconstruction and Construction Phase*

A plan for the management of waste during preconstruction and construction is detailed below. As previously stated, preconstruction and construction practices must be measured and analyzed in order to determine the efficacy of the plan and whether further revision of the plan is required. A method statement detailing specific waste management practices during site clearing activities and construction shall be prepared by the Contractor prior to the commencement of works.

3.1.1. *Waste Assessment / Inventory*

- The Environmental Officer must develop, implement and maintain a waste inventory reflecting all waste generated during construction for both general and hazardous waste streams.
- Construction method and materials should be carefully considered in view of waste reduction, re-use, and recycling opportunities.
- Once a waste inventory has been established, targets for recovery of waste (minimisation, re-use, recycling) should be set.

3.1.2. *Waste collection, handling and storage*

- Each contractor/ subcontractor must implement their own waste recycling system, i.e. separate bins for food waste, plastics, paper, wood, glass cardboard, metals, etc.
- Portable toilets must be monitored and maintained daily.
- Below ground storage of septic tanks, if installed, must withstand the external forces of the surrounding environment. The area above the tank must be demarcated to prevent any vehicles or heavy machinery from driving around the area.
- Waste collection bins and hazardous waste containers must be provided by the principal contractor and placed at various areas around site for the storage of organic, recyclable and hazardous waste.
- A dedicated waste area must be established on site for the storage of all waste streams, before removal from site.
- Signage/ colour coding must be used to differentiate disposal bins for the various waste streams (i.e. paper, cardboard, metals, food waste, glass etc.).
- Hazardous waste must be stored within a bonded area constructed according to FMEnv requirements. The volume of waste stored in the bunds must not exceed 110% of the bund capacity.
- The location of all temporary waste storage areas must aim to minimise the potential for impact on the surrounding environment, including prevention of contaminated runoff, seepage, and vermin control.
- Waste storage shall be in accordance with all Regulations and best-practice guidelines and under no circumstances may waste be burnt on site.
- Vegetation removed from the site must be chipped, removed from the site and disposed of at an appropriate waste disposal facility or used as mulch on site.
- The Environmental Officer shall be responsible for ensuring the continuous sorting of waste and maintenance of the area. He/ She shall train other team members on waste handling and management.
- All waste removed from site must be done so by a registered/ licensed subcontractor, whom must supply information regarding how waste recycling/ disposal will be achieved. The registered subcontractor must provide waste manifests for all removals at least once a month.

3.1.3. *Management of waste storage areas*

- The position of all waste storage areas must be located away from water courses and ensure minimal degradation to the environment.
- Waste storage areas must be under roof or the waste storage bins/ containers must be covered with tarpaulins (or similar material) to prevent the ingress of water.
- Collection bins placed around site must be maintained and emptied on a regular basis.
- Waste must be stored in designated containers and not on the ground.
- Inspections and maintenance of bunds must be undertaken daily. Bunds must be inspected for leaks or cracks in the foundation and walls.
- It is assumed that any rainwater collected inside the bund is contaminated and must be removed and stored as hazardous waste, and not released into the environment. If any leaks occur in the bund, these must be removed immediately.

3.1.4. *Disposal*

- Waste generated on site must be removed on a regular basis, as determined by the Environmental Officer. This frequency may change during construction depending on waste volumes generated at different stages of the construction process.
- Waste must be removed by a suitably qualified contractor and disposed at an appropriately licensed landfill/ dumpsite site. Proof of appropriate disposal must be provided by the contractor.

3.1.5. *Record keeping*

The success of the waste management plan is determined by measuring criteria such as waste volumes, cost recovery from recycling, cost of disposal. Recorded data can indicate the effect of training and education, or the need for education. It will provide trends and benchmarks for setting goals and standards. It will provide clear evidence of the success or otherwise of the plan. Records will include:

- Documentation (waste manifest, certificate of issue or safe disposal) must be kept detailing the quantity, nature, and fate of any regulated waste for audit purposes.
- Waste management must form part of the monthly reporting requirements in terms of volumes generated, types, storage and final disposal.

3.1.6. *Training*

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

3.2 *Operational and Maintenance Phase*

It is expected that the operational and maintenance phases will result in the production of limited general waste consisting mostly of cardboard, paper, plastic, tins, metals and vegetation materials especially from the training centres. Limited hazardous wastes (end-of-life EEE) may also be generated during maintenance activities. All waste generated will be required to be temporarily stored at the facility in appropriate containers prior to disposal at a permitted landfill site.

The following waste management principles apply during the operational phase:

- The O&M contractor and Site Manager must develop, implement and maintain a waste inventory reflecting all waste generated during operation for both general and hazardous waste streams.
- Adequate waste collection bins at site must be supplied. Separate bins should be provided for general and hazardous waste.
- Recyclable waste must be removed from the waste stream and stored separately.
- All waste must be stored in appropriate temporary storage containers (separated between different operational wastes, and contaminated or wet waste) at each operational area prior to being taken to the waste storage area for final sorting (if required). Waste storage shall be in accordance with all best-practice guidelines and under no circumstances may waste be burnt on site.
- Vegetation removed from the site must be chipped, removed from the site and disposed of at an appropriate waste disposal facility or used as mulch on site.
- Waste generated on site must be removed on a regular basis throughout the operational phase.
- Waste must be removed by a suitably qualified contractor and disposed at an appropriately licensed landfill site. Proof of appropriate disposal must be provided by the contractor.
- Waste EEE especially from damaged panels or end-of-life batteries shall be managed in line with the EPR plans set during purchase of all e-equipment associated with the project, and also in line with the FMEnv/NESREA regulations on e-wastes.

3.3 *Decommissioning Phase*

The project is expected to last for a minimum of 25 years, where with proper maintenance and management, it could last for up to 40years. Waste management principles applicable during this waste will include:

- Informing the appropriate ministries including FMEnv and NESREA about the decommissioning;
- Ensuring best practices in demolition and decommissioning to prevent pollution or contamination associated with improper waste handling.
- Use of the EPR as a standard for managing all associated e-wastes.
- Disposal of all other waste types using certified waste managers and at appropriate licensed landfills.

4.0 MONITORING OF WASTE MANAGEMENT ACTIVITIES

Records must be kept of the volumes/ mass of the different waste streams that are collected from the site throughout the life of the project. The appointed waste contractor is to provide monthly reports to the operator containing the following information:

- Monthly volumes/ mass of the different waste streams collected;
- Monthly volumes/ mass of the waste that is disposed of at a landfill site;
- Monthly volumes/ mass of the waste that is recycled; and
- Data illustrating progress compared to previous months.

This report will aid in monitoring the progress and relevance of the waste management procedures that are in place.

5.0 WASTE MANAGEMENT MITIGATION AND MONITORING COST

Finances must be allocated for proper waste management. The cost of mitigation and monitoring for waste management from pre-construction to operations and maintenance phase has been factored into each phase in the ESMP. This will cover trainings, PPE, receptables, containment areas and disposals. The cost for decommissioning will be however be required to be developed at the decommissioning phase with the realities at that period.

6.0 CONCLUSION

The waste management plan iterated above has been prepared with a view to ensuring that all wastes generated from the proposed project are effectively disposed. The effectiveness of the plan is premised on a number of factors, including, prompt and timely carting away of the wastes and using the right materials and equipment. To this end, waste disposal will be carried out only by contractors certified/approved by the Kaduna State Environmental and Protection Agency. In addition, adequate supervision shall be provided by the REA-PMU and the respective MDAs.

Annex 4: Biodiversity Management Plan.

POTENTIAL ENVIRONMENTAL ASPECTS AND IMPACTS

The majority of the development footprint is covered by native grassland. The potential impacts of the project on the vegetation community would be both direct and indirect. The direct impacts include access roads, inverter stations and other buildings, parking and solar panel piles. The indirect impacts include areas under panels, between panel rows and areas not being used, which would experience difference levels of shading, rainfall and temperature. During the project's planning phase, it became evident that there were some complex issues associated with the potential impacts upon native grassland as a result of installation of the solar panels and operation of the solar farm. Potential indirect impacts on native grassland include but are not limited to:

- Existing use of the native grassland over many decades for stock grazing, cropping and the impacts such grazing and other existing agricultural use of the native grassland might already be behaving upon grassland integrity and growth.
- What impact installation of the solar panels and associated aspects might have on the native grassland and use of the grassland habitat by fauna.
- Might there be negative, neutral or positive impacts to the native grassland as a result of the solar panel installation.
- What impacts factors such as shading from the solar panels might have on the native grassland.
- Opportunities to work with the ecology and natural seasons of the native grassland to avoid or minimize negative impacts while still being able to construct and operate the solar farm.

Key aspects of the Project that could result in impacts to biodiversity have been deSCribed in Table 1.1.

Table 4.1: Potential biodiversity impacts as a result of the project.

Impact	Frequency	Intensity	Duration	Consequence
Direct				
Habitat clearance for permanent and temporary construction facilities (e.g. solar infrastructure, compound sites, stockpile sites, access tracks).	Regular	High	Construction	• Direct loss of native flora and fauna habitat including: grassland habitat, woodland habitat and aquatic habitat in few community sites. • Potential over- clearing of habitat outside of the development footprint. • Injury and mortality to fauna during clearing of fauna habitat and habitat trees. • Disturbance to fallen timber, dead wood and bush rock.
Direct				
Fire Break (10 m)creation and maintenance	Regular	Moderate	Construction and operations	• Alteration to grassland habitat and clearing of some woodland. • Impact on ground dwelling fauna.
Vehicle movements	Regular	Moderate to high	Construction and operations	• Patches of bare ground created by repeated tyre movements.
Indirect				
Impact	**Frequency**	**Intensity**	**Duration**	**Consequence**
Edge and barrier Effects	Regular	Moderate	Operations	• Colonisation by weeds, non-native plants and pest animals.
Management of grassland biomass by mowing	Regular	High	Operations	• Potential degradation of native grassland by increased

				biomass reducing native species germination.
Management of grassland biomass by grazing	Regular	High	Operations	• Potential degradation of native grassland by producing nutrient rich patches from sheep waste under shaded panels. Nutrient enrichment may favour exotic animals over natives.
Shading by solar panels	Regular	Moderate	Operations	• Changes in soil moisture. • Changes in species abundance by benefitting certain species over others (likely positive).
Accidental spills and contaminati on from construction activities (including compound sites)	Rare	Moderate	Construction	• Pollution of waterways.
Earthworks	Regular	Moderate	Construction	• Erosion and sedimentation of waterways.
Noise	Regular	Low	Construction	• Construction machinery and

Direct				
				activities may

				disturb local fauna.
Dust generation	Regular	Low	Construction	• Inhibit the function of plant species and communities, waterways.
Light spills During night works	Rare	Low	Construction	• Night works may alter fauna activities /movements.
Increased vehicle traffic	Regular	Low	Construction	• Increase potential for fauna mortality through vehicle strike.
General construction activities	Regular	Moderate	Construction	• Feral pest, weed and/or pathogen encroachment.
Vehicle movements	Regular	Moderate	Construction and operations	• Weeds spread to moderate condition SCT 45 grassland.
Fencing	Regular	Low	Construction and operations	• Fauna fatalities.

BIODIVERSITY MITIGATION AND MANAGEMENT MEASURES

A range of mitigation requirements and control measures are identified in the EIA, and ESMP. Specific measures and requirements to address impacts to biodiversity are outlined in Table 2.1. The measures have been listed to cover broad activities and as such there may be some repetition of mitigation measures.

Table 4.2: Biodiversity management and mitigation measures

Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
Prior to the commencement of construction, the contractor must prepare A Biodiversity Management Plan for the development in consultation with DPP, and to the satisfaction of the PMU. This BMP: a. include a deSCription of the measures that would be implemented for: • minimising the amount of native vegetation clearing within the approved development footprint; • minimising the loss of key fauna habitat; • managing potential indirect impacts on threatened and migratory species, including: — flora species and — fauna species; • rehabilitating and revegetating temporary disturbance areas; • protecting native vegetation and key fauna habitat outside the approved disturbance areas; • maximising the salvage of vegetative and soil resources within the approved disturbance area for • beneficial reuse in the enhancement or the rehabilitation of the site; and controlling weeds and feral pests;	• This BMP EIA • Coarse wood debris (CWD) reuse protocol • Pest and Weed Control Protocol • Ground Disturbance Protocol	Pre-construction	Site HSE Manager	• This BMP EIA

Protecting and promoting the growth of native plant species (including Plant Community Types) and controlling the growth of exotic ground cover; b. include a seasonally-based program to monitor and report on the effectiveness of these measures against the detailed performance and completion criteria; and c. include details of who would be responsible for monitoring, reviewing and implementing the plan, and timeframes for completion of actions.	• Inspection and monitoring forms. • Grassland Monitoring program			
Prior to construction, surveys must be conducted for Andropogon gayanus (Gamba grass), Hyparrhenia rufa (Jaragua grass), Imperata cylindrica (Spear grass), Pennisetum polystachion, Cynodon dactylon, Dactyloctenium aegyptiacum, Gardenia ternifolia, Protea elliotti, Acacia ataxacantha ,Bombax costatum (Red silk cotton) , various Ficus species (Figs), the palm Raphia sudanica ,Borassus aethiopum (African fan palm) , Anchomanes welwitSChii (Isu-Baka).Aspilia africana (Yunyun), Tridax procumbens, and Chromolaena odorata (Siam weed).to determine presence or absence on the site. If a species credit is required for any of these species, then this must be incorporated into the final credit profile and offset strategy before construction commences.	EIA	Pre-construction	N/A	--------- EIA
Where trees are to be retained, an adequate VEZ will be provided around each tree for the duration of construction.	• Exclusion materials (temporary fencing/tape) • Vegetation Clearing Procedure	• Pre-construction • Construction	Site HSE Manager	EIA
Stockpiling and storage of materials and machinery will be avoided within the dripline (extent of foliage cover) of any native tree.	• This BMP • Mapped VEZs	Construction	• Site HSE Manager • Lead Civil Superintendent	EIA
Any fallen timber, dead wood and bush rock (if present) encountered on site will be left in situ or relocated to a suitable place nearby. Rocks will be removed with suitable machinery so	• Vegetation Clearing Procedure • Vegetation Clearing Protocol	Construction	• All plant operators	EIA

as not to damage the underlying rock or result in excessive soil disturbance.	• Mapped VEZs		• Site HSE Manager	
Native vegetation areas to be retained will be delineated and construction activities will be excluded from these areas. Clearing and construction contractors will be given inductions that make clear the importance of these areas and component species.	• Mapped VEZs • Induction/training materials	• Pre-construction • Construction	Site HSE Manager	EIA
No plantings will occur within VEZs.	• This BMP • Mapped VEZs	• Construction • Operation	• Site HSE Manager • Lead Field Technician	DPP Consultation
Native grassland will be managed through mowing and/or grazing on the following recommendations: • November – December graze sheep/mow. Primarily this will reduce the level of dry matter from annual growing species for summer fire hazard. The annuals will tend to have a greater palatability/digestibility than the natives at this stage and be preferentially grazed. • Remove sheep/mow mid-August. This will allow annual grass seed heads to emerge evenly. • Mow to 5-10 cm mid-September/October when annual grasses flowering. This will prevent seed set of exotic annual species enhancing native abundance as well as reducing combustible load. • Destock/low stocking rate over summer. Enhance seed set of perennial native species. • Only mow/graze during dry season if grassland growth will result in average dry matter exceeding 5000 kg/ha DM.	• This BMP • Biomass assessment (each October) • Lease agreement with livestock owner(s) where applicable • Grassland monitoring results (after first year)	Operation	Site HSE Manager	Grassland Monitoring Program
Awareness training during site inductions regarding enforcing site speed limits.	• Toolbox talks • Induction materials	Pre-construction Construction	Site HSE Manager	EIA

Plain wire is to be used on internal fencing where practicable and where it meets safety and security requirements of the solar farm.	• Infrastructure design plans • This BMP	Pre-construction	• Project Manager • Lead Civil Superintendent	EIA
A Vegetation Clearing Procedure will be developed as required to: • Include best practice methods for the removal of woody vegetation and non-woody vegetation. • Trees will be removed in such a way as not to cause damage to surrounding vegetation. The root system areas will be rehabilitated by filling these areas with spoil from close by road construction. This spoil will have similar soil and grass composition and only come from within • the solar farm to promote germination of similar grass species. • A suitably qualified ecologist/expert to ensure that this process promotes the rehabilitation of these areas. • Require that where work cannot avoid encroaching into the Tree Protection Zone, it does not impinge on the structural root zones (SRZ) of trees to be retained. • All trees to be removed should be disposed of in accordance with the CDW procedure or WMP. Vegetation clearing protocol includes staged habitat removal, and a requirement for an ecologist to be present during the felling of all hollow-bearing trees to ensure that potential impacts on fauna are minimized.	• Vegetation Clearing Procedure • *National Environmental (Control of Bush/ Forest fire and Open Burning) Regulations, S.1. No 15, 2011.* National Environmental (Protection of Endangered Species in International Trade) Regulations, S. I. No. 16, 2011 • National Environmental (Control of Alien and Invasive Species) Regulations, S. I. No 32, 2013. • National Environmental (Soil Erosion and Flood Control) Regulations, S. I. No. 12, 2011	Pre-construction	Project Manager	• Agency submissions • DPP consultation
A pre-clearing process will be implemented before clearing begins. Pre-clearing surveys will be carried out by an ecologist and will include general fauna surveys, general tree hollow inspections and waterway inspections. Habitat trees will be clearly marked with flagging tape.	• Qualified Ecologist • Marking tape/spray • Vegetation clearing procedure	• Pre-construction • Construction	Site HSE Manager	Agency submissions

Prior to the commencement of work, a physical boundary of the approved clearing limit is to be clearly delineated and implemented. The delineation of such a boundary may include the use of temporary fencing, flagging tape, parawebbing or similar.	• Mapped VEZs • Temporary fencing, flagging tape	• Pre-construction • Construction	Site HSE Manager	• DPP consultation
Trees with hollows should not be removed between 1 September and 1 January, in order to mitigate direct impacts to threatened fauna during the breeding season. Clearing of Hollow Bearing Trees will be avoided where possible.	Vegetation clearing protocol	• Pre-construction • Construction	• Project Manager • Site HSE Manager	Agency submissions
Clearing and construction contractors would be given inductions that make clear the importance of the VEZs and their component species.	• Mapped VEZs • Training materials	• Pre-construction • Construction	Site HSE Manager	EIA
The vegetation clearing protocol (section 5.2.1) will be followed for all vegetation clearing.	Vegetation clearing procedure	Construction	Site HSE Manager	Agency submissions
An Unexpected threatened species finds procedure will be followed where any unexpected fauna is encountered	• Qualified ecologist • This BMP	• Pre-construction • Construction	Site HSE Manager	EIA
Construction activities and storage of materials for boundary fencing should be wholly contained within the proposal area. Disturbance to road reserves other than access points identified in the EIA must not occur.	• This BMP • Mapped project footprint and approved infrastructure locations • Ground disturbance permit procedure	• Pre-construction • Construction	• Site HSE Manager • Lead Civil Superintendent	EIA
Minimise clearing and avoid unnecessary disturbance associated with the construction and operation of the project.	• This BMP • Mapped project footprint and approved infrastructure locations • Ground disturbance permit procedure	Construction	• Site HSE Manager • Lead Civil Superintendent	DPP consultation
	•		•	

ANNEX 5

SPECIFIC WORKS AND KEY ACTIONS REQUIRED

1.1 CONSTRUCTION ACTIVITIES

This construction methodology is indicative of the staging that will be implemented at the project site. Some activities may occur in parallel, particularly given the size of the project site. The following methodology is indicative of construction sequencing and vehicle movements.

There are a lot of vehicle movements involved in the construction of the solar farm. Most of these movements terminate at the site entrance/laydown area. The majority of vehicular traffic onsite is by light vehicle and restricted to internal access tracks only. The notable exceptions are during piling, tracker install, trenching and panel installation. Tracked piling rigs and wheeled forklifts will traverse the grasslands along and a cross each row. However, this is limited to only a handful of movements (pile delivery, piling, tracker install and panel fitting). Repetitive vehicle movements will be avoided to reduce soil impacts and time wastage. Tracked mini-piling machines will be used.

The SChedule of work in Table 4.1 guides the key actions required for management of biodiversity for the project.

Table 1.1: SChedule of construction works

Project Phase	Potential Disturbance	Key actions and Mitigation	Performance Target
Construction site set up, construction of access.	• Disturbance to native groundcover from vehicle movements. • Disturbance and removal of fauna habitat including woody debris. • Spread of weeds, particularly high threat exotic plants.	• Clearly delineate the approved clearing and disturbance footprint using temporary fencing, flagging tape, Para webbing or similar. • Machinery, trucks and equipment will be restricted to designated parking areas. Disturbance to road reserves other than access points identified in the EIA must not occur. • Wash and inspect plant and vehicles as per Traffic Management Procedure. • Implement ground disturbance permit procedure prior to any clearing activity. • Pre-clearing surveys will be carried out by an ecologist and will include general fauna surveys, general tree hollow inspections and waterway inspections. Habitat trees will be clearly marked with flagging tape. • Trees with hollows will not be removed between 1 September and 1 January, in order to mitigate direct impacts to threatened fauna during the breeding season. • Implement Vegetation Clearing Protocol for vegetation removal. • Place CWD in remaining vegetated areas where practicable. • Record clearing and ground disturbance via spatial mapping.	• No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed the identified in the EIA. • No mortality of native fauna during vegetation removal. • No pollution or siltation of aquatic ecosystems, wetlands, endangered ecological communities or threatened species habitat. • 5% low threat exotic plant cover. Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.

		• Install and maintain erosion and sediment (ERSED) controls.	
Internal road construction	• Erosion and sedimentation of drainage channels from levelling and bridge construction. • Disturbance to native fauna from lights and noise. • Disturbance of groundcover from stockpiles. • Spread of weeds, particularly high threat exotic plants.	• Provide awareness training during site inductions and toolbox talks-emphasise the importance of native groundcover. • Machinery, trucks and equipment will be restricted to designated parking areas. No parking on roadside vegetation will occur. • Plant and vehicles will be washed and inspected as per Traffic Management Procedure. • Stockpiling and storage of materials and machinery will occur only on designated direct disturbance areas. • Stockpiling and storage of materials will avoid the dripline (extent of foliage cover) of any native tree. • Direct any lighting away from woodland vegetation. • Install and maintain ERSED controls.	• No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed identified in the EIA. • No dirty water leaves the site • Dirt tracking is minimised on sealed public roads.5% low threat exotic plant cover. • Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.
Construction of solar farm infrastructure	• Erosion and sedimentation of drainage channels from levelling and bridge construction. • Disturbance to existing native fauna from lights and noise. • Disturbance of groundcover from stockpiles. • Spread of weeds, particularly high threat exotic plants.	• Provide awareness training during site inductions and toolbox talks- emphasise the importance of native groundcover. • Machinery, trucks and equipment will be restricted to designated parking areas. No parking on roadside vegetation will occur. • Stockpiles and storage of materials and machinery will avoid the dripline (extent of foliage cover) of any native tree. • Stockpiling and storage of materials will occur only on designated direct disturbance areas.	• No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed identified in the EIA. • 5% low threat exotic plant cover • Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.

		• Direct any lighting away from woodland vegetation. • Plant and vehicles will be washed and inspected as per Traffic Management Procedure. • Topsoil will be stockpiled and replaced over direct disturbance areas as soon as practicable as per Rehabilitation and • Revegetation Protocol. • Install and maintain ERSED controls.	
Removal o f temporary construction equipment	• Disturbance to existing native fauna from lights and noise. • Disturbance of groundcover from stockpiles. • Spread of weeds, particularly high threat exotic plants.	• Provide awareness training during site inductions and toolbox talks- emphasize the importance of native groundcover. • Machinery, trucks and equipment will be restricted to designated parking areas. No parking on roadside vegetation will occur. • Stockpiles and storage will be occurring only on designated direct disturbance areas. • Direct any lighting away from woodland vegetation. • Provide awareness training during site inductions and toolbox talks- emphasize the importance of native groundcover. • Machinery, trucks and equipment will be restricted to designated parking areas. No parking on roadside vegetation will occur. • Stockpiles and storage will be occurring only on designated direct disturbance areas. • Direct any lighting away from woodland vegetation.	• No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed identified in the EIA. • Moderate condition of Plant Community Type grassland not to exceed 2% high threat exotic plant cover, or 5% low threat exotic plant cover. • No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed identified in the EIA. • Moderate condition of Plant Community Type grassland not to exceed 2% high threat exotic plant cover, or 5% low threat exotic plant cover.

1.2 OPERATIONAL ACTIVITIES

1.2.1 *Security and maintenance*

Operational traffic within the panel area will be minimal with approximately 3-5 vehicles based permanently at the site. Periodical infrastructure upgrades may be required and will generate additional traffic movements for short periods. DPP will be contacted prior to any major upgrades or maintenance works and in the event of any incident affecting biodiversity.

Table 3.2: SChedule of operation works

Project Phase	Expected Disturbance	Key actions and Mitigation	Performance Target
Operation	• Minor ground disturbance from panel maintenance. • Disruption to the movement of native fauna. • Fauna mortalities due to contact with project infrastructure such as fences and panels. • Spread of high threat exotic plants.	• Awareness training for operational staff. • Record incidents of fauna mortalities and report threatened species encounters to DPP. • Wash and inspect vehicles as per the Traffic Management Procedure. • Implement Weed Management Procedure. • Implement Animal Pest Management Procedure as required.	• Moderate condition Plant Community Type grassland not to exceed 2% high threat exotic plant cover, or 5% low threat exotic plant cover. • Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover. • No native fauna mortalities.
Grassland management	Impacts on native grassland condition from managing fuel load.	• Manage native grassland as per the Native Grassland Management Procedure. • Wash and inspect vehicles as per the Traffic Management Procedure.	• Moderate condition Plant Community Type grassland not to exceed 2% high threat exotic plant cover, or 5% low threat exotic plant cover. • Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.

ANNEX 6

COMPLIANCE MANAGEMENT

ROLES AND RESPONSIBILITIES

The Project Team's overall roles and responsibilities are outlined hereunder. Key responsibilities relating to managing biodiversity during construction are:

- The EEE III Project Contractor is responsible for the development and maintenance of all management plans including the overarching environmental management strategy as listed in the EIA
- The EEE III Project Contractor /Project Manager is responsible for ensuring groundworks occur onsite in accordance with the BMP. This includes but is not limited to disturbance in designated areas only, traffic management restricting movements off internal access tracks, topsoil storage and reuse, rehabilitation of disturbed works are carried out as soon as practicable.
- The Site HSE Manager who manages the ground disturbance permit process and records a running total of vegetation clearing within the development site. The Site HSE Manager also manages the contracts with ecologists for environmental monitoring.
- The Lead Civil Superintendent is responsible for supervising construction workers and will ensure they are sufficiently trained in the protection of biodiversity and minimising disturbance detailed below. The Lead Civil Superintendent in conjunction with the Site HSE Manager will oversee weed control and rehabilitation of the site.
- The Onsite Logistics Manager is responsible for implementing the Traffic Management Plan, which includes controlling and recording heavy vehicle movements onsite. Workers involved in installing solar infrastructure will be trained and directed to limit vehicle movements between the rows of panels.

Key responsibilities relating to managing biodiversity during operation are:

- The Operator is responsible for the development and maintenance of all management plans including the overarching environmental management strategy as indicated in the EIA
- The Operations and Maintenance (O&M) Manager is responsible for ensuring groundworks occur onsite in accordance with the BMP. This includes but is not limited to disturbance in designated areas only, traffic management restricting movements off internal access tracks, topsoil storage and reuse, rehabilitation of disturbed works are carried out as soon as practicable. The O&A Manager also manages the contracts with ecologists for environmental monitoring as necessary.
- The Lead Field Technician now manages the ground disturbance permit process. The Lead Field Technician will oversee bushfire management, weed control and rehabilitation of the site to achieve biodiversity outcomes.

- The Engineering Supervisor is responsible for supervising maintenance works and will ensure workers are sufficiently trained regarding protection of biodiversity and minimizing disturbance.

TRAINING

All employees, contractors and staff working on site will undergo induction training covering all procedures and protocols included within this BMP. Site induction provides an introduction to the ground disturbance permit and vegetation clearing processes, traffic movement restrictions and hygiene, threatened fauna identification and handling and locations of environmentally sensitive areas. Further details regarding staff induction and training are outlined in the EIA.

Staff and contractors will attend pre-commencement meetings at the beginning of each shift, which will include the details of any urgent biodiversity matters such as any breeched of protocols or procedures. Longer toolbox meetings will occur weekly where staff and contractors will be made aware of any less urgent biodiversity matters and reinforce training on implementing protocols and procedures.

INSPECTIONS AND MONITORING

Inspections of sensitive areas and activities with the potential to impact biodiversity will occur monthly for the duration of construction and annually for the operation of the project. General biodiversity monitoring will include a quantitative and ongoing assessment of grassland and woodland condition. Monitoring and evaluation of success will include a reflection on the seasonal conditions for the previous period. Monitoring during construction will be monthly inspections of high disturbance areas, groundcover, protected woodland areas and boundary fence lines. These monthly inspections will include:

- Details of Course Woody Debris (CWD) placement, recorded as it occurs.
- A review of any fauna killed or injured. Threatened fauna mortalities will be reported to DPP and the deaths of any birds resulting from contact with fences or solar panel will be recorded.
- Fauna relocations relating to vegetation clearing will be recorded.
- Areas of high and low threat exotic plants will be recorded and controlled on a seasonal basis Biodiversity monitoring during operation will include:
- A quantitative assessment of groundcover will occur 6 months after construction. If groundcover is less than 70% cover during this time, corrective actions will be required. This will include consideration of soil conditions such as compaction, frequency of traffic movements, low seedbank storage, lack of soil moisture and nutrient imbalance. If soil chemistry the growth limiting factor, soil testing will be used to determine any need for amelioration.
- Feral animal and weed control surveys will occur on a seasonal basis.

Trigger points for corrective action include:

- Damaged exclusion fencing or signage.
- CWD stacked, not distributed.
- Any storage or infrastructure located underneath driplines of trees.
- Presence of injured or deceased fauna.
- SCours greater than 50 mm deep and 100 m long.
- Bare ground within native grassland patches greater than 20 m^2.
- High threat exotic plant covers greater that 2% of moderate condition plant community type
- Low threat exotic plant covers greater than 5% of moderate condition plant community type.
- High threat exotic plant covers greater than 5% for the remainder of the development site.
- Low threat exotic plant covers greater than 50% for the remainder of the development site.
- Groundcover achieves seed set across less than 70% of area.
- Observed feral animals or observations from neighbours. A monitoring program summary is provided in Table 4.1

Table 4.1: Monitoring program summary – minimum requirements

BMP Section	Monitoring Plan	Timing / Frequency	Responsibility	Decision trigger / adaptive response	Reporting
	Pre-construction				
Section 5.2.1	Inspection of VEZ marking and fencing (no-go zones) including individual trees.	At commencement of Project.	Site HSE Manager and Suitably qualified ecologist.	If fencing is damaged it is rectified.	On-site reporting.
Section 5.2.2	Survey before removal of tree vegetation. Hollows to be rechecked prior to clearing.	Before Clearing Commences on-site.	Suitably qualified ecologist.	Implement fauna handling procedure if native fauna is found roosting in hollows.	Ecologist Report.
Section 5.2.1	Visual inspection of vegetation clearance activities.	Weekly.	Site HSE Manager.	Clearing not aligned to survey, clearing to cease immediately.	On-site reporting.
Section 10.1	Issue Ground Disturbance permit.	Weekly During Construction.	Site HSE Manager.	Work will cease if no aligned to Ground Disturbance Permit.	On-site reporting.
During construction					

Section 5.2.1	Visual inspection of vegetation clearance activities.	Regularly at least weekly.	Site HSE Manager.	• If lack of exclusion fencing leads to damage to retained vegetation, stop work and report incident. Reinstate exclusion fencing as required. • Incident to be detailed at staff and contractor pre-commencement meetings at the beginning of each shift	• Site HSE Manager to inform DPE of non-compliance within 7 days. • Site HSE Manager to inform DPP immediately of incidents causing harm to threatened species, o r ecological communities.
Section 5.4	Maintain a log of salvaged animals and actions taken to relocate them.	As required	Site HSE Manager.	If threatened species ar identified, then trigger e review and s a report.	Ecologist Report.
5.4k	Inspections for fauna where footings have been left overnight.	Daily as required.	Site HSE Manager.	No work to proceed until fauna removed from footings.	On-site reporting.
	Inspection of rehabilitation works during construction.	Monthly.	Site HSE Manager.	N/A	On-site reporting.

BMP Section	Monitoring Plan	Timing / Frequency	Responsibility	Decision trigger / adaptive response	Reporting
5.4	Inspection to detect high and low threat exotic plant cover throughout development site.	Quarterly.	• HSE Manager and • Ecologist.	• High threat exotic plant cover of 2% and low threat exotic plant cover of 5% for moderate condition Plant community type. • High threat exotic plant cover of 5% and low threat exotic plant cover of 50% for the remainder of the development site.	• Site HSE Manager • Annual report to DPP.
	Inspection of high threat exotic plant cover control sites.	Monthly.	• HSE Manager and • Ecologist.	Following corrective action.	• Site HSE Manager • Annual report to DPP.
Post-construction					
	Maintain a log of mowing activities to be included with quarterly reporting on grassland management.	Quarterly.	Operations Manager.	Biomass equal to or exceeding 5000 kg/ha dry matter.	• Site HSE Manager • Annual report to DPP.
	Inspection of revegetated areas after all sowing is complete.	6 Monthly.	Operations Manager	Failed patches >5m² Seed set across less than 80% of the area.	• Site HSE Manager • Annual report to DPP.
Operation					

	Inspection of high and low threat exotic plant cover control sites	Quarterly	Operations Manager	• High threat exotic plant cover of 2% and low threat exotic plant cover of 5% for moderate condition PLANT COMMUNITY TYPE • High threat exotic plant cover of 5% and low threat exotic plant cover of 50% for the remainder of the development site.	• Lead Field Technician • Annual report to DPP.
	• Grassland monitoring program: • Re-sampling / Framework for Biodiversity Assessment in PLANT COMMUNITY TYPE • Sampling of at least thirty permanent 1 x 10 m plots for plant species richness and cover, % bare ground, litter and plants, and non-biomass vaSCular	• Six-monthly, and autumn spring. • Three years, starting autumn or spring construction • Five-yearly for the life of the project.	Expert ecologist	Increase in exotic species richness and cover	• Expert ecologist to undertake monitoring and analysis. • Annual reporting to Project Manager and DPP.

AUDITING

The Site HSE Manager will maintain a compliance register for the Project to ensure audits and reporting requirements are met within SCope and within set timeframes. The compliance register will include a list of biodiversity commitments identified in the EIA, and this BMP. Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this BMP and compliance with other relevant approvals, licenses and guidelines including: Independent Environmental Audit within six months from the commencement of construction. This will be prepared in accordance with the relevant Independent Audit Post Approval Requirements. A copy of the report will be submitted to DPP and REA PMU.

Corrective measures or actions to improve the environmental performance of the Project recommended by auditors will be reviewed by the senior management team and incorporated into strategies, plans or programs required under by the Development Consent. The recommendations of the Independent Environmental Audit must be implemented to the satisfaction of the Secretary. Additional audit requirements are detailed in the ESMP

REPORTING

Reporting requirements and responsibilities are documented in detailed in the ESMP. EEP II Project Contractor will document the outcomes of pre-construction surveys required. The Proponent will progressively monitor the clearing of native vegetation and provide a Compliance Report and mapping to ensure compliance. The Site HSE Manager will inform DPP of any non- compliance incident within 7 days of occurrence. Any additional mitigation or management measures relevant to biodiversity have been incorporated into this BMP. Any independent environmental audit, and the Proponent's response to the recommendations in any audit will be made publicly available on the internet. Any other biodiversity matter will also be made publicly available as required by DPP.

REVIEW AND IMPROVEMENT

This BMP will be reviewed every three years. Continuous improvement of this BMP will be achieved by the ongoing evaluation of performance against the BMP environmental policies, objectives and targets to identify opportunities for improvement.The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance.
- Determine the cause or causes of non-conformances and deficiencies.
- Develop and implement a plan of corrective and preventative action to address non-conformances and deficiencies.
- Verify the effectiveness of the corrective and preventative actions.
- Document any changes in procedures resulting from process improvement

PROTOCOLS AND PROCEDURES

GROUND DISTURBANCE PERMIT PROCESS

The ground disturbance permit process is integral to communicate the distinction between vegetation projection areas and the ground disturbance footprints which contractors will be working within. This process is also vital to enable the Contractor to track and control vegetation clearing on a daily, weekly and monthly basis. The ground disturbance permit process is managed by the Site HSE Manager and is summarised below;

- Contractors are informed within their contract and site induction that all ground disturbing activities require them to obtain a ground disturbance permit prior to undertaking the work.
- The ground disturbance permit form is available in hard copy at the site office or through Committee of community development and must be submitted to the Site HSE Manager via email at least 48 hours before the work is undertaken.
- The Site HSE Manager will compare the proposed ground disturbance area to the project footprint detailed in the current approved development design.
- The Site HSE Manager will visit the site if required and mark out vegetation projection areas and 10 m buffer zones if applicable.
- The Site HSE Manager will either issue the permit unamended or contact the contractor for further clarification.
- Once the permit has been issued, the contractor may undertake ground works as per their contract.
- Once the work has been completed (date specified in the permit), the Site HSE Manager will inspect the site, request any additional clean up or remediation activities and sign-off that the conditions of the permit have been met.
- The Site HSE Manager will then record the disturbed area as part of a running total disturbed area for the project.

An example of the ground disturbance permit form is provided in Figure 5.1 below.

Project: Solar Farm	**Project No:**
Requested By:	
Habitat Clearing Start Date:	**Expected Completion Date:**

HABITAT CLEARING LOCATIONS – ATTACH DRAWINGS / SKETCHES IF NECESSARY

Location	Comments

This section to be completed by Ecologist and Site HSE Manager for clearing of trees, logs, rocky features, and other habitat features, with reference to constraints mapping.

Has the limit of clearing been clearly delineated?	
All trees / vegetation / habitat to be retained identified and No-Go Areas fenced off?	

State how identified:	
Have habitat trees been identified and appropriately marked?	
State how identified:	
Are specific targeted surveys required?	
State how survey was completed, including results:	
Is there a risk of weed infestation or spread?	
Are any animals present? (If Yes, relocation required)	
Are any active nests/burrows present? (If Yes, relocation required)	
If soil disturbance is to occur, has an ERSED Plan been created and have these controls been installed?	

Have relevant workers been given toolbox talks on limit of clearing, fauna handling procedures and any other SHE Controls?	
Can habitat features be re-used for habitat enhancement?	
Can the habitat feature be re-used immediately?	
If not re-used immediately, where will it be stockpiled?	
Comments:	

APPROVALS

Inspection completed by Ecologist: **Date:**

Ecologist Signature Required

Approval by Site HSE Manager: **Date:**

Site HSE manager Signature Required

SIGN-OFF(ONCE WORKS COMPLETED)

Have the conditions of the permit been met? **Date:**

Site HSE Manager Signature Required

Figure 5.1: Sample ground disturbance permit form

VEGETATION CLEARING PROTOCOL

When undertaking vegetation clearing, the following process shown in Figure 5.2 must be followed to minimise the area of disturbance and the amount of vegetation to be cleared.

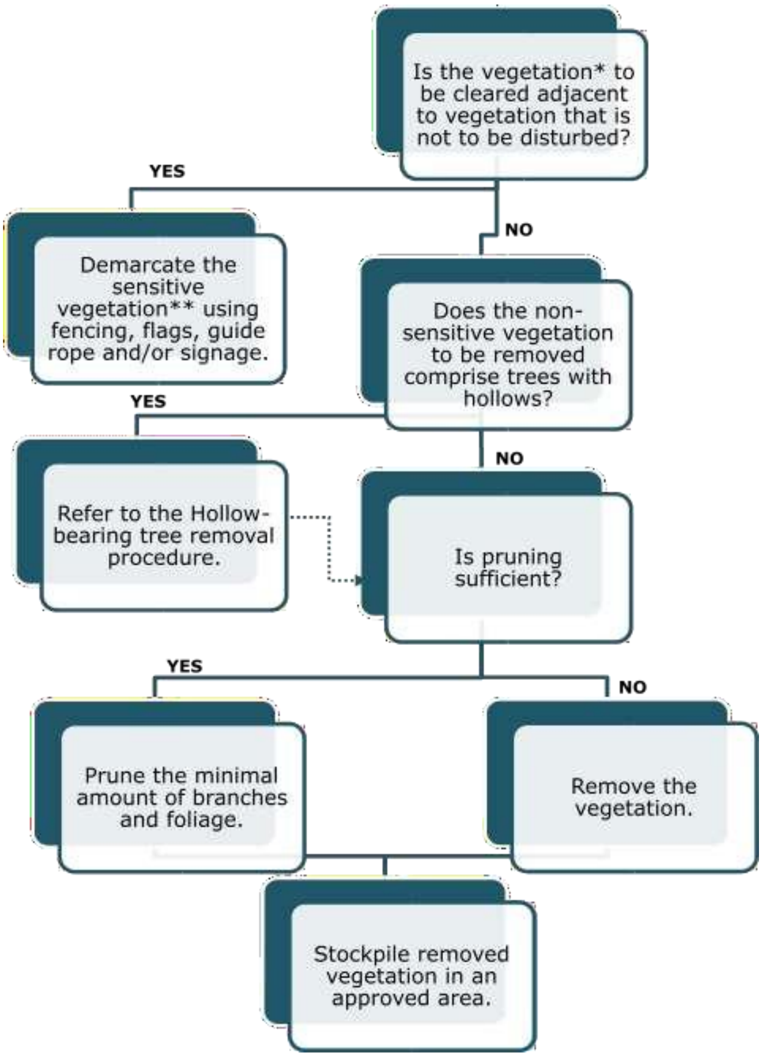


Figure 5.2: Vegetation clearance procedure

Vegetation Exclusion Zones

Sensitive vegetation will be protected by exclusion fencing and signage (e.g., Figure 5.3 and Figure 5.4). A 10 m VEZ will be established inside perimeter fencing. A 20 m VEZ will be established around internal woodland vegetation to ensure that sensitive vegetation is not impacted accidentally. The only exception to internal 20m zones is in the approved areas highlighted in Annex C where it will remain a 10m Exclusion Zone. In these areas the project contractor will ensure an ecologist inspects these areas to ensure there will be no impact to protected vegetation root systems. This inspection will be documented and kept on record. Exclusion fencing will define vegetation to be retained and beyond that a VEZ will be established to mitigate impacts from construction activities.

Figure 5.3: Example of exclusion zone signage.

Figure 5.4: Example of exclusion zone fencing.

Lopping, pruning and trimming procedure

Heavy machinery should not be used for pruning or trimming. Appropriate tools to use are loppers, chain saws and vehicle mounted saws. In the first instance, hollow bearing limbs should be retained. If this is not possible the hollow bearing limb should be inspected by the Project Ecologist / suitably qualified expert and placed in adjacent un- disturbed vegetation to provide fauna habitat. Tree limbs are to be removed using the three-cut method as shown below in Figure 5.4.

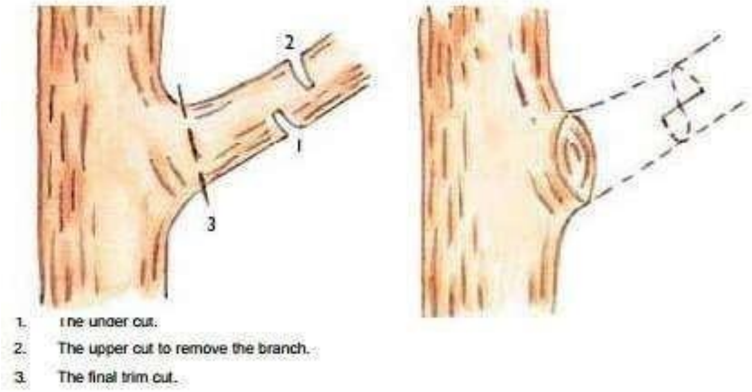


Figure 5.5: Tree cutting method

Hollow-bearing tree removal procedure

Hollow-bearing trees are important habitat feature for a variety of native animals such as possums, gliders, birds and bats. Before clearing any hollow-bearing trees, it is important to consider if animals are present. The following procedure (Figure 5.6) is a guide to give animals an opportunity to eSCape a hollow-bearing tree prior to it being removed.

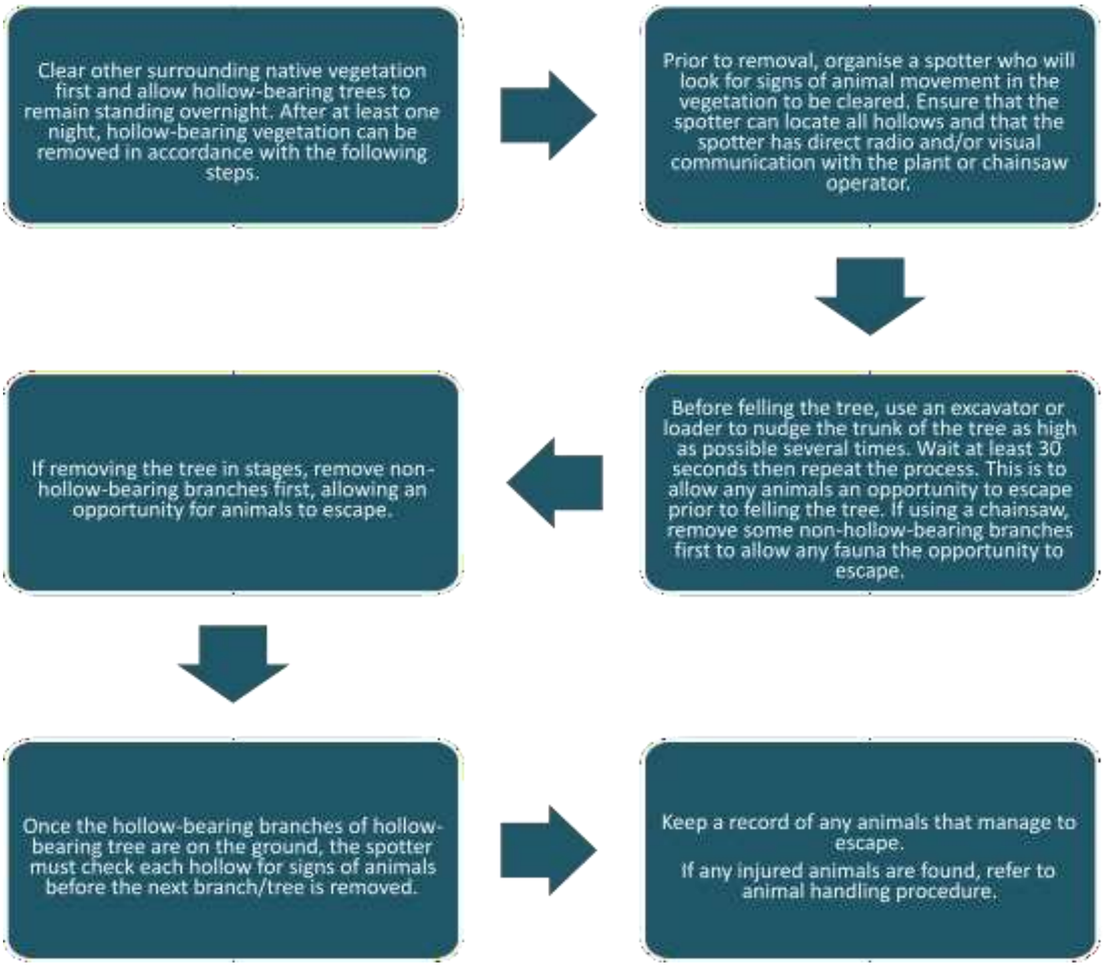


Figure 5.6: Hollow baring tree removal procedure

Removal of trees outside the approved clearing limits

The approved clearing limit is the line between the vegetation to be removed and the vegetation to be retained. It will be shown on all design plans as required. This is to be avoided where at all possible. Where additional impacts to trees are proposed, the following process should be followed:

- The Supervisor should notify the Site HSE Manager of the location and need for the tree impact via the ground disturbance permit process.
- The Site HSE Manager/Lead Field Technician should assess that the tree (or other vegetation type) is not heritage listed, a habitat tree, nominated for retention or protected under relevant legislation and is legally able to be removed and/or trimmed. Alternatives to removing the tree should also be investigated at this stage.
- The Site HSE Manager/Lead Field Technician should notify consult a heritage specialist if heritage significance is suspected, which may require a site visit.
- The Supervisor should await written confirmation from the Site HSE Manager prior to re- commencing works around the tree(s).

Re-use of coarse woody debris

Felled timber greater than 600 mm (primarily tree trunks) will generally be removed from site. Felled timber greater than 200 mm and less than 600 mm will be used as CWD for habitat enhancement and to maximize the salvage of resources within the disturbance area for beneficial reuse. CWD can be used to enhance habitat values in existing vegetation and rehabilitated areas including derived native grassland (either in offset areas or areas adjoining impacted areas). CWD can provide:

- Habitat for micro invertebrates.
- Habitat for macroinvertebrates.
- Habitat for vertebrates using fallen timber for shelter, e.g. skinks, geckoes, dunnarts.
- Habitat for vertebrates using fallen timber for foraging, e.g. tree creepers, robins.
- A source of nutrients for native vegetation.
- Increased habitat complexity.

CWD will be placed within protected woodland areas as diSCrete logs rather than in piles to reduce fire risk and potential for use as shelter by feral animals such as rabbits. CWD will be placed at diSCrete intervals at densities to ensure that the CWD Benchmark for the receiving SCT is not exceeded. The density of CWD must take into account existing fallen timber. Removal, transportation, and placement of CWD will be carried out in a manner that minimizes disturbance to native vegetation, including the canopy, trees, shrubs, standing dead timber, fallen timber, and groundcover, as well as topsoil. CWD between 10 and 200 mm in diameter will be chipped and used for disturbed area rehabilitation.

UNPLANNED TREATENED SPECIES FINDS PROCEDURE

This procedure depicted in Figure 5.7 is derived from information provided by the WWF and Federal Ministry of Environment **wildlife reSCue** centres. Any nests found in habitat features to be removed should be inspected by the Ecologist to determine whether fauna is using the nest, and whether relocation of the fauna and the nest to an adjacent area is viable.As a general principle, any native animals found with the construction area should be avoided. Fauna should only be handled by a qualified ecologist or wildlife carer with relevant skills and experience (e.g. snake handling), and only when absolutely necessary.

Any onsite protected fauna found within a habitat feature to be removed should be captured and relocated according to the following steps. Any onsite protected fauna injured during a construction activity should be captured and a registered wildlife handler or veterinarian contacted.

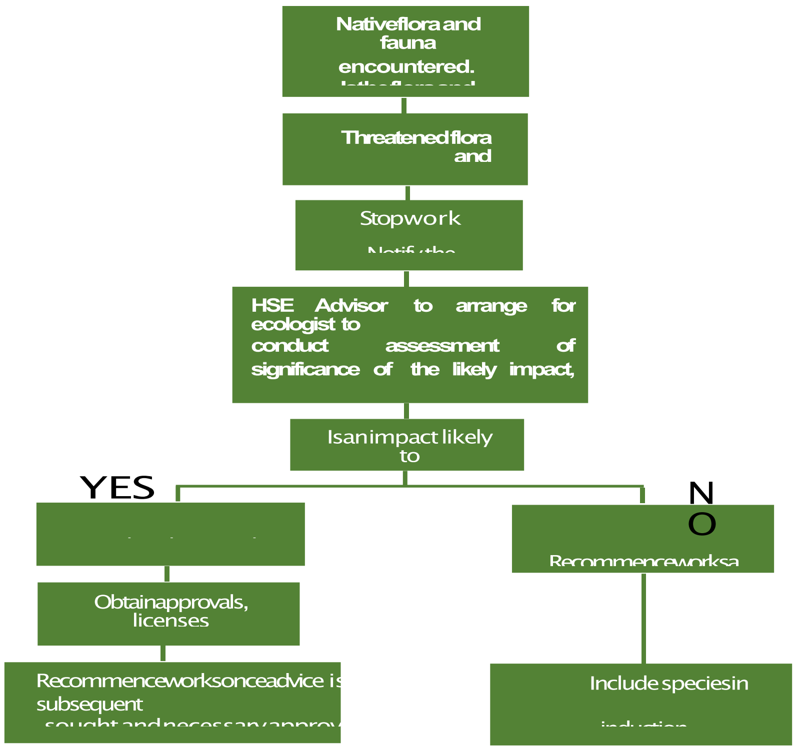


Figure 5.7: Threatened fauna encounter procedure

Step 1

Remove any threat to the animal that could cause or exacerbate an injury.

Step 2

Use appropriate equipment to capture the animal. This may include:

- Frogs: disposable gloves, disinfectant on hands and equipment between animals, disposable plastic bags (one per animal, one use only).
- Mammals: gloves, cloth bags/cotton pillow slips, up-to-date Bat Lyssavirus vaccinations.

Step 3

Contain the animal to minimise stress. Gently place the animal in a holding box specifically designed for holding animals. Cotton pillowslips may be used to cover mammals, or mammals may be placed inside them. Boxes should be placed in a quiet, safe, dark location (not in a vehicle unless temperature is constantly monitored). Do not give the animal food or water.

Step 4

Call the respective ecologist contact person or DPP, who will provide advice on what to do until a trained WILDLIFE reSCuer can come to take the animal away.

Step 5

Release fauna into similar habitats, as near as possible to their capture location. Diurnal (day-active) fauna should be released during the day of capture. Nocturnal (night-active) fauna should be released at or after dusk. Arboreal fauna should be slowly released from their bag onto the trunk of a tree, with bats and gliders placed on a tree with rough or peeling bark and hollows.

Step 6

Details of fauna captured and relocated should be recorded in the following register. Any injury or death of a threatened species should be reported to the Site HSE Manager.

Table 5.1: Threatened species register

Date	Species	Location and time captured	Location and time released	Behaviour and condition on release	Details of any injuries/ death	Contact details of vet/wildlife handler if transferred to their care

NATIVE GRASSLAND MANAGEMENT PROCEDURE

Native grassland will be managed through mowing and/or grazing following specific recommendations of grassland. The objective for the grassland management regime is to effectively balance biodiversity outcomes and reduce the risk of fire, exacerbated by high fuel loads. Early in the construction phase, grassland will be mowed to 100 – 200 m to facilitate the installation of panel infrastructure. Following this initial mowing, the grassland will then be managed throughout the remainder of the construction phase and then during operations for the life of the project.

PEST AND WEED MANAGEMENT PROTOCOL

The Project Manager or Site HSE Manager will initiate collaboration with adjoining landholders to control animal pests and exotic plant species that may traverse property boundaries. These initial communications will inform collaborative past and weed management measures into and during operation.

Animal Pest Management Procedure

Due to perimeter fencing limiting entry to the project site by large mammal pests such as feral cats, and rabbits, it is anticipated that most pest control activities will be limited to the control of small mammals such as rodents and invertebrates. Larger pest animals may however be present at the site early in during the construction phase and may enter the site periodically through the main access way.

Feral cats/ pest control

Reducing the impact of the feral cats relies on a mixture of control techniques comprising poison baiting, shooting, trapping, fencing and guard animals. All these techniques have a short-term effect on local numbers. No single control method will be successful on its own and when feral cats are removed from an area, reinvasion or immigration from existing untreated areas generally occurs within 2 to 6 weeks.

Rabbit pest control

The rabbit is a declared noxious animal. Landholders are obliged to control rabbit populations on their land. The aim of control is to reduce the impact of rabbits on farm enterprises and the natural environment. The success of rabbit control should be determined more by how many rabbits remain than by how many rabbits have been removed. Rabbits have the ability to rapidly re-invade and recolonize areas following control, so control programs should involve as large a number of properties as possible. Set clear, attainable objectives for control work, taking account of available financial and physical resources.

Two broad rabbit control strategies are applied to rural lands: the combination of poisons and harbor destruction in three Stages of rabbit control:

- Stage 1- Initial reduction.
- Stage 2- Follow up control.
- Stage 3- Advanced control.

Control methods include:

- Monitoring of population density prior to deciding a control method.
- Poisons.
- Harbour destruction.
- Fumigation.

- Shooting.
- Trapping.

Pesticide application record

Pesticide application will only be administered by authorized personnel with Respective environmental accreditation –in accordance with SafeWork requirements. Pesticides will only be applied in accordance label instructions for that product. A Pesticide Application Record will be completed and public notifications made in accordance with relevant legislation, where pesticides are to be used in areas that could be accessed by members of the public. Only pesticides registered for use near water may be used near any waterways.

Weed Management Procedure

During construction, the project has the potential to spread weeds through the movements of heavy machinery and light vehicles. Weeds will be controlled through:

- An adaptive management approach whereby management actions will be adjusted to optimise the grassland growth addressing on-site observations as per the Native Grassland Management Procedure in section 5.4.
- For more intensive infestations of weeds, the use of selective herbicides may be warranted to prevent seed set and promote weed control. The advice of an ecologist and agronomist will be sort to advise on the control of weed infestations.
- Any supplementary feeding of livestock will use treated or processed feed to remove viable seeds and prevent weeds being introduced to the site.

A detailed weed management procedure is provided below.

Invasive weeds

The BMP lists the implementation of weed control measures to ensure invasive weed problems are not exacerbated. Once weeds are identified within the construction area, they should be marked up on relevant drawings.

Weed inspection

The Site HSE Manager/Lead Field Technician will inspect the project area for weeds as required:

- Prior to clearing and grubbing.
- When a potential weed infestation has been identified.
- Prior to rainy season till around August to identify high and low threat exotic plants before they go to flower and seed.

Exotic plant cover will be mapped with GPS following inspections including noting the specie(s) degree of infestation and capturing an image for monitoring purposes.

Weed treatment

A general guide to weed control and management is presented above. More detailed information, including herbicide types and application rates, can be sought from the project Ecologist.

Herbicide application record

Herbicide application will only be administered by authorized personnel with environment accreditation in accordance with SafeWork requirements. Herbicides will only be applied in accordance label instructions for that product. A Herbicide Application Record will be completed and public notifications made in accordance with relevant legislation, where herbicides are to be used in areas that could be accessed by members of the public. Only herbicides registered for use near water may be used near any waterways.

Follow-up inspection

The Site HSE Manager/Lead Field Technician will ensure that a follow-up inspection is undertaken of identified exotic plant cover to ensure treatment was successful. Where high threat exotic plants cannot be effectively destroyed prior to topsoil stripping, weed contaminated topsoil will be isolated and disposed of at an approved offsite licensed facility as directed by the Site HSE Manager/Lead Field Technician.

Ongoing management & monitoring

Monitoring of exotic plant cover will occur as part of the routine monthly inspections to determine effectiveness of management controls. The presence of any exotic plant cover and the necessary management actions will be noted on the Environmental Inspection Checklist (refer to EMS).

MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE

POLLUTION CONTROL LABORATORY

Address: Farm Centre, Near Cool FM, Kano State.

Tel: +2347030166686

*Our Ref:*________________ *Your Ref:*_______________ *Date:*______________

CLIENT: RURAL ELECTRICATION AGENCY (REA) ON BEHALF OF FEDERAL GOVERNMENT OF NIGERIA.

PROJECT NAME: NIGERIAN ELECTRIFICATION PROJECT (NEP) PHASE II (DESERT TO POWER), ESIA FOR THE ENERGIZING EDUCATION PROGRAMMED.

PROJECT ADDRESS: FEDERAL UNIVERSITY OF HEALTH SCIENCE, AZARE BAUCHI STATE.

DATE: 29TH JANUARY, 2026.

WATER QUALITY ASSESSMENT RESULT

Sample Quantity: 1 Litre **Preservation Method:** Iceing

Please find below the result of water Quality Assessment, as shown below, on the Condition submitted to the Laboratory.

S/N	Parameters	Unit	GW Pt_1	GW Pt_2	GW Pt_3	GW Pt_4	GW Pt_5	Surface Water	Control	FMENT Limits
a)	**Coordinates**									
1	Latitude	N	11.669047	11.667588	11.671142	11.669047	11.66347	11.671142	11.671142	-
2	Longitude	E	10.220624	10.221389	10.220624	10.222624	10.221382	10.221382	10.221289	-
3	Altitude	M	503.6	511.2	543.6	531.0	498.1	537.1	5631.1	-
a)	**Physicochemical Test**									
4	Colour	TCU	Clear	Clear	Clear	Clear	Clear	Pale brown	Clear	Clear
5	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	unobjectionable
6	Taste	-	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	unobjectionable
7	Turbidity	NTU	1	1	0	0	2	9	1	50
8	pH	-	7.22	7.13	7.03	7.27	7.10	7.77	6.81	6.5-8.5
9	Temperature	^0C	28.0	27.0	27.6	27.0	28.0	28.4	29.0	Ambient
10	Dissolve Oxygen	mg/L	3.3	3.3	3.6	3.2	3.1	2.9	2.8	2 – 8
11	Total Dissolve Solid	mg/L	31	27	27	27	29	127	52	500
12	Electrical Conductivity	µs/cm	62	54	62	54	58	255	104	1000
13	Total Suspended solid	mg/L	3	2	2	3	1	14	8	20
14	Salinity	mg/L	0.00	0.00	0.00	0.00	0.00	0.01	0.00	<1000
15	ORP (MV)	(MV)	206	192	198	194	174	153	178	200-600
16	B.O.D	mg/L	0.4	2.1	1.6	0.8	1.1	2.6	2.0	NS
b)	**Chemical Test**									
17	Ammonium (NH_4^+)	mg/L	0.036	0.021	0.011	0.013	0.015	0.338	0.030	NS
18	Potassium (K^+)	mg/L	0.0	0.0	0.0	0.0	0.1	0.8	0.2	20

19	Calcium (Ca^{2+})	mg/L	0.8	3.0	3.1	2.1	2.0	2.1	0.6	200
20	Sodium (Na^{+})	mg/L	2	7	6	6	4	19	8	20
21	Magnesium (mg^{2+})	mg/L	0.3	1.8	1.6	1.3	1.0	0.7	0.3	20
22	Sulphate (SO_4^{2+})	mg/L	32	18	11	9	8	13	10	100
23	Nitrate (NO_3^{2-})	mg/L	4.0	6.0	8.0	5.2	3.6	16.3	5.4	50
24	Chloride (Cl^{-})	mg/L	2.1	3.2	3.2	1.8	1.6	1.2	1.1	150
25	Phosphate (PO_4^{2-})	mg/L	0.35	0.14	0.35	0.42	0.29	0.23	0.23	NS
26	Nitrite (NO_2^{-})	mg/L	0.01	0.00	0.00	0.01	0.00	1.81	0.01	0.2
c)	**Heavy Metal**									
27	Zinc (Zn^{2+})	mg/L	0.03	0.01	0.02	0.01	0.01	0.01	0.01	3.0
28	Iron (Fe^{2+})	mg/L	0.023	0.037	0.019	0.066	0.048	0.084	0.000	0.3
29	Cupper (Cu^{2+})	mg/L	0.03	0.03	0.04	0.07	0.01	0.01	0.06	1.5
30	Chromium (Cr^{3+})	mg/L	0.02	0.02	0.02	0.06	0.04	0.05	0.02	0.05
31	Lead (Pb^{2+})	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01
32	Cobalt (CO^{2+})	mg/L	0.15	0.17	0.05	0.21	0.22	0.26	0.18	0.2
33	Mercury (Hg^{+})	µg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
34	Nickel (Ni^{2+})	mg/L	0.039	0.032	0.011	0.010	0.039	0.017	0.000	0.07
d)	**Organics**									
35	Oil and Grease	mg/L	0	0	0	0	0	1	0	10
36	Benzene	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
37	Toluene	mg/L	0	0	0	0	0	0	0	0.7
38	Ethylbenzene	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.30
39	Xylene	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
40	Phenols	mg/L	0.007	0.001	0.000	0.000	0.014	0.099	0.001	0.05
e)	**Microbiological Test**									
41	E. Coli	Cfu/ml	0	1	0	0	1	5	1	Nil
42	Feacal Coliform	Cfu/ml	0	0	0	0	0	4	0	Zero
43	Total Coliform	Cfu/ml	0	0	0	0	0	13	0	10

GENERAL SOIL QUALITY ASSESSMENT RESULT/TEST

Sample Quantity: 1kg

Sequel to the Analysis conducted below are the Results obtained from Azare Proposed Nigeria Electrification site (Bauchi) State.

S/N	Parameters	Unit	BSS_1	BSS_2	BSS_3	BSS_4	BSS_5	BSS_6	BSS_7	BSS_8	BSS_9	BSS_{10}	BSS_{11}	BSS_{12}	BSS_{13} Control
a)	**Coordinates**														
1	Latitude	N	11.667667	11.669298	11.667665	11.667588	11.667212	11.671154	11.669298	11.66763	11.667583	11.667577	11.671142	11.671146	11.6711142
2	Longitude	E	10.2212589	10.213932	10.221496	10.221505	10.222174	10.220938	10.213932	10.222597	10.223083	10.223339	10.221289	10.221156	10.221289
b)	**Physical Test**														
4	Colour	TCU	Reddish	Pale Reddish	Reddish	Brownish	Brownish	Dark Brownish	Dark Brownish	Dark Brownish	Pale Reddish	Brownish	Dark brownish	Brownish	Pale Brownish
5	pH	-	5.96	5.49	5.51	6.74	5.26	5.89	5.46	5.60	6.13	6.36	5.46	6.36	6.44
6	Electrical Conductivity	µs/cm	1652	1348	1551	1175	1376	1121	1159	1648	1161	1533	1616	1376	902
7	Temperature	^0C	32.0	31.1	32.4	31.9	31.5	30.9	32.3	32.4	32.8	30.8	32.3	31.5	31.4
8	ORP	MV	203	234	204	206	206	228	236	230	172	213	195	177	171
9	Salinity	%	0.08	0.07	0.07	0.05	0.04	0.05	0.06	0.05	0.08	0.05	0.07	0.08	0.07
c)	**Exchangeable Cation**														
8	Calcium (Ca^{2+})	mg/kg	0.27	0.30	1.01	0.07	0.07	0.23	0.65	0.44	0.39	0.25	0.10	1.05	0.07
9	Magnesium (mg^{2+})	mg/kg	0.14	0.12	0.57	0.06	0.09	0.06	0.31	0.16	0.21	0.09	0.11	0.59	0.08
10	Sodium (Na^{+})	mg/kg	3	2	2	2	5	3	4	5	1	3	3	14	7
11	Potassium (K^{+})	mg/kg	0.0	0.0	0.9	0.0	0.0	0.0	0.3	0.2	1.5	0.0	0.0	0.6	0.1
12	Ammonium (NH_4^{+})	mg/kg	0.041	0.053	1.086	0.026	0.112	0.306	0.996	0.994	0.805	0.024	0.022	2.143	0.057
d)	**Exchangeable Anion**														
13	Sulphate (SO_4^{2+})	mg/kg	7	7	13	5	5	6	8	6	13	6	3	11	5
14	Phosphate (PO_4^{2-})	mg/kg	0.05	0.07	0.09	0.00	0.00	0.05	0.13	0.11	0.21	0.02	0.00	0.03	0.06

15	Nitrate (NO_3^{2-})	mg/kg	2.8	3.1	8.7	2.1	0.9	2.5	4.0	3.3	4.5	2.7	0.5	9.1	1.1
16	Chloride (Cl^-)	mg/kg	0.39	0.41	1.44	0.21	0.00	0.45	0.79	0.79	0.68	0.33	0.00	1.35	0.09
	Organics														
17	Phenols	mg/kg	0.026	0.029	0.059	0.021	0.024	0.027	0.030	0.028	0.064	0.024	0.015	0.059	0.026
18	Calcium Carbon	mg/kg	144	144	132	100	110	130	115	104	134	110	73	139	101
19	Oil & Grease	mg/kg	0	0	0	0	0	0	0	0	0	0	0	0	0
f)	**Heavy Metals**														
20	Iron	mg/kg	0.133	0.177	0.546	0.108	0.057	0.144	0.281	0.198	0.319	0.166	0.122	0.054	0.103
21	Cupper	mg/kg	0.00	0.00	0.63	0.04	0.01	0.00	0.25	0.14	0.12	0.05	0.00	0.55	0.03
22	Chromium	mg/kg	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.01	0.00	0.00	0.09	0.00
23	Zinc	mg/kg	0.00	0.00	0.13	0.00	0.06	0.00	0.04	0.01	0.18	0.03	0.00	0.07	0.00
24	Cobalt	mg/kg	0.000	0.075	0.000	0.047	0.000	0.000	0.000	0.000	0.001	0.014	0.000	0.121	0.039
25	Nickel	mg/kg	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000	0.008	0.002	0.000	0.008
26	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	0.000	0.000
27	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	0.000	0.000
g)	**Soil Characteristic**														
28	Loam	%	0	2	3	3	1	0	2	3	18	2	6	3	31
29	Sandy	%	9	14	8	13	10	20	11	6	4	12	9	13	15
30	Clay	%	28	10	24	33	46	43	51	9	27	30	22	14	29
31	Silt	%	63	74	65	51	43	35	36	82	51	56	63	70	25
h)	**Microbiological Test**														
32	E. Coli	Cfu/ml	1	3	0	1	1	8	6	2	0	0	0	0	0
33	Fungal	Cfu/ml	47	39	51	74	104	29	47	126	57	39	74	136	37

GENERAL AIR QUALITY ASSESSMENT

Below are the in-situ Air Quality Assessment data obtained at the proposed Nigeria electrification project at Bauchi State (Azare) on 29th January, 2026

S/N	Parameters	Unit	BP_1	BP_2	BP_3	BP_4	BP_5	BP_6	BP_7	BP_8	BP_9	BP_{10}	BP_{11}	BP_{12}	BP Control
1	Latitude	N	11.667667	11.669298	11.667665	11.667588	11.667212	11.671154	11.669298	11.66763	11.667583	11.667577	11.671142	11.671146	11.671142
2	Longitude	E	10.2212589	10.213932	10.221496	10.221505	10.222174	10.220938	10.213932	10.222597	10.223083	10.223339	10.221289	10.221156	10.221289
3	Nitrogen (iv) Oxide	ppm	0.1	0.00	0.2	0.1	0.1	0.0	0.2	0.1	0.1	0.8	0.1	0.2	0.1
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	0.00
5	Carbon (ii) Oxide	ppm	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Carbon (iv) Oxide	ppm	643	298	541	543	493	564	643	635	630	343	621	635	587
7	EX	% /e/	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Ammonia Gas	ppm	0.1	0.4	0.6	0.0	0.2	0.9	0.0	0.5	0.1	0.4	0.6	0.0	0.2
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
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
11	Chlorine gas	ppm	0.01	0.00	0.03	0.02	0.01	0.02	0.01	0.02	0.14	0.36	0.02	0.01	0.47
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	$PM_{2.5}$	$\mu g/m^3$	127	128	128	127	129	128	128	127	128	131	126	128	126
15	PM_{10}	$\mu g/m^3$	167	171	172	173	168	165	168	168	169	165	168	172	173
16	$PM_{1.0}$	$\mu g/m^3$	73	72	80	81	32	82	71	72	70	80	82	79	78
17	TVOC	mg/m^3	0.14	0.17	0.13	0.09	0.14	0.20	0.16	0.12	0.19	0.17	0.13	0.09	0.14
18	HCOH	mg/m^3	0.122	0.127	0.124	0.121	0.1322	0.148	0.103	0.153	0.197	0.142	0.147	0.107	0.147
19	Temperature	^{O}C	31.6	31.4	32.0	31.1	33.1	32.5	33.2	32.8	33.0	32.6	33.0	32.6	33.2
20	R/Humidity	%	43	48	44	50	49	53	58	43	47	51	43	54	53
21	Ozone	Ppm	0.01	0.01	0.00	0.00	0.0	0.00	0.03	0.00	0.03	0.03	0.00	0.00	0.03
22	A Q I	-	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
23	Sound Level	dB	54.1	61.6	57.1	53.9	55.5	62.7	62.1	50.5	51.0	586	55.1	54.3	59.9

Key:

ppm:	Part Per Million
$\mu g/m^3$:	Microgram per meter cube
mg/m3:	Milligram per meter Cube
dB:	Decible
Bp:	Bauchi Point

Best Regards,

POLLUTION CONTROL
LABORATORY M.O.E KANO
SIGN
DATE

Sani. Abdulkadir H. Umar
Asst. Chief Scientific Officer

CamScanner

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

CUSTODY TRANSFER FORM

Client Name:	Nigerian Electrification Agency (REA)	Relinquished by (Sinature):	Date: 29/01/2026	Time: 10:00am
Project Name:	Nigerian Electrification Project (NEP)	Received by (Signature):	Date:	Time:
Address:	College of Health Sciences Azare	FMEVT Representative:	Date:	Time:
Consultant		Address:		

Type of Simple			Number of Samples: 13 Samples + Control
Water Sample ☐	Soil Sample ☑	Others (Specify): ☐	Date Sampled: 29/01/2026

S/No.	Sample ID	Sample Location	Laboratory Description of Sample
1	BSS 1	Bauchi Soil Sample (Azare)	BSS 1
2	BSS 2	✓	BSS 2
3	BSS 3	✓	BSS 3
4	BSS 4	✓	BSS 4
5	BSS 5	✓	BSS 5
6	BSS 6	✓	BSS 6
7	BSS 7	✓	BSS 7
8	BSS 8	✓	BSS 8
9	BSS 9	✓	BSS 9
10	BSS 10	✓	BSS 10
11	BSS 11	✓	BSS 11
12	BSS 12	✓	BSS 12
13	BSS 13 control	✓	BSS 13 control

CamScanner

In-situ Water Quality

S/N	Parameters	unit	AZBH.	$AZBH_2$	$AZBH_3$	$AZBH_4$	AZWW	$AZBH_5$ Control	$AZBH_6$
1.	pH	—	7.22	7.13	7.03	7.27	7.10	7.77	6.81
2	Temperature	°C	28.0	27.0	27.6	27.0	28.0	28.4	29.0
3	Dissolve oxygen	mg/l	3.3	3.3	3.6	3.2	3.1	2.9	2.8

29th/01/2026

Lab. Representative

CamScanner

Project: Nigerian Electrification Agency (REA), Nigerian Electrification Project (NEP)
Site Address: Federal University of Health Science Azare. Bauchi State.
Date: 29th / January / 2026.

Ambient Air Quality Measurements

Station Code	Stations Bauchi (Azare)	Latitude 11.667667	Longitude 10.213532	Elevation —	Parameters									
					HCL (ppm)	TVOC (ppm)	O_3 (ppm)	C_2H_4 (ppm)	PH_3 (ppm)	PM1.0 (ppm)	HCHO (ppm)	Temp (^0C)	HUM (%)	Noise (dB)
1	BP1				1.2	0.14	0.01	0.000	0.00	73	0.122	31.6	43	54.1
2	BP2				0.4	0.17	0.01	0.000	0.00	72	0.127	31.4	48	61.6
3	BP3				0.5	0.13	0.00	0.000	0.00	80	0.124	32.0	44	57.1
4	BP4				1.8	0.09	0.00	0.000	0.00	81	0.121	31.1	50	53.9
5	BP5				1.3	0.14	0.00	0.000	0.00	32	0.132	33.1	49	55.5
6	BP6				1.4	0.20	0.00	0.000	0.00	82	0.148	32.5	53	62.7
7	BP7				0.7	0.16	0.03	0.000	0.00	71	0.103	33.2	58	62.1
8	BP8				0.3	0.12	0.00	0.000	0.00	72	0.153	32.8	43	50.5
9	BP9				0.1	0.19	0.03	0.000	0.00	70	0.157	33.0	47	51.0
10	BP10				0.5	0.17	0.03	0.000	0.00	80	0.142	32.6	51	58.6
11	BP11				0.6	0.13	0.00	0.000	0.00	82	0.147	33.2	43	55.1
12	BP12				1.4	0.09	0.00	0.000	0.00	79	0.107	32.6	54	54.3
13	BPcontrol				1.7	0.14	0.03	0.000	0.00	78	0.147	33.2	53	59.9

29/01/2026.

FMEVT REPRESENTATIVE

DATE

CONSULTANT REPRESENTATIVE

DATE

FMEVT ACCREDITED LABORATORY REPRESENTATIVE

DATE