ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

FOR THE PROPOSED SOLAR-HYBRID POWER PLANT AND ASSOCIATED INFRASTRUCTURE AT THE FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA (FUTMINNA) NIGER STATE

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

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

DRAFT FINAL REPORT

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
AC	Alternating Current
AfDB	African Development Bank
ALARP	As Low as Reasonably Practicable
AoI	Area of Influence
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
DC	Direct Current
DO	Dissolved Oxygen
EPR	Extended Producer Responsibility
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
FMEnv	Federal Ministry of Environment
FUT	Federal University of Technology
GBV	Gender-Based Violence
GPS	Global Positioning System
HSE	Health, Safety, and Environment
IEC	International Electro-technical Commission
ISS	Integrated Safeguards System
IUCN	International Union for Conservation of Nature
NAAQS	Nigerian Ambient Air Quality Standards
NEP	Nigeria Electrification Project
NESPA	Niger State Environmental Protection Agency
NiMet	Nigerian Meteorological Agency
OHS	Occupational Health and Safety
OS1	Operational Safeguard 1
OS2	Operational Safeguard 2
PCE	Personal Protective Equipment
PV	Photovoltaic
QHSE	Quality, Health, Safety, and Environment
RAP	Resettlement Action Plan
REA	Rural Electrification Agency
SESA	Strategic Environmental and Social Assessment
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
TSP	Total Suspended Particulates
WHO	World Health Organization

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EXECUTIVE SUMMARY

ES 1: INTRODUCTION

This report documents the Environmental and Social Impact Assessment (ESIA) study for the proposed project of a Solar Powered Plant infrastructure in FUT Minna, Niger State. The Nigeria Electrification Project (NEP) which seeks to increase electricity access to households, public institutions, micro, small and medium enterprises (MSMEs) and to provide clean, safe, reliable and affordable electricity to unserved and under-served rural communities through mini-grid/off-grid renewable power solutions. The NEP is being implemented by the Rural Electrification Agency (REA), on behalf of the Federal Government of Nigeria (FGN), and co-financed by the African Development Bank (AfDB).

One of the key components of the NEP is Energizing Education Programme (EEP). The objective of the EEP is to provide dedicated, clean and reliable power supply to 37 Federal Universities and 7 affiliated University 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 Centre for each of the beneficiary universities.

The EEP is being implemented in phases. The first phase (Phase I) covers 9 universities and 1 affiliated Teaching Hospital and it is currently ongoing, while the second phase (Phase II), to be funded by the AfDB loan under the NEP, covers 7 Universities and 2 affiliated Teaching Hospitals.

One of the beneficiary Universities under the EEP Phase II is the Federal University of Technology Minna (FUT Minna) in Niger State, Northwest region of Nigeria. FUT Minna was established on February 1, 1983, FUT Minna took over facilities from the former Government Teachers' College Bosso, now its Bosso Campus, with the main Gidan Kwano Campus spanning 10,650 hectares along Minna-Bida Road. Its motto is "Technology for Empowerment," focusing on self-reliance in science, engineering, and technology.

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, an Environmental and Social Impact Assessment (ESIA) of the proposed solar-hybrid power plant and associated infrastructure in FUT Minna, Niger State (the “Project”) has been conducted.

The ESIA study is also in fulfillment of commitments documented in the Environmental and Social Management Framework (ESMF) for NEP. The ESIA study covers the entire life-cycle of the proposed Project (i.e. pre-construction, construction, commissioning, operation, decommissioning and closure).

The overall objective of the ESIA is to identify and assess the potential and associated impacts of the proposed Project throughout its life-cycle and to put in place appropriate environmental and social measures to eliminate or mitigate the identified adverse impacts and enhance the associated benefits. This is aimed at ensuring that the proposed project is developed and operated in an environmentally and socially sustainable manner.

The specific objectives of the ESIA study are to:

i. Establish and document the existing environmental and social conditions of the Project's Area of Influence prior to construction, including any cultural resources and sensitive components of the environment.

ii. Assist Project design and planning by identifying those aspects of location, construction, operation and decommissioning which may cause adverse environmental and social impacts, including occupational and community health and safety issues.

iii. Develop appropriate and practicable mitigation measures and environmental and social management plan (ESMP) including monitoring programme, responsible parties, time-frame and cost estimates required to address the identified adverse impacts and enhance the associated Project benefits (e.g. positive climate impact).

iv. Identify, where required, the need for development and implementation of a Resettlement Action Plan (RAP) / Livelihood Restoration Plan (LRP).

v. Conduct stakeholder consultations to capture the concerns of the various stakeholders (e.g. relevant government institutions, potentially affected persons, etc.) about the Project including gender-based violence (GBV) risks.

vi. Prepare a detailed report presenting clear and concise information on the findings of the ESIA study.

vii. Obtain FMEnv. approval for the proposed Project.

ES 2 : PROJECT JUSTIFICATION

The proposed Project in FUT Minna is part of the FGN's EEP Phase II, under NEP. The Project will help to significantly address the power supply challenges currently facing the University, which will also lead to many positive spill-over effects. The associated infrastructure such as the training centre to be provided as part of the Project would enhance learning in renewable energy leading to certification, while the street lighting will improve security within the campus as a result of proper lighting.

The potential project benefits include the following among others:

i. Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
ii. Reduction in fossil fuel consumption by the University thereby leading to reduction in carbon emissions and improvement in eco-balance.
iii. Significant reduction in the cost of power generation by the University through diesel-fuelled generators.
iv. 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.
v. Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the project.
vi. Improvement in livelihood enhancing activities within the University.
vii. Direct and indirect employment opportunities during project development and operation.

viii. Increase in local and regional economy through award of contracts and purchase of supplies for Project development.
ix. Increase in financial and technical collaborations between the FGN, the University, REA, African Development Bank and other relevant Ministries, Departments and Agencies (MDAs).

Envisaged Sustainability

Technical Sustainability

The project development shall be handled by a qualified and experienced 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 FUT Minna. 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 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 FUT Minna Works and Physical Planning Department. 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.

Environmental Sustainability

The environmental sustainability measures for the Project include the use of a renewable source of energy (solar) for electricity generation (with negligible greenhouse gas (GHG) emissions compared to fossil fuel-burning power plants). 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

Economic Sustainability

The proposed project is part of the FGN's EEP initiative, a component of NEP. NEP is being funded by the AfDB. The proposed project in FUT Minna, 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 cost, among others. Also, the monthly payment to the electric distribution company Niger State for power consumption through the grid would stop. 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 the 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 funds generated 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.

ES 3: PROJECT DESCRIPTION

The description of environmental conditions of the project's area of influence is based on both desk research and field investigations. Field sampling was conducted by a team of environmental and social specialists.

FUT Minna spans two main campuses with vast lad area primarily at its permanent site. The main Gidan Kwano Campus covers 10,650 hectares along the Minna-Kataeregi-Bida Road, designed for expansion and hosting most academic schools. The smaller Bosso Campus, repurposed from a former teachers' college in Minna city, supports specific units like preliminary studies without a specified separate land size.

The proposed project site is situated in the permanent site of the University at Gidan Kwano campus. The Permanent site of FUT Minna, known as Gidan Kwano Campus lies in Niger State, North Central Nigeria, along the Minna- Bida Road about 12km from Minna city centre. Its coordinates are approximately 9°41' N latitude and 6°31' E longitude, at an elevation of 258.5 meters above sea level.

At the time of site visit, about 85% of the project site lies fallow though a small portion of the area is used as farmland. The crops planted include yam, maize, and other staple foods. The unused portion of the site was covered by secondary vegetation, mostly grass, shrubs, and a few trees. The topography of the site is relatively flat and sloped towards the north of the site. There are no physical structures within the site. The nearest community to the project site is the Bosso community located about 3.5 km away from the University campus. There is no local community presence within the site neither is the site used for grazing or wood/food gathering activities by the local community. The proposed project site is far removed from any physical structures.

ES 4: DESCRIPTION OF THE ENVIRONMENT

The description of the existing environmental and socioeconomic conditions of the project's area of influence (AoI), which covers the project site and its surrounding environment up to 2 km, including the area where the cumulative impacts of the project may be experienced were considered and covered in the study. 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).

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 1 km 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 3 km radius from the centre of the project site, as illustrated in Figure 4.1.

The environmental components of the study area described in this chapter cover the following:

i. Climate and meteorology;
ii. Geology and hydrogeology;
iii. Air quality and noise;
iv. Groundwater;
v. Soil;
vi. Terrestrial flora;
vii. Terrestrial fauna;
viii. Land use;

ix. Socio-economic and health.

Based on the field observation, there is no surface water body within the project site and its immediate surroundings.

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:

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

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.

Field Sampling and Laboratory Analysis

Field Sampling

In order to effectively characterize the environment of the study area, field sampling was conducted from February 03rd-05th, 2026. The objective of the field exercise was to obtain the baseline data of the project's AoI 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 (Bosso 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.

ES 5: 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.

ES 6: MITIGATION MEASURES

The recommended mitigation measures for the identified negative impacts associated with the proposed project are documented in the research. 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 the report, are negligible to minor significance.

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

Fire and Explosion

i. Only PV modules which comply with international and local standards for electrical performance and safety shall be used.
ii. Only solar cables suitable for outdoor applications and severe weather conditions shall be used
iii. Inverters shall not be mounted on combustible walls such as wood panels or combustible sandwich panels
iv. Inverters shall be easily accessible and protected from severe weather conditions.
v. The local fire department shall be informed of and familiarized with the photovoltaic installation.
vi. PV systems shall only be installed by qualified contractors.
vii. PV systems shall be inspected regularly by qualified professionals.
viii. PV systems shall be regularly checked for damage from rodents and other pests, which could compromise wiring or insulation.
ix. Batteries installed for the power plant shall be monitored regularly to prevent overcharging and deep discharging during operations
x. 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
xi. The batteries shall be housed in well-ventilated, dust free containers under optimal conditions.
xii. Emergency response plan shall be developed and implemented.
xiii. Fire extinguishers, fire notices, warning signs) shall be installed at different locations within the Plant site.

Electrocution

i. Use of signs, barriers and public outreach to prevent public contact with distribution cables shall be employed.

ii. Grounding conducting objects (e.g. fences or other metallic structures) shall be installed where required to prevent shock.

Occupational Hazard

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

ES 7: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Environmental Management Plan (EMP) is a site specific plan developed to ensure that a project is implemented in an environmentally sustainable manner where all stakeholders including the project proponent, contractors and subcontractors, including consultants, understand the potential environmental risks that will arise from the proposed project and take appropriate measures to properly manage that risk.

The EMP for the proposed project is a central document that stipulates strategies and procedures for managing the significant adverse potential and associated environmental impacts of a proposed project. It is also a standalone tool that provides assurance that the proffered mitigation outlined is effectively implemented throughout the project's life.

Environmental Management Plan (EMP) is instituted for the proposed project to ensure that impact mitigation; control and recovery measures outlined in this report are followed. The EMP is designed to commit the proponent to operate with little or no long term negative impacts on the project. This EMP shall be updated and revised on a regular basis throughout the project's life-cycle.
Specifically, the EMP is geared towards:

i. Ensuring that environmental, social, health & safety factors are carefully managed throughout the project cycle.
ii. Ensuring compliance with regulatory authority stipulations and guidelines;
iii. Ensuring that there is sufficient allocation of resources on the project budget so that the scale of EMP-related activities is consistent with the significance of project impacts;
iv. Verify environmental performance through information on impacts as they occur;
v. Respond to changes in project implementation not considered in this ESIA;
vi. Respond to unforeseen events; and
vii. Provide feedback for continual improvement in environmental performance.
viii. Specify the procedures and methods of the plan
ix. Specify the institutional arrangements required to implement the environmental impact mitigation enhancement measures, and
x. Include a monitoring program, for selected environmental parameters, to assess the success of the mitigating/enhancement measures, as well as their timely execution
xi. Provide an implementation schedule for the plan

ESMP Budget

The total costs of the ESMP implementation including costs for mitigation, monitoring and capacity building is estimated as: Forty five million One hundred thousand Naira only, as detailed in Table 7.7 below:

Table7.7: ESMP Budget

Fundamental ESMP Activities	Cost Estimates (NAIRA)	Cost Estimates (USD)

ESMP Implementation Cost	30,600,000	**23,182**
Monitoring Cost	4,100,000	**3,106**
Capacity Building	2,000,000	**1515**
GRM Implementation Cost	5,000,000	**3,788**
Additional Management Cost	3,400,000	**2,576**
Total	**45,100,000**	**34,167**

Dollar rate at 1Dollar to 1,320NGN as at September, 2026

ES 8: 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 Photovoltaic (PV) 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. The decommissioning activities will typically include the following:

i. Dismantling and removal of PV panels and associated infrastructure (mounting structure, power evacuation route, inverters, transformers, batteries, etc.);
ii. Removal of any sub-surface installations (e.g. underground cables);
iii. Waste generation and management;
iv. Rehabilitation of any impacted environmental component (e.g. soil).

In the event of decommissioning, REA, in conjunction with the management of the FUT Minna, 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:

i. Evacuation of the dismantled PV panels and other related items (such as inverters, and control devices) to the manufacturers for recycling;
ii. Transportation of spent batteries to recycling facilities;
iii. Restoration of the Project site to baseline conditions (as much as practicable) in line with legislative and regulatory requirements.
iv. Assessing the residual impact, if any, the project has on the environment.
v. 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.

ES 9: STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

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:

i. inform and educate stakeholders about the proposed project;
ii. gather local knowledge to improve the understanding of the environmental and social context;
iii. better understand the locally-important issues;
iv. provide a means for stakeholders to have input into the project planning process;
v. 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.

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 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.

ES 10: CONCLUSION AND RECOMMENDATIONS

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.

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 ESIA study recommends the following:

i. The REA, through its Project Management Unit (PMU), as well as the Management of FUT Minna, 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.

i. 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.

ii. Implementation of the project's Stakeholder Engagement Plan (including grievance redress mechanism) shall be maintained.

CHAPTER ONE
INTRODUCTION

1.1 Background Information

The Nigeria Federal Executive Council approved the Power Sector Reform Program (PSRP) on March 22, 2017. One of the PSRP initiatives is the Nigeria Electrification Project (NEP) which seeks to increase electricity access to households, public institutions, micro, small and medium enterprises (MSMEs) and to provide clean, safe, reliable and affordable electricity to un-served and under-served rural communities through mini-grid/off-grid renewable power solutions. The NEP is being implemented by the Rural Electrification Agency (REA), on behalf of the Federal Government of Nigeria (FGN), and co-financed by the African Development Bank (AfDB).

One of the key components of the NEP is Energizing Education Programme (EEP). The objective of the EEP is to provide dedicated, clean and reliable power supply to 37 Federal Universities and 7 affiliated University 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 centre for each of the beneficiary universities.

The EEP is being implemented in phases. The first phase (Phase I) covers 9 universities and 1 affiliated Teaching Hospital and it is currently ongoing, while the second phase (Phase II), to be funded by the AfDB loan under the NEP, covers 7 Universities and 2 affiliated Teaching Hospitals.

One of the beneficiary Universities under the EEP Phase II is the Federal University of Technology Minna (FUT Minna) in Niger State, Northwest region of Nigeria. FUT Minna was established on February 1, 1983, FUT Minna took over facilities from the former Government Teachers' College Bosso, now its Bosso Campus, with the main Gidan Kwano Campus spanning 10,650 hectares along Minna-Bida Road. Its motto is "Technology for Empowerment," focusing on self-reliance in science, engineering, and technology.

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, an Environmental and Social Impact Assessment (ESIA) of the proposed solar-hybrid power plant and associated infrastructure in FUT Minna, Niger State (the “Project”) has been conducted.

The ESIA study is also in fulfillment of commitments documented in the Environmental and Social Management Framework (ESMF) for NEP. The ESIA study covers the entire life-cycle of the proposed Project (i.e. pre-construction, construction, commissioning, operation, decommissioning and closure).

1.2 Objectives of the ESIA Study

The overall objective of the ESIA is to identify and assess the potential and associated impacts of the proposed Project throughout its life-cycle and to put in place appropriate environmental and social measures to eliminate or mitigate the identified adverse impacts and enhance the associated benefits. This is aimed at ensuring that the proposed project is developed and operated in an environmentally and socially sustainable manner.

The specific objectives of the ESIA study are to:

viii. Establish and document the existing environmental and social conditions of the Project's Area of Influence prior to construction, including any cultural resources and sensitive components of the environment.

ix. Assist Project design and planning by identifying those aspects of location, construction, operation and decommissioning which may cause adverse environmental and social impacts, including occupational and community health and safety issues.

x. Develop appropriate and practicable mitigation measures and environmental and social management plan (ESMP) including monitoring programme, responsible parties, time-frame and cost estimates required to address the identified adverse impacts and enhance the associated Project benefits (e.g. positive climate impact).

xi. Identify, where required, the need for development and implementation of a Resettlement Action Plan (RAP) / Livelihood Restoration Plan (LRP).

xii. Conduct stakeholder consultations to capture the concerns of the various stakeholders (e.g. relevant government institutions, potentially affected persons, etc.) about the Project including gender-based violence (GBV) risks.

xiii. Prepare a detailed report presenting clear and concise information on the findings of the ESIA study.

xiv. Obtain FMEnv. approval for the proposed Project.

1.3 Scope of the ESIA Study

The scope of the ESIA study covers the following:

i. Review of applicable local and international laws, regulations, standards and industry codes that apply to the proposed Project.

ii. Description of all actions/activities that will be carried out in the course of the Project development and implementation.

iii. Desktop review of relevant documents pertaining to the project and the environment where the project would be located. These documents include the NEP ESMF, amongst others.

iv. Field data gathering covering biophysical and socioeconomic components of the project's Area of Influence.

v. Consultations with relevant stakeholders including government institutions, project affected persons, University management representatives, etc. Detailed information on stakeholder consultations conducted as part of the ESIA study for the proposed project.

vi. Laboratory analysis of field samples collected and result analysis.

vii. Impacts identification and evaluation, and development of appropriate and practicable mitigation measures.

viii. Report preparation and disclosure.

1.4 ESIA Study Approach

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 Environmental and Social (E&S) Safeguard Policies.

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.

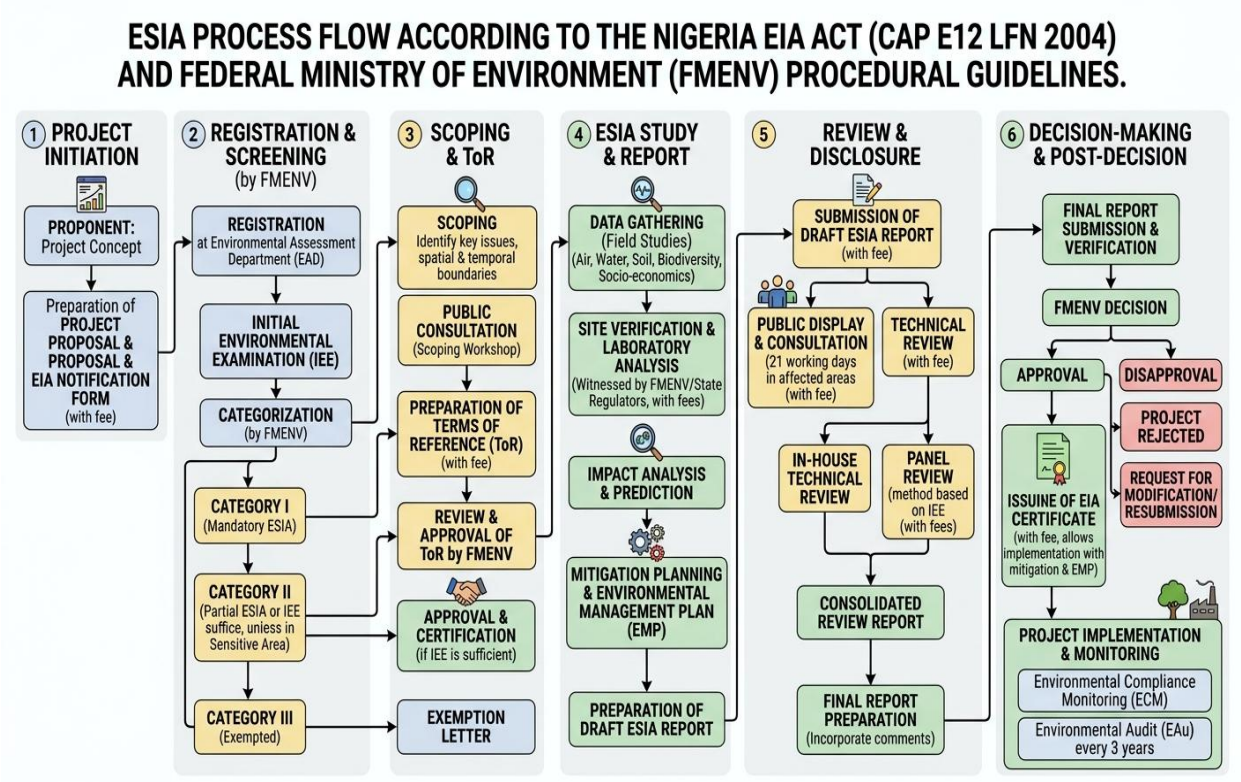

Figure 1.1: Process flow chart presentation of the methodology for the ESIA

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.

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 EIA process in Nigeria.

1.6.1 National Policy, Guidelines and Regulations (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 proposed Project are summarized as follows:

i. **National Policy on the Environment, 1989 (revised in 1999 and 2017):** The National Policy on the Environment (1989) (revised 1999 and 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:

- ✓ Secure a quality environment adequate for good health and well-being;
- ✓ Conserve the environment and natural resources for the benefit of present and future generations;
- ✓ Raise public awareness and promoting understanding of the essential linkages between the environmental resources and developments and encouraging individual and community participation's in environmental improvement efforts;
- ✓ Maintain and enhance the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity;
- ✓ Co-operate with other countries, international organizations and agencies to achieve optimal use and effective prevention or abatement of trans-boundary environmental degradation.

ii. **National Guidelines and Standards for Environmental Pollution Control in Nigeria, 1991:** This was launched on March 12th, 1991 and represents the basic instrument for monitoring and controlling industrial and urban pollution.

iii. **S.I. 9 National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991:** This Statutory Instrument imposes restrictions on the release of toxic substances into the environment and stipulates requirements for pollution monitoring, machinery for combating pollution, contingency plan, and safety for workers.

iv. **S.I. 15 National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991:** This Statutory Instrument regulates the collection, treatment and disposal of solid and hazardous wastes from municipal and industrial sources.

v. **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 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.

vi. **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.

vii. **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.

viii. 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.

  AUJET - Adeleke University
- **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

ix. **National Environmental Standards and Regulation Enforcement Agency:** The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the FGN 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 applicable NESREA's regulations to the proposed Project include:

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.
- ✓ **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 control of air pollutants that may affect the ambient environment.
- ✓ **National Environmental (Permitting and Licensing Systems) 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 (Battery Control) Regulations, 2024**

1.6.2 Federal Ministry of Power: The Federal Ministry of Power is the policy making arm of the Federal Government with the responsibility for the provision of power in the country. The Ministry is guided by the provisions of the Electricity Act No 28 of 1988, the National Electric Power Policy, 2001, the Electric Power Sector Reform Act, 2005, the Roadmap for Power Sector Reform, 2010, the National Energy Policy, 2013 and the National Energy Efficiency Action Plans, 2015.

1.6.2.1 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.

1.6.3 Endangered Species Act 1985: The FGN enacted the Endangered Species (Control of International Trade and Traffic) Act 11, 1985 which makes, among 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.

1.6.4 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.

1.6.5 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.

1.6.6 Criminal Code of 1990 (now CAP 38 LFN 2004): The Nigerian Criminal Code makes it an offence punishable with up to 6 months imprisonment for any person who violates the atmosphere

in any place so as to make it noxious to the health of persons in general dwelling or carry on business in the neighbourhood, passing along a public way; or does any act which is, and which he knows or has reason to believe to be, likely to spread the infection of any disease dangerous to life, whether human or animal.

1.6.7 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.

1.6.8 National Policy on Occupational Safety and Health 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.

1.6.9. 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 power plant and associated infrastructure will be sited within the land property owned by FUT Minna. No additional land outside the University campus will be expropriated for the proposed Project. 1

1.6.10 Violence Against Persons (Prohibition) Act, 2015 and the Employee Compensation Act, 2010: 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. 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.

1.6.11 State and Local Government Environmental Authorities: In Nigeria, States and local government councils are empowered under the law to set up their own environmental protection bodies for the purpose of maintaining good environmental quality in the areas of related pollutants under their control.

1.6.12 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:

1.6.12.1 International Guidelines and Integrated Safeguard Standards:

The African Development Bank (AfDB) aligns its operations with international standards through frameworks like the Integrated Safeguards System (ISS), procurement policies, and ethical codes, emphasizing environmental, social, and governance (ESG) principles.

Integrated Safeguards System (ISS)

The ISS, updated and effective since May 31, 2024, sets ten Environmental and Social Operational Safeguards (OSs) for projects funded by the AfDB, covering risk assessment, biodiversity conservation, worker safety, and non-discrimination, especially for vulnerable groups. It incorporates Good International Industry Practice (GIIP), World Bank Group EHS Guidelines, and promotes harmonization with other development finance institutions. Borrowers must meet these standards throughout project life-cycles, with Guidance Notes providing technical advice on implementation.

The African Development Bank's Integrated Safeguards System (ISS), updated in 2024, outlines ten Environmental and Social Operational Safeguards (OSs) to manage risks in funded projects.

The Ten (10) Integrated Safeguard System

These safeguards apply across project life-cycles, aligning with global standards like World Bank EHS Guidelines.

OS 1: Assessment and Management of Environmental and Social Risks and Impacts – Requires comprehensive risk screening, categorization, and management plans.

OS 2: Labour and Working Conditions – Ensures fair wages, safe workplaces, and protection against child/forced labor.

OS 3: Resource Efficiency and Pollution Prevention and Management – Promotes efficiency, waste reduction, and control of emissions/hazardous materials.

OS 4: Community Health, Safety, and Security – Addresses risks from project activities to nearby communities.

OS 5: Land Acquisition, Restrictions on Land Access/Use, and Involuntary Resettlement – Minimizes displacement and ensures fair compensation/rehabilitation.

OS 6: Biodiversity Conservation and Sustainable Natural Resource Management – Protects ecosystems, species, and sustainable resource use.

OS 7: Indigenous Peoples – Safeguards rights, cultures, and free prior informed consent for Indigenous groups.

OS 8: Cultural Heritage – Prevents damage to tangible/intangible heritage and supports protection.

OS 9: Financial Intermediaries – Mandates sub-projects to meet ISS standards via client policies and monitoring.

OS 10: Stakeholder Engagement and Information Disclosure – Requires inclusive consultation, grievance mechanisms, and public disclosure.

AfDB ISS compliance is integrated into the project cycle, starting with screening and requiring borrowers to conduct assessments and implement management plans under AfDB supervision.

Project Screening and Categorization

AfDB performs initial screening post-project identification to categorize as low (A, B, C,) or substantial risk, defining required environmental and social (E&S) assessments and audit frameworks. Borrowers prepare Terms of Reference (ToR) for Environmental and Social Impact Assessment (ESIA) and ESMP based on this.

Assessment and Disclosure

Borrowers procure and submit ESIA/ESMP studies; AfDB conducts due diligence, discloses ESIA for public consultation (120 days for public sector, 60 for private before Board approval). Financial agreements include E&S compliance covenants and reporting obligations.

Approval and Implementation

Board approves project with E&S conditions; borrowers implement ESMP, with AfDB providing supervision, monitoring, audits, and grievance mechanisms throughout the life-cycle. Post-completion, clients contribute to ongoing mitigation as needed.

Procurement Guidelines

AfDB procurement follows harmonized standards with other multilateral development banks (MDBs), using Open Competitive Bidding (International) for contracts over UA 300,000, with Standard Bidding Documents ensuring eligibility from member countries and restrictions compliance. Policies emphasize transparency, integrity, and sustainable development outcomes aligned with SDGs and the Paris Agreement.

Ethical and Conduct Standards

The AfDB Code of Conduct mandates staff integrity, loyalty, and adherence to Bank rules and host country laws, drawing from international civil service norms. It supports accountability via independent evaluation and grievance mechanisms.

Sustainability and Global Alignment

AfDB partners with IFRS on ISSB Standards for sustainability disclosures in Africa and aligns with UN Guiding Principles on Business and Human Rights for risk management. These frameworks enhance environmental sustainability, social inclusivity, and transparency in operations.

1.6.13 International Conventions

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. The international conventions (ratified by Nigeria) and regulations that are relevant to the proposed Project include:

i. 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 June16, 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.

ii. 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.

iii. 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.

iv. 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.

v. 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.

vi. 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".

vii. Declaration of the United Nations Conference on Human Environment

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.

viii. 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. Nigeria ratified the guidelines in 2001.

1.6.13.1 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 II, 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 FUT Minna, 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, Niger State Ministry of Environment and other relevant regulatory agencies, as part of their statutory responsibilities.

1.8 The Report Structure

The report structure is in line with the FMEnv. guidelines, this report is structured as follows:

- **Preliminary Sections:** containing table of contents, lists of ESIA preparers, Executive Summary, among 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 time-frame including responsibility for the implementation of the recommended measures.
- **Chapter Eight:** presents an overview of remediation/decommissioning plan after project closure.
- **Chapter Nine:** describes the stakeholder engagement activities carried out during the ESIA and an overview of the grievance redress mechanism for the project
- **Chapter Ten:** Conclusion and Recommendations.

The report also includes references and appendices.

CHAPTER TWO
PROJECT JUSTIFICATION

This chapter presents the justification for the proposed Solar Hybrid Mini-Grid system and associated infrastructure in FUT Minna, Niger State, 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

The Federal Universities in Nigeria has remained the highest preferable choice for students seeking admission into tertiary institutions in the country. However, inadequate power supply from the grid remains a major challenge facing many of these universities. The proposed intervention project at the FUT Minna Part of the FGN's initiatives to address inadequate power supply in the country is the Nigeria Electrification Project (NEP). NEP is an innovative programme that seeks to provide electricity access to off-grid communities across the country through renewable power sources. It is being implemented by REA and co-financed by the AfDB.

One of the components of the NEP is EEP, with the objective of providing dedicated, clean and reliable power supply to Federal Universities and affiliated University Teaching Hospitals across the country. However, the current phase covers 7 universities and 2 affiliated teaching hospitals. Also, the EEP is 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 proposed Project in FUT Minna is part of the FGN's EEP Phase II, under NEP. The Project will help to significantly address the power supply challenges currently facing the University, which will also lead to many positive spill-over effects. The associated infrastructure such as the training centre to be provided as part of the Project would enhance learning in renewable energy leading to certification, while the street lighting will improve security within the campus as a result of proper lighting.

2.2 Value of the Project

NEP is being co-financed by the AfDB through a USD 200 million sovereign loan. However, USD 70 million has been allocated for the implementation of the Energizing Education Programme (EEP) as a component of NEP. The finance required for the proposed project in FUT Minna will be obtained from this allocation.

2.3 Project Benefits

The proposed project is expected to deliver a wide range of benefits, underscoring the importance of reliable and steady power supply. Some benefits align directly with the project's objectives, while others stem from the way the project is designed to achieve them.

Key Benefits

- **Academic stimulation** Access to constant and reliable electricity will boost academic and research activities, thereby advancing educational outcomes.
- **Reduced fossil fuel use** The University's average monthly diesel consumption is estimated at about 100,000 litres of Automotive Gas Oil (AGO), according to energy audits. This reduction will lower carbon emissions and improve environmental balance.
- **Lower generation costs** FUT Minna operates approximately 15 diesel generators, spending ₦45–50 million monthly to self-generate about 3,000 kW of power for 14 hours

daily. Savings from reduced generator use will be redirected to other beneficial undertakings.

- **Improved campus security** Enhanced Street lighting will reduce opportunistic crimes, gender-based violence, and related threats, fostering safer social interactions.
- **Renewable energy learning** A training centre will be established, strengthening renewable energy education and practical skill acquisition.
- **Livelihood enhancement** Access to reliable power will support small businesses and services within the University.
- **Employment opportunities** Both direct and indirect jobs will be created during project development and operation, leading to new skills and income-generating spill-over effects.
- **Economic growth** Local and regional economies will benefit through contract awards and procurement of supplies for project development.
- **Institutional collaboration** The project will strengthen financial and technical partnerships between the Federal Government, FUT Minna, REA, AfDB, and other relevant MDAs.

2.4 Envisaged Sustainability

2.4.1 Technical Sustainability

The project development shall be handled by qualified and experienced 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 FUT Minna. 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 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 FUT Minna Works and Physical planning Department. 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 source of energy (solar) for electricity generation (with negligible greenhouse gas (GHG) emissions compared to fossil fuel-burning power plants). 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 EMP 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 Federal Government of Nigeria's Energy Efficiency Program (EEP), which is a component of the Nigeria Electrification Project (NEP). The NEP is funded by the African Development Bank (AfDB) through a loan in US Dollars, of which a portion is allocated specifically for projects under the EEP. The proposed project at FUT Minna, under EEP Phase II, will be financed from the NEP fund.

Upon completion, the project will significantly reduce the University's reliance on diesel generators, thereby lowering expenses on diesel fuel and generator maintenance. In addition, the monthly payments currently made to the Niger State electricity distribution company for grid power consumption will cease, as the University consumes an average of several watt-hours monthly from the grid. Part of the savings realized will be directed toward maintaining the project facilities over the long term.

A cost-reflective service charge, determined in consultation with University management and users, will be applied to all facilities within the campus. Private business establishments operating within the University will also be allowed to connect to the power project, with metered billing to generate additional revenue for the institution. The funds generated will be used to sustain operational costs and procure replacement components such as batteries and panels when necessary.

Furthermore, the project will strengthen the University's Internally Generated Revenue (IGR), supporting other developmental initiatives and reducing dependence on Federal Government allocations.

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 Chapter 4). 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.

2.5 Project Alternatives

2.5.1 Site Alternatives

An approximately 5.0 hectares of land within the FUT Minna campus has been allocated by the University authority for the proposed project. The preferred site is located at about 150m away to the University's mini power station. The site has been selected based on a number of considerations including: (i) absence of any ecologically sensitive areas and/or cultural resources within and around the project site. (ii) the project site is easily accessible through the existing road network within the campus ; (iii) the project site is going to be secured because it is sited around busy students busy routes. (iv) the topography of the project site is suitable for the installation of panels, ; and (v) Other alternative sites considered within the University campus for the proposed project were rejected due to some factors such as: (i) poor physical terrain (topography) which are considered not technical fit for the installation of solar panels. (ii) poor accessibility and security reasons.

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

The power plant to be provided as part of proposed project in FUT Minna 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, oil-fueled 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 bio-fuel 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 FUT Minna will significantly avoid the generation of GHG emissions associated with fossil-fueled power plants. Thus, the proposed Project will help contribute to Nigeria's NDC on climate change.

2.5.2.2 Solar Power Technology Alternatives

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

i. Concentrated Solar Power (CSP) Systems
ii. 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

S/N	Features	CSP Technology	PV Technology
1	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.
2	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
3	Land requirement	CSP technology is best suited for areas of high direct normal solar radiation.	PV technology has a wider geographical area of application. PV technology requires about 2

		CSP technology requires about 4 hectares of land per MW of capacity	hectares of land per MW of capacity
4	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
5	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
6	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.
7	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
8	Average life span	25 years	25 years
9	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.
10	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.

Sources: Online

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; and iii) thin film. The typical appearance of Monocrystalline solar panels are shown in Figure 2.2 and 2.3, poly-crystalline silicon PV panels in Figure 2.4 and 2.5. Based on the consideration of cost and efficiency, poly-crystalline silicon PV panels are envisaged to be used for the proposed project.

Monocrystalline solar panels are the most efficient and durable solar option, featuring 18-24%+ efficiency and a 25-30+ year lifespan. Made from a single, high-purity silicon crystal, they are identified by their sleek black appearance and high-power output, making them ideal for space-constrained rooftops. Though higher in upfront cost, they offer superior performance, especially in hot, low-light conditions.


Figure 2.2 and 2.3: Appearance of a mono-crystalline PV panels

Polycrystalline solar panels, often identified by their blue, speckled, multi-crystalline appearance, are a cost-effective solar solution made by melting raw silicon, making them generally more affordable than monocrystalline alternatives. While they offer lower efficiency (typically 15-17%) and power output, they are durable, reliable options for budget-conscious, large-space installations.


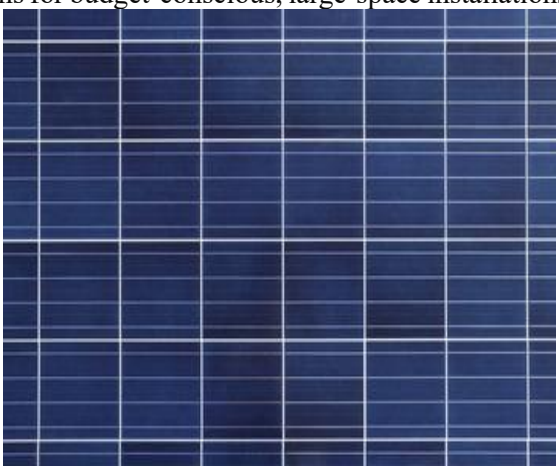

Figure 2.4 and 2.5:Appearance of Polycrystalline PV panels

For the proposed project, polycrystalline PV panels are envisaged to be the choice panels that will be used based on considerations of cost and efficiency.

2.5.3 Battery Types

The proposed solar power plant in FUT Minna 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:

i. 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. 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).

ii. 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.

iii. Flow Batteries

The vanadium redox flow battery (VRFB) is the most common technology in this type of batteries. 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. 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.

iv. 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. 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 battery alternative for the proposed Project.

2.6 Project Options

2.6.1 No Project Option

Currently, in FUTH Minna, the current demand for electricity in the campus significantly exceeds just generation and 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-fueled 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

Such option is usually taken when conditions are unfavourable to project implementation such as in dire situation like 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 favorably 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 nonviable for the Project.

2.6.3 Go 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

3.1 Introduction

This chapter presents the technical description of the proposed project including the project location, associated components, power generation and evacuation approach, and development activities. Waste streams associated with the proposed project over its life cycle, and the proposed handling techniques are also discussed.

3.2 Project Location

3.2.1 About FUT Minna

Federal University of Technology Minna (FUTMinna) is a Nigerian federal government-owned university located in Minna, Nigeria.

FUT Minna specialises in technological education and offers bachelor's and master's degrees in various technology-related fields. The University is a designated Centre of Excellence in Biotechnology and Genetic Engineering and has a core competence in the development of vaccines and drugs, and also small arms design in partnership with the Armed Forces of Nigeria.

FUT Minna was established in 1983, and the first Vice- Chancellor was Professor J.O Ndagi who served from 1983 to 1990. The governing bodies are the Council and the Senate. Primarily, the University took over the facilities of the former Government Teachers' College Bosso, for use permanently. This site now serves as the Bosso Campus of the University. The main campus *Gidan Kwano* which is situated on 10,650 hectares of land is located along the Minna - Kataeregi - Bida Road. The Institution is listed in the *Guide to Higher Education in Africa*, *Association of African Universities* and the *International Association of Universities, 1999*.

Library

The University Library was established in 1984 and is known as the Ibrahim Badamasi Babangida Library. The library is subscribed to many database with over 80,000 collections of printed books, journals and other materials to enhance teaching, learning and research in the university community. The Information technology service unit has over 350 computers with internet connectivity that provide access to electronic resources. The present University Librarian is Dr. Katamba Abubakar Saka. The main library has the following units:

i. Circulation Unit
ii. Serial unit
iii. Government document unit
iv. Thesis unit
v. E-Library unit
vi. Digital Library
vii. Reprographic units

The branch library is located in Bosso Campus for supporting services such as Reference service and the library is called Auwal Ibrahim Library. All these units are grouped into three departments for effective services.

The Federal University of Technology, Minna (FUTMINNA) operates through10 schools (faculties) offering diverse technology, engineering, science, and health-related departments. Major departments span Engineering (Electrical, Civil, Mechanical, Mechatronics, Computer, Chemical),

Agriculture, Information Technology, Environmental Technology, Life Sciences, Physical Sciences, and a new College of Medical Sciences (MBBS, Nursing).

Schools and Departments at FUTMINNA

1. **School of Engineering and Engineering Technology (SEET)**

i. Electrical and Electronics Engineering

ii. Computer Engineering

iii. Telecommunication Engineering

iv. Mechatronics Engineering

v. Civil Engineering

vi. Mechanical Engineering

vii. Chemical Engineering

viii. Agricultural and Bio-Resources Engineering (also listed under SIPET)

2. **School of Agriculture and Agricultural Technology (SAAT)**

i. Agricultural Economics and Extension Technology

ii. Animal Production

iii. Crop Production

iv. Food Science and Technology

v. Soil Science and Land Management

vi. Water Resources, Aquaculture and Fisheries Technology

vii. Forestry and Wildlife Technology (New)

3. **School of Infrastructure, Process Engineering and Technology (SIPET)**

i. Agricultural and Bioresources Engineering

ii. Chemical Engineering

iii. Civil Engineering

iv. Material and Metallurgical Engineering

4. **School of Information and Communication Technology SICT)**

i. Computer Science

ii. Cyber Security Science

iii. Information and Media Technology

iv. Data Science

v. Software Engineering

5. **School of Life Sciences (SLS)**

i. Biochemistry

ii. Biology

iii. Microbiology

iv. Plant Biology

v. Animal Biology

vi. Forensic Science

vii. Public Health

6. **School of Physical Sciences (SPS)**

i. Chemistry

ii. Geography

iii. Mathematics/Statistics

iv. Physics

v. Geology

vi. Industrial Mathematics

vii. Meteorology

7. **School of Environmental Technology (SET)**

i. Architecture

ii. Building

iii. Estate Management

iv. Quantity Surveying

v. Surveying and Geoinformatics

vi. Urban and Regional Planning

8. **School of Science and Technology Education (SSTE)**

i. Industrial and Technology Education

ii. Educational Technology

iii. Science Education

9. **College of Medical Sciences and Health Technology (CMSHT)**

i. Medicine and Surgery (MBBS)

ii. Human Anatomy

iii. Human Physiology

iv. Nursing Science

v. Medical Laboratory Science

10. **School of Postgraduate Studies** (Manages postgraduate studies across the above departments)

11. **School of Law**

Centres

i. Centre for Preliminary and Extra Mural Studies (CPES)
ii. Centre of Excellence in Disaster Risk Management and Developmental Studies, operated by the National Emergency Management Agency (NEMA).
iii. Centre for Climate Change and Freshwater Resources, which is associated with the Federal Ministry of Environment, a node of the Global Institute for Bio Exploration (Rutgers University, NJ, USA)
iv. Centre for Human Settlements and Urban Development (CHSUD) associated with the UN Human Settlements programme.
v. Directorate of Research and Development (DRID).
vi. Centre for Genetic Engineering and Biotechnology (CGEB).
vii. Centre for Open Distance and e-Learning (CODeL).
viii. West African Service Centre on Climate Change and Adapter Land Use (WASCAL).
ix. Africa Centre of Excellence for Mycotoxin and Food Safety.

Affiliations

Institutions affiliated to the University are; (i) Federal College of Education (Technical) Akoka, Lagos State, (ii) Nigeria Federal Polytechnic Offa, Kwara State, Nigeria.

Recreation and sports

As part of its overall fitness program, the university includes a floodlit sports arena on both campuses, athletics cinder tracks, badminton indoor courts, basketball courts, table tennis facilities, volleyball courts, football pitches, a fitness gymnasium, extensive pedestrian walkways, a 9-hole golf course and a student recreation centre.

The student-run radio station Search FM 92.3 Campus radio started official transmission in August 2010. Unfortunately, the radio station was gutted by fire in 2013. As of now, the radio station has a new building and a fully equipped studio which was commissioned in 2014 by the Vice Chancellor.

Plate 3.1: Showing the Senate Building of the University

Plate 3.2: Showing the Library complex of the University

3.2.2 Description of the Project Site

FUT Minna spans two main campuses with vast lad area primarily at its permanent site. The main Gidan Kwano Campus covers 10,650 hectares along the Minna-Kataeregi-Bida Road, designed for expansion and hosting most academic schools. The smaller Bosso Campus, repurposed from a former teachers' college in Minna city, supports specific units like preliminary studies without a specified separate land size.

The proposed project site is situated in the permanent site of the University at Gidan Kwano campus. The Permanent site of FUT Minna, known as Gidan Kwano Campus lies in Niger State, North Central Nigeria, along the Minna- Bida Road about 12km from Minna city centre. Its coordinates are approximately 9°41' N latitude and 6°31' E longitude, at an elevation of 258.5 meters above sea level.

At the time of site visit, about 85% of the project site lies fallow though a small portion of the area is used as farmland. The crops planted include yam, maize, and other staple foods. The unused portion of the site was covered by secondary vegetation, mostly grasses, shrubs, and a few trees. The topography of the site is relatively flat and sloped towards the north of the site. There are no

physical structures within the site. The nearest community to the project site is the Bosso community located about 3.5 km away from the University campus. There is no local community presence within the site neither is the site used for grazing or wood/food gathering activities by the local community. The proposed project site is far removed from any physical structures.

Plate 3.3: Showing the portion of the proposed project area that is used for farming activities

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Plate 3.4: Showing the portion of the proposed project area that is fallow

Plate 3.5: Showing the area of the proposed site at FUT Minna Campus Gidan Kwano

Figure 3.1: Administrative Map of Nigeria showing Niger State

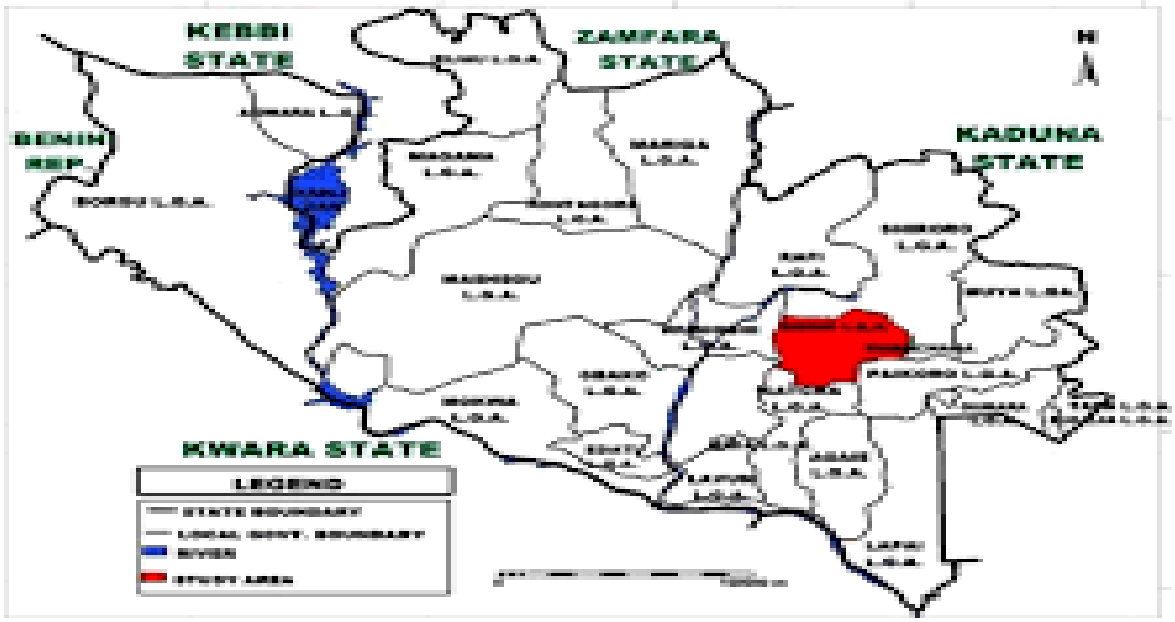

Figure 3.2: Administrative Map of Niger State highlighting Bosso Local Government Area

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. Each of these components as relate to FUT Minna is discussed below.

3.3.1 Proposed Solar-Hybrid Power Plant

S/N	Item	Value	Duration / Remarks
1	Audit Year	2026	Conducted by REA in collaboration with NUC
2	Total Campus Population	~25,000 students & staff	Estimated average daily users
3	Number of Academic Buildings	45	Includes lecture halls, labs, offices
4	Number of Hostels	15	Student accommodation blocks
5	Streetlights Installed	~600 units	Majority powered by grid/diesel
6	Average Monthly Grid Consumption	~1,200,000 kWh	From Niger State distribution company
7	Average Monthly Diesel Consumption	~100,000 litres	Automotive Gas Oil (AGO)
8	Number of Diesel Generators	15 units	Ranging from 250–500 kVA
9	Daily Generator Runtime	~14 hours	To supplement unreliable grid supply
10	Average Monthly Diesel Cost	₦45–50 million	Based on prevailing fuel prices
11	Self-Generated Power Capacity	~3,000 kW	From diesel generators
12	Average Monthly Grid Payment	₦20–25 million	Paid to distribution company
13	Carbon Emissions from Diesel	~270 tonnes CO_2/month	Based on fuel consumption
14	Renewable Energy Potential	~5 MW solar PV	Estimated rooftop and ground-mount capacity
15	Existing Solar Installations	<500 kW	Pilot projects only
16	Average Power Demand	~4.5 MW	Peak load across campus
17	Critical Facilities Powered	Teaching hospitals, ICT centres	Priority loads
18	Maintenance Cost for Generators	₦5–7 million monthly	Spare parts, servicing
19	Energy Efficiency Gap	~40%	Losses due to inefficient systems

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 aluminium 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 FUT Minna are of poly-crystalline silicon as discussed in Chapter 2. However, the exact number of the panels is yet to be finalized.

The PV panels to be installed will have following characteristics:

i. 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.
ii. 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.
iii. All PV panels that are electrically in the same string will have the same orientation (azimuth and tilt angle).
iv. 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-hybrid 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-fuelled generating sets (2 – 3 Nos) would be installed at the project site for recharging the batteries during unfavourable 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.

Power distribution cabinet and synchronization panel: Power from the inverters will be synchronized before it is evacuated to injection station (power house in the University). During plant operation, more than one inverter will be used to convert DC from the PV panels to AC, hence

the need for synchronization. Synchronization is the process of matching the speed and frequency of all the operating inverters before the generated power is evacuated. The power from the inverters will be inefficient unless they are running at the same frequency. Therefore, a synchronization panel will be used for matching the speed and frequency of all the
inverters installed for the power plant.

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 11kV underground armoured cable. The distance between the Project site and the existing power house is approximately 70m. Information on the size of the evacuation cable is not available yet.

Low and medium voltage switch gear 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 switch gear 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 switch gear cabinet is shown in Plate 3.5.

Plate 3.6: Showing a typical switch gear cabinet

3.3.2 Rehabilitation of Existing Distribution Infrastructure

The energy audit conducted at the University 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 ------kW. Where required, the existing distribution network will be upgraded to accommodate the generated power from the proposed solar hybrid power plant.

Plate 3.7: Showing an existing electric distribution infrastructure situated beside the proposed project site (existing electric sub-station of FUT Minna)

3.3.3 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 5.0ha of land earmarked for the proposed 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)", among others.

3.5 Project Implementation Phases

3.5.1 Pre-construction Phase Activities

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

3.5.2 Construction Phase Activities

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

It is envisaged that approximately 2,000 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 workers 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 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 structures.

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.

Chapter 8 of this report contains detailed information on the activities associated with the decommissioning of the proposed solar-hybrid 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 regular 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 season (usually from April to October in Niger State), direct cleaning of the PV panels is estimated to occur not more than three times. However, during the dry season (November to March), the frequency of cleaning will depend on the rate of dust accumulation, and it is envisaged to be about 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 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 (PPEs) 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 PPEs 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:

i. **Reduction at Source** – The elimination or minimization of waste generation through equipment modifications and installation of pollution abatement equipment.
ii. **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.
iii. **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.
iv. **Residue Disposal** - disposal of wastes in a Government-approved dumpsite.

Existing waste management practice in FUT Minna

The University has an Environmental Unit that handles general waste generated within the University. Wastes (mostly office and domestic wastes) from various waste collection points within the University are collected and disposed of at government approved dumpsites in Minna. However, there are no clear procedures for handling e-waste in the University.

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 Niger State Environmental Protection
Authority (NSEPA).

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 to be reused for backfill during landscaping and the 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-coloured waste receptacles for food waste, blue-coded bins for paper, and yellow-coded bins for general rubbish) and periodically disposed of (at least once a week throughout the construction period or on the need basis depending on the volume of the waste) at a government-approved dumpsite through a third party waste contractor approved by NSEPA. It is estimated that approximately $0.3m^3$ 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 labeled, closed containers prior to evacuation by a third party waste contractor approved by NSEPA for treatment and disposal.

Operational Phase

Solid wastes generated during the operational phase of the project will be incorporated into the existing FUNAAB waste management approach (there is an environmental Unit within the University that collects solid wastes for disposal). Approximately $3.0cm^3$ 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 (in line with the EPR model). Spent, damaged or expired batteries will also be returned to the manufacturer for recycling. Alternatively, the spent batteries will be recycled by local and accredited battery recycling companies in Nigeria. 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 NSEPA.

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 plans 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

S/N	Waste Stream	Sources	Waste Generation Phase Construction (C), Operation (O), Decommissioning (D)	Handling Techniques
1	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 Niger State Environmental Protection Agency (NSEPA).
2	Cleared vegetation	During site clearing and preparation	C	Composting, collection for biomass fuel
3	Scrap metals	Used tubular and casings, metal drums, used iron rods	C, O, D	Scrap metals will be collected for recycling
4	Excavated	Foundation	C, D	Excavated

	materials	works		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.
6	Damaged/expired PV panels	PV modules	C, O, D	Return to the manufacturer for recycling using the EPR model
7	Expired inverters	Electrical installation	O, D	Return to the manufacturer for recycling using the EPR model
8	Damaged/expired Batteries	Power generation	O, D	Return to the manufacturer for recycling using the EPR model
9	Sewage	Training and Development center	C, O, D	Periodic evacuation of content of the septic tank by NSEPA accredited third party waste contractor.

3.9 Project Schedule

The proposed project is planned to be operational by the fourth quarter (Q4) of 2027. The tentative project schedule is provided in Table 3.3 below:

Table 3.3: Project Schedule

S/N	Project Schedule	Timeline											
		2026				2027				2028			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Site allocation												
2	Energy Audit												
3	ESIA study and Approval												
4	Selection of EPC Contractor and												

	contract signing												
5	Civil, electrical, and mechanical design												
6	Procurement (manufacturing and transportation)												
7	Preconstruction and construction Phase Activities												
8	Commissioning												
9	Commencement of operation												

CHAPTER FOUR
DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction

This chapter provides a description of the existing environmental and socioeconomic conditions of the project's area of influence, which covers the project site and its surrounding environment up to 2 km, 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).

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 1 km 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 3 km radius from the centre of the Project site, as illustrated in Figure 4.1.

The environmental components of the study area described in this chapter cover the following:

x. Climate and meteorology;
xi. Geology and hydrogeology;
xii. Air quality and noise;
xiii. Groundwater;
xiv. Soil;
xv. Terrestrial flora;
xvi. Terrestrial fauna;
xvii. Land use;
xviii. Socio-economic and health.

Based on the field observation, there is no surface water body within the project site and its immediate surroundings.

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:

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

In order to effectively characterize the environment of the study area, field sampling was conducted from February 03rd-05th, 2026. The objective of the field exercise was to obtain the baseline data of the project's AoI 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 (Bosso 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: Showing photograph of field sampling activity during water sample collection

Plate 4.2: Showing photograph of field sampling activity during soil sample collection

Plate 4.3: Showing photograph of field sampling activity during Air quality measurement

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, among others:

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

4.2.2.2 *Laboratory Analysis of Field Samples*

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 40^{C} for the samples was maintained in-transit with the use of ice-chest and ice chips in different insulating containers.

The field samples were analyzed 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	Che mical Oxygen Demand	Closed Reflux dichromate method	mg/l	-
4	Oil and Grease	N-Hexane Extraction Method	mg/l	mg/kg
5	Alk alinity	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 tetraacetic acid method	mg/l	mg/kg
14	Magnesium	Titration with EDTA method	mg/l	mg/kg
15	Mercury	Cold Vapour Atomic Absorption Spectrophotometry	mg/l	mg/kg
16	Lead	Atomic Absorption Spectrophotometry	mg/l	mg/kg
17	Nickel	Atomic Absorption Spectrophotometry	mg/l	mg/kg
18	Cadmium	Atomic Absorption Spectrophotometry	mg/l	mg/kg
19	zinc	Atomic Absorption Spectrophotometry	mg/l	mg/kg
20	Copper	Atomic Absorption Spectrophotometry	mg/l	mg/kg
21	Chromium	Atomic Absorption Spectrophotometry	mg/l	mg/kg
22	Manganese	Atomic Absorption Spectrophotometry	mg/l	mg/kg
23	Total Iron	Atomic Absorption Spectrophotometry	mg/l	mg/kg

4.3 Description of Biophysical Environment of the Study Area

4.3.1 Climate and Meteorology

The climate of the Niger State is tropical with alternating wet and dry seasons. It is strongly influenced by I.T.D.Z weather patterns. Maritime tropical air masses, characterized by warm, humid south-westerly winds and the continental air mass, characterized by hot, dry north-easterly

winds, converge in the I.T.D.Z. The alternating wet season and dry season phenomenon is determined by the north-south oscillation of air masses in the I.T.D.Z.

Movement of these air masses results in two main seasons; a wet season from April to October, and a dry season from November to March. During the dry season there are periods when the harmattan (a period characterized by dry dusty winds spells and relatively low temperatures) is experienced. This typically occurs during the months of December and March. Table 4.2 summarizes the monthly mean climatic characteristics of the Project area in Niger State from 2016 to 2025.
The average rainfall for the state is 759mm in the northern parts and 1,051mm in the southern parts around Bosso Local Government Areas. The dampest months are August and September. The length of the rainy season averages 85 to 92 days per year. Evapo-transpiration exceeds rainfall for most parts of the year. There is one primary rainfall peak each year. This occurs between June and September when the mean monthly rainfall is 198mm.

Temperature

The maximum temperature of the project area is high and ranges between 30.1°C and 41.8°C in August and April, while mean minimum temperature was between 14.6°C and 29.0ºC in January and April. The table below shows the maximum and minimum temperature data of the study area from year 2016 to 2025. The hottest month of the year is between March and April when temperature can rise as high as 41.8°C. The table below shows the ten (10) years temperature minimum (TMIN) and temperature maximum (TMAX) variation for the study area.

Table 4.2: Minimum Temperature (TMIN) for Niger State 2016 to 2025

MINIMUM TEMPERATURE (°C)										
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Jan	18.0	17.3	17.7	17.5	18.9	14.6	17.3	20.0	18.5	19.7
Feb	22.7	23.4	23.1	23.2	22.0	21.2	21.7	22.2	24.3	22.6
Mar	26.1	24.5	24.8	24.6	26.3	23.3	25.7	25.5	27.1	27.1
Apr	28.0	27.6	29	28.3	27.8	24.1	29.0	28.4	28.6	28.3
May	27.0	25.7	25.7	25.8	26.1	25.5	26.8	26.6	25.8	26.6
Jun	24.6	25.1	23.7	24.4	25.1	25.4	22.5	25.0	24.0	25.0
Jul	23.9	24	23	23.5	24.4	23.2	24.6	24.4	24.1	24.7
Aug	23.6	23.9	23.3	23.6	23.9	21.6	24.3	24.1	24.2	24.3
Sep	23.1	23.4	23.1	23.3	23.7	21.2	24.1	24.0	24.1	24.2
Oct	24.0	24.2	23.9	24	23.9	23.0	24.5	24.8	24.8	23.8
Nov	21.9	19	21.8	20.4	22.4	19.5	21.8	21.4	21.5	23.0
Dec	17.1	17.4	18.1	17.7	18.8	17.0	20.7	20.1	19.5	18.6

Source: NIMET Abuja, 2026.

Table 4.3: Maximum Temperature (TMAX) for Niger State 2016 to 2025

MAXIMUM TEMPERATURE (°C)										
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Jan	36.5	33.5	33.5	33.4	36.1	33.6	33.4	36.0	33.4	35.4
Feb	39.7	38.8	38.4	38.2	37.3	39.0	37.0	36.6	39.1	36.2
Mar	40.7	41.2	39.9	39.7	40.1	40.0	41.0	41.0	40.4	41.3
Apr	41.8	40.9	41	40.9	39.2	40.3	40.7	40.0	40.1	40.4
May	37.3	36.9	35.8	35.6	35.6	39.4	36.7	35.6	35.5	35.8

Jun	33.5	34.8	32.8	33.4	33.3	35.0	33.7	32.8	32.8	34.1
Jul	31.7	32	30.8	31.4	31.5	33.2	32.2	31.8	32.6	32.4
Aug	30.9	31.4	30.4	30.9	30.1	31.8	31.5	31.3	31.0	31.6
Sep	31.1	30.6	31.3	35.9	31.6	30.8	32.0	31.8	31.7	32.0
Oct	32.6	33.5	33.2	33.2	34.2	33.8	35.0	35.2	35.3	32.1
Nov	36.3	35.3	37	36.3	36.9	36.0	36.9	37.3	36.9	36.2
Dec	35.5	34.5	35.8	35.2	35.3	35.3	37.3	35.4	33.9	34.8

Source: NIMET Abuja, 2026.

Relative Humidity (RH)

Relative Humidity (RH) refers to the amount of water in the atmosphere compared to the amount required to saturate it under the same temperature. RH is expressed as a percentage. The surface air, at the beginning of the dry season in November, it is usually very hot. The season starts with a marked and abrupt drop in the moisture content of the surface air followed by a change in the direction of the surface winds.

July and August record the highest RH with value ranging from 68 to 80% in the morning and declines to between 19%. The RH humidity for the study area generally increases from January towards July. Subsequently, a decline pattern in the RH humidity is noticed as harmattan sets in.

Harmattan period is experienced between December and February. The season is characterized by very strong and cold parching and dust-laden winds. At this period, trees shed their leaves; grasses die out entirely and are burnt off. Visibility is generally reduced. The extremely dust laden atmosphere shuts out insulations and leads to low temperatures. The thickness of this haze and dust layer of the harmattan exceeds a height of 1500 meters. This appears like a dense fog and gives the day a dull and melancholy look. Very little direct insulation can reach the ground on such days and consequently the daily maximum temperatures become lower.

Table 4.4: Monthly RH (%) for Niger State (2016 to 2025)

RELATIVE HUMIDITY (%)										
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Jan	26	25	29	33	28	27	21	26	27	26
Feb	21	29	29	32	24	22	19	25	29	25
Mar	25	22	27	30	24	22	83	24	24	26
Apr	54	36	44	43	41	38	77	45	40	45
May	57	57	60	67	56	52	64	57	65	67
Jun	70	63	70	74	66	66	55	66	77	76
Jul	81	69	77	78	68	70	88	75	79	75
Aug	80	74	79	84	78	77	80	77	81	80
Sep	82	78	77	78	71	75	90	80	79	77
Oct	75	65	67	66	56	64	65	70	70	79
Nov	49	33	42	47	32	32	73	41	43	60
Dec	39	26	32	38	30	32	23	32	28	30

Source: NIMET Abuja, 2026.

Rainfall

The rainy season, which is the dominant season with significant levels of rainfall begins in May and ends in October. It is characterized by the tropical maritime air mass (South West trade wind). This blows across the Atlantic Ocean. The wind is warm and wet; hence, it brings rainfall in to the area. The average annual rainfall ranges from 0 to 310 mm. The table 4.3 below shows record of monthly mean rainfall from year 2016 to 2025. The table 4.5 below shows peak rainfall at July and gradually declines towards September.

Table 4.5: Monthly Rainfall Data

RAINFALL (mm)										
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Jan	0	0	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0	0	0
Mar	0.7	0	0	17.1	2.7	0	0	0	0	0
Apr	34.9	2.5	0	0	57.2	19.5	49.7	69.8	8.6	20.5
May	42.5	58.8	108	61	66	28.2	148.8	161.8	104.5	140.5
Jun	193.7	29.9	198.9	142.4	134.3	47	255.9	114	178.2	169.8
Jul	176	75.7	157.3	93.8	148.1	98.9	113.8	239.7	233.1	144.8
Aug	134.7	134.1	209.8	111.8	157.4	153.4	209	158	144.8	310.8
Sep	128	209.8	189.5	178.7	156.5	213.4	263.4	172.4	262.9	236
Oct	104	64.7	67.2	41.6	41.6	57.4	30.2	0	38.5	247.8
Nov	0	0	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0

Source: NIMET Abuja, 2026

Wind Speed (m/s)

Wind directions and speed are the most critical meteorological parameters, as they govern the dispersion of pollutants. Wind direction is reported as the direction from which the wind blows and is based on surface observation. Over the course of a year, wind usually blows in all direction, with varying velocities and frequencies. Certain directions occur more frequently than others, these are known as prevailing wind directions.

The wind pattern of the study area follows the I.T.D.Z thus it is mainly south west during the wet season and north east during the dry season. In general, the south westerlies and the North east-trades are dominant winds over the study area throughout the year. While the south westerly winds are associated with rain and dominate during the rainy season of the study area, the north east trade winds are dry and are dominant during the dry season. The dry winds are commonly referred to as the Harmattan winds, they blow across the Sahara Desert and by the time they reach the project area, they are loaded with dust. The south westerlies blow across the Atlantic Ocean, and hence, they are rain bearing where they blow by the time they reach the project site.

The speed of the winds at any particular time and place determines air pollution concentration. Air pollution concentration decreases with increasing wind speed. This is part of the dispersion process. However, while there is good dispersion of gases and particles with high wind speed, there is more potential for raising and suspending surface dusts. When wind speeds are in near zero, local circulation may lead to very high pollutant concentration near ground level. Wind speed increases with height as surface friction reduces.

Table 4.6: Wind Speed Data

WIND SPEED (KNOT)										
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Jan	1.9	5.8	4.2	4.1	4.6	4.6	4.1	4.1	4.3	4.3
Feb	2.5	4.4	5.0	5.3	5.4	4.9	5.4	4.6	5.1	5.1
Mar	5.6	7.5	6.3	6.6	4.7	5.3	5.9	8.6	6.2	6.2
Apr	5.7	5.9	6.7	5.0	5.7	5.1	5.5	6.2	5.7	5.5
May	6.2	5.3	3.6	5.7	4.2	4.6	4.3	6.7	4.8	5.0
Jun	4.1	6.6	4.7	4.3	4.3	4.5	3.6	5.0	4.4	4.4
Jul	4.2	4.8	4.7	4.0	4.5	2.4	3.6	5.0	4.0	3.9
Aug	4.2	4.8	4.9	3.7	4.2	2.6	5.1	3.5	4.0	3.9
Sep	4.2	3.7	3.8	3.1	3.0	3.3	3.8	3.5	3.4	3.3
Oct	5.2	4.2	4.4	3.5	4.1	2.1	4.4	2.2	3.5	3.3
Nov	4.8	4.0	5.7	4.0	3.7	3.7	5.5	3.9	4.4	4.2
Dec	3.7	5.2	3.4	3.8	5.0	4.5	3.5	4.9	4.2	4.3

Source: NIMET Abuja, 2026

Sunshine Hours (Hours)

The sun, as the major source of radiant energy provides about 99.97% of the energy in the earth-atmosphere system. This radiant energy is emitted as electromagnetic waves.

The general pattern of number of sunshine hours in Nigeria is lowest in the coastal areas and highest in the extreme north-east. The generally lower sunshine hours in the north are due to lesser amount of cloudiness and rainfall, characteristics of the northern region of the country.

Table 4.7: Sunshine Hours Data

SUNSHINE HOURS (HOURS)										
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Jan	9.5	8.1	7.5	8.7	9.2	9.1	8.7	9.4	8.0	8.8
Feb	9.1	7.5	5.8	8.3	7.8	9.6	7.6	6.6	6.7	8.3
Mar	6.9	7.0	6.7	8.2	7.3	8.7	5.6	6.6	7.5	6.4
Apr	7.9	6.4	7.7	7.3	8.2	7.7	6	7	7.1	8.9
May	7.4	7.4	7.8	6.1	7.3	8.3	8.3	7.4	6.6	7.9
Jun	7.4	7.7	7.4	7.8	7.6	6.8	7.1	8	4.2	7.8
Jul	5.2	7.1	5.3	5.7	7.0	6	7.4	5.9	6.3	5.2
Aug	5.0	5.2	5.3	4.6	4.7	6.5	6.8	6.1	5.4	6.8
Sep	6.6	5.4	6.5	6.5	5.9	5.7	7.5	6.6	6.6	6.9
Oct	7.7	8.2	8.0	8.3	8.2	8.6	7.7	7.8	7.9	8.9
Nov	9.9	10.2	9.5	9.5	8.6	9.4	8.1	9.1	7	9.3
Dec	9.7	8.6	9.7	9.4	8.2	8.8	8.7	6.5	9.1	8.1

Source: NIMET Abuja, 2026

Evaporation Pitche (ml)

Table 4.8: Evaporation Pitche Data

EVAPORATION PITCHE (ml)										
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Jan	9.2	6.9	7.8	6.7	7	8.1	6.9	8.1	8.6	10.6
Feb	9.1	9.7	9.7	7	10.4	9.7	7.4	11.3	10.6	10.7
Mar	7.3	9.7	7.2	6.7	7.7	10.6	6.7	10.7	8.7	7.9
Apr	6.4	4.9	6	5.6	4.6	6.8	6.8	6.2	6.3	5.9
May	3.9	2.9	3.3	3.1	2.7	3.5	3.8	4.3	4.3	4.8
Jun	2.7	2.4	2.7	2.3	3	2.4	2.9	2.8	2.7	3.2
Jul	2.1	1.9	1.9	1.9	1.9	1.8	1.9	2	2.6	1.9
Aug	2.1	1.5	1.7	1.6	1.9	1.7	2	2.1	1.7	1.8
Sep	2.1	2.2	1.9	1.7	2.3	1.9	2.1	2.2	1.9	2.2
Oct	2.5	2	2.2	2.6	2.3	6.5	2.6	3	3.5	2.7
Nov	3.5	5.2	5	5.5	3.9	4.6	5.1	6.1	7.3	8.3
Dec	6.3	7.9	6	6	6.3	6.2	7.8	7.5	8.6	8.2

Source: NIMET Abuja, 2026

4.3.2 Geology and Hydrogeology

4.3.2.1 Geology

Minna, Niger State is predominantly underlain by precambrian crystalline basement rocks, part of the Nigerian shield formed over 2 billion years ago. These igneous and metamorphic rocks cover much of the central and northern areas, intruded by granites and overlain by younger sediments along river valleys.

The basement complex includes migmatite-gneiss, schist, granite gneiss, and porphyritic granites, with Pan-African orogeny (700–500 Ma) emplacing "Older Granites." Sedimentary covers are limited to Cretaceous rocks in the Nupe Basin (southeast), with sand stones, shales, and iron stones along the Niger River floodplains.

Tectonic Setting

Located in the central Nigerian Province, the state experienced Archean to Proterozoic metamorphism and three major orogenies: Liberian (2.75 Ga), Eburnean (2.2 Ga), and Pan-African. Younger granites and ring complexes are absent here, unlike the Jos Plateau to the east.

Rich in minerals like gold, lead-zinc, talc, and granite; Minna area features batholiths and ridges. Groundwater occurs in weathered basement fractures (10–20 m deep) and alluvial aquifers along Niger/Kaduna rivers.

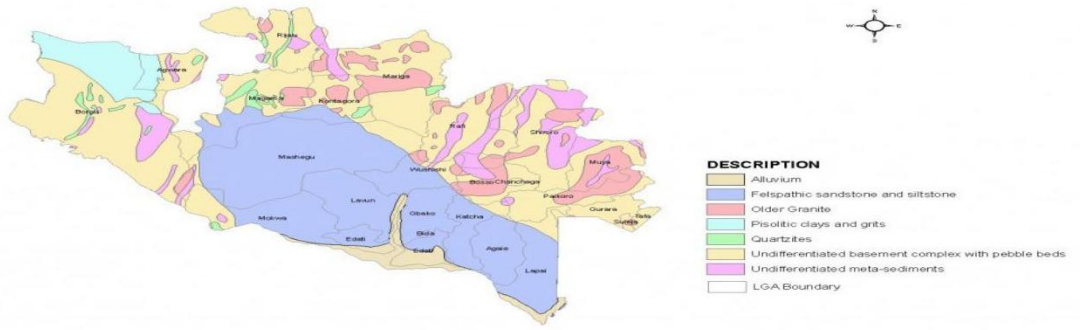

Figure 4.1: Geological map of Niger State, Nigeria

4.3.2.2 Hydrogeology

Niger State's hydrogeology is defined by a mixed, roughly 50/50 division between Precambrian basement complex rocks (granites, gneisses) and Cretaceous sedimentary rocks of the Bida Basin. Groundwater exists in weathered/fractured basement aquifers and sandstone/conglomerate sedimentary aquifers, with yields varying from 0.6–2.8 L/s, often requiring targeted geophysical surveys.

Key Hydrogeological Features:

i. **Geology:** The western and central areas are primarily Basement Complex (igneous/metamorphic), while the eastern and southern parts belong to the Bida Basin (sedimentary).

Aquifer Types:

i. **Basement Complex:** Groundwater is limited to fractured, jointed, or weathered zones. Yields are generally lower (0.8–1.8 L/s in granites, lower in schists).

ii. **Sedimentary Basin:** Higher permeability in sand stones and grit allows for better aquifers, with yields of 1.4–2.8 L/s.

iii. **Groundwater Levels & Quality:** Depth to water varies, but generally ranges from 0.8m to over 7m. While mostly suitable for consumption, some areas show high nitrate (NO^{-3}), iron (Fe), and cadmium (Cd) levels, likely due to agricultural activity and waste.

4.3.3 Ambient Air Quality and Noise

In-situ air quality measurements were conducted in the Project's area of influence with the use of pre-calibrated digital hand-held monitoring equipment (Aeroqual series 500; Aerocet 531; Graywolf particle counter) for the following parameters: Sulphur (IV) Oxide (SO_2), Nitrogen (IV) Oxide (NO_2), Methane (CH_4), Carbon Monoxide (CO), Carbon (IV) Oxide (CO_2), Volatile Organic Compounds (VOC), Hydrogen Sulphide (H_2S) and Total Suspended Particulate (TSP).

Ambient noise levels were measured using an Extech Integrated Sound Level Meter with a detection range of 30 dB(A) to 130 dB(A). Noise Level measurements were taken at a height of approximately 2m above ground level and the response time was set to slow and read on the 'A' frequency weighting scale in unit decibels. A total number of thirteen (13) sampling locations were established for ambient air quality and noise study. The air quality and noise sampling locations map is presented in Figure 4.10.

4.3.3.1 Air Quality Standards

The concentrations of air quality parameters recorded at the project area were compared to the Nigerian Ambient Air Quality Standards (NAAQS), World Health Organization (WHO) Air Quality Guidelines. The summary of these limits is provided in Tables 4.9 to 4.10.

Table 4.9: Ambient Air Quality Standards

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

Source: FMEnv, 1991

Table 4.10: Noise Exposure Limits for Nigeria

S/N	Duration per Day, Hour	Permissible Exposure Limit dB(A)
1	8	90
2	6	92
3	10	105
4	0.5	110
5	0.25	115

Source: FMEnv, 1991

Table 4.11. Ambient Air quality measurement in the projects Area of Influence (AoI)

S/N	Parameters	Unit	AM_1	AM_2	AM_3	AM_4	AM_5	AM_6	AM_7	AM_8	AM_9	AM_{10}	AM_{11}	AM_{12}	AM_{13}
1	**Latitude**	N	9.53738	9.53773	9.53822	9.53743	9.53677	9.53652	9.53648	9.53623	9.53655	9.53720	9.53709	9.537404	9.53800
2	**Longitude**	E	6.44493	6.44495	6.44758	6.44769	6.44618	6.44559	6.43896	6.43828	6.44559	6.43763	6.44067	6.44159	6.44136
3	**Nitrogen (iv) Oxide**	ppm	0.3	0.2	0.3	0.3	0.3	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.2
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	1	0	0	0
6	**Carbon (iv) Oxide**	ppm	431	450	451	436	450	552	437	437	441	425	426	451	540
7	**EX**	% /e/	0	0	0	0	0	0	0	0	0	0	0	0	0
8	**Ammonia Gas**	ppm	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0.00	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.3

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	$PM_{2.5}$	µg/m^3	35	45	36	32	70	31	32	30	32	37	33	41	48
15	PM_{10}	µg/m^3	46	60	45	42	88	42	42	41	48	53	51	60	65
16	$PM_{1.0}$	µg/m^3	24	33	24	21	57	21	21	20	23	26	25	32	34
17	TVOC	mg/m^3	0.000	0.001	0.021	0.003	0.000	0.000	0.014	0.036	0.003	0.026	0.006	0.001	0.009
18	HCOH	mg/m^3	0.000	0.000	0.003	0.001	0.000	0.000	0.003	0.012	0.000	0.018	0.002	0.002	0.110
19	Temperature	^OC	28.7	29.4	28.8	29.6	29.5	29.5	29.4	29.3	28.8	30.1	30.0	29.9	31.8
20	R/Humidity	%	28	28	28	28	29	28	28	30	30	28	28	28	28
21	Ozone	Ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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

Source: REA Field Measurement, 2026

4.3.3.2 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.

4.3.3.3 Soil Sampling

A total of thirteen (13) soil sampling points. The soil samples was carried out using a stainless steel auger. The soil samples collected were homogenized in plastic containers 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 GPS coordinates of the soil sample was also taken as presented in Table 4.11 while the Ambient air quality measurement/soil sampling locations map is shown in Figure 4.2.

Table 4.12: Results of Physico-chemical and Microbiological analysis soil samples from the study area

S/N	Parameters	Unit	MSS_1	MSS_2	MSS_3	MSS_4	MSS_5	MSS_6	MSS_7	MSS_8	MSS_9	MSS_{10}	MSS_{11}	MSS_{12}	MSS_{13} Control
Coordinates															
1	**Latitude**	N	9.53738	9.53773	9.53822	9.53743	9.53677	9.53652	9.53648	9.53623	9.53655	9.53720	9.53709	9.537404	9.53800
2	**Longitude**	E	6.44493	6.44495	6.44758	6.44769	6.44618	6.44559	6.43896	6.43828	6.44559	6.43763	6.44067	6.44159	6.44136
3	**Elevation**	M	496.3	433.9	443.1	486.1	486.1	485.2	486.1	485.3	479.1	476.3	485.5	496.2	416.3
Physical Test															
4	**Colour**	TCU	Brownish	Brownish	Brownish	Dark Brownish	Brownish	Dark Brownish	Pale Brown	Brownish	Grayish Brown	Pale Brown	Pale Ash	Brownish	Dark Brownish
5	**pH**	-	6.68	7.00	5.50	6.23	6.26	6.08	6.65	6.69	6.12	6.87	5.77	6.43	6.69
6	**Electrical Conductivity**	µs/cm	1567	1517	902	962	1071	1224	1154	1458	1361	899	1159	1326	1457
7	**Temperature**	^{0}C	31.4	31.0	28.9	30.4	29.6	31.9	31.6	31.8	32.4	32.0	32.8	30.7	33.2
8	**ORP**	MV	175	127	167	170	154	164	158	199	134	166	159	14	154
9	**Salinity**	%	0.07	0.03	0.07	0.07	0.07	0.07	0.07	0.08	0.00	0.06	0.02	0.02	0.03
Exchangeable Cation															
8	**Calcium (Ca^{2+})**	mg/kg	1.05	0.69	0.13	1.10	0.44	0.65	0.22	0.18	0.29	0.41	0.55	0.57	0.70
9	**Magnesium (mg^{2+})**	mg/kg	0.49	0.29	0.06	0.54	0.24	0.33	0.09	0.04	0.13	0.02	0.06	0.20	0.33
10	**Sodium (Na^+)**	mg/kg	4	3	3	3	6	0	0	3	6	6	9	13	0
11	**Potassium (K^+)**	mg/kg	1.7	0.4	0.1	1.5	0.2	0.2	0.3	0.6	1.2	1.1	0.4	0.9	0.2
12	**Ammonium (NH_4^+)**	mg/kg	0.017	0.036	0.113	0.012	0.076	0.004	0.086	0.041	0.087	0.013	0.100	0.063	0.141
Exchangeable Anion															
13	**Sulphate (SO_4^{2+})**	mg/kg	10	14	5	10	11	3	2	8	13	7	9	3	22
14	**Phosphate (PO_4^{2-})**	mg/kg	1.84	0.13	0.13	1.40	0.94	0.01	0.54	0.11	0.48	1.01	0.74	1.22	0.20
15	**Nitrate (NO_3^{2-})**	mg/kg	9.1	5.7	1.2	10.8	4.8	6.9	1.9	2.2	16.1	4.3	13.6	4.1	8.3
16	**Chloride**	mg/k	3.7	3.4	0.9	4.3	2.2	3.7	0.5	0.6	1.8	0.2	0.9	1.8	6.2

	(Cl^-)	g													
Organics															
17	**Phenols**	mg/kg	0.064	0.066	0.020	0.078	0.049	0.071	0.017	0.012	0.013	0.038	0.004	0.013	0.096
18	**Calcium Carbon**	mg/kg	12	4	13	20	35	9	26	16	9	35	18	27	6
19	**Oil & Grease**	mg/kg	0	0	0	0	0	0	0	0	0	0	0	0	0
Heavy Metals															
20	**Iron**	mg/kg	0.09	0.21	0.01	0.11	0.20	0.28	0.06	0.13	0.07	0.24	0.09	0.03	0.35
21	**Cupper**	mg/kg	0.16	0.10	0.00	0.07	0.13	0.17	0.01	0.02	0.01	0.03	0.00	0.04	0.19
22	**Chromium**	mg/kg	0.01	0.04	0.00	0.01	0.01	0.02	0.00	0.01	0.02	0.00	0.00	0.01	0.03
23	**Zinc**	mg/kg	0.08	0.00	0.00	0.01	0.02	0.02	0.00	0.03	0.01	0.00	0.00	0.00	0.03
24	**Cobalt**	mg/kg	0.139	0.17	0.000	0.014	0.025	0.022	0.000	0.017	0.004	0.026	0.011	0.020	0.026
25	**Nickel**	mg/kg	0.017	0.022	0.055	0.013	0.017	0.026	0.002	0.012	0.000	0.017	0.006	0.013	0.032
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
Soil Characteristic															
28	**Loam**	%	63	54	57	60	63	41	55	58	47	52	63	35	49
29	**Sandy**	%	12	8	4	14	23	6	19	11	22	9	12	12	12
30	**Clay**	%	22	29	16	20	11	38	13	20	19	27	12	13	14
31	**Silt**	%	3	9	23	6	3	15	13	11	7	1	41	26	27
Microbiological Test															
32	**E. Coli**	Cfu/ml	2	2	3	5	6	8	2	3	6	7	2	7	7
33	**Fungal**	Cfu/ml	141	130	154	162	170	194	125	155	174	187	126	181	190

Source: Pollution Control Laboratory, 2026

Soil Physical Properties (Sand, Clay Silt): In general, the soil samples from the project site had high loam fractions in both topsoil and subsoil. The soil sample profile had a loam fraction varying from (41.0– 63.0%), clay fraction varying from (11.0 -29.0 %) while the proportions of other soil fractions were as follows sand (4.0 – 23.0%) and silt (1.0 – 41.0 %). as indicated in Tables 4.11. Based on the results, the loam soil is the dominant fraction in the soil within the Project area.

Soil pH (soil reaction): The pH of the soil samples from the project sites ranged from 5.50 to 7.00 which implies that the soils in the study area can be classified as slightly acidic to neutral. It show that the soil environment of the project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on site.

Soil Anions: The general concentration of anions in the soil samples from the project site were found to be within the acceptable range for normal agricultural performance. Sulphate concentrations were the highest and these ranged from 10.0 mg/kg to 22.0 mg/kg, Nitrate concentrations ranged from 1.2 mg/kg to 9.1 mg/kg, Phosphate concentrations were also low, ranging from 0.10 mg/kg to 1.84 and Chloride concentration ranged from 0.2 mg/kg to 6.2 mg/kg.

Soil Cations: The concentrations of Sodium (Na^+), Calcium (Ca^{2+}), Potassium (K^+), Magnesium (Mg^{2+}) and Ammonium (NH_4^+) recorded in soil samples from the project site fall within natural occurrence levels. Within the project site, Na^+ recorded the highest concentration which ranged from 0.0 mg/kg to 13.0 mg/kg.

Heavy Metals: Heavy metals occur naturally in the environment at low concentrations (Table 4.11); however elevated levels of these metals in the environment may be experienced due to anthropogenic activities. The presence of heavy metals in soil at the level within the naturally occurring concentration is, therefore, not indicative of contamination. The concentration of metals in uncontaminated soil is primarily related to the geology of the parent material from which the soil was formed (McLean and Bledsoe, 1992).

4.3.3.4 Surface and Groundwater Quality

Surface and Groundwater quality refers to the state of water that is located on the surface or beneath Earth's surface. Naturally, surface/groundwater contains mineral ions. Microbial matter is also a natural constituent of groundwater. In order to assess the quality of existing groundwater in the project area, water samples were collected from existing groundwater resources in the project area and analyzed. The results of the physico-chemical and microbial characteristics of the groundwater samples were compared with the WHO standards (highest desirable level and maximum permissible limits for substances and characteristics affecting the acceptability of water for domestic use) as well as the FMEnv prescribed limits for drinking water as highlighted in the National Guidelines and Standards for Water Quality in Nigeria, 1999.

4.3.3.5 Surface and Groundwater Sampling

Groundwater samples were collected from four (4) different boreholes in the project area including a control during the field sampling exercise, while one (1) Surface water was also collected for sampling. At each sampling location, surface and groundwater samples were collected into a 2-litre polyethylene bottle for general physico-chemical analysis, while samples for oil & grease determination were collected in 1-litre glass bottle and preserved with concentrated sulphuric acid. Samples for heavy metals were fixed with concentrated nitric acid. Pre-sterilized 50ml McCartney bottles were used for samples meant for microbial analysis. In-situ measurements of pH, Electrical Conductivity, Total Dissolved Solids (TDS), Temperature, and Dissolved Oxygen (DO) were taken at each location using Extech Digital DO700 meter.

Table 4.13: Results of physico-chemical and microbial parameters analysed in Surface water and Groundwater samples collected within the study area

S/N	Parameters	Unit	GW M_1	GW M_2	GW M_3	Surface Water M_4	GW Control	FMENT Limit
A	**Coordinates**							
1	Latitude	N	9.530806	9.537112	9.5341862	9.537008	9.596370	-
2	Longitude	E	6.449736	6.444268	6.447051	6.439888	6.429633	-
3	Altitude	M	-	-	-	-	-	-
B	**Physicochemical Test**							
4	Colour	TCU	Clear	Clear	Clear	Clear Gray	Clear	Clear
5	Odour	-	Odourless	Odourless	Odourless	Bad Odour	Odourless	Unobjectionable
6	Taste	-	Tasteless	Tasteless	Tasteless	Bitter	Tasteless	Unobjectionable
7	Turbidity	NTU	0	0	0	27	0	50
8	pH	-	6.69	7.59	6.79	8.92	6.55	6.5 – 8.5
9	Temperature	^{0}C	29.5	29.0	28.9	32.2	30.1	Ambient
10	Dissolve Oxygen	mg/L	3.4	3.1	3.6	2.8	3.5	2 – 8
11	Total Dissolve Solid	mg/L	201	182	244	298	190	500
12	Electrical Conductivity	µs/cm	373	365	499	597	403	1000
13	Total Suspended solid	mg/L	1	0	3	13	1	20
14	Salinity	mg/L	0.00	0.02	0.06	0.09	0.02	<1000
15	ORP (MV)	(MV)	123	156	253	341	201	200-600
16	B.O.D	mg/L	0.4	0.8	0.9	2.0	1.4	NS
C	**Chemical Test**							
17	Ammonium (NH_4^+)	mg/L	0.006	0.018	0.003	0.103	0.003	NS
18	Potassium (K^+)	mg/L	0.2	0.3	1.4	2.8	0.2	20
19	Calcium (Ca^{2+})	mg/L	0.2	0.2	0.2	0.4	0.1	200
20	Sodium (Na^+)	mg/L	4	0	3	16	9	20
21	Magnesium (mg^{2+})	mg/L	0.63	0.24	0.25	3.43	0.21	20
22	Sulphate (SO_4^{2+})	mg/L	39	38	43	126	39	100
23	Nitrate (NO_3^{2-})	mg/L	6.0	2.9	3.0	27.5	3.0	50
24	Chloride (Cl^-)	mg/L	0.3	0.1	0.1	4.2	0.8	100
25	Phosphate (PO_4^{2-})	mg/L	0.11	0.05	0.02	1.86	0.14	NS
26	Nitrite (NO_2^-)	mg/L	0.000	0.000	0.000	0.2000	0.000	0.2
D	**Heavy Metal**							
27	Zinc (Zn^{2+})	mg/L	0.14	0.07	0.16	1.86	0.05	3.0
28	Iron (Fe^{2+})	mg/L	0.002	0.068	0.093	0.304	0.411	0.3

29	Copper (Cu^{2+})	mg/L	0.18	1.23	0.89	0.00	1.05	1.5
30	Chromium (Cr^{3+})	mg/L	0.00	0.00	0.00	0.07	0.01	0.05
31	Lead (Pb^{2+})	mg/L	0.000	0.000	0.000	0.000	0.000	0.01
32	Cobalt (CO^{2+})	mg/L	0.01	0.00	0.30	0.29	0.17	0.2
33	Mercury (Hg^{+})	µg/L	0.000	0.000	0.000	0.000	0.000	0.001
34	Nickel (Ni^{2+})	mg/L	0.831	0.056	0.231	1.752	0.866	0.070
E	**Organics**							
35	Oil and Grease	mg/L	0	0	0	2	0	10
36	Benzene	mg/L	0.00	0.00	0.00	0.00	0.00	0.01
37	Toluene	mg/L	0	0	0	0	0	0.7
38	Ethylbenzene	mg/L	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	0.5
40	Phenols	mg/L	0.007	0.001	0.000	0.013	0.000	0.05
	Microbiological Test							
41	E. Coli	Cfu/ml	0	0	0	2	0	Nil
42	Feacal Coliform	Cfu/ml	0	0	0	7	0	Nil
43	Total Coliform	Cfu/ml	0	0	0	26	3	10

Source: Pollution Control Laboratory, 2026

The pH of the water samples ranged from 6.55 to 8.92 while the in-situ water temperature ranged between 28.9^{0}C and 32.2^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C (Ambient) for potable water. Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 365µS/cm to 597µS/cm. The conductivity values obtained in the water samples were within the FMEnv/WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 182mg/l to 298mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the water samples was very low (0.00 to 0.09 ppm) indicating a fresh water environment. Heavy metals in the water samples were analysed using Atomic Absorption Spectrophotometer (AAS). Zinc, Copper, Lead, and Mercury were within the FMEnv/WHO limits, while Iron, Cobalt, Chromium, and Nickel slightly exceeded the limit of FMEnv/WHO in the water samples analysed. The concentrations of Oil & Grease in the water samples were below the detection limit of the analytical instrument. Coliform was also undetected in the water samples.

4.3.4 Terrestrial Flora and Fauna

4.3.4.1 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 identification of flora specimen was done both in situ (field) and ex situ using appropriate and relevant literature's.

The vegetation of Minna, Niger State, is primarily characterized as a Guinea Savannah, featuring a mix of trees, shrubs, and grasses. The landscape is a diverse woodland savanna consisting of species like Daniella oliveri, Vitellaria paradoxa (shea tree), and Mangifera indica, with Hyptis suaveolens often dominating the understory. The vegetation is highly diverse but faces significant pressure from rapid urbanization and agricultural expansion.

Key characteristics of the vegetation in the Minna area of Niger State include:

i. **Vegetation Type:** The area belongs to the Southern/Northern Guinea Savannah zone.

ii. **Plant Composition:** The vegetation consists of woody trees, shrubs, and herbs. Important species include *Daniella oliveri*, *Vitellaria paradoxa*, *Parkia biglobosa*, *Khaya senegalensis*, and *Vitex doniana*.

iii. **Family Distribution:** The most common families found are Fabaceae, Poaceae, Asteraceae, and Lamiaceae.

iv. **Urbanization Impact:** Rapid urbanization and development between 2010 and 2020 have significantly reduced the natural vegetation, increasing built-up areas.

v. **Disturbed Areas:** The vegetation in many parts of Minna is secondary and has been influenced by farming and human activity.

The area features a mosaic of savanna woodlands, with vegetation density increasing in the wet season and reducing in the dry season

Major Vegetation Type in Minna, Niger State

The dominant vegetation in Minna is Southern Guinea Savanna, which is characterized by:

i. Tall grasses
ii. Scattered trees and shrubs
iii. Open woodland savanna

The grasses often belong to genera such as:

i. Andropogon
ii. Hyparrhenia
iii. Pennisetum

These grasses can grow between 1–3 meters during the rainy season.

Common Trees and Plant Species

Typical tree species found in the Minna savanna include:

i. Lophira lanceolata
ii. Annogeissus leiocarpus
iii. Afzelia africana
iv. Daniellia oliveri

Other widely occurring trees in the area include:

v. Neem
vi. Mango
vii. Mahogany
viii. Shea-butter tree (*Vitellaria paradoxa*)

These trees are usually **widely spaced**, allowing grasses to dominate the ground layer.

Structural Characteristics

The vegetation structure around FUT Minna typically consists of:

i. Grass Layer – Dominant ground vegetation.
ii. Shrub Layer – Small shrubs scattered across the landscape.
iii. Tree Layer – Short to medium-height trees (about 10–16m tall).

Human Influence on Vegetation

Vegetation around FUT Minna has been modified by human activities such as:

i. Farming and cultivation
ii. Bush burning
iii. Urban expansion
iv. Grazing by livestock

Table 4.14: Plant Species observed around proposed site

S/N	Dominant Species Encountered	Family Name	Common Name (Local name)	Plant Forms
1	*Ageratum conyzoides*	Asteraceae	Goat Weed	Herb
2	*Carica papaya*	Caricaceae	Pawpaw	Tree
3	*Zea Mays*	Poaceae	Maize	Shrub
4	*Manihot esculenta*	Euphorbiaceae	Cassava	Shrub
5	*Colocasia esclulenta*	Araceae	Cocoyam	Shrub
6	*Ipomoea batatas*	Convolvulaceae	Potato	Climber
7	*Mangifera indica*	Anacardaceae	Mango	Tree
8	*Dioscorea rotundata*	Dioscoreaceae	White yam	Climber
9	*Solanum lycopersicum*	Solanaceae	Tomato	Shrub

Source: REA Field survey, 2026

4.3.4.2 Fauna Species

The methodology used in identifying the terrestrial fauna species within the project site includes direct sighting, sound, nest type, and foot prints. The fauna characteristics of the project site and the project area of influence are discussed in the section below.

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.

Table 4.15: List of Fauna Species Encountered in the Project Site

S/N	Common (Local) Names	Species	Family	Group
1	Millipede	*Archispirostreptus gigas*	Spirostretidae	Arthropoda
2	Black ant	*Lasius niger*	Formicidae	Insecta
3	Earthworm	*Lumbricus terrestris*	Acanthodrilidae	Annelida
4	Lizard	*Varanus albigularis*	Varanidae	Reptilia
5	Butterfly	*Chlosyne rosita*	Nymphalidae	Insecta
6	Soldier ant	*Strongylognathus alboini*	Formicidae	Insecta
7	Housefly	*Musca domestica*	Muscidae	Insecta

Source: REA Field survey, 2026

4.3.4.3 Land Use and Land Cover of Minna, Niger State

The Land Use and Land Cover of Minna describes how land in the area is utilized by humans (land use) and the physical features that cover the land surface (land cover). Studies using **GIS and remote sensing** classify Minna's landscape into several major categories.

Major Land Use and Land Cover Types in Minna

The main LULC classes identified in Minna include:

1. **Built-up Areas**

i. Residential houses, roads, commercial centers, and institutions.
ii. Concentrated mainly around the city centre and expanding outward.

2. **Agricultural Land (Farmland)**

i. Crop farms, fallow land, and cultivated fields.
ii. This is the **dominant land use** in the area.

3. **Vegetation**

i. Natural vegetation, shrubs, and scattered woodland.
ii. Mostly found in the outskirts of the city.

4. **Bare Ground**

i. Open soil surfaces, construction sites, and undeveloped land.

5. **Water Bodies**

i. Rivers
ii. streams
iii. Ponds
iv. reservoirs.

These five classes are commonly used in GIS classification of Minna's landscape.

Land Use/Land Cover Distribution (Example: 2024)

A recent satellite-based study classified the land cover of Minna as follows:

Land Cover Type	Area (km²)	Percentage
Agricultural Land	129.01	69.75%
Built-up Area	69.98	37.85%
Bare Ground	12.15	6.57%
Vegetation	5.17	2.80%
Water Bodies	0.68	0.37%

i. **Agriculture dominates** the landscape.
ii. **Urban (built-up) areas are rapidly increasing** due to population growth and infrastructure development.

Land Use Change Trends in Minna

Rapid Urban Expansion

i. Built-up area increased from **28.68 km² (15.5%) in 2015** to **69.98 km² (37.9%) in 2024**.
ii. This growth reflects urbanization and expansion of housing, roads, and commercial activities.

Agriculture Still Dominant

i. Agricultural land remains the largest land cover type but slightly declined after 2018 due to urban encroachment.

Decline in Vegetation

i. Vegetation cover reduced significantly from **8.32% in 2021 to about 2.8% in 2024**, mainly because of urban development and farming activities.

Reduction in Bare Land

i. Many previously unused areas have been converted into farmland or built-up areas.

Factors Influencing Land Use in Minna

Key drivers of land use change include:

i. Population growth and urban expansion
ii. Infrastructure development
iii. Agricultural activities
iv. Government institutions and educational facilities
v. Transportation network development

These factors contribute to the rapid transformation of land cover patterns.

4.3.4.4 Description of Land Use and Land Cover of Minna

The Land Use and Land Cover map of Minna illustrates the spatial distribution of different land cover types within the city and its surrounding areas. The map was produced using Geographic Information System (GIS) and satellite imagery, which classify the land surface into distinct categories such as built-up areas, agricultural land, vegetation, bare land, and water bodies.

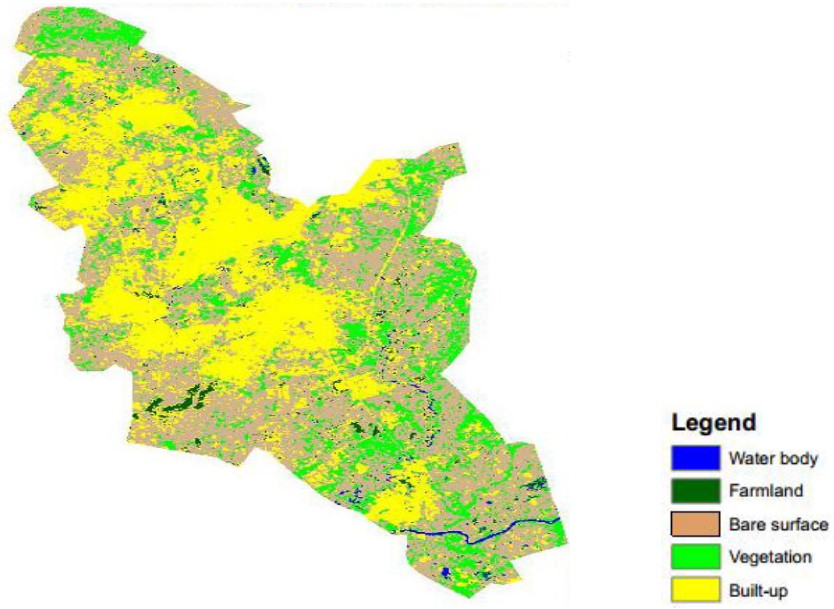

Figure 4.2: Map Description of Land Use and Land Cover of Minna

From the map, agricultural land occupies the largest portion of the study area. These farmlands are mainly located around the peri-urban and rural fringes of the city where land is available for crop cultivation. Farming activities dominate these areas, indicating that agriculture remains an important economic activity for residents.

The built-up areas are concentrated mainly in the central parts of the city and along major road corridors. These include residential neighborhoods, commercial areas, educational institutions, and transportation infrastructure. Urban development radiates outward from the city center, showing clear evidence of urban expansion and population growth.

Areas covered by natural vegetation appear mostly on the outskirts of the city where human activities are less intensive. The vegetation mainly consists of shrubs, grasses, and scattered trees typical of the Guinea savanna ecological zone.

Bare surfaces or exposed land are also visible on the map. These areas represent undeveloped land, construction sites, eroded surfaces, or fallow farmland. They are scattered throughout the city but are more common in newly developing areas where land is being prepared for construction or farming.

Water bodies, including streams, ponds, and reservoirs, occupy a very small proportion of the total land area. These water features are important for domestic use, irrigation, and local ecological balance.

Overall, the map shows that land use in Minna is strongly influenced by agriculture and rapid urbanization. The increasing expansion of built-up areas into surrounding farmlands and vegetation indicates ongoing urban growth, which has significant implications for environmental management and sustainable land use planning.

4.4 Socio-economic Conditions of the Study Area

4.4.1 Introduction

The proposed project will be sited within the FUT Minna campus in Niger State. In close proximity, there is no local community presence within the project site. However, the identified community within the 2km radius of the project site is Gidan Kwano, Bosso LGA of Niger State. This section thus provides baseline information on the socio-economic and health survey conducted in the community.

4.4.2 Study Approach and Methodology

4.4.2.1 Study Area

The study was conducted in the campus been the project host and Gidan Kwano community in Bosso LGA of Niger State. Bosso LGA is a rapidly developing peri-urban area in Niger State, characterized by agricultural livelihoods, increasing urbanization due to proximity to Minna, and emerging agro-industrial investments. Its socio-economic importance is growing, particularly in education and agriculture, though infrastructure development remains a key need.

4.4.2.2 Population of the Study Area

The target populations for this study are the community members of Gidan Kwano including students who live opposite the University campus. All respondents interviewed during the survey were above 18 years and they gave informed consent.

4.4.2.3 Study Design

The study employed a sequential mixed methods research design using quantitative and qualitative methods of data gathering, analysis, and reporting. Information obtained during the study was investigated to separate perception from reality and to check for information consistency, reliability, and validity. The study employed questionnaire administration for quantitative data gathering;

while Key informant interview (KII), Focus Group Discussions (FGD) and stakeholders' consultation were used for the qualitative data gathering.

4.4.3 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 socioeconomic baseline report is structured as follows:

i. Demographic Profile;
ii. Administrative institutions
iii. Infrastructure and Services
iv. Land Acquisition
v. Waste management

4.4.3.1 Demographic Information

Gender

24% of the respondents are female while 76% are indicated to be male in the project area. Table 4.16 indicated the frequency and the percentage of the respondents accordingly and Figure 4.3 visualize the percentages of both genders using Pie chart.

Table 4.16: Gender of the respondents

Value	Frequency	Percentage
Female	118	23.94
Male	375	76.06

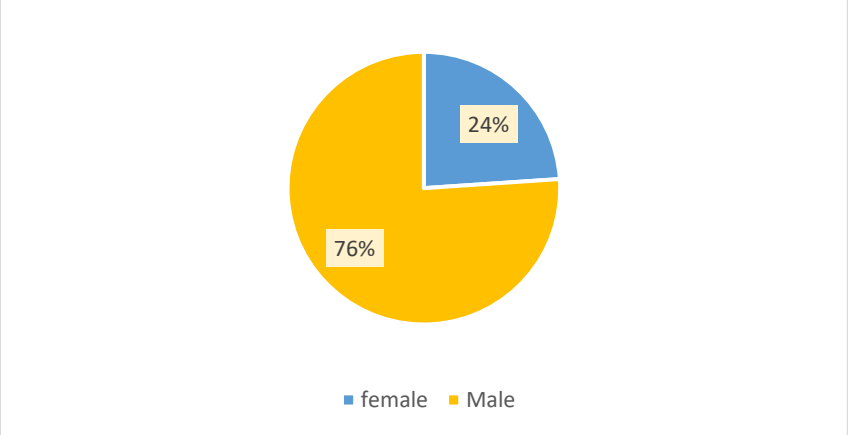

Figure 4.3: Gender of the respondents

Age range of the respondents

The respondents within the age range of 18-22 are indicated to be 59%, 23-27 are indicated to be 28%, 28 & above are indicated to be 5% and below 18 are indicated 8%. Table 4.17 shows the age range of the respondents including their frequencies accordingly. Figure 4.3 indicates the percentages of the age ranges of the respondents using Pie chart.

Table 4.17: Age range of the respondents

Value	Frequency	Percentage
18-22	290	58.8
23-27	139	28.2
28 & above	26	5.3
below 18	38	7.7

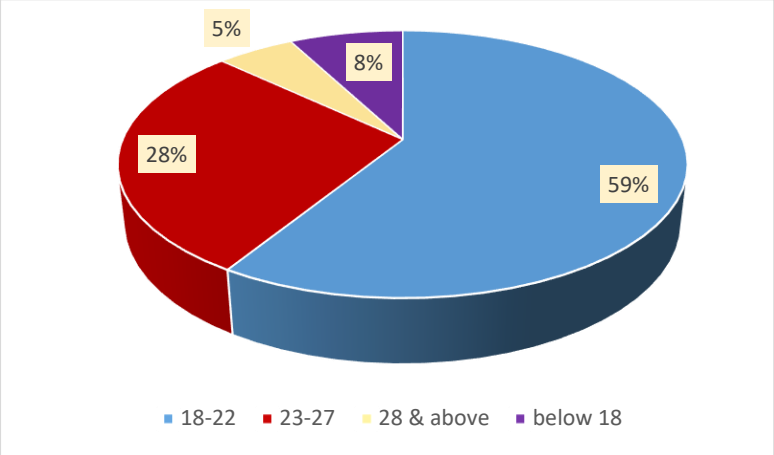

Figure 4.4: Age range of the respondents

Level of study

The respondents in 100level are 1%, 200level are 42%, 300level are 30%, 400level 12%, 500level are 13% while postgraduate respondents are 2%. Table 4.18 shows the level of study of the respondents and the frequencies at which they appear. Figure 4.4 indicates the level of study of the respondents with their percentages accordingly.

Table 4.18: Level of study

Value	Frequency	Percentage
100l	5	1.0
200l	205	41.6
300l	150	30.4
400l	57	11.6
500l	66	13.4
Postgraduate	10	2.0

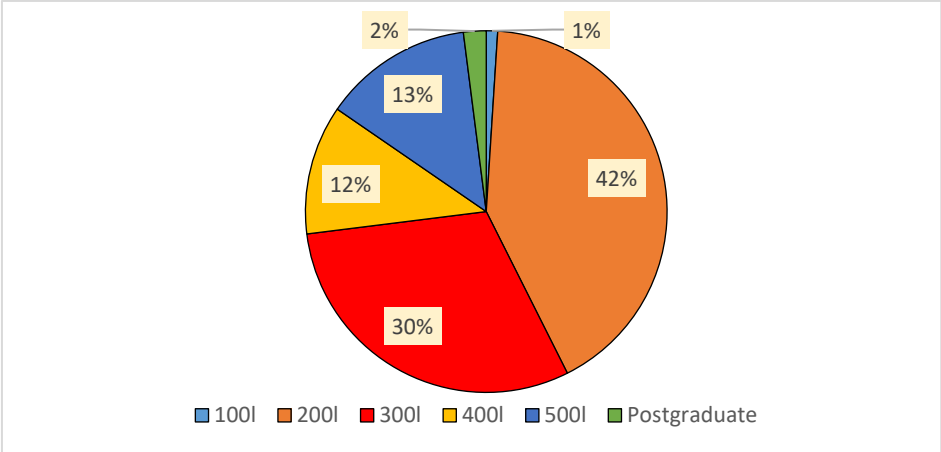

Figure 4.5: Level of study

Faculty/Department of the Respondents

2% of the respondents are in Agricultural Engineering Department, 1% in Animal Production, 1% in Architecture, 1% in Building, 1% in Chemical Engineering, 7% in Civil Engineering, 4% in Computer Engineering, 13% in Computer Science, 1% in CPF, 1% in CSS, 9% in Cyber Security, 2% in Electrical and Electronics Engineering, 1% in ERP, 7% in Information Technology, 1% in ISMS, 2% in M.C.E, 4% in Mechanical engineering, 1% in Mechatronics Engineering, 2% in Physics Department, 1% in PMT, 2% in Quantity Surveying, 1% in School of Environmental, 1% in school of Life Sciences, 1% in School of Physical Sciences, 1% in SEET, 14% in SICT, 5% in SIPET, 2% in SIT, 1% in Software Engineering, 1% in SPS, 1% in TEE and 1% in TME. Table 4.19 shows the Faculty/Departments of the respondents and their frequencies.

Table 4.19: Faculty/Departments of the Respondents

Value	Frequency	Percentage
Agric Engineering	10	2.0
Animal Production	5	1.0
Architecture	5	1.0
Building Technology	5	1.0
Chemical Engineering	5	1.0
Civil engineering	36	7.3
Computer Engineering	21	4.3
Computer Science	65	13.2
CPF	6	1.2
CSS	6	1.2
Cyber Security	42	8.5
Electrical & Electronics	11	2.2
ERP	5	1.0
Information Tech	33	6.7
ISMS	6	1.2

M.C.E	12	2.4
Mechanical Engineering	21	4.3
Mechatronics Engineering	5	1.0
Physics dept	12	2.4
PMT	5	1.0
Quantity survey	11	2.2
School of Environmental	5	1.0
School of Life Sciences	5	1.0
School of Physical Science	5	1.0
SEET	5	1.0
SICT	71	14.4
SIPET	25	5.1
SIT	10	2.0
Software Engineering	5	1.0
SPS	5	1.0
TEE	6	1.2
TME	6	1.2

Type of accommodation

66% of the respondents indicated to be accommodated outside the project area (off-campus), 5% are living with family while 30% got accommodated within the campus (on campus). Table 4.20 indicated the accommodations of the respondents with their frequencies accordingly. Figure 4.6 shows the type of accommodation and the percentages of the respondents being accommodated in each using pie chart.

Table 4.20: Types of Accommodation

Value	Frequency	Percentage
Living with family	24	4.9
Off-campus	323	65.5
On-campus	146	29.6

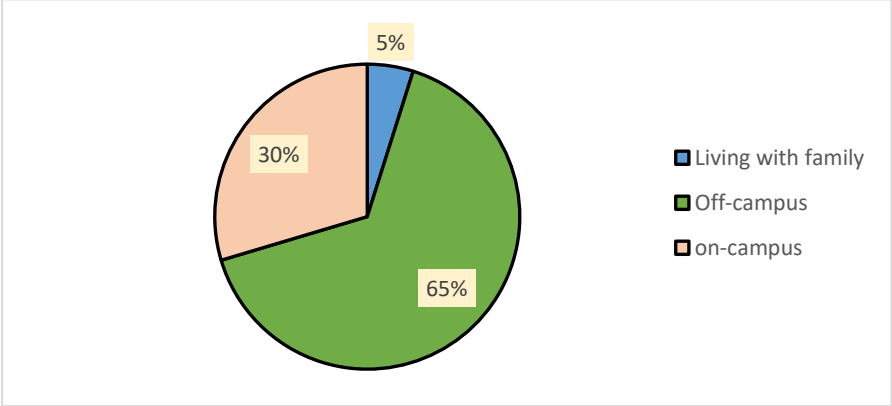

Figure 4.6: Type of Accommodation

4.4.3.2 Access to Energy

Access to Electricity

42% of the respondents do not have access to electricity, 37% are sometimes having access to electricity and 21% have direct access to electricity. Table 4.21 indicated the respondents access to electricity including the frequencies of the options. Figure 4.7 indicated the values of access to electricity and the percentages of the respondents on each value using pie chart.

Table 4.21: Access to Electricity

Value	Frequency	Percentage
No	208	42.2
Sometimes	180	36.5
yes	105	21.3

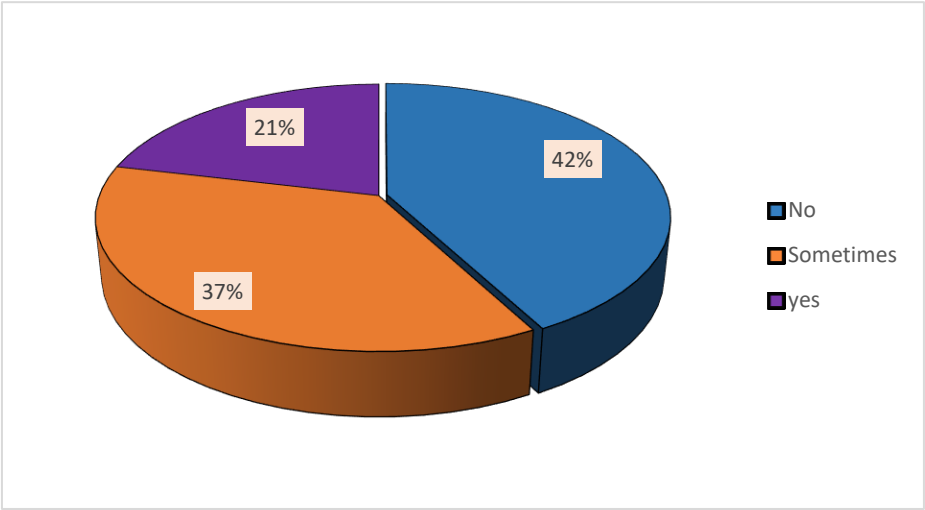

Figure 4.7: Access to Electricity of the Respondents at the project area

Average hours (time) of Electricity supply

13% of the respondents receive average hours of electricity for 11-15hours, 46% receive average hours of electricity for 1-5hours, 14% receives average hours of electricity for 14hours and 26% receives average hours of electricity for 6-10hour s only. Table 4.22 indicated the hours of electricity supply and the number of respondents responding to each hour. Figure 4.8 visualize the hours of electricity supply including the percentages of respondents based on their selection using pie chart.

Table 4.22: Average hours of Electricity supply

Value	Frequency	Percentage
11-15hrs	66	13.4
1-5hrs	226	45.8
16-24hrs	71	14.4
6-10hrs	130	26.4

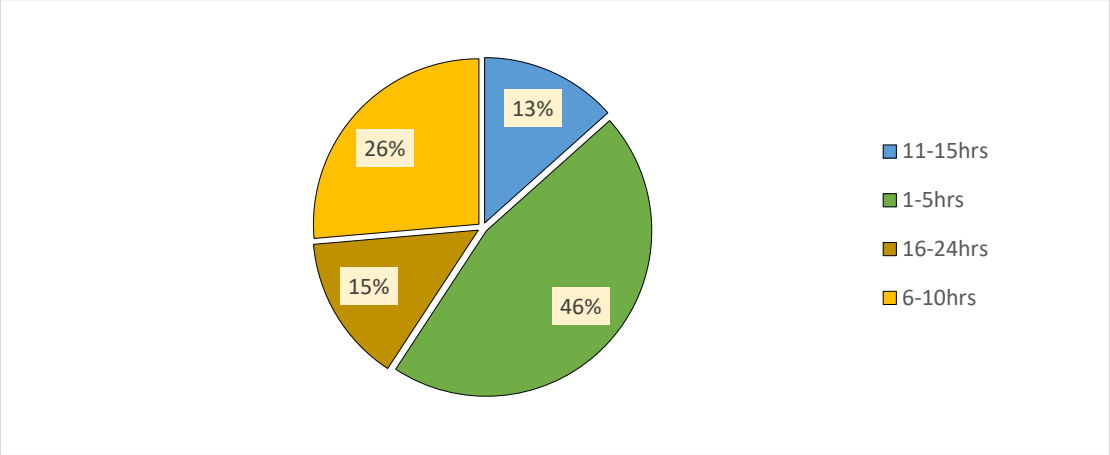

Figure 4.8: Average hours of Electricity supply

Primary source energy

The maximum number of respondents source their energy primarily from National grid indicated as 97%, while Minimum number source their energy primarily from Generator indicated as 3%. Table 4.23 indicated the primary sources of energy and the frequencies of the respondents sourcing energy from them. Figure 4.9 indicates the primary source of energy and the percentage of their energy source using pie chart.

Table 4.23: Primary Source of Energy

Value	Frequency	Percentage
generator	14	2.8
national grid	479	97.2

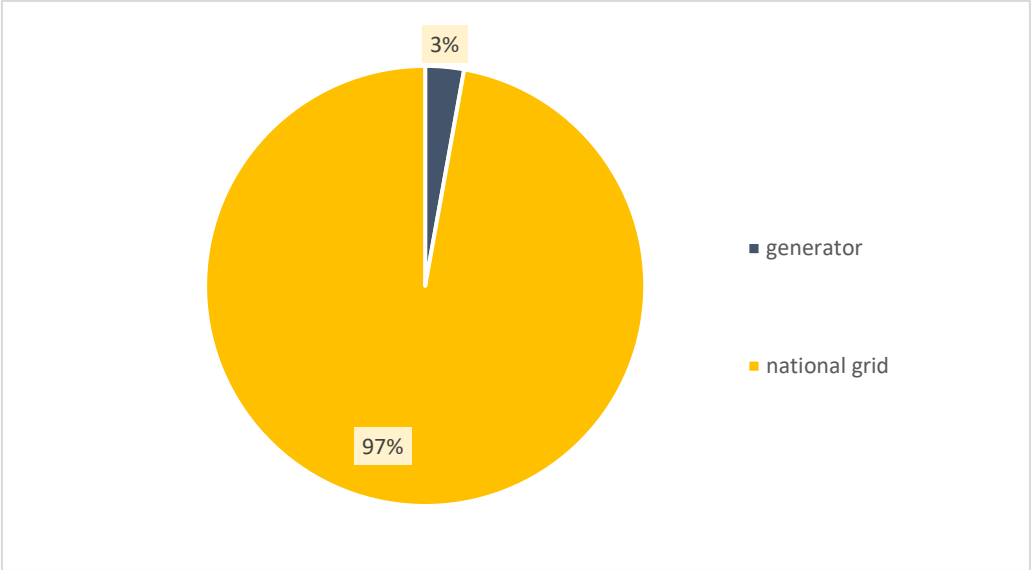

Figure 4.9: Primary source of energy

4.4.3.3 Energy Usage Patterns

Regularly used Appliance

52% of the respondents uses their laptop, phone and fan regularly, 15% uses only phone and laptop regularly, 11% uses only mobile phone regularly, 7% uses mobile phone and fan regularly, 6% uses all listed appliances regularly, 5% uses only fan regularly and 3% uses air conditioner, mobile phone and fan regularly. Table 4.24 indicated all kind of appliances being utilized by the respondents and the frequency based on their usages. Figure 4.10 indicated the common appliances being used by the respondents and the percentage of their usages using pie chart.

Table 4.24: Regularly used Appliance

Value	Frequency	Percentage
Air conditioner, Phone & fan	14	2.8
All	31	6.3
fan	29	5.9
Laptop and phone	75	15.2
Laptop,phone & fan	258	52.3
Mobile phone	54	11.0
mobile phone & fan	32	6.5

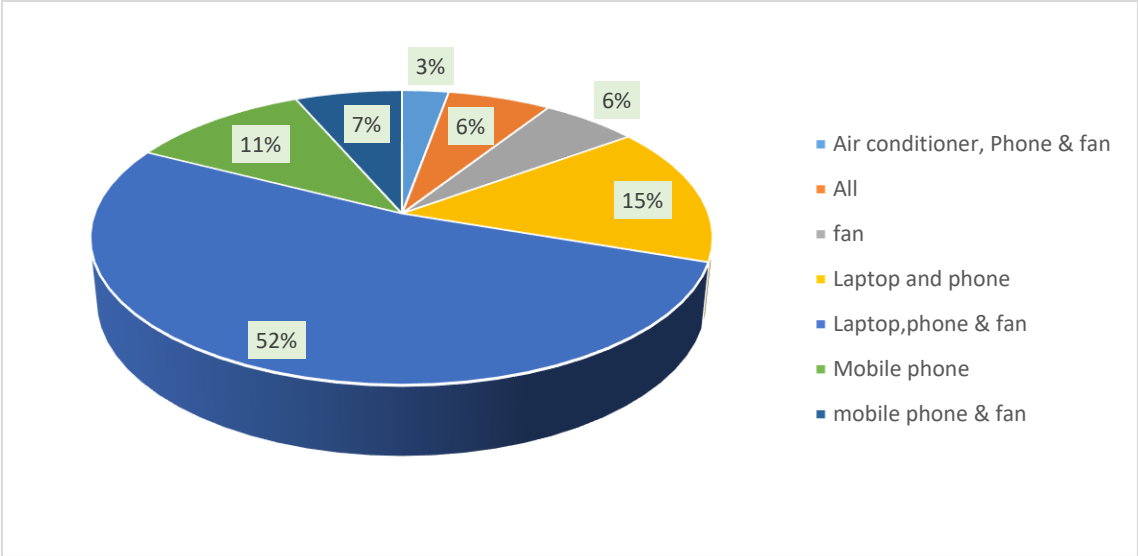

Figure 4.10: Regularly used Appliance

Average hours of Electricity usage for Academic purpose

38% of the respondents at the project area uses electricity for 2-4hours doing academic activities, 19% uses electricity for 5 – 7 hours, 7% uses electricity for less than 2 hours and 40% uses electricity for more than 7 hours for academic engagements. Table 4.25 indicates the average hours of the electricity usage by the respondents and their frequencies based on selection. Figure 4.11 visualize the average hours of electricity usage for academic purpose and the percentage of the respondents attached to each hours using pie chart.

Table 4.25: Average hours of Electricity usage for Academic purpose

Value	Frequency	Percentage
2-4hrs	166	33.7
5-7hrs	94	19.1
less than 2	34	6.9
more than 7	199	40.4

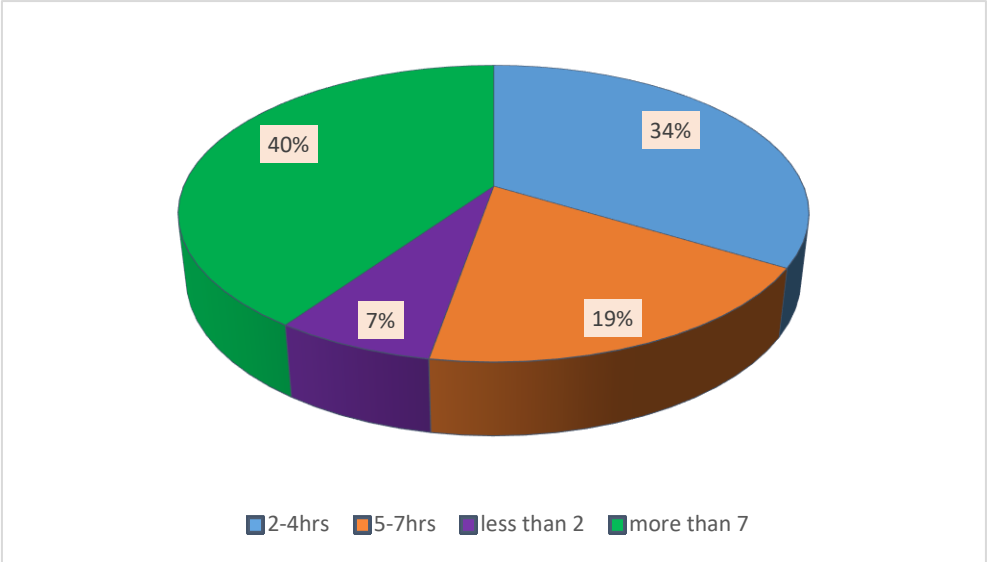

Figure 4.11: Average hours of electricity usage for academic purpose

Time of highest electricity usage

13% of the respondents make use of electricity mostly in the afternoon, 23% mostly in the evening, 5% uses electricity mostly in the morning while 59% uses electricity mostly in the night. Table 4.26 shows each time respondents mostly use electricity including their frequencies as applied. Figure 4.12 indicates the time of most electricity usage by the respondents and their percentages accordingly using pie chart.

Table 4.26: Time of highest electricity usage

Value	Frequency	Percentage
Afternoon	64	13.0
Evening	114	23.1
Morning	26	5.3
Night	289	58.6

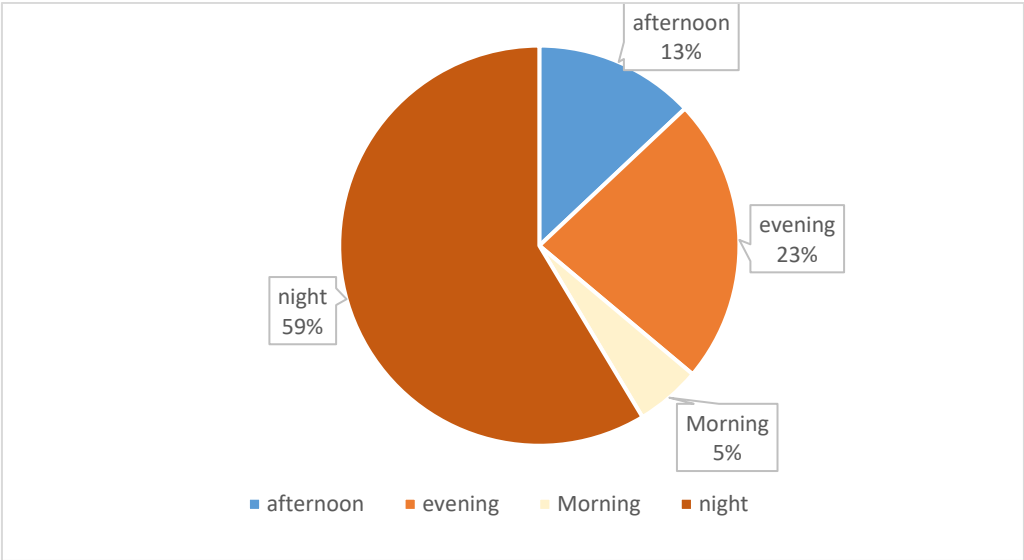

Figure 4.12: Time of highest Electricity usage

4.4.3.4 Energy Needs for Academic

How power outages affect Respondents' Academic Activities

Power outages at the project area affects academic activities of 95% of the respondents while it doesn't affect the academic activities of 5%. Table 4.27 shows how power outages affect academic activities of the project area. Figure 4.13 depicts the percentages of the respondents whose academic activities are obstructed and are not by power outages using pie chart.

Table 4.27: How power outages affect Respondents' Academic Activities

Value	Frequency	Percentage
No	27	5
Yes	466	95

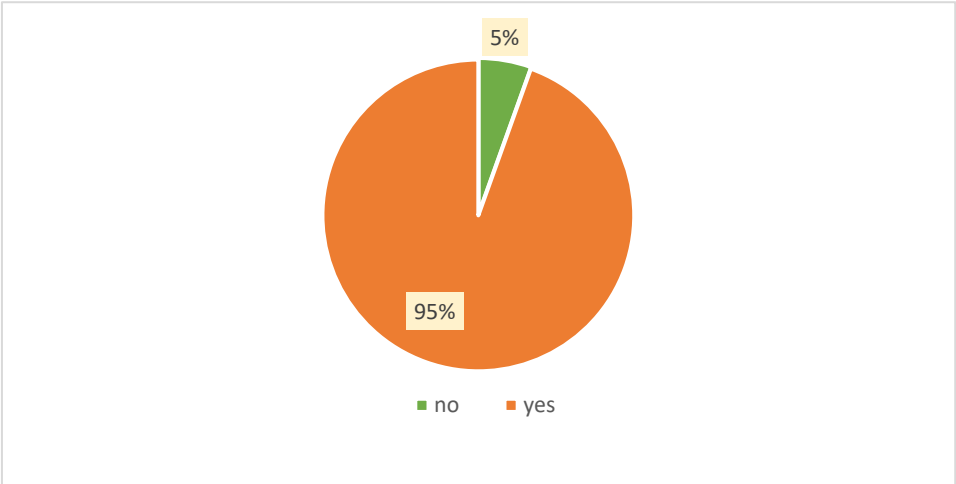

Figure 4.13: How power outages affect Respondents' Academic Activities

Activities that are most affected by power outages

Respondents that power outages affect all their activities are indicated as 48%, 7% indicated charging to be affected most, 5% indicated online classes, 22% indicated reading and charging, 7% indicated research and charging, 1% indicated research and 5% indicated studying. Table 4.28 depicts the activities of the respondents being disrupted by power outages and the number of respondents selecting each activity. Figure 4.14 shows the percentage at which an activity is affected by each activity of the respondents using pie chart.

Table 4.28: Activities that are most affected by power outages.

Value	Frequency	Percentage
All	236	48
charging	34	7
online classes	23	5
Reading and Charging	109	22
Research	6	1
research & charging	33	7
studying	25	5
None	27	5

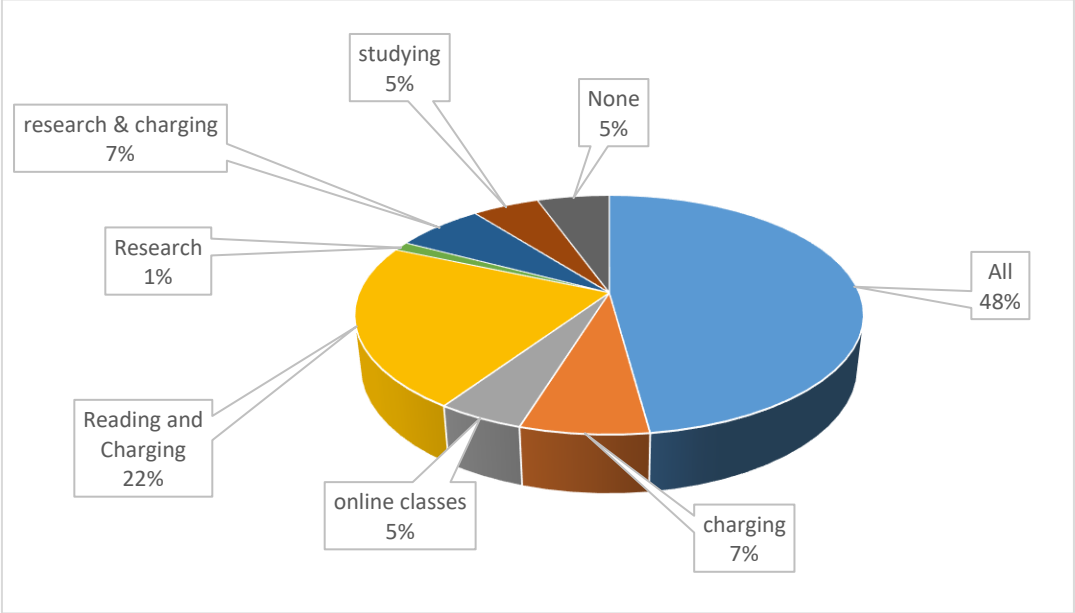

Figure 4.14: Activities that are most affected by power outages.

How often respondents' need electricity for internet access and online learning

66% of the respondents indicated that they always need electricity for internet access and online learning, 26% indicated that they often need electricity for internet access and online learning while 8% indicated they sometimes need electricity for internet access and online learning. Table 4.29 Indicated how frequent respondents' need electricity for internet access and online learning. Figure 4.15 depicts the percentage of respondents who "always,

often and Sometimes" need electricity for internet access and online learning using pie chart.

Table 4.29: How often respondents' need electricity for internet access and online learning

Value	Frequency	Percentage
Always	326	66
Often	127	26
sometimes	40	8

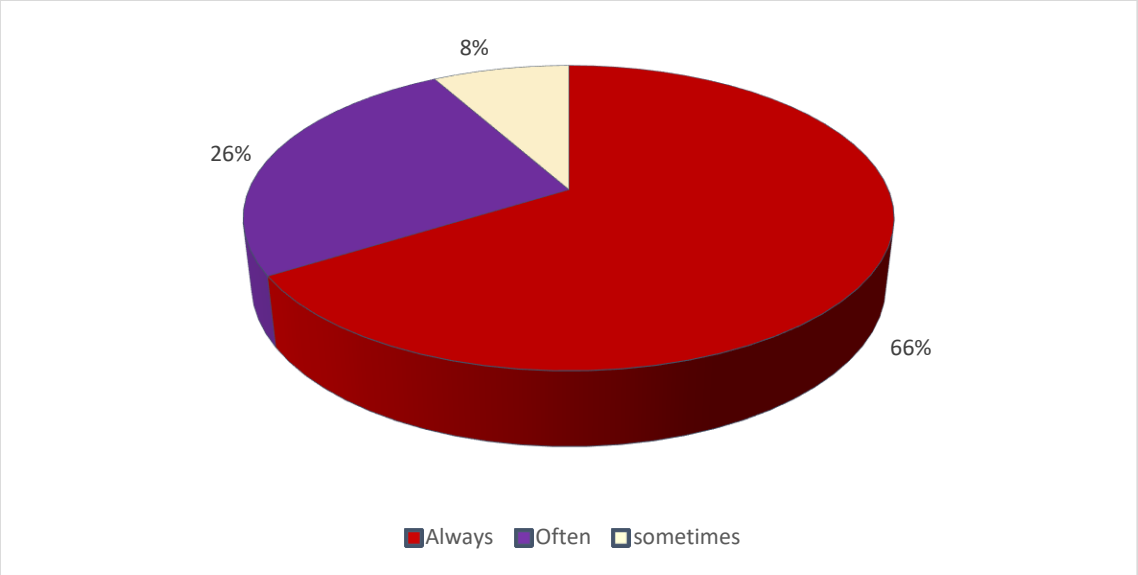

Figure 4.15: How often respondents' need electricity for internet access and online learning

4.4.3.5 Energy Efficiency And Sustainability

Energy saving Practices Awareness

46% of the respondents indicated that they are not aware of energy-saving practices while 54% indicated that they're aware of energy-saving practices. Table 4.30 shows the scale of respondents' awareness on energy-saving practices. Figure 4.16 visualize the level of respondents' energy-saving practices awareness using pie chart.

Table 4.30: Energy-saving practices awareness

Value	Frequency	Percentage
No	228	46
Yes	265	54

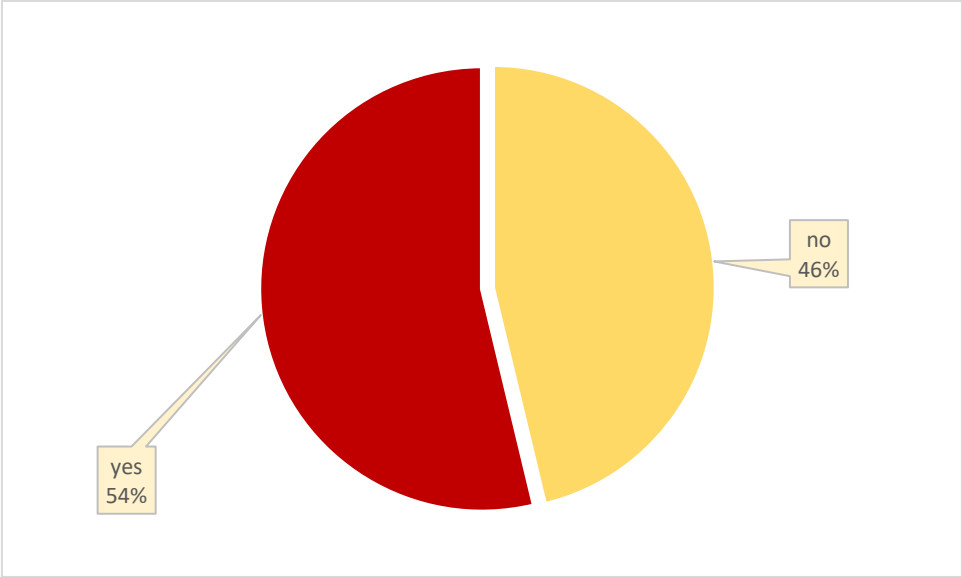

Figure 4.16: Energy-saving Practices Awareness

How respondents' consciously try to reduce Electricity Consumption

18% of the respondents indicated to always try to reduce electricity consumption, 12% never try to reduce the consumption of electricity, 58% indicated they sometimes reduce the consumption of electricity while 12% of the respondents rarely reduce electricity consumption at the project area. Table 4.31 shows the scale of how consciously respondents' try to reduce electricity consumption. Figure 4.17 depicts the level and percentage of conscious reduction of electricity consumption at the project area using pie chart.

Table 4.31: How respondents' consciously try to reduce Electricity Consumption

Value	Frequency	Percentage
always	89	18
Never	61	12
rarely	59	12
sometimes	284	58

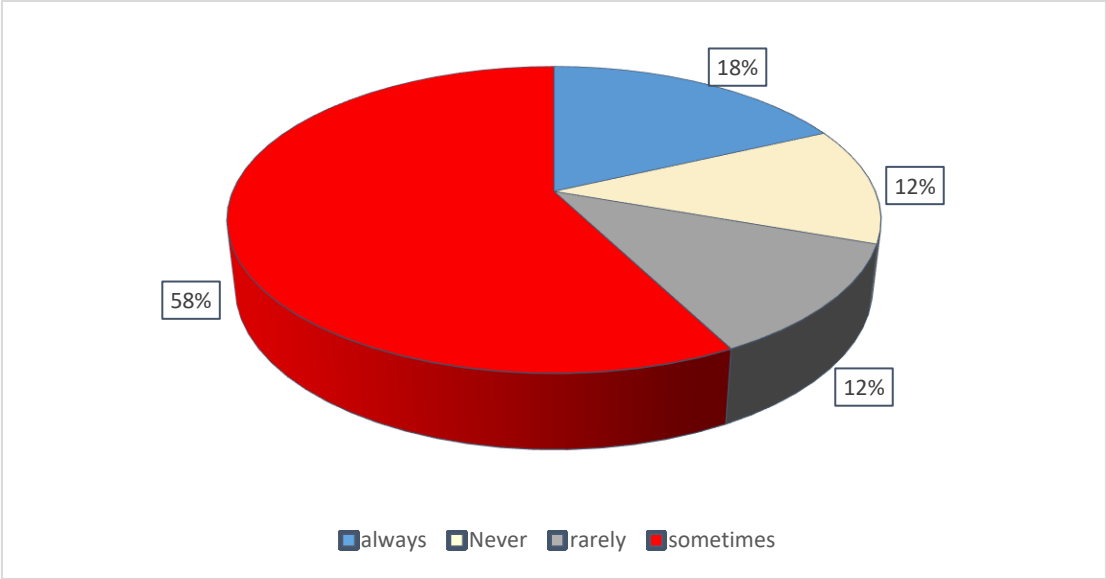

Figure 4.17: How respondents' consciously try to reduce Electricity Consumption

Support for the use of Renewable Energy on campus

94% indicated to support the use of renewable energy on campus while 6% are not sure of their support. Table 4.32 indicates the support of respondents for the use of renewable energy on campus. Figure 4.18 shows the level of respondents' support for the use of renewable energy on campus using pie chart.

Table 4.32: Support for the use of Renewable Energy on campus

Value	Frequency	Percentage
Not sure	29	6
Yes	464	94

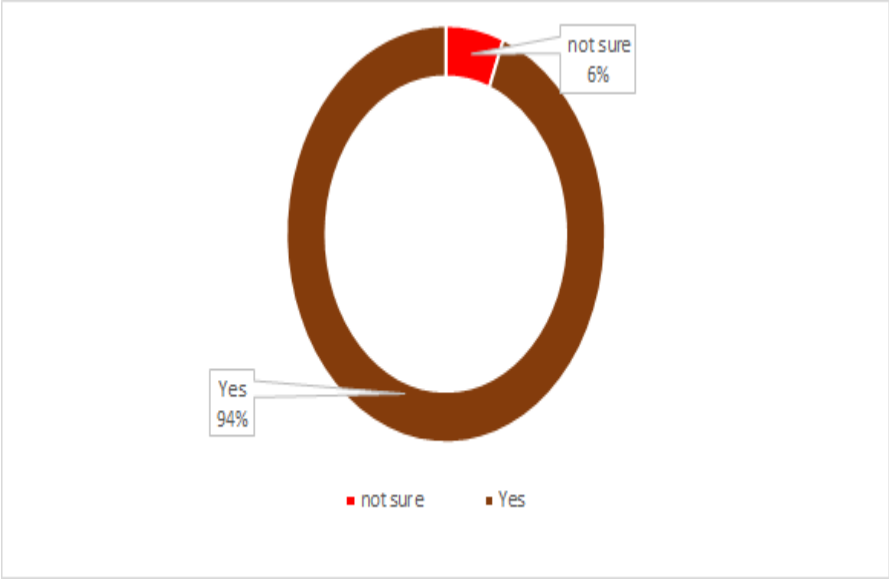

Figure 4.18: Support for the use of Renewable Energy on campus

4.4.3.6 Challenges and Suggestions

Major Energy-related challenges faced by the Respondents

There was no response on this segment from 30% of the respondents while 6% indicated unavailability of water as their major challenge, 1% indicated studying, lighting and charging as their challenge, 3% indicated studying and lighting, 14% indicated reading, 2% indicated power outage, 4% indicated no challenge, 19% indicated lighting only as their challenge, 1% indicated lack of communication, 4% indicated internet access and charging as their challenge, 1% indicated food preparation and charging, 14% indicated charging of gadgets as their major challenge. Table 4.33 detailed the respondents' energy-related challenge at the project area.

Table 4.33: Major Energy-related challenges faced by the Respondents

Value	Frequency	Percentage
Charging	70	14
Food preparation & charging	5	1
Internet access & charging	20	4
lack of communication	6	1
Lighting	96	19
none	21	4
Power outage	12	2
Reading	68	14
studying and lighting	15	3
studying, lighting & Charging	5	1
unavailability of water	28	6
No response	147	30

Respondents' satisfaction on the current Energy supply at the project area

There are 5% of respondents never responded to the level of energy supply satisfaction at the project area, 31% indicated dissatisfied, another 31% indicated Neutral, 14% indicated satisfied, 18% indicated very dissatisfied while 1% indicated very satisfied. Table 4.34 shows the satisfaction of respondents on level of current energy supply and their frequencies. Figure 4.19 depicts the percentages of the level of satisfaction of respondents at the project area using pie chart.

Table 4.34: Respondents' satisfaction on the current energy supply at the project area

Value	Frequency	Percentage
Dissatisfied	154	31
Neutral	154	31
Satisfied	69	14
Very Dissatisfied	87	18
Very Satisfied	5	1

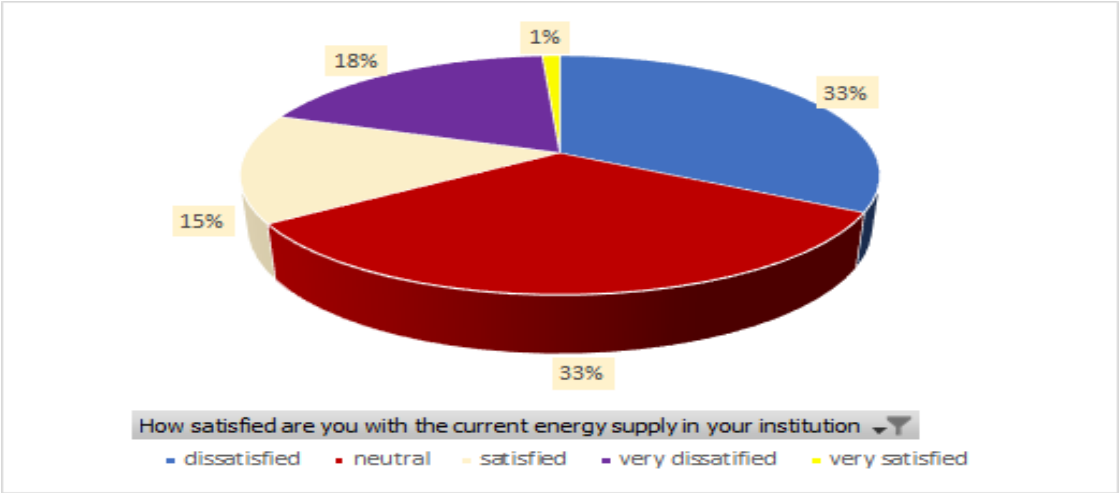

Figure 4.19: Respondents' satisfaction on the current Energy supply at the project area

Suggestions to improve Respondents' Energy need

36% of the respondents never responded in regard to their suggestions on improving energy needs, 0% indicated solar powered borehole, 3% indicated renewable energy source, 2% indicated prompt repair of electricity when faulty and fixed hour of supplication, 30% indicated installation of solar power, 11% indicated improvement from school management, 3% indicated fixed time/hours of electricity supplication, 3% indicated charging hubs, 1% indicated Biogas as their improvement suggestion while 10% indicated adequate power supply as their suggestions. Table 4.35 shows different respondents' opinion on the improvement of energy need at the project area.

Table 4.35: Suggestions to improve Respondents' Energy need

Value	Frequency	Percentage
Adequate power supply	51	10
Biogas	7	1
Charging hubs	14	3
Fixed hours of Supplication	16	3
Improvement from School Management	53	11
Installation of Solar Power	150	30
Prompt repair when faulty and fixed hours of supplication	9	2
Renewable Energy source	15	3
Solar Powered Borehole	1	0

The questionnaire of the socio-economics survey and the ESIA checklist is attached as annexes in the draft report.

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 the FUT Minna, Niger State, 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:

i. Establish the significance of identified potential impacts that may occur as a result of the proposed Project activities;
ii. Differentiate between those impacts that are insignificant and those that are significant; and
iii. Apply mitigation hierarchy measures for the identified significant and 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.

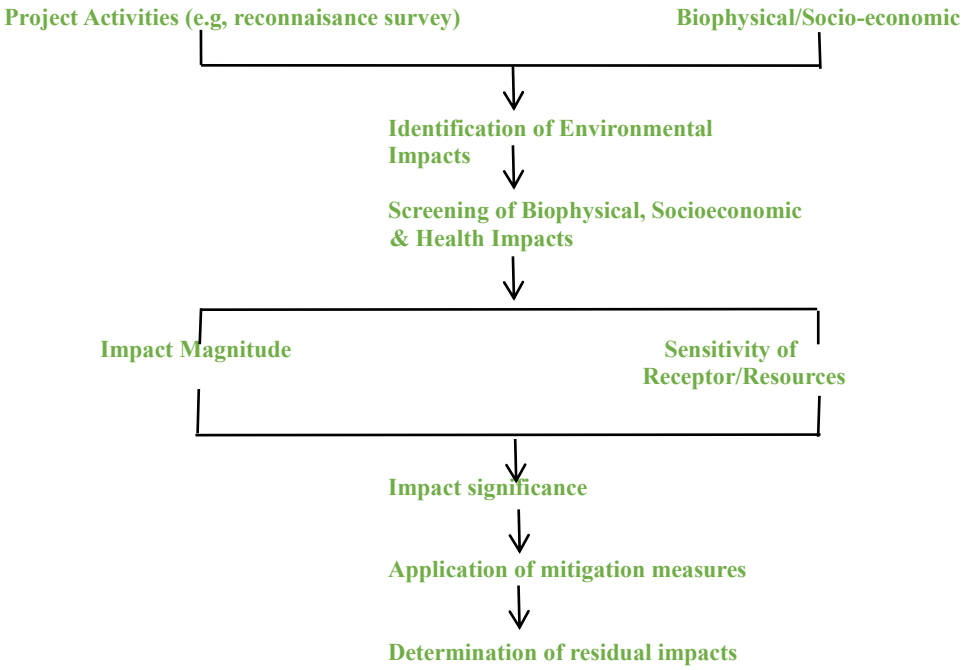

Figure 5.1: Overview of the Impact Assessment Process

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:

i. Interact with the existing natural environment including its physical and biological elements;
ii. Interact with the existing socio-economic environment; and
iii. 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.

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 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:

i. Knowledge of the project activities as summarized in Table 5.1.
ii. 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 5.2.
iii. Consultation with relevant stakeholders including potentially affected community
iv. Review of other EIA reports on similar projects/environments.
v. Series of experts group discussions, meetings and experience on similar projects.

Table 5.1: Summary of 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***	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
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

Table 5.2: Resource and Impacts Indicators Considered

S/N	Environmental Receptor/Medium	Comment	Impact Indicators
	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 environs.	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 environment.	Decrease in underground water/aquifer reservoir level; groundwater contamination.
	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 environs.	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 environs.	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 environment.	Changes in demography, gender ratio, age distribution, socioeconomic structure, etc. of the local community.
	Utilities	The existing utilities (e.g. power supply, water, sewer services, etc.) in the Project's environment.	Changes in existing utilities; potential damage to public utilities.
	Infrastructure	The existing infrastructure such as road, waste handling facilities, etc. within the project's environment.	Potential damage to road infrastructure; road traffic and accidents; increased pressure on waste management facilities.
	Employment/income	The employment situation in the Project's environment.	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; discrimination, etc.
Other (Health and Safety)			
	Construction workers	Health and safety of	Accident, injury, fatality,

		construction workers.	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.

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:

i. Impact Magnitude which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency;
ii. Value/Sensitivity/Fragility and importance of the relevant Receptor;
iii. 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:

i. Legislative controls;
ii. Designated status within the land use planning system;
iii. Number of affected individual receptors;
iv. An empirical assessment based on characteristics such as rarity or condition;
v. Ability of the resource or receptor to absorb change; and
vi. 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), aspect, population or species (biological) and at sufficient magnitude to cause a significant measureable numerical increase in measured concentrations or levels (when compared with national or international limits and standards specific to the receptors) or a decline in species abundance

beyond which natural process would not return that population or species, to its former level within several generations.

A *Medium Magnitude Impact* 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 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 5.3 below presents the impact magnitude criteria for socio-economic and health impacts.

Table 5.3: Impact Magnitude Criteria for Socio-economic Impacts

S/N	Category	Ranking	Definition
1	***High***	4	i. Major impacts on human health (e.g. serious injury). ii. Significant impact on the livelihoods of individuals (i.e. access to income source restricted over lengthy period of time). iii. Serious impact on access to community facilities and utilities iv. Breach of economy social policy and/or regulation.
	Medium	3	i. Modest impact on human health and well-being. ii. Moderate impact on individual livelihoods (e.g. restricted access to income source). iii. Medium impact on access to community facilities and utilities (e.g. access to utilities restricted for long periods (weeks) of time). iv. Potential breach of company social policy and/or legislation.
	Low	2	i. Limited impact on human health and well-being (e.g. occasional dust, odour, traffic noise). ii. Some impact on the livelihoods of individuals (e.g. isolated incidents related to ethnic tensions and some

			restrictions on access to income source). iii. 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	i. Possible nuisance to human health and well-being (e.g. occasional unpleasant odours) ii. Inconvenience experienced in accessing community facilities and utilities (e.g. electricity supply disruption for short (hours) period of time). iii. No impact on livelihood, community facilities and human health.
	Positive	+	i. Beneficial improvement to human health. ii. Benefits to individual livelihoods (e.g. additional employment opportunities). iii. Improvements to community facilities/utilities. iv. 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:

i. 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.
ii. 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.
iii. 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 socioeconomic receptors are defined in Table 5.4.

Table 5.4: Bio-physical and Socio-economic Receptor-Sensitivity/ Fragility/Value Criteria

S/N	Category	Ranking	Definition
Physical			
	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			
	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.

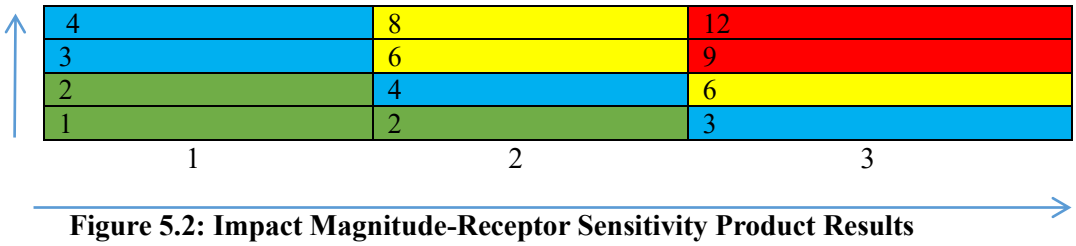

Figure 5.2: Impact Magnitude-Receptor Sensitivity Product Results

Whereas ↑ is impact magnitude, while ⟶ is Receptor sensitivity/Fragility/Value/Importance.

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 5.5 below.

Table 5.5: 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.

5.5 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. Also, the installation of streetlights as part of the proposed project will boost safety and security within the University. In addition, the project will improve social economic activities within the University and help to enhance internally generated revenue. Furthermore, there are employment opportunities associated with the proposed project for skilled, semiskilled

and unskilled workforce. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spillover effects. For example, during the construction phase, about 3,000 workers probably would be engaged. The larger portion (60%) of the workforce (especially semiskilled 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:

i. Potential impact of the proposed 3.0MW solar-hybrid power plant and associated infrastructure
ii. 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 Six of this report) are expected to further reduce the impact rating as low as reasonably practicable.

5.5.2.1 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:

i. Site selection
ii. Site clearing and preparation
iii. Mobilization of equipment and materials to site

Site Selection

Approximately 5.0ha of land within FUT Minna campus has been allocated by the University management for the proposed ------- MW solar-hybrid power plant. No additional land take, either from a private or public property outside the University will be expropriated for the project. At the time of site visit, about 60% of the entire project site was being used for farming by students/staff of the University and some members of the community within the surroundings of the University. The exact number of persons involved could not however be established at the time of visit. The crops planted include yam, maize, and vegetables.

The discussion with the University management indicates that the persons affected will be given adequate time to harvest their crops prior to commencement of construction activities, and alternative farmland within the University will be provided for them upon the fulfillment of official procedure in farmland allocation . Therefore, the impact significance of site selection for the proposed Project on the existing land use is rated moderate.

Site Clearing and Preparation

The Project site will be cleared of vegetation prior to construction activities. The site clearing activities would involve the use of earth moving equipment such as 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 associated with the proposed project will lead to loss of terrestrial flora on the project site. The potential impact on the terrestrial flora is considered to be negative, direct, site specific and largely irreversible. The impact magnitude on the terrestrial flora is considered to be medium considering the size of the site (5.0ha) 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 fauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species (including fauna) encountered or reported in the project site belongs to the IUCN classification of threatened animal species. The fauna species observed on the site were mostly small animals, insects, and birds. 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 5.0ha of land. The impact significance is considered minor.

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

With regard to the clearing of the project site for construction purpose, the potential impact on terrestrial fauna species may include loss of individual or localized population of fauna species or disturbance to fauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species (including fauna) encountered or reported in the project site belongs to the IUCN classification of threatened animal species which include those classified as critically endangered, endangered or vulnerable. The sensitivity of the fauna species recorded on the project site is thus regarded as low. The impact magnitude is considered to be medium given that the site clearing activities would cover approximately 5.0ha of land. The impact significance is thus considered minor**.**

Potential Impact on Soil

The proposed site clearing and preparation activities could potentially impact the soil environment of the project site. The potential effects on soil include degradation due to site preparation e.g. compaction of 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 over disturbance areas will negatively affect soil formation, moisture levels, soil density, soil chemistry, and biological activity. Uncontrolled site clearance of vegetation could lead to direct surface soil exposure and hence erosion of soil which could be significant.

The impact magnitude is considered as medium as the extent of soil erosion could be high, especially if the site clearing activities are carried out in the wet season. However, based on the results of laboratory analysis conducted on soil samples from the project area, the project site is not considered to be significantly prone to land based erosion. The soil texture analysis of soil samples collected at the project site and its surrounding environment showed high percentage of clay followed by sand and then silt. Thus, the impact significance of site clearing on soil environment of the study area is considered minor.

Potential Impact on Air Quality and Ambient Noise

The pollutants which could impair air quality during site clearing activities are particulate matter in form of dust, and NOx, CO, Total Suspended Particulates (TSP), SOx from combustion engines of the earth moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is 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 concentrations of air pollutant criteria beyond the FMEnv, WHO, and the World Bank Ambient Air Emission Limits were recorded in the Project site and its surrounding environment. The impact significance of site clearing on the ambient air environment of the project site is considered to be minor.

Potential Impact on Workers Safety

Site clearing and preparation are potentially hazardous activities. Accidents may occur especially when those involved are unskilled. Such accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. The site clearing activities will take less than 1 week and the number of workers required would be less than five (5). The impact significance is considered to be 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.

It is anticipated that the potential impacts will be similar to those experienced during site clearing activities. The capacity for assimilation of vehicular emissions and dust associated with the mobilization activities in the project's environment 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 accident, 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 cars, followed by buses and motorcycles, while trucks are also common. 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. It is expected that the potential impacts will be similar to those experienced during site clearing and preparation activities. The impact significance is considered to be minor.

Summary of Potential Negative Impacts Associated with Pre-Construction Phase

Table 5.6 below summarizes the potential impacts associated with the pre-construction phase of the proposed project.

Table 5.6: Summary of Potential Negative Impacts Associated with the Pre-Construction Phase of the proposed project

S/N	Activity	Receptor	Associated Impact	Significance
	Site Selection	Land use	Loss of agricultural research farmlands	Moderate
	Site clearing and preparation	Terrestrial flora and fauna	i. Vegetation loss ii. Direct impacts on vegetation and soild welling organisms; indirect impacts on fauna species in the immediate surroundings of the project site	Minor
		Soil	i. Loss of top soil ii. Soil compaction and degradation iii. Increased erosion potential iv. Reduction in structural stability and percolative ability of soil	Minor
		Air Quality and Noise	i. Air quality impacts due to emission from site clearing equipment ii. Increase in ambient noise levels	Minor
		Workers Safety	Injuries and accidents to workers during site clearing and reparation.	Minor
	Mobilization of construction equipment and materials to site	Air Quality and Noise	i. Air quality impacts from vehicular emissions (TSP, NOx, CO, SOx) ii. Increase in noise levels	Minor
		Infrastructure (road)	Increase in vehicular movement and traffic including potential for road accident	Minor
		Workers Safety	Injuries and accidents to workers during loading and offloading of construction materials.	Minor

5.5.2.2 Construction Phase

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

Potential Impact on Air Quality

Air quality could be impacted due to dust generation from earth moving equipment and emissions (like SO_2, TSP, CO, NOx, 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 surrounding environment 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.The potential source of noise during the construction phase of the project will 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 3dB(A) at the nearest receptor location offsite (e.g. existing electric sub-station 100m away). The potential impact magnitude is regarded as medium considering that the construction activities may take up to about 12 months. The impact significance prior to mitigation is rated moderate**.**

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 and installation activities. These activities also have the potential to increase siltation as a result of accelerated erosion. The impact magnitude is considered to be medium considering that foundation works would only be required for the proposed training centre while the trenching for the underground power evacuation cable to be installed would be minimal. The sensitivity of the soil environment of the project area is considered to be low based on the laboratory results. No evidence of heavy metal and/or hydrocarbon pollution was recorded in soil samples from the project area. Thus, 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 fauna. 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 fauna species based on desktop reviews and field observation. The impact significance is regarded as minor.

Potential Impact on Hydro-geology and Groundwater Quality

The construction activities could lead to potential impacts on hydro-geology of the project area. These include increased sediment load in the drainage channels as a result of erosion; increased storm water runoff from a decrease in infiltration; and increased runoff from hard standing areas.

Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles and/or storage containers. Currently, there are no boreholes within the project site and the nearest borehole to the project is over 300m away. The results of laboratory analysis conducted on groundwater samples from existing boreholes in the project area did not reflect any heavy metal and hydrocarbon pollution. It is not anticipated that construction activities will have any direct impacts on the underground aquifer in the project area. Therefore, the potential for groundwater contamination as result of construction activities is rated minor**.**

The potential impact on the existing underground aquifer (water reserve) of the project area as a result of water abstraction for construction activities such as concrete mixing and washing of construction equipment is considered to be negligible since the use of water for construction activities would be minimal. There are several boreholes within the University campus as noted during the site visit. The recharge of the existing boreholes in the project 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.

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 due to lack of adequate training, thereby reinforcing gender stereotypes and gender pay gaps. Furthermore, there is the possibility of gender-based violence cases (GBV) against women employed to work at the Project site. However, FGD with the women in the local community revealed that GBV incidents have been reported within the community. They also stated that there are systems (traditional, religious, and state) in place to address such cases. Therefore, the sensitivity to gender impacts is rated low and 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 the influx of workers to the community for 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. Additional ressure may also be placed on existing social infrastructure. Considering that the proposed number of workers (approximately 3,000) 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 amount of project vehicles and trucks that will be used during the construction Phase. 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 schedule date of completion of the project development especially if the man-hour losses are high. Potential impacts to construction workers include increase in noise level and air emissions from construction activities, injuries, electrical shocks, accident, and denial of rights. The impact significance is considered moderate.

Waste Generation and Disposal

Potential Impact on Soil

Construction activities are associated with waste generation. The potential wastes to be generated during the construction phase of the project include scrap metals, electrical cables, spent oils, damaged batteries, wood/planks, paper waste, food remnants, leftover sand and gravel, etc. The waste streams if not properly handled, could contaminate the soil environment within the project site and its surrounding environment. The impact sensitivity of the soil environment of the project area is low judging by the results of laboratory analysis conducted on the soil samples. 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; the nearest existing groundwater source to the project site is approximately 150m away. The impact sensitivity is medium because the groundwater is a major source of potable water within the project environs. The potential for groundwater contamination as result of waste disposal is rated minor.

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 FUT Minna are collected by the Environmental Unit and taken to designated dumpsites outside the University. General wastes such as packaging materials and refuse will be collected and sorted on site before disposal by the Environmental Unit. However, as part of the project design, construction wastes such as scrap electrical components, batteries, damaged/defective PV panels are planned to be returned to the manufacturers based on a take-back scheme or local recycling companies (approved by regulatory authorities) for proper recycling. The

quantity of domestic wastes to be disposed of would be minimal. Thus, the impact of construction wastes disposal on the waste management facility of the project area is considered negligible.

Summary of Potential Negative Impacts Associated with Construction Phase

Table 5.7 below summarizes the potential negative impacts associated with the construction phase of the proposed project.

Table 5.7: Summary of Potential Negative Impacts Associated with the Construction Phase of the proposed Project

S/N	Activity	Receptor	Associated Impact	Significance
1	Civil and Electrical Works/Installation Activities	Air Quality	i. Air quality impacts due to emission from construction equipment (SPM, NOx, CO, SOx) ii. Increase in dust from cleared land and windblown stockpiles	Minor
		Ambient Nosie	Increase in noise level due to construction activities	Moderate
		Soil	i. Increased erosion potential as a result of construction activities such as excavation ii. Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Minor
		Terrestrial Flora and Fauna	i. Loss of plant species as a result of introduction of alien plants which may prevent the natural recovery of the natural vegetation on the site and power evacuation route. ii. Loss of fauna as a result of increased human activity and associated noise.	Minor
		Groundwater	Decrease in groundwater aquifer as a result of groundwater abstraction for construction activities e.g. concrete mixing, equipment washing, etc.	Negligible
		Gender	i. Discrimination of women during employment ii. GBV (sexual harassment, intimate partner violence, poor working conditions)	Moderate
		Socio-economic	Influx of people, increase in sexual transmitted diseases.	Moderate

		and health		
		Infrastructure (road)	Road damage, traffic and safety impacts.	Minor
		Construction Workers safety	Injury to construction workers during construction activities.	Moderate
2	Waste Generation and Disposal	Soil	Soil contamination from solid and liquid construction waste streams.	Minor
		Groundwater	Groundwater contamination of liquid construction waste streams.	Minor
		Infrastructure (waste management facility)	i. E-waste generation ii. Disposal of construction wastes to existing waste management facility in the Project area.	Minor

5.5.2.3 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 generally below the FMEnv recommended limits. Also, the nearest sensitive receptor to the Project site (female hostel) is approximately 200m away. 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 existing population and infrastructure (road) of the project area. Due to the short duration of the commissioning phase, the impacts are considered to be negligible.
Table 5.8 summarizes the potential negative impacts associated with the commissioning phase of the proposed project.

Table 5.8: Summary of Potential Impact Associated with the Commissioning Phase of the proposed project

S/N	Activity	Receptor	Associated Impact	Significance
1	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 Noise

The potential sources of noise during the Power Plant operations are inverters and batteries. Typically, the designed noise level from an inverter is approximately 30-35dB(A) while that of a battery is 15-20 dB(A). The associated noise levels from the inverters an batteries are not envisaged to result in a maximum increase in background levels of 3dB(A) at the nearest receptor location offsite (e.g. student's hostel located about 700 m away). The impact significance is considered to be negligible.

Potential Impact on Gender

Women have conventionally been under-represented in the energy sector; they are often marginalized from many power sector employment and training opportunities. There is a potential that this situation may come to play during the operations phase of the project as women may experience discrimination during employment and training opportunities. Also poor working conditions and GBV issues such as sexual harassment, intimate partner violence, assault (physical and psychological), are likely to arise during operations. Although the number of personnel working at the project site would reduce, the likelihood of impacts predicted during the construction phase still exists. Therefore, the impact significance is rated 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.

Regarding EMF radiations, Solar PV panels, inverters, batteries, and other components that make up solar PV arrays produce extremely low frequency EMF when generating and transmitting electricity. To protect the general public from health effects from short-term high level magnetic fields, the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 2010) advised an exposure limit for extremely low frequency magnetic fields at 2000 mG (milligauss – the unit used to measure magnetic field strength). Solar PV panels produce low levels of extremely low frequency (ELF) EMF, with measured field strengths of -1mG. The measured EMF level decreases as the distance from the PV panel increases (Chang and Jennings, 1994).

Research has 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 workforce.

Routine Maintenance, Waste Generation and Disposal

Potential Impact on Soil

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

Potential Impact on Groundwater

Potential impacts may include decrease in amount of groundwater reservoir as a result of water abstraction for cleaning of the PV panels. Cleaning of the PV panels is envisaged to be carried out at least three (3) times during the dry season. Based on previous experience, each panel would require approximately 5-10litres of water per cleaning cycle. The water required for the cleaning purpose would be obtained from the existing boreholes within the University campus. 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 serious effect on the existing groundwater aquifer of the project area as well as the local water use. Thus, the impact significance is considered minor.

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 FUT Minna 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.) will not be disposed of in such manner. These wastes shall be returned to the manufacturers based on a take-back agreement or handled by licensed waste contractors. Other categories of waste such as office and domestic wastes that will be generated during operations will be handled by FUT Minna 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 FUT Minna is considered minor.

Potential Impact on Occupational Health, and Safety of Workers

During routine maintenance, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries). The impact significance is considered to be minor primarily due to the low number of staff.

Summary of Potential Negative Impacts Associated with Operation Phase

Table 5.9 below summarizes the potential negative impacts associated with the operational phase of the proposed project.

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

S/N	Activity	Receptor	Associated Impact	Significance
1	Power Generation and distribution	Noise	Noise from batteries and inverters during power generation and evacuation	Negligible
		Gender	i. Discrimination during employment and training opportunities ii. GBV (sexual harassment, intimate partner violence, poor working conditions)	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	i. Electric shock, injuries to personnel associated with the Power Plant operations, ii. Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions	Moderate
2	Routine Maintenance, Waste Generation	Soil	Soil contamination from spent batteries and inverters	Minor
		Groundwater	Groundwater abstraction from cleaning of PV panels	Minor
		Infrastructure (waste management facility)	i. E-waste generation ii. Waste disposal to existing waste management facility within the Project area	Minor
		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. 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 farmland, 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:

i. Identification of hazards/risks
ii. Likelihood of occurrence
iii. Consequence/severity of the hazards

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

Likelihood of occurrence	***Severity of potential damage/injury***			
	Negligible	*Marginal*	*Critical*	*Catastrophic*
Certain	*High*	*High*	*Extreme*	*Extreme*
Likely	*Moderate*	*High*	*High*	*Extreme*
Posible	*Low*	*Moderate*	*High*	*Extreme*
Unlikely	*Low*	*Low*	*Moderate*	*Extreme*
Rare	*Low*	*Low*	*Moderate*	*High*

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 marginal consequence. The hazard is classified as moderate 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.

5.6.2.4 E-waste and End of Life Battery Disposal

E-waste and battery waste are well known to be a challenge in many developing countries and emerging economies; especially within in many urban areas where collection and recycling are often conducted by unqualified persons with little regard to emission control and impacts on human and environmental health. The OHS impacts on workers handing battery recycling, un-certified facilities, inadequate waste disposal practices are high. The probability of this risk and hazard is rated high because solar components are not readily recycled (refurbished) in Nigeria. Management of Li-ion battery technologies are still in the infancy if any in Nigeria. Most Li-ion batteries especially those used in mobile phones and other hand held devices are disposed with municipal solid wastes. Also, unusable components from solar products are usually disposed of with municipal solid wastes for open burning (Magalini *et al*., 2016). This results in the release of toxic chemicals to the environment. The hazard is classified as high 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

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 all 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 outlined for this study:

i. Anticipate and avoid risks and impacts;
ii. Where avoidance is not possible, minimize or reduce risks and impacts to acceptable levels;
iii. Once risks and impacts have been minimized or reduced, mitigate;
iv. 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 option

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

xiv. Only PV modules which comply with international and local standards for electrical performance and safety shall be used.
xv. Only solar cables suitable for outdoor applications and severe weather conditions shall be used
xvi. Inverters shall not be mounted on combustible walls such as wood panels or combustible sandwich panels
xvii. Inverters shall be easily accessible and protected from severe weather conditions.
xviii. The local fire department shall be informed of and familiarized with the photovoltaic installation.
xix. PV systems shall only be installed by qualified contractors.
xx. PV systems shall be inspected regularly by qualified professionals.
xxi. PV systems shall be regularly checked for damage from rodents and other pests, which could compromise wiring or insulation.

xxii. Batteries installed for the power plant shall be monitored regularly to prevent overcharging and deep discharging during operations
xxiii. 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
xxiv. The batteries shall be housed in well ventilated, dust free containers under optimal conditions.
xxv. Emergency response plan shall be developed and implemented.
xxvi. Fire extinguishers, fire notices, warning signs) shall be installed at different locations within the Plant site.

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

Occuparional Hazard
v. Provision of an adequate work-positioning device system for workers shall be ensured.
vi. Hoisting and lifting equipment shall be rated and maintained and operators trained in their use.
vii. Appropriate Personal Protective Equipment shall be worn.
viii. 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:

i. 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.
ii. 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.

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:

i. Power distribution priority shall be given to all classrooms, lecture theatres, research centers, libraries, laboratories, and other academic buildings especially during learning hours.
ii. 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 3,000 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:

i. 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.
ii. 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.
iii. The EEP Gender Action Plan shall be implemented to ensure that the project does not increase women's burden and that women not only contribute, but also benefit from it.
iv. 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. Some persons 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 expenditure framework to enhance this potential opportunity.

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

S/N	Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Pre-construction Phase						
1	Site selection	Land use	Loss of agriculture research farmlands	Moderate	i. Livelihood Restoration Plan (LRP) shall be developed and implemented in consistent with Involuntary Resettlement Instruments for the affected persons ii. The affected students shall be notified about the land take and given ample time to harvest their crops before commencement of construction activities iii. FUT Minna management shall provide a letter of commitment signed by the Vice Chancellor to provide alternative sites for the affected land users iv. All affected persons on the site shall be provided with alternative land within the main campus to continue their activities.	Minor
	Site clearing and preparation	Terrestrial flora and fauna	i. Vegetation loss ii. Direct impacts on vegetation and soil-dwelling organisms; indirect	Minor	i. To avoid the direct impacts of vegetation loss, Vegetation clearing shall be limited to the areas within the site needed for the Project. ii. The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing	Negligible

			impacts on fauna species in the Immediate surroundings of the project site		exceeding the approved working corridor shall be prohibited. iii. Bush burning shall be avoided. iv. Use of herbicides for site clearing shall be avoided. v. Any cleared areas which are not used will be revegetated using plants or seeds of locally occurring species. vi. Hunting or deliberate killing of animals by workers shall be prohibited and monitored. Workers shall be sensitized on ecological protection.	
		Soil	i. Removal of top soil and soil compaction associated with site clearing ii. Loss of top soil iii. Increased erosion potential iv. Reduction in structural stability and percolative ability of soil	Moderate	i. Removal of vegetation and soil cover shall be restricted to the areas required for the Project. ii. Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas. iii. Disturbed areas will be rehabilitated as soon as possible to prevent erosion. iv. The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. v. Clearing exceeding the approved working corridor shall be prohibited. vi. Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	Minor
		Air quality and noise	i. Air quality impacts due to emission from site clearing equipment	Minor	i. Site clearing equipment / machinery shall be operated and maintained under optimum fuel efficient conditions. ii. Noise suppression equipment shall be fitted on machinery.	Negligible

			ii. Increase in ambient noise levels		iii. Site clearing activities shall be carried out only during the daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr) iv. Equipment/machinery with lower sound power levels shall be selected and used for site clearing. v. A procedure for receiving and addressing noise complaints shall be developed and implemented	
		Workers Safety	Injuries and accidents to workers during site clearing and preparation.	Minor	i. Site clearing shall be limited to the day time as much as possible (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr) ii. Labourers and touts no hired shall not be engaged for off-loading materials iii. Provision of adequate personal protective equipment (PPE) such as nose masks shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.	Negligible
	Mobilization of personnel, materials and equipment to site	Air quality and noise	i. Air quality impacts from vehicular emissions ii. Increase in ambient noise levels	Minor	i. 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. ii. All materials with potential to result in dust emissions shall be covered during transport. iii. Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h so as to reduce dust	Negligible

					generation.	
		Infrastructure (road)	Increase in vehicular movement and traffic around the project site;	Minor	i. A traffic management plan (TMP) shall be developed by the EPC Contractor and implemented. ii. Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided. iii. The local community shall be sensitized about the project activities and the need to comply with the traffic management plan put in place. iv. Project related vehicles shall be regularly serviced and maintained. v. 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. vi. 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.	Negligible
		Workers Safety	Injuries and accidents to workers during loading and offloading construction	Minor	i. Mobilization of materials shall be limited to the day time as much as possible (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr) ii. Provision of adequate PPE especially gloves and hard hats to workers shall be	Negligible

					ensured. All employees will be required to wear the appropriate PPE whilst performing their duties. iii. Labourers and touts not hired shall not be patronised for off-loading materials. iv. The site shall be secured with perimeter fencing and/or security. v. Separate sanitary amenities and potable water facilities for men and women shall be provided	
Construction Phase						
	Civil and Electrical Works/ Installation Activities	Soil	i. Increased erosion potential as a result of construction activities such as excavation ii. Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Minor	i. Excavation works shall not be executed under aggressive weather conditions. ii. Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion. iii. Disturbed areas shall be rehabilitated with erosion control plants (using native plant species) as soon as possible to prevent erosion. iv. Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.	Negligible
		Air Quality	i. Air quality impacts due to emission from construction	Minor	i. Regular maintenance and servicing of construction equipment /machinery shall be ensured. ii. Only modern and well maintained	Negligible

			equipment ii. Increase in dust from cleared land and windblown stockpiles		equipment and machinery shall be used for construction activities. iii. Routine water sprinkling shall be carried out to minimize dust generation during construction.	
		Ambient Noise	i. Increase in noise level due to construction activities; ii. Disturbance to Neighbouring community and local ecology	Minor	i. 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. ii. Construction machinery shall be turned off when not in use. iii. Machinery/equipment to be used for construction work shall meet industry best standard in relation to noise attenuation. iv. Construction equipment shall be properly maintained and serviced. v. Major construction activities shall be limited to a particular area within the site. vi. Construction-related vehicles shall be limited to access areas. vii. Noise complaints related to the construction activities shall be assessed and appropriately addressed. viii. Noise monitoring at locations with persistent noise complaints shall be maintained.	Negligible

		Terrestrial Flora and Fauna	i. Loss of plant species as a result of introduction of alien plants which may prevent the natural recovery of the natural vegetation on the site. ii. Loss of fauna as a result of increased human activity and associated noise.	Minor	i. Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities. ii. All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimize introduction of alien species. iii. 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. iv. Regular monitoring will be undertaken to ensure that alien plants are not increasing as a result of the disturbance that has taken place. v. Hunting or deliberate killing of animals by construction workers shall be prohibited and monitored. vi. 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.	Negligible
		Infrastructure (Road)	Road damage, traffic and safety impacts.	Minor	i. A Trafic Management Plan (TMP) shall be developed by the EPC Contractor and implemented. ii. Speed limits for all construction-related vehicles shall be established and enforced. iii. Construction related vehicles shall be regularly serviced and maintained.	Negligible

					iv. Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active. v. Drivers' competency shall be assessed and where required training shall be provided. vi. 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. vii. 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 damages as quickly as possible.	
		Gender	i. Discrimination during employment and training opportunities ii. GBV (sexual exploitation, sexual harassment, intimate partner violence, poor working conditions)	Moderate	i. The EEP GBV Action Plan shall be implemented for the Project ii. All workers on the project shall be required sign a code of conduct (CoC) to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) iii. GBV sensitive channels for reporting in GRM shall be implemented for the Project iv. The EPC Contractor shall be required to hire a Social and Gender officer. v. Collaboration with appropriate	Minor

					government institutions or GBV service providers on potential GBV case management shall be ensured. vi. All workers shall be required to undergo regular training and refreshers on GBV vii. The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site. viii. 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.	Moderate	i. Health and Safety Plan shall be developed and implemented by the EPC Contractor. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence ii. Construction workers shall be sensitized and monitored on the need to be safety conscious. iii. Daily toolbox talks prior to commencement of work activities shall be carried out. iv. Construction activities shall be limited to daytime as much as possible. v. Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules. vi. Proper safety signs and signage shall be placed at strategic locations within the site.	Minor

					vii. 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. viii. Safety training focused on safe working practices, information on specific hazards, first aid and firefighting shall be included in the induction programme for workers. ix. A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented. x. The site shall be secured with perimeter fencing and/or security. xi. Sanitary amenities and potable water shall be provided	
		Socio-economic and health	Influx of people, increase in sexual Transmitted disease	Moderate	i. Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible. ii. 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 iii. Any child dropout should be reported to the relevant government agency iv. The local community shall be informed of the Project activities prior to commencement of work. v. An induction and sensitization programme, including a Code of	Negligible

					Conduct, for all construction workers shall be carried out prior to construction activities. This will 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. vi. Awareness education about GBV/SEA/HIV/AIDS and other sexually transmitted diseases shall be created among the workforce and extended to the local community. vii. The CoC shall include provisions to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse by workers within the local community. viii. Public access shall be restricted to construction area via security fencing and appropriate signage. ix. Substance abuse prevention and management programs shall be implemented for workers. x. Sanctions (e.g., suspension and dismissal) shall be introduced for workers involved in criminal activities xi. Procedure for receiving and addressing community concerns shall be developed and implemented.	
	Waste Disposal and Generation	Infrastructure (waste management	i. E-waste generation ii. Disposal of	Minor	i. A Waste Management Plan shall be developed by the EPC Contractor and implemented	Negligible

		facility)	construction wastes to existing waste management facility in the project area.		ii. Training shall be provided for workers on safe storage, use and handling of e-waste on site. iii. E-wastes generated shall be stored in appropriate locations set up at the Project site prior to recycling and/or disposal iv. Waste receptacles shall be provided within a secured area for collection of solid waste. v. Construction vehicles and equipment shall be serviced regularly.	
		Soil	Soil contamination from solid and liquid construction waste streams.	Minor	i. Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. ii. Portable spill containment and clean-up kits shall be available onsite. iii. 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	i. Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site. ii. Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. iii. Portable spill containment and clean-up kits shall be available onsite.	Negligible

					iv. Waste management plan (WMP) shall be developed and implemented. v. Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. vi. Construction waste, as much as practicable, shall be reused or recycled. vii. 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	i. The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ii. Strict compliance to the Standard Operating Procedures shall be ensured. iii. The inverters and batteries to be used for the project shall meet industry best standard in relation to noise attenuation.	Negligible
		Workers	Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Moderate	i. Plant testing shall be carried out by experienced personnel. ii. Adequate PPE shall be worn. iii. The Project components shall be installed in line with the pre-established standards and as per manufacturer recommendations. iv. The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project v. Strict compliance to the Standard Operating Procedures (SOPs) shall be	Negligible

					ensured. vi. Prior to the Plant commissioning, appropriate emergency equipment (such as first aid box, fire extinguishers) shall be provided onsite. vii. Plant testing shall be restricted to the daytime. viii. Sanitary amenities and potable water shall be provided	
		Campus Occupants' safety	Wrong electrical connection leading to explosion/fire.	Minor	i. Strict compliance to the SOPs shall be ensured. ii. Prior to the Plant commissioning, appropriate emergency equipment (such as first aid box, fire extinguishers) shall be provided onsite. iii. Plant testing shall be restricted to the daytime.	Negligible
Operational Phase						
	Power Generation and Evacuation	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 such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage will be used.	Negligible
		Health, safety and welfare of staff during Plant operation	i. Electric shock, injuries to Personnel associated with the Power Plant operations, ii. Work related issues such as	Moderate	i. Appropriate PPE shall be provided for workers. ii. Training shall be provided to employees on emergency preparedness and responses. iii. Provision of medical insurance scheme for employees shall be ensured. iv. Appropriate safety signage shall be	Negligible

			discrimination, denial of rights, unfair treatment, poor working conditions		placed at strategic locations within the site. v. Strict compliance to the SOPs / code of conduct shall be ensured. vi. A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.	
		Gender	vii. Discrimination During employment and training opportunities viii. GBV (sexual harassment, intimate partner violence, poor working)	Moderate	i. Equal treatment of workers shall be ensured. ii. Continuous implementation of the GBV Action Plan for EEP shall be sustained for the Project iii. 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) iv. GBV sensitive channels for reporting in GRM shall be implemented for the Project v. The O&M Contractor shall be required to hire a Social and Gender officer. vi. Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained. vii. All workers shall be required to undergo regular training and refreshers on GBV viii. The O&M Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site.	Negligible

					ix. All gender-based violence incidents shall be reported and dealt with as per the law.	
	Routine Maintenance, Waste Generation and Disposal	Infrastructure (waste management facility)	i. E-waste generation ii. Waste disposal to existing waste management facility within the project area	Minor	i. A Waste Management Plan shall be developed by the O&M Contractor and implemented ii. Training shall be provided for workers on safe storage, use and handling of e-waste on site. iii. E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal iv. Waste receptacles shall be provided within a secured area for collection of solid waste.	Negligible
		Soil	Soil contamination from spent batteries and inverters	Minor	i. General housekeeping to ensure the site is not overgrown with grasses shall be maintained ii. General waste bins shall be provided at designated locations on site for temporary storage of different waste streams. iii. General waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. iv. WMP shall be developed by the O&M Contractor and implemented. v. Burning of waste shall be prohibited. vi. Damaged/expired Lithium ion batteries, solar panels, inverters and electric components shall be returned to the manufacturer based on the EPR model. Prior to returning them to the	Negligible

					manufacturers, they will be stored on impermeable surfaces within the site.	
		Health, safety and welfare of staff during maintenance	Electric shock, injuries to personnel during maintenance	Minor	i. Appropriate PPE shall be provided for workers. ii. Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. iii. Strict compliance to the SOPs shall be ensured.	Negligible
		Groundwater	Groundwater abstraction from cleaning of PV panels	Minor	i. Water management plan shall be implemented ii. 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. iii. Periodic monitoring of groundwater resources in the Project's area of influence shall be implemented.	Negligible

CHAPTER SEVEN
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Overview

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

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

7.2 Objectives of the ESMP

The key objectives of the ESMP are to:

Ensure the effective implementation of all mitigation measures identified in this ESIA;

Promote compliance with applicable national environmental regulations and relevant international standards, including those of the Federal Ministry of Environment and the African Development Bank;

Establish a monitoring framework to track environmental and social performance using clearly defined and measurable indicators;

Promote community health and safety through effective management of project-related risks;

Ensure transparent stakeholder engagement and provide mechanisms for addressing grievances;

Promote fair and inclusive employment practices, including equal opportunity for qualified individuals;

Facilitate capacity building through training, awareness, and continuous supervision of project personnel; and

Provide a basis for corrective actions and continuous improvement in project implementation.

7.3 Scope and Content of the ESMP

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

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

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

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 be serviced before	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)

ctivities	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)
		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)	
	Vegetal waste from clearance can deface the environment	Implement site-specific waste management plan in Annex in conjunction with Kaduna State Environmental	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	

ctivities	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)
		Protection Agency for effective waste management and safe handling/disposal of waste.									
	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 limit/parking zone		Absence of spillages Satisfactory Soil quality test	Project camp sites and equipment packing zones	Monthly	SC & REA-ESO	
	Construction material vehicle. Noise level above permissible noise level, (60dB and 50dB for day and night respectively)	Ensure transportation SCheduling for construction materials, equipment and vehicle. off peak hours/ weekends when it will cause	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 o routine REA monitoring)

ctivities	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)
	[1] during movement can disturb the community	least disturbance. Retrofit machines with sound proofing devices.									
	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; 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)	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

ctivities	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)
	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 o routine REA monitoring)
ite econnaiss nce, urveys nd nvestigati ns	Slips, trips, falls, snake bites, insect bites, minor injuries and exposure to difficult terrain	Conduct site-specific risk assessment; provide appropriate PPE (safety boots, reflective vests, gloves); ensure workers are briefed on hazards; maintain first aid kits on site; implement buddy system for fieldwork	Contractor/Survey Team	300,000	Number of incidents and near misses; PPE availability and usage; number of safety briefings conducted	Site inspection; incident reports; PPE records; toolbox talk records	Zero fatalities; 100% PPE compliance; no lost-time injuries	Survey routes and project site	Weekly during surveys	REA-ESO, Project Engineer	150,000
ransporta ion of ersonnel o and from ite	Road traffic accidents, injuries, fatalities	Use licensed drivers and roadworthy vehicles; enforce speed limits; prohibit use of mobile phones while driving; conduct defensive	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

ctivities	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)
		driving training; maintain journey management plan									
Mobilizatio of quipment nd Materials	Crush injuries, struck-by incidents, manual handling injuries	Develop lifting and handling procedures; use trained personnel; establish traffic management measures; inspect lifting equipment; provide PPE	Contractor	400,000	Number of lifting incidents; PPE compliance; equipment inspection status	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
Worker nduction nd Pre-Mobilizatio 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
stablishm nt of emporary ite acilities nd Offices	Fire hazards, electrical hazards, poor sanitation, occupational illnesses	Provide fire extinguishers and emergency equipment; ensure safe electrical installations;	Contractor	500,000	Number of fire extinguishers available; sanitation facilities provided; housekeeping	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

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)
		provide potable water and sanitation facilities; maintain housekeeping standards			inspection scores						
Sub-Total				**3,880,000.00**							**1,050,000.00**
3. Social Impacts											
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	Mobilization of equipment at weekends. Laterite excavation sites	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

ctivities	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)
	noise and movement	should not be located near residential areas.									
	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 group/youth group to sensitize the community on	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

ctivities	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)
		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 o routine monitoring costs)
	Vulnerable groups (women, aged people, people living with disability) as identified will be at more disadvantage to social risks	Implement SEA/SH/GBV prevention measures. Provide access slabs where required and should be considered in the project	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 o routine monitoring costs

ctivities	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 disturbance to their movement	designs. Also, consult with these groups regularly to address any concerns relating to the project and educate them on the GRM channels									
	Physical and Economic displacement including temporary restriction within the perimeter of the site asides construction workers, suppliers. Compensation for Economic trees on the Land	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 i the RA report
		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	Recommended that the contractor hire semi to unskilled labour locally.	Contractor Supervising Consultant	Part of staf 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

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)
	local resources.	Contractor to provide amenities for workers									
	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
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 standard security arrangement
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											
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	

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)
	Surface soil excavation for foundation from Movement of heavy vehicles/Stationary vehicles and equipment	Creation of limit zones Rip compacted areas to reduce runoff and re-vegetate where necessary (every affected tree/shrub should be replaced by two (2)	Contractor	NA	Visible demarcation of vehicles and equipment limit zone	Visual observation Soil Compaction test	Visual observation Soil Compaction test	Project camp sites and equipment packing zones	Monthly	Supervising Consultant REA-ESO Project Engineer	Part of routine maintenance
	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

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)
	Excessive vibrations from operations of construction trucks	Ensure construction trucks are well maintained to prevent excessive vibrations caused by worn-out or malfunctioning parts.	Contractor	Built into Contractor's cost	Presence of affected buildings	Visual inspection	Machinery fitted with acoustic shield	Project areas	Monthly	Supervising Consultant REA-ESO	60,000.00
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	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)
		project design, and should be 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	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	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 Well stocked first aid box	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)
	Exposure to harmful chemicals	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		signs, tapes & barricades) 600,000.00 (first aid)							
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 hours/days/period	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)
		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
	Conflicts between contractor and	Good work enforcement program.	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

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)
	community members	Grievance Redress Mechanism (see Annex 11)									
	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	sure that children and minors are not employed directly or indirectly on the project.	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)
	Vulnerable groups as identified will be at more disadvantage to social risks and disturbance to their movement	lement 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**
OPERATION PHASE											

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)
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; maintain emission control systems	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
Fuel Storage and Handling	Fuel leakage, soil contamina	Store fuel in bunded areas with at least 110% containment	Mini-grid Operator	200,000	No evidence of spills; spill response	Site inspection	No visible Leakage on site	Generator /Fuel Storage Area	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)
	tion, groundwater pollution, fire risk	capacity; provide spill kits; train personnel in spill response; conduct routine inspections; implement fire prevention measures			equipment available						
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, Inverters, Distribution Lines)	Electrocution, electric shock, burns, public safety risks	Install warning signs; maintain fencing and restricted access; conduct routine inspections; implement Lock-Out/Tag-Out (LOTO) procedures; train operators and technicians	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)
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 households, female-headed households, persons with disabilities and other	Develop and implement an inclusive connection policy; conduct community sensitization on connection procedures; prioritize vulnerable households during connection rollout; maintain disaggregated customer database;	Mini-grid Operator	500,000	Number of connected households; percentage of low-income households connected; percentage of female-headed households connected; number of vulnerable households connected;	Review of customer records; household surveys; stakeholder consultations; grievance register review	≥80% of willing households connected within service area; ≥90% of access complaints resolved within specified timeframe; annual increase in vulnerable	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)
	vulnerable groups	establish grievance mechanism for access-related complaints			access-related complaints received and resolved		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 opportunities and community tensions	Ensure transparent connection procedures; monitor distribution of productive-use connections; support access for small businesses, women-led enterprises and vulnerable groups; periodically review beneficiary profile	Mini-grid Operator, Community Energy Committee	350,000	Distribution of customer categories; number of productive-use beneficiaries; proportion of women-owned and vulnerable-group enterprises benefiting; complaints relating to discriminatio	Customer database review; business beneficiary surveys; stakeholder consultations; grievance mechanism review	No substantiated cases of discrimination; equitable representation of vulnerable groups among beneficiaries; reduction in complaints relating to unequal access	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)
					n or preferential treatment						
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**

7.5 Roles, Responsibilities and Accountabilities

The Rural Electrification Agency Project Management Unit (NEP-PMU) supervises the implementation of the ESMP throughout the project life span while conformance with the mitigation measures will be ensured by the Engineering, Procurement and Construction (EPC) contractor during the construction phase and by the operations and maintenance (O&M) contractor during the operational phase of the project. Table 7.2 indicates the Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP.

Table 7.2: Institutional Roles & Responsibilities for ESMP Implementation

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

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

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

		• Contractors must assign at site, personnel in charge of Environment, health and safety procedure. • Compliance to BOQ specification in procurement of material and construction • Provide oversight function during construction and decommissioning

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7.6 Additional Management Plans

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

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

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

7.7 Monitoring and Evaluation Plan

The monitoring plan (Internal and External Monitoring) for the ESMP is presented in the Table 7.3 below. Monitoring results shall be documented with preventive/corrective actions to be implemented.

Table 7.3: Monitoring Plan for the ESMP

Monitoring	Action	Responsibility	Period	Performance Indicator
Internal Monitoring	Regular site visit to ensure that the mitigation measures and actions specified in the ESMP are implemented and as bound by the contract is satisfactorily implemented.	E&S team of the NEP PMU	During Preconstruction, Construction and Operation Phases	Monitoring Reports and documentation as described below
	Daily monitoring of the contractor performance and adherence to GBV/SEA/SH obligations	Supervision Consultant, GBV Specialist	During Preconstruction and Construction phases	Monitoring Reports presented to the PMU.

	Site visits for supervision and inspection to ensure contractor adhere strictly to the E&S requirements of the project	Supervising Consultant Environmental, Social, GBV specialists	During Preconstruction and Construction phases	Observations and Monitoring Reports presented to the PMU.
External Monitoring	Periodic site visit to ensure project is implemented in an environmentally & socially sustainable manner using the monitoring indicators specified in the ESMP Matrix and other national and international environmental & social requirements	FMEnv, NESREA, Niger State Ministry of Environment, Representatives of the project community, Minna, and other relevant MDAs.	During Preconstruction, Construction and Operation Phases	Inspect monitoring reports from the PMU Provide feedback on observations. Enforce corrective actions where necessary.
	Periodic monitoring of timely, mandatory and confidential reporting for E&S activities	Third Party Monitors	During Preconstruction, Construction and Operation Phases	Monitoring Reports presented to the AfDB

7.8 Training, Awareness and Capacity Building for Zonal Offices

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

All staff employed will be trained in the following:

- ✓ General operation of the plant;
- ✓ Environmental management;
- ✓ Specific job roles and procedures;
- ✓ Occupational health and safety; and
- ✓ Contingency plans and emergency procedures.
- ✓ Training will include:
- ✓ Induction training on appointment;
- ✓ Specialist training (as required for specific job role); and
- ✓ Refresher training as required.
- ✓ Training for local community on general environmental awareness and ESMP mitigation measures pertaining to community health, safety and security shall also be provided.

7.8.1 ESMP Capacity Building Plan

The various actors involved in the ESMP implementation will need capacity enhancement to ensure adequate understanding of ESMP/ OHS/ Waste Management/ Code of Conduct requirements amongst other areas identified. Proposed topics and target audience is outlined in Table 7.4.

Table 7.4: Proposed Capacity Building Plan

Target Audience	Training Overview	Cost Estimates (Naira)
Site Engineer, ESC contractor and their sub-	In-depth understanding of the mitigation measures proffered by the	1,000,000

contractors, O&M Contractor	ESMP. Training on implementation of all emergency response procedures; training on Health, Environment, Safety, and Security Management Plan	
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**

7.9 Implementation Schedule and Reporting

The project has an estimated completion period of 12-18months as outlined in Table 7.5 Activities related to the ESMP Matrix as seen above should to be integrated into the overall construction schedule.

Implementation will be in line with the finalized overall project schedule, as all activities are integrated into the project design. This will take place from the planning stages to ensure quality equipment and support services are sourced, through construction, commissioning, operation to decommissioning phases. Once monitoring begins, any observation of an environmental problem, such as non-compliance or adverse impacts will be reported immediately by the officers responsible to respective authorities in REA and corrective/ remedial actions will be taken without delay to ensure optimal performance of the project while promoting environmental sustainability.

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

Table 7.5: ESMP Implementation Schedule

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

11	Environmental and Social Monitoring and Auditing	FMEnv, SMEnv,											
12	Reporting on ESMP Implementation	ESO/SSO											

7.10 ESMP Disclosure

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

Table 1: ESMP Disclosure

s/n	Entity	Disclosure Requirements
1	Federal Ministry of Environment (FMEnv). Disclosure according to Country System in line with Nigeria EIA Act Cap E12 LFN, 2004	The PMU will disclose the ESIA for 21 days as required by the Nigeria EIA public notice and review procedures in the following offices: - FMEnv Office, - Niger State Ministry of Environment - Minna LGAs - NEP-PMU Office Disclosure will also include advert in 2 newspapers: one national and one local (state) newspapers and Radio Jingles. The purpose will be to inform stakeholders about the project activities; environmental and social impacts anticipated and proposed environmental and social mitigation measures.
2	AfDB	The ESIA will be disclosed for 120 days in line with the AfDB disclosure requirements for public sector Category 1 projects. The Summary of the ESIA will also be disclosed on AfDB website after clearance.

7.11 ESMP Budget

The total costs of the ESMP implementation including costs for mitigation, monitoring and capacity building is estimated as: N57,365,000.00 (Fifty-Seven Million, Three Hundred and Sixty-Five Thousand Naira, only.) which converts to $41,629.17 (Forty-One Thousand, and Six Hundred and Twenty-Nine Dollars, Seventeen Cents), as detailed in Table 7.7 below:

Table7.7: ESMP Budget

Fundamental ESMP Activities	**Cost Estimates (NAIRA)**	**Cost Estimates (USD)**
ESMP Implementation Cost	30,600,000	**22,500**
Monitoring Cost	4,100,000	**3,015**
Capacity Building	2,000,000	**1471**
GRM Implementation Cost	5,000,000	**3,677**
Additional Management Cost	3,400,000	**2,500**

Total	**45,100,000**	**33,163**

Dollar rate at 1Dollar to 1,360NGN as at May, 2026

CHAPTER EIGHT
REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

8.1 Introduction

This chapter discusses the activities associated with the decommissioning of the proposed project, including the potential impacts associated with the decommissioning activities as well as the environmental and social measures to address the issues. In addition, the overview of remediation plan after the decommissioning/closure of the project is provided.

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 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. The decommissioning activities will typically include the following:

v. Dismantling and removal of PV panels and associated infrastructure (mounting structure, power evacuation route, inverters, transformers, batteries, etc.);
vi. Removal of any sub-surface installations (e.g. underground cables);
vii. Waste generation and management;
viii. Rehabilitation of any impacted environmental component (e.g. soil).

8.3 Management of Decommissioning Activities

In the event of decommissioning, REA, in conjunction with the management of the FUT Minna, 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:

vi. Evacuation of the dismantled PV panels and other related items (such as inverters, and control devices) to the manufacturers for recycling;
vii. Transportation of spent batteries to recycling facilities;
viii. Restoration of the Project site to baseline conditions (as much as practicable) in line with legislative and regulatory requirements.
ix. Assessing the residual impact, if any, the project has on the environment.
x. 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:

i. 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:
ii. Description of the site and components to be decommissioned.
iii. Description of the decommissioning scope, objectives, end state and strategy;
iv. Activities to be performed during the decommissioning;

v. Schedule of decommissioning activities;
vi. Estimate of the decommissioning cost;
vii. Estimated inventory of waste streams to be generated during the decommissioning and handling techniques;
viii. Decommissioning team (qualifications, roles and responsibilities)
ix. 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.
x. 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.
xi. The Project site shall be left in a safe and environmentally acceptable condition.
xii. Hazard identification and analysis shall be conducted to determine special safety concerns to be addressed.
xiii. 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
xiv. Third party notifications shall be carried out before any demolition and shall be conducted in a phased sequence.
xv. 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:

✓ Ensuring that employees are fully informed about the decommissioning and how it will affect them before the project finally closes.
✓ Building community capacity to manage opportunities and impacts arising from the decommissioning and post-decommissioning phase of the project.
✓ Providing training to build local skills tailored to project decommissioning and post-decommissioning activities (e.g. equipment dismantling, rehabilitation activities, monitoring, etc.).
✓ Providing training to transfer project-learned skills to alternative and secondary industries tailored to respond to market economy.

xvi. 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. The environmental and social management measures for the identified potential impacts of the decommissioning activities are presented in Table 8.1.

8.3.1 Used Battery Management at Decommissioning Phase

Lithium-ion batteries that have reached the end of their life spans are classified as hazardous waste. The used batteries decommissioned from the power plant shall be packed separately from other materials. Damaged batteries in a critical stage, in particular, require special expertise in handling, as they can be flammable. Currently, Lithium-ion battery recycling in Nigeria is at the infancy stage as most local recycling companies specialize in recycling lead-acid batteries. This presents a challenge to the recycling of used batteries locally. Therefore, the Extended Producer Responsibility (EPR) policy shall be adopted for the project. It includes the take-back, recycling and final disposal of the product including its packaging. The manufacturers / suppliers of the batteries shall be responsible for the recycling and safe disposal of the used batteries. The costs of
recycling and disposal will be internalized in the price of the batteries or take-back agreements will be provided. During decommissioning activities, the batteries shall be removed, discharged, and packaged according to the manufacturer / supplier's instructions before transportation to the endpoint.

plans for the batteries and other electrical components. The plan shall include the development of procedures for safe handling, storage, and transport of the used batteries generated during Project operations. Also, procedures for identification and engagement of a certified battery recycling companies or vendors based in Nigeria shall be developed and implemented for the project.

8.4 Abandonment Plan

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

i. Identification of the components of the Project that will be abandoned and/or removed;
ii. The proposed methods for abandonment or re-use of the project equipment/material applicable;
iii. Processes put in place to mitigate potential environmental impacts associated with the abandonment process; and
iv. 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).

The decommissioning, abandonment and/or closure programme shall generally be managed by a team of competent personnel from REA-Project Management Unit, the Department of Works and Physical Planning in FUT Minna, the Federal Ministry of Environment.

8.5 Roles, Responsibilities and Accountability for Decommissioning Phase

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

Contractor(s) Engaged for Decommissioning Activities

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

REA-PMU

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

FUT Mnna Site Manager

i. 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.
ii. Report to the Director of Works and Physical Planning Department in FUT Minna on contractor's performance regarding the implementation of environmental and social measures. Director of Works and Physical Planning Department in FUT Minna.
iii. Jointly supervise the activities of the contractor(s) engaged for decommissioning.
iv. Suggest environmental and social management plan improvements to REA to address non-compliance issues and upcoming issues.
v. Approve the decommissioning plan for the project
vi. Monitor the implementation of environmental and social measures and management actions documented in the decommissioning plan.
vii. Discuss environmental and social management plan improvements to REA to address non-compliance issues and upcoming issues.

Director of Works and Physical Planning Department in FUT MINNA

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

CHAPTER NINE
STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

This chapter describes the Stakeholder engagement activities as well as the grievance mechanism to be implemented for the proposed solar-hybrid power plant and associated infrastructure in the FUT MINNA, under the Federal Government's Energizing Education Programme.

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. 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 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:

vi. inform and educate stakeholders about the proposed project;
vii. gather local knowledge to improve the understanding of the environmental and social context;
viii. better understand the locally-important issues;
ix. provide a means for stakeholders to have input into the project planning process;
x. take into account the views of stakeholders in the development of effective mitigation measures and management plans; and
xi. lay the foundation for future stakeholder engagement.

9.3 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 Contractor shall develop and implement an effective SEP which shall be maintained throughout the life-cycle of the project. A sample format for the SEP is outlined in the Environmental and Social Management framework (ESMF) for NEP.

9.4 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.

9.4.1 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:

i. ***Managing costs:*** Effective engagement can help project REA avoid costs, in terms of money and reputation;
ii. ***Managing risk:*** Engagement helps project REA and communities to identify, prevent, and mitigate environmental and social impacts that can threaten project viability;
iii. ***Enhancing reputation:*** By publicly recognizing human rights and committing to environmental protection, REA and financial institutions involved in financing the project can boost their credibility and minimize risks;
iv. ***Avoiding conflict:*** Understanding current and potential issues such as land rights and proposed project activities;
v. ***Improving corporate policy:*** Obtaining perceptions about a project, which can act as a catalyst for changes and improvements in REA corporate practices and policies;
vi. ***Identifying, monitoring and reporting on impacts:*** Understanding a project's impact on stakeholders, evaluating and reporting back on mechanisms to address these impacts; and
vii. ***Managing stakeholder expectations:*** Consultation also provides the opportunity for REA to become aware of and manage stakeholder attitudes and expectations.

Table 9.1: Stakeholder Engagement Process

Stakeholder Engagement	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 life-cycle. REA shall maintain regular communication with its stakeholders throughout the project life-cycle.
Stakeholder Consultation	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 and Partnerships	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

Stakeholder Involvement	This entails procedures that allow the direct involvement of stakeholders in project related functions in order to foster transparency and credibility.
Reporting to 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.

Table 9.2: Stakeholder Group Consultation Methods

Stakeholder Group	Consultation Method
Government and Regulators	i. Email exchanges and letters ii. One-on-one consultations iii. Formal meetings
Project beneficiaries (FUT Minna Management, Physical Planning, Students)	i. Formal meetings ii. One-on-one consultations iii. Strategic collaboration
Employees	i. Phone / email / text messaging/ WhatsApp ii. Focus group meetings iii. Management/departmental meetings
NGO's	i. Phone/email ii. One-on-one interviews iii. Town hall meetings iv. Focus group meetings

9.4.2 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.

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 9.1: Engagement with the VC and Director Physical Planning of FUTMinna

Plate 9.2: Engagement with the Physical Planning Department of FUTMinna

Plate 9.3: Engagement with students in campus at FUT Minna

Plate 9.4: Engagement with selected youth of Gidan Kwano, Bosso LGA, Minna

Plate 9.5: Engagement with community leaders at Gidan Kwano Bosso LGA

Plate 9.6: Engagement with selected youth of Gidan Kwano Bosso LGA

9.4.3 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:

i. **Commitment:** is demonstrated when the need to understand, engage and identify the key stakeholders is recognized and acted upon;
ii. **Integrity:** occurs when engagement is conducted in a manner that fosters mutual respect and trust;
iii. **Respect:** is created when the rights, values and interests of stakeholders and neighbors are recognized;
iv. **Transparency:** is demonstrated when stakeholder concerns are responded to in a timely, open and effective manner;
v. **Inclusiveness:** is achieved when broad participation is encouraged and supported by appropriate participation opportunities; and
vi. **Trust:** is achieved through open and meaningful dialogue that respects stakeholder's values and opinions.

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.

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.

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	6

Judicial System/Courts of Competent Jurisdiction	

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 (₦5,000,000), disaggregated as follows:

Activity	Estimated Cost (₦)
Establishment of Community Grievance Committees	500,000
GRM awareness and sensitization campaigns	800,000
Production of grievance forms, registers and IEC materials	400,000

Installation of grievance boxes and communication materials	300,000
Hotline, SMS and communication expenses	600,000
Committee meetings and mediation sessions	800,000
Capacity building and training of GRM personnel	700,000
Monitoring, reporting and database management	500,000
GBV/SEA/SH referral support and specialist services	200,000
Contingency (approximately 4%)	200,000
Total	₦5,000,000

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

10.1 Conclusion

The ESIA of the proposed solar power plant and associated infrastructure in FUT Minna, under the EEP Phase II, has been conducted in accordance with the relevant requirements of the FMEnv guidelines and the applicable The African Development Bank's Integrated Safeguards System (ISS), and Operational Safeguard 2 (OS 2) which addresses land acquisition, displacement, and compensation, 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:

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

ii. Reduction in fossil fuel consumption by the FUT Minna, thereby leading to reduction in carbon emissions and improvement in the eco-balance.

iii. Significant reduction in the cost of power generation by the FUT Minna through diesel-fueled generators.

iv. 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.

v. Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the project.

vi. Improvement in livelihood enhancing activities within the University.

vii. 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.

viii. Increase in local and State economy through award of contracts and purchase of supplies for project development.

ix. Increase in financial and technical collaborations between the FGN, the University, REA, African Development Bank and other relevant Ministries, Departments and Agencies (MDAs).

The negative impacts identified of the proposed project were mostly of minor to moderate significance, and they are largely site-specific and localized. There are no cultural resources within and around the project site that would be affected during the project development and operation. The identified potential negative impacts include:

i. Decreased in ambient air quality due to construction and decommissioning activities.
ii. Increase in ambient noise level due to construction and decommissioning activities.
iii. Decrease in soil quality due to improper management of wastes generated during construction, operation and decommissioning.
iv. Minimal loss of terrestrial flora species (largely grasses) during site preparation for construction activities.
v. Environmental nuisance due to improper disposal of e-waste including spent /damaged batteries.
vi. Influx of potential job seekers during construction which could pose indirect impacts on the nearby local community.
vii. Occupational health and safety issues during construction, operation and decommissioning.

10.2 Recommendations

The ESIA study recommends the following:

iii. The REA, through its Project Management Unit (PMU), as well as the Management of FUT Minna, 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.

iv. 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.

v. Implementation of the project's Stakeholder Engagement Plan (including grievance redress mechanism) shall be maintained.

REFERENCES

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ANNEX ONE: TERMS OF REFERENCE

1 INTRODUCTION/ BACKGROUND

The Federal Government of Nigeria (FGN), through the Rural Electrification Agency (REA), is implementing the Nigeria Electrification Project Phase II (Desert-to-Power) with financial support from the African Development Bank

(AfDB). The project's primary objective is to accelerate Nigeria's electrification efforts by deploying sustainable, off-grid and grid-connected solar-powered renewable energy solutions. By leveraging Nigeria's vast solar energy resources, the initiative aims to provide clean, reliable, and long-lasting electricity to Federal Universities and their affiliated teaching hospitals. The broader goal is to enhance academic performance, support research initiatives, and improve healthcare service delivery.

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

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

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

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

2 DESCRIPTION OF THE PROJECT

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

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

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

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

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

3 STATUTORY LEGAL AND ADMINISTRATIVE FRAMEWORK

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

- African Development Bank's Integrated Safeguards System (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.

4 OBJECTIVES OF THE ASSIGNMENT

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

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

- Conduct inclusive stakeholder engagement (including women, youth, and persons with disabilities); and
- Build local institutional capacity for ESMP implementation.

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

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

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

This modular approach ensures:

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

5 SCOPE OF THE ASSIGNMENT – METHODOLOGY AND GENERAL APPROACH

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

Phase 1 – Desk Review and Scoping

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

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

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

Phase 3 – Impact Assessment

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

Phase 4 – Stakeholder Engagement

- Conduct Free, Prior, and Informed Consultations (FPIC) with communities, institutions, and Federal/ state agencies.
- Ensure inclusive participation of women, youth, and persons with disabilities.
- Maintain engagement logbooks with signatures, photos, and feedback.
- Establish and operationalize a multi-tier costed Grievance Redress Mechanism (GRM).
- Develop a costed stakeholder engagement plan.

Phase 5 – ESMP Development: Each ESMP shall include:

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

Phase 6 – Reporting and Disclosure

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

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

6 DELIVERABLES AND PAYMENT SCHEDULE

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

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

#	Deliverables	Timeline *(After contract signing in weeks)*
1.	**A. Inception Report:** - This should include methodology and work plan with clearly defined strategy for carrying out the assignment with timelines for the various outputs. The report should include: • Detailed Project including plan for the on-site activities • Complete Work plan document • Draft Survey Tools	2 weeks

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

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

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

1. Executive Summary

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

2. Introduction

- Project Background: Description of the project's goals, location, and key stakeholders.
- ESIA Purpose and Scope: The specific objectives of the ESIA, focusing on identifying, assessing, and mitigating the environmental and social impacts of the project.

- Regulatory Framework: Reference to the relevant Nigerian regulations (e.g., EIA Act Cap E12 LFN 2004), AfDB's Integrated Safeguards System (ISS), Nigerian Climate Change Act (2021), and international standards (e.g., IFC Performance Standards, ISO 14001, ISO 45001).

3.1 Project Description

- Project Components: A detailed description of the project components, including all infrastructure and technologies (e.g., solar-hybrid mini-grid systems, energy storage, etc.). Also, the consultant shall describe the proposed project and its geographic, environmental, social, and temporal context, including associated facilities, third parties, and any offsite investments that may be required.
- Project Phases: Explanation of all phases of the project lifecycle, including planning, construction, operation, and decommissioning.
- Project Activities: A breakdown of project activities and their potential environmental and social implications.
- Includes a map of sufficient detail showing the project site and the area that may be affected by the project's direct, indirect, and cumulative impacts.
- Presents the basis for selecting the project design proposed, including for applying the mitigation hierarchy.

3.2 Analysis of Project Alternatives

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

4. Legal and Institutional Framework

- National Legislation: Overview of Nigerian laws, including the EIA Act, Nigerian Climate Change Act (2021), and other FMEnv regulations. In addition, the E&S institutional and regulatory framework is comprehensively analyzed, not focusing only on environmental and land laws but including social protection policies/strategies, and the project's sector relevant standards/norms related to E&S health and safety.
- AfDB Safeguard Policies: Summary of the AfDB's Integrated Safeguards System (ISS), including the environmental and social safeguard policies that must be adhered to.

- International Standards: Reference to IFC Performance Standards, ISO 14001, and ISO 45001, which guide the ESIA process.
- Permits and Approvals: A list of the necessary permits and clearances required by local authorities and the relevant ministries for the project.
- Analyses the legal and institutional framework for the project within which the ESA is carried out, consisting of:
    - the host country's applicable policy framework, national and local laws and regulations, and the respective institutional capabilities (including implementation) concerning E&S issues;
    - national environmental or social action plans or strategies, and obligations of the country directly applicable to the project under relevant international and regional treaties and agreements;
    - applicable requirements under the OSs and the African Development Bank's Integrated Safeguards System (ISS) Guidance Notes;
    - the identification of differences between the Borrower's existing Environmental and Social Framework, and requirements relating to the project that may affect how the project is carried out in a manner consistent with the OSs;
    - a description of how any deficiencies in the host framework can be addressed through administrative, legislative or regulatory change, institutional strengthening, and capacity building.

5. Baseline Environmental and Social Conditions

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

6. Stakeholder Engagement

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

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

Other aspect to consider include:

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

7. Impact Assessment

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

- Methodology: A thorough impact analysis (***quantitative NOT generic***) and identification of feasible measures addressing each significant and moderate impact and risk.
- Environmental Impacts: Analysis of potential environmental impacts (e.g., land degradation, water and air quality, noise, waste generation, etc.).
- Social Impacts: Evaluation of potential social impacts, including displacement, changes to local livelihoods, public health, and community wellbeing.
- Cumulative Impacts: Assessment of how the project may interact with other projects or activities in the region, and the cumulative impacts on the environment and society.

8. Environmental and Social Risks and Opportunities

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

9. Mitigation and Management Plans

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

  • Identify measures to enhance positive impacts and opportunities.
  • Identify differentiated measures so that adverse impacts do not fall disproportionately on the vulnerable.

• Assess the feasibility of mitigating the E&S impacts, the capital and recurrent costs of proposed mitigation measures, and their suitability under local conditions, and the institutional, training, and monitoring requirements for the proposed mitigation measures.
Specify issues that do not require further attention, providing the basis for this determination.

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

10. Monitoring and Evaluation

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

11. Conclusions and Recommendations

- Summary of Findings: A concise summary of the key environmental and social impacts, along with the proposed mitigation measures.
- Project Justification: Justification for the project's viability and positive outcomes relative to its environmental and social risks.
- Further Actions: Recommendations for additional studies, monitoring, or mitigation measures that may be necessary.

Appendix: Detailed Management Plans and Supporting Documentation

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

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

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

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

7 DURATION OF THE ASSIGNMENT

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

ANNEX TWO: ENVIRONMNETAL AND SOCIAL ASSESSMENT CHECKLIST

Project Alternatives – On-Site Checklist

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

2. BASELINE ENVIRONMENTAL CONDITIONS – DAILY FIELD CHECKLIST

2.1 Climate Change Considerations

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

2.2 Physical Environment

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

2.3 Environmental Quality

Parameter	What to Verify	Method	Daily Check	Remarks
Biodiversity	Flora/fauna presence	Ecological survey		
Water Quality	Surface & groundwater condition	Sampling + visual inspection		
Air Quality	Dust, emissions	Instrument + observation		
Noise	Ambient noise levels	Sound meter		

2.4 Sensitive Environmental Receptors

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

3. SOCIAL BASELINE – DAILY CHECKLIST

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

Existing Infrastructure	Roads, power, water, health	Physical inspection		

4. STAKEHOLDER ENGAGEMENT

4.1 Vulnerable Groups & Context

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

4.2 Stakeholder Identification & Engagement

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

5. STAKEHOLDER CONCERNS – ISSUE-BASED CHECKLIST

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

6. DAILY SUMMARY OF FINDINGS

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

ANNEX FOUR: WASTE MANAGEMENT PLAN

BACKGROUND

This waste management plan has been developed as part of the ESIA for the proposed Energizing Education Program, Phase II in Federal University of Technology, Minna (FUTMINNA). 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 analysed 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 categorisation 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

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 minimise 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 minimise and appropriately manage the waste generated on site, the following good management practices will be used:

- Reduction of waste generation (through management practices, avoiding or decreasing materials use, etc.) is the primary goal of this plan.
- Non-hazardous wastes will be segregated from hazardous wastes.
- Wastes to be sent to licensed recycling/dumpsites will be segregated by type.
- Effort will be made to minimise the quantity of hazardous materials used.
- Personnel that handle hazardous materials and wastes, will be trained for proper handling and management.
- Spills of hazardous materials will be prevented through careful and sensible management of the materials.
- Regular inspections of storage areas will be conducted. If damaged or leaking containers are detected, they will be replaced.
- Preventive maintenance will be performed on equipment to avoid potential spills.
- Waste storage areas will have secondary containment or spill trays.
- Under no circumstances will waste be disposed on site.

Classification of Wastes

The Project activities will lead to the generation of various non-hazardous and hazardous wastes.

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.

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.

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 optimize 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

	Packaging materials, 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/ expired Batteries/ Inverters	Hazardous waste	Off-site Management according to the EPR with the producer or an approved FMEnv facility
	Domestic waste generated by workers including food packs, cans, bottles	General solid (putrescible)	Off-site disposal at an approved facility
	Sanitary Waste/Sewage	General solid (putrescible)	Off-site disposal at an approved facility
	Waste water / recycled water / storm water	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 aluminum 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

Project Phase - Waste Management Plan

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 analysed 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.

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.

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.

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 Niger State Environmental and Protection Agency. In addition, adequate supervision shall be provided by the REA-PMU and the respective MDAs.

ANNEX FIVE: CLIMATE CHANGE ADAPTATION AND MITIGATION PLAN

Introduction

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

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

Climate Context of the Project Area

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

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

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

Climate Change Risks to the Project

Climate Risk	Potential Impact on Project
Increased temperature	Reduced efficiency of solar panels and battery systems
Intense rainfall events	Soil erosion, flooding of trenches, damage to infrastructure
Strong winds	Damage to solar panel mounting structures
Prolonged dry periods	Increased dust generation affecting panel efficiency
Extreme weather events	Disruption of construction and operation activities

Climate Change Mitigation Measures

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

Reduction of Greenhouse Gas Emissions

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

Sustainable Construction Practices

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

Waste Management

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

Climate Change Adaptation Measures

Infrastructure Design and Siting

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

Erosion and Soil Management

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

Solar Panel Efficiency Management

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

Structural Stability

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

Operational Resilience

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

Institutional Responsibilities

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

Monitoring Indicators

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

Capacity Building and Awareness

- Training of workers on climate-resilient construction practices

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

ANNEX SIX: LABOUR MANAGEMENT PLAN

1.0 Introduction

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

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

2.0 Types of Project Workers

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

Direct Workers

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

Contracted Workers

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

Community Workers (Where Applicable)

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

3.0 Key Labour Risks

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

4.0 Labour Management Measures

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

- **Working Conditions**
  - Clear terms of employment (contracts, wages, working hours)
  - Compliance with national labour regulations

- Provision of adequate welfare facilities (water, sanitation, rest areas)

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

- **Code of Conduct**

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

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

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

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

5.0 Worker Grievance Redress Mechanism (GRM)

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

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

6.0 Roles and Responsibilities

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

7.0 Monitoring Indicators

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

ANNEX SEVEN: HSE PLAN

1.0 INTRODUCTION

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

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

2.0 PROJECT DESCRIPTION

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

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

2.1 Purpose

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

Specifically, this plan aims to:

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

2.2 HSE Objectives

The Objectives for this plan are to:

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

2.3 Scope of Work

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

2.4 Policy Statement

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

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

3.0 KEY RESPONSIBILITIES

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

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

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

3.1 Project Manager Responsibilities

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

3.2 Project Supervisors Responsibilities

- Enforcing all phases of the established HSE plan.
- Set good example in HSE issues.

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

3.3 HSE Manager/Supervisor Responsibilities

- Prepare relevant OHS documentation and procedures.
- Monitor the efficient implementation of OHS requirements.
- Participate and organize the OHS risk assessments.
- Advise management of compliance and of conditions requiring attention.
- Conduct regular HSE inspections.
- Make thorough analysis of statistical data and inspections; delineates problem areas; and makes recommendation for solutions.
- Take part in the review of all OHS incidents and assist in investigating incident.
- Monitor the efficient implementation of the Project's OHS requirements.
- Organize the Project's OHS risk assessment exercises.
- Check on the use of all types of personal protective equipment specifies the use of appropriate PPE for the various work activities. Evaluates their effectiveness and suggests improvements where indicated.

3.4 HSE Advisor Responsibilities

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

3.5 All employees Responsibilities

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

4.0 Competency

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

5.0 Fitness

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

6.0 HSE Training

6.1 Induction/Orientation

Every new or rehired employee and Subcontractors employees must undergo mandatory OHS orientation / induction. The purpose of the Induction is to educate workers and make them aware of the major potential hazards he or she shall come into contact with while working on the site; also, it is one more opportunity to stress the importance of HSE being the first priority in the operations.

The content of the HSE orientation / induction shall cover the following subjects:

- Site safety rules.
- Personnel protective equipment requirements (PPE).
- Environmental sensitivity and protection.
- Preparation and planning of the job (Daily Pre-task talk).
- Emergency plan and muster points.

6.2 Project Specific HSE Training

In addition to the HSE orientation /induction, there shall be specific site HSE trainings which shall cover the following topics:

- Manual handling.
- Electrical Safety
- Emergency Prevention, Preparedness and Response
- Work at height training
- First Aid training (for site First Aiders)
- Lifting and Rigging
- Safe Driving techniques (for drivers)

7.0 Hazard identification & HSE risk assessment

7.1 Project HSE Risk Assessment

The project HSE risk assessment shall be developed and recorded. The Project's HSE risk assessment shall be conducted by a team consisting of HSE Manager/ Supervisor and technical managers/supervisors. It must be approved by the Project manager.

7.2 Fire Risk Assessment

A fire risk assessment shall be developed and recorded. A fire safety plan shall be in place in the site.

7.3 Job Hazard Analysis

Job hazard analysis is required when the hazards and risks associated with a specific task is to be identified so as to implement control measures. The HSE department together with the technical managers/supervisors shall develop a job hazard analysis when applicable.

8.0 EMERGENCY PREPAREDNESS AND RESPONSE

Emergency procedures and evacuation plan shall be developed by the HSE Department and displayed on the notice board. These procedures shall be communicated to all staff. Also each section/department shall have at least a trained first aider at all times.

9.0 HSE IMPLEMENTATION AND PERFORMANCE MONITORING

9.1 HSE Meetings

HSE management meetings shall be held once a month. The meeting is to help identify safety problems, develop solutions, review incident reports, provide training and evaluate the effectiveness of our safety program. Some of the meetings shall be:

- Project/Site Management HSE Meeting for management and supervision (Monthly).
- Tool box talk meetings for all workforce (Weekly).
- Pre-task briefing for all workforces (Daily).
- Special situation meeting (As required).

9.2 HSE Reporting

All incidents and illnesses must be reported to site supervisor after which investigation shall commence and recorded so that appropriate corrective actions shall be implemented to prevent any re-occurrence and report findings shall be forwarded to management for review. Reporting requirements shall include notification of incident, investigation report, and monthly report. Notification of Incident form shall be developed which shall be filled and submitted to HSE department for investigation.

9.3 HSE Inspection and Audits

For continual improvement of HSE management system, HSE inspection and audit shall be conducted. An inspection checklist shall be developed. This is to ensure that the HSE management system is being adhered to. The inspection shall be conducted by the HSE department together with site management.

9.4 Corrective and Preventive Actions and Non-Conformities

During the cause of inspections, concerns raised shall be addressed and closed out. It is expected that in a period of two weeks, a close out inspection shall take place to verify that the corrective actions have been closed.

10.0 PROJECT HSE RULES

The project HSE rules shall be developed and supervision shall develop specific rules and procedures when necessary.

The following site rules shall be implemented at all times. The Site Manager shall draw these rules to the attention of their own workmen or staff. All sub-contractors must ensure that these rules are drawn to the attention of their workmen and staff.

The Principal Contractor may implement additional site rules during the contract programme. Any such additional rules shall be notified to all personnel engaged on the project prior to their implementation. The HSE rules shall include but not limited to:

1. Personal Protective Equipment must be worn at all times.
2. All instructions issued by the Site Manager regarding the storage, handling or cleaning of materials, plant and equipment must be followed.
3. All vehicles must be parked in the designated areas.
4. Any workman suffering from a medical condition that might affect his work and/or that could require specific Medical treatment must inform the supervisor before commencing work.
5. All site tools shall either be battery operated or 110 volts.
6. No one shall be permitted on site if it is believed that they are under the influence of alcohol or drugs.
7. Vehicles must not reverse without a banksman in attendance.
8. All visitors to site must undergo a site-specific induction and operative Identity badges must be worn at all times.
9. All excavations must be secured.
10. Smoking and eating shall only be permitted in the designated area. This area shall be identified during induction.
11. No hot works operations are permitted without a hot work permit in place.
12. There shall be no radios or other music playing devices on site.
13. Good housekeeping practices to be adopted**.**
14. Compliance with all Ethical Power Permit to Work systems
15. The site keyed access procedure must be strictly adhered to.
16. All Contractors must comply with Site Health & Safety Guidelines / Site Safety Method Statement
17. No untrained worker shall be permitted to operate heavy machineries.

11.0 SAFE WORK PRACTICES

Implementing safe work practices is one of the keys to achieving our HSE objectives and some of these safe work practices include:

11.1 Personal Protective Equipment (PPE)

The basic PPE required for the project shall be Safety Glasses, Safety Boots, Hand Gloves, Hard Hat and Coverall. Any other PPE shall be used as applicable. Management is responsible for the provision of PPE and usage shall be enforced at all time. PPE shall be provided in circumstances where exposure to hazards cannot be avoided by other means or to supplement existing control measures identified by a risk assessment. An assessment shall be made to ensure that the PPE is suitable for purpose and is appropriate to the risk involved. Information, instruction & training shall be given to all employees on safe use, maintenance and storage of PPE. Employees shall, in accordance with instructions given, make full use of all PPE provided and maintain it in a serviceable condition and report its loss or defect immediately to the maintenance department where it shall be replaced. PPE shall be replaced when it is no longer serviceable and returned on a new for old basis. Employees shall sign to state that they have received PPE when issued.

12.0 WELFARE FACILITIES

The provision of welfare facilities on the site shall be communicated to all operatives at site induction.

A cleaning regime shall be implemented and maintained for the duration of the construction phase to ensure the site welfare facilities remain in a clean and tidy condition.

If mains drinking water becomes unavailable during the construction phase bottled water shall be brought to site for all operatives for the necessary period.

13.0 SIGNAGE

Adequate provision for warning and directional signs shall be made.

14.0 PROJECT HSE PROCEDURES

OHS procedures shall be developed. Project activities shall generally be controlled in accordance with OHS Procedures. These procedures shall include:

- Lifting and Rigging Procedure
- HSE Reporting Procedure
- Working at Height Procedure.
- Emergency Procedure.

ANNEX EIGHT: LAB RESULT

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 ON BEHALF OF FEDERAL GOVERNMENT OF NIGERIA (FGN).
PROJECT NAME:	NIGERIAN ELECTRIFICATION PROJECT (NEP) PHASE II (DESERT TO POWER), ESIA FOR THE ENERGIZING EDUCATION PROGRAMMED.
PROJECT ADDRESS:	FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA (NIGER STATE).
DATE:	FEB, 2026.

GENERAL AIR QUALITY ASSESSMENT

Please find below the result of General Air Quality Assessment Carried out at the proposed site of Nigeria electrification project Phase II at Federal University, of Technology Minna.

S/N	Parameters	Unit	AM_1	AM_2	AM_3	AM_4	AM_5	AM_6	AM_7	AM_8	AM_9	AM_{10}	AM_{11}	AM_{12}	AM_{13}
1	Latitude	N	9.53738	9.53773	9.53822	9.53743	9.53677	9.53652	9.53648	9.53623	9.53655	9.53720	9.53709	9.537404	9.53800
2	Longitude	E	6.44493	6.44495	6.44758	6.44769	6.44618	6.44559	6.43896	6.43828	6.44559	6.43763	6.44067	6.44159	6.44136
3	Nitrogen (iv) Oxide	ppm	0.3	0.2	0.3	0.3	0.3	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.2
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	1	0	0	0
6	Carbon (iv) Oxide	ppm	431	450	451	436	450	552	437	437	441	425	426	451	540
7	EX	%/e/	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Ammonia Gas	ppm	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0.00	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.3
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	$PM_{2.5}$	$\mu g/m^3$	35	45	36	32	70	31	32	30	32	37	33	41	48
15	PM_{10}	$\mu g/m^3$	46	60	45	42	88	42	42	41	48	53	51	60	65
16	$PM_{1.0}$	$\mu g/m^3$	24	33	24	21	57	21	21	20	23	26	25	32	34
17	TVOC	mg/m^3	0.000	0.001	0.021	0.003	0.000	0.000	0.014	0.036	0.003	0.026	0.006	0.001	0.009
18	HCOH	mg/m^3	0.000	0.000	0.003	0.001	0.000	0.000	0.003	0.012	0.000	0.018	0.002	0.002	0.110
19	Temperature	^OC	28.7	29.4	28.8	29.6	29.5	29.5	29.4	29.3	28.8	30.1	30.0	29.9	31.8
20	R/Humidity	%	28	28	28	28	29	28	28	30	30	28	28	28	28
21	Ozone	Ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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

WATER QUALITY ASSESSMENT RESULT

Sample Quantity: 1.5 Litre **Preservation Method:** Iceing

Sequel to the Analysis Conducted, below are the data obtained on the samples of Ground water and Surface water Collected from Federal University of Education Minna.

S/N	Parameters	Unit	GW M_1	GW M_2	GW M_3	Surface Water M_4	GW Control	FMENT Limit
a)	**Coordinates**							
1	Latitude	N	9.530806	9.537112	9.5341862	9.537008	9.596370	-
2	Longitude	E	6.449736	6.444268	6.447051	6.439888	6.429633	-
3	Altitude	M	-	-	-	-	-	-
a)	**Physicochemical Test**							
4	Colour	TCU	Clear	Clear	Clear	Clear Gray	Clear	Clear
5	Odour	-	Odourless	Odourless	Odourless	Bad Odour	Odourless	Unobjectionable
6	Taste	-	Tasteless	Tasteless	Tasteless	Bitter	Tasteless	Unobjectionable
7	Turbidity	NTU	0	0	0	27	0	50
8	pH	-	6.69	7.59	6.79	8.92	6.55	6.5 – 8.5
9	Temperature	^0C	29.5	29.0	28.9	32.2	30.1	Ambient
10	Dissolve Oxygen	mg/L	3.4	3.1	3.6	2.8	3.5	2 – 8
11	Total Dissolve Solid	mg/L	201	182	244	298	190	500
12	Electrical Conductivity	µs/cm	373	365	499	597	403	1000
13	Total Suspended solid	mg/L	1	0	3	13	1	20
14	Salinity	mg/L	0.00	0.02	0.06	0.09	0.02	<1000
15	ORP (MV)	(MV)	123	156	253	341	201	200-600
16	B.O.D	mg/L	0.4	0.8	0.9	2.0	1.4	NS
b)	**Chemical Test**							
17	Ammonium (NH_4^+)	mg/L	0.006	0.018	0.003	0.103	0.003	NS
18	Potassium (K^+)	mg/L	0.2	0.3	1.4	2.8	0.2	20
19	Calcium (Ca^{2+})	mg/L	0.2	0.2	0.2	0.4	0.1	200
20	Sodium (Na^+)	mg/L	4	0	3	16	9	20
21	Magnesium (mg^{2+})	mg/L	0.63	0.24	0.25	3.43	0.21	20
22	Sulphate (SO_4^{2+})	mg/L	39	38	43	126	39	100
23	Nitrate (NO_3^{2-})	mg/L	6.0	2.9	3.0	27.5	3.0	50
24	Chloride (Cl^-)	mg/L	0.3	0.1	0.1	4.2	0.8	100
25	Phosphate (PO_4^{2-})	mg/L	0.11	0.05	0.02	1.86	0.14	NS
26	Nitrite (NO_2^-)	mg/L	0.000	0.000	0.000	0.2000	0.000	0.2
c)	**Heavy Metal**							
27	Zinc (Zn^{2+})	mg/L	0.14	0.07	0.16	1.86	0.05	3.0
28	Iron (Fe^{2+})	mg/L	0.002	0.068	0.093	0.304	0.411	0.3
29	Cupper (Cu^{2+})	mg/L	0.18	1.23	0.89	0.00	1.05	1.5
30	Chromium (Cr^{3+})	mg/L	0.00	0.00	0.00	0.07	0.01	0.05
31	Lead (Pb^{2+})	mg/L	0.000	0.000	0.000	0.000	0.000	0.01
32	Cobalt (CO^{2+})	mg/L	0.01	0.00	0.30	0.29	0.17	0.2
33	Mercury (Hg^+)	µg/L	0.000	0.000	0.000	0.000	0.000	0.001
34	Nickel (Ni^{2+})	mg/L	0.831	0.056	0.231	1.752	0.866	0.070

d)	**Organics**							
35	Oil and Grease	mg/L	0	0	0	2	0	10
36	Benzene	mg/L	0.00	0.00	0.00	0.00	0.00	0.01
37	Toluene	mg/L	0	0	0	0	0	0.7
38	Ethylbenzene	mg/L	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	0.5
40	Phenols	mg/L	0.007	0.001	0.000	0.013	0.000	0.05
e)	**Microbiological Test**							
41	E. Coli	Cfu/ml	0	0	0	2	0	Nil
42	Feacal Coliform	Cfu/ml	0	0	0	7	0	Nil
43	Total Coliform	Cfu/ml	0	0	0	26	3	10

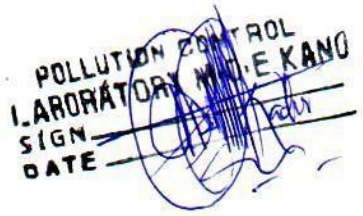
SOIL ANALYSIS RESULT

Find below the result of soil Samples Analysis collected from Federal University of Technology Minna on the condition submitted to the Laboratory.

S/N	Parameters	Unit	MSS_1	MSS_2	MSS_3	MSS_4	MSS_5	MSS_6	MSS_7	MSS_8	MSS_9	MSS_{10}	MSS_{11}	MSS_{12}	MSS Control
a)	**Coordinates**														
1	Latitude	N	9.53738	9.53773	9.53822	9.53743	9.53677	9.53652	9.53648	9.53623	9.53655	9.53720	9.53709	9.53740	9.[illegible]8
2	Longitude	E	6.44493	6.44495	6.44758	6.44769	6.44618	6.44559	6.43896	6.43828	6.44559	6.43763	6.44067	6.44159	6.[illegible]1
3	Elevation	M	496.3	433.9	443.1	486.1	486.1	485.2	486.1	485.3	479.1	476.3	485.5	496.2	4[illegible]3
b)	**Physical Test**														
4	Colour	TCU	Brownish	Brownish	Brownish	Dark Brownish	Brownish	Dark Brownish	Pale Brown	Brownish	Grayish Brown	Pale Brown	Pale Ash	Brownish	D[illegible]k B[illegible]w ni[illegible]
5	pH	-	6.68	7.00	5.50	6.23	6.26	6.08	6.65	6.69	6.12	6.87	5.77	6.43	6[illegible]9
6	Electrical Conductivity	µs/cm	1567	1517	902	962	1071	1224	1154	1458	1361	899	1159	1326	1[illegible]7
7	Temperature	^0C	31.4	31.0	28.9	30.4	29.6	31.9	31.6	31.8	32.4	32.0	32.8	30.7	3[illegible]2
8	ORP	MV	175	127	167	170	154	164	158	199	134	166	159	14	1[illegible]4
9	Salinity	%	0.07	0.03	0.07	0.07	0.07	0.07	0.07	0.08	0.00	0.06	0.02	0.02	0[illegible]3
c)	**Exchangeable Cation**														
8	Calcium (Ca^{2+})	mg/kg	1.05	0.69	0.13	1.10	0.44	0.65	0.22	0.18	0.29	0.41	0.55	0.57	0[illegible]0
9	Magnesium (mg^{2+})	mg/kg	0.49	0.29	0.06	0.54	0.24	0.33	0.09	0.04	0.13	0.02	0.06	0.20	0[illegible]3
10	Sodium (Na^+)	mg/kg	4	3	3	3	6	0	0	3	6	6	9	13	
11	Potassium (K^+)	mg/kg	1.7	0.4	0.1	1.5	0.2	0.2	0.3	0.6	1.2	1.1	0.4	0.9	0[illegible]2
12	Ammonium (NH_4^+)	mg/kg	0.017	0.036	0.113	0.012	0.076	0.004	0.086	0.041	0.087	0.013	0.100	0.063	0.[illegible]1

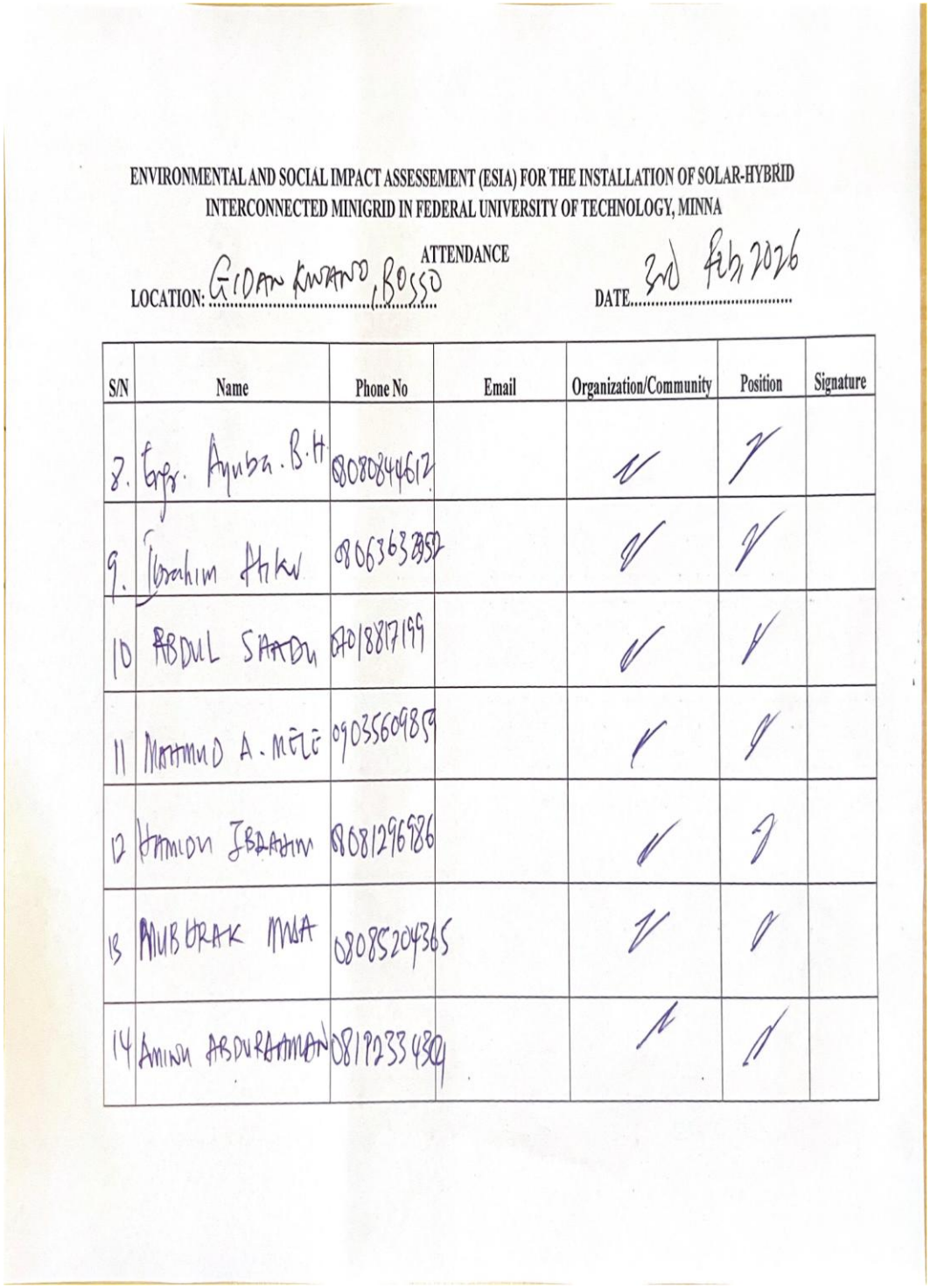
d)	**Exchangeable Anion**														
13	Sulphate (SO_4^{2+})	mg/kg	10	14	5	10	11	3	2	8	13	7	9	3	1
14	Phosphate (PO_4^{2-})	mg/kg	1.84	0.13	0.13	1.40	0.94	0.01	0.54	0.11	0.48	1.01	0.74	1.22	0 0
15	Nitrate (NO_3^{2-})	mg/kg	9.1	5.7	1.2	10.8	4.8	6.9	1.9	2.2	16.1	4.3	13.6	4.1	8
16	Chloride (Cl^-)	mg/kg	3.7	3.4	0.9	4.3	2.2	3.7	0.5	0.6	1.8	0.2	0.9	1.8	6 2
	Organics														
17	Phenols	mg/kg	0.064	0.066	0.020	0.078	0.049	0.071	0.017	0.012	0.013	0.038	0.004	0.013	0. 96
18	Calcium Carbon	mg/kg	12	4	13	20	35	9	26	16	9	35	18	27	
19	Oil & Grease	mg/kg	0	0	0	0	0	0	0	0	0	0	0	0	
f)	**Heavy Metals**														
20	Iron	mg/kg	0.09	0.21	0.01	0.11	0.20	0.28	0.06	0.13	0.07	0.24	0.09	0.03	0 5
21	Cupper	mg/kg	0.16	0.10	0.00	0.07	0.13	0.17	0.01	0.02	0.01	0.03	0.00	0.04	0 9
22	Chromium	mg/kg	0.01	0.04	0.00	0.01	0.01	0.02	0.00	0.01	0.02	0.00	0.00	0.01	0 3
23	Zinc	mg/kg	0.08	0.00	0.00	0.01	0.02	0.02	0.00	0.03	0.01	0.00	0.00	0.00	0 3
24	Cobalt	mg/kg	0.139	0.17	0.000	0.014	0.025	0.022	0.000	0.017	0.004	0.026	0.011	0.020	0. 26
25	Nickel	mg/kg	0.017	0.022	0.055	0.013	0.017	0.026	0.002	0.012	0.000	0.017	0.006	0.013	0. 32
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. 00
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. 00
g)	**Soil Characteristic**														
28	Loam	%	63	54	57	60	63	41	55	58	47	52	63	35	4
29	Sandy	%	12	8	4	14	23	6	19	11	22	9	12	12	
30	Clay	%	22	29	16	20	11	38	13	20	19	27	12	13	
31	Silt	%	3	9	23	6	3	15	13	11	7	1	41	26	1
h)	**Microbiological Test**														
32	E. Coli	Cfu/ml	2	2	3	5	6	8	2	3	6	7	2	7	
33	Fungal	Cfu/ml	141	130	154	162	170	194	125	155	174	187	126	181	1 0

Best Regards,



San. Abdulkadir H. Umar
Asst. Chief Scientific Officer

ANNEX NINE: ATTENDANCE



ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT (ESIA) FOR THE INSTALLATION OF SOLAR-HYBRID INTERCONNECTED MINIGRID IN FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

ATTENDANCE

LOCATION: GIDAN KWANO, BOSSO DATE 3rd Feb, 2026

S/N	Name	Phone No	Email	Organization/Community	Position	Signature
8.	Engr. Ayuba. B. H	08080446172		✓	✓	
9.	Ibrahim Haku	08063638527		✓	✓	
10	ABDUL SHARDU	08018817199		✓	✓	
11	MAHMUD A. MELE	09035609859		✓	✓	
12	HAMIDU IBRAHIM	08081296986		✓	✓	
13	MUBARAK MMA	08085204365		✓	✓	
14	AMINU ABDURRAHMAN	08172334304		✓	✓	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT (ESIA) FOR THE INSTALLATION OF SOLAR-HYBRID INTERCONNECTED MINIGRID IN FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

ATTENDANCE

LOCATION: Gidan Kwano, Bosso DATE: 3rd Feb, 2016

S/N	Name	Phone No	Email	Organization/Community	Position	Signature
1	Peter Bassa	08137529764		Gidan Kwano		
2.	Abdulrahman Tunusa	07010220488		Gidan Kwano		
3	Abubakar Mohammed	07136999969		Gidan Kwano		
4.	Sadu Hamidu	08026608444		//		
5	Abubakar Sadu	07053784946		//		
6.	Anijo Buba	08073266958		Gidan Kwano		
7	Alh. Yauba. A Moh	07013404559		Gidan Kwano		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT (ESIA) FOR THE INSTALLATION OF SOLAR-HYBRID INTERCONNECTED MINIGRID IN FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

ATTENDANCE

LOCATION: Futminna DATE: 5th Feb, 2026

S/N	Name	Phone No	Email	Organization/Community	Position	Signature
1	Zainab Mohammed	08135112514		Futminna	Staff	
2	Hauwa Mohammed	08157116844		//	//	
3.	Sadiq Sabo Ahmed	07089908999		//	//	
4.	Bello Hamza Ewuro	08163618214		//	//	
5	Abubakar Ahmed	07864786368		//	//	
6.	Ahmad Mohammed.	08033758795		//	/	
7.	Arc. MB Sayo	08168618126		//	/	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT (ESIA) FOR THE INSTALLATION OF SOLAR-HYBRID INTERCONNECTED MINIGRID IN FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

ATTENDANCE

LOCATION: FUTMINNA DATE: 5th Feb, 2024

S/N	Name	Phone No	Email	Organization/Community	Position	Signature
8	Desmond opara	08138551886		PLOT ELDS	RAP/ESS	
9.	Steph Chori Bulus	08026971899				
10						