NIGERIAN ELECTRIFICATION PROJECT

RURAL ELECTRIFICATION AGENCY

ENERGY = EMPOWERMENT = EFFICIENCY

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

OF THE PROPOSED

5 MW SOLAR-HYBRID POWER PLANT AND ASSOCIATED INFRASTRUCTURE

At

FEDERAL UNIVERSITY OF TECHNOLOGY (FUTB) BABURA, JIGAWA STATE (LOT 1 – NORTHWEST) UNDER THE NIGERIA ELECTRIFICATION PROJECT (DESERT TO POWER) PHASE II

SUBMITTED TO:

FEDERAL MINISTRY OF ENVIRONMENT, ABUJA

DRAFT REPORT **SEPTEMBER 2026**

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

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Project Consultant: **BOLBEN ENERGY AND ENVIRONMENTAL SERVICES LIMITED**

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LIST OF ACRONYMS, UNITS AND ABBREVIATIONS

Cubic metres	(m^3)
Decibel	(dB)
Hectare	(Ha)
Hertz	(Hz)
Kelvin	(K)
Kilometres	(Km)
Kilovolt-ampere	(kVA)
Kilovolts	(Kv)
Kilowatts	(Kw)
Megawatt	(MW)
Meter per second	(m/s)
Metres	(M)
Volt	(V or E)
Watt per square meter	(W/m^2)
Watt	(W)
AfDB	African Development Bank
AIDS	Acquired Immunodeficiency Syndrome
APPI	Area of Potential Project Influence
ARAP	Abbreviated Resettlement Action Plan
ASUU	Academic Staff Union of Universities
BMP	Biodiversity Management Plan
BOD	Biochemical Oxygen Demand
COPE	Care of the People
CWD	Coarse woody debris
DISCOs	Distribution Companies
DRG	Debt Relief Gains
EA	Environmental Assessment, and Modification Reports
ECN	Energy Commission of Nigeria
EEP	Energizing Education Programme
EIA	Environmental Impact Assessment

EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EMS	Environmental Management System
EMP	Environmental Management Plan
ESC	Erosion and sediment control
ESCP	Erosion and Sediment Control Plan
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
FEED	Front End Engineering Design
FEC	Federal Executive Council
FEPA	Federal Environmental Protection Agency
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
HSE	Health, Safety, and Environment
HT	High Tension
ICREEE	Inter-ministerial Committee on Renewable Energy and Energy Efficiency
IPP	Independent Power Project
LGA	Local Government Area
LT	Low Tension
NACOP	National Council on Power
NASU	Non-Academic Staff Union
NEEAP	National Energy Efficiency Action Plan
NEP	Nigeria Electrification Project
NEPP	National Electric Power Policy
NERC	Nigerian Electricity Regulatory Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NiMET	Nigerian Meteorological Agency
NML	Noise Management Level
NOx	Nitrogen oxides

NSIFT	National Social Insurance Trust Fund
NUC	National University Commission
O&M	Operations and maintenance
PAPs	Project Affected Persons
PCT	Plant Community Type
PESCP	Progressive Erosion and Sediment Control Plan (aka ESCP)
PMP	Project Management Plan
POCR	Pre-operation Compliance Report
RAP	Resettlement Action Plan
RAV	restricted access vehicles
RBL	Rating Background Level
REA	Rural Electrification Agency
SEforAll	Sustainable Energy for All
Sp./spp.	Species/species (plural)
STEL	Short Term Exposure Limit
SWMP	Soil and Water Management Plan
TCN	Transmission Company of Nigeria
TCP	Traffic Control Plans
TMP	Traffic Management Plan
TWA	Time Weighted Average
VEZ	Vegetation exclusion zone (different to Asset protection zone surrounding infrastructure)
VLMP	Vegetation and Land Management Plan
WMP	Waste Management Plan
WTCs	Workshop Training Centres
WPMP	Weed and Pest Management Plan

EXECUTIVE SUMMARY

ES 1 INTRODUCTION

The Federal Government of Nigeria (FGN), through the Rural Electrification Agency (REA), is seeking financing from the African Development Bank (AfDB) under the Nigeria Electrification Project (NEP) – Desert to Power Phase II. Part of this financing shall be allocated for consultancy services for the preparation of Environmental and Social Impact Assessments (ESIAs) for selected Federal Universities under the Energizing Education Program (EEP).

The Energizing Education Program (EEP) is a strategic Federal Government of Nigeria initiative aimed at developing dedicated off-grid and solar-hybrid independent power plants, as well as rehabilitating and strengthening existing distribution infrastructure, in order to provide clean, reliable, and sustainable electricity to Federal Universities and affiliated University Teaching Hospitals across the country.

Under this program, beneficiary institutions will receive:

- Utility-scale solar-hybrid mini-grid systems exceeding 1 Megawatt (MW) capacity;
- Rehabilitation and upgrading of internal distribution networks;
- Solar-powered street lighting systems for improved illumination and campus security;
- Establishment of world-class Renewable Energy Workshop and Training Centres to enhance local capacity development in solar power engineering, operations, and maintenance.

This ESIA Report has been prepared specifically for the proposed 5-Megawatt (MW) Solar-Hybrid Power Plant and Associated Infrastructure at the Federal University of Technology (FUT) Babura, Jigawa State, North-West Nigeria. The Project will occupy 10 hectares of land within the permanent campus of FUT Babura in Babura Local Government Area of Jigawa State.

The 5 MW solar-hybrid power system will consist of:

- Ground-mounted solar photovoltaic (PV) arrays;
- Lithium-ion Battery Energy Storage System (BESS);
- Inverters, transformers, and switchgear;
- Substation and internal transmission/distribution network;
- Solar-powered street lighting infrastructure;
- Control room and operations building;
- Renewable Energy Workshop and Training Centre;
- Perimeter fencing, security installations, and ancillary facilities.

The Project is designed to:

- Provide uninterrupted power supply to support teaching, research, and innovation;
- Reduce reliance on diesel generators and unstable grid supply;
- Enhance institutional productivity and academic excellence;
- Improve safety and security on the campus for enhanced learning;

- Contribute to Nigeria's renewable energy transition and climate change mitigation commitments.

The ESIA has been conducted in accordance with national environmental legislation, African Development Bank Integrated Safeguards System (ISS, 2024), and international best practices to ensure that all environmental and social risks are properly identified, assessed, and mitigated throughout the Project lifecycle.

Legal and Administrative Framework

In order to establish the proposed 5 MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura, Jigawa State, full compliance with applicable Federal, State, and International laws, regulations, guidelines, and conventions is required. The ESIA has therefore been undertaken within the framework of the following legal and institutional instruments with the applicable National Laws and Regulations including:

a) **Electricity Act, 2023 -** The Electricity Act, 2023 is the principal legislation governing the generation, transmission, distribution, and supply of electricity in Nigeria. The Act promotes a competitive electricity market and encourages private sector participation in the power sector. It also supports the development of renewable energy and improved access to electricity. The Act requires electricity projects to comply with applicable environmental and regulatory requirements. Consequently, projects must obtain the necessary permits and approvals from relevant authorities and implement measures to minimize environmental and social impacts.
b) **Environmental Impact Assessment (EIA) Act CAP E12 LFN 2004** – Provides the statutory basis for environmental assessment of projects likely to have significant environmental impacts and mandates approval from the Federal Ministry of Environment (FMEnv).
c) **EIA Sectoral Guidelines for Power Sector (2013)** – Provides sector-specific guidance for power generation, transmission, and distribution projects. In addition, relevant EIA guidelines for Renewable Energy projects were consulted to ensure that environmental and social considerations specific to renewable energy technologies are adequately addressed.
d) **FMEnv EIA Procedural Guidelines (2017, updated 2021)** – Defines procedures for ESIA preparation, review, disclosure, and certification in Nigeria. The 2021 updated version of the guideline was also consulted and applied in preparing this ESIA. The update provides revised procedural requirements for screening, review, and approval processes.
e) **National Policy on the Environment 2016** – Establishes Nigeria's environmental management principles.
f) **Climate Change Act 2021** – Provides legal framework for achieving low greenhouse gas emissions and climate-resilient development.
g) **National Environmental (Protection of Endangered Species in International Trade) Regulations, S. I. No. 16, 2011:** Provides measures for the protection and conservation of endangered species by regulating their collection, possession, transportation, and international trade.
h) **National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, S. I. No. 15, 2011:** Establishes controls on bush, forest fires, and open burning to prevent environmental degradation, air pollution, and damage to vegetation and property.

i) **National Environmental (Desertification Control and Drought Mitigation) Regulations, S. I. No. 13, 2011:** Provides measures for preventing and controlling desertification and mitigating the environmental and socio-economic impacts of drought.

j) **National Environmental (Wetlands, River Banks and Lake Shores) Regulations, S. I. No. 26, 2009:** Provides for the protection and sustainable management of wetlands, river banks, and lake shores by controlling activities that may cause erosion, pollution, degradation, or loss of these ecosystems.

k) **Nigeria's Nationally Determined Contributions (NDC 3.0) under the Paris Agreement (2025)** – Nigeria's NDC 3.0, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2025, sets out the country's updated commitments to greenhouse gas emission reduction, climate change mitigation and adaptation, and sustainable development. The NDC 3.0 strengthens Nigeria's climate action across key sectors, including energy, transport, oil and gas, agriculture, waste, and land use, with emphasis on low-carbon development, renewable energy deployment, energy efficiency, and climate resilience.
This ESIA aligns with the objectives of the updated NDC to support emissions reduction and sustainable development.

l) **Guidelines on Environmental Audit (2010)** – Provides compliance monitoring framework.

m) **National Environmental Standards and Regulations Enforcement Agency (NESREA) Act (2007)** and sectoral regulations – Regulates environmental standards compliance.

n) **Public Health Act CAP 103 LFN 1995** – Addresses public health protection measures.

o) **Electric Power Sector Reform Act, 2005** – Governs electricity generation, transmission, and distribution in Nigeria.

p) **Roadmap for Power Sector Reform (2010)** – Guides reforms in the Nigerian power sector.

q) **National Energy Policy (2013)** – Promotes renewable energy integration.

r) **Nigerian Electricity Regulatory Commission (NERC) Act (2005)** – Regulates electricity market operations.

s) **Energy Commission of Nigeria Act No. 19 of 1989** – Oversees national energy planning.

t) **Land Use Act CAP L5 LFN 2004** – Governs land acquisition and land rights in Nigeria.

u) **Penal Code Act CAP 53 LFN 2008** – Addresses legal enforcement.

v) **Nigerian Urban and Regional Planning Act CAP N138 LFN 2004** – Regulates land development and planning.

w) **Employees Compensation Act 2010** – Provides compensation framework for workplace injuries.

x) **FMEnv Abandonment and Decommissioning Guidelines (1995, updated framework 2017)** – Guides closure and restoration of facilities.

y) **Jigawa State Ministry of Environment Regulations** – State-level environmental oversight.

z) **Jigawa State Ministry of Lands and Survey Regulations** – Governs land allocation and surveying requirements.

aa) **Babura Local Government Authority Regulations** – Local administrative compliance.

The applicable International Conventions and Safeguards include:

a) **African Development Bank (AfDB) Integrated Safeguards System (ISS, 2023)** – The AfDB ISS provides a comprehensive framework for environmental and social risk management in development projects. The updated ISS (2023) includes ten Operational Safeguards (OS1–OS10), which replaced the earlier five-safeguard (OS1–OS5), structure under the 2013 version. These safeguards cover key areas such as environmental and social assessment, resettlement, biodiversity conservation, pollution prevention, labor conditions, and stakeholder engagement. The ESIA has been prepared in accordance with the applicable requirements of the 2023 ISS framework.
b) **IFC Performance Standards on Environmental and Social Sustainability** – International benchmark for environmental and social risk management.
c) **International Union for Conservation of Nature (IUCN) Guidelines (1996)** – Biodiversity conservation standards.
d) **Convention on International Trade in Endangered Species (CITES), 1975** – Protection of endangered species.
e) **Convention Concerning the Protection of the World Cultural and Natural Heritage (1972)** – Safeguards cultural heritage.
f) **United Nations Framework Convention on Climate Change (UNFCCC), 1992** – International climate treaty.
g) **Paris Agreement (2015)** – Global climate mitigation commitment.
h) **ILO Conventions** – Labour standards and workers' rights.

The ESIA for the proposed 5 MW Solar-Hybrid Power Plant at FUT Babura has been prepared to ensure alignment with all applicable statutory requirements and international safeguard obligations, thereby facilitating environmental approval, AfDB no-objection, and sustainable project implementation.

ES 2 PROJECT JUSTIFICATION

Need for the Project

The justification for the proposed 5 MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura, Jigawa State is primarily based on the urgent need to provide stable, reliable, and sustainable electricity supply to Nigeria's Federal Universities in order to strengthen research output, technological innovation, academic excellence, and institutional productivity.

Federal universities in Nigeria, particularly emerging institutions such as FUT Babura, face persistent electricity challenges characterized by:

- Unstable grid supply;
- Frequent outages;
- High dependence on diesel generators;
- Escalating operational energy costs;
- Disruptions to laboratory experiments and research;

- Limited power availability for workshops and ICT infrastructure.

As a University of Technology, FUT Babura requires continuous and quality power supply for:

- Science and Engineering laboratories;
- Renewable energy research facilities;
- Mechanical and electrical workshops;
- Computer and ICT centres;
- Administrative blocks;
- Student hostels;
- Campus-wide lighting and security systems.

The Energizing Education Programme (EEP), under the Nigeria Electrification Project (NEP), is part of the Federal Government's broader strategy to reform and stabilize energy supply within public tertiary institutions. It is also aligned with Nigeria's climate change mitigation commitments. The Project contributes directly to Nigeria's Nationally Determined Contributions (NDC 3,0) under the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC), which commits Nigeria to achieving at least a 20% reduction in greenhouse gas emissions by 2030 (unconditional target), with potential for 47% conditional reduction. By replacing diesel-based electricity generation and reducing grid instability, the 5 MW solar-hybrid system at FUT Babura will significantly lower carbon emissions while enhancing institutional performance.

Key Benefits of the Project

The benefits of the proposed Project include, but are not limited to, the following:

- **Stimulation of Academic and Research Activities:** Provision of constant and reliable electricity will significantly improve laboratory experiments, engineering simulations, fabrication processes, ICT systems, and research productivity within FUT Babura. This will enhance academic output and global competitiveness.
- **Improvement in Health and Safety Infrastructure:** Reliable power will support campus health facilities, water supply systems, emergency services, and improve safety systems across the University.
- **Reduction in Fossil Fuel Consumption:** The solar-hybrid system will drastically reduce reliance on diesel generators, thereby lowering fuel consumption, reducing greenhouse gas emissions, minimizing noise pollution, and decreasing air pollutant concentrations.
- **Reduction in Operational Costs:** The University will experience significant cost savings from reduced diesel procurement and generator maintenance. These savings can be redirected toward research development, infrastructure improvement, staff welfare, and student services.
- **Enhanced Campus Security and Social Interaction:** Solar-powered street lighting infrastructure will improve nighttime visibility, reduce opportunistic crimes, enhance movement within campus, and promote safer social interactions among students and staff.

- **Renewable Energy Capacity Development:** The establishment of a Renewable Energy Workshop and Training Centre under the Programme will provide hands-on technical training in solar power systems, battery storage, and smart grid technologies, enhancing employability and skill development among students.
- **Improvement in Livelihood Activities:** Reliable electricity supply supports small-scale businesses within the campus such as printing services, ICT hubs, food services, and other entrepreneurial ventures.
- **Direct and Indirect Employment Opportunities**: The Project will create employment during construction (skilled and unskilled labor), and during operations and maintenance phases, including technical, administrative, and security roles.
- **Local Economic Stimulation:** Procurement of materials, services, logistics, accommodation, and labor will contribute to the local economy of Babura and Jigawa State.
- **Institutional and Technical Collaboration:** The Project strengthens collaboration between:
  - Federal Government of Nigeria (FGN)
  - Rural Electrification Agency (REA)
  - African Development Bank (AfDB)
  - FUT Babura
  - Relevant Ministries, Departments and Agencies (MDAs)
- **Climate Change Mitigation Contribution:** The 5 MW solar-hybrid plant is estimated to generate approximately 8,000–8,500 MWh annually. The avoided emissions of about 5,500–5,800 tonnes CO_2/year were calculated by applying a diesel generator emission factor (≈0.65–0.70 kg CO_2/kWh) to the annual electricity generation.

Envisaged Sustainability of the Project

Technical Sustainability

The technical sustainability of the Project will be ensured through:

- Engagement of qualified and experienced EPC Contractor selected by REA;
- Compliance with international engineering standards and manufacturer specifications;
- Supervision by REA Project Management Unit (PMU);
- Oversight by FUT Babura Department of Works and Physical Planning;
- Deployment of high-efficiency solar PV modules and lithium-ion battery storage systems;
- Use of modern monitoring systems (SCADA-based performance tracking).

The design life of the solar PV system is approximately 25 years, while associated buildings such as the training center may exceed 40 years with proper maintenance. Upon completion of construction, an Operations and Maintenance (O&M) Contractor will be engaged to manage system performance in collaboration with university technical staff.

Economic Sustainability

The Project will significantly reduce diesel generator usage within FUT Babura, thereby lowering operational expenditures.

Key economic sustainability mechanisms include:

- Reduced electricity payments to the Distribution Company;
- Reduced diesel fuel procurement costs;
- Reduced generator service and replacement costs;
- Implementation of cost-reflective service charges for connected facilities within campus (including private businesses);
- Revenue reinvestment into operations and maintenance of the solar facility.

This model reduces dependency on Federal Government allocations and promotes institutional financial autonomy.

Environmental Sustainability

Environmental sustainability is achieved through:

- Utilization of renewable solar energy;
- Negligible greenhouse gas emissions during operation;
- Reduced air pollution compared to fossil fuel systems;
- Proper waste management protocols for batteries and electrical components;
- Establishment of REA PMU Environmental and Social Safeguards Specialists to oversee compliance;
- Diligent Implementation of the project-specific Environmental and Social Management Plan (ESMP) shall ensure the environmental sustainability of the project.

The Project aligns with Nigeria's transition toward low-carbon development pathways.

Social Sustainability

Stakeholder consultations were conducted as part of the ESIA process to ensure inclusive participation and transparency. The implementation of the project-specific ESMP shall ensure the social sustainability of the project.

The consultation process:

- Identified relevant stakeholders within FUT Babura and surrounding communities;
- Gathered concerns and expectations;
- Assessed community perception;
- Established early trust-building mechanisms.

A Stakeholder Engagement Plan (SEP) has been developed to guide ongoing engagement throughout the Project lifecycle. Additionally, a Grievance Redress Mechanism (GRM) has been established by REA to:

- Receive complaints;
- Address concerns promptly;

- Provide transparent conflict resolution channels;
- Ensure inclusivity, including gender-sensitive reporting mechanisms.

The commitment and support of the proponent to ensure the implementation of the ESMP should be included in the revised report.

Project Alternatives

In assessing the most suitable technology for the 5 MW solar-hybrid system at FUT Babura, several alternatives were evaluated based on:

- Environmental and social performance;
- Operational efficiency;
- Cost-effectiveness;
- Reliability under semi-arid climatic conditions;
- Lifecycle sustainability.

Alternatives considered included:

- Monocrystalline vs Polycrystalline PV modules;
- Fixed-tilt vs Tracking systems;
- Lithium-ion vs Lead-acid battery storage systems;
- Diesel-only generation;
- Grid-only reliance.

After evaluation, the preferred alternative is:

- High-efficiency photovoltaic (PV) modules suitable for high solar irradiance zones;
- Lithium-ion Battery Energy Storage System due to higher efficiency, longer lifespan, lower maintenance, and better performance under high temperature conditions.

This option provides optimal balance between environmental performance, reliability, and long-term sustainability.

ES 3 PROJECT DESCRIPTION

The Rationale for the Project

The proposed 5 MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura is part of the proposed solar-hybrid system that will address these challenges by providing a dedicated and cleaner source of electricity. The Project also supports Nigeria's Nationally Determined Contributions (NDC 3.0) under the Paris Agreement (2025) by promoting renewable energy and reducing greenhouse gas emissions. Furthermore, it aligns with the Power Sector Recovery Programme (PSRP) approved by the Federal Executive Council (FEC) on 22 March 2017, which aims to improve reliability and sustainability in Nigeria's power sector.

Project Site and Location

The Project is located within the permanent campus of the Federal University of Technology (FUT) Babura in Babura Local Government Area of Jigawa State, North-West Nigeria. The proposed solar

facility will occupy approximately 10 hectares of land within the University premises. The site lies within the Sudan/Sahel Savanna ecological zone and is characterized by semi-arid climatic conditions, high solar irradiance, and relatively flat terrain. These characteristics make the location technically suitable for solar photovoltaic installation. The selected site is within University-owned land and does not fall within protected ecological areas or major water bodies. Its proximity to existing campus infrastructure allows for efficient integration into the University's internal power distribution network.

Project Components and Activities

The EEP Phase implementation at FUT Babura will be established as a 5 MW solar-hybrid power system. The Project will consist of solar photovoltaic panels, lithium-ion battery storage, electrical infrastructure, and supporting facilities within the 10-hectare site.

The major components include:

- A ground-mounted solar PV farm installed on fixed-tilt mounting structures;
- Lithium-ion Battery Energy Storage System (BESS) to ensure power stability and nighttime supply;
- A substation with transformers and switchgear for voltage regulation and power evacuation;
- Internal transmission lines and solar-powered street lighting within the campus;
- Buildings including a control room, site office, and Renewable Energy Workshop/Training Centre.

Construction activities will involve site preparation, installation of mounting structures, panel installation, cable laying, substation construction, and system testing. During operation, routine maintenance, monitoring, and system performance checks will be carried out to ensure long-term efficiency. The solar panels will be mounted on fixed structures designed for durability under the climatic conditions of Jigawa State.

ES 4 DESCRIPTION OF THE PROJECT EXISTING ENVIRONMENT

The description of the environmental and social conditions of the proposed 5 MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura is based on both desktop studies and detailed field investigations. Field sampling and surveys were conducted within an approximate 500-metre spatial boundary around the proposed project footprint. A multidisciplinary team of environmental and social specialists undertook the baseline assessment. Quality Assurance and Quality Control (QA/QC) procedures were strictly observed to ensure that samples collected were properly preserved, transported, and analysed under stable laboratory conditions. The collected samples were analysed for relevant physicochemical and microbiological parameters in order to establish reliable baseline conditions against which future project impacts can be evaluated. The baseline environmental components assessed include climate and meteorology, air quality and noise, soil characteristics, groundwater conditions, vegetation, wildlife, and socio-economic conditions.

Climate and Meteorology

Secondary meteorological data for the study area were obtained from the Nigerian Meteorological Agency (NiMet). Given the geographical proximity and data reliability considerations, long-term meteorological records from the nearest operational NiMet station covering the North-West region were reviewed. The dataset examined covered approximately the past decade (2011–2021), providing a representative understanding of prevailing climatic trends relevant to the FUT Babura project area. Nigeria's climate is largely influenced by the seasonal movement of the Inter-Tropical Convergence Zone (ITCZ), which oscillates north and south of the equator.

The project area in Babura, Jigawa State, falls within the semi-arid climatic zone of Northern Nigeria. The climate is characterized by two distinct seasons:

- A prolonged hot dry season, typically from October to May, often accompanied by Harmattan conditions between December and February;
- A relatively short rainy season, usually from June to September.

Temperatures in the area are generally high, particularly during the peak dry season months, while rainfall is moderate and seasonal. The high solar irradiance levels associated with this climatic regime make the area technically suitable for solar photovoltaic energy generation. However, the semi-arid conditions also imply seasonal dust events, which are relevant considerations for solar panel maintenance and operational planning.

Geology

The project area is located within the Guinean forest-savanna mosaic zone which is a distinctive ecological region characterized by a blend of forested areas and savannas, creating a diverse landscape. Geology, the study of rocks, minerals and the physical make-up of the solid earth, determines the environment and national resources. Also, the industrial potential and wealth of a nation. After climate, geological factor agent, is perhaps, the greatest impact on economic activities, since soil, water supply and vegetation are, to a large extent, influenced by the nature of the underlying rock.

Ecology and Biodiversity

The project ecological zone is defined by open woodland interspersed with grasses and drought-resistant shrubs. Vegetation cover is generally discontinuous rather than dense, allowing wide visibility across the landscape and reinforcing the visual impression of openness that characterizes the Babura area. Within the proposed solar site, plant cover consists primarily of scattered trees and shrubs with seasonal grasses occupying the understory. During the dry season, much of the herbaceous vegetation becomes sparse and desiccated, while woody species retain structural dominance in the landscape.

The dominant tree and shrub species recorded during the survey include:

- **Acacia spp.** – commonly referred to as thorn trees or gum Arabic trees, recognizable by their umbrella-shaped canopies and adaptive spines that reduce water loss and

deter browsing.

- **Ziziphus spp.** – commonly known as the jujube tree, a hardy species that produces small edible fruits and thrives in arid environments.
- **Cassia spp.** (Senna species) – commonly called senna trees, known for their compound leaves and yellow flowering structures.
- **Ficus spp.** – fig trees, which provide shade and fruit for wildlife and livestock.
- **Combretum spp.** – commonly known as bushwillow, a drought-tolerant shrub or small tree frequently encountered in savanna landscapes.

Overall, the biological environment can be described as typical of a semi-arid, human- influenced savanna landscape with moderate ecological value. No endangered, rare, or legally protected wildlife species were recorded within the project footprint or immediate Area of Influence. The ecological integrity of the site has already been shaped by long-standing human activities such as livestock grazing, small-scale agriculture, and fuelwood harvesting. The site does not serve as:

- A migratory wildlife corridor
- A breeding ground for threatened species
- A designated conservation area

Stakeholder Engagement

Stakeholder Consultation was carried out on the 6th February 2026 as an integral component of the ESIA process for the proposed 5 MW Solar-Hybrid Power Plant at FUT Babura. The engagement process involved stakeholder identification and analysis, consultations with institutional representatives, community members, and relevant regulatory authorities. The consultations served multiple purposes:

- To inform stakeholders about the nature and scope of the proposed Project;
- To gather local knowledge and baseline information;
- To identify potential concerns and expectations;
- To promote transparency and early conflict prevention.

Fifty (50) structured questionnaires were administered systematically to selected respondents within and around the University. Forty-five (45) were retrieved, yielding a response rate of approximately 90%. The sample size reflected the prevailing conditions at the time of the study, noting that public universities nationwide were on industrial strike, resulting in reduced campus population during the survey period.

A Stakeholder Engagement Plan (SEP) and Grievance Redress Mechanism (GRM) have been developed to ensure continuous consultation, transparent communication, and structured handling of complaints throughout the project lifecycle.

ES 5 ASSOCIATED AND POTENTIAL IMPACTS OF THE PROJECT

The assessment of potential environmental and social impacts associated with the proposed 5 MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura was carried out using a systematic and structured methodology. An interaction matrix was developed to identify the relationship between project activities (pre-construction, construction, commissioning, and operation phases) and key environmental and social receptors, including soil, vegetation, air quality, groundwater, biodiversity, socio-economic conditions, and occupational health and safety.

Following impact identification, a Risk Assessment Matrix was applied to screen and rank potential impacts based on:

- Nature of impact (positive or negative);
- Magnitude;
- Duration (short-term or long-term);
- Spatial extent (site-specific or wider area);
- Reversibility;
- Likelihood of occurrence.

Summary of Potential Impacts

Pre-Construction Phase

- Vegetation loss *(Minor)*
- Removal of top soil and soil compaction associated with site clearing *(Minor)*
- Increase in ambient noise levels (*Minor*)
- Air quality impacts due to emission from site clearing equipment (*Minor*)
- Injuries and accidents to workers during site clearing and preparation. (*Minor*)
- Injuries and accidents to workers during loading and off- loading construction materials. (Minor)

Construction Phase

- Increased erosion potential as a result of construction activities such as excavation (*Moderate*)
- Increase in dust from cleared land and windblown stockpiles (*Moderate*)
- Increase in noise level due to construction activities; (*Minor*)
- Increased runoff from hard standing areas could result in creation of drainage lines, which could impact on site infrastructure. (*Minor*)
- 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. (*Minor*)
- Loss of fauna as a result of increased human activity and associated noise. (*Minor*)
- Road damage, traffic and safety impacts. (*Minor*)
- Discrimination during employment and training opportunities (*Minor*)
- Injury to construction workers during construction activities. (*Moderate*)
- Influx of people, increase in sexual transmitted diseases. (*Moderate*)

- Soil contamination from solid and liquid construction waste streams. (*Minor*)
- Disposal of construction wastes to existing waste management facility in the Project area. (*Minor*)
- Groundwater contamination (*Minor*)

Commissioning Phase

- Increase in ambient noise level (*Minor*)
- Occupational and health hazards (eg., electrocution, wrong electrical connection) (*Moderate*)
- Wrong electrical connection leading to explosion/fire. (*Minor*)

Operational Phase

- Electric shock, injuries to personnel associated with the Power Plant operations, (*Moderate*)
- Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions (*Moderate*)
- Discrimination during employment and training opportunities (*Moderate*)
- GBV (sexual harassment, intimate partner violence, poor working) (*Moderate*)
- Soil contamination from used/spent batteries and inverters. (*Minor*)
- Electric shock, injuries to personnel during maintenance (*Minor*)
- Groundwater abstraction from cleaning of PV panels(*Minor*)

ES 6 MITIGATION MEASURES

The mitigation measures proposed for the 5 MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura are designed to address all significant adverse environmental and social impacts identified during the impact assessment phase. The measures are structured according to the project lifecycle, namely: pre-construction, construction, commissioning, and operation & maintenance phases. The implementation of these measures will be supervised by the Rural Electrification Agency (REA) Project Management Unit (PMU) and executed primarily by the Engineering, Procurement and Construction (EPC) Contractor and subsequently the Operations and Maintenance (O&M) Contractor.

The HSE Policy will remain active throughout the project lifespan. Safety signage will be maintained at strategic points across the facility. Employees will be required to comply strictly with established Standard Operating Procedures (SOPs). The Grievance Redress Mechanism (GRM) will remain operational throughout the project lifecycle to address concerns raised by workers or stakeholders. The GBV Action Plan will also remain in effect, and all employees will continue to sign and adhere to the Code of Conduct. The O&M Contractor will employ a Gender/GBV Officer and maintain collaboration with relevant government institutions or service providers where necessary. Gender-segregated sanitary facilities will be maintained on-site.

An approved Waste Management Plan (WMP) will be implemented and periodically reviewed to ensure effective handling of operational waste, including eventual battery replacement and end-of-life component management. Overall, the implementation of these mitigation measures ensures that adverse

environmental and social impacts associated with the proposed 5 MW Solar-Hybrid Power Plant at FUT Babura are minimized to acceptable levels in accordance with national regulations and AfDB safeguard requirements. Following the identification of potential impact identified in the previous section a summary of the mitigation measures is presented in this section:

Summary of Mitigation Measures

Pre-Construction Phase

- The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited. (*Negligible*)
- Removal of vegetation and soil cover shall be restricted to the areas required for the Project. (*Negligible*)
- Site clearing equipment / machinery shall be operated and maintained under optimum fuel-efficient conditions. (*Negligible*)
- Noise suppression equipment shall be fitted on machinery. (*Negligible*)
- Site clearing shall be limited to the daytime as much as possible. (*Negligible*)
- All materials with potential to result in dust emissions shall be covered during transport. (*Negligible*)
- Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided. (*Negligible*)
- Provision of adequate PPE, especially gloves and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties. (*Negligible*)

Construction Phase

- Disturbed areas shall be rehabilitated with erosion control plants (using native plant species) as soon as possible to prevent erosion. (*Minor*)
- Routine water sprinkling shall be carried out to minimize dust generation during construction. (*Negligible*)
- Construction activities shall be limited to daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). If 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. (*Negligible*)
- The EPC Contractor will be required to design appropriate drainage system that takes due regard of the natural drainage system; (*Negligible*)
- Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities. (*Negligible*)
- Speed limits for all construction-related vehicles should be established and enforced. (*Negligible*)
- All workers on the project shall be required to sign a code of conduct to prohibit any form of Gender

Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) (*Negligible*)

- Health and Safety Plan shall be developed and implemented. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence. (*Minor*)
- 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. (*Minor*)
- Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. (*Negligible*)

Commissioning Phase

- The inverters and batteries to be used for the Project shall meet industry best standard inrelation to noise attenuation. (*Negligible*)
- The Project components shall be installed in line with the pre-established standards and as per manufacturer's recommendations. (*Negligible*)
- Prior to the project commissioning, appropriate emergency equipment (such as first aid boxes, fire extinguishers) shall be provided onsite. (*Negligible*)

Operation Phase

- Training shall be provided to employees on emergency preparedness and responses. (*Minor*)
- Equal treatment of workers shall be ensured with Continuous implementation of GBV action plan for the Project (*Minor*)
- General housekeeping to ensure the site is not overgrown with grasses shall be maintained. (*Negligible*)
- Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. (*Negligible*)
- Manual cleaning of the PV panels with water shall be regulated as much as practicable. The frequency of cleaning PV panels with water shall be dependent on the rainfall pattern in the project area. (*Negligible*)

ES 7 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

The Environmental and Social Management Plan (ESMP) constitutes a core component of this Environmental and Social Impact Assessment (ESIA). It provides a structured framework for managing, monitoring, and mitigating the identified environmental and social impacts associated with the proposed 5 MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura.

The ESMP covers the entire lifecycle of the Project, including pre-construction, construction, commissioning, operation, and eventual decommissioning phases. It outlines:

- Specific mitigation measures;
- Desired environmental and social outcomes;
- Performance indicators;
- Monitoring parameters and frequency;
- Institutional responsibilities;

The total estimated cost of implementing the Environmental and Social Management Plan is **US$53,340**, equivalent to approximately **₦80,010,000** at the exchange rate of **₦1,500 per** US Dollar applied at the time of preparing this ESIA. The estimate covers pre-construction, construction, initial operational and commissioning activities, direct mitigation measures, capacity building and training over an approximately 24-month implementation period. A detailed breakdown of the ESMP implementation cost is provided in Section 7.10 and Table 7.13 of this report.

Cost of ESMP Implementation

S/N	ESMP Activities	Cost (USD)
1	**Pre-Construction Phase Implementation** (disclosure, staffing, approvals, early monitoring)	6,800
	Construction Phase ESMP Implementation (monitoring, mitigation execution, supervision, reporting)	12,990
	Operational Phase ESMP Implementation (Initial Period) (monitoring, waste management oversight, safety compliance)	12,800
	Commissioning Phase ESMP Activities (inspection, testing oversight, reporting)	500
2	**Direct Mitigation Measures** (environmental controls, erosion measures, safety controls, signage, etc.)	6,100
3	Capacity Building and Training (Table 7.11)	14,150
TOTAL ESTIMATED ESMP COST		**53,340**

The recommended environmental and social management measures are detailed within the report, categorized by project phase and impact type.

The Rural Electrification Agency Project Management Unit (REA-PMU) shall retain principal oversight responsibility for the implementation of the ESMP. While certain responsibilities may be delegated to the EPC Contractor and subsequently to the Operations and Maintenance (O&M) Contractor, REA-PMU shall ensure compliance through supervision, audits, and performance reporting.

Relevant regulatory authorities at Federal, State, and Local Government levels, including the Federal Ministry of Environment and Jigawa State environmental agencies, shall participate in monitoring and compliance verification as required by law. Regular environmental and social monitoring will be conducted throughout the project phases to:

- Ensure adherence to national regulatory requirements;
- Evaluate the effectiveness of mitigation measures;
- Identify emerging risks;
- Implement corrective actions where necessary.

Stakeholder consultations initiated during the ESIA process shall continue throughout the Project lifecycle in accordance with the Stakeholder Engagement Plan (SEP), and the Grievance Redress Mechanism (GRM) shall remain active to address concerns in a timely and transparent manner.

ES 8: CONSULTATIONS, STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

Consultations formed a key component of the ESIA for the proposed 5 MW Solar Photovoltaic Power Plant at the Federal University of Technology (FUT) Babura, Jigawa State. A Stakeholder Engagement Plan (SEP) was prepared to guide systematic engagement throughout the project life cycle, including pre-construction, construction, operation and decommissioning phases. The process ensured that concerns, expectations and inputs of affected and interested parties were incorporated into project planning and decision-making.

Stakeholders engaged during the ESIA process included:

- University Management, staff and students
- Host community representatives
- Government and regulatory agencies
- Contractors and service providers
- Development partners

Consultation methods adopted comprised:

- Public consultation meetings
- Key Informant Interviews (KIIs)
- Focus Group Discussions (FGDs)
- Structured socioeconomic surveys
- Meetings with regulatory authorities

The consultation process complied with the Nigerian EIA Act (Cap E12 LFN 2004), FMEnv procedural requirements and applicable international safeguard standards. Feedback obtained indicated strong support for the Project, particularly due to expected benefits such as improved electricity reliability, reduced reliance on diesel generators, enhanced learning and research conditions, and overall environmental improvement. Information disclosure will be undertaken through placement of the ESIA in designated public locations, observance of the statutory 21-day disclosure period, and continuous communication throughout implementation. A Stakeholder Register will be maintained to document consultations, issues raised and follow-up actions.

A project-specific Grievance Redress Mechanism (GRM) has been established to provide a transparent and accessible platform for addressing complaints. The GRM:

- Allows submission of grievances verbally or in writing
- Maintains a formal Grievance Register
- Provides defined timelines for response and resolution
- Includes escalation procedures where required
- Ensures confidentiality and survivor-centered handling of GBV/SEA/SH-related cases

ES 9 SUMMARY AND CONCLUSION

The proposed 5 MW Solar-Hybrid Power Plant under the Energizing Education Programme (EEP) at the Federal University of Technology (FUT) Babura is an environmentally sustainable and socially beneficial development. The Project aligns with Nigeria's renewable energy transition objectives and contributes to climate change mitigation efforts under the Paris Agreement. It will significantly improve electricity reliability within the University, enhance research and academic performance, reduce diesel dependence, lower operational costs, and strengthen campus security through solar-powered street lighting.

Although certain adverse environmental and social impacts have been identified, these impacts are localized, manageable, and largely short-term in nature. Appropriate mitigation measures have been incorporated into the Environmental and Social Management Plan (ESMP), and institutional arrangements have been established to ensure effective implementation and monitoring.

Subject to full compliance with the mitigation measures and ESMP provisions outlined in this report, the proposed 5 MW Solar-Hybrid Power Plant at FUT Babura is considered environmentally acceptable and socially sustainable. It is therefore recommended for EIA Approval by the Federal Ministry of Environment and subsequent commencement of project implementation.

ACKNOWLEDGEMENT

The Rural Electrification Agency (REA) wishes to express its sincere appreciation to the Federal Government of Nigeria, the Federal Ministry of Finance, and the Federal Ministry of Environment for the opportunity granted to undertake this Environmental and Social Impact Assessment (ESIA) for the proposed 5 MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura, Jigawa State, Nigeria, under the Nigeria Electrification Project (NEP).

The Agency acknowledges the valuable contributions of the Environmental Consultant, Bolben Energy and Environmental Services Ltd, contracted to carry out this ESIA study. Their technical expertise, professional diligence, and commitment to environmental and social best practices were instrumental in the successful completion of this assessment.

We are particularly grateful to the Management and Staff of the Federal University of Technology (FUT) Babura for their cooperation, provision of relevant information, logistical support, and access to facilities throughout the duration of the study.

The Agency also appreciates the participation and constructive inputs of stakeholders, including community representatives, regulatory agencies, and other relevant institutions who contributed to the ESIA process through consultations and engagement activities.

Their collective support and collaboration have significantly enriched the quality and integrity of this assessment.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Nigeria has an estimated population of 211 million people (World Population Review, 2021), and a huge deficiency in access to electricity. Nigeria currently generates about 3,879 MW out of an installed capacity of 12,522 MW of electricity. Given the large population and rapidly developing industrial sectors, the power generated and distributed to the end customers is grossly inadequate.

The insufficiency of grid-supplied power hinders business productivity and growth throughout Nigeria. Nigeria's Power Sector Recovery Program (PSRP) estimates that the erratic supply of power results in an annual economic loss of more than US$25 billion (PSRP, 2018). One of the reasons for this power inadequacy is distribution losses. Distribution losses are often caused by faulty or outdated equipment which impacts technical performance. Other major issues and challenges in the distribution sub-sector are as follows:

- Long radial feeder routes
- Lack of redundancy/alternate feeds
- Overloaded equipment
- Lack of maintenance
- Inadequate funding for the electricity distribution business
- Environmental elements (e.g., corrosion, erosion, lightning)

Government investment in power generation and distribution has been unable to keep up with the demands, which has necessitated the Federal Government of Nigeria (FGN) to embark on a power sector reform program through which private sector participation is encouraged. The government is committed to promoting private sector investment in renewable energy projects as part of the Roadmap for Power Sector Reform and in line with the National Energy Policy. The Renewable Energy Master Plan (REMP), 2005 seeks to aggressively pursue the adoption and use of renewable energy to address the energy deficit in Nigeria.

Electricity supply is a pre-condition for poverty reduction and economic development. Nigeria agrees with the 17 Sustainable Development Goals (SDGs) – part of a wider 2030 agenda for Sustainable Development which builds on the Millennium Development Goals (MDGs) of the United Nations (UN). The goal 7 of the SDGs is ensuring universal access to affordable and clean energy.

Recognizing the need for action, The Federal Government of Nigeria (FGN) has set a goal to increase access to electricity to 75% and 90% by 2020 and 2030 respectively and at least 10% of the renewable energy mix by 2025 as contained in the National Electric Power Policy (NEPP) of 2001 and the Rural Electrification Policy of 2005 respectively (RESIP, 2016). It is in view of the foregoing that the Rural Electrification Agency (REA) proposes to install a solar photovoltaic power plant at Federal University of Technology, Babura, Babura Local Government Area, Jigawa State.

THE PROPONENT

Rural Electrification Agency (REA) is the Implementing Agency of the Federal Government of Nigeria (FGN) tasked with the electrification of unserved and underserved communities to catalyze economic growth and improve quality of life for Nigerians. The Agency had it Headquarters at No. 22 Freetown Street, Wuse 2, Abuja, Federal Capital Territory

The agency proposes to develop a solar power photovoltaic project of 5MW capacity within the premises of Federal University of Technology, Babura in Jigawa State. The project will provide electricity via Solar Photovoltaic (PV) systems to the Institution. The plant would generate electrical power by converting solar radiation into direct current (DC) electricity using solar panels that exhibit the photovoltaic effect and converting the DC power to alternating current (AC) by inverters and then evacuates the produced energy to a distribution network.

In line with the stipulations of the EIA Act CAP E12 LFN 2004 that all developmental projects likely to have impact on the environment be subject to the Environmental Impact Assessment (EIA) process. Rural Electrification Agency (REA) intends to conduct the ESIA study for the proposed 6.5MW Solar Power Project.

1.2 Overview of the Project

Solar Photovoltaic (PV) system converts sunlight directly into electricity. The key components of a PV power system are various types of photovoltaic cells (often called solar cells) interconnected and encapsulated to form a photovoltaic module, the mounting structure for the module or array, the inverter, the storage battery, and charge controller. The proposed solar project will have a sufficient power to run small industrial loads. The project will ensure the provision of safe and reliable power supply to the government agency.

1.3 Project Location

The proposed project would be sited on a piece of land measuring about 10.2Ha situated within the permanent campus of the Federal University of Technology Babura, Jigawa State. The geographical coordinates of the site are 12.7302583N, 9.0043292E.

Figure 1.1: Map of Nigeria highlighting Jigawa State.

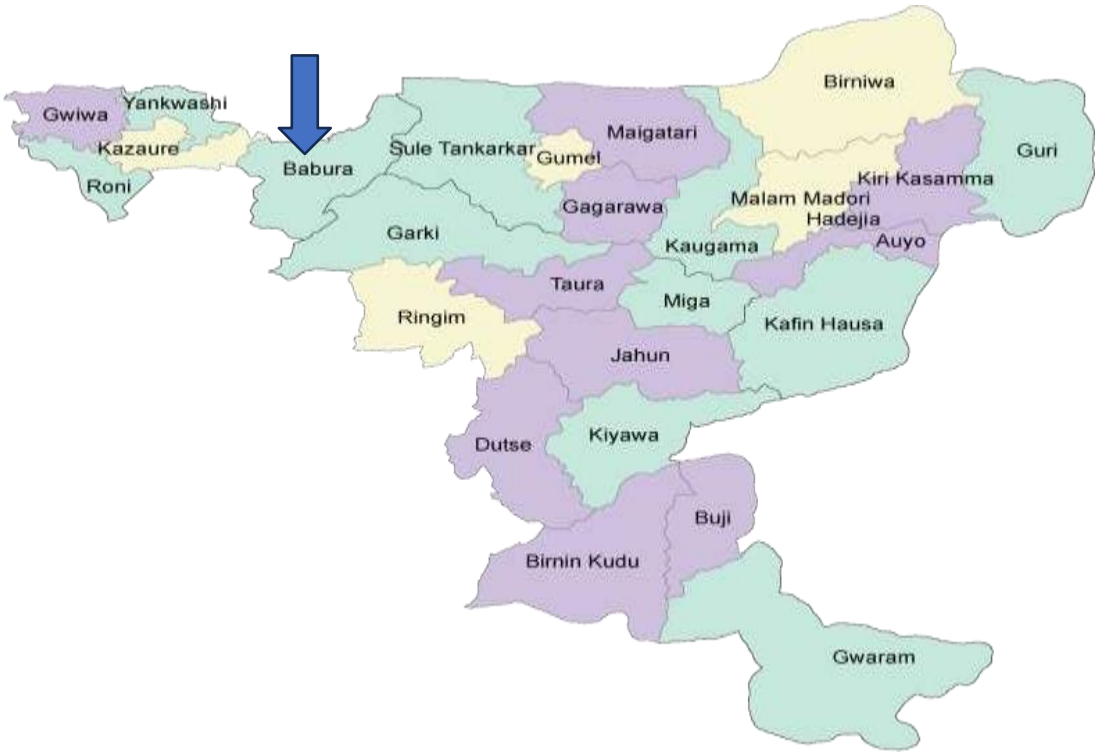

Figure 1.2 Map of Jigawa State indicating Babura LGA

1.4 EIA Objectives

The overall objective of the EIA is to put in place appropriate mitigation measures and management actions required to address and monitor the potential and associated environmental and social risks and impacts of the Project throughout its life cycle. This is to ensure that the Project is developed and operated in an environmentally sustainable manner. The specific objectives are to:

- Establish the existing state of the project environmental and social conditions and identify any sensitive components therein;
- Provide opportunity for engagement and consultations with all relevant and critical stakeholders and other interested parties, including regulatory agencies, non-governmental organizations, and residents in the project area;
- Identify aspects of the project that may interact positively or negatively with the environmental and social conditions of the project area.
- Measures will also be put in place to enhance the beneficial impacts of the project;
- Develop a project and location specific environmental and social management plan (ESMP) and procedures for effective and proactive management of potential risks and impacts associated with the project; and
- Provide all necessary data/evidence for the issuance of an ESIA Certificate for the project.

1.5 Scope of the ESIA

In accordance with the EIA Process of the Federal Ministry of Environment, a scope of work for the project was developed covering the following:

- Review of National and International laws, regulations and codes that are applicable to the project;
- Stakeholder engagement and consultations;
- Project description during all phases of the project (construction, operation, and decommissioning);
- Description of existing environmental conditions at the project location;
- Evaluation of potential and associated impacts of the project;
- Recommendation of appropriate mitigation measures and monitoring program covering the project life cycle.
- Preparation of draft and final EIA report

1.6 ESIA Methodology

The collection of environmental baseline data/information, environmental impact analysis and the preparation of the report were performed by a multi-disciplinary team. The team selection was based on characteristics of the project environment and experience/discipline of each specialist. A team leader coordinated the tasks and team members towards achieving set targets as well as liaison with client. The methods adopted in performing specific tasks of the EIA for the proposed Plant Project are as follows:

Desktop Research

The geography and the relevant environmental, socio-economic and health information on the proposed project location were gathered from maps, charts, articles, previous study reports on the area and similar environment, photographs, fisheries research publications, textbooks, etc. The information generated enabled definition of limits of the area to be assessed.

Field Data Collection

The information gathered from desktop consultation and site identification were used in categorizing the major habitats in the area, and their respective sampling requirements defined to effectively collect qualitative and quantitative data on the flora and fauna of the project area. The fieldwork covered all relevant elements of the ecological, socio-economic and health conditions to complement information obtained from desktop studies.

Consultation with Stakeholders and Experts

In order to more efficiently deliver improved project sustainability and protect the interest of the affected communities, especially the poor and vulnerable, an elaborate public consultation process was undertaken as part of this EIA. It involved engaging them in a dialogue characterized by two-way information flow.

Consultation allowed obtaining from the affected population information that might influence the

decision-making process in scoping, project design, mitigation, monitoring and management plans, as well as the analysis of alternatives to be implemented. The decision- making authorities (Rural Electrification Agency (REA), Jigawa State Environmental Protection Agency (JISEPA) as well as the Federal Ministry of Environment etc.) and the representatives of the host communities were consulted (as appropriate) for their opinions on issues relating to the potential ecological, socio-economic and health impacts of the proposed project.

Stakeholder Engagement Activities

Stakeholder engagement is a two-way process of communication between the project proponent and its stakeholders. It is a key aspect of the EIA process, allowing stakeholders to express their views about Project. It involves sharing information and knowledge, seeking to understand the concerns of others and building relationships based on collaboration, thereby allowing stakeholders to understand the risks, impacts and opportunities of a project in order to achieve positive outcomes.

Objectives of Stakeholders' Engagement

The objective of the engagement process is to present the proposed project and ESIA process to stakeholders and to identify associated potential issues, concerns and opportunities. This phase involved: identification of preliminary list of stakeholders; meetings with a number of government departments and stakeholder groups; and focus group discussions with local community members. Specifically, Rural Electrification Agency (REA) and her consultants consulted the following organizations:

- Federal Ministry of Environment;
- Jigawa State Environmental Protection Agency (JISEPA)
- Babura Local Government Council

Stakeholder Engagement Planning

The stakeholder engagement process followed the requirements of the Nigerian Environmental Impact Assessment Act No 86 (1992) as amended by EIA Act Cap E12 LFN 2004, and was also guided by environmental and social policies, guidelines and performance standards of the World Bank Group. To fulfill these requirements, the Project developed a plan for engagement with stakeholders that was aligned to key stages of the ESIA process. The plan included the following key steps.

- Identification of stakeholders and mechanisms for their engagement (meetings, letters, press releases, etc);
- Development of project information for and a Background Information document (BID) to convey high level project information and provide an overview of the project and potential impacts; and
- Identification of where in the EIA process certain stakeholders should be contacted and how'

Disclosure

During disclosure, this ESIA report will be submitted to the FMEnv. The relevant authorities will determine the level of engagement required during disclosure of the ESIA report and meetings with the local communities. The objective of this engagement would be to explain the results of the EIA and to obtain feedback.

Grievance Redress Mechanism

International standards require that a grievance mechanism be put in place. A grievance mechanism is a company process that enables any stakeholder to make a complaint or a suggestion about the way a project is being implemented and that provides a mechanism for follow-up and resolution, if appropriate.

Impact Identification and Evaluation

The environmental aspects of the proposed project that may interact positively or negatively with the environment at the construction, operation and decommissioning phases were identified at this stage of the assessment. The FMEnv's EIA Sectoral Guidelines for Infrastructure projects, the World Bank Environmental Source Book and Risk Assessment report, among other information, were used in the process.

The ISO 14001 – Environmental Management System approach was adopted in evaluating the potential and associated impacts of the project on the environment.

Impact Mitigation

Mitigation measures designed to prevent, reduce or control the adverse impacts of the proposed project activities were proffered using professional judgment based on scientific deductions and project experience. Other resource materials also consulted include the FMEnv's EIA Sectoral Guidelines for Infrastructures projects, the African Development Bank ISS and guidance notes etc. Similarly, enhancement measures were proffered to ensure that beneficial impacts of the project are optimized. Furthermore, post-auditing or monitoring has been designed into the social and environmental management plan of the proposed project to allow for continual operations improvement.

The flowchart presented as ***Figure 1.3*** summarizes the general approach adopted in this EIA.

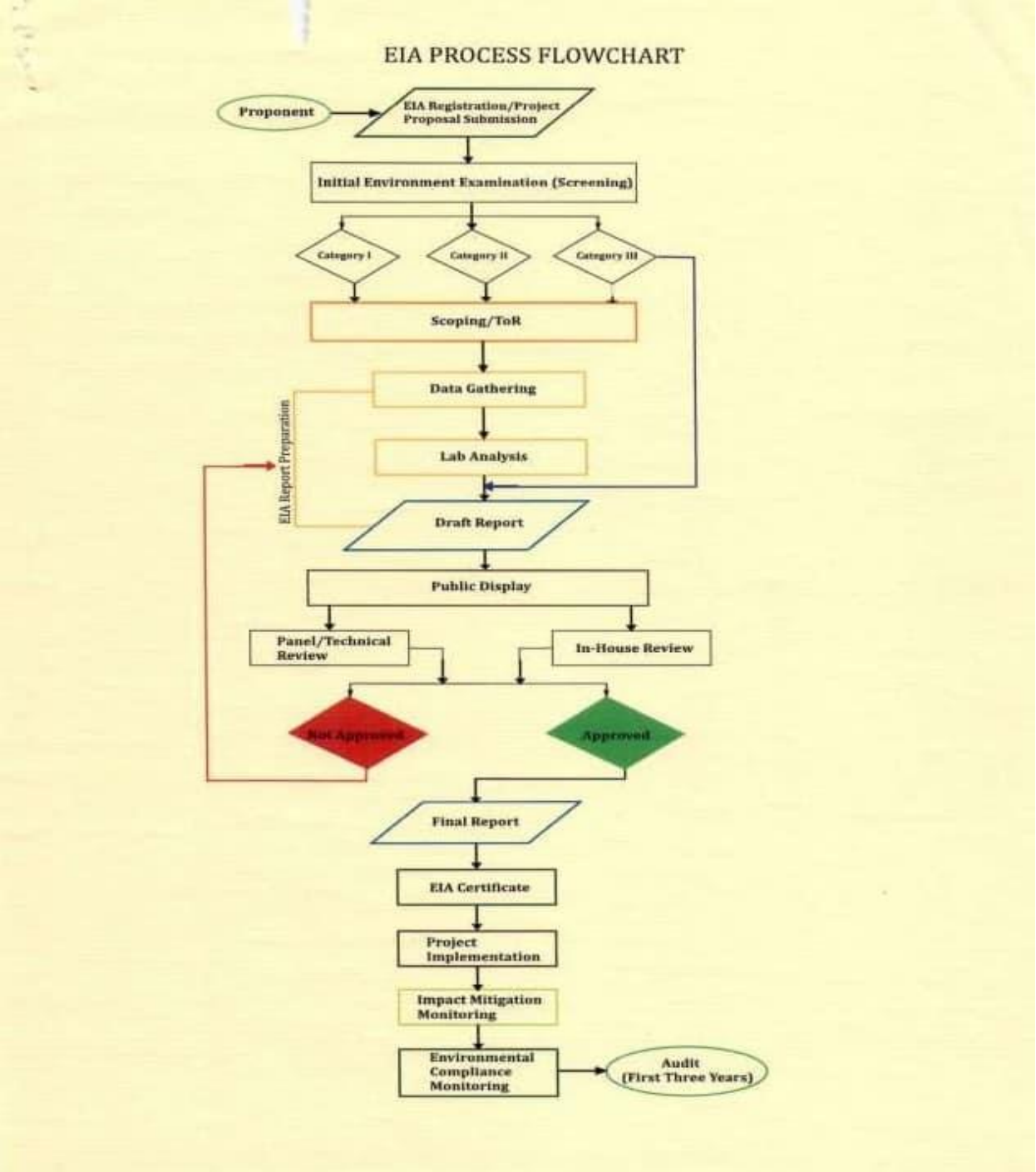

Figure 1.3: The Federal Ministry of Environment EIA Process Diagram.

1.7 Administrative and Legal Framework

In this section, an overview of the relevant statutory regulations, legislation and guidelines to the proposed Project and the EIA study is provided. The Project shall ensure compliance with the applicable local and international regulations and standards throughout its life cycle.

1.7.1 Applicable National Policies Nigerian National Energy Policy (2004)

The National Energy Policy mandates the protection of the environment in the exploitation of Nigeria's fossil fuels. It also emphasizes the exploration of renewable and alternative energy sources. The policy objectives are:

- Ensure the development of the nation's energy resources with diversified options for national energy security and efficient energy delivery
- Guarantee increased contribution of energy productive activities to national income;
- Guarantee adequate, reliable and sustainable supply of energy at appropriate costs and in an environmentally friendly manner
- Guarantee an efficient and cost-effective consumption pattern of energy resources;
- Accelerate the process of acquisition of technology and managerial expertise in the energy sector and indigenous participation in energy sector industries,
- Promote increased investments and development of energy sector industries with substantial private sector participation;
- Ensure comprehensive, integrated and well-informed energy sector plans and programmes for effective development;
- Foster cooperation in energy trade and projects development regionally and globally; and
- Successfully use the nation's abundant energy resources to promote international cooperation.

Renewable Electricity Policy (2006)

Renewable energy is a key aspect of the national strategy to increase access to electricity. The objectives of the policy are to:

- Expand electricity generating capacity to meet national economic and social development goals;
- Encourage the diversification of energy sources through renewable energy;
- Increase access to electricity services nationwide, especially in rural areas;
- Stimulate growth in employment generation through and expanded renewable electricity industry;
- Enhance development through domestic manufacturing of renewable electricity components;
- Promote renewable energy market through cost-reducing incentives;
- Provide effective protection to consumers through regulation; and
- Reduce air pollution and greenhouse gas emissions.

National Policy on the Environment (2016)

Nigeria is committed to safeguarding the country's natural and built environment for the use of present and future generations. This commitment demands efficient resource use and the reduction of environmental impacts of all developmental activities. The policy aims to:

- Achieve sustainable development and secure quality of environment adequate for good health and wellbeing;
- Conserve and use the environment and natural resources for the benefit of present and future generations;
- Restore, maintain and enhance the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity.
- Raise public awareness and participation, and promote understanding of the essential linkages between the environment, resources and development,

National Electric Power Policy (2001)

The Policy set the following as critical objectives for Nigeria's electric power sector:

- Ensure that the power sector attracts private investment both from Nigeria and from overseas
- Develop a transparent and effective regulatory framework for the power sector.
- Develop and enhance indigenous capacity in electric power sector technology.
- Promote competition to meet growing demand of the electricity market.
- Review and update electricity laws to promote private sector operation and competition.

1.7.2 Applicable National Regulations

National Environmental Standards and Regulations Enforcement Agency (NESREA) Act (2007, amended 2018)

The NESREA Act (2007) established NESREA with the responsibility for the protection and development of the environment of Nigeria as well as natural resources conservation, sustainable development and enforcement of environmental standards, regulations, rules, laws, policies and guidelines. The Act repealed the Federal Environmental Protection Agency (FEPA) Act of 1988.

National Environmental (Battery Control) Regulations, 2024

This regulation provides control measures for the handling, storage, transportation, recycling, and disposal of batteries in Nigeria. It is aimed at reducing environmental contamination from hazardous substances such as lead, lithium, and acid contained in batteries. It is particularly relevant to renewable energy and hybrid systems where battery energy storage is used, ensuring safe end-of-life management and prevention of soil and water pollution.

National Environmental (Permitting and Licensing System) Regulations, S.I. No. 29, 2009
This regulation establishes the framework for environmental permitting and licensing of activities that may have significant environmental impacts. It requires project developers to obtain necessary permits from NESREA before commencement of regulated activities. It ensures that environmental compliance is formally approved, monitored, and enforced throughout the project lifecycle.

National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, S.I. No. 20, 2011
This regulation sets emission standards for vehicles using petrol and diesel engines to reduce air pollution from transport sources. It establishes permissible emission limits and promotes regular inspection and maintenance of vehicles. It is relevant to construction and operational phases of projects where vehicular movement contributes to air quality impacts.

National Environmental (Electrical/Electronic Sector) Regulations, S.I. No. 79, 2022
This regulation governs the management of electrical and electronic equipment waste (e-waste) in Nigeria. It promotes environmentally sound management, recycling, and extended producer responsibility (EPR) for electronic products. It is relevant to solar projects due to components such as inverters, panels, control systems, and other electrical equipment that may become waste at end-of-life.

National Environmental (Noise Standards and Control) Regulations, S.I. No. 35, 2009
This regulation establishes permissible noise levels for different categories of areas such as residential, industrial, and commercial zones. It aims to protect human health and the environment from excessive noise pollution. It is relevant during construction and operation phases where machinery, generators, and transport activities may generate noise impacts.

National Environmental (Plastic Waste Control) Regulations, 2026
This regulation focuses on the reduction, control, and management of plastic waste in Nigeria through waste minimization, recycling, and restrictions on certain plastic products. It promotes sustainable plastic use and proper waste disposal practices to reduce environmental pollution. It is relevant to project activities that generate packaging waste, construction materials, and single-use plastics.

Environmental Impact Assessment (EIA) Act CAP -E12 LFN 2004

This Act makes an EIA mandatory for major development projects and prescribes the procedure for conducting and reporting an EIA. It is the primary regulation governing EIAs in Nigeria. The Act sets out the procedure and methods for conducting an EIA. Section 2(2) requires that where a proposed project is likely to significantly affect the environment, an EIA must be carried out in accordance with the Act. The Environmental Impact Assessment (EIA) Procedures and Charges Regulations, 2021 (Official Gazette No. 105) was also considered, as it provides updated procedural requirements and applicable charges for ESIA processing, review, and certification in Nigeria.

National Environmental Impact Assessment Procedural and Sectoral Guidelines

This establishes the regulatory framework for assessing and mitigating the environmental impacts of proposed projects. Administered primarily by the Federal Ministry of Environment, these guidelines ensure development projects proceed sustainably while minimizing ecological and social disruption.

Following the promulgation of the EIA Act, the FMEnv developed National EIA Procedural Guidelines and sectoral guidelines for different areas of the economy. Applicable to the proposed project are the EIA Guidelines for Power Sector (2013), with FMEnv EIA Guidelines for Renewable Energy, and the FMEnv Environmental and Social Management Plan (ESMP) Guidelines for Solar Mini-Grid Projects in Nigeria. This ESIA ensures compliance with the approved EIA procedures and relevant sector-specific requirements.

National Environmental (Protection of Endangered Species in International Trade) Regulations, S. I. No. 16, 2011: Provides measures for the protection and conservation of endangered species by regulating their collection, possession, transportation, and international trade.

National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, S. I. No. 15, 2011: Establishes controls on bush, forest fires, and open burning to prevent environmental degradation, air pollution, and damage to vegetation and property.

National Environmental (Desertification Control and Drought Mitigation) Regulations, S. I. No. 13, 2011: Provides measures for preventing and controlling desertification and mitigating the environmental and socio-economic impacts of drought.

National Environmental (Wetlands, River Banks and Lake Shores) Regulations, S. I. No. 26, 2009: Provides for the protection and sustainable management of wetlands, river banks, and lake shores by controlling activities that may cause erosion, pollution, degradation, or loss of these ecosystems.

Harmful Waste (Special Criminal Provisions) Act CAP 165 LFN 1990

This establishes the legal framework for effective control of the disposal of toxic and hazardous waste into any environment within Nigeria. It prohibits the carrying, depositing and dumping of harmful waste on any land, territorial waters and matters relating thereto.

Climate Change Act 2021

Nigeria's 2021 Climate Change Act provides for an ambitious framework for mainstreaming climate actions in line with national development priorities and sets a net-zero target for 2050- 2070. The Act codifies national climate actions by mandating the Ministry of Environment to set, among others, a carbon budget, keeping average increase in global temperature within $2^{o}C$ and pursuing efforts to limit

the temperature increase to 1.5°C above pre-industrial levels. It further approves the formulation of a National Climate Change Action Plan in every five-year cycle to ensure that the national emission profile is consistent with the carbon budget goals and prescribes measures for identifying actions for climate adaptation and mitigation.

The Act applies to both public and private entities within Nigeria's territorial jurisdiction and directs both to implement mechanisms geared towards fostering a low-carbon emission, environmentally sustainable, and climate resilient society. The Act obligates any private entity with employees numbering 50 and above to put in place measures to achieve the annual carbon emission reduction targets in line with the Action Plan; and designate a climate change officer responsible for submitting annual reports to the National Climate Change Secretariats, at meeting its carbon emission reduction and climate adaptation plan.

The Act also establishes the National Council on Climate Change, chaired by the President of Nigeria, with members from both the public and private sectors, including members of the civil society, women, youth, and persons with disabilities. It empowers the Council with significant powers to coordinate national climate actions, administer the newly established Climate Change Fund, mobilize resources to support climate actions, and collaborate with the Nigerian Sovereign Green Bond in meeting Nigeria's NDC.

Land Use Act CAP 202 LFN 2004

This act sets the legal basis for land acquisition and resettlement in Nigeria. It vests land in the Governor of each State and provides that it shall be held in trust for the use and common benefit of all people. The administration of land is divided into urban land which will be directly under the control and management of the Governor of each State; and non-urban land, which will be under the control and management of the Local Governments.

National Building Code (2007)

The code provides guidelines for regulating building construction activities across the country. It serves as a model code for adoption by all public works departments, local bodies and construction companies involved in building construction works. The code contains administrative regulations, development control rules and general building requirements; fire safety requirements; stipulations regarding materials, structural design and construction (including safety); and building and plumbing services.

1.7.2.1 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 2023, 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.

Electricity Act (Cap 106 of 1990)

he Electricity Act (Cap 106, Laws of the Federation of Nigeria 1990) is a foundational legislative framework that governed the Nigerian electricity supply industry prior to the sector's major reforms. It primarily provided regulations for electrical installations, licensing, and the technical operation of electric power networks.

Energy Transition Plan (ETP, 2022)

The Nigeria Energy Transition Plan provides a strategic roadmap for achieving net-zero carbon emissions by 2060 while ensuring reliable and affordable energy access. The plan outlines sector-specific pathways for decarbonization across power, transport, industry, cooking, and oil and gas sectors. It emphasizes increased deployment of renewable energy technologies, including solar power, improved energy efficiency, and gradual reduction of dependence on fossil fuels such as diesel and petrol. ETP supports sustainable economic growth, energy security, and alignment with global climate change commitments.

Electric Power Sector Reform Act (EPSR), 2005

An Act to provide for the formation of companies to take over the functions, assets, liabilities and staff of the National Electric Power Authority, to develop competitive electricity markets, to establish the Nigeria Electricity Regulatory Commission; to provide for the licensing and regulation of the generation, transmission, distribution and supply of electricity; to enforce such matters as performance standards, consumer rights and obligations; to provide for the determination of tariffs.

Factories Act (CAP 126 LFN 2004)

Provision is made for health and safety of persons employed in places statutorily defined as factories and for which a certificate of registration is required by law. It requires that workers should be adequately protected from occupational health and safety hazards.

Employee Compensation Act (2010)

This act provides for guaranteed and adequate compensation for employees or their dependents for any injury, death, disease or disability arising out of during employment.

Labour Act (2004)

This act was enacted to ensure protection of wages, contracts of employment, and terms and conditions of employment. It specifies obligations of an employer to pay worker’s wages in legal tender, and to issue a written contract or statement detailing payment modalities after three months of commencement of employment.

The National Gender Policy 2021-2026

The 1999 Constitution the Federal Republic of Nigeria prohibits discrimination based on places of origin, sex, religion, status, ethnic or linguistic association. Successive governments have always demonstrated commitment to upholding this and to promote gender equality and women’s

empowerment in varying degrees. To facilitate gender equality and women's empowerment, the FGN created favorable national legal and policy frameworks and put in place institutional mechanisms in this regard. Moreover, Nigeria, as a member of the United Nations, signed and ratified the various relevant international instruments, treaties and conventions without reservation. These instruments have always emphasized that member nations put in place the necessary mechanisms needed to eliminate gender discrimination, ensure equality and human dignity to all men and women.

Violence Against Persons (Prohibition) Act (VAPP Act, 2015)

The Act provides a legal framework for the prevention and prohibition of all forms of violence against persons in Nigeria, including physical, sexual, psychological, and economic abuse. It also prohibits harmful traditional practices and supports the protection of vulnerable groups. The Act establishes measures for effective remedies, protection, and support for survivors of violence.

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

The Act was established to:

- promote co-operation and co-ordination among states and local governments in the preparation and implementation of urban and regional plans;
- formulate urban and regional planning standards in Nigeria;
- ensure effective supervision and monitoring of the execution of projects in urban and regional areas; and
- ensure development control over Nigeria.

The specific requirements of the Act pertinent to the proposed development as contained in Part II of the Act are as follows:

Planning Authority Approval

- It is mandatory for a developer to submit a development plan which would be approved by the Development Control Department (department under the commission);
- It is mandatory for a developer (whether private or government) to apply for development permit by using specified forms and providing information such as plans; design drawings and other information as may be prescribed by regulation made pursuant to this section.
- No development shall commence by any Government or its agencies without obtaining an approval from the relevant Development Control Department.
- Plan required to be made under this Act shall be prepared by registered Architect of Town Planner or Engineer and shall be in accordance with the provisions of this Act.

Submission of Detailed Environmental Impact Statement

A developer shall at the time of submitting his application for development submit to an appropriate

Control Department a detailed environmental impact statement for an application for:

- Residential land in excess of 2 hectares; or
- Permission to build or expand a factory or for the construction of an office.
- Permission for a major recreational development.

Validity of Development Permit:

A development permit granted to a developer shall:

- Remain valid for two years from date of communication of the plan to the approval of a developments permit to a developer; and
- Where a developer fails to commence development within two years the development permit shall be subject to re-validation by the Control Department which issued the original permit.

Acquisition of Land and Compensation

Part IV of the Act requires that where it is necessary to obtain any land in connection with planned urban or development in accordance with the policies and proposals of any approved plan, any right of occupancy subsisting on that land shall be revoked on the recommendation of the appropriate authority. All matters connected with the payment of compensation for the revocation of the right of occupancy under the Act shall be governed in accordance with the relevant provision of the Land Use Act. Any compensation payable because of the revocation of the right of occupancy shall be paid within a reasonable period.

Penal Code Act of Nigeria 2004

The Act makes it an offence punishable with up to 6 month's imprisonment for any person who:

- violates the atmosphere in any place to make it noxious to the health of persons in general dwelling or carry on business in the neighborhood, or 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.

Other national regulations that are applicable to this project include:

- National Guideline and Standard for Environmental Pollution Control (1991)
- Abandonment Guideline (FMEnv Sectoral Guidelines, 1995)
- Electricity (Private Licences) Regulations, 1965;
- Electricity (Annual Returns) Regulations, 1974;
- Electricity Installation Regulations, 1996;
- Electricity Supply Regulations, 1996;
- Energy Commission of Nigeria Act, Cap 109 LFN 1990;

- Utilities Charges Commission Act No. 104 of 1992;
- National Wood Fuel Substitution Programme
- Trade Union Act (2005)
- Trade Dispute Act (2004)
- Public Health Law Act (CAP 103 LFN 47 1995)

National Policy on Occupational Safety and Health (2016)
The policy provides the national framework for ensuring safe and healthy working conditions across all sectors in Nigeria. It aims to prevent workplace injuries, occupational diseases, and fatalities through the establishment of safety standards, risk management measures, and compliance requirements for employers and employees. The policy is relevant to project activities involving construction, operation, and maintenance phases.

1.7.2.2 State Regulations

The Project site falls within the jurisdiction of Jigawa State Government. The key State administrative authorities and legal instruments that apply to the Project are briefly described below:

Jigawa State Ministry of Environment and Climate Change: The Jigawa State Ministry of Environmental and Climate Change was formed to ensure sustainable development and environmental protection of the state. Its functions include:

- Routine liaison and ensuring effective harmonization with the FMEnv to achieve the objectives of the National Policy on the Environment;
- Cooperate with FMEnv and other relevant National Directorates/Agencies in the promotion of environmental education;
- Monitoring compliance with waste management standards;
- Monitor the implementation of the ESIA and the Environmental Audit Report (EAR) guidelines and procedures on all developments policies and projects within the State.
- Identify the ecological problems of the State including the devastating erosion and flood, brief the government on their sources and effects and find solutions to them;
- Monitor degradations of river basins and estuaries take measures to protect their ecosystems;
- Identify water, air and soil pollution and their sources and carryout measures to prevent them;
- Carry out activities necessary for the protection and sustainable development of the environment.

The Jigawa State Environmental Protection Agency: Jigawa State Environmental Protection Agency (JISEPA) was established by law in 1992 as an agency of the state ministry of environment. The agency promotes a safe and healthy environment for the people of Jigawa, ensure sustainable development and enforce environmental protection. Its duties include:

- Research and development activities for environmental protection
- Educate the general public on the types of disposal methods acceptable by the State Government for domestic and industrial wastes
- Co-ordinate the activities of all the agencies in the state connected with environmental matters;
- Conduct public enlightenment campaigns and disseminate vital information on environmental matters
- Render advisory services and support to all Local Government in the state in areas of solid waste management matters;
- Take measures to guarantee consistent effectiveness of environmental structures throughout the state for solid waste collection and disposal,
- Formulate master plans for solid wastes management for development of environmental standard mobilize the inhabitants of all areas in the state.

1.7.3 Local Government Areas

The Proposed Project is located at the Federal University of Technology, Babura, Babura Local Government Area, Jigawa State. The LGAs being the third tier of government are empowered to ensure economic planning and development of the communities under their area of influence. The common interest of these communities, traditional association and administrative convenience of the communities is equally administered by the local government councils. In addition, all environmental and health matters especially waste management and related public health issues at the LGAs are managed by the Environment and Public Health Department guided by Environmental Sanitation edicts and bye-laws.

1.7.4 International Convention and Agreements, Best Practice Standards and Guidelines

Nigeria is signatory to several international conventions and agreements relating to industry, development, and environmental management. In certain cases, conventions and agreement have influenced policy, guidelines and regulations and must be compiled with during the planning, construction, and operation of the project. In addition to the national policies and regulations reviewed, consideration was given to relevant international conventions and frameworks ratified or adopted by Nigeria. These include applicable International Labour Organization (ILO) Conventions on labour rights, occupational health and safety, and non-discrimination; the United Nations Sustainable Development Goals (SDGs); the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW); the Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (Maputo Protocol); and other relevant international instruments relating to gender equality, social inclusion, human rights, and sustainable development. These frameworks provide guidance for promoting decent work, gender equity, stakeholder inclusion, and sustainable project implementation. Among several of such conventions, treatises and agreement includes:

1.7.4.1 United Nations (UN) published guiding Principles on the Human Environment in 1972

Ten of these Guiding Principles were defined as formal declarations that express the basis on which an environmental policy can be built, and which provide a foundation for action. Some of the principles relevant to the projects are:

Principles Two: The nature resources of the earth, including the air, water, land, flora, and fauna and especially representative's samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management as appropriate.

Principles Six: The discharge of toxic substances or of other substances and the release of harmful substances, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted to ensure that serious or irreversible damage is not inflicted upon the ecosystems. The just struggle of the people of all countries against pollution should be supported.

Principles Seven: States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.

Principle Seventeen: This principle specifically states that "Environmental Impact Assessment, as a National Instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a component National Authority".

1.7.4.2 United Nations Conference on Environment and Development (1992) (Popularly referred to as Agenda 21)

The United Nations Conference on the Environment and Development (UNCED) in 1992 led to the adoption of agenda 21, which recommended a set of 21measures for waste management. Some of the recommendations include the following:

- Prevent and minimize waste production.
- Reuse or recycle the waste to the extent possible.
- Treat waste by safe and environmentally sound methods.
- Dispose of the final residues by landfill in confined and carefully designated sites.
- Integrate environment into development planning at all levels of Government and the private sector.
- Commence a transition to sustainable development
- Address sectorial priorities, plan policies and strategies for the major sectors of the economy
- Simultaneously foster regional and global partnership.

1.7.4.3 Convention on Biological Diversity (1992)

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.

1.7.4.4 Basel Convention on the control of Trans-boundary Movements of Hazardous Wastes and Their Disposal (1987)

The convention focuses attention on the hazards of the generation and disposal of Hazardous wastes. The convention defines the wastes to be regulated and control their trans-boundary movement to protect human and environmental health against their adverse effects.

1.7.4.5 Convention on the Conservation of Nature and Natural Resources, 1986

This convention came into force in Nigeria on May 7th,1974. The objectives of the convention to encourage individual and joint action for the conservation, utilization and development of soil, water flora and fauna for the present and future welfare of mankind, from an economic, nutritional, scientific, educational, cultural, and aesthetic point of view**.**

1.7.4.6 Montreal Protocol on Substances that Deplete the Ozone Layer, 1987 (as Amended)

The objective of the convention is to protect the ozone layer by-taking precautionary measure to control global emissions of substances that deplete it. This convention is aimed at protecting workers against occupational Hazards in the working environment.

1.7.4.7 Convention on the Protection of workers against occupational Hazards on the working environment due to Air Pollution, Noise and Vibration

The objective of the convention is to prevent accidents and injury to health by minimizing the causes of hazards inherent in the working environment.

1.7.4.8 Convention on Occupational Safety and Health and the Working Environment

The convention EIAs the objective of enhancement of the existing legal framework for occupational safety regulating the management of chemicals in the workplace with the broad purpose of protecting the environment and the public, and with the specific objective of protecting workers from harmful effects of chemicals.

1.7.4.9 United Nations Convention on Climate Change

The Convention on the Climate Change was signed in 1992 during the Rio Earth Summit but was put into force in 1994. The Convention called on developed countries and economies in transition to limit their emissions of the greenhouse gases which cause global warming, although it does not impose mandatory emissions on developing countries.

1.7.4.10 UNFCCC, Paris agreement of 2016 [The agreement was signed on 22 September 2016 and ratified by Nigeria on 16th May 2017]

The world is in a race to limit climate change and find workable, practical, and cost-efficient solutions (Renewable Energy, Circular Economy, and Natural Capital) to this emergency that is redefining global partnerships in a way not seen before. This is a race we, as humanity, can win. But for this to happen, unprecedented leadership, sacrifices, concessions from all nations big and small are needed. Nigeria has ratified the 2915 Paris Agreement. This is commendable considering it is one of the top six greenhouse gas emitters in Africa. The Paris Agreement builds upon the Convention and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework, and an enhanced capacity-building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

1.7.4.11 Nationally Determined Contributions (NDCs)

Nationally Determined Contributions (NDCs) under the Paris Agreement embody Nigeria's efforts to reduce greenhouse gas emissions and adapt to the impacts of climate change. Nigeria has progressively updated its commitments through NDC 1.0, the Updated NDC (NDC 2.0) submitted in 2021, and the current NDC 3.0, which builds on previous mitigation and adaptation targets. The current NDC 3.0 reinforces Nigeria's commitment to a low-carbon and climate-resilient development pathway while supporting sustainable economic growth and energy access. The implementation of these commitments is expected to contribute significantly to emissions reduction, climate resilience, and the achievement of national development objectives.

1.7.4.12 Polluters Pays Principle (Adopted by Nigeria in 1999)

In environmental law, the polluter pays principle is enacted to make the party responsible for producing pollution responsible for paying for the damage done to the natural environment. It is regarded as a regional custom because of the strong support it has received in most Organization for Economic Co-operation and Development (OECD) and European Community (EC) countries. The polluter pays principle underpins environmental policy such as an ecotax, which, if enacted by the government, deters, and essentially reduces greenhouse gas emissions. Some eco-taxes underpinned by the polluter pays principle include: the Gas Guzzler Tax, in the US, Corporate Average Fuel Economy (CAFE) – a "polluter pays" fine. The U.S. Superfund law requires polluters to pay for clean-up of hazardous waste sites when the polluters can be identified. Polluter pays is also known as

extended producer responsibility (EPR). This is a concept that was probably first described by Thomas Lindhqvist for the Swedish government in 1990. EPR seeks to shift the responsibility for dealing with waste from governments (and thus, taxpayers and society at large) to the entities producing it. In effect, it internalized the cost of waste disposal into the cost of the product, theoretically meaning that the producers will improve the waste profile of their products, thus decreasing waste and increasing possibilities for reuse and recycling.

1.7.4.13 Stockholm Convention Against Persistent Organic Pollutants of 2004

Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty, signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs). In 1995, the Governing Council of the United Nations Environment Programme (UNEP) called for global action to be taken on POPs, which is defined as "chemical substances that persist in the environment, bio- accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment‖. Following this, the Intergovernmental Forum on Chemical Safety (IFCS) and the International Programme on Chemical Safety (IPCS) prepared an assessment of the 12 worst offenders, known as the dirty dozen. The INC met five times between June 1998 and December 2000 to elaborate the convention, and delegates adopted the Stockholm Convention on POPs at the Conference of the Plenipotentiaries convened from 22–23 May 2001 in Stockholm, Sweden. The negotiations for the Convention were completed on 23 May 2001 in Stockholm. The convention entered into force on 17 May 2004 with ratification by an initial 128 parties and 151 signatories. Co-signatories agree to outlaw nine of the dirty dozen chemicals, limit the use of DDT to malaria control, and curtail inadvertent production of dioxins and furans. Parties to the convention have agreed to a process by which persistent toxic compounds can be reviewed and added to the convention if they meet certain criteria for persistence and transboundary threat. The first set of new chemicals to be added to the Convention was agreed upon at a conference in Geneva on 8 May 2009. As of June 2018, there are 182 parties to the Convention, (181 states and the European Union). Notable non- ratifying states include the United States, Israel, Malaysia, and Italy. The Stockholm Convention was adopted to EU legislation in REGULATION (EC) No 850/2004.

1.7.4.14 Cartagena Protocol on Biosafety of 2003

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international agreement on biosafety as a supplement to the Convention on Biological Diversity effective since 2003. The Biosafety Protocol seeks to protect biological diversity from the potential risks posed by genetically modified organisms resulting from modern biotechnology The Biosafety Protocol makes clear that products from new technologies must be based on the precautionary principle and allow developing nations to balance public health against economic benefits. It will for example let countries ban imports of genetically modified organisms if they feel there is not enough scientific evidence that the product is safe and requires exporters to label shipments containing genetically altered

commodities such as corn or cotton.

1.7.4.15 Vienna Convention for the Protection of the Ozone Layer

This Convention was instituted in 1985 and places general obligation on the countries to make appropriate measures to protect human health and the environment against adverse effects resulting from human activities which tend to deplete the ozone layer.

1.7.4.16 Convention on access to Information, Public Participation in Decision making and access to Justice in Environment Matters (Aarhus 1998)

Article 1 (Objective) notes that "in order to contribute to the protection of the right of every person of present and future generations to live in an environment adequate to his or her health and well-being, each Party shall guarantee the rights of access to information, public participation in decision-making, and access to justice in environmental matters in accordance with the provisions of this Convention.''

1.7.4.17 Kyoto Protocol on the Reduction of Greenhouse Gases 1997

Kyoto Protocol is an international treaty adopted in 1997 that aimed to reduce the emission of gases that contribute to global warming. The protocol called for reducing the emissions of six greenhouse gases in 41 countries plus the European Union to 5.2 percent below 1990 levels.

International Best Practices

Other considerations of the ESIA include other international best practices. International institutions provide guidance on best practices for the ESIA process and place emphasis on achieving sustainable environmental, social, and health outcomes. They also provide environmental standards and limits for emissions and discharges. Some key project impact mitigation measures such as resettlement are also specified. The overall project design and this ESIA will align with international best practices such as guidelines published by the International Finance Corporation (IFC) and the World Bank. The following is a summary of the specific international requirements and standards that will be applied to this ESIA. It should be noted that, given the private-sector nature of the development, the IFC Performance Standards described below will be most directly applicable to the project in this case.

1.7.4.18 World Bank Guidelines on Environmental Assessment

The World Bank requires an Environmental Impact Assessment (EIA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable to improve decision making. Additionally, the policy specifies that the Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of EIA. The Bank classifies projects into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. Details of World Bank EIA procedures and guidelines are published in the bank's EA Source Books Vols. II–III of 1991

1.7.4.19 World Bank Operational and Safeguard Policies

The World Bank is committed to several operational and safeguards policies that aim to prevent and mitigate undue harm to people and their environment in any development initiative involving the bank. These policies provide guidelines for bank and borrower staff in the identification, preparation, and implementation of programs and projects. There are ten World Bank Environmental/Safeguard Policies. Not all these policies are triggered by the Special Agro-industrial Processing Zone (SAPZ) Hub development. The World Bank policies that have been triggered by the proposed Special Agro-industrial Processing Zone (SAPZ) Hub are:

Operational Policy (OP)/Bank Procedure (BP) 4.01: Environmental Assessment (last updated February 2011). This is the umbrella policy for the Bank's environmental 'safeguard policies' which among others include:

Operational Policy/Bank Procedure 4.04 (Natural Habitat) – seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society**.**

Operational Policy/Bank Procedure 4.36 –(Forests.) This policy aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development**.**

Operational Policy /Bank Procedure 4.11 – Physical Cultural Resources seeks to avoid, or mitigate, adverse impacts on cultural resources from development projects that the World Bank finances.

The Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus improve decision making. Such EA is carried out by the borrower to evaluate a project's potential environmental risks and impacts in its area of influence. The EA process analyzes project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The Bank favours preventive measures over mitigatory or compensatory measures, whenever feasible. EA looks at the interaction of the project with the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and where applicable, transboundary, and global environmental aspects.

1.7.4.20 The IFC Performance Standards 2012

The IFC applies Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in the private sector. The IFC Performance Standards

encompass eight topics:

Environmental and Social Assessment and Management System: Commercial clients/investees are required to manage the environmental and social performance of their business activity, which should also involve communication between the client/investee, its workers, and the local communities directly affected by the business activity. This requires the development of a good management system, appropriate to the size and nature of the business activity, to promote sound and sustainable environmental and social performance as well as lead to improved financial outcomes.

Labour and Working Conditions: For any business, its workforce is a valuable asset and a sound worker-management relationship is a key component of the overall success of the enterprise. By protecting the basic rights of workers, treating workers fairly, and providing them with safe and healthy working conditions, commercial clients/investees can enhance the efficiency and productivity of their operations and strengthen worker commitment and retention.

Pollution Prevention and Abatement: Increased industrial activity and urbanization often generate increased levels of pollution to air, water, and land that may threaten people and the environment at the local, regional, and global level. Commercial clients/investees are required to integrate pollution prevention and control technologies and practices (as technically and financially feasible as well as cost-effective) into their business activities.

Community Health, Safety, and Security: Business activities can increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failures, and releases of hazardous materials as well as impacts on a community's natural resources, exposure to diseases, and the use of security personnel. Commercial clients/investees are responsible for avoiding or minimizing the risks and impacts on community health, safety, and security that may arise from their business activities.

Land Acquisition and Involuntary Resettlement: Land acquisition due to the business activities of a commercial client/investees may result in the physical displacement (relocation or loss of shelter) and economic displacement (loss of access to resources necessary for income generation or as means of livelihood) of individuals or communities. Involuntary resettlement occurs when affected individuals or communities do not have the right to refuse land acquisition and are displaced, which may result in long-term hardship and impoverishment as well as environmental damage and social stress. Commercial clients/investees are required to avoid physical or economic displacement or minimize impacts on displaced individuals or communities through appropriate measures such as fair compensation and improving livelihoods and living conditions.

Biodiversity Conservation and Sustainable Natural Resource Management: Protecting and conserving biodiversity (including genetic, species, and ecosystem diversity) and its ability to change and evolve, is fundamental to sustainable development. Commercial clients/investees are

required to avoid or mitigate threats to biodiversity arising from their business activities and to promote the use of renewable natural resources in their operations.

Indigenous Peoples: Indigenous Peoples are recognized as social groups with identities that are distinct from other groups in national societies and are often among the marginalized and vulnerable. Their economic, social, and legal status may limit their capacity to defend their interests and rights to lands and natural and cultural resources. Commercial clients/investees are required to ensure that their business activities respect the identity, culture, and natural resource-based livelihoods of Indigenous Peoples and reduce exposure to impoverishment and disease.

Cultural Heritage: Cultural heritage encompasses properties and sites of archaeological, historical, cultural, artistic, and religious significance as well as unique environmental features and cultural knowledge, innovations, and practices of communities embodying traditional lifestyles, which are protected for current and future generations. Commercial clients/investees are required to avoid significant damage to cultural heritage due to their business activities.

1.7.4.21 Environmental and Social Safeguards Policies (African Development Bank)

The African Development Bank issued its Environmental Assessment Guidelines (EAG) in 1992, but since then, many changes have occurred in the Bank's structure and operations. The revised Environmental and Social Assessment Procedures (ESAP 2015) have therefore been updated to reflect the more integrated approach addressing all cross-cutting themes as well as the new organizational structure. The main purpose of the Environmental and Social Assessment Procedures (ESAP) is to improve decision-making and project results to ensure that Bank-financed projects, plans, and programs are environmentally and socially sustainable as well as in line with Bank's policies and guidelines. The ESAP applies to the Bank's public- sector operations. Similar procedures were developed and approved for the Bank's private sector operations: AfDB Environmental Review Procedures for Private Sector Operations (2000). Other relevant AfDB policies are AfDB Policy on the Environment (2004), AfDB Environmental Review Procedures for Private Sector Operations (2000), AfDB Gender Policy (2001), AfDB Policy on Poverty Reduction (2004), and AfDB Policy on Involuntary Resettlement (2003). In the development of the ESIA, the AfDB ESAP guideline was used to address the following areas:

- Aims
- Brief project description and key components
- Major environmental and social impacts and climate change risk
- Enhancement/mitigation measures and complementary initiatives
- Environmental and social monitoring program
- Public consultations and disclosure requirements vii. Institutional arrangements and capacity building requirements
- Estimated costs

- Implementation schedule and reporting
- Conclusion
- References and contacts

1.7.4.22 The African Development Bank (AfDB) Integrated Safeguards System (ISS)

The E&S safeguards of the AfDB are a cornerstone of the Bank's support for inclusive economic growth and environmental sustainability in Africa. The AfDB' ISS is the major standard regulation adhered with in putting together the ESIA. This is because the AfDB is the financier of the project. The Bank ISS is designed to promote the sustainability of project outcomes by protecting the environment and people from the potentially adverse impacts of projects. This requires that all the activities under the project will comply with the safeguard requirements of the ISS during projects preparation and implementation. The safeguards aim to:

- Avoid adverse impacts of projects on the environment and affected people, while maximizing potential development benefits to the extent possible.
- Minimize, mitigate, and/ or compensate for adverse impacts on the environment and affected people when avoidance is not possible.
- Help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage E&S risks.

1.8 The Integrated Safeguards Policy Statement

This describes common objectives of the Bank's safeguards and lays out policy principles. It is designed to be applied to current and future lending modalities, and it considers the various capacities and needs of regional member countries in both the public and private sectors. The Integrated Safeguards comprises of Policy Statement that sets out the basic tenets that guide and underpin the Bank's approach to environmental safeguards. The Bank's Integrated Safeguards Policy Statement sets out the Bank's own commitments to and responsibilities for delivering the ISS: to

i. Ensure the systematic assessment of E&S impacts and risks.
ii. Apply the Oss to the entire portfolio of Bank operations.
iii. Support clients and countries with technical guidance and practical support in meeting the requirements.
iv. Implement an adaptive and proportionate approach to E&S management measures to be agreed with clients as a condition of project financing.
v. Ensure that clients engage in meaningful consultations with affected groups; respect and promote the protection of vulnerable groups, in a manner appropriate to the African context.

1.8.1 Operational Safeguards (Oss)

These are a set of ten safeguard requirements that Bank clients are expected to meet when addressing social and environmental impacts and risks. Bank staff use due diligence, review, and supervision to ensure that, clients comply with these requirements during project preparation and implementation. Over time the Bank may adopt additional safeguard requirements or update existing requirements to enhance effectiveness, respond to changing needs, and reflect evolving best practices. The ten OSs were designed to:

- Better integrate considerations of E&S impacts into Bank operations to promote sustainability and long-term development in Africa.
- Prevent projects from adversely affecting the environment and local communities or, where prevention is not possible, minimize, mitigate and/or compensate for adverse effects and maximize development benefits.
- Systematically consider the impact of climate change on the sustainability of investment projects and the contribution of projects to global greenhouse gas emissions.
- Delineate the roles and responsibilities of the Bank and its borrowers or clients in implementing projects, achieving sustainable outcomes, and promoting local participation.
- Assist regional member countries and borrowers/clients in strengthening their own safeguards systems and their capacity to manage E&S risks.

1.8.2 Operational Safeguard Description Triggered (Yes/No)

OS 1: Environmental and social assessment. This overarching safeguard governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements. This OS is triggered. The construction and operation of the solar farm shall have environmental interactions with potential negative impacts to the people and the environment.

OS 2: Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation. This safeguard consolidates the policy commitments and requirements set out in the Bank's policy on involuntary resettlement and incorporates a few refinements designed to improve the operational effectiveness of those requirements. This OS is triggered. The construction activities shall took place on land being used for other activities.

OS 3: Biodiversity and Ecosystem Services: This safeguard aims to conserve biological diversity and promote the sustainable use of natural resources. It also translates the commitments in the Bank's policy on integrated water resources management into operational requirements. This OS is not triggered. The project is on a piece of land being used for farming activities with limited sensitive ecological receptors. Areas of ecological importance particularly the stream on the site will be conserved/enhanced as part of project landscaping activities to ensure the preservation of the natural habitat for aquatic organisms.

OS 4: Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials and Resource Efficiency This safeguard covers the range of key impacts of pollution, waste, and hazardous materials for which there are agreed international conventions, as well as comprehensive industry-specific and regional standards, including greenhouse gas accounting, that other multilateral development banks follow. This OS is triggered. The construction and operation activities will generate waste including hazardous waste which will require proper management to prevent environmental pollution.

OS 5: Labour Conditions, Health, and Safety This safeguard establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation. It also ensures greater harmonization with most other multilateral development banks. This OS is triggered. Many workers are envisaged to be engaged during the construction and operation of the solar farm. These workers would need to comply with HSE policies and requirements and be kept safe.

OS6: Community Health, Safety and Security: This safeguard ensures that project activities do not expose surrounding communities to avoidable health, safety, or security risks. It requires assessment and management of impacts such as traffic hazards, air and noise pollution, and potential security concerns. Mitigation measures must be implemented to protect public health and safety during construction and operation. It also promotes emergency preparedness and response planning. This OS is not triggered

OS7: Cultural Heritage: This safeguard ensures that cultural, historical, and archaeological resources are identified and protected from project-related disturbance. It requires proper screening and assessment before any ground disturbance activities. Where cultural heritage is found, appropriate mitigation measures such as avoidance or salvage are implemented. It also promotes consultation with relevant authorities and local communities. This OS is not triggered

OS8: Financial Intermediaries: This safeguard applies when projects are financed through banks or other financial institutions. It ensures that these intermediaries apply proper environmental and social risk management systems to sub-projects they finance. It requires screening, monitoring, and reporting of environmental and social risks at all financing levels. This ensures compliance even when direct project implementation is not handled by the AfDB. This OS is not triggered

OS9: Climate Change: This safeguard requires projects to consider both climate change mitigation and adaptation risks. It encourages the reduction of greenhouse gas emissions and supports low-carbon development pathways. It also requires assessment of climate-related vulnerabilities such as flooding, heat stress, or extreme weather. The goal is to enhance project resilience to climate impacts. This OS is not triggered

OS10: Stakeholder Engagement: This safeguard ensures that affected communities and stakeholders are meaningfully involved throughout the project cycle. It requires timely disclosure of project information in an accessible manner. It promotes consultation, participation, and responsiveness to stakeholder concerns. It also ensures that grievance mechanisms are established and functional. This OS is not triggered

1.9 Structure of the Report

Chapter 1 – Introduction: summarizes project overview and background. It also presents the objectives of the study, and the ESIA scope of work.

Chapter 2 – Project Justification/Alternatives: describes the need for the project, potential, value, benefits and envisaged sustainability. The project and process related alternatives considered during project concept and design stages are also discussed.

Chapter 3 – Project Description: describes the design basis of the proposed project, process description and site location, preparation and construction, and project plant operations.

Chapter 4 – Description of the Environment: summarizes the physical environment (air, surface water, ground water, and soil), biodiversity, and socioeconomic conditions in the project area

Chapter 5 – Potential Environmental and Social Impacts: discusses and analyses the potential impacts resulting from project activities during construction and operational phases.

Chapter 6 – Mitigation/Measures: describes the mitigation measures recommended for the identified impacts.

Chapter 7 – Environmental and Social Management Plans (ESMP): provides site specific management plans that list the required actions to be taken, performance targets and required records to be kept. Implementation and monitoring provides roles and responsibilities for implementation, monitoring actions, frequency and cost estimate.

Chapter 8 – Summary and Conclusions: summarizes conclusions drawn during the analysis and provides recommendations for future work.

References – A full list of the published sources used in the report.

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Introduction

Nigeria faces a paradoxical energy crisis: despite possessing vast natural resources and a substantial installed power capacity, the nation struggles to meet its electricity demand. This persistent deficit has created a chasm between supply and consumption, forcing households and industries to rely heavily on expensive and environmentally harmful self-generation alternatives such as diesel generators.

Actual power dispatch frequently falls below 4,000 MW, a stark contrast to the estimated national demand exceeding 40,000 MW. This shortfall stifles socioeconomic development, particularly impacting Small and Medium Scale Enterprises (SMEs), which are widely recognized as critical drivers of economic growth. Reliable electricity is not merely a commodity; it is the bedrock upon which modern education, healthcare, security, and industrial productivity are built. In Nigeria, the gap between electricity demand and supply represents a non-ideal market failure—one where availability, rather than market forces, dictates supply. This project is positioned as a direct intervention to remedy that failure.

2.2 Need for the Project

As the largest economy in Sub-Saharan Africa, Nigeria's growth trajectory is paradoxically undermined by the inadequacy of its power sector. Although the country possesses the technical capacity to generate approximately 12,522 MW from existing thermal and hydro plants, operational inefficiencies restrict output to roughly 4,000 MW. For a population exceeding 200 million, this output is grossly insufficient.

This crisis is not merely a technical fault; it is a fiscal and social liability. The Power Sector Recovery Program (PSRP) estimates that erratic power supply costs the Nigerian economy over US$25 billion annually in lost productivity (PSRP, 2018). Beyond economic metrics, the impact is visceral: hospitals lack power for life-saving equipment, students cannot study after dark, and businesses face prohibitively high operating costs.

Compounding this is Nigeria's status as the country with the largest off-grid population in Africa. Over 100 million people lack access to grid electricity. The disparity is starkly geographic; urban access rates sit at approximately 86%, whereas rural access languishes at just 41.1% (Mshana and Miyares, 2019). To achieve universal electricity access by 2030, Nigeria must connect between 500,000 to 800,000 households annually, a target unattainable through grid extension alone.

In response, the Federal Government has pivoted toward renewable energy policy as a strategic lever to diversify the energy mix, reduce fossil fuel dependency, and bridge the supply-demand gap. This

policy direction provides the regulatory backbone for decentralized solar solutions. Furthermore, international momentum toward decarbonization underscores the timeliness of this project. By aligning domestic energy deficits with global sustainability goals, the proposed solar power plant represents a critical intervention.

In view of the above, the implementation of the Solar Power Project at Federal University of Technology Babura, Jigawa State is fully justified.

2.3 Project Benefits

The proposed project is expected to yield a broad spectrum of socioeconomic, environmental, and technical benefits, including but not limited to:

- Enhanced Power Availability: Reliable electricity supply for domestic, commercial, and industrial applications;
- Economic Productivity: Reduction of downtime and operational costs for businesses dependent on stable power;
- Job Creation: Direct and indirect employment opportunities during construction, operation, and maintenance phases;
- Clean Energy Transition: Reduction in greenhouse gas emissions and displacement of fossil fuel-based backup generation;
- Energy Equity: Provision of affordable, safe, and clean electricity to host communities and underserved populations;
- Community Safety: Installation of street lighting to enhance security and extend productive hours;
- Skills Development: Capacity building and technical training for local manpower in solar PV operations and maintenance;
- Multiplier Effects: Stimulation of local economies through spin-off enterprises and improved commercial activity.

2.4 Project Options and Alternatives

2.4.1 Project Options

Three strategic options were evaluated prior to project approval: No Project, Delay Project, and Implement Project. Each was assessed based on feasibility, urgency, and socioeconomic impact.

The "No Project" Option.

This option implies the complete abandonment of the proposed intervention. While it incurs no direct capital cost, it perpetuates the status quo of energy poverty. The socioeconomic benefits, including employment, local contracting, equipment supply, and improved productivity, would remain unrealized. Given the acute need for power in the target location. This option offers no strategic value.

Decision: **Not Recommended.**

The "Delayed Project" Option.

Project deferment is typically warranted in cases of civil unrest, funding shortages, or widespread public opposition. In this instance, no such impediments exist. The project site is stable, stakeholder buy-in is secured, and the demand for electricity is immediate. To delay implementation would be to postpone development benefits without justification.

Decision: **Not Recommended.**

The "Implement Project" Option.

Proceeding with implementation ensures the timely delivery of clean, reliable energy to the project area. This option maximizes value for the proponent, the host community, and the government by catalyzing economic activity and improving quality of life. It represents the most prudent and beneficial course of action.

Decision: **Recommended.**

2.4.2 Project Alternatives

2.4.3 Site Alternatives.

The proposed location within the University, was selected based on a multi-criteria assessment. The site offers: Immediate land availability with minimal acquisition requirements; High solar irradiation levels suitable for PV generation; No requirement for resettlement or complex land rights arbitration; The University premises location is already a Federal Government Site with no potential for land legacy issues.

Proximity to load centers with inadequate grid supply. These factors render alternative sites less viable.

Technology Alternatives:

Solar PV vs. Wind.

While wind power offers low emissions and long-term fuel cost savings, it was deemed unsuitable for this project due to:

- Insufficient and inconsistent wind speeds for base load generation;
- High capital expenditure relative to output;
- Significant land requirements;
- Absence of a mature regulatory and tariff framework for small-scale wind in Nigeria.

Conversely, Solar PV was selected due to:

- High reliability (no moving parts, low failure rates);
- Minimal noise and environmental impact;
- Low operation and maintenance costs;
- Simplicity of design and scalability;
- Rapid deployment capability.

Equipment Alternatives:

Battery Storage

Energy storage is critical for nighttime load stabilization. Two technologies were assessed:

Feature	Lead-Acid (Hoppecke)	Lithium-Ion
Initial Cost	Lower	Higher
Maintenance	Moderate	Negligible
Lifespan	Shorter	Longer
Depth of Discharge Tolerance	Low	High
Weight	Heavy	Lightweight
Recyclability	Established	Improving

Decision: Hoppecke Lead-acid batteries were selected for the initial phase due to lower upfront capital requirements and proven reliability in similar Nigerian contexts. However, the project framework accommodates a future transition to Lithium-ion technology, which offers superior lifecycle value and operational efficiency.

2.5 Envisaged Sustainability

To ensure that the project delivers enduring value without unintended adverse consequences, a multi-dimensional sustainability framework has been established. This framework governs technical delivery, environmental stewardship, financial viability, and social inclusion.

2.5.1 Technical Sustainability

The solar PV system is engineered for remote, decentralized deployment. Design, installation, and commissioning will be executed by certified personnel in strict adherence to international standards (IEC) and local grid codes. The Rural Electrification Agency (REA), as project proponent, will enforce rigorous quality assurance protocols, including routine performance monitoring and preventive maintenance schedules. This ensures operational continuity beyond the initial project lifecycle.

2.5.2 Environmental Sustainability

The project represents an inherently low-impact intervention. By displacing diesel generator usage, it contributes to a net reduction in local air pollution and national carbon emissions. All phases of the project will be governed by the REA's Health, Safety and Environment (HSE) Policy and Emergency Preparedness Plan. Compliance with the National Environmental Standards and Regulations Enforcement Agency (NESREA) and World Bank environmental safeguards is mandatory. Waste management, particularly regarding used batteries and electronic components, will follow approved recycling and disposal protocols. The recommendations of the Environmental and Social Impact Assessment (ESIA) will be strictly implemented to ensure mitigation of all residual risks.

The project will generate solar-related electronic waste (e-waste) and spent batteries at the end of

their operational life. Appropriate measures will be implemented for the collection, storage, transportation, recycling, and disposal of obsolete solar panels, batteries, inverters, and other electrical components in accordance with applicable national regulations and industry best practices. Preference will be given to licensed recyclers and authorized waste management facilities for the handling of end-of-life equipment. An end-of-life management plan will be developed and implemented to minimize environmental and health risks associated with solar e-waste and battery disposal.

2.5.3 Economic and Commercial Sustainability

Although solar PV requires significant upfront capital expenditure, lifecycle cost analysis strongly favors this technology over continued reliance on diesel generators. Fuel costs are eliminated, maintenance requirements are minimal, and price volatility is removed. Furthermore, the project catalyzes local economic development through the creation of skilled and semi-skilled jobs in manufacturing, installation, operations, and maintenance. This workforce development component strengthens the local labor market and builds domestic capacity for Nigeria's broader energy transition.

2.5.4 Social Sustainability

The social sustainability of the proposed Solar PV Project is strongly anchored in its stakeholder engagement framework. By conducting consultations during the ESIA process, the Project has ensured that all relevant stakeholders are given the opportunity to contribute their perspectives at an early stage. This participatory approach not only enhances inclusiveness but also builds trust and transparency, laying a solid foundation for long-term relationships with the university community, residents, and other interested parties.

The preparation of a Stakeholder Engagement Plan (SEP) further reinforces social sustainability by institutionalizing continuous dialogue throughout the Project's life cycle. This ensures that stakeholders remain informed, involved, and empowered to influence decisions that may affect them. Such ongoing engagement promotes accountability and strengthens the Project's legitimacy within the community.

In addition, the establishment of a grievance redress mechanism (GRM) by REA provides a structured communication channel for stakeholders to raise concerns. This mechanism ensures that grievances are addressed promptly and fairly, thereby reducing potential conflicts and fostering social harmony. Even though anticipated issues are minimal, the GRM demonstrates a proactive commitment to safeguarding stakeholder interests.

Overall, these measures early consultations, continuous engagement through the SEP, and the GRM collectively contribute to the Project's social sustainability. They ensure inclusiveness, responsiveness, and fairness, while promoting mutual trust between the Project developers and stakeholders. This participatory governance model enhances the Project's resilience and strengthens its social license to operate. Details of the stakeholder consultations conducted to date are presented in Chapter 4 of this report.

Occupational Health and Safety (OHS) and Community Health and Safety (CHS) considerations

are integral to the proposed project. Occupational health and safety measures will be implemented to protect workers from hazards associated with construction, electrical installations, equipment handling, and maintenance activities. Community health and safety measures will focus on managing risks related to increased traffic, restricted access to work areas, electrical safety, emergency preparedness, and other project-related activities that may affect surrounding communities. Appropriate mitigation measures, training, monitoring, and stakeholder awareness programs will be implemented throughout the project lifecycle to ensure the health and safety of workers and the public.

CHAPTER THREE
PROJECT DESCRIPTION

3.1 Introduction

This chapter describes in detail the technology and design of the proposed solar project to be constructed, installed and operated. Information on the application, ancillary facilities, stage by stage development, project schedule, life span, consumables is contained in this chapter. It also discusses the project anticipated waste streams, operations, decommissioning and project implementation plan.

3.2 Project Location

The proposed project would be sited on a piece of land measuring about 10Ha situated within the permanent campus of the Federal University of Technology Babura, Jigawa State. The geographical coordinates of the site are 12.7302583N, 9.0043292E.

Figure 3.1: Map of Nigeria Highlighting Jigawa State

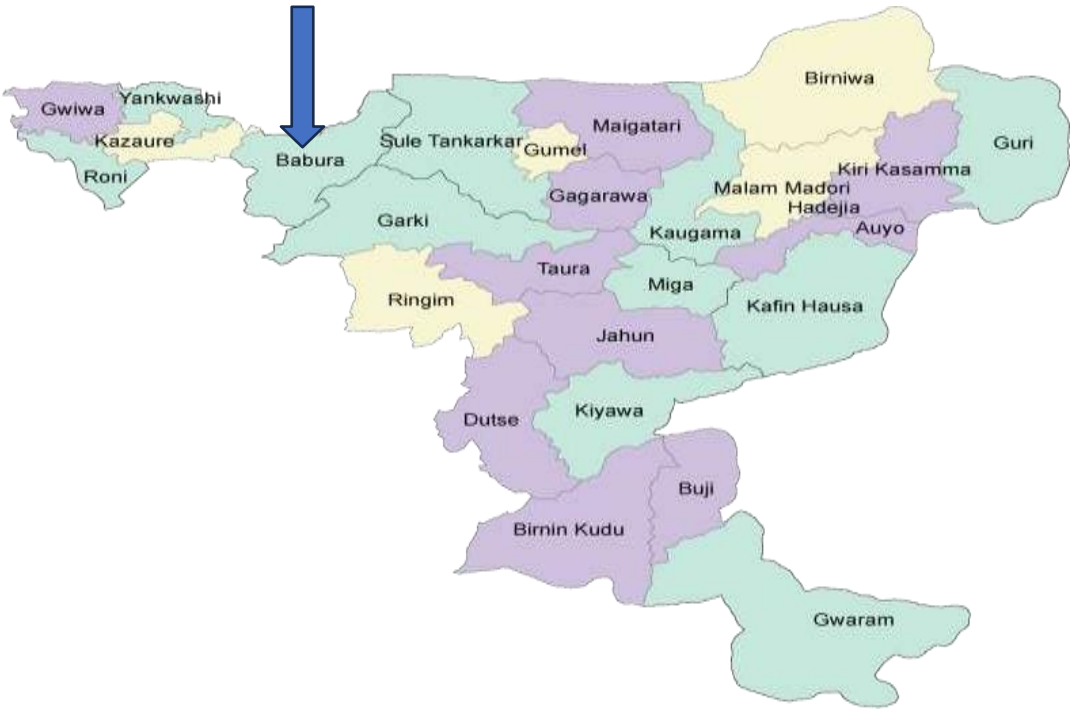

Figure 3.2: Map of Jigawa State indicating Babura LGA

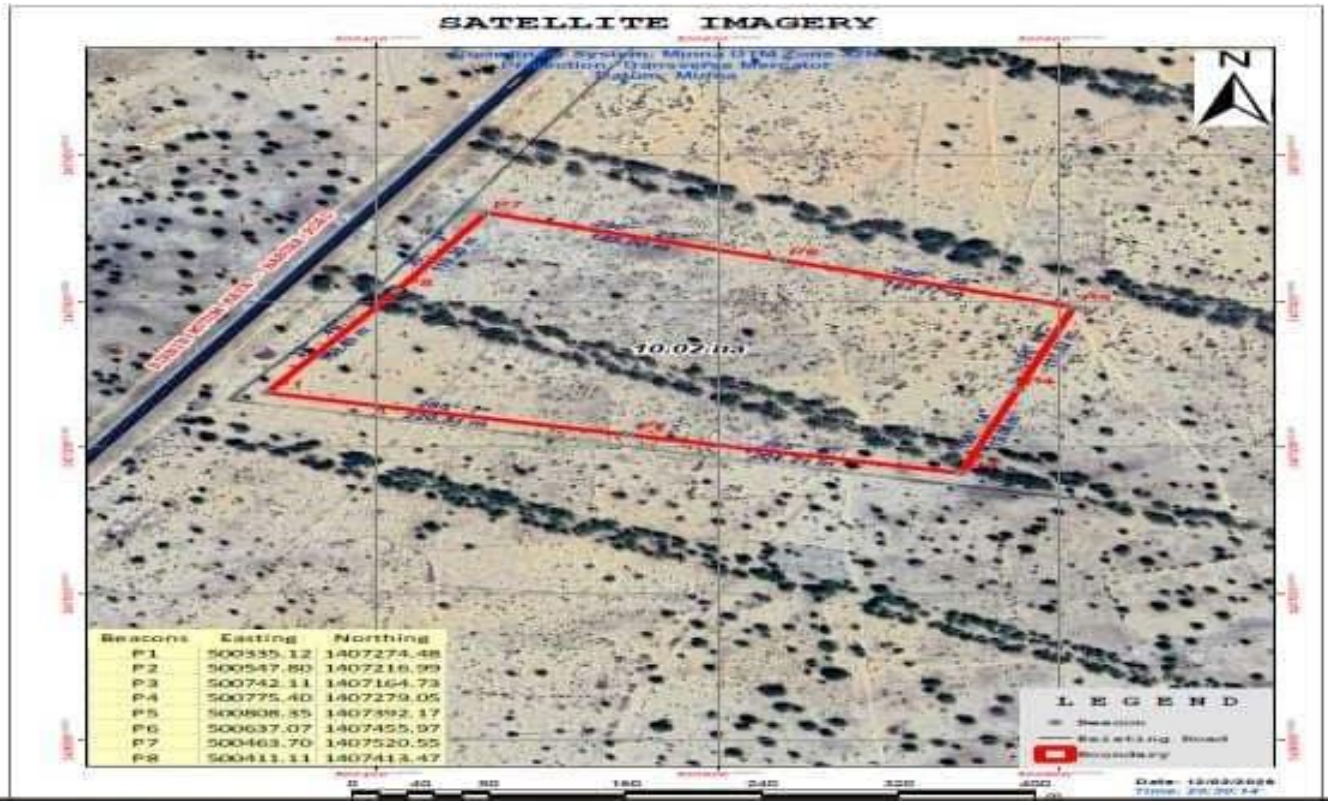

Figure 3.3: Satellite Imagery of the Project Area

Source: BOLBEN LTD Fieldwork 2026.

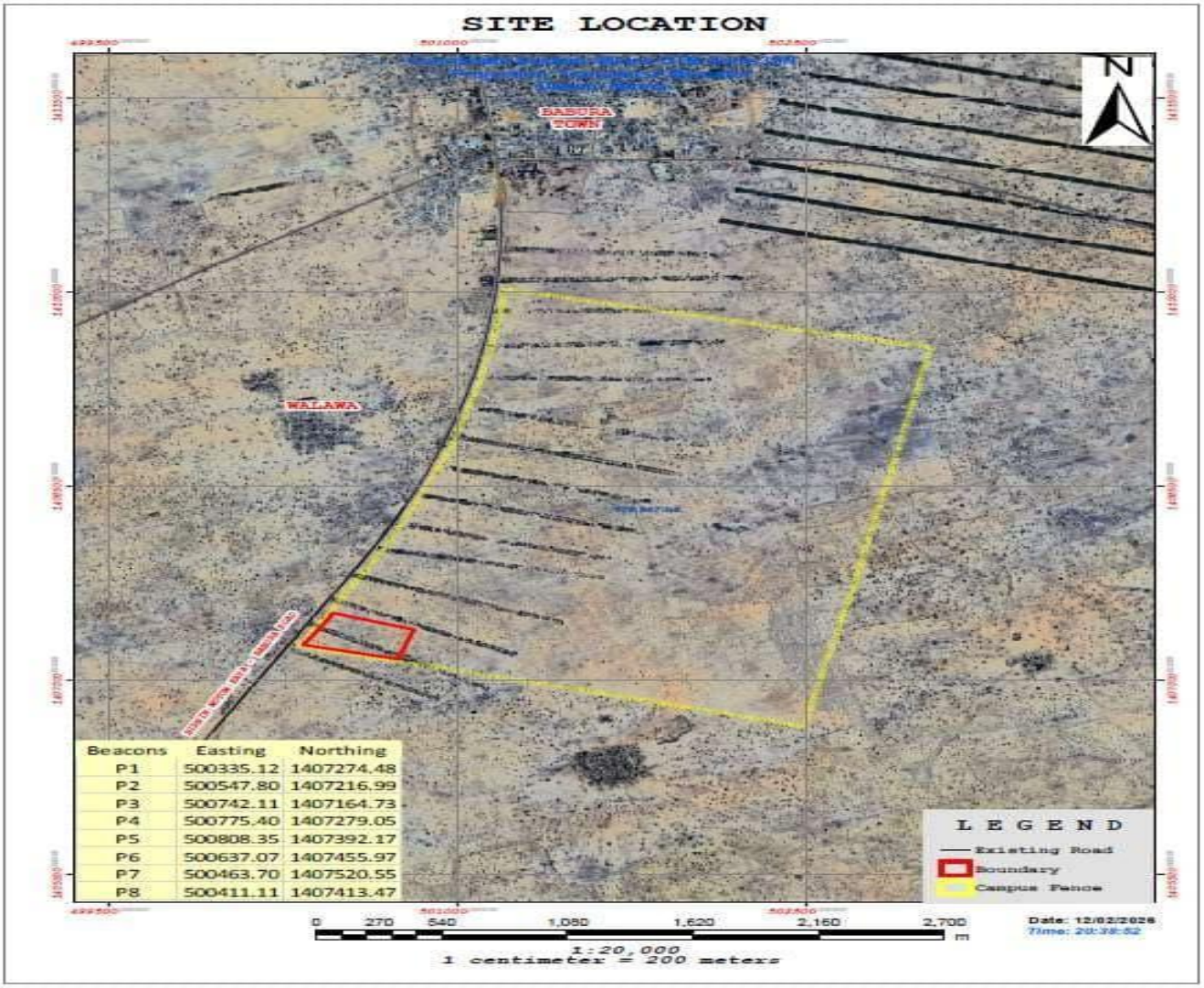

Figure 3.4: Site Location

Source: BOLBEN LTD Fieldwork 2026

3.3 Project Overview

The proposed solar project is a photovoltaic (PV) solar farm installation which will be installed on a galvanized steel support structure of about 1.5 meters height. PV modules will be mounted in table form that will connect, via angled brackets, to steel columns which will be driven into the ground. These assemblies will be organized into arrays; placement of the arrays within the facility site will be based on constraints including topography and biological considerations. The PV Modules are electrically connected by wire harnesses and combiner boxes that collect power from several rows of modules and feed the power conversion system (PCS) via underground DC cables.

3.3.1 Project Components

The project comprises six components:

- A solar PV farm complete with inverters and transformers,
- Substation,
- Transmission line,
- Access Road,
- Buildings (control room, site office, renewable energy workshop training centre (WTC), and
- Streetlight.

The main characteristic of the fixed mounted structure is presented on Table 3.1.

Table 3.1: Main characteristics of the fixed mounting structure

Fixed structure characteristics	
Structure type	1H
Tilt angle	9.0 °
Poles type	Bi pole
Pitch distance	3.04 m
Designed for	MONOFACIAL modules
Fixed structure characteristics	
Minimum ground clearance	0.5 m
Gap between modules in the axis direction	0.0 mm
Gap between modules in the pitch direction	0.0 mm

(Source: REA EEP 3 FEED)

Table 3.2 gives a summary of the project's characteristics and figure 3.5 shows the electrical configuration of the PV plant.

Table 3.2: Key Project Characteristics

Main characteristics	
Location	Nigeria, Jigawa
Rated power (AC)	4180.0 kWac
Peak Power (DC)	5018.3 kWdc
Ratio DC/ AC	1.20
Civil characteristics	
Suitable plot area	15. 02 ha
Ground coverage ratio (GCR)	32.00 %
Structure type	Fixed structure
Pitch distance	3.07m

Electrical characteristics	
PV modules 335.0 (Wp)	14980
Power station (up to 1980.0 kW)	3
Number of inverters (up to 110.0 KVA)	38
Environmental Characteristics	
Gaseous Emissions	None
Discharges	Uncontaminated storm water to be diverted around plant, to be made discharged to natural water courses as appropriate.
Noise	< 15 dB(A) at nearest noise sensitive premises ≤ 15 dB(A) at plant boundary
Roads	An existing single road offering access to the field will be rehabilitated within the university to link the plants perimeter. All other means of transportation will be held within the boundaries of the field.

(Source: REA EEP 3 FEED)

The advantages of solar energy include its non-polluting nature; it is non-depletable, reliable, and free fuel. The disadvantages of solar energy are that the solar energy concentration is very dilute, so collectors with large surface area are needed. In addition, solar radiation is neither constant nor continuous for terrestrial applications (i.e. low-capacity factor). The solar energy received depends on latitude, season, time-of-day, and atmospheric conditions.

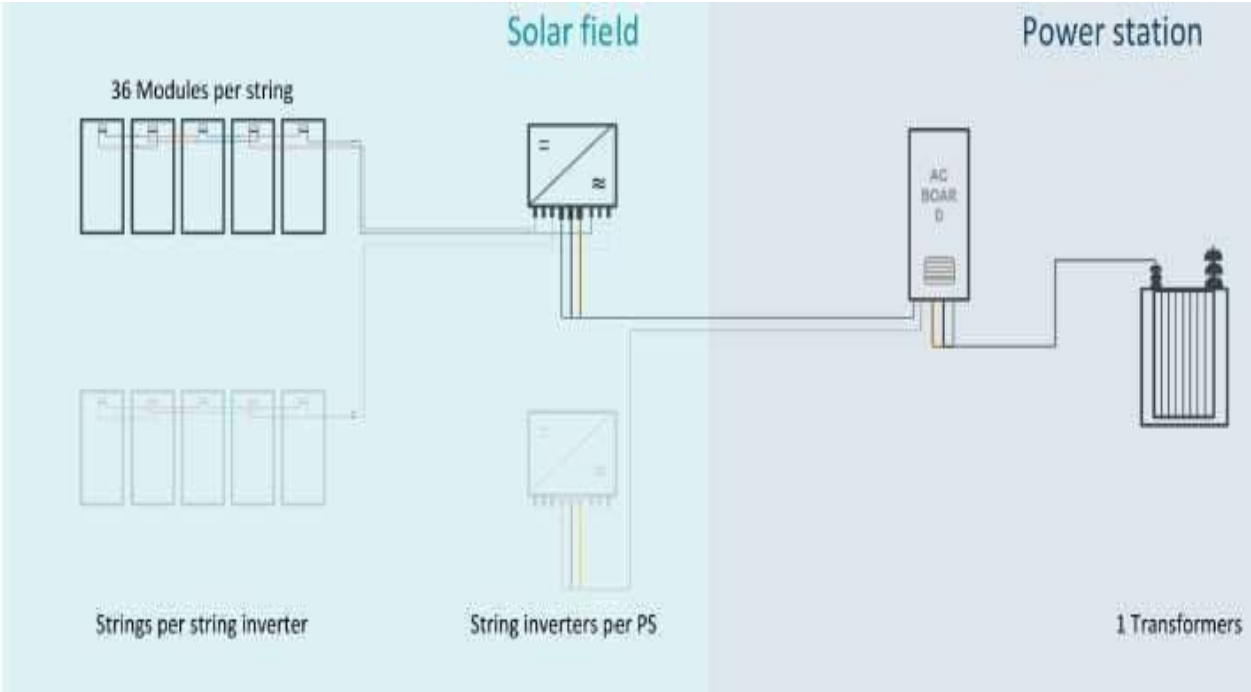

Figure 3.5: Simplified electrical configuration diagram
(Source: REA EEP 3 Front End and Engineering Design)

3.3.2 Description of Associated Components of the Project

Solar PV Farm (*Solar PV Modules)*

A PV cell is a semiconductor device that converts sunlight into electricity using photovoltaic effect. Multiple cells can be combined to form a PV module. The efficiency of a PV module is measured by its ability to absorb light particles called photons. The more photons that are absorbed, the more efficient the panel is at converting light into electricity.

The proposed solar farm would consist of arrays of modules, mounted on fixed structures to obtain a total project capability of about **5,000** (kWp) of direct current (DC). The feedstock (solar radiation) is readily available as a byproduct from sunlight, and the long-term supply is guaranteed. The panels are generally considered to have a lifetime of upwards of 30 years (Alsema, E.A., de Wild- Scholton, M.J., & Fthenakis, V.M. (2006).

The selected minimum reference photovoltaic module has a peak power of 415.0 W, and the technology of the cells is Si-poly. The features of the photovoltaic module are shown in Table 3.3, an example picture of a Monofacial Si-poly module is shown in 24.

Table 3.3: Photovoltaic module characteristics

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

Figure 3. 6: Example of a Monofacial Si-poly photovoltaic module
(Source: REA EEP 3 FEED)

Inverters

Inverters are installed in the containers or outside on proper mounting solution. Inverter receives DC electrical energy that flows from photovoltaic panels and transforms it into AC electrical energy that is passed to the national grid. The inverter adapts itself to the photovoltaic string to get the maximum electrical energy available and pass it to the grid. This method is called Maximum Power Point Tracking (MPTT).

In Figure 3.7, a commonly used photovoltaic inverter for utility-scale PV plant is presented, and its characteristics detailed in table 3.6. The single line diagram for the inverter is shown in figure 3.6.

Figure 3. 7: Example of string photovoltaic inverter
(Source: REA EEP 3 FEED)

Table 3.4: Inverter characteristics

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

(Source: REA EEP 3 FEED)

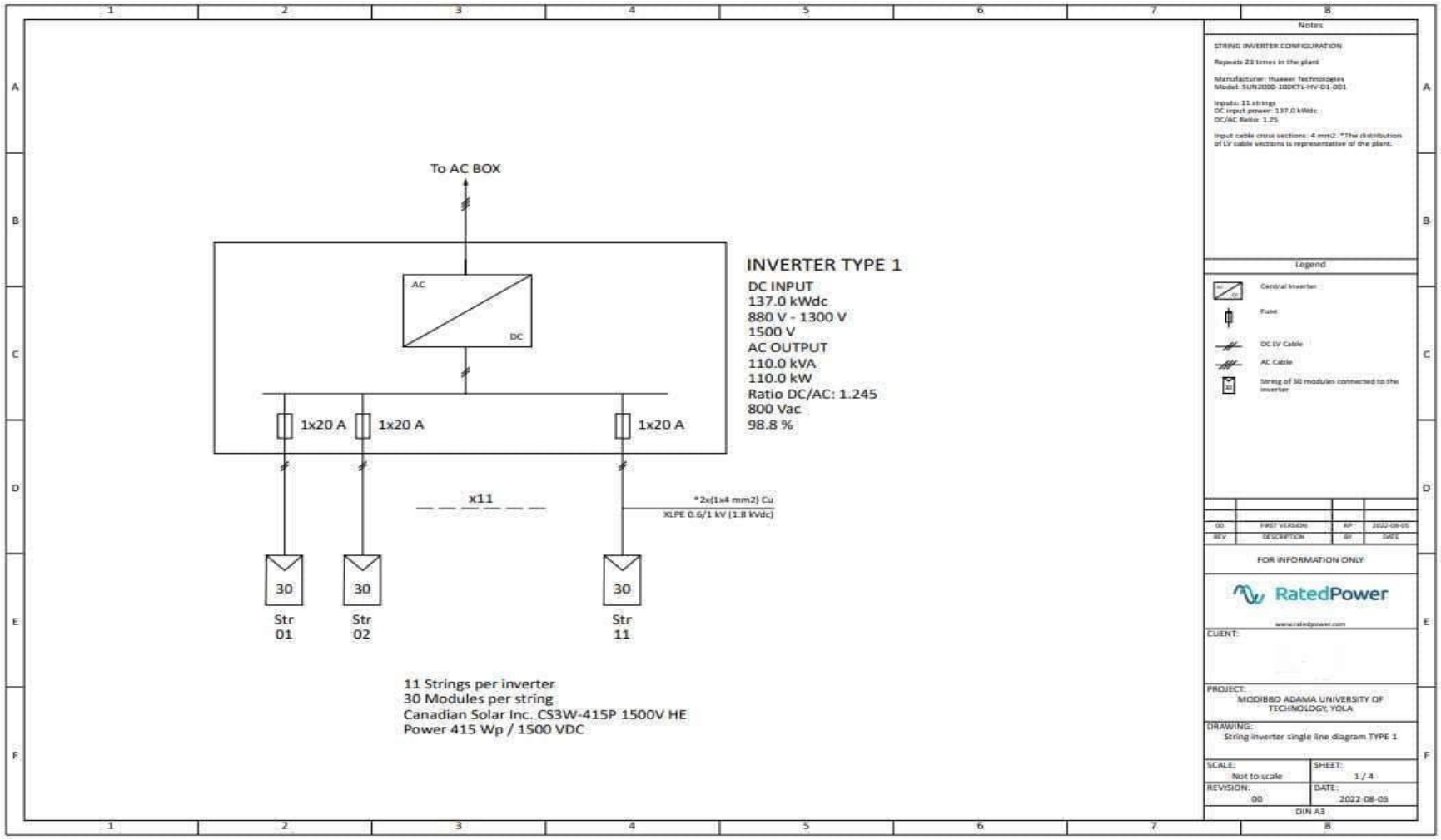

Figure 3.8: String Inverter Single Line Diagram
(Source: EEP3 FEED)

Transformers

All inverters are connected to a transformer. The role of the transformers is to step- up the voltage from an inverter nominal voltage to a medium voltage of the national grid. Transformers consist of three coils. One coil is connected to the high voltage; two coils are connected to each of the inverter unit's master/slave. The proposed project layout comprising the solar power plant site and transmission line have taken into account the solar radiation, wind direction and evacuation corridor. An example of a power transformer is shown in Figure 3.9.

Figure 3.9: Example of Transformer
(Source: REA EEP 3 FEED)

The main features of the power transformer are shown in Table 3.5.

Table 3.5: Transformer characteristics

Transformer characteristics	
Rated power	1980.0 kVA
Voltage ratio	0.8/ 11.0kV
Cooling system	ONAN
Tap changer	2.5%, 5%, 7.5%, 10%
Short circuit (Xcc)	0.08

(Source: REA EEP 3 FEED)

Weather Station

The Solar Monitoring Weather Station includes common meteorological sensors, mounting accessories, a data logger or the signal translator, power supply, and communications hardware. The equipment can be powered from a solar panel power system. The standard sensor array includes two pyranometers, a combined temperature and relative humidity sensor, wind speed and wind direction sensors, and surface mounted temperature sensors to measure solar panel temperature**.**

Power station

The power stations or transformer stations are indoor buildings or containers. The voltage of the energy collected from the solar field is increased to a higher level to facilitate the evacuation of the energy generated. The power transformers will be housed in the power station. An example of an Indoors power station is shown in Figure 3.10.

Figure 3.10: Example of a power station

The power station shall be supplied with medium voltage switchgears that include one transformer protection unit, one direct incoming feeder unit, one direct out coming feeder unit and electrical boards. Particularly, for the first power station of each MV line, a direct incoming unit will not be installed. The main features of the default power station are shown in Table 3.6. Figure 3.11 is the Power Station Single Line Diagram.

Table 3.6: Power station characteristics

Power Station Characteristics	
Number of transformers	1
Voltage ratio	0.8/20.0kV
Service Indoors	Indoors

(Source: REA EEP 3 FEED)

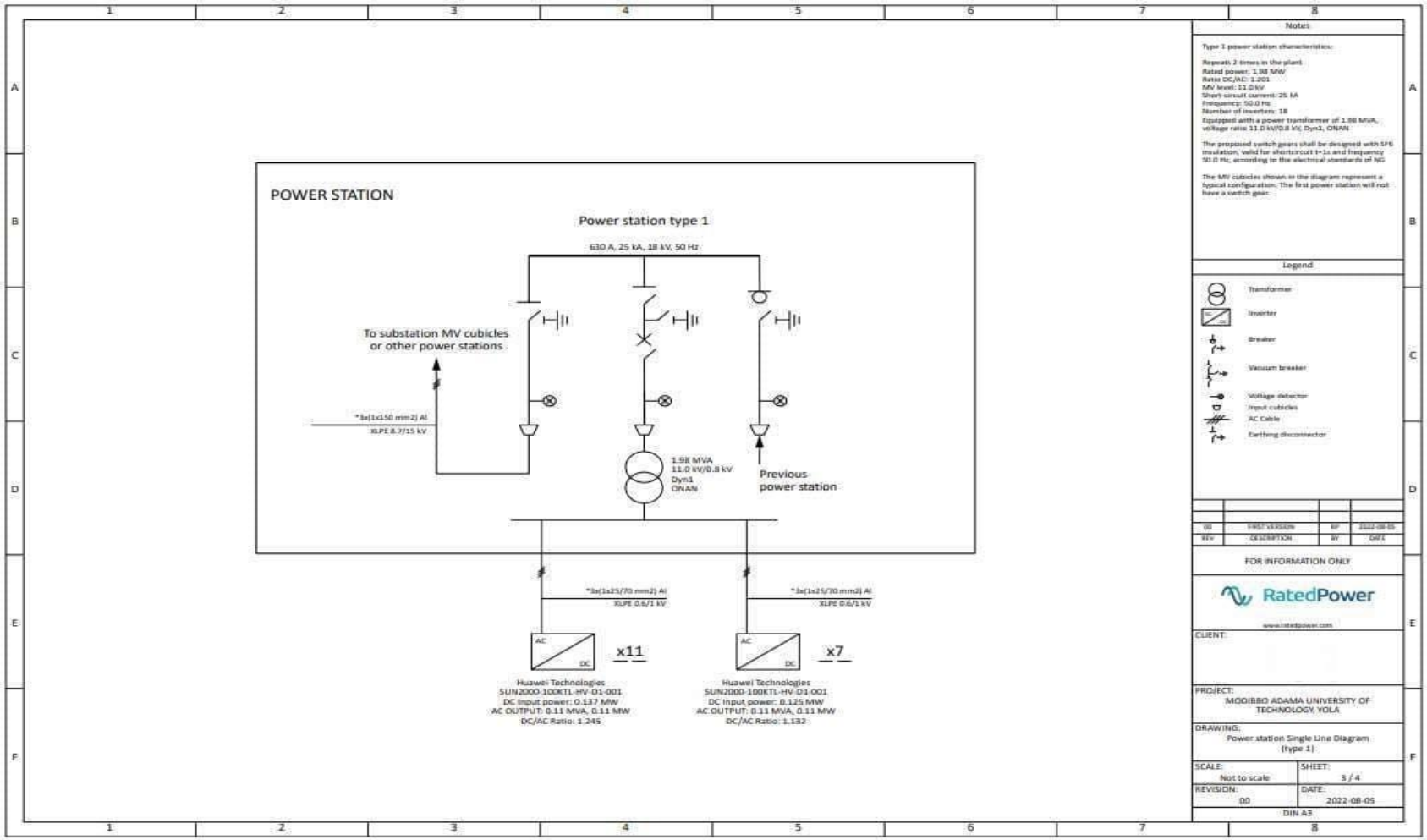

Figure 3. 11: Power station Single line Diagram
(Source: EEP3 FEED)

Access Roads

Gravel paved earth access roads within the facility will be constructed (figure 3.12). The roads will link all project components and be laid out in an efficient manner to ensure easy access for operation and maintenance as well as access from outside the facility. For the design of the proposed PV plant, roads of 4.0 m have been used. These roads run a total distance of 404.09 m. Road ditches used for drainage and for channeling water are placed on one side of the roads. Figure 3.12 shows a Typical Road Cross Section for the university. A total perimeter of 1135.42 m of chain link fence surrounds the different areas of the PV plant. The fence has at least 2.0 m of height and 3.0 m between posts. For every 50.0 m fence, a light post of 4.0 m omight and a microwave barrier system are installed. For every 100.0 m fence, a video camera post of 6.0 m height is installed.

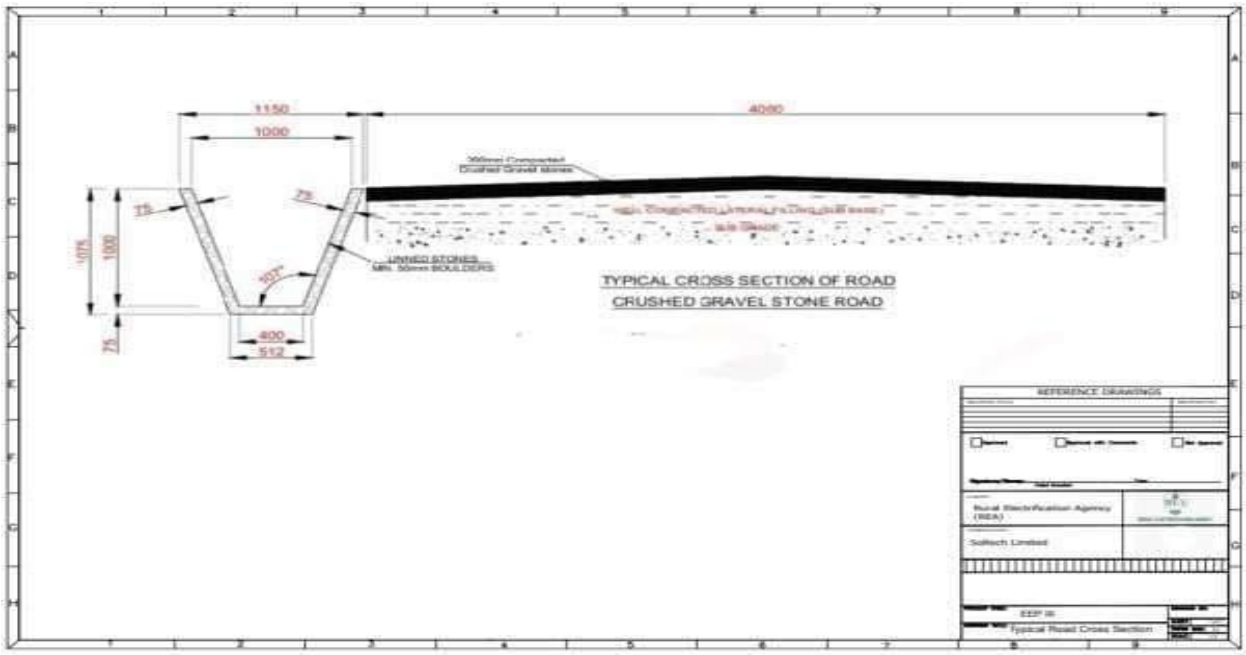

Figure 3. 12: Typical Road Cross Section
(Source: REA NEP 3 FEED)

Buildings

A renewable workshop centre will be built and ancillary facilities that include residential quarters for the security, maintenance, and control room staff who will be required full-time, a guard house and an office/control centre. Figure 3.13 is an illustration of the elevation plans of the training Centre.

Control Building

The control building would take up an area of approximately 30 m × 15 m. The main construction compound would temporarily require an area of approximately 60 m × 40 m, however; this area would be fully reinstated after construction.

Lay down and Staging Area

A staging area where solar panels would be assembled would be constructed within the project area. The entire area would be enclosed by a chain link fence with a gate. Regular cleaning of the solar panels would be accomplished by either rinsing with water, blowing with compressed air, or a combination of both. Expected waste from this area would include wooden crates, plastics wrappings and Styrofoam.

Figure 3.13: Elevation plans of the training Centre
(Source: EEP FEED)

Transmission Line

The power generated from the proposed solar power plant would be evacuated through an 11kV transmission line to the university load center through underground cable. The path for the underground cable will be beside the existing road.

3.3.3 Operation and Maintenance

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

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

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

Condition-based maintenance: which involves monitoring equipment and plant operations real-time and addressing potential problems early on to prevent plant downtime. This includes continuous monitoring via remote and on-site methods, warranty enforcement, and planned and unplanned equipment replacement.

Maintenance activities will be carried out by skilled manpower with backgrounds in electrical/electronic engineering and unskilled local labour where applicable. Specific maintenance activities include the following:

PV Modules

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

Energy Requirement

Power for welding and other electrical construction activities will be supplied primarily through diesel-powered generator sets installed on-site, with supplementary use of portable inverter systems or temporary grid supply where available.

Electrical System

- Inverter components need to be checked to prevent breakdowns which can occur during very hot weather conditions.

- Electrical wiring and earthing protection need to be checked for wear and tear. Also, the underground cabling needs to be monitored regularly for damages from pests. Infra- red technology may be employed to identify spots where there are electricity leaks.

Civil Structures

- Mounting structures need to be checked regularly for bending damage which can affect the PV modules
- Access roads, drainage works, plant foundation and array structures need to be checked by visual inspection for water damage during the rainy season

Vegetation

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

A stockpile of spare parts will be kept on-site to facilitate replacement of broken-down or out-dated solar panels and inverters. On-site security and inventory management will be implemented to prevent theft of spare parts and installed plant components. Monitoring of the PV system components needs to be conducted to ensure increased system output and to reduce downtime. Traditional monitoring methods that compare actual energy generation against predicted energy generation will help to track the system's relative health.

3.4 Project Activities

The Project activities are grouped as follows:

- Installation phase activities
- Operation phase activities
- Decommissioning phase activities

3.4.1 Installation Phase Activities

Activities during the installation phase of the Project include civil, mechanical and electrical works which include the installation of PV panels, inverters, laying of cables for power transmission and distribution and palisade fence.

These activities shall be carried out by the contractors. The contractors to be engaged for the Project shall employ indigenes as their workforce. The number of contract workers to be hired will be determined by the contractors engaged for the Project. Various categories of workers will be engaged by the contractors which will include of low-skilled workers (e.g. construction labour), semi-skilled workers (drivers, equipment operators), and skilled personnel (e.g. engineers). No worker will be housed on site during the installation phase. It is envisaged that majority of the workers (about 70 %)

will be drawn from the Project area.

3.4.2 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.

3.4.3 Operational Phase Activities

The operational phase of the Project will involve power generation and distribution to the different blocks within the DSS Headquarters as well as the preventative, corrective and predictive maintenance of the power plant and associated facilities.

3.5 Water Use and Supply

The use of water for construction activities will be minimal because construction works requiring cement mixing will not be much on site. Water is required majorly during operational phase of the integrated solar power plant for periodic cleaning of PV panels to prevent dust build-up (especially during the dry season), since dust can affect their performance by inhibiting the amount of irradiation that reaches the solar cells. The rate of build-up of dust on the PV panels is dependent on a number of factors including soil type, local wind speed and the mounting structure used for the panels.

Manual cleaning of the PV panels with water shall be regulated as much as practicable. During the periods of rainy season, 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 is planned to be on a bi-weekly basis but may increase due to high dust generation usually experienced in the Northern parts 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. With an estimated installation of about 11,000 PV panels, the total estimated water requirement is approximately 55,000–60,000 litres per cleaning cycle. The water required for the cleaning purposes would be obtained from the single borehole which shall be dug within the project site which will the useful in all phases of the project.

3.6 Health and Safety

Rural electrification Agency (REA) is aware that occupational health and safety as well as community health and safety issues are likely to occur during construction, operation and maintenance of the solar power project. Workers may be exposed to physical hazards, trip and fall hazards, exposure to dust during site clearing, risk of electrical hazards and other related dangers. Rural electrification Agency shall implement all reasonable precautions that will guarantee the health and safety of workers throughout the project implementation stages. Rural electrification Agency has developed a preventive and protective measure that prioritizes eliminating hazard,

controlling of hazard, minimizing of hazard and the use of personal protective equipment (PPEs). It is the duty of Rural Electrification Agency to ensure that only trained and certified personnel are allowed to work in areas where there is potential risk of harm. However, all workers will be trained on risk identification and hazard perception. A detailed occupation health and safety plan has been developed and presented in Chapter Seven as part of the Environmental and Social Management Plan (ESMP) for the solar project.

3.7 Emergency Preparedness/Shut-Down Measures

Solar PV facilities are generally low-risk installations but the presence of high DC voltages, grid interconnection infrastructure, inverters, battery energy storage systems necessitate the incorporation of emergency response measures to ensure personnel safety, asset protection, and environmental safeguarding. Emergency situations that could occur during the operational phase may include but not limited to electrical faults, components malfunction/overheating, fire outbreak, extreme weather events, vandalism, etc. In the event of an emergency, the following shutdown and isolation systems shall be incorporated into the plant design:

- DC Isolation Measures
- AC Isolation Measures
- Rapid Shutdown Functionality so that the system shuts down to reduce voltage levels in the event of fire or emergency intervention
- Inverter Protection Systems

The facility shall also have:

- Smoke Detectors
- Portable fire extinguishers (CO_2 and dry chemical type) located at inverter stations and battery enclosures;
- Clearly marked emergency shutdown buttons;
- Fire-resistant cable routing where required;
- Lightning protection and surge arresters integrated into the system design.

Additionally, coordination shall be established with the University Safety Unit and local fire services to ensure familiarity with the facility layout and shutdown procedures.

3.8 Waste Management

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

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

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

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

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

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

Residue Disposal - disposal of waste in a government-approved dumpsite.

The project is expected to generate approximately 10–25 tonnes of construction waste, mainly comprising metal scraps, packaging materials, electrical installation waste, and general construction debris. During operation, minimal maintenance waste of less than 1 tonne per year is anticipated. At end-of-life, significant waste streams may include approximately 80–120 tonnes of batteries and 220–275 tonnes of solar panels, which will require proper collection, recycling, and disposal in accordance with applicable environmental regulations.

A detailed waste management plan has been prepared for waste that will be generated during the operation and maintenance phase of the project, especially the hazardous materials from project components like waste batteries, PV panels etc. and which is presented in Chapter Seven as part of the environmental and social management plan.

3.9 Contribution to Sustainable Development

The proposed project aligns with the United Nations SDGs, particularly the following SDG goals:

- **SDG 7**: Affordable and Clean Energy
- **SDG 11**: Sustainable Cities and Communities
- **SDG 12**: Responsible Consumption and Production
- **SDG 13**: Climate Action

By showcasing a replicable clean energy model, the project serves as a catalyst for decentralized renewable energy integration and sustainable urban waste management. The project aligns with both the State Climate Action Plan and Nigeria's Energy Transition Plan (ETP), which emphasize distributed renewable energy as key to achieving net-zero goals by 2060.

CHAPTER FOUR

DESCRIPTION OF THE EXISTING ENVIRONMENTAL AND SOCIAL CONDITIONS

4.1 The Study Approach

Environmental baseline study of the 5MW Solar Photovoltaic Power Plant Project at Federal University of Technology, Babura, Jigawa State is undertaken to establish the situation of the physical, biological, social and health environment of the study area prior to the commencement of the project development. This serves as baseline or benchmark to assess and monitor the impacts of the proposed project at Babura, Jigawa State.

Consequently, upon completion of the environmental and social baseline study, the results generated would serve as a benchmark against which any potential beneficial or non- beneficial impact of the proposed project on the environment and socioeconomics of the project area would be identified and assessed.

The main environmental components considered in the environmental baseline study include:

- **Physical components**: soil, ground water resources, air quality, noise and climatology;
- **Biological environment**, which includes flora, (i.e trees, grass), fauna (i.e, birds, mammal), threatened, and/or endangered species (plant/animals), species diversity, overall ecosystem stability etc.
- **Cultural** and **socio-economic components**: Distribution of socio-economic resources indicative of human welfare, i.e. educational system, transportation/land use networks, and other infrastructures like water supply, wastewater/domestic disposal, solid waste management, public services, medical facilities and health impacts.

An integrated approach was adopted in presenting the multidisciplinary results of the baseline studies. The environmental baseline studies conducted were grouped under five main categories viz:

- **Physico-chemical Environment studies**
  - Climate and Meteorology
  - Land Use
  - Air Quality and Noise Level
  - Water quality – Groundwater
  - Soil and Ground Studies

There are no surface water bodies within the project area.

- **Biological Environment studies**
  - Flora and Fauna
  - Soil and Water Microbiology
- **Socio-Economic studies**
  - Corporate Social Responsibility to the host community
  - Educational, Socio and cultural setting in the study area

- **Health Status**
    - Health infrastructure and human health disease patterns.

- **Waste Management Analysis**

The baseline field data gathering was carried out in one season (dry season) within the first two weeks of February, 2026 as approved by the Federal Ministry of Environment (FMEnv).

4.2 Environmental and social Baseline Data Acquisition Methods

The acquisition of data basically involved field data gathering, measurements and the collection of representative samples used to establish the environmental conditions of the study area. This exercise involved a multi-disciplinary approach and was executed within the framework of a Quality, Health, Safety, and Environment (QHSE) Management System approach. This approach ensured that the required data and samples were collected in accordance with agreed requirements (scientific and regulatory) using the best available equipment, materials and personnel. Elements of this approach include:

- review of existing reports that contain environmental information on the study area;
- designing and development of field sampling strategies to meet work scope and regulatory requirements;
- pre-mobilization activities (assembling of field team, sampling equipment/materials calibrations/checks, review of work plan and schedule with team, and job hazard analysis);
- mobilization to field;
- fieldwork implementation - sample collection (including positioning and field observations), handling, documentation and storage protocols and procedures;
- Demobilization from field; and
- Transfer of sample custody to the laboratory for analyses.

The following sections present the field data gathering methodology/procedures and the descriptions of the environmental baseline conditions of the study area. Detailed documentation of the fieldwork execution including descriptions of the laboratory analytical methods and procedures, the detection limits for the various parameters analyzed as well as an overview of the general QHSE plan adopted for field data gathering and laboratory analysis is presented.

4.2.1 Desktop Studies

Desktop studies involved the acquisition of relevant background information on the environment of the study area. Materials that were consulted included approved reports on previous environmental surveys in the area, publications, textbooks, articles, as well as spatial data like maps and satellite imagery, alongside government regulatory frameworks and statistical databases on the area and similar environments.

4.2.2 Field Sampling for Baseline Data Acquisition

The data gathering exercise was undertaken during the dry season, on the 6th of February 2026. See ***Appendix II for the authorisation letter from the Federal Ministry of Environment for a one season field sampling for data acquisition***.

The specific objectives of the field sampling were to:

- Determine the ambient air quality and noise level of the study area;
- Determine the physico-chemical and biological characterization of groundwater water of the study area;
- Establish the socio-economic and health status of the host and impacted communities.

The exercise involved in-situ measurement of salinity, temperature and pH. Samples were taken at defined sample points using bottle sampler for water quality determinants. These were stored and preserved as appropriate for each analysis. Water samples were collected for laboratory analyses using

- 2-litre plastic bottle for groundwater samples for physicochemical analysis;
- 1-litre plastic bottle for groundwater samples for microbiological analysis;
- 1-litre glass bottle with Teflon seal cap for groundwater samples to be analysed for hydrocarbon content (oil and grease, etc.).

4.2.3 Field Studies and Sampling Design

Sampling was designed to comprehensively capture all the ecological and socio-economic components peculiar to the study area. Design of field activities was made prior to mobilization. This was aided by information obtained during reconnaissance survey of the project area.

Sampling locations were decided as waypoints in Geographic Position System (GPS) and later plotted on a samples location map used during field studies (see figure 4.4 for map). Locations for biophysical sampling considered ecological types around the project areas, vulnerable environmental attributes with regards to the potential and associated impacts of the environment and control or buffer zones. Socio economic and health impact studies on the other hand, considered human habitations, infrastructure, cultural heritage sites and prevailing health conditions of people within the sphere of influence to the project area. The spatial location maps of the sampled points are presented in the respective component sections.

The Quality Assurance/Quality Control (QA/QC) procedures were implemented during sample collection, labeling, analyses and data verification. Chain of custody procedures including sample handling, transportation, logging and crosschecking in the laboratory were also implemented.

All the samples collected were analyzed at Kano State Ministry of Environment Pollution Control Laboratory, a Federal Ministry of Environment Accredited laboratory with accreditation certificate No. 0004099. The area of influence of the project/spatial boundaries was 3km from the centre of the project site. The samples taken for analysis are soil, air and groundwater, for soil and air quality ten different points were taken while for groundwater, three samples were taken. Below are the parameters analyzed for each of the three samples.

Table 4.1: Parameters Sampled/Analyzed for the EIA Study

S/N	Soil Parameters	Air Parameters	Water parameters
1	Colour	Sound Level	Colour
2	Temperature	SO2	Taste
3	pH	NO2	Odour
4	K+	H2S	pH
5	Na+	HCN	Electrical Conductivity
6	Ca+	PH3	Total Dissolve Solid
7	NH4+	NH3	Temperature
8	Mg2+	C2H4 (Ethene)	Total Suspended Solid
9	SO42-	HCl	Dissolve Oxygen
10	Cl-	Cl2	Nitrate
11	NO2-	TVOC	Calcium
12	NO32-	HCHO	Nitrite
13	PO42-	Pm2.5	Magnesium
14	TPH	Pm10	Total Hardness
15	Phenols	Pm1.0	Chlorine
16	Benzene	O3	Sodium
17	Oil & Grease	CO	Sulphate
18	Porosity	CO2	Chromium (Cr2+)
19	Permeability	Temperature	Zinc (Zn2+)
20	Sand	R/Humidity	Lead (Pb2+)
21	Silt	AQI	Arsenic (Ar2+)
22	Clay		Iron (Fe2+)
23	E. Coli		Mercury (Hg+)
24	Fungi		E. Coli
25			Total Coliform

Fieldwork Activities/Laboratory Analysis

Fieldwork activities/Laboratory analyses were carried out to complement secondary data gathered from literature and to collect new and additional primary data to fill information gaps. The activities were carried out in accordance with FMEnv and recommended international methods. The laboratory analyses of the samples collected were carried out at **Kano State Ministry of Environment and Climate Change Pollution Control Laboratory at Tarauni, Kano State.**

4.2.4 Field Data

Environmental Field data is gathered or collected during field exercises, gives a real time description of the state of that specific environment, at a particular time. Field data helps in **quantitatively** & **qualitatively** describing the state of the project site which has been selected for the study. The analysis of environmental field data is a particularly complicated task, because the potential sources of impacts recorded at a site, might be diverse, and of which they might not all be traceable to a single project. Therefore, due diligence must be done to ensure the integrity of environmental data

analysis.

In subsequent sections, the field data gathered/collected/generated during the EIA study are presented in line with the FMEnv EIA guidelines.

Table 4.2: Sample Matrix

S/N	Environmental component	Sampling points or Stations
1	Groundwater	2 + 1 Control
5	Vegetation	
6	Soil	5 + 1 Controls
7	Ambient Air Quality	13 + 2 Controls
8	Socio-economic and Health	62 Questioners and Interviews

Field Surveys

The field sampling was carried out for this study in line with the FMEnv approved ToR. Sampling and observations for air quality and noise, soil, groundwater, vegetation, and wildlife were carried out during fieldwork. The socio-economic survey was obtained through consultation with the project community **(S*ee Appendix I: Page 227 for pictorial evidence*),** which is within 3km radius of the proposed project site, and administration of 50 questionnaires through stratified random sampling. Sample collection and handling procedures to maintain the integrity of samples and enhance quality of the results, were in accordance with international standards and with reference to FMEnv guidelines and standards. This was followed by detailed ecological sampling and laboratory analysis of samples.

All biophysical sampling and observation points were geo-referenced using Garmin eTrex 22x, Rugged Handled GPS Navigator, and Garmin eTrex 10. The sample positions are also shown on the map of the project site. Quality assurance was applied to all aspects of the study including sample collection, handling, laboratory analysis, data coding, statistical analysis, presentation and communication of results.

Quality Assurance

All equipment and materials and their calibration certificates were inspected and certified by the regulator before the commencement of the field sampling. The methodology and procedures for sample collection, storage/handling and analysis were such that integrity was assured. To ensure the accuracy and reliability of in-situ field measurements, field instruments were calibrated prior to use and cross-checked from time to time. Sampling points were properly geo- referenced. Field portable pH meter was calibrated using pH4, pH7 and pH9 buffer solutions. The conductivity and dissolved solids meter were checked against solutions of known conductivity and dissolved solids provided by the manufacturers.

All sample containers for water sample collection were rinsed with the water being sampled before putting the sample into the containers. Amber bottles were used for BOD5 samples while sterile vials were used for all microbiology samples. Plain glass bottles were used to collect water samples for THC. Soil samples for physio-chemical analysis were collected in appropriately labelled and sealed

polythene bags in accordance with the quality assurance criteria. Aluminium foils were used for soil samples for THC. Ice-chests were used to preserve samples in the field before transportation to the laboratory for analysis.

All parameters were analyzed within their shelf life. Chain of custody procedures including sample handling, transportation, logging and crosschecking in the laboratory were also implemented. The samples were preserved in ice-chest during transportation to the laboratory.

4.3 Environmental Conditions of the Proposed Project Area

4.3.1 Climate and Meteorological Features

Observed Weather Parameters

Ambient air temperature during the field survey was in the range of 32 – 36°C, Relative Humidity ranged from 60% - 69%, while the wind speed ranged from 0.7m/s – 3.3m/s. While in the surrounding communities, ambient air temperature during the field survey was in the range of 34 - 37°C, Relative Humidity ranged from 54% - 63%, while the wind speed ranged from 0.4m/s – 1.6m/s.

Jigawa State predominately enjoys two major seasons (rainy between May and October, and dry between October and April). The harmattan weather from the northeast trade wind occurs for a brief duration within these periods characterized by a dusty, intense dryness and coldness. The presence of high altitudes and the terrain of the state moderate the influence of the weather on the territory. Table 4.3 shows the data on climatic variables over the study area.

Table 4.3: Meteorological Data for the Study Area (2023)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Nov	Oct	Dec	Year
Record high °C (°F)	44.0(111.2)	45.0(113.0)	48.0(118.4)	48.0(118.4)	51.0(123.8)	46.0(114.8)	42.0(107.6)	39.0(102.2)	41.0(105.8)	41.0(105.8)	41.0(105.8)	40.0(104.0)	51.0(123.8)
Average high °C (°F)	32.8(91.04)	36.36(97.45)	39.73(103.51)	41.55(106.79)	41.34(106.41)	38.51(101.32)	34.64(94.35)	32.11(89.8)	34.75(94.55)	37.01(98.62)	35.92(96.66)	32.47(90.45)	36.43(97.57)
Daily mean °C (°F)	26.01(78.82)	29.37(84.87)	33.24(91.83)	35.72(96.3)	36.29(97.32)	34.38(93.88)	30.92(87.66)	28.61(83.5)	30.6(87.08)	32.47(90.45)	30.64(87.15)	26.5(79.7)	31.23(88.21)
Average low °C (°F)	15.79(60.42)	18.75(65.75)	22.98(73.36)	26.24(79.23)	28.83(83.89)	28.17(82.71)	25.57(78.03)	23.8(74.84)	24.63(76.33)	25.44(77.79)	22.2(71.96)	17.4(63.32)	23.32(73.98)
Record low °C (°F)	9.0(48.2)	13.0(55.4)	16.0(60.8)	19.0(66.2)	22.0(71.6)	22.0(71.6)	19.0(66.2)	14.0(57.2)	21.0(69.8)	19.0(66.2)	17.0(62.6)	11.0(51.8)	9.0(48.2)
Average precipitation Mm (inches)	0.0(0)	0.25(0.01)	0.95(0.04)	3.91(0.15)	21.4(0.84)	58.05(2.29)	121.14(4.77)	234.49(9.23)	60.34(2.38)	15.16(0.6)	0.0(0)	0.0(0)	42.97(1.69)
Average precipitation days(≥ 1.0 mm)	0.0	0.09	0.36	1.09	3.55	8.73	16.0	18.82	9.09	2.82	0.0	0.0	5.05
Average relative humidity (%)	17.94	14.03	12.91	19.2	31.8	41.17	54.94	67.21	57.75	36.5	18.79	19.73	32.66
Mean monthly sunshine hours	11.59	11.55	11.56	11.55	12.59	12.79	11.18	10.8	11.32	10.7	8.7	10.22	11.21

Source: NIMET, 2023

Temperature

The average temperature varies because of its two distinct seasons. High temperatures are normally recorded between the months of April and September. The daily minimum and maximum temperatures are 15oC and 35oC. In the dry season the average temperature can soar up to 37oC, while the rainy season witnesses a maximum temperature of 30oC. The average annual temperature rarely falls below 30.7oC (Ifatimehin, Ishaya and Ujoh, 2010). Figure 4.1 Shows the temperature pattern of the project sites as remotely captured.

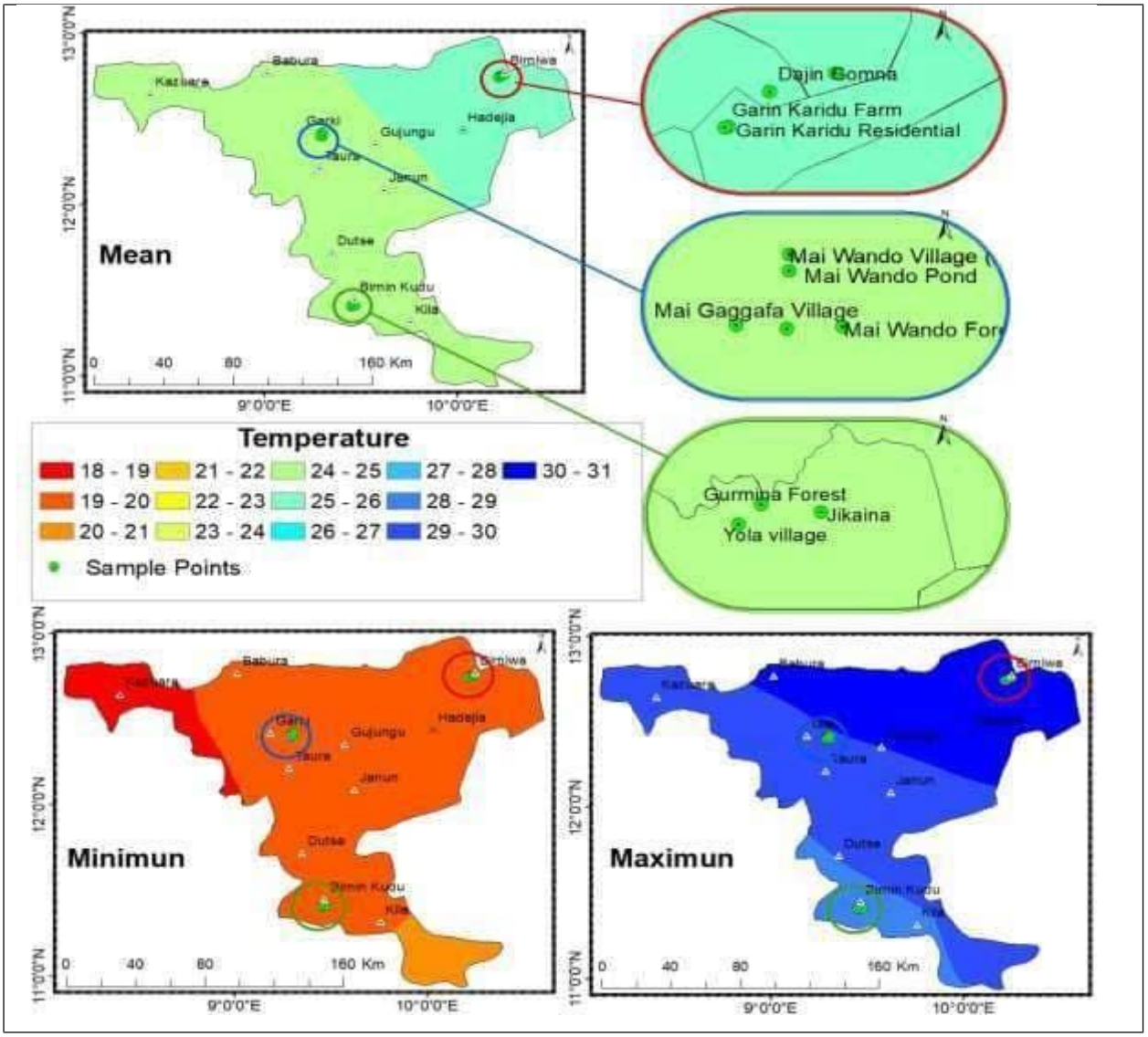

Figure 4.1: Temperature pattern of the study area

Rainfall

The rainfall pattern in Jigawa state is affected by its territory location farther north. Jigawa typically receives about 42.97 millimeters (1.69 inches) of precipitation and has 60.55 rainy days (16.59% of the time) annually. The annual distribution of rainfall indicates a peak in September. The rainy season lasts from May to September with average rainfall of between 600 millimeters to 1000 millimeters. The southern part of the state has a higher percentage of rainfall than the northern part. Figure 4.2: shows precipitation (rainfall) distribution in the project sites.

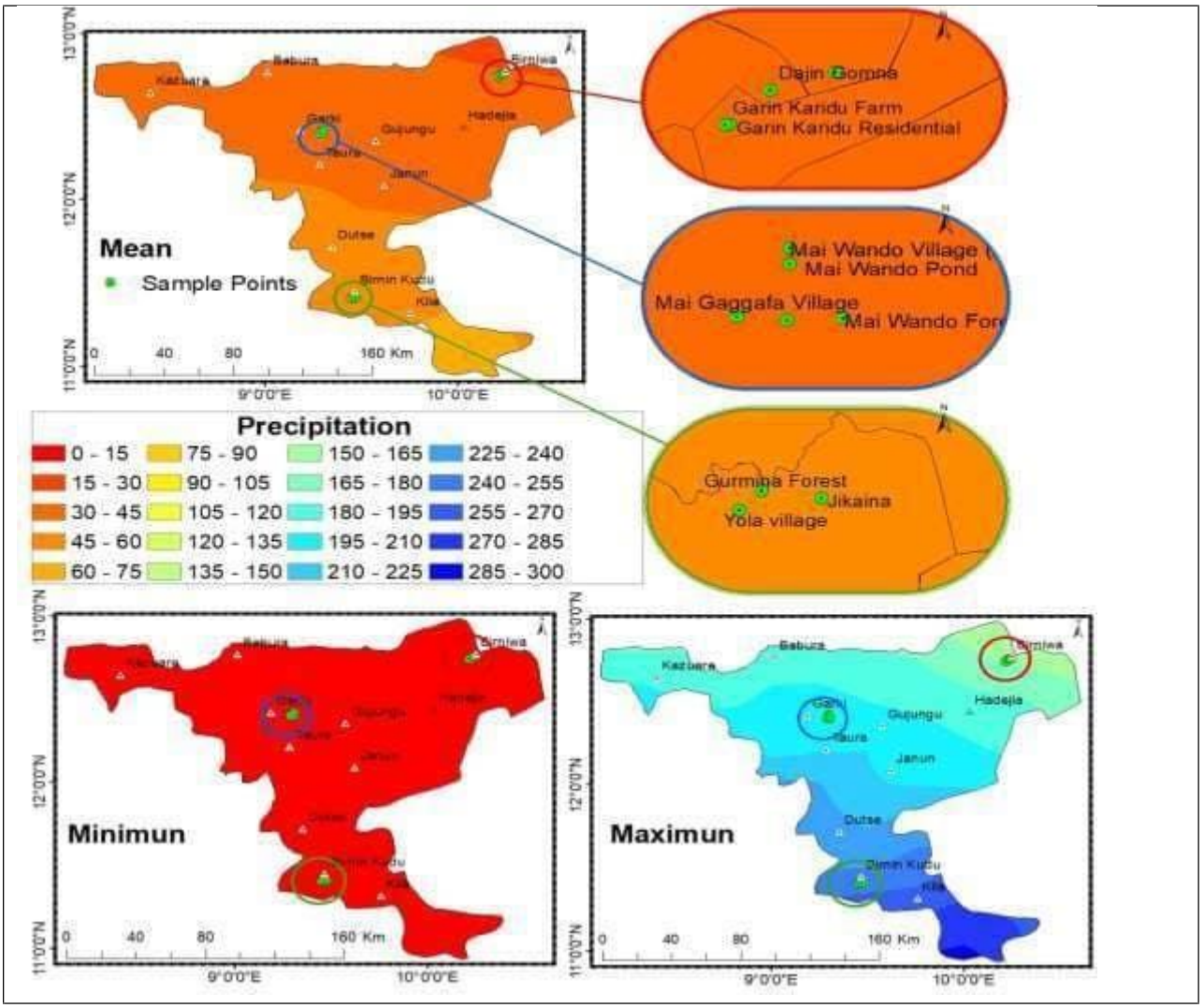

Figure 4.2: Distribution of precipitation in Jigawa state
(Source: European Centre for Medium Range Weather Forecast)

Relative Humidity

Relative humidity (RH), which is the moisture content in the atmosphere, expressed as a percentage of the amount of moisture that can be retained by the atmosphere (moisture-holding capacity) at a given temperature and pressure without condensation, was examined across the project sites. Jigawa state has an annual average relative humidity of about 32.66% with the months of February and March experiencing the lowest humidity of below 15% while July- September has the highest humidity in with rainfall in the area. As expected, mean monthly relative humidity values are high for the wet season months with the highest values occurring within the months of July and September. This is when the influence of the moisture-laden southwesterly is greatest. The relative humidity falls considerably in the afternoons in the dry season and rises everywhere during the raining season. Figure 4.3 shows the humidity of the project sites.

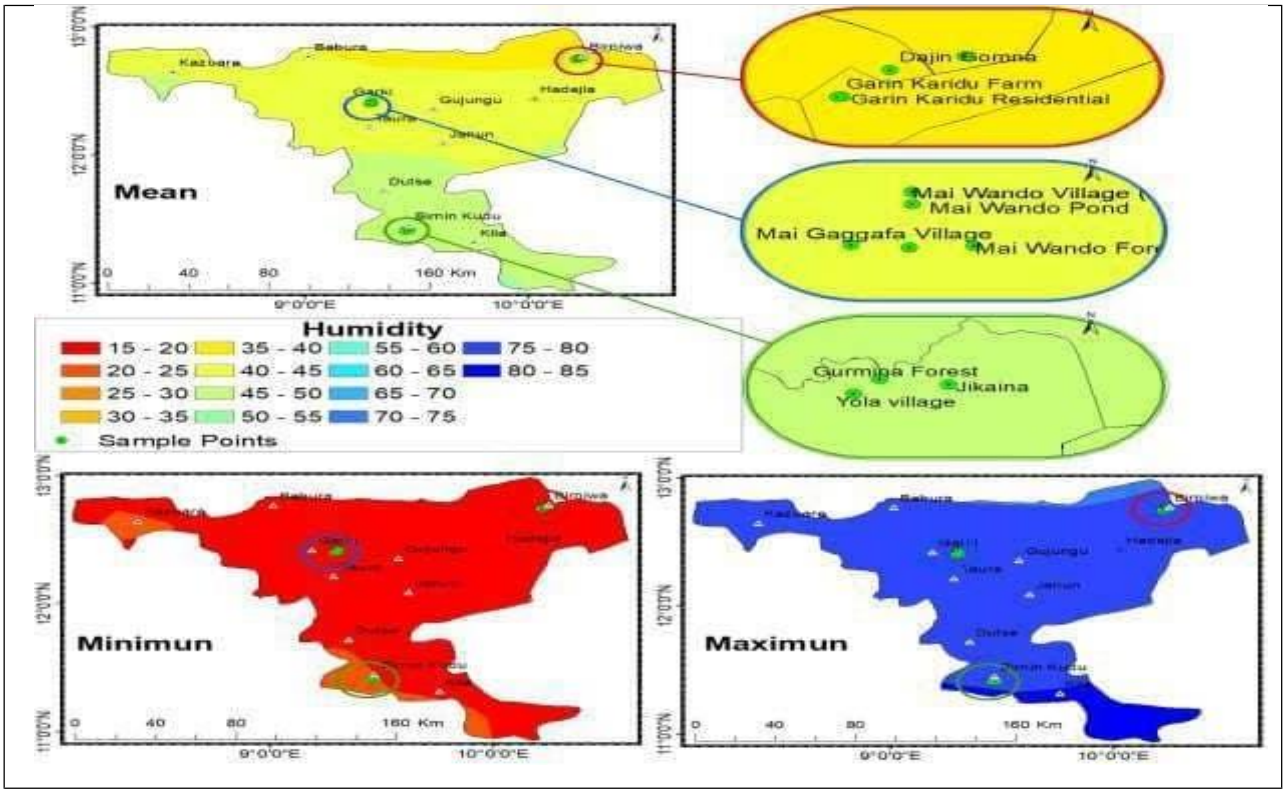

Figure 4.3: Mean Monthly Relative Humidity

Wind Direction and Speed

Wind range in the project sites is influenced by seasonal migration of the dry and moist air masses through the region. The months of May to September are characterized by moist Southern air masses. As the dry air mass descends from the North, the region is dominated by Northeasterly winds. This wind predominates from October through April and is usually dust laden as they descend from the dry interior of the continent.

Sunshine

The monthly mean sunshine hour in the project sites across Jigawa state is 11.12hours. Between November and April, the state receives about 250 hours in the south to over 275 hours in the north-east. This drops to about 125 hours monthly average during the rainy season (Ishaya and Hassan, 2013).

4.3.2 Air Quality and Noise Characteristics

One of the main components of Earth's interdependent physical systems is the atmosphere. An atmosphere is made of the layers of gases surrounding a planet or other celestial body. Earth's atmosphere is composed of about 78% nitrogen, 21% oxygen, and one percent other gases. These gases are found in atmospheric layers (troposphere, stratosphere, mesosphere, thermosphere, and exosphere) defined by unique features such as temperature and pressure. The atmosphere protects life on Earth by shielding it from incoming ultraviolet (UV) radiation, keeping the planet warm through insulation, and

Plate 4.1: Measurements of air quality and noise at the project site.

The introduction into the air any chemical, physical or biological agent in quantities large enough to produce harmful effects on man and its surrounding is a call for concern. Effects of air pollutants on human health, vegetation, property or the global environment as well as create aesthetic insults in the form of brown or hazy air or unpleasant smells have been reported in the literature (Smith, 1991, Rim-Rukeh and Okokoyo, 2003., Pope, 1992., McComick *et al*., 1995). Air quality parameters such as Total Volatile Organic Compounds (TVOC), Formaldehyde (HCHO) Formaldehyde were taken in-situ, both within and outside the proposed project site.

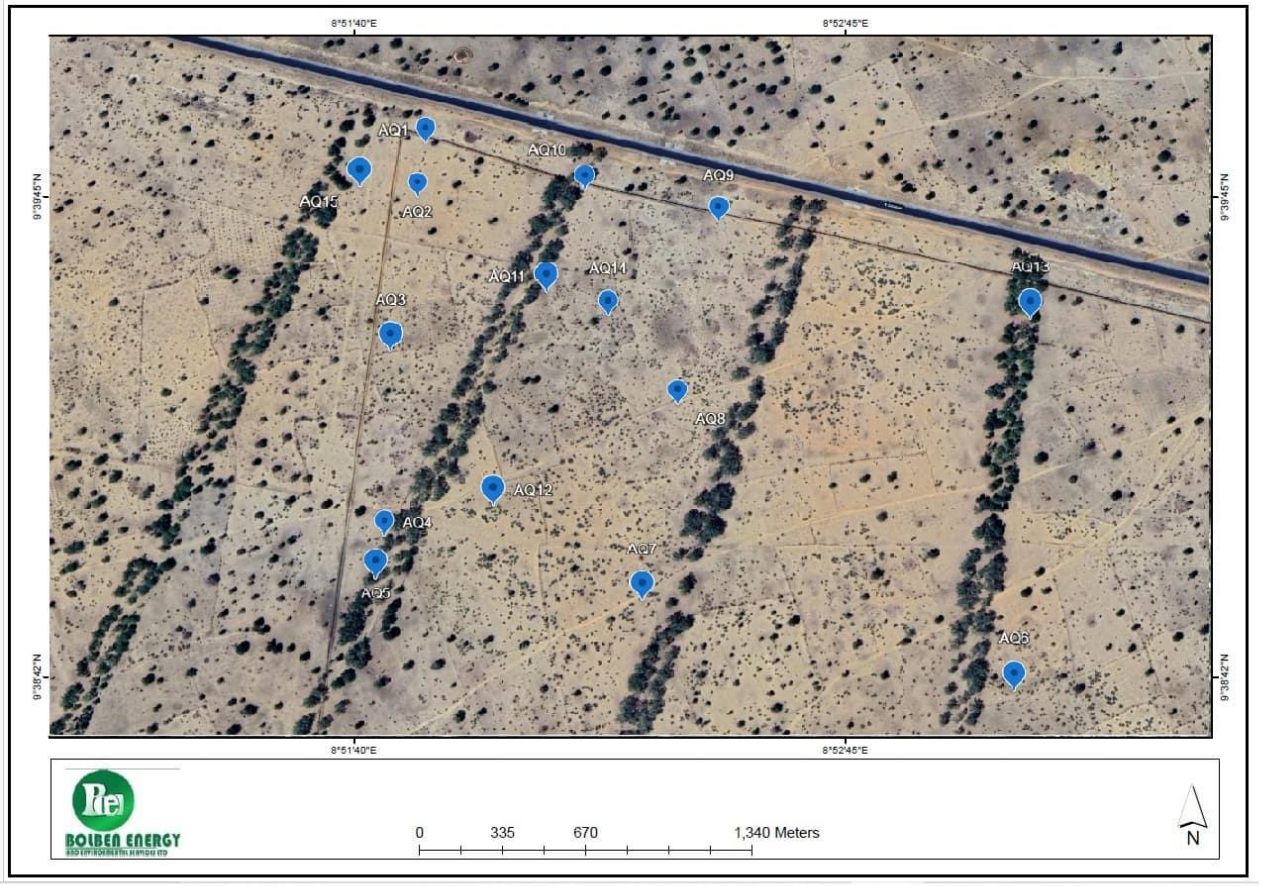

Figure 4.4: Air Quality and Noise Level Samples Location Map

Table 4.4: Air Quality Analysis (In-situ Parameters Recorded).

SITE A	SOUND LEVEL METER (DBA)		AIR QUALITY							COORDINATES	
STATION	Minimum Readings	Maximum Readings	AQI	TEMPERATURE(^{0}F)	HCHO (mg/m3)	TVOC(mg/m3)	Pm2.5(ug/m3)	Pm10(ug/m3)	No. of particles(per/l)	Latitude	Longitude
1	35.6	64.6	59	92.2 at 10.89%	0.01	0.04	16.1	30	2470	12.729943	9.003095
2	35.8	62.7	48	93.3 at 10.9%	0.03	0.12	11.4	20.7	1745	12.729816	9.003585
3	26	61.1	25	94.2 at 9.8%	0.04	0.19	8.9	16.5	1393	12.729380	9.004992
4	38.5	65.8	36	91.8 at 9.8%	0.05	0.21	11.3	21.2	1615	12.729122	9.006512
5	37	66.0	28	99.6 at 7.8	0.01	0.05	5.1	9.4	889	12.728993	9.006862
6	33	73.2	15	102 at 7.8%	0.01	0.04	4.8	9.3	777	12.733663	9.008713
7	28.9	57.9	32	107 at 6.7%	0.02	0.04	8.1	15.2	1214	12.731031	9.007452
8	33.4	57.5	47	107 at 6.1%	0.02	0.04	9.7	18.4	1579	12.731610	9.005857
9	43.5	68.8	39	105 at 6.1%	0.01	0.05	8.5	16.2	1331	12.732215	9.004288
10	38.1	70.1	48	101 at 7%	0.03	0.09	9.2	18.6	1533	12.731213	9.003796
11	41.9	60.3	40	99.1 at 7.8%	0.02	0.03	13.7	24.3	1973	12.730716	9.004678
12	32.4	72.5	17	101 at 7.1%	0.01	0.02	4.6	7.7	663	12.729992	9.006414
13	31.4	79.7	33	111 at 5.8%	0.01	0.03	6.8	38.1	1220	12.734570	9.005712
14	31.2	64.6	41	111 at 5.1%	0.01	0.05	11.7	21.1	1421	12.731201	9.004973
15	39.3	16.1	20	111 at 4.9%	0.01	0.05	4.1	9.1	816	12.729343	9.003378
	90		-	-	10	-	250	250	-	FMEnv /WHO/ USEPA Standard*	
	-		-	-	10	-	40	150	-	NESREA Limit	

Result Discussion

Particulate Matter (PM): Particulate matter (PM) refers to tiny particles, both solid and liquid, suspended in the air. These particles can vary in size, shape, and composition, and are a major component of air pollution. PM can be categorized based on size, with PM2.5 (particles smaller than 2.5 micrometers) and PM10 (particles smaller than 10 micrometers) being the most commonly regulated and studied due to their significant health impacts. The results for PM2.5 had its highest value at Point 1 and Point 11 with values of 16.1 and 13.7µg/m3 respectively while PM10 had their highest value at point 13 and point 1 with a value of 38.1 and 30 µg/m3 respectively. None of these values were up to the set limit for particulate matter.

Formaldehyde (HCHO): Formaldehyde, also called methanal, is an organic compound, the simplest of the aldehydes, used in large amounts in a variety of chemical manufacturing processes. In the atmosphere, formaldehyde usually breaks down quickly to create formic acid and carbon monoxide, which can also be harmful to substances. The results obtained showed that formaldehyde was not in the range of 0.01-0.04mg/m3 which is all within the regulatory limit.

Total Volatile Organic Compounds (TVOC): TVOC is a group of a wide range of organic chemical compounds such as benzene, ethylene glycol, formaldehyde, methylene chloride, tetrachloroethylene, toluene, xylene, and 1,3-butadiene. Some VOCs are proven carcinogens. TVOC recorded were in the range of 0.02-0.21mg/m3. Generally, it indicates low TVOC levels, though Station 4 (0.21) warrants further investigation.

Ambient Noise Level

Environmental noise is caused by unwanted and high propagation of sound with ranging impacts on human, animals and the environment and can be harmful at different degrees. Noise assessment and monitoring is important as it can have negative social and economic impacts, of which some are irreversible such as permanent deafness. Other impacts could be discomfort, headache, lack of concentration, vibrational damage on buildings and structures. Most stations recorded sound levels within acceptable daytime limits (typically 55 70 dBA for mixed residential/commercial areas). Station 13 showed the highest maximum reading at 79.7 dBA, which may indicate proximity to high-activity areas or traffic corridors requiring noise mitigation measures.

*See **Appendix VII** for pictorial evidence of air/noise data gathering activities. **Page 240.***

4.3.3 Soil and Ground Investigation

4.3.3.1 Soil Characteristics

Land and by extension, the Soil is considered the most vital resources made available to man by nature. This is because it provides an indispensable medium for the development of agriculture, vegetation, forestry, rural and urban land uses, etc. Field observations indicated that the site soils are predominantly sandy to sandy loam in texture, with moderate aggregation and relatively low organic matter content. Slight compaction was observed in some areas, attributable to livestock grazing and natural surface consolidation. Soil coloration ranges from light brown to reddish brown, consistent with savanna-derived ferruginous soils formed under alternating wet and dry climatic conditions. In terms of porosity, it is excessively drained. The soil is brownish and covered with ironstones they become reddish-brown in colour. It has very low

water retention and high percolation loses characteristics. The physical characteristics of the project site's soil sub-surface exploration records are shown on table 3 below and at back cover. The main use of land in the study area is for institutional, socio-economic and farming activities. The textual composition of the soil is sandy loam. Particle size distribution is very important in the soil as it determines water intakes rates, water storage, the ease of the soil tilling, the amount of aeration, which is vital for plant growth, and soil fertility. The soil textural composition reflects one that is easy to till, has aeration for good plant growth, easily wet and able to stand the proposed structure.

*See **Appendix VI** for pictorial evidence of soil sample gathering activities **Page 239.***

Plate 4.2: Soil Sampling and Ground Investigation

To understand the ground conditions beneath the site, an Electrical Resistivity Tomography (ERT) survey was conducted across the project footprint. This geophysical investigation allows for non-invasive characterization of subsurface layers and identification of potential anomalies that could affect foundation stability or construction feasibility. The ERT profile revealed a relatively uniform subsurface composition across the surveyed transect. The dominant soil horizons consist of sandy-loam to sandy-clay materials with lateritic influence in the upper layers. Importantly:

- No shallow bedrock outcrops were detected within typical foundation depth ranges.
- No significant low-resistivity zones indicative of perched groundwater was observed.
- The resistivity distribution was relatively homogeneous across the profile length.

No subsurface anomalies, voids, or unstable zones were identified that would pose a significant

construction risk. This uniformity suggests consistent geotechnical properties across the footprint, reducing uncertainty in foundation design. From an engineering perspective, these subsurface conditions are suitable for:

- Shallow reinforced concrete foundations for inverter and substation structures
- Pile-driven or driven-post mounting systems for solar panel arrays
- Cable trenching without encountering major lithological obstruction

Environmental inspection of the soil profile revealed:

- No visible hydrocarbon contamination
- No industrial waste residues
- No evidence of dumping or prior industrial disturbance
- Moderate to low inherent soil fertility
- Moderate susceptibility to wind erosion during prolonged dry periods

The homogeneity of the soil profile, as confirmed by both field observation and ERT data, indicates that additional redundant sampling would not significantly improve baseline accuracy. The collected samples are therefore considered representative of the entire project footprint. Overall, the soil environment does not present contamination concerns and is suitable for the proposed development, provided that erosion control and dust management measures are implemented during construction.

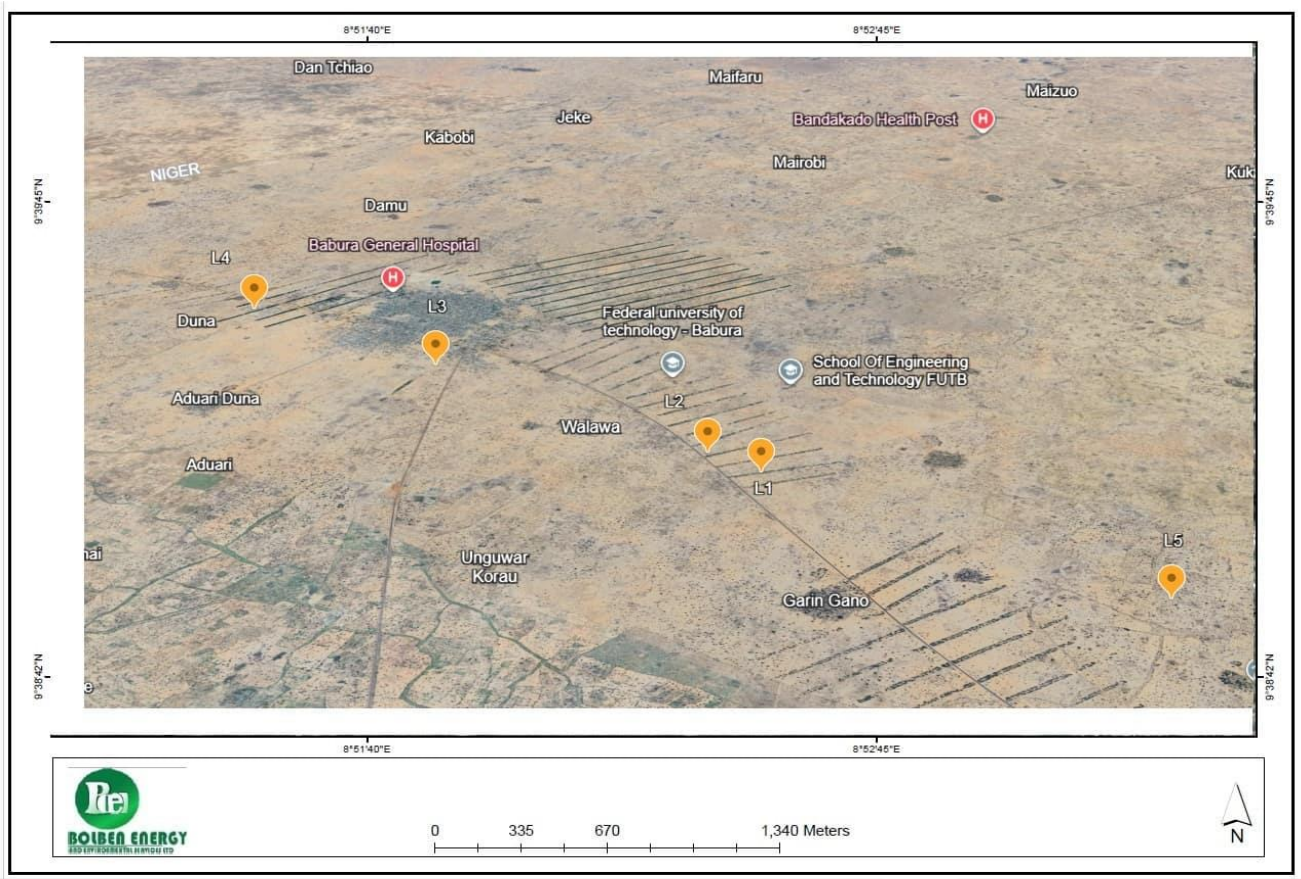

Figure 4.5: Map of Soil Sampling Location within the Project Site

4.3.3.2 Ground (Subsurface) Interpretation

The Electrical Resistivity Tomography (ERT) profile across the 108 m traverse at the proposed FUT Babura Solar PV site reveals a clearly stratified but laterally consistent subsurface sequence extending to approximately 7 m depth. The resistivity distribution reflects the semi-arid geological and climatic conditions typical of Babura, Jigawa State. The uppermost layer, extending from the surface to approximately 2.5 m depth, is characterized by relatively high resistivity values ranging from about 80 Ωm to greater than 500 Ωm (represented by red to dark red zones on the resistivity section). This horizon is laterally continuous across the entire profile and corresponds to dry sandy loam to ferruginous lateritic soils. These soils are typical of savannah environments and are formed under alternating wet and dry seasonal conditions. Field characteristics and resistivity response indicate:

- Well-drained savannah-derived sandy to sandy-loam soils
- Low organic matter content
- Low natural moisture content due to high evapotranspiration
- Absence of significant clay enrichment

In Babura's semi-arid climatic regime, where rainfall is seasonal and evaporation rates are high, surface soils tend to be electrically resistive because of their dryness and limited pore water content. The resistivity values exceeding 80 Ωm confirm the absence of shallow water saturation and indicate that no expansive clay-rich horizon is present within typical foundation depths. The drainage characteristics are therefore good, and this upper layer can be considered mechanically competent for shallow reinforced concrete foundations and driven PV mounting posts.

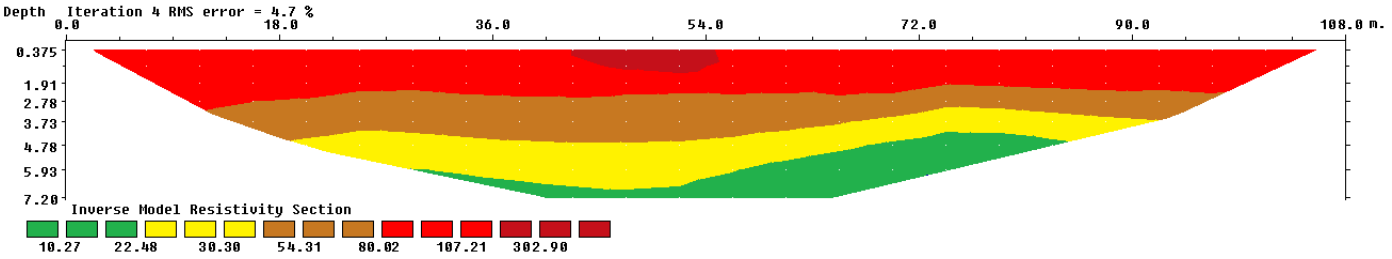

Figure 4.6: Ground (Subsurface) Image of the Site

Beneath this lateritic cap, from approximately 2.5 m to 5 m depth, the resistivity values decrease to between about 20 Ωm and 100 Ωm. This intermediate layer represents a moderately weathered sandy-clay horizon that forms a transitional zone between the dry surface laterite and the deeper subsurface formation. The reduced resistivity relative to the surface layer reflects slightly higher moisture retention and increased clay content. The geophysical response is consistent with:

- Moist sandy-clay mixtures
- Partially compacted weathered materials
- Slight clay enrichment within the soil matrix

Importantly, this layer appears laterally uniform across the profile, with no abrupt resistivity contrasts or localized anomalies. The absence of sharp discontinuities suggests consistent geotechnical properties

throughout the site footprint. From an engineering perspective, such uniformity reduces uncertainty in foundation design and indicates predictable soil behavior during construction activities such as trenching and piling. At greater depth, between approximately 5 m and 7 m, the resistivity values further decrease to a range of about 5 Ωm to 30 Ωm. This lower resistivity horizon becomes slightly more pronounced toward the central and eastern portions of the profile. In the geological context of Babura and surrounding parts of Jigawa State, such resistivity values typically correspond to:

- Moist clayey materials
- Weathered fine-grained sediments
- A deeper moisture-enriched weathered horizon

While the reduced resistivity suggests higher moisture content relative to overlying layers, several important observations can be made. The conductive zone is broad and gradually developed rather than sharply defined. There is no vertical conductive plume that would suggest leakage, contamination, or preferential infiltration pathways. Additionally, no abrupt discontinuities indicative of fractures, faults, or structural weaknesses are evident. These characteristics indicate that the lower-resistivity zone represents a natural moisture-enriched weathered formation rather than a perched aquifer or localized groundwater accumulation. The groundwater table in this region is therefore likely deeper than the maximum depth investigated by the ERT survey. Overall, the subsurface stratification reflects a stable, laterally consistent soil profile typical of semi-arid savannah terrain in northern Nigeria, with no geophysical evidence of instability, shallow groundwater interference, or subsurface structural hazards that would compromise the proposed solar farm development.

4.3.3.3 Groundwater Implications for the Proposed Project

Babura, Jigawa State, is situated within the semi-arid Sudan savannah climatic belt of northern Nigeria. The hydrogeological setting of the area is strongly influenced by seasonal rainfall patterns, high evapotranspiration rates, predominantly sandy surface formations, and generally deep groundwater table conditions. Recharge occurs mainly during the rainy season, while prolonged dry periods significantly reduce near-surface moisture retention. Interpretation of the ERT section to a depth of approximately 7 m indicates no evidence of shallow groundwater occurrence within the investigated depth range. The resistivity distribution does not show any laterally continuous low-resistivity band near the surface that would suggest a perched water table. Furthermore, there is no indication of narrow vertical conductive anomalies that would typically signify fracture-controlled groundwater flow or preferential seepage pathways.

The deeper low-resistivity zone observed between approximately 5 m and 7 m depth is broad and gradational rather than sharply defined. This pattern is characteristic of naturally moist weathered materials rather than a saturated aquifer horizon. The absence of abrupt resistivity contrasts or structural discontinuities further supports the conclusion that there is no shallow aquifer within the depth of investigation. In the Babura region and much of northern Jigawa State, productive groundwater is commonly encountered at significantly greater depths, typically:

- Within weathered or fractured basement zones between about 20 m and 50 m depth, where applicable; or
- Within deeper sedimentary aquifer systems where regional geology permits.

The resistivity profile therefore supports the interpretation of a relatively deep groundwater table beneath the project site. This has several important engineering implications:

- Low likelihood of capillary rise affecting near-surface soils
- Minimal risk of foundation weakening due to water saturation
- No anticipated groundwater interference during shallow excavation or cable trenching
- Reduced risk of uplift or hydrostatic pressure beneath foundation slabs

From a construction and operational standpoint, the groundwater regime is favorable for the proposed solar farm development. Shallow foundations for inverter stations, substations, and mounting structures can be designed without the need for groundwater dewater measures. Based on geophysical evidence and regional hydrogeological characteristics, groundwater conditions at the FUT Babura project site are not expected to adversely affect foundation performance or long-term structural stability of the solar photovoltaic installation.

4.3.3.4 Environmental Condition of the Project Site Ground

The Electrical Resistivity Tomography (ERT) results indicate that the subsurface conditions at the FUT Babura site are environmentally stable and consistent with natural savannah soil formation. The resistivity values across the profile do not reveal any anomalous ultra-low resistivity zones (e.g., values typically below 0.5 Ωm) that would suggest contamination from industrial effluents, leachates, or saline intrusion. There is also no geophysical signature indicative of hydrocarbon contamination, such as localized conductive plumes or irregular low-resistivity pockets associated with subsurface leakage. The resistivity pattern is laterally continuous and gradational, which further confirms the absence of anthropogenic disturbance or subsurface dumping.

The overall geoelectric response is characteristic of ferruginous tropical soils commonly developed under semi-arid savannah conditions in northern Nigeria. The stratification observed, comprising a lateritic sandy-loam surface layer, underlain by moderately weathered sandy-clay, and deeper moist clayey materials, reflects natural pedogenic and weathering processes typical of the Babura area.

The subsurface conditions demonstrate:

- Uniform and laterally consistent stratification
- A deep groundwater regime
- No evidence of structural discontinuities, faults, or voids
- Stable and predictable geotechnical behavior

From both environmental and engineering perspectives, the site does not show signs of contamination, instability, or subsurface anomalies that would constrain development. The resistivity characteristics align well with expected soil and weathering profiles for Babura, Jigawa State. Consequently, the subsurface conditions confirm the environmental integrity of the site and support its suitability for the proposed 5 MW Solar Photovoltaic Power Plant development.

Table 4.5: Physiochemical Analysis of Soil Samples

S/N	Parameters	Unit	L1B	L1T	L2B	L2T	L3B	L3T	L4B	L4T	L5B	L5T
a)	**Coordinates**											
1	Latitude	N	12.72977	12.72977	12.73471	12.73471	12.76243	12.76243	12.78582	12.78582	12.70071	12.70071
2	Longitude	E	9.00503	9.00503	9.00541	9.00541	9.00555	9.00555	9.00532	9.00532	9.00562	9.00562
3	Elevation	M	474.1	473.1	450.4	450.6	464.0	465.7	465.6	465.3	457.0	457.3
b)	**Physical Test**											
4	Colour	TCU	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
5	pH	-	6.18	5.93	6.61	5.76	5.30	5.84	6.17	5.16	4.88	5.37
6	Electrical Conductivity	µs/cm	808	490	834	978	846	1487	1165	580	727	832
7	Temperature	0_C	32.8	30.8	31.7	30.4	30.2	30.2	30.8	32.1	32.3	31.7
8	ORP	MV	164	148	231	188	208	161	192	206	280	222
9	Salinity	%	0.03	0.02	0.04	0.04	0.04	0.07	0.06	0.02	0.03	0.04
c)	**Exchangeable Cation**											
10	Calcium (Ca^{2+})	mg/kg	0.22	0.82	0.14	0.60	0.45	0.40	0.22	0.60	0.42	0.44
11	Magnesium (mg^{2+})	mg/kg	0.12	0.41	0.08	0.30	0.22	0.19	0.13	0.28	0.19	0.22
12	Sodium (Na^{+})	mg/kg										
13	Potassium (K^{+})	mg/kg	0.7	1.4	0.2	1.0	0.7	0.7	0.4	1.0	0.7	0.7
14	Ammonium (NH_4^{+})	mg/kg	0.0004	0.0032	0.0125	0.0062	0.0031	0.0024	0.000	0.000	0.0140	0.003
d)	**Exchangeable Anion**											
15	Sulphate (SO_4)	mg/kg	8	23	5	15	13	13	10	20	14	16
16	Phosphate (PO_4^{2-})	mg/kg	0.66	0.47	0.42	0.61	0.58	0.78	0.39	0.55	0.32	0.30
17	Nitrate (NO^{2-})3	mg/kg	1.7	5.4	1.3	4.0	3.1	3.3	1.7	3.2	2.4	2.8
18	Nitrite (NO^{-})2	mg/kg	0.08	0.23	0.05	0.15	0.13	0.13	0.10	0.20	0.14	0.16
19	Chloride (Cl^{-})	mg/kg	0.13	0.5	0.89	0.53	0.55	0.04	0.01	0.56	0.82	0.11

S/N	Parameters	Unit	L1B	L1T	L2B	L2T	L3B	L3T	L4B	L4T	L5B	L5T
	Organics											
20	Phenols	mg/kg	0.000	0.010	0.006	0.003	0.014	0.006	0.053	0.000	0.001	0.013
21	Calcium Carbon	mg/kg	37	15	64	21	9	33	47	2	18	21
22	Oil & Grease	mg/kg	0	0	0	0	0	0	0	0	0	0
f)	**Heavy Metals**											
23	Iron	mg/kg	0.106	0.142	0.148	0.148	0.193	0.219	0.177	0.234	0.199	0.154
24	Cupper	mg/kg	0.24	0.48	0.37	0.48	0.52	0.47	0.33	0.35	0.27	0.41
25	Chromium	mg/kg	0.01	0.04	0.01	0.02	0.04	0.03	0.05	0.05	0.04	0.05
26	Zinc	mg/kg	0.02	0.11	0.02	0.11	0.12	0.10	0.07	0.14	0.08	0.06
27	Cobalt	mg/kg	0.010	0.030	0.001	0.074	0.016	0.000	0.000	0.000	0.000	0.000
28	Nickel	mg/kg	0.013	0.019	0.011	0.016	0.017	0.012	0.010	0.017	0.013	0.016
29	Mercury	µg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	Lead	µg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
g)	**Soil Characteristic**											
31	Loam	%	37	29	26	23	35	41	33	41	27	29
32	Sandy	%	0	0	3	2	6	2	3	1	6	3
33	Clay	%	38	41	39	42	33	40	43	52	30	39
34	Silt	%	25	30	32	33	32	17	21	6	37	29
h)	**Microbiological Test**											
35	E. Coli	Cfu/100g	4	7	2	6	4	4	2	2	1	2
36	Fungal	Cfu/100g	86	252	75	219	183	165	69	68	56	71

Key:
Mg/L: Milligram per litre
Mg/kg: milligram per kilogram
µg/L: Microgram per Litre
µg/kg: Microgram Kilogram
TCU: True Colour Unit
µS/cm: Micro Siemens per centimeter
NTU: Nephlometric turbidity Unit
Cfu/ml Coliform Forming Unit per 100ml

Result Discussion

Physical Characteristics

The soils are predominantly loam-clay mixtures with moderate clay content. Such soils are generally suitable for infrastructure development but require adequate drainage design. Soil pH ranged from slightly acidic to moderately acidic. This is typical of tropical soil and does not indicate contamination.

Exchangeable Cations and Anions

Calcium, magnesium, potassium, sulphate, nitrate, and chloride concentrations are low and consistent with uncontaminated natural soils.

Heavy Metals

Lead and mercury were not detected in any soil samples. Nickel, chromium, zinc, copper, cobalt, and iron concentrations are very low and fall within international environmental quality benchmarks.

Organics

Oil and grease were not detected in any soil samples, indicating no petroleum contamination. Phenols were detected only in trace amounts within acceptable limits.

Conclusion

The soil baseline conditions indicate no evidence of contamination. The site is environmentally suitable for the proposed electrification infrastructure development. All the parameters of the soil sample are largely within acceptable regulatory and international safeguard limits.

*See **Appendix III** for pictorial evidence of the soil samples laboratory analysis. **Page 233.***

4.3.3.5 Geology

The project area is located within the Guinean forest-savanna mosaic zone which is a distinctive ecological region characterized by a blend of forested areas and savannas, creating a diverse landscape. Geology, the study of rocks, minerals and the physical make-up of the solid earth, determines the environment and national resources. Also, the industrial potential and wealth of a nation. After climate, geological factor agent, is perhaps the greatest impact on economic activities, since soils, water supply and vegetation are, to a large extent, influenced by the nature of the underlying rock.

Half of Nigeria's land is composed of three main basement complexes created in the west, the north-west and the south-east. Between these messfs, sedimentary basic are string out along a north-east/south-west axis from lake Chad to Niger delta, i.e. along the length of the lower Niger-Benue River systems. The north-west/south-east trending Bida Basin follow the course of the upper Niger River,

Structural Setting

There are two main types of rocks in the region – biotite gneiss and Amphibolites. The rock types have major structural formations which are minor folds, joint lineation and foliations. Joints and fractures are very visible in the biotites Gneiss with the emergence of light forest along the fracture plains and the cavities which in some cases are as wide as 0.5m. Two sets of fracture system were observed, the concordant and discordant fracture which will facilitate easy excavation with minimum vibration. The Amphibolites have weak display of fractures joints.

Petrogenesis

Biotite gneiss is the dominant country rock within the project area, covering more than 95% of the landmass. The expose part of the rock is partly weathered. However, excellent crystalline outcrops are found close to the Plant site. The biotite gneiss is characterized by the high concentration of ferromagnet materials, especially gneiss giving it a dark appearance. The rock is generally medium course gained and strongly foliated. The rock exhibits some contorted banding consisting of alteration of dark and light bands that ranges in thickness between 10cm – 30cm. The dark bands are very rich in biotite mineral, while the light leucocratic bands are predominantly quartz and feldspar which are essential components of pegmatiods.

Petrographic studies of slides from bipotite gneiss show dominant minerals to include the following: quartz, plagioclase, and microcline and iron oxides as opaque. Quartz occurs as an anhedral to subhedral occasionally as enhedral crystal. The crystals vary in size from a few millimeter blebs to large crystals. Few inclusions of biotites are notices is on quartz grains. Also, occasional inter-growth of quartzs and microclines were observed in the samples.

Amphibolite

Amphibolite in the study area constitutes 3% of the total rock mass/outcrop, occurring as low laying oval shape bouldes dotting the eastern fringes of the project area. The major outcrop of amphibolite is located between biotites gneiss and occurs as diortic. The rock is generally massive, dark, dense and not filiated. It is medium to fine grain with stints of fine grain whitish quartz crystals. Petrographic study of the rock showed that it contained mainly horn blend, plagioclase and quartz, while the accessories minerals are biotite and iron mineral.

Topography

The elevation across the site ranges narrowly between 381 m and 389 m above mean sea level, indicating only slight variations in height. The lower basin zones form gently depressed areas, while the moderate and elevated sections gradually rise toward the highest ridgeline portions. This small elevation difference reflects a mild and uniform slope rather than steep or irregular terrain. Such gentle gradients provide stable ground conditions, making the site suitable for infrastructure development, including photovoltaic or electrification installations, with minimal risk of structural instability, erosion, or excessive earthworks.

Elevation Classification:

- 381–383 m: Lower basin zones
- 383–385 m: Moderate ground
- 385–387 m: Elevated terrain
- 387–389 m: Highest ridgeline portions

The gentle gradient supports photovoltaic or electrification installations with low risk of structural instability.

The slope analysis shows that the site is predominantly flat to gently inclined, with most areas having gradients between 0% and 5%. These very gentle to gentle slopes provide stable ground conditions and allow for easy construction, efficient drainage, and minimal earthwork requirements, making the land highly suitable for infrastructure and building development. Areas classified as moderate to moderately sloped present only minor constraints and can still support development with basic site preparation. However, the few localized zones with steeper slopes above 9% may be more susceptible to surface runoff and soil erosion, and therefore may require erosion control measures such as terracing, vegetation cover, or drainage management to ensure stability and long-term sustainability.

Slope ranges identified:

- 0% –2.17% (Very Gentle)
- 2.18% –3.74% (Gentle)
- 3.75% –4.95% (Moderate)
- 4.96% –5.97% (Moderately Sloped)
- 5.98% –7.00% (Sloping)
- 7.01% –15.39% (Steeper localized zones)

Majority of site falls within **0–5% slope category**, making it highly suitable for development. Localized steeper areas (above 9%) require erosion control measures.

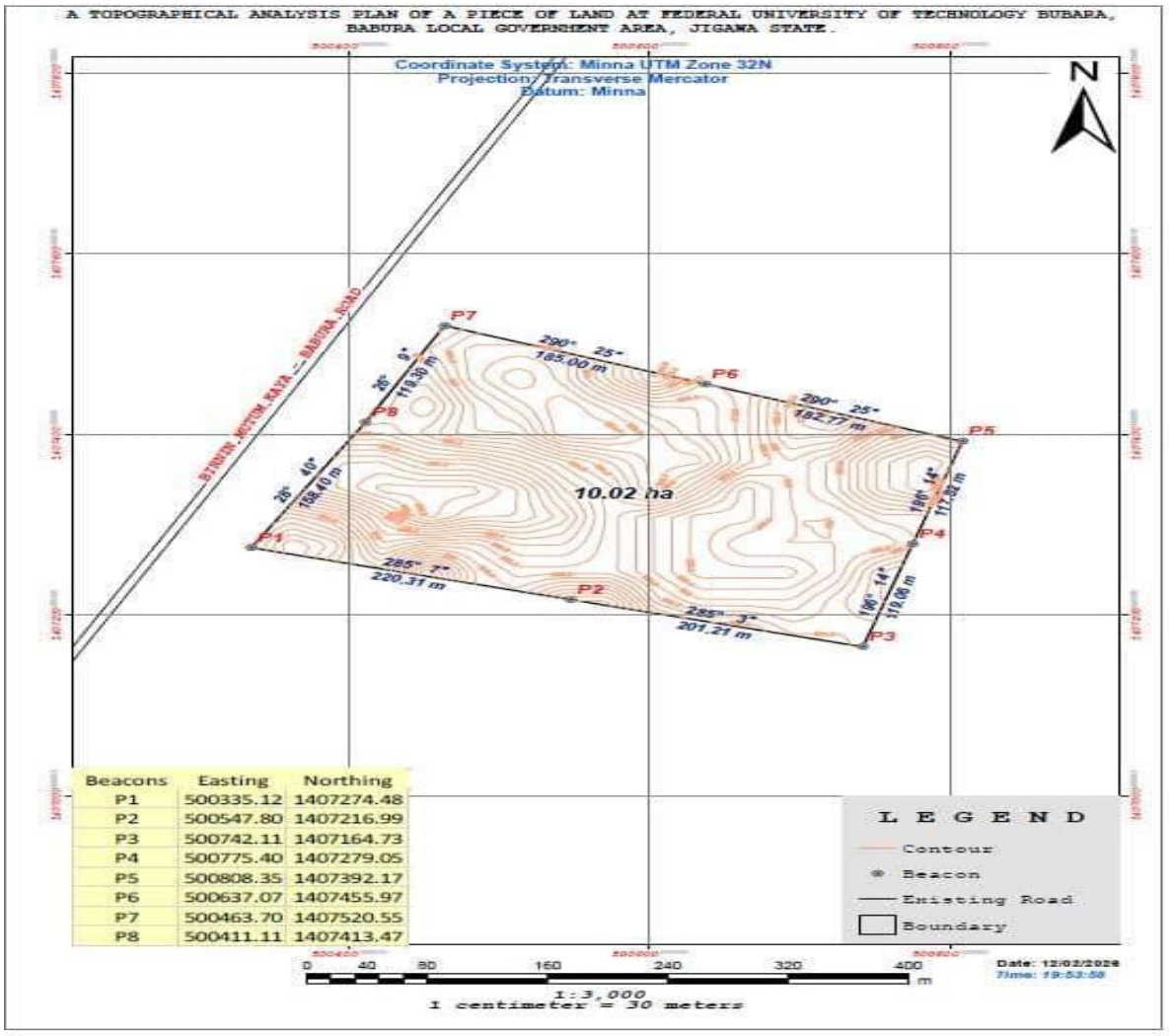

Figure 4.7: Topographical Plan of the Project Area

Hydrology and Groundwater Characteristics

The distribution and circulation of ground water are controlled by geological factors such as lithology, texture, and structure of rocks. They are also controlled by hydrological and metrological factors such as stream flows and rainfall. Over most of the area underlain by the basement complex there is a thin, discontinuous mantle of weathered rock with a thickness of about 15m. In the basement complex, groundwater occurs either in the weathered mantle or in the joint and fracture systems in the un-weathered rocks. Generally, however, basement complex forms a poor source for groundwater. The decomposed mantle is often too thin to harbour large quantities of water and is usually too clayey to be highly permeable. The joints are normally too poorly developed to compensate for the inadequacy of the zone of weathered rocks overlying them. Some wells, if properly sited, normally provide adequate supply of water. Underground Water sample was collected from a borehole within and around the project site. A control was also collected from a nearby settlement about 500m away from the site. The results of the physical and chemical properties of the analyzed water samples are presented in Table 4.6.

Plate 4.3: Groundwater samples location Map.

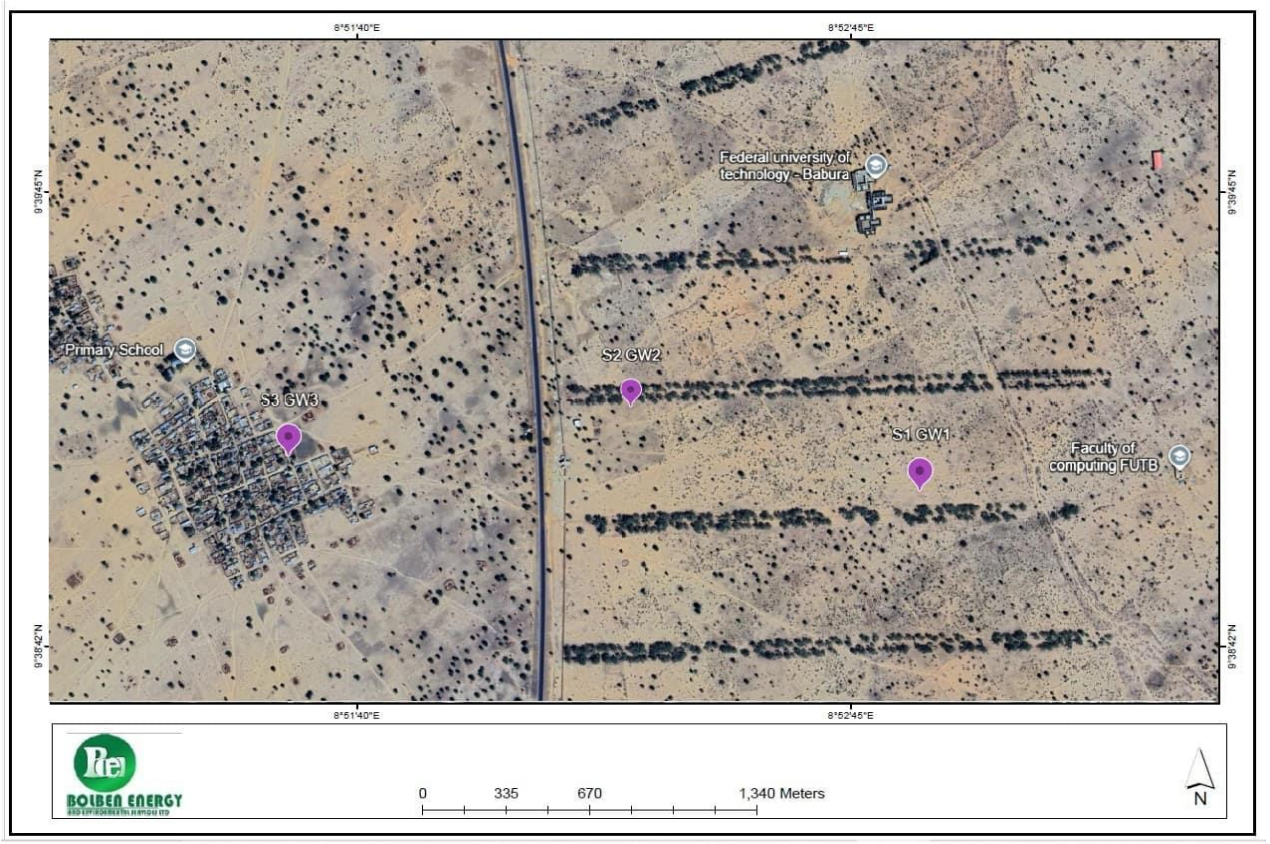

Plate 4.4: Groundwater samples location Map.

Table 4.6: Physico-Chemical and Biological Characteristics of Groundwater at the Regasification Power Plant's Project Site

S/N	Parameters	Unit	GW1 S1	GW2 S2	GW3 S3	FMEnv Limit
A	**Coordinates**					
1	Latitude	N	12.740908	12.743804	12.744791	-
2	Longitude	E	9.014429	9.010230	9.004455	-
3	Altitude	M	439.3	486.1	486.5	-
B	**Physicochemical Test**					
4	Colour	TCU	Clear	Clear	Clear	Clear
5	Odour	-	Odourless	Odourless	Odourless	Unobjectionable
6	Taste	-	Tasteless	Tasteless	Tasteless	Unobjectionable
7	Turbidity	NTU	0	0	1	50
8	pH	-	7.13	6.31	5.27	6.5 – 8.5
9	Temperature	0C	34.5	32.5	29.8	Ambient
10	Dissolve Oxygen	mg/L	4.0	3.7	3.8	2 – 5
11	Total Dissolve Solid	mg/L	56	45	281	500
12	Electrical Conductivity	µs/cm	112	90	562	1000
13	Total Suspended solid	mg/L	0	0	4	20
14	Salinity	mg/L	0.00	0.00	0.07	<1000
15	ORP (MV)	mg/L	98	85	228	200 – 600
16	B.O.D	mg/L	2.1	2.0	2.5	NS
C	**Chemical Test**					
17	Ammonium (NH_4^+)	mg/L	0.001	0.00	0.002	NS
18	Potassium (K^+)	mg/L	0.0	0.0	0.1	20
19	Calcium (Ca^{2+})	mg/L	2.1	1.8	0.6	200
20	Sodium (Na^+)	mg/L	4	2	9	20
21	Magnesium (mg^{2+})	mg/L	0.8	0.3	1.8	20

S/N	Parameters	Unit	GW1 S1	GW2 S2	GW3 S3	FMEnv Limit
22	Sulphate (SO_4^{2+})	mg/L	5	7	13	100
23	Nitrate (NO_3^{2-})	mg/L	2.1	3.0	2.2	50
24	Chloride (Cl^-)	mg/L	0.0	0.0	0.1	150
25	Phosphate (PO_4^{2-})	mg/L	0.28	0.22	0.49	NS
26	Nitrite (NO_2^-)	mg/L	0.1	0.0	0.1	0.2
c)	**Heavy Metal**					
27	Zinc (Zn^{2+})	mg/L	0.141	1.201	0.224	3.0
28	Iron (Fe^{2+})	mg/L	0.01	0.01	0.02	0.3
29	Cupper (Cu^{2+})	mg/L	0.01	0.01	0.02	1.5
30	Chromium (Cr^{3+})	mg/L	0.04	0.02	0.04	0.05
31	Lead (Pb^{2+})	mg/L	0.000	0.000	0.000	0.01
32	Cobalt	mg/L	0.05	0.52	0.07	0.2
33	Mercury	µg/L	0.000	0.000	0.000	0.001
34	Nickel	mg/L	0.001	0.000	0.000	0.07
d)	**Organics**					
35	Oil and grease	mg/L	0	0	0	10
36	Benzene	mg/L	0.00	0.00	0.00	0.01
37	Toluene	mg/L	0	0	0	0.7
38	Ethylbenzene	mg/L	0.000	0.000	0.000	0.30
39	Xylene	mg/L	0.0	0.0	0.0	0.5
40	Phenols	mg/L	0.001	0.000	0.000	0.05
e)	**Microbiological Test**					
41	E. Coli	Cfu/ml	0	0	0	Nil
42	Feacal Coliform	Cfu/ml	0	0	0	Nil
43	Total Coliform	Cfu/ml	1	0	3	10

Result Discussion: This section provides a comprehensive interpretation of the laboratory results for water quality assessment conducted at the project site. The analysis evaluates compliance with FMEnv standards and assesses environmental suitability for the proposed electrification project.

Physicochemical Parameters

The water samples generally fall within acceptable regulatory limits. Turbidity levels were extremely low, indicating clear water with minimal suspended solids. Total Dissolved Solids (TDS) and Electrical Conductivity values are well below maximum permissible limits, indicating low salinity and good water quality.

pH values ranged between slightly acidic and neutral. One sample recorded a value below the recommended range (6.5–8.5), indicating slight acidity which may contribute to pipe corrosion but does not pose immediate health risks. Dissolved Oxygen (DO) levels were within acceptable range, indicating adequate oxygen availability. Biochemical Oxygen Demand (BOD) values were low, suggesting minimal organic pollution.

Chemical Parameters

Major ions including sulphate, nitrate, chloride, calcium, sodium, and magnesium were within permissible limits. No indication of nutrient pollution was observed. Oil and grease, benzene, toluene, ethylbenzene, and xylene were not detected, indicating absence of hydrocarbon contamination.

Heavy Metals

Lead, mercury, nickel, copper, iron, and chromium concentrations were within regulatory standards. However, one sample showed elevated cobalt concentration above recommended limits. This may be geogenic in origin and requires periodic monitoring.

Microbiological Quality

E. coli and faecal coliform were absent in all samples, indicating no faecal contamination. Total coliform counts were detected at very low levels and remain within acceptable standards. Routine disinfection and monitoring are recommended.

Conclusion

Groundwater constitutes the primary source of water supply within the University campus and surrounding host community. In the absence of perennial surface water bodies within the Area of Influence (AoI), boreholes serve as the dominant water abstraction system for domestic and

institutional use. As part of the baseline assessment, three borehole groundwater samples were collected, two from within the University campus and one from the adjoining host community, to establish the existing hydrochemical condition prior to project implementation. Sampling was conducted using standard procedures to avoid cross- contamination, and in-situ measurements were taken using calibrated portable meters before laboratory confirmation where necessary.

Groundwater temperatures ranged between 29.85–34.5°C and reflect the prevailing high ambient conditions typical of semi-arid Northern Nigeria. The pH values (from 4.75–7.13) show that two of the boreholes fall within near-neutral conditions, while one borehole recorded a mildly acidic value (pH 4.75). This localized acidity is likely attributable to lithological influence, shallow soil-water interaction, or natural geochemical processes rather than anthropogenic contamination. Electrical conductivity (26–136 µS/cm) and total dissolved solids (45–281 ppm) levels are relatively low, indicating limited mineralization. Salinity values are negligible and do not suggest saline intrusion or evaporative concentration effects. Collectively, the data indicate that groundwater within the project area is characterized by:

- Low mineral content
- No evidence of saline encroachment
- No observable signatures of industrial or hydrocarbon contamination
- No abnormal chemical anomalies

It is also important to note that no surface water receptors, such as streams, rivers, wetlands, or ponds, were identified within the project footprint or the immediate 500-metre Area of Influence during the field survey. Surface water in this region is seasonal and typically confined to temporary depressions during peak rainfall events. Overall, the groundwater environment reflects natural background conditions typical of a semi-arid savanna setting and demonstrates no pre-existing environmental stress linked to industrial activity.

*See **Appendix II** for pictorial evidence of the water sample laboratory analysis. **Page 230.***
*See **Appendix VIII** for pictorial evidence of water sample collection activities. **Page 241.***

Ecology and Biodiversity

According to the convention on Biological Diversity, Biodiversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic systems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems". Biodiversity considerations are very important in environmental management. Many developmental activities are likely to play a major role in the overall reduction of biodiversity; hence there is need for proper understanding of the existing environmental setting in terms of habitat types, selected flora and fauna species, endangered or threatened species. This will help in developing mitigation measures for protecting and conserving biodiversity, maintaining ecosystem services and sustainably

managing the living natural resources. This section presents a description of the terrestrial flora and fauna and other natural resources and habitats constituting the biological environmental setting.

Vegetation (Terrestrial Flora)

There is no doubt that the world's terrestrial flora is under pressure largely from rapid urbanization. The proposed project is an example of anthropogenic activity that can add pressure on the relatively sparse vegetation in the study area. Baseline information of at least the plant species composition of the project area will help in developing mitigation measures or conservation plans for any impact of the proposed project.

Vegetation and Ecological Setting

The vegetation within the project footprint and its surrounding Area of Influence reflects a typical Sudan Savanna ecosystem, characteristic of semi-arid Northern Nigeria. This ecological zone is defined by open woodland interspersed with grasses and drought-resistant shrubs. Vegetation cover is generally discontinuous rather than dense, allowing wide visibility across the landscape and reinforcing the visual impression of openness that characterizes the Babura area. Within the proposed solar site, plant cover consists primarily of scattered trees and shrubs with seasonal grasses occupying the understory. During the dry season, much of the herbaceous vegetation becomes sparse and desiccated, while woody species retain structural dominance in the landscape.

The dominant tree and shrub species recorded during the survey include:

- **Acacia spp.** – commonly referred to as thorn trees or gum Arabic trees, recognizable by their umbrella-shaped canopies and adaptive spines that reduce water loss and deter browsing.
- **Ziziphus spp.** – commonly known as the jujube tree, a hardy species that produces small edible fruits and thrives in arid environments.
- **Cassia spp.** (Senna species) – commonly called senna trees, known for their compound leaves and yellow flowering structures.
- **Ficus spp.** – fig trees, which provide shade and fruit for wildlife and livestock.
- **Combretum spp.** – commonly known as bushwillow, a drought-tolerant shrub or small tree frequently encountered in savanna landscapes.

In addition to these common species, several economically and culturally important trees were identified within the broader study area:

- **Adansonia digitata** – the Baobab tree, a distinctive large-trunked species valued for its fruit pulp, medicinal properties, and water storage capacity.
- **Vitellaria paradoxa** – the Shea butter tree, an economically significant species whose nuts are processed into shea butter used for food and cosmetics.
- **Diospyros mespiliformis** – commonly referred to as African Ebony or Jackal berry

tree, valued for its hardwood and fruit.

These species provide important ecosystem services, including shade provision, soil stabilization, carbon sequestration, and food resources for both humans and animals. They also contribute to local livelihoods through fruit harvesting, fuelwood collection, and traditional medicinal uses. Vegetation within the immediate project footprint is generally sparse and patchy. Shrub density varies across the site, with some areas exhibiting reduced cover due to grazing pressure and periodic fuelwood harvesting. Livestock movement has also contributed to localized compaction and minor vegetation thinning.

The vegetation structure is typical of a human-influenced savanna landscape and does not demonstrate features associated with high conservation value ecosystems. Importantly, no rare, endemic, or IUCN-listed threatened plant species were observed during the field survey. The ecological characteristics of the site indicate that it does not constitute:

- A designated critical habitat
- A protected forest reserve
- An ecologically sensitive wetland or riparian corridor

Plate 4.4a: Zobo Trees (Hibiscus sp.)

Plate 4.4b: Neem tree (Azadiracta Indica sp.)

Plate 4.4c: Shrubs around the area

Plate 4.4d: Kalgo (Piliostigma thornningii sp.)

Plate 4.4e: Guinea corn (Sorghum bicolor sp)

Plate 4.4f: Ziziphus Abyssinica sp

Wildlife and Faunal Observations

Wildlife presence within the project area reflects a human-modified savanna ecosystem where domesticated livestock and adaptable wild species coexist. The absence of dense woodland or permanent water bodies limits the diversity of large fauna; however, the site supports species

commonly associated with semi-arid savanna habitats.

Mammals

Livestock is dominance within the landscape and reflects its use as grazing land and indicates long-term anthropogenic influence. Mammalian observations during the survey included:

- **Lepus capensis** – the Cape Hare, identified through direct sightings and indirect evidence such as tracks and droppings.
- Small rodents, including bush rats and ground squirrels, which occupy burrows within sandy soils.
- Domesticated livestock such as cattle, goats, and sheep, commonly observed grazing within and around the site.
- Donkeys and camels, which are widely used in the region for transportation and agricultural activities.

Reptiles

These reptiles are well adapted to open, sun-exposed savanna conditions and are not considered conservation- sensitive species. Reptile species observed include:

- **Varanus spp.** – monitor lizards, typically found near burrows and open ground areas.
- **Agama agama** – the red-headed rock agama, a small lizard frequently seen basking on exposed surfaces.

Invertebrates

The invertebrate population reflects a functioning but simplified savanna ecological system. A variety of invertebrates were recorded, including:

- Termites, which play an important ecological role in soil aeration and nutrient cycling.
- Ants and grasshoppers, common in dry savanna ecosystems.
- Wasps and bees, contributing to pollination services within the ecosystem.

Animals	
	
A Heard of Cattles	**Camels**

Plate 4.5: Pictures of Fauna observed within the project Area of Influence.
Source: BOLBEN LTD Fieldwork: EIA of the proposed 1-MW Solar PV facility at FUTB By REA,2026.

Ecological Interpretation

Overall, the biological environment can be described as typical of a semi-arid, human-influenced savanna landscape with moderate ecological value. No endangered, rare, or legally protected wildlife species were recorded within the project footprint or immediate Area of Influence. The ecological integrity of the site has already been shaped by long-standing human activities such as livestock grazing, small-scale agriculture, and fuelwood harvesting. The site does not serve as:

- A migratory wildlife corridor
- A breeding ground for threatened species
- A designated conservation area

Table 4.7: Some Indigenous Fauna in the Project Location

S/N	Common Name (English)	Local Name (Hausa)	Scientific Name	IUCN Status	Estimated Frequent
1	Lizards	Kadangare	*Lacertilia*	Least concern	9
2	Giant Rat	Gafiya	*Crycetamys gambiansis*	Critically Endangered	2
4	Laughing dove	Kurchiya	*Streptopalia senegalensis*	Least concern	9
5	Spot swordtail Butterfly	Malam bude ido mai dugo	*Graphium nomius (Esper)*	Least concern	2
6	Plain Tiger Butterfly	Malam bude ido	*Danaus Chrysippus*	Least concern	1
Total					**23**

Source: BOLBEN LTD Fieldwork: EIA of the proposed 1-MW Solar PV facility at FUTB By REA,2026.

4.4 Socioeconomics

The socio-economic survey collated baseline socio-cultural, economic and infrastructural indices of the study areas, while the consultation process elicited responses on stakeholders' concerns and expectations from the proposed project. This study is an integral part of environmental and social impacts management and overall sustainable development arrangement. The objectives of the socio-economic survey include:

- Study and documentation of the socio-economic and cultural situation of the project area.
- Determining the impacts of the project on settlements, cultural treasures, population, social and physical infrastructures, predominant economic structures and the baseline health status of the people.
- Documenting the views of the affected population, industries and other relevant institutions/agencies in terms of environmental problems, perceived community problems and needs; and
- The engagement of stakeholders, with a view:

- to enabling the stakeholders, understand the project processes and cycle;
- to consider the views and opinions of stakeholders concerning the construction, operation and decommissioning of the project.
- to developing and maintain a robust relationship the government and the project affected communities
- to prevent any form of social unrest among various levels of stakeholders that might arise from the development of the proposed project.

*See **Appendix IV** for the attendances of the consultation and field activities.*
*See **Appendix V** for the pictorial evidence of the consultations.*

4.4.1 Scope of Study

The study was conducted in Federal University of Technology Babura and other surrounding areas within the 3Km radius of the project location. It covered the socio-cultural resources of these communities, demographic issues including population and growth, age and sex distribution, and adult literacy. Others were such indicators of the quality of life of the residents as quality of housing, access to potable water, availability of functional infrastructural amenities, livelihood activities and patterns, and income levels. Health facilities and their patronage, disease prevalence and disease vectors, water and sanitation, and nutrition were also studied. Additionally, the study discusses the perceptions, concerns and expectations of members and residents of these communities, and establishes the proposed project's potential impacts, impact

4.4.2 Study Approach

The EIA guideline has made it mandatory to consult communities on the possible impact of a proposed project. It is also binding to integrate community views at the project design stage. Socio-economic and community health impact assessment tools are designed to integrate the desires and aspirations of the community with those of the project proponent. In line with the EIA objectives, wide consultations were held and community aspirations were recorded. Public forums were held with the aim of creating more awareness on the proposed project and to prompt community support. The views expressed at the public forums are also an integral part of this report. The photographs taken at the forums are attached to this report.

This phase of study consisted of data collation on the baseline social and economic indices of the study area. Relevant data were presented under various subheadings, including social environment (Socio-cultural/psychological environment, demography, education and literacy, quality of life, poverty and inequality, human development indices); economic survey (production factors, labour force participation, employment/unemployment, and market survey). The consultation programme for the socio-economic impact assessment of the proposed project consisted of a two-tier process:

i. **Reconnaissance** visits to key community stakeholders (political leaders, traditional rulers and civic leaders). This was done for legitimate purposes, as to secure permission and cooperation for the study; and
ii. **Direct Consultation** with Identified Stakeholders. This phase consisted of the utilization of participatory tools to elicit information from stakeholders on community baseline data, expected impacts (direct/indirect, adverse/beneficial, short/long term etc). Attempts were also made to ascertain stakeholders' concerns as well as identify areas by which affected communities may be assisted by project proponent alone, or in conjunction with relevant NGOs and government agencies at various levels.

Sampling Procedure and Data Collection Techniques

In obtaining socio economic data of the project area, the exploratory survey method was adopted. This involved key informant interviews, group interviews using structured questionnaires. A "key informant" is generally a person judged to have good knowledge of the area under study, community leader, youth leader, a traditional ruler, an opinion leader etc. thTheuestionnaire used in obtaining socio economic data employed a combination of "open- ended" and "closed" questionnaire format. Open-ended questions are more suitable for qualitative data while closed questions are more suitable for

quantitative data. Simple random and purposive techniques were employed in sampling of the population of the study area.

Qualitative data was generated through informed meetings and also observation in small groups of stakeholders in the various communities with diverse socio-economic background and interest. Such groups include; Age grade, Farmers group, Market women and Youth Associations. Each group meeting focused first on political/administrative structure of the community/population characteristics, ethnic composition, and existing infrastructural facilities, predominant occupation as well as cultural practice and treasures.

4.4.3 Sources of Data

Primary and secondary sources were used for the survey. The research instruments employed for the survey were basically:

i. Desk reviews of available secondary data
ii. Direct Observation
iii. Individual Interview
iv. Questionnaire Administration
v. Focus Group discussion and
vi. Maps and published literatures (journals)

Mode of Data Collection for Socio – Economic Survey

The survey was conducted through constructed questionnaires which were administered by trained personnel to get the desired result. The target area coverage for the survey is three (3km) kilometers from the centre of the site. A total of fifty (50) questionnaires were administered and distributed to eight areas which falls within the 3km radius of the proposed project site. The population of the area was the key determinant of the number of questionnaires distributed in the area.

Primary Sources

The administered questionnaires were employed to gather quantitative information concerning household and communal characteristics; while the direct observation, individual interviews and focus group discussions were employed to assess the concerns of the community inhabitants on matters bordering on the social, economic and health implications of the proposed flyover project in their community as well as their collective expectations from the proponent and government.

Secondary Sources

In instances where primary sources could not provide the required data, secondary data sources were relied upon. At the community level, such secondary data was sought from desk reviews which provided official and published information on the community including population figures and records revealed by other existing structures such as local government records and hospitals for baseline records. Information was also obtained from existing national data sources including National Population Commission (NPC), National Bureau of Statistics (NBS), Electronic maps and website of Lagos State Government. Some other data were collected from international sources such as the World Bank, the United Nations (UN) and the African Development Bank (AfDB).

Analytical Techniques

Descriptive statistics were utilized to analyze collated data. These included means, percentages, frequency tables and charts. Data collected on various socio-economic parameters from all the affected areas were also analyzed using different tools as appropriate. The questionnaire survey involved sampling households within the community using a set of questionnaires.

4.5 Field Study Strategy

The field study comprised the following operations:

i. Pre-testing of questionnaires;
ii. Household listing;
iii. Field identification of households selected for interviews;
iv. Questionnaire administration and interview of key informants; and
v. Focus group discussions;

The socioeconomic baseline assessment was undertaken to understand the human environment within which the proposed solar project will operate. The study combined structured questionnaire administration, institutional consultations, and community engagement to capture perceptions, energy challenges, and expectations.

4.5.1 Response Profile

The survey population was drawn from individuals within the study area who were accessible and relevant to the research objectives. A total of 55 respondents were randomly selected to ensure broad representation and reduce bias. Of these:

- 50 questionnaires were administered. This number was chosen to balance adequate coverage with practical constraints such as time and resources.
- 45 complete questionnaires were validated and recovered,
- Yielding an approximate 90% response rate.

The figure was considered sufficient to capture meaningful variations in responses and provide credible insights into community perceptions, and allowance was made for possible non-response, which helped strengthen the validity of the data generated.

Respondents included students, academic staff, non-academic staff, and members of the host community. The high response rate reflects strong stakeholder interest in the proposed project.

4.5.2 Population and Socio-Demographic Characteristics Historical
4.5.3 Overview of Project Location

Babura is a Local Government Area in the north of Jigawa State, Nigeria. It shares border with Baure Local government of Katsina State from North, Kazaure from West, Sule Tankarkar from East and Danbatta local government of Kano State from South. Its headquarters are in the town of Babura. The current District Head of Babura who doubles as the Sarkin Bai of Ringim, Ringim Emirate Council, Alhaji Muhammad Nata'ala Mustapha (Councillor & King Maker) has been on throne since April 2019 after the death of his brother Alhaji Hadi Mustapha Musa of the Bani Ya Musa clan. It has an area of 992 km^2 and a population of 208,101 at the 2006 census.

4.5.4 Community Structure/Administration

There is a homogenous traditional administrative system in the villages that make up the study area. The Emir is Head/Chairman of the Dutse emirate council and is supported by Councilors, District Heads, Village Heads and Ward Heads. Ward Heads adjudicate on cultural and civil matters that are within their ward purviews. This includes hearing and settling of disputes and non-criminal cases. Issues that are not satisfactorily resolved at the ward level is taken to the Barden Kude (Village Head). In the event that any matter is beyond the Barden Kude, or parties disagree with the judgment of the Barden Kude, the matter goes to the Hakimi (District Head). It is only when a case is not resolved by the district head that it goes to the Emir and his cabinet Counselors.

Ceremonially, the Emirate is the first port of call for prime guests to the Emirate. Governors, Ministers and Investors usually pay courtesy visits to the Emir as a mark of honour and to inform him of their intention, thereby receiving not only his royal blessings but also relevant information about the people and culture.

4.5.5 Population/Demographics

Based on the 2006 census conducted, the population of Jigawa State stood at 4,361,002, however, according to the National Bureau of Statistics, the projected population of the State in 2019 was 6,779,080 and in 2022 it was projected as 7,499,100. (NBS, 2020). Population in the different Zones and their LGAs where the proposed schools' interventions will be carried out is presented in Table **9** showing that the Jigawa North West comprising the Ringim, Gumel, Babura and Kazaure zones is the most populated in the State, while Birnin Kudu LGA in the Birni Kudu zone (Gwaram, Buji and Birni Kudu LGAs) in Jigawa South West is the most populated LGA.

Table 4.8: Jigawa State population in zones

Name of Zone	Name of LGA of Jigawa State	Senatorial District	Population in 2006	Projected population in 2022
Dutse Zone	Dutse		251,135	431,800
	Kiyawa	Jigawa Southwest	172,952	297,400
Birni Kudu Zone	Gwaram		271,368	466,600
	Buji		97,284	167,300
	Birnin Kudu		314,108	540,100
Jahun zone	Jahun		229,882	395,300
	Miga		127,876	219,900
Sub-Total – Jigawa South West			**1,464,605**	**2,518,400**
Ringim Zone	Ringim	Jigawa Northwest	192,407	330,900
	Garki		150,261	431,800
	Taura		131,861	226,700
Gumel zone	Gumel		106,371	182,900
	Gagarawa		82,153	141,300
	Maigatari		177,057	304,500
Babura zone	**Babura**		212,955	366,200
	Sule Tankarkar		134,813	231,800
Kazaure Zone	Kazaure		161,161	277,100

Name of Zone	Name of LGA of Jigawa State	Senatorial District	Population in 2006	Projected population in 2022
	Roni		77,414	133,100
	Gwiwa		128,730	221,400
	Yankwashi		95,643	164,500
Sub-Total – Jigawa Northwest			**1,650,826**	**3,012,200**
Kafin Hausa Zone	Kafin Hausa		267,284	459,600
	Kaugama		128,981	221,800
	Auyo	Jigawa Northeast	132,268	227,400
Birninwa Zone	Birninwa		142,015	244,200
	Guri		113,363	194,900
	Kiri Kasama		192,583	331,200
Hadeija Zone	Hadejia		104,286	179,300
	Malam Madori		164,791	283,400
Sub-Total – Jigawa Northeast			**1,245,571**	**1,920,000**
Total Population			**4,361,002**	**7,499,100**

Source: City Populations – Statistics, maps and charts (web)

4.5.6 Demography of the Project Area Age

Age is an indicator of the phase of adult life an individual might have attained. Table 4.11 shows that 18 – 30 years had 74.1%, 31 – 45 years had 16.7%, 46 years and above had 9.3%, This result shows that young or starter households (of either below 18 – 25 and 26 – 35) constitute 74.1% while the established households (households in the area 31 – 45 age categories) constitute 16.7% of the population. The ageing households (50 and above) constitute only 9.3%. This result indicates that the project areas have young population.

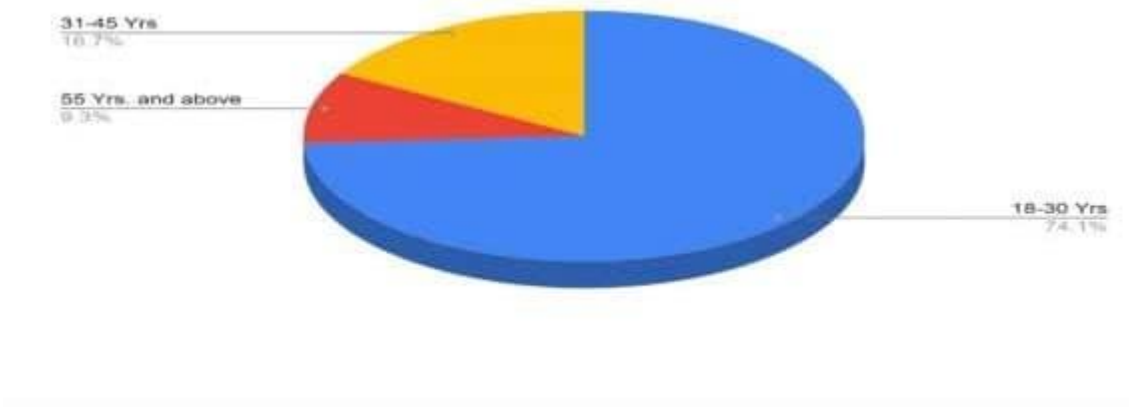

Figure 4.8: Age of the Sampled Respondents

4.5.7 Gender

Gender also indicates the roles individuals play in households, although this varies depending on the society in question. It is usually seen as clear-cut male and female. Figure 4…. shows the gender profile of respondents sampled within the project area. Whereas females constitute only 46.3%, males constitute 53.7%.

Figure 4.9: Gender Profile of the Respondents

4.5.8 Marital Status

More than half of the total respondents sampled (72.2%) were single and as Figure 4 shows that (24.1%) were married and separated constituted about (3.7%).

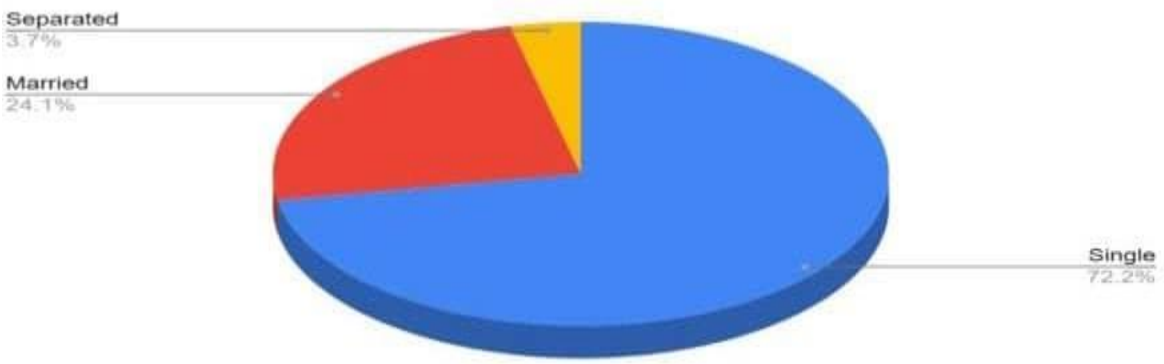

Figure 4.10: Marital Status of Respondents

4.5.9 Religious Belief

The people living around the project site are predominantly Muslims. The survey shows Muslims to be 94.4% while 6.6% are Christian, there were no other forms of religion found from the sampled population as indicated in the figure below.

Figure 4.11: Religious Belief of Respondents

4.5.10 Education

The Basic Education system of Nigeria regard a person with Basic eight (JSS 3) as an educated person. The survey indicates that about 22.2% of the respondents attended secondary school and 11.1% had NCE/ND while 66.7% of the respondents had either HND or Degree (BSc). It can be said that the population around the project is highly educated.

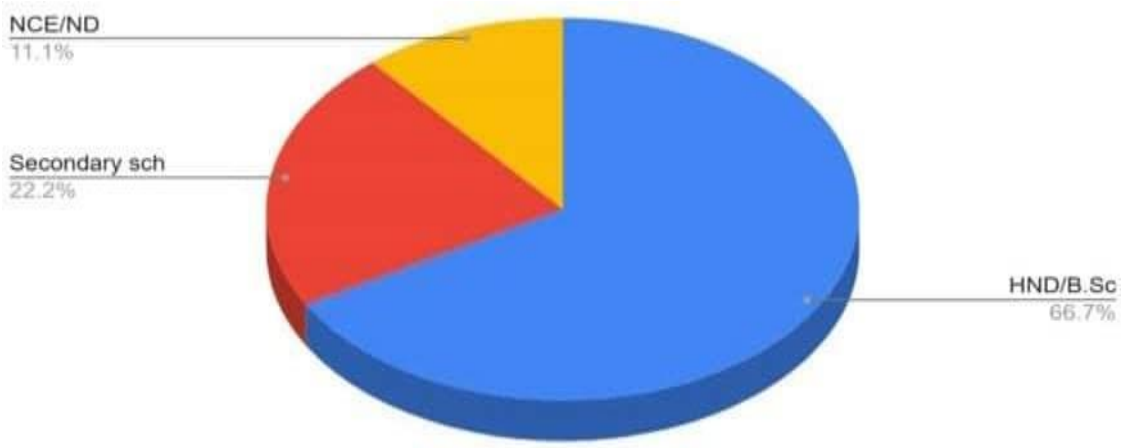

Figure 4.12: Respondent Highest level of Education

4.5.11 Occupation of the Respondents

Respondents were engaged in numerous occupations as shown in Figure4… Occupations of respondent were spread into trading (3.7%), farming (16.7%), Civil servants (18.5%) and Student (61.1%). Looking at these results, it can be said that a good number of the sampled population are either farmers or civil servants apart from the students.

Figure 4.13: Occupations of Heads of Households

4.5.12 Income

About 63% earn 0-30, 000 naira per month while about 14.8% earns about 31,000 – 60,000Naira and 22.2% earns 120,000 ~~na~~ira and above. In general, reliable income data are difficult to come by in Nigeria. Even though the income data from this study is disturbing because about 63% of the respondents are earning below the national minimum wage at the time of this survey. This may put a considerable large population of the survey area below the international poverty line according to World Bank (1990).

Figure 4.14: Income Earnings per Month

4.5.13 Language Spoken by the Respondents

Most of the respondents (79.6%) were hausa spoken, 314.8% speaks English, 3.7% were Reshe/Cishingini and 1.9% were Zarma/Dendi.

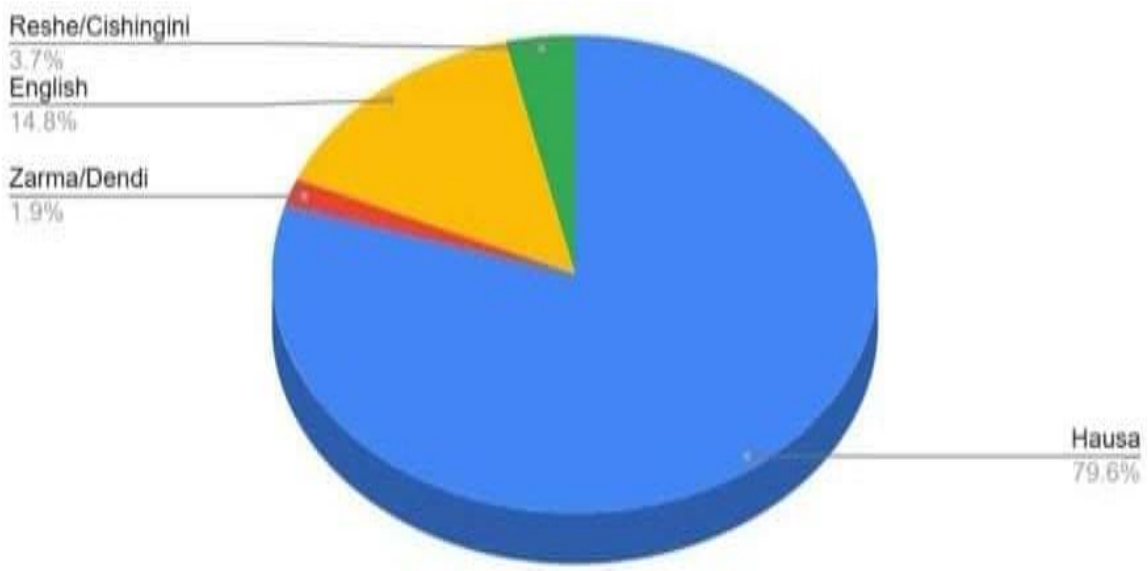

Figure 4.15: Language Spoken by the Respondent

4.5.14 Water Supply

Water supply is a real challenge in most communities in Nigeria; Figure 4.11 reveals that water supply in the surveyed areas comes from three major sources (Borehole, Open Stream). 94.4% of the respondents obtain their water from boreholes, 3.7% from open wells and 1.9% obtain water from streams. The major source of water in the surrounding communities is borehole water.

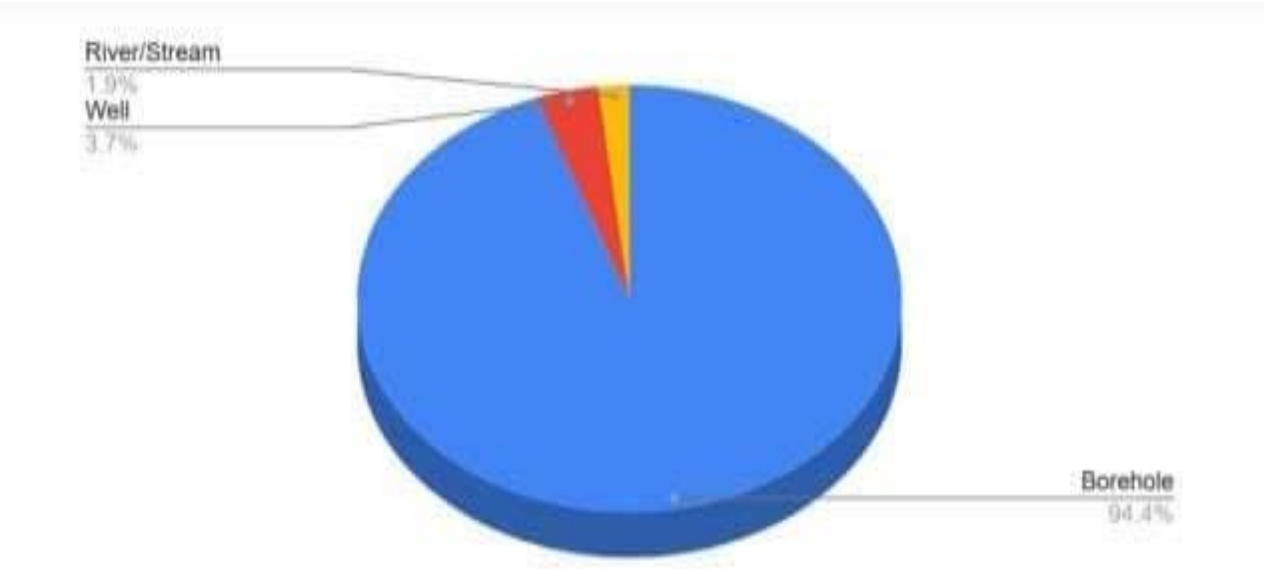

Figure 4.16: Source of Water Supply

4.5.15 Power Supply

A look at figure 4.17 shows that the communities surrounding the project site indicated that electricity was available. About 78% of the total respondents indicated that electricity was available in the area, 22% indicated that electricity was not available. The source of electricity used in various households around the project was investigated and it reveals that the project area uses solar (59.3%), 33.3% uses the National Grid as the major source of their electricity and only 3.7% of the respondents indicated that they use generators as their source of electricity.

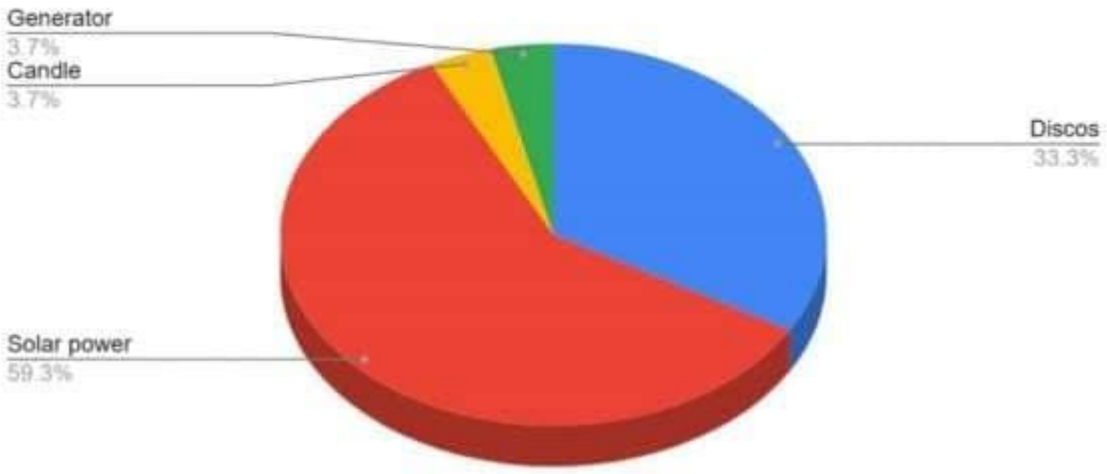

Figure 4.17: Availability of Electricity

4.5.16 Major Source of Energy for Cooking in each household of respondents

Food is one of the basic necessities of life, humans require a lot energy to cook/prepare meals, this energy can contribute to greenhouse gases when cleaner sources are not used. The survey investigated the time of energies employed by households around the project site for cooking and it was found out that most of the households use Liquefied Petroleum Gas (LPG) or cooking gas as their major source of cooking energy (75%), this was closely followed by firewood (18.5%) and charcoal (5.6%), it is believed that with time the usage of LPG for cooking in the project area will greatly increase as most respondents interviewed are thinking towards that direction.

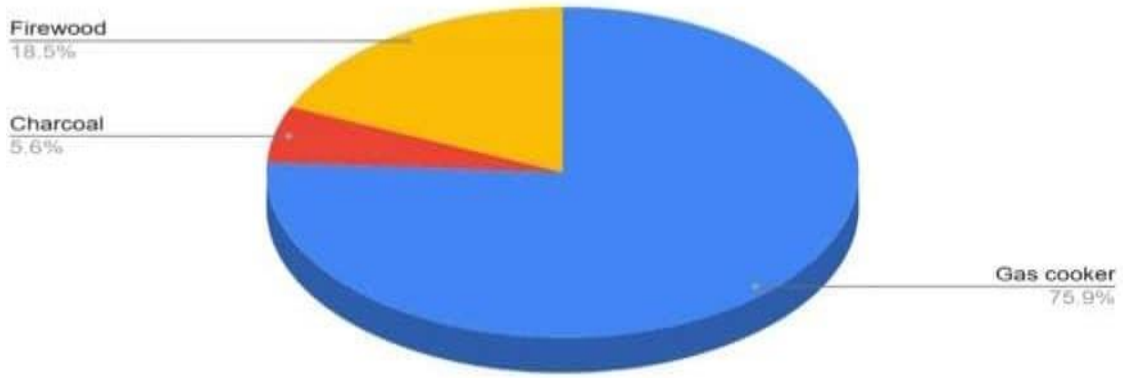

Figure 4.18: Source of Energy for Cooking

4.5.17 Health Facilities

Common Diseases suffered by members of the Community

Healthcare is a major facility and its provision essential, the survey carried out showed that most of the communities surrounding the project area have a functional health care facility. The disease/sickness that frequently take respondents to the healthcare facilities were also investigated and it was revealed that the most prevalent disease/Sickness in the surrounding communities of the project area is Malaria (63%). Others include typhoid (18.5%), Cholera (7.4%), Asthma (3.7%), Pneumonia (3.7%) with skin disease having (3.7%) as well.

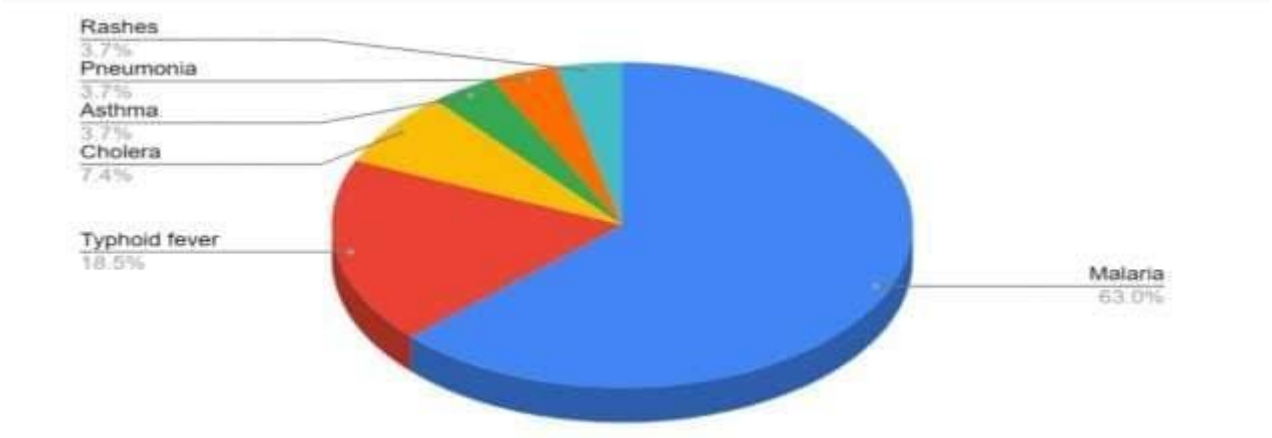

Figure 4.19: Predominant Disease around the project area

4.5.18 Type of Healthcare Facility Patronized by Respondents

Type of Health care facility provided and distributed in the project areas shows that the surrounding communities of the project site had both Government General Hospital and Private Clinics. Most respondents indicated that the Government General Hospital was the place where they receive their health care services (48.1%). While (25.6%) indicated that they use PHC and about 6.3% uses private clinics instead of the General hospital. The survey reveals that the Government General Hospital is living up to its responsibility of providing healthcare services to the communities around the project area.

Figure 4.20: Healthcare facility around the project area

4.5.19 Respondent's Assessment of Health care Facility

Respondents were also asked to assess the quality of their healthcare facilities within the communities and (46.3%) assessed the facilities as very good and good, (7%) assessed it as fair. This further confirmed the fact that the healthcare facilities within the project area are not doing badly.

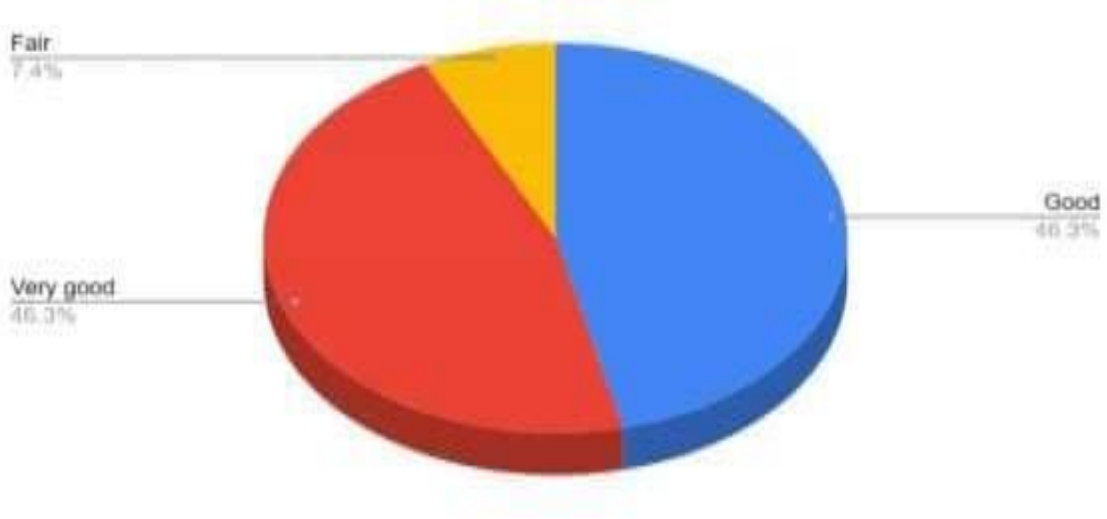

Figure 4.21: Respondents Assessment of Health Care Facility

4.5.20 Waste Management/Sanitation

Poor solid waste management is an environmental concern as it causes air pollution and could contaminate surface and underground water which could have far reaching adverse health impacts on the population in the area. Pit latrine coverage is over 27.8% of the population, about 68.5% make use of water closet, 3.7% use ventilated pit latrine and bush respectively.

Figure 4.22: Waste Management Practice in the Project Area

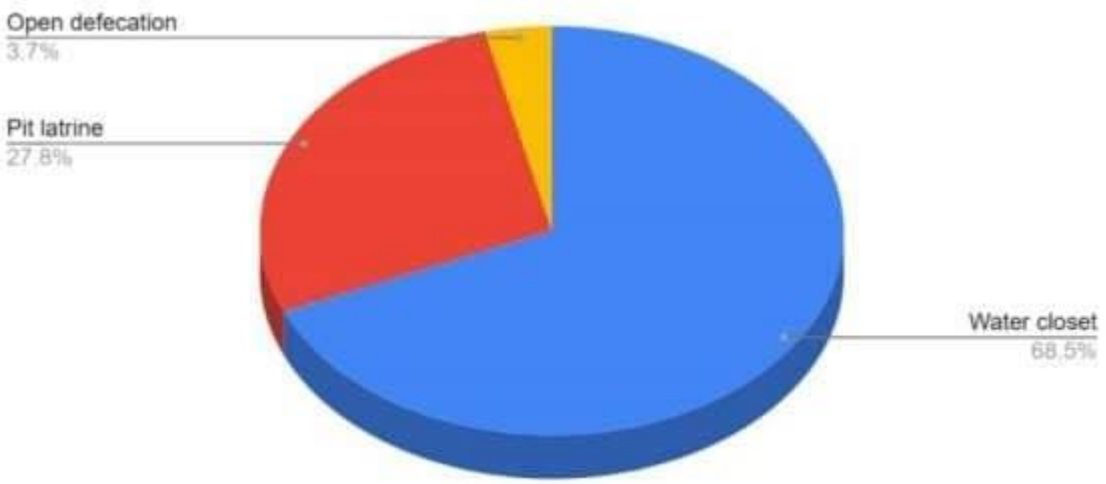

Figure 4.23: Toilet facility utilization

4.5.21 Benefit of the proposed 5MW Solar Photovoltaic Power Project

- Improved Electricity
- Job Opportunities
- Economic Growth
- Reduction of Emission of Greenhouse gases
- Minimizing the number of generators thereby reducing noise generation

4.5.22 Challenges of the 5MW Solar Photovoltaic Power Project

- Increase in Noise especially during construction activities
- Generation of dust during construction
- Traffic congestion during movement of materials and equipment to site
- Air pollution from release of gases

4.5.23 Suggested mitigations to challenge the proposed 5MW Solar Photovoltaic Power Project

- Employment people from the host communities especially during construction
- Put all measures in place to reduce noise and dust pollution.

CHAPTER FIVE

ASSOCIATED AND POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

5.1 Introduction

The proposed 5MW Solar Photovoltaic Power Plant Project at the Federal University of Technology Babura, Jigawa State has overall positive impacts by providing a competitive, cost-effective, pollution free reliable mode of solar power to the University campus and its surrounding host communities. It will certainly meet the ever-increasing demand of power within the institution and its 3km Area of Influence and will help to bridge the gap between demand and supply of power as established in earlier chapters of this report. However, the proposed project may have some negative impact on the environment during site preparation, construction and operation phases. During the construction phase, the impacts may be regarded as temporary or short-term due to activities such as land clearing, trenching, excavation, installation of mounting structures, inverters, transformers and transmission infrastructure. While long-term impacts may be observed during the operation stage, particularly those associated with maintenance activities, water use for panel cleaning, vegetation management and equipment replacement.

5.2 Impact Assessment Overview

The potential for an Environmental and Social impact exists where an environmental and social aspect has been identified, i.e. where a project activity associated with the proposed 5MW Solar PV Power Plant has been determined to have the potential to interact with the biophysical and socio-economic environment described in Chapter Four of this report.

The assessment process was as follows:

I. Identification of the various potential impacts using interaction matrix to show the relationship/interaction between the project environmental components within the Federal University of Technology Babura and surrounding communities, and planned project activities such as site clearing, installation of PV modules, construction of substation, transmission line laying and operational maintenance.
II. A screening of potential impacts associated with each phase of the project is performed using a Risk Assessment Matrix; and
III. A detailed evaluation of the individual impact producing factors that comprise each aspect of the project phases is then performed. The significances of the potential impacts are quantified using the same rationale as for the screening.

The assessment of impact significance is both in qualitative and quantitative terms. Qualitatively, the impact significance is ranked on four (4) widely accepted levels: Major, Moderate, Minor and Negligible. The impact assessment covers the entire life cycle of the Project, i.e.: pre-construction, construction, commissioning, operation, and decommissioning of the proposed solar power plant at Babura.

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

A number of project activities would be carried out in phases for the development of the 5MW Solar Photovoltaic Power Plant at Federal University of Technology Babura. These planned activities are what would impact on the environmental components positively or negatively

within the project site and its Area of Influence. The PV-based power plant project activities are grouped into five phases as follows:

a) **Pre-Construction phase:** Involves activities such as award of contract, project design and planning, consultation with stakeholders within Babura and surrounding communities, recruitment of workforce, site demarcation and preparation, and transportation of utility scale PV-based power plant components including solar modules, inverters, transformers and mounting structures to the project site within the University.
b) **Construction phase:** It involves activities such as mobilization of workforce and equipment to site, digging, trenching, bulldozing, grading, soil compaction; installation of mounting structures, PV modules, inverters, transformers, underground cabling, construction of access roads, control buildings, substation and transmission line infrastructure. This phase is usually a short term one.
c) **Commissioning phase:** It involves the integrated application of a set of engineering techniques and procedures to check, inspect and test every operational component of the solar power plant, from individual functions such as inverters, transformers, switchgears and monitoring systems, up to complex amalgamations such as modules, subsystems and the complete grid-connected system before handover for operation.
d) **Operational phase:** This is usually 'long term', involving activities from post construction to pre-decommissioning. It commences once the power plant has been commissioned for use. Activities include use of natural resources such as water for cleaning of solar modules and domestic use by operational staff, plant and equipment operations, vegetation control within the facility, routine maintenance of inverters, transformers, monitoring systems and associated infrastructure.
e) **Decommissioning phase:** It begins once the power plant use is discontinued or the project life span has come to an end, involving dismantling of PV modules, removal of mounting structures, decommissioning of transformers and electrical systems, and site restoration activities.

It should be noted that impacts can occur at any time during these phases mentioned above, i.e. pre-construction, construction, commissioning, operational and decommissioning phases of the project. Some impacts may, however, occur in some or all phases of the project.

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

- Interact with the existing natural environment including its physical and biological elements such as soil, groundwater, air quality, vegetation and wildlife within the Sudan Savanna ecosystem of Babura;
- Interact with the existing socio-economic environment including the University community and surrounding settlements within the 3km Area of Influence; and
- Breach relevant policy, legal and administrative frameworks including national legislation, relevant international legislation/conventions, standards and guidelines, and corporate environmental policy and management systems applicable to renewable energy development in Nigeria.

The FMEnv EIA Procedural Guidelines, the African Development Bank Integrated Safeguard Systems Operational Safeguards, and ISO 14001 approach among other references were used in the identification process. The assessment approach generally involved matching the various activities of the different stages of the proposed 5MW Solar PV Project (as described in Chapter 3 of this report) with the components of the existing environment described in Chapter Four. Consequently, the possible changes (and extent of changes) in the environment because of the interactions have been identified and evaluated, hence mitigation measures proffered to reduce, offset or ameliorate such changes.

The potential/associated adverse and beneficial impacts of the proposed solar power plant project on the existing environment were identified at this stage of the ESIA. The Risk Assessment Matrix (RAM) has been employed in determining risks posed by the identified potential/associated impacts of the project to proffer appropriate mitigation measures. In predicting impacts, the experiential/practical 'worst case scenario' approach has been applied to determine the extreme effects of project activities on environmental components, while 'consensus of opinions' has been made use of to determine the importance of affected environmental components within the project area. The impact evaluation results make up the pedestal for developing the Environmental and Social Management Plan (ESMP) of the proposed 5MW Solar Photovoltaic Power Plant Project.

5.3.1 Potential Impact Characterization

The following characteristics were also used to define potential impacts that may be associated with the proposed Project at Federal University of Technology Babura:

- **Negative:** An impact that is considered to represent an adverse change from the baseline environmental and socio-economic conditions established in Chapter Four or to introduce a new undesirable factor within the project area.
- **Positive:** An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor such as improved electricity supply, employment opportunities and reduced greenhouse gas emissions.
- **Direct:** Impacts that result from the direct interaction between a planned project activity such as excavation or installation works and the receiving bio-physical and socio-cultural environment.
- **Indirect:** Impacts that result from other activities that are encouraged to happen because of the project, including increased economic activities around the University community.
- **Temporary:** Temporary impacts are predicted to be of short duration, reversible and intermittent/occasional in nature, especially during construction activities.
- **Short-term:** Short-term impacts are predicted to last only for a limited period but will cease on completion of the activity, or because of mitigation measures and natural recovery.
- **Long-term:** Impacts that will continue for the life of the solar power plant project but cease when the project stops operating.
- **Permanent:** Potential impacts that may occur during the development of the project and cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime.

- **On-site:** Impact that is limited to the project site within the Federal University of Technology Babura.
- **Local:** Impacts that affect locally important environmental resources or are restricted to Babura LGA and the immediate 3km Area of Influence.
- **Regional:** Impacts that affect regionally important environmental resources or are experienced at a regional scale within Jigawa State as determined by administrative boundaries.
- **National:** Impacts that affect nationally important environmental resources; affect an area that is nationally protected; or have macroeconomic consequences in relation to Nigeria's renewable energy transition agenda.
- **Reversible:** An impact that the environment can return to its natural state through mitigation and natural processes.
- **Irreversible:** An impact that the environment cannot return to its original state, e.g. the extinction of an animal or plant species.
- **Cumulative:** Potential impacts that may result from incremental changes caused by other past, present or reasonably foreseeable actions together with the proposed 5MW Solar Photovoltaic Power Plant Project. This also includes synergy with other electrification or infrastructure projects in Babura and Jigawa State.
- **Residual:** Both environmental and social impacts that will remain after the application of mitigation measures to project impacts during each of the project phases.

5.3.2 Screening and Scoping for Potential Impacts

The first step in identifying impacts associated with the proposed 5MW Solar Photovoltaic Power Plant Project at Federal University of Technology Babura is the development of an interaction matrix which shows the relationship/interaction between the project environmental and social components within the 3km Area of Influence and planned project activities as described in Chapter Three of this report. A modified version of the Leopold Interaction-matrix technique was employed to screen and scope for the potential impacts of the proposed Solar PV Project on the physical, biological, socio-economic and health environment of Babura, Jigawa State. The basis for the screening was derived from the following:

- Knowledge of the Project activities associated with the 5MW Solar PV power plant including site preparation, installation of PV modules, inverters, transformers, substation, underground transmission line and associated infrastructure.
- Detailed information on the environmental and socio-economic setting of the Project's area of influence as established in Chapter Four, including soil characteristics, groundwater conditions, vegetation profile, wildlife observations and socio-economic baseline data.
- Consultation with relevant stakeholders within the University community and surrounding host communities in Babura LGA.
- Review of other ESIA reports on similar solar photovoltaic projects and comparable environments within Northern Nigeria.

Table 5.1: Project Activities Environmental and Social Interaction Impact Significance Matrix

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

Table 5.2: Solar Power Plant Impacts Categorization

Project Activities	Associated and Potential Impacts	Categorization								
		DRT	IDT	ADV	BNF	RVS	IVS	CML	LGT	SHT
Pre-construction Phase										
• Permitting and statutory approvals • Stakeholders' engagement and MoU negotiations • Recruitment of workforce • Mobilization to site • Land preparation and clearing • Contractor engagement and sub-contracting • Workforce influx	Employment opportunities arising from recruitment of workers									
	Business opportunities for local contractors through sub-contracting Activities									
	Skill acquisition and enhancements to locals and future workforce									
	Improvement in quality of life for adequately compensated individuals									
	Conflicts over employment issues (quotas and methods)									
	Issues/ dispute on memorandum of understanding with project proponent									
	Influx of people (migrant workers, sub-contractors and suppliers) and increased pressure on existing social infrastructure									
	Increase in social vices (like theft, prostitution) resulting from increased number of people in the area									
Construction Phase										
• Land preparation and Clearing • Civil works (excavation, trenching, grading, foundation works) • Installation of PV modules, inverters, transformers and substation • Installation of underground cables • Construction buildings,	Agitations over land disputes, wrong stakeholder leadership tussles, etc									
	Loss of vegetation covers and forest products (fuel wood, medicinal plants) due to site clearing and preparation activities									
	Increased risks of accidents leading to injury/ death and loss of during mobilization									
	Risks of armed robbery attack and hostage taking leading to injury/ of personnel									
	Nuisance (noise and vibrations) from movement of heavy-duty equipment and vehicles affecting site workers and wildlife									
	Dust particles and vehicular emissions from increased movement									
	Generation of waste such as scrap metal, wood, sand, concrete, paper, domestic and municipal waste									
Commissioning and Operational Phases										
• esting and commissioning • Grid synchronization • Power generation and distribution • Routine maintenance of PV plant • Washing of solar modules • Renewable energy training activities	Generation of electricity supply									
	Increased opportunities and quality of life (small, medium, large scale) due to enhanced power delivery									
	Improvement in air quality due to reduced emissions from owned diesel or petrol generators									
	Reduced demand for petrol and diesel used for power generation									
	Injuries/ fatalities of personnel due to incidents/ accidents from operating the power plant									
	Soil/ groundwater contamination from accidental petrol /engine oil spill during refueling of vehicle									
	Workplace accidents/ incidents (cuts, trip, falls etc) leading to injury/ death of personnel during operations									

Project Activities	Associated and Potential Impacts	Categorization								
		DRT	IDT	ADV	BNF	RVS	IVS	CML	LGT	SHT
	Acquisition of skills by individuals to be employed to operate the									
	Depletion of groundwater resources for washing solar modules									
Decommission Phase										
• Mobilization of dismantling equipment • Removal of PV modules and infrastructure • Disposal of obsolete components • Site restoration	Loss of employment, business opportunities and decreased economic Activity									
	Reduced power generation to the University and low power supply									
	Risks of injuries from possible collision with abandoned structures									
	Risk of accident and injury to workers during demolition of structures									
	Increased dust and vehicular emissions from decommissioning Activities									
	Traffic obstruction on major roads from movement of vehicles decommissioned process									
	Availability of land for alternative uses									
	Loss of site aesthetic qualities due to abandoned and dilapidated structures									

Key and Explanation		
Direct (DRT)	Indirect (IDT)	Adverse (ADV)
Beneficial (BNF)	Reversible (RVS)	Irreversible (IVS)
Cumulative (CML)	Long term (LGT)	Short term (SHT)
	Activity interacts with ecological or social component	
	Activity does not interact with ecological or social component	

5.4 Determination of Impact Significance

The significance of impacts likely to arise from the project implementation was evaluated using a structured three-stage approach:

- Impact Magnitude, which reflects the combined effect of the geographical extent, duration, intensity, frequency and scale of a potential impact resulting from project activities;
- Receptor Value, Sensitivity or Fragility, which considers the importance and vulnerability of the affected environmental or socio-economic component;
- Overall Impact Significance, determined through the integration of the magnitude of impact and the sensitivity of the affected receptor.

Determining impact magnitude requires estimating the potential environmental or socio-economic changes arising from both routine and non-routine project operations. This may include, for example, the spatial footprint of land disturbance during construction, projected variations in ambient noise levels, dust emissions during earthworks, or groundwater abstraction volumes during module cleaning activities.

Receptor sensitivity, on the other hand, is influenced by several considerations, including:

Applicable environmental laws and regulatory standards;

- Planning or conservation status of the affected land or resource;
- The number and type of receptors potentially affected (e.g., students, staff, nearby residents, ecological resources);
- The resilience or capacity of the receptor to withstand or recover from change; and
- Public perception regarding the importance or vulnerability of the affected resource.

In establishing the final impact significance, compliance with environmental regulations, quality objectives and statutory pollution thresholds was also considered.

5.4.1 Method for Determining Impact Magnitude

Adverse impacts associated with the proposed solar PV development were categorized into four magnitude levels: Negligible, Low, Medium and High, depending on their predicted severity and scale. For beneficial impacts, it was considered sufficient to state the expected positive outcome without assigning a magnitude classification, since such impacts represent developmental gains aligned with renewable energy objectives and institutional advancement.

5.4.1.1 Magnitude Criteria for Biophysical Impacts

A High Magnitude Impact is one that affects a substantial portion of the project area, ecological system, or environmental resource to a degree that results in significant measurable changes relative to established national or international standards. This may involve exceedance of regulatory thresholds or ecological disruption beyond the ability of natural systems to recover within a reasonable timeframe. A Medium Magnitude Impact produces measurable changes in environmental parameters or species distribution but does not compromise the integrity or long-term sustainability of the affected system or population. A Low Magnitude Impact is localized and limited in scale, resulting in minor, short-term variations in environmental quality that remain within acceptable limits and do not materially alter ecosystem structure or function. A Negligible Magnitude Impact produces changes that are either too small to measure reliably or fall within the range of natural background variability typical of the semi-arid savanna environment of Jigawa State.

5.4.1.2 Magnitude Criteria for Socio-economic Impacts

In assessing socio-economic impacts, magnitude was evaluated from the standpoint of affected stakeholders. This assessment considered:

The perceived importance of the impact to the affected population;

- The capacity of individuals or communities to adapt to the anticipated change;
- The degree to which access to employment, services, infrastructure or economic opportunities is enhanced or diminished;
- The overall implications for human well-being, income levels and quality of life.

For example, employment generation during construction may be considered highly beneficial by unemployed youth, whereas unmet expectations regarding job allocation could generate social tension if not properly managed. The ranking framework applied to socio-economic impact magnitude is presented in Table 5.3.

Table 5.3: Event Magnitude Rankings

Importance	Attributes
High	• Highly undesirable outcome (e.g., impairment of endangered, protected habitat, species) • Detrimental, extended flora and fauna behavioural change (breeding, spawning, moulting) • Major reduction or disruption in value, function or service of impacted resource • Impact during environmentally sensitive period • Continuous non-compliance with international best practices • Negative changes in livelihood status, household income/assets or living conditions affecting a high proportion of people resulting in economic loss and protests the project. • Reputational damage and/or drop in business revenue that threatens the future viability of economic activity. • Increased risk to public health leading to a fatality or injury. • Damage to public infrastructure (such as a sewer, water pipeline, etc.) leading to environmental or socio-economic impacts to other users.
Medium	• Negative outcome • Measurable reduction or disruption in value, function or service of impacted resource • Potential for non-compliance with international best practices • Negative change in livelihood status, household assets/income or living conditions. • Temporary disruption to businesses resulting in a small drop in business revenue. • Increased risk to public health that can be controlled using detailed mitigation measures. • Disruption to public infrastructure (such as a road closure) results in inconvenience to other users.
Low	• Imperceptible outcome • Insignificant alteration in value, function or service of impacted resource • Within compliance, no controls required • Minor disruption to livelihoods or living conditions resulting in a localized, reversible and temporary nuisance.
Negligible	• Temporary disruption to businesses that does not result in a loss of revenue or any reputational damage. • No change in the health status of local communities. • Temporary disruption to public infrastructure (such as road closure) that results in minor inconveniences to affected communities.

5.4.2 Determining Receptor Sensitivity

Receptor sensitivity describes the environmental or socio-economic importance of a resource or community that may be affected by project activities. It reflects the degree to which a receptor is vulnerable to change, including the extent of human reliance on that receptor for livelihoods, health, cultural value or economic benefit.

In evaluating sensitivity for the proposed project, receptors were classified into three principal categories: biological/ecological receptors, physical receptors and human receptors. Attention was given to impacts that may directly affect people, especially those that influence access to natural resources, employment, water supply or environmental quality. Natural resources that are critical to local livelihoods, such as groundwater sources or productive land, are regarded as more sensitive than resources where impacts would be indirect or less consequential.

Where the receptor is **physical** (for example, soil or groundwater systems), its existing condition, resilience to disturbance, and relative importance at local, state or national level were considered. For this project, the baseline soil and groundwater characteristics established in Chapter Four provide the reference condition against which sensitivity was evaluated. Where the receptor is **biological** (for example, terrestrial vegetation within the Sudan Savanna ecosystem), its ecological value, conservation status, distribution and vulnerability to the specific type of disturbance were assessed. Receptors of regional or national ecological importance would attract higher sensitivity ratings. Where the receptor is **human**, sensitivity was determined by evaluating the vulnerability of affected individuals or groups, including students, university staff and host community residents within the 3 km Area of Influence. Consideration was given to factors such as economic dependence, access to alternative resources, public perception, and adaptive capacity.

To this assessment, receptor sensitivity was classified into three categories: **Low, Medium and High**, based on defined criteria. The detailed criteria used to rank receptor sensitivity are presented in Table 5.4.

Table 5.4: Receptor Sensitivity Ranking

Sensitivity	Criteria
Low	A receptor is classified as having low sensitivity where there is adequate capacity and resources to adjust to change without significant deterioration in well-being or functionality. Such receptors are generally resilient and capable of adapting to temporary or moderate disturbances. Receptors of low sensitivity may include: • Individuals who can readily cope with short-term disruptions in access, services, or income without long-term consequences (for example, temporary road diversions within the University campus during construction). • Businesses or service providers with stable financial structures that can absorb short-term operational restrictions or may even benefit from project-related activities.
Medium	A receptor is considered to have medium sensitivity where there is limited flexibility or moderate difficulty in adjusting to change. While adaptation is possible, it may require time, external support, or result in noticeable short-term hardship. Receptors of medium sensitivity may include: • Individuals whose livelihoods depend significantly on local economic activities and who may experience temporary income disruption during construction activities. • Small-scale enterprises within and around the University that are sensitive to changes in access, customer flow, or short-term environmental disturbance. • Community members whose daily routines may be moderately affected by increased traffic, noise, or temporary land access restrictions
High	A receptor is classified as highly sensitive where there is minimal capacity to adapt to change and where impacts may significantly affect quality of life, health, safety, or economic stability. These receptors are typically vulnerable groups requiring special consideration and protective measures. Receptors of high sensitivity may include: • Individuals with low-income levels or marginal livelihoods who have limited economic resilience. • Vulnerable persons such as the elderly, people with disabilities, or those requiring special assistance during construction and operational phases. • Informal land users or individuals without secure tenure rights may be disproportionately affected by land-related decisions. • Small or marginal businesses that may not easily withstand prolonged disruption in economic activity.

5.4.3 Significance

For both environmental and socio-economic impacts associated with the proposed 5MW Solar-Hybrid Power Plant at the Federal University of Technology (FUT) Babura, impact significance is determined as a function of two key variables: impact magnitude and receptor sensitivity. The combined outcome of these two variables is categorized as **Negligible, Minor, Moderate or Major**, as presented in Table 5.5.

An impact is considered **Negligible** where a receptor or resource is not meaningfully affected by a project activity, or where any predicted change is so small that it cannot be distinguished from normal background fluctuations. Such impacts are typically imperceptible and do not alter the baseline environmental or socio-economic conditions. A **Minor** impact occurs where a measurable effect may be observed, but its intensity remains low and within acceptable regulatory standards. This may also apply where the affected receptor has low sensitivity or strong adaptive capacity. Minor impacts, whether positive or negative, do not compromise environmental integrity or socio-economic stability.

A **Moderate** impact represents a more noticeable effect that remains within established regulatory thresholds or accepted performance standards. These impacts fall between minor effects and the level at which statutory limits would be exceeded. Although more pronounced, moderate impacts are still considered manageable through standard mitigation and monitoring measures. Impacts classified as Negligible, Minor or Moderate are generally regarded as acceptable provided appropriate environmental management measures are implemented. A **Major** impact is identified where predicted effects may exceed regulatory standards or where a high-magnitude change affects receptors of high sensitivity or value. Such impacts may result in substantial alteration of baseline conditions and therefore require enhanced mitigation measures, stricter monitoring, and, where necessary, design modification to reduce their severity.

Table 5.5: Impact Significance

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

(Source: International Association for Impact Assessment)

To ensure objectivity and technical robustness in determining overall impact significance for the Babura Solar Project, structured expert consultations were conducted. These consultations applied screening matrices and predefined criteria for magnitude and receptor sensitivity in a systematic manner. The results of this evaluation form the basis for the development of targeted mitigation measures and the Environmental and Social Management Plan (ESMP).

5.5 Impacts Discussion

5.5.1 Potential Positive Impacts

5.5.1.1 Improvement in Power Supply

The proposed 5MW Solar Photovoltaic Power Plant Project is designed to provide an independent, reliable and sustainable electricity supply to the Federal University of Technology (FUT) Babura, Jigawa State. The Project will significantly enhance power stability within the University campus, reducing dependence on erratic grid supply and privately owned diesel generators. Improved electricity availability will positively influence academic, research and administrative activities by extending productive hours, improving illumination in lecture halls, laboratories, hostels and offices, and supporting digital learning infrastructure. Enhanced power reliability will strengthen institutional performance and overall service delivery within the University.

5.5.1.2 Reduction in Carbon Emissions

Solar energy represents a clean and renewable alternative to fossil fuel-based power generation. By replacing diesel-powered generators previously used within the campus and surrounding host community, the Project will contribute to a measurable reduction in greenhouse gas emissions. The use of photovoltaic technology eliminates combustion-related emissions, thereby reducing air pollutants such as carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO_2), and particulate matter. This contributes to improved ambient air quality within the University and its 3 km Area of Influence. Furthermore, the Project aligns with Nigeria's commitment under its Nationally Determined Contributions (NDCs) toward reducing greenhouse gas emissions. To strengthen this positive contribution:

- The system design allows for modular expansion in the event of increased electricity demand resulting from future institutional growth.
- Priority power allocation strategies may be adopted to eliminate or significantly reduce reliance on diesel generators.
- The University will promote energy efficiency measures such as the use of LED lighting, low-energy appliances and behavioural energy conservation practices.
- Opportunities for participation in voluntary carbon credit mechanisms may be explored to enhance climate-related benefits.

5.5.1.3 Reduction in Noise and Air Pollution

With reduced operation of diesel generators within the campus, there will be a substantial decrease in noise levels and generator-related emissions. This will improve acoustic comfort in lecture halls, residential areas and administrative buildings. The transition to solar energy will also reduce localized air pollution, thereby benefiting both human health and the surrounding terrestrial environment. Sensitive receptors such as students, staff and nearby residents will experience improved environmental quality.

5.5.1.4 Improved Learning and Capacity Development

As part of the Project, a renewable energy training component will be integrated into the University's academic framework. This will facilitate knowledge transfer in solar technology installation, maintenance and renewable energy management.

The establishment of this capacity development platform will enhance technical competence among

students and staff, strengthen research potential in renewable energy systems, and support the certification of trained individuals. Over time, this contributes to workforce development within Jigawa State and Nigeria at large.

5.5.1.5 Increased Visibility and Safety

The installation of solar-powered streetlights within the campus will improve nighttime visibility and enhance security. Better illumination reduces risks associated with dark areas, improves pedestrian safety, and minimizes hazards linked to the use of candles or fuel-based lighting sources. Improved lighting infrastructure will strengthen campus security management and contribute to a safer academic environment.

5.5.1.6 Increased Socio-Economic Benefits

The Project will generate both direct and indirect employment opportunities across multiple skill categories. During the construction phase, job opportunities will be created for skilled and unskilled labour including technicians, equipment operators, security personnel and support staff. Preference will be given to qualified individuals from the host community and Jigawa State. To ensure equitable employment benefits:

- A Labour and Employment Management Plan (LEMP) will be developed prior to construction, specifying workforce sourcing targets and influx management procedures.
- The Engineering, Procurement and Construction (EPC) Contractor will publicize job opportunities in advance through appropriate communication channels.
- Skills acquisition and technical training programmes will be implemented prior to and during construction to enhance employability of local workers.
- Gender-sensitive employment measures will be adopted to ensure inclusive participation and prevent disproportionate burdens on women.

During the operational phase, permanent employment opportunities will be created for plant operators, electrical and mechanical technicians, maintenance staff, cleaners and security personnel. Periodic capacity-building programmes will be conducted to maintain technical competence. Overall, improved electricity access is expected to stimulate small and medium-scale enterprises within and around the University, enhance economic productivity, and improve overall quality of life.

5.5.2 Potential Negative Impacts

Despite the significant positive outcomes, certain adverse impacts may arise during the pre-construction, construction, operation and decommissioning phases of the Project. These impacts have been grouped into the following thematic areas for detailed assessment:

- Land use changes
- Impacts arising from movement of equipment, personnel and materials
- Traffic-related impacts
- Impacts on air quality
- Noise level
- Impacts on terrestrial vegetation and fauna
- Impacts on groundwater resources

- Waste generation and management impacts
- Soil quality impacts
- Visual and aesthetic impacts
- Socio-economic impacts
- Public health impacts
- Occupational health and safety risks

5.5.2.1 Pre-Construction / Mobilization Phase

The pre-construction phase of the proposed 5MW Solar Photovoltaic Power Plant Project at the Federal University of Technology (FUT) Babura includes the following activities:

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

A. Site Selection

Approximately 10 hectares of land within the Federal University of Technology (FUT) Babura campus has been designated by the University Management for the establishment of the 5MW Solar Photovoltaic Power Plant and associated renewable energy training facilities. No additional land acquisition from private individuals or public property outside the University boundary will be required for the Project. The selected site falls within a modified Sudan Savanna ecosystem characterized by sparse grasses, scattered shrubs and isolated trees, as documented in the baseline ecological survey (Chapter Four). No permanent structures, cultural heritage features, wetlands or conservation-designated areas were identified within the proposed footprint. Considering the current institutional land use classification of the area and the absence of sensitive receptors such as protected habitats or settlements, the impact of site selection on existing land use is considered localized and controlled. Therefore, the impact significance associated with site selection is rated as **moderate**, primarily due to the conversion of open vegetated land to utility infrastructure within the University premises.

B. Site Clearing and Preparation

Prior to construction, vegetation within the designated footprint will be cleared to allow for installation of photovoltaic panels, mounting structures, inverter stations and internal access routes. Clearing activities will involve the use of light earth-moving equipment such as tractors and loaders.

The potential environmental and social impacts associated with site clearing are discussed below.

i. Potential Impact on Terrestrial Flora and Fauna

Site clearing will result in the removal of grass, shrubs and a limited number of scattered trees within the project footprint. As established in Chapter Four, the vegetation is typical of a human-influenced Sudan Savanna landscape and does not contain rare, endemic or IUCN-listed threatened species. The anticipated impact on flora is **negative, direct, site-specific and largely irreversible** within the immediate footprint. However, since:

- The area represents a modified habitat,
- No endangered plant species were recorded,
- There are no protected ecological zones within the site,
- Local communities do not depend on the site for critical ecosystem services.

The receptor sensitivity is considered **low**. Given that clearing is confined to approximately 10 hectares within a broader campus environment, the magnitude is rated **medium**, resulting in an overall impact significance of **minor**. With respect to fauna, temporary disturbance may occur due to noise, vegetation removal and human presence. Small mammals, reptiles and birds recorded during baseline studies (e.g., savanna lizards, rodents, and avifauna species) are generally mobile and capable of relocating to adjacent habitats within and beyond the University property.

Since no threatened wildlife species were identified and alternative habitat exists in surrounding savanna areas, the magnitude of impact on fauna is considered **low**, localized and short-term. Therefore, the overall significance is rated **minor**.

ii. Potential Impact on Soil

Clearing and preparation activities may affect the soil environment through:

- Compaction from machinery movement
- Surface disturbance
- Temporary exposure of topsoil
- Increased susceptibility to erosion

The baseline soil assessment identified the site soils as predominantly loam-clay mixtures with moderate drainage characteristics and gentle slopes (0–5% across most of the site). These conditions reduce susceptibility to severe erosion. Although vegetation removal temporarily increases erosion risk, particularly if conducted during the rainy season, the overall erosion potential of the site is considered moderate to low due to its gentle topography and soil composition. The magnitude of potential soil disturbance is therefore assessed as **medium**, while receptor sensitivity is **low to medium**, given the absence of high-value agricultural production or fragile soil systems. Consequently, the overall impact on soil is considered **minor**.

iii. Potential Impact on Air Quality and Ambient Noise

During site clearing, emissions may arise from:

- Dust generation (particulate matter)
- Combustion gases (CO, NOx, SOx) from equipment engines
- Temporary increase in ambient noise levels

Baseline air quality monitoring indicated that particulate matter and gaseous pollutants are currently within regulatory limits, and ambient noise levels are generally within acceptable thresholds for institutional environments. Site clearing activities are expected to be:

- Short-term (approximately one week)
- Localized
- Intermittent
- Reversible

Given the limited duration and scale of activities, and the relatively low sensitivity of the surrounding air shed, the magnitude is assessed as **low**, resulting in a **minor** impact significance on ambient air quality and noise.

iv. Potential Impact on Workers' Safety

Site clearing involves use of machinery and manual labour, creating risks such as:

- Slips, trips and falls
- Equipment-related injuries
- Manual handling accidents

The number of workers involved at this stage is expected to be limited (less than 10 personnel), and the activity duration is short (approximately one week).

With proper supervision and adherence to occupational health and safety procedures, the likelihood and consequence of incidents remain manageable. Therefore, the overall impact significance on workers' safety during site clearing is considered **minor**.

C. Mobilization of Equipment, Materials and Personnel to Site

The pre-construction phase will involve transportation of machinery, photovoltaic modules, mounting structures, electrical components, tools and workforce to the Project site. These activities will occur over a limited time period prior to full construction.

i. Potential Impact on Air Quality and Ambient Noise

Vehicle movement may temporarily increase:

- Dust emissions
- Exhaust gases
- Noise levels along access routes

However, considering that the Project is located within an institutional setting already experiencing routine vehicular activity, and that mobilization will be limited in duration, the air shed is considered capable of assimilating temporary emissions. The magnitude of impact is assessed as **low**, and receptor sensitivity is also **low**, resulting in a **minor** overall impact significance.

ii. Potential Impact on Infrastructure (Roads and Traffic)

Mobilization activities may increase traffic volume within the campus and adjoining access roads. Potential impacts include:

- Temporary congestion
- Increased risk of minor traffic accidents
- Short-term inconvenience to road users

Given that vehicular movement within the University is already moderate to high, receptor sensitivity is considered **medium**. However, because mobilization activities are short-lived (approximately one week), the magnitude is **low**.

Therefore, the overall significance of traffic-related impacts during mobilization is assessed as **minor**.

iii. Potential Impact on Workers' Safety During Mobilization

Loading and off-loading of heavy equipment and construction materials may expose workers to:

- Musculoskeletal injuries
- Crushing hazards
- Falling objects

With implementation of standard occupational health and safety procedures, the risk level is manageable. Given the limited workforce size and duration of mobilization, the overall impact significance is considered **minor**.

Table 5.6 presents a summary of the identified potential impacts associated with the pre-construction phase of the proposed 5MW Solar Photovoltaic Power Plant Project at FUT Babura.

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

Activity	Receptor	Associated Impact	Significance
Site clearing and preparation	Terrestrial flora and fauna	• Removal of grass, shrubs and scattered trees within the 10-ha project footprint • Direct disturbance to vegetation and soil-dwelling organisms • Temporary displacement of small mammals, reptiles and avifauna in the immediate vicinity of the Project site	**Minor**
	Soil	• Loss of topsoil due to vegetation removal • Soil compaction from movement of clearing equipment • Increased susceptibility to localized erosion • Temporary alteration of soil structure and infiltration characteristics	**Minor**
	Air Quality and Noise	• Temporary increase in dust (particulate matter) from land clearing • Emissions (CO, NOx, SOx) from construction equipment engines • Short-term increase in ambient noise levels	**Minor**
	Workers' Safety	• Risk of occupational injuries during vegetation clearing and equipment operation • Slips, trips and falls during site preparation	**Minor**
Mobilization of construction equipment and materials to site	Air Quality and Noise	• Vehicular emissions (TSP, NOx, CO, SOx) from transportation of materials • Temporary increase in ambient noise along access routes	**Minor**
	Infrastructure (Road and Traffic)	• Increased vehicular movement within the University and access roads • Temporary traffic congestion • Elevated risk of minor traffic accidents	**Minor**
	Workers' Safety	• Risk of injuries during loading and off-loading of heavy materials• Manual handling injuries • Equipment-related accidents	**Minor**

5.5.2.2 Construction Phase

The construction phase of the proposed 5MW Solar Photovoltaic Power Plant Project at the Federal University of Technology (FUT) Babura represents the most environmentally and socially interactive stage of the project lifecycle. This phase will extend for approximately twelve (12) months and will involve intensive civil, electrical and mechanical activities within the 10-hectare project footprint. Construction activities will include:

- Excavation and trenching for foundations and underground cable routes;
- Concrete mixing and foundation casting for mounting structures;
- Installation of photovoltaic (PV) modules and mounting frames;
- Construction of inverter stations and the renewable energy training centre;
- Installation of street lighting infrastructure;
- Upgrade of internal electricity distribution systems;
- Movement and storage of construction materials;
- Temporary workforce accommodation arrangements (if required);
- Generation and management of construction-related wastes.

Given the scale and duration of these activities, the construction phase has the greatest potential to interact with the physical, biological and socio-economic components of the existing environment as established in Chapter Four.

A. Equipment, Personnel and Plant Material Movement

The movement of personnel, construction equipment and plant materials is inevitable during this phase. Vehicles to be deployed will include heavy-duty trucks for transporting PV modules and mounting systems, cement trucks for foundation works, excavators for trenching, as well as light vehicles for supervisory and administrative staff.

i. Impact on Air Quality

Vehicular movement and equipment operation will result in the emission of combustion-related pollutants including carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO_2) and particulate matter (PM). In addition, dust emissions will arise from exposed surfaces, movement along unpaved sections of the site, excavation activities and stockpiling of sand and gravel. From the baseline study (Chapter Four), ambient air quality parameters including PM2.5, PM10, TVOC and HCHO were recorded within regulatory limits. The air shed of the project area is therefore considered relatively clean and not heavily industrialized.

During construction, the following effects may occur:

- Temporary reduction in local air quality within the project footprint;
- Increased suspended particulate matter in immediate working zones;
- Short-term exposure of workers and nearby campus users to dust.

However, emissions will remain localized within the project site and immediate surroundings. There are no densely populated residential settlements directly adjacent to the footprint. Given the intermittent nature of activities and the natural dispersion capacity of the semi-arid environment, the impact magnitude is considered medium before mitigation. With receptor sensitivity considered low to medium within the institutional setting, the overall impact significance is moderate prior to implementation of dust suppression and emission control measures.

ii. Impact on Traffic and Road Infrastructure

Construction will increase traffic frequency along access routes within the University campus and connecting public roads. Potential effects include:

- Temporary congestion during peak delivery periods;
- Increased probability of minor traffic incidents;

- Accelerated wear of internal access roads;
- Temporary obstruction during off-loading of heavy components.

The existing traffic baseline indicates moderate daytime activity due to academic and administrative operations. While the increase in heavy-duty vehicle movement may cause inconvenience, it is not expected to overwhelm road capacity. Given that construction traffic will be scheduled and controlled, the magnitude is considered low to medium. Receptor sensitivity is medium due to the academic setting and high pedestrian activity. Therefore, impact significance is moderate before mitigation.

B. Civil and Electrical Works

i. Impact on Soil Environment

Excavation for mounting structures, trenching for underground 11kV cables and foundation construction will disturb the soil profile within the project area.

The following impacts are anticipated:

- Removal and redistribution of topsoil;
- Soil compaction from heavy machinery;
- Reduction in infiltration capacity;
- Alteration of soil structure;
- Increased surface runoff during rainfall events;
- Potential localized erosion in exposed areas.

Chapter Four established that the soils within the project site are predominantly loam-clay mixtures with moderate drainage characteristics and slopes largely within 0–5%. While generally stable, these soils can be vulnerable to erosion if vegetation cover is removed during the rainy season. The magnitude of soil disturbance is considered medium due to the scale of installation and underground cable works. Receptor sensitivity is also medium because soil stability contributes to long-term structural integrity and environmental quality. Thus, the impact significance on soil during construction is moderate prior to mitigation.

ii. Impact on Terrestrial Flora and Fauna

Although initial site clearing would have removed most vegetation within the footprint, construction activities will further intensify disturbance through:

- Continuous human presence;
- Machinery operation;
- Noise and vibration;
- Night-time security lighting.

These disturbances may:

- Displace small mammals and reptiles;
- Interrupt foraging patterns of avifauna;
- Reduce microhabitat availability;
- Increase vulnerability of ground-dwelling organisms.

However, baseline ecological assessment confirmed:

- The area is a modified Sudan Savanna ecosystem;

- No endangered or IUCN-listed threatened species were identified;
- The site does not function as a migratory corridor;
- Adjacent habitats remain available for species relocation.

Given the limited ecological sensitivity of the site, receptor sensitivity is low. Impact magnitude is low to medium due to the temporary nature of disturbance. Therefore, the overall impact significance is minor to moderate prior to mitigation.

iii. Impact on Groundwater Resources

Construction may affect groundwater through:

- Accidental spills of diesel, lubricants or hydraulic fluids;
- Increased sediment transport into drainage pathways;
- Limited abstraction of groundwater for construction use.

The baseline hydrogeological study indicated:

- Groundwater quality is within regulatory limits;
- No existing contamination;
- Aquifer system is typical of basement complex terrain;
- No surface water bodies within the project footprint.

The planned abstraction for construction activities is minimal relative to the campus water supply system. Therefore, groundwater depletion risk is negligible. The main risk relates to accidental contamination. Given the controlled institutional environment and limited storage of hazardous materials, the likelihood is low. Thus, overall groundwater impact significance is minor prior to mitigation.

C. Socio-Economic and Community Health Impacts

i. Workforce Influx and Social Dynamics

Construction activities will introduce a temporary workforce, including skilled technicians, engineers and unskilled labourers. Potential impacts include:

- Temporary strain on campus services;
- Alteration of social interactions;
- Risk of behavioural misconduct;
- Potential increase in communicable diseases;
- Risk of gender-based violence if unmanaged.

However, it is anticipated that a substantial proportion of the workforce will be sourced locally from Babura and surrounding communities. This reduces influx-related pressure. Given the 12-month duration and University-controlled environment, social risk magnitude is medium. Receptor sensitivity is medium due to the academic setting and presence of young population (as shown in demographic baseline). Overall socio-economic impact significance is moderate before mitigation.

ii. Gender Impacts

There is potential for gender imbalance in employment opportunities during construction, particularly in technical and manual roles traditionally dominated by men. Possible impacts include:

- Reduced access for women to skilled construction roles;
- Reinforcement of gender stereotypes;
- Risk of economic exclusion.

However, the project includes a renewable energy training component, providing opportunity for female student participation in technical capacity building. If inclusive employment policies are implemented, gender-related impact significance can be maintained at minor to moderate.

iii. Occupational Health and Safety

Construction activities inherently carry elevated occupational risks, including:

- Falls from height;
- Electrical exposure;
- Machinery accidents;
- Heat stress due to high ambient temperatures (32–37°C recorded during baseline survey);
- Exposure to dust and noise.

Given the intensity and duration of construction activities, the magnitude of occupational risk is high prior to mitigation. Receptor sensitivity is high because worker safety directly affects human health. Therefore, impact significance on construction worker safety is moderate to major priority prior to implementation of strict safety management systems.

iv. Waste Generation and Disposal

Construction will generate:

- Solid waste (scrap metal, packaging, broken panels, wood, concrete debris);
- Liquid waste (sewage, minor quantities of used oil);
- Air emissions from machinery.

Improper waste handling may:

- Contaminate soil;
- Effect of groundwater;
- Create aesthetic impacts;
- Attract disease vectors.

However, the quantity of hazardous waste is expected to be low. PV modules and electrical components will be managed through manufacturer take-back or licensed recyclers. Thus, impact magnitude is low to medium depending on waste type. Overall significance is minor to moderate before mitigation.

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

Activity	Receptor	Associated Impact	Significance
Impacts from Equipment, Personnel and Plant Material Movement	**Air Quality**	• Emission of combustion-related gases (CO, NO_2, SO_2) from trucks, excavators and other construction vehicles operating within and around the project site. • Incremental contribution to greenhouse gas emissions from fuel combustion. • Generation of fugitive dust from vehicle movement on unpaved surfaces and exposed soils within the 10 ha project footprint.	**Minor**
	Social System (Road Infrastructure)	• Increased movement of heavy-duty trucks transporting PV modules, mounting structures, transformers and construction materials along campus access roads and adjoining public roads. • Temporary traffic congestion during delivery periods.	**Minor**
	Health and Safety	• Risk of vehicular collisions involving construction vehicles, students, staff or residents. • Risk of injury during loading and off-loading of heavy components.	**Minor**
Civil and Electrical Works / Installation Activities	**Air Quality**	• Localized increase in Suspended Particulate Matter (SPM) from excavation, trenching and stockpiling. • Exhaust emissions (NOx, CO, SOx) from operation of generators, concrete mixers and earth-moving equipment.	**Minor**
	Ambient Noise	• Elevated noise levels from operation of excavators, drilling equipment, concrete mixers and material handling equipment. • Intermittent disturbance to academic activities and minor displacement of fauna species.	**Minor**
	Soil Environment	• Disturbance and removal of topsoil during foundation works and cable trenching. • Increased erosion potential during rainfall events due to exposed surfaces. • Soil compaction reduces infiltration capacity and alters structural stability.	Moderate
	Terrestrial Flora and Fauna	• Further disturbance of modified savanna vegetation within the project footprint. • Displacement of small mammals, reptiles and avifauna due to noise and human presence. • Potential introduction of invasive plant species during landscaping or material importation.	Minor
	Groundwater Resources	• Minor abstraction of groundwater for concrete mixing and equipment washing. • Potential contamination from accidental spills of fuel, oil or lubricants.	Minor
	Gender	• Potential under-representation of women in technical and skilled construction roles.	Moderate

Activity	Receptor	Associated Impact	Significance
		• Risk of gender-based harassment or discrimination if safeguards are not enforced.	
	Socio-economic and Community Health	• Temporary influx of workers increasing pressure on campus facilities. • Risk of communicable disease transmission and social disruption if unmanaged.	Moderate
	Infrastructure (Road Network)	• Increased wear and tear on internal University access roads due to movement of heavy trucks. • Short-term traffic safety risks within campus.	Minor
	Construction Worker Safety	• Risk of occupational injuries including falls, machinery accidents, electrical hazards and heat stress.	Moderate
Waste Generation and Disposal	**Soil**	• Potential soil contamination from improper disposal of scrap metal, packaging waste, concrete residues and spent oils.	Minor
	Groundwater	• Risk of infiltration of liquid wastes (particularly hydrocarbons) into subsurface soil.	Minor
	Infrastructure (Waste Management Facility)	• Increased burden on existing campus waste handling system from domestic construction waste. • Requirement for proper management of electrical waste (cables, damaged PV modules) through approved recycling channels.	Negligible

5.5.2.3 Commissioning Phase

Upon completion of all civil, electrical and mechanical installation works, the 5MW Solar Photovoltaic Power Plant at Federal University of Technology Babura will undergo commissioning. The commissioning phase involves systematic inspection, testing and verification of all installed components to confirm compliance with design specifications, safety standards and operational performance criteria. Activities during this phase will include:

- Energization and synchronization of inverters and transformers;
- Testing of the 11kV underground transmission line;
- Functional testing of protection systems and switchgear;
- Calibration of monitoring systems and weather station equipment;
- Verification of battery storage performance;
- Final inspection by engineers, regulatory authorities and project stakeholders;
- Formal commissioning ceremony and handover.

The commissioning phase is short in duration, typically lasting between one to several days, and does not involve major ground disturbance. However, certain environmental and social interactions may occur during this stage.

A. Potential Impact on Noise

During commissioning, temporary increases in ambient noise levels may occur due to:

- Low-frequency humming from energized transformers and inverters;
- Testing of electrical equipment under load conditions;
- Movement of official vehicles transporting commissioning personnel and regulatory inspectors;
- Use of public address systems during ceremonial activities;

- Crowd-related noise during formal handover events.

Baseline noise measurements within the project area indicate generally acceptable ambient noise levels consistent with an institutional setting. The noise generated during commissioning is expected to be:

- Short-term;
- Localized within the plant boundary;
- Intermittent rather than continuous;
- Within permissible regulatory thresholds.

The inverter and transformer humming noise is characteristic of electrical installations but remains low-level and non-intrusive at standard setback distances. Given the brief duration and limited spatial extent of these activities, the magnitude of impact is considered low. With receptor sensitivity considered medium due to the academic environment, the overall impact significance is rated minor.

B. Potential Impact on Occupational Health and Safety

The commissioning phase presents specific occupational risks, particularly during electrical testing and energization. Potential hazards include:

- Electrical shocks resulting from incorrect wiring;
- Arc flash incidents;
- Equipment malfunction during load testing;
- Exposure to energized components;
- Accidental contact with live conductors.

Although systems are designed and installed according to engineering standards, the testing stage inherently involves interaction with live electrical systems. The magnitude of potential impact is considered medium due to the nature of electrical testing. Worker receptor sensitivity is high because electrical hazards pose serious injury risks. Therefore, the impact significance on workers' health and safety during commissioning is considered moderate prior to implementation of strict safety protocols.

C. Potential Impact on Public Safety

During commissioning, especially on the day of formal inauguration, there may be increased public presence including:

- University management;
- Government officials;
- Community representatives;
- Media personnel;
- Students and staff.

Potential risks to the public include:

- Accidental exposure to energized equipment if restricted areas are not properly secured;
- Electrical shock from unauthorized access;
- Trip and fall hazards within the plant area.

However, commissioning activities are conducted within a fenced and controlled facility. Public access to energized equipment areas is typically restricted. Given the short duration and institutional control

measures, the magnitude of public safety risk is low. Thus, the impact significance on the general public is rated minor.

D. Potential Impact on Infrastructure (Road Network)

The commissioning event may result in a temporary increase in vehicular movement within the University campus and along access roads due to attendance by guests and officials.

Possible effects include:

- Short-term traffic build-up at campus entry points;
- Increased demand for parking space;
- Minor congestion during peak arrival and departure times.

Given that commissioning is typically a one-day event and University roads are already designed to accommodate institutional activities, the magnitude of impact is very low. Receptor sensitivity is medium due to regular campus traffic activity; however, due to the extremely short duration of the event, the overall impact significance is considered negligible. Commissioning impacts are therefore largely short-lived, localized and manageable within standard operational controls (Table 5.8).

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

Activity	Receptor	Associated Impact	Significance
Plant Testing and Energization	**Ambient Noise Environment**	• Temporary increase in background noise levels due to energization of transformers and inverters (low-frequency humming). • Noise from operational testing of electrical systems and short-term vehicular movement associated with commissioning activities.	Minor
	Workers (Occupational Health and Safety)	• Risk of electrical shock, arc flash or electrocution during testing and synchronization of live components. • Risk of minor injuries during equipment inspection and system calibration.	Moderate
	Campus Occupants' Safety (Students and Staff)	• Potential exposure to energized components if restricted areas are not properly secured. • Risk of electrical faults leading to fire hazards in the unlikely event of improper wiring during testing.	Minor
	Population Influx (Visitors and Officials)	• Temporary increase in number of visitors, government officials and stakeholders during commissioning ceremony. • Short-term crowding within designated areas of the campus.	Negligible
	Infrastructure (Road Network within Campus)	• Slight increase in vehicular traffic during commissioning events. • Minimal risk of traffic congestion or minor road safety incidents.	Negligible

5.5.2.4 Operational Phase

The operational phase of the proposed 5MW Solar Photovoltaic Power Plant at Federal University of Technology Babura will commence after successful commissioning and handover. This phase represents the long-term lifecycle of the facility, with an estimated operational lifespan of approximately 25 years. Operational activities will primarily include:

- Electricity generation through photovoltaic conversion;
- Transmission and distribution within the University network;
- Monitoring of inverters, transformers and battery storage systems;
- Routine inspection and preventive maintenance;
- Periodic cleaning of PV modules;
- Replacement of faulty components when necessary;
- Security and facility management.

Unlike the construction phase, operational activities involve minimal physical disturbance. However, certain environmental and social interactions remain relevant and are discussed below.

A. Power Generation and Distribution

i. Potential Impact on Noise

The principal noise sources during normal operation are:

- Inverters (approximately 30–35 dB(A));
- Battery storage units (approximately 15–20 dB(A));
- Transformer humming.

These components generate low-frequency operational noise that is continuous but relatively quiet. Given the plant layout and setback distances within the 10-hectare fenced facility, projected operational noise levels are not expected to increase background levels by more than 3 dB(A) at the nearest off-site receptor. Baseline ambient noise levels within the University environment are influenced by normal academic activities and vehicular movement. The incremental contribution from the Solar Power Plant is therefore insignificant. The impact magnitude is very low, receptor sensitivity is medium (institutional setting), and the overall impact significance is considered negligible.

ii. Potential Impact on Gender

Historically, the energy sector has experienced gender imbalance, with limited female representation in technical and operational roles. During the operational phase, there is a potential risk that employment and technical training opportunities may disproportionately favor male personnel if no inclusive policy is implemented. However, the Project includes a Renewable Energy Training Centre within the facility, designed to promote technical skill acquisition among both male and female students and staff of the University. During operations:

- Both male and female personnel will be eligible for technical training;
- Employment opportunities (approximately 10–15 staff) will include administrative, technical and support roles;
- Periodic capacity building programs will be conducted.

Although the workforce size during operations will be significantly smaller than during construction, any potential discrimination or unequal access to opportunity remains a concern.
Given the institutional environment and planned inclusion measures, the impact magnitude is low and receptor sensitivity is medium. Therefore, the impact significance is regarded as minor.

iii. Potential Impact on Socio-Economic Environment and Community Health

❖ **Visual Impact**

The operational Solar PV arrays will remain visible within the designated project footprint. However:

- The site is located within university property;
- It is not situated along a designated scenic corridor or tourism route;
- The surrounding landscape is already institutional and semi-modified.

The visual profile of the PV panels and associated infrastructure will be consistent with modern energy facilities and is not expected to detract significantly from campus aesthetics. Given the location and land-use classification, the impact magnitude is very low. Receptor sensitivity is low. Therefore, visual impact significance is negligible.

iv. Potential Impact on Occupational Health, Safety and Welfare of Workers

During normal operations, workers may be exposed to:

- Electrical hazards;
- Shock risks during inspection or troubleshooting;
- Mechanical injuries during maintenance;
- Battery handling risks;
- Heat stress due to climatic conditions (high ambient temperatures in Jigawa State);
- Workplace-related issues such as unfair treatment or discrimination.

Although the number of operational staff will be relatively small (approximately 10–15 personnel), exposure to energized systems presents inherent risks. The magnitude of occupational risk during operations is lower than during construction but remains present due to electrical exposure. Worker sensitivity is high. Therefore, the impact significance on occupational health and safety during operations is considered moderate prior to mitigation and implementation of strict safety protocols.

B. Routine Maintenance, Waste Generation and Disposal

i. Potential Impact on Soil

Routine maintenance will generate limited quantities of waste, primarily:

- Damaged or degraded PV modules;
- Spent batteries (over lifecycle);
- Faulty inverters or electronic components;
- Packaging materials;
- Cleaning residues.

The most significant waste stream during the operational phase is electronic waste (e-waste). Improper handling could result in:

- Soil contamination from battery electrolytes;
- Leaching of heavy metals from damaged panels;

- Hydrocarbon contamination from minor lubricants.

However, all major components will be subject to manufacturer take-back agreements in line with Extended Producer Responsibility (EPR) principles. Temporary on-site storage will be conducted in designated, secure areas. Given the relatively low frequency of component replacement and controlled handling procedures, the impact magnitude is low. Soil receptor sensitivity is medium. The overall impact significance is minor.

ii. Potential Impact on Groundwater

Groundwater abstraction during operations will primarily be associated with:

- Cleaning of PV panels, particularly during the dry season.

Based on operational estimates:

- Approximately 5 litres of water per panel cleaning cycle;
- Cleaning frequency higher during dry season due to dust accumulation;
- Water sourced from boreholes within the Project site.

Considering:

- The relatively small volume compared to total campus groundwater abstraction;
- Seasonal recharge during rainy season;
- Absence of major surface water bodies within the footprint;

The potential reduction in groundwater reserves is minimal. Therefore, impact magnitude is low, receptor sensitivity is medium, and the impact significance is considered minor.

iii. Occupational Health and Safety During Routine Maintenance

Maintenance activities involve:

- Electrical inspections;
- Cleaning of panels;
- Replacement of components;
- Occasional troubleshooting.

Workers may be exposed to:

- Electrical shock hazards;
- Fall risks during panel cleaning;
- Minor mechanical injuries.

Given the limited workforce and scheduled nature of maintenance activities, exposure frequency is low. Thus, impact magnitude is low and overall significance is minor.

The operational phase is therefore characterized by negligible impacts on ambient noise, EMF and visual quality, minor impacts on soil and groundwater, moderate significance for occupational health and safety prior to mitigation, and minor gender and socio-economic risk (Table 5.9).

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

Activity	Receptor	Associated Impact	Significance
Power Generation and Distribution	**Noise Environment**	• Continuous low-level operational noise from inverters, transformers and battery storage systems during electricity generation and transmission.	Negligible
	Gender	• Potential under-representation of women in operational and technical roles. • Risk of workplace discrimination, sexual harassment or unequal working conditions if safeguards are not enforced.	Minor
	Socio-economic (Visual Character)	• Presence of PV arrays and associated infrastructure resulting in minor alteration of the visual landscape within the University campus.	Negligible
	Socio-economic (Community Health)	• Extremely low-frequency electromagnetic field (EMF) emissions from PV modules, inverters and underground transmission lines, with potential perceived health concerns.	Negligible
	Health, Safety and Welfare of Operational Staff	• Risk of electrical shock, arc flash or mechanical injuries during routine monitoring and troubleshooting. • Potential workplace-related issues such as discrimination or unfair labour practices.	Moderate
Routine Maintenance, Waste Generation and Disposal	**Soil**	• Potential soil contamination from improper handling or storage of spent batteries, faulty inverters or damaged PV modules (e-waste).	Minor
	Groundwater	• Minor groundwater abstraction for periodic cleaning of PV panels, particularly during dry season.	Minor
	Soil and Groundwater Quality	• Risk of localized soil and groundwater contamination from accidental spills of lubricants or battery electrolytes during maintenance activities.	Negligible
	Health, Safety and Welfare of Maintenance Staff	• Electrical hazards and minor mechanical injuries during inspection, cleaning and component replacement activities.	Minor

5.5.3 Potential Cumulative Impacts

Cumulative impacts refer to environmental or social effects that arise from the incremental interaction of the proposed Project with other past, existing or reasonably foreseeable developments within the same area of influence. These impacts may not be significant when considered in isolation; however, when combined with other stressors, they may contribute to measurable changes in environmental quality or socio-economic conditions. The principle underlying cumulative impact assessment recognizes that environmental systems have threshold limits. Even minor additional disturbances may trigger disproportionate effects when receptors are already under pressure. Therefore, evaluation of cumulative effects is essential to ensure long-term sustainability of environmental and social resources.

For the proposed 5MW Solar Photovoltaic Power Plant at Federal University of Technology Babura, the assessment of cumulative impacts considered:

- Existing University infrastructure and operations;
- Ongoing campus expansion projects;

- Vehicular activities along access roads;
- Current groundwater abstraction within the campus;
- Regional climatic conditions and environmental background stressors.

Based on review of baseline data and field observations, the following cumulative interactions were considered:

5.5.3.1 Cumulative Impact on Road Traffic

The University environment already experiences daily vehicular movement from staff, students and service providers. During construction and commissioning, project-related traffic adds temporarily to this baseline. However, during the operational phase, traffic generation is minimal due to the limited number of operational staff. No major industrial developments are occurring simultaneously within the immediate vicinity of the Project site. Given the short-term nature of construction traffic and the low operational traffic intensity, the cumulative impact on road infrastructure and traffic congestion is considered low.

5.5.3.2 Cumulative Impact on Ambient Noise

The project site is located within an institutional setting where background noise arises from academic activities, vehicular movement and minor construction works. Operational noise from the Solar Power Plant (primarily inverter and transformer humming) is extremely low and localized. When combined with existing campus noise levels, the incremental contribution is negligible. Therefore, cumulative noise impacts are considered low.

5.5.3.3 Cumulative Impact on Groundwater Availability

Groundwater abstraction within the University campus currently supports domestic and institutional use. The Project will require limited groundwater abstraction, primarily for periodic cleaning of PV modules. Given:

- The modest volume of water required per cleaning cycle;
- Seasonal recharge during rainy season;
- Absence of major competing industrial water users within the immediate project area;

The additional demand from the Solar Power Plant is not expected to significantly influence groundwater levels. Hence, cumulative impact on groundwater availability is assessed as low. Overall, the nature, scale and footprint of the proposed Solar PV Project do not introduce significant additive stress to existing environmental systems. The potential cumulative impacts associated with road traffic, ambient noise and groundwater abstraction are therefore considered low and manageable.

5.5.3.4 Risk and Hazard Assessment

Risk assessment involves systematic identification, evaluation and analysis of hazards that may arise from project activities and determining the likelihood and severity of associated consequences. It provides a structured basis for developing preventive and control measures to minimize adverse outcomes. For the proposed Solar Power Plant, risk and hazard assessment was undertaken across all project phases, including pre-construction, construction, commissioning, operation and decommissioning.

The process included:

- Identification of potential hazards linked to civil works, electrical installations, equipment operation and maintenance;
- Evaluation of the probability of occurrence of identified hazards;
- Assessment of potential consequences in terms of injury, environmental damage, asset loss or service disruption;
- Categorization of risk levels to guide mitigation planning.

Key hazard categories identified include:

A. Electrical Hazards

- Risk of electrocution during installation and testing;
- Arc flash incidents during energization;
- Fault-induced fire outbreaks;
- Battery-related electrical hazards.

These risks are more prominent during commissioning and maintenance phases.

B. Occupational Safety Hazards

- Falls from height during panel installation;
- Machinery-related injuries during excavation;
- Manual handling injuries;
- Heat stress due to high ambient temperatures in Jigawa State;
- Slips and trips within the plant area.

These risks are most significant during construction.

C. Environmental Hazards

- Fuel or lubricant spills during construction;
- Improper disposal of e-waste during operations;
- Soil erosion from exposed surfaces;
- Accidental groundwater contamination.

D. Community and Infrastructure Risks

- Traffic-related accidents during material transport;
- Fire outbreak within electrical installations;
- Unauthorized access to energized equipment.

Risk levels were determined by considering, likelihood of occurrence (rare, unlikely, possible, likely), severity of consequence (minor injury, major injury, fatality, environmental damage, service disruption). The assessment indicates that most identified risks fall within low to moderate categories when appropriate engineering controls, safety procedures and regulatory compliance measures are implemented. A detailed Risk Assessment Matrix and corresponding mitigation measures are presented in Chapter Seven as part of the Environmental and Social Management Plan (ESMP).

Table 5.10: Risk Assessment Matrix

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

(Source: Adapted from Adelaide Hills council- Example Risk Assessment Template)

5.5.4 Project-Specific Risks and Hazards

Beyond routine environmental and social impacts assessed earlier, the proposed 5MW Solar Photovoltaic Power Plant presents specific operational and technical risks that require targeted management. These risks are primarily associated with electrical systems, battery storage units, and occupational activities within the facility.

5.5.4.1 Fire and Explosion

One of the principal hazards associated with solar photovoltaic installations is fire risk arising from electrical faults. Although PV systems do not involve combustion processes during normal operation, they are electrical installations and therefore subject to potential faults such as:

- Short circuits;
- Ground faults;
- Reverse currents;
- Loose or degraded connections;
- Insulation failure;
- Arc faults within DC circuits.

Fault conditions may generate localized overheating (hotspots), which can ignite adjacent combustible materials such as cable insulation, packaging remnants or vegetation if not properly controlled. The project includes battery storage systems (Hoppecke lead-acid batteries in the initial phase). Although lead-acid batteries present lower thermal runaway risks compared to lithium-ion systems, hazards may still arise from:

- Hydrogen gas accumulation during charging;

- Improper ventilation;
- Overcharging conditions;
- Internal short circuits;
- Electrolyte leakage.

Failure within inverter units or transformer components may also generate overheating and fire hazards if protective relays fail to operate correctly. An uncontrolled fire within the plant could:

- Damaged electrical infrastructure;
- Interrupt power supply to the University;
- Pose safety risks to staff;
- Escalate if not contained promptly.

Given the presence of high-voltage equipment and battery storage systems, and considering worst-case scenarios, this hazard is classified as high risk prior to mitigation. However, with installation of fire detection systems, surge protection, grounding systems, and strict electrical compliance standards, residual risk will be significantly reduced.

5.5.4.2 Electrocution

The Solar Power Plant operates at medium voltage levels (including 11kV transmission and inverter output systems). Direct or indirect contact with energized components may result in:

- Electrical shock;
- Severe burns;
- Cardiac arrest;
- Secondary injuries from falls.

Electrocution risks may occur during:

- Maintenance activities;
- Fault troubleshooting;
- Equipment testing;
- Unauthorized access to restricted areas.

While plant design incorporates grounding systems, circuit breakers, protective relays and insulated enclosures, human error remains a potential risk factor. Given that the facility is fenced and access-controlled, and only trained personnel will operate the system, the likelihood of occurrence is low. However, the severity of consequences is high. Therefore, electrocution is classified as moderate risk prior to mitigation.

5.5.4.3 Occupational Hazards

Occupational hazards are most significant during construction but remain relevant during operations and maintenance.

Construction-related risks include:

- Falls from height during installation of PV modules;
- Injuries from heavy equipment operation;
- Manual handling injuries;
- Heat stress due to high ambient temperatures in Jigawa State;
- Exposure to dust and noise.

Operational and maintenance-related hazards include:

- Electrical exposure during inspection;
- Mechanical injuries during equipment servicing;
- Slips, trips and falls within the plant area;
- Battery handling risks;
- Prolonged exposure to outdoor working conditions.

Electrical accidents may lead to:

- Shock and burns;
- Involuntary muscle contraction;
- Secondary trauma from falls.

Given the technical nature of the plant and the requirement for skilled operation, the probability of occurrence is considered fair if safety protocols are not strictly enforced. However, with implementation of occupational health and safety management systems, risk levels are manageable. This hazard category is therefore classified as moderate risk prior to mitigation.

5.6 Summary of Anticipated Impacts

The assessment of environmental and social impacts across all project phases indicates that the proposed 5MW Solar Photovoltaic Power Plant at Federal University of Technology Babura will generate predominantly positive impacts, particularly in terms of:

- Improved electricity reliability;
- Reduced reliance on diesel generators;
- Lower greenhouse gas emissions;
- Enhanced institutional productivity;
- Capacity development through renewable energy training;
- Employment and skill acquisition opportunities.

However, certain negative impacts and project-specific risks have been identified, including:

- Occupational injuries during construction;
- Electrical hazards during commissioning and operations;
- Potential gender imbalance in employment opportunities;
- Soil disturbance and erosion during civil works;
- Minor groundwater abstraction during operations;
- Risk of fire associated with electrical faults;
- Temporary socio-economic disturbances during construction.

Most environmental impacts are short-term, localized and reversible. The most significant risks relate to occupational health and electrical safety. These risks can be effectively managed through implementation of:

- Engineering controls;
- Strict adherence to electrical standards;
- Fire detection and suppression systems;
- Occupational health and safety procedures;

- Gender inclusion policies;
- Environmental management measures.

The mitigation measures outlined in Chapter Six and the Environmental and Social Management Plan (ESMP) in Chapter Seven will reduce adverse impacts to the lowest practicable level while enhancing identified positive outcomes.

Table 5.11: Summarized Environmental and Social Impacts of Solar Power Plant

Direct Impacts	Indirect Impacts	Cumulative Impacts
Environmental Impacts		
• Reduction in noise and air pollutants from diesel generator sets previously used within the University. • Decrease in fossil fuel consumption and associated greenhouse gas (GHG) emissions. • Reduced carbon emissions contributing to Nigeria's Energy Transition objectives. • Land use modification within the 10-hectare project footprint. • Temporary soil disturbance during civil works and installation. • Localized air, soil and water quality impacts during construction. • Generation of battery and electronic waste (end-of-life components). • Increased erosion susceptibility during land clearing and excavation. • Occupational health and safety risks to workers during construction and operation.	• Improved environmental quality due to reduced reliance on petrol and diesel generators. • Reduced indoor and outdoor air pollution within campus environment. • Improved campus environmental sustainability profile. • Enhanced energy efficiency practices within the University. • Strengthened institutional climate change mitigation initiatives.	• Long-term reduction in cumulative greenhouse gas emissions from institutional energy use. • Reduced cumulative noise pollution across campus. • Minimal incremental demand on groundwater resources for panel cleaning. • Limited cumulative impact on biodiversity due to modified savanna ecosystem and absence of sensitive habitats.
Social Impacts		

Direct Impacts	Indirect Impacts	Cumulative Impacts
• Extended hours of reliable lighting for academic and administrative activities. • Improved learning environment and research productivity. • Enhanced campus security through installation of street lighting. • Creation of employment opportunities during construction and operation. • Capacity building through Renewable Energy Training Centre. • Potential temporary access restrictions within construction zones. • Occupational health and safety risks to workers.	• Reduction in expenditure on diesel and generator fuel, allowing reallocation of institutional funds to academic development. • Stimulation of small-scale economic activities within and around the University due to improved power supply. • Increased access to ICT infrastructure (internet, communication systems, research equipment). • Promotion of gender inclusion in renewable energy training and employment opportunities.	• Long-term improvement in educational service delivery and institutional reputation. • Contribution to regional socio-economic development through energy stability. • Potential social tensions if employment and procurement opportunities are not transparently managed. • Enhanced energy equity within the University community.

CHAPTER SIX
MITIGATION MEASURES

6.1 Introduction

This chapter outlines the mitigation measures proposed to address the associated and potential environmental and social impacts identified for the proposed 5MW Solar Photovoltaic Power Plant Project at Federal University of Technology (FUT) Babura, Jigawa State. The mitigation framework is derived from the impact assessment presented in Chapter Five and is guided by a structured risk evaluation process. A comprehensive Risk Assessment Matrix (as conceptually illustrated in Figure 6.1) was applied to determine the level of mitigation required for each identified impact. The assessment considered multiple determining factors, including:

- Frequency of occurrence;
- Severity of consequence;
- Sensitivity and value of affected receptors;
- Spatial scale of impact;
- Duration and reversibility;
- Legal and regulatory compliance requirements;
- Institutional reputation and public perception;
- Economic implications;
- Communication risks and grievance potential.

Mitigation measures have been developed to ensure that adverse environmental and social impacts are prevented, minimized, controlled or offset to levels that are **As Low As Reasonably Practicable (ALARP)**. In determining appropriate mitigation measures, the following considerations were considered:

- Availability of technical expertise and institutional capacity within FUT Babura;
- On-site environmental conditions and baseline characteristics;
- Applicable national and international environmental standards;
- Stakeholder concerns raised during consultation;
- Feasibility, cost-effectiveness and sustainability of proposed controls.

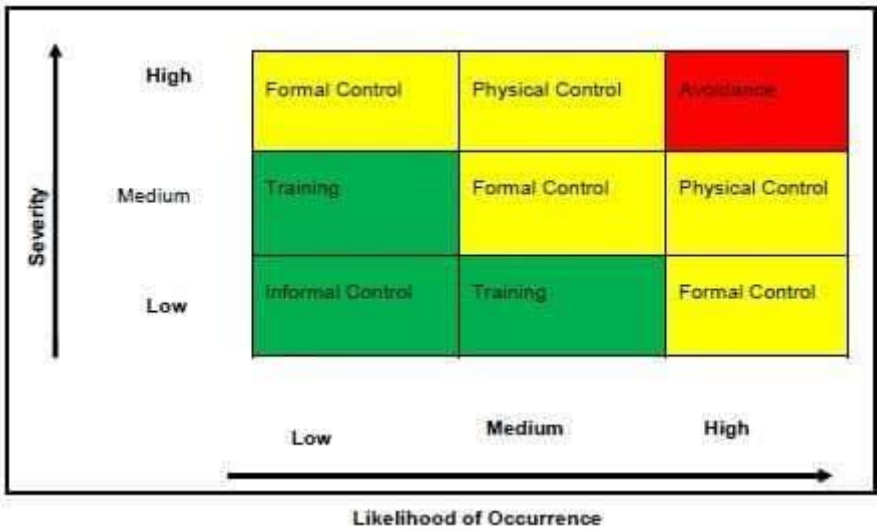

Figure 6. 1: Matrix for Determination of Mitigation Measures

6.2 Mitigation Measures and Approach

Mitigation in the context of this Environmental and Social Impact Assessment (ESIA) refers to structured interventions designed to eliminate, reduce, manage or compensate for adverse impacts associated with project implementation. The mitigation hierarchy adopted for the proposed Solar Power Plant follows internationally recognized best practice and is summarized as follows:

- **Anticipate and Avoid:** Identify potential environmental and social risks at planning stage and prevent them from occurring through appropriate design and siting decisions.
- **Minimize or Reduce:** Where avoidance is not feasible, implement engineering, administrative or operational controls to reduce impacts to acceptable levels.
- **Mitigate:** Apply corrective or management measures to address impacts that cannot be entirely minimized.
- **Compensate or Offset:** Where significant residual impacts remain after mitigation, provide appropriate compensation or offset measures, where technically, legally and financially viable.

This hierarchical approach ensures that mitigation measures are proactive rather than reactive and are integrated into project planning, construction, operation and eventual decommissioning. The following sections provide phase-specific mitigation measures for:

- Pre-construction activities;
- Construction phase impacts;
- Commissioning activities;
- Operational phase impacts;
- Decommissioning phase considerations;
- Project-specific risk management (fire, electrocution and occupational hazards).

Table 6.1: Summary of Mitigation Approaches for the 5 MW Solar-Hybrid Power Plant Project at FUT Babura

Project Phase	Mitigation Hierarchy	Approach
Project Design Phase	**Avoidance and Minimization**	• Micro-siting of the solar PV arrays, Battery Energy Storage System (BESS), substation and ancillary facilities within the allocated 10-hectare University land to avoid unnecessary disturbance of savanna vegetation and grazing paths. • Optimization of internal layout to reduce vegetation clearance and soil compaction. • Routing of the 11 kV underground transmission cable along existing access corridors within the University to prevent additional land disturbance. • Design of perimeter fencing and access roads to prevent fragmentation of adjacent land uses and to control livestock intrusion.
Construction Phase	**Avoidance**	• Scheduling of vegetation clearance and earthworks outside peak rainy season where practicable to reduce erosion risks. • Programming of noisy activities during daytime working hours to minimize disturbance to campus academic activities and nearby communities.
	Minimization	• Implementation of dust suppression measures (controlled watering of exposed surfaces where required). • Noise control through proper maintenance of machinery and use of low-noise equipment. • Establishment of designated laydown areas to prevent unnecessary land degradation. • Installation of temporary erosion control measures such as drainage channels and sediment traps. • Controlled vegetation clearing strictly within the demarcated footprint. • Enforcement of contractor Environmental, Health and Safety (EHS) procedures. • Timely conclusion of construction activities to avoid delays and quicken recovery or restoration process.
	Restoration and Rehabilitation	• Progressive rehabilitation of temporarily disturbed areas following completion of civil works. • Re-vegetation of exposed soils using native Sudan/Sahel Savanna species to reduce erosion and restore ecological stability. • Restoration of any damaged campus infrastructure (roads, drainage, utilities) to pre-construction condition or better.
Operational Phase	**Minimization**	• Engineering controls to ensure inverter and battery noise emissions remain within permissible limits. • Regular inspection and maintenance of lithium-ion BESS units to prevent leakage, overheating or fire risks. • Implementation of water conservation measures during panel cleaning to prevent over-abstraction of groundwater. • Routine vegetation management to prevent fire hazards and shading of PV modules. • Controlled access to operational areas to reduce occupational and public safety risks.
	Abatement Controls	• Proper management of operational wastes including damaged PV modules, inverters and batteries under Extended Producer Responsibility (EPR) agreements.

Project Phase	Mitigation Hierarchy	Approach
		• Spill prevention and containment measures for oils and lubricants used in maintenance activities.
End-of-Life / Decommissioning Phase	**Avoidance**	• Scheduling decommissioning activities to avoid disruption to academic sessions and sensitive ecological periods where relevant.
	Minimization	• Controlled dismantling of PV modules, mounting structures and electrical systems to reduce dust, noise and material waste. • Segregation and safe transportation of recyclable materials and hazardous waste (e.g., batteries) to certified facilities.
	Restoration and Rehabilitation	• Removal of all above-ground infrastructure unless retained for reuse. • Backfilling of trenches and stabilization of soils. • Reinstatement of vegetation cover using native species where feasible. • Restoration of the site to an environmentally stable condition consistent with future land-use planning by FUT Babura.

In developing mitigation measures for the identified adverse environmental and social impacts discussed in Chapter Five, priority was accorded to preventive strategies that eliminate impacts at source. Where complete avoidance was not technically feasible, practical and cost-effective control measures based on established best available technologies and good international industry practice were recommended to reduce the magnitude and significance of the impacts. In situations where residual impacts may persist after implementation of avoidance and minimization measures, restoration, rehabilitation or compensation mechanisms were considered as secondary or last-resort options.

The mitigation measures outlined in Table 6.2 have therefore been designed to ensure that all identified negative impacts associated with the proposed 5 MW Solar Photovoltaic Power Plant Project at the Federal University of Technology, Babura, Jigawa State are reduced to levels that are environmentally acceptable and socially manageable. With proper implementation, monitoring, and enforcement through the Environmental and Social Management Plan (ESMP), the residual impacts of the Project are expected to range from negligible to minor significance. Furthermore, based on the baseline environmental conditions, impact assessment outcomes, and proposed management controls, there are no anticipated long-term adverse impacts associated with the Project that cannot be effectively mitigated to acceptable residual levels. The Project is therefore considered environmentally and socially sustainable, provided that the recommended mitigation and monitoring measures are diligently implemented throughout its life cycle.

Table 6. 2: Mitigation Measures for the Potential Negative Impacts of the proposed Project

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Pre-construction Phase					
Site clearing and preparation	Terrestrial flora and fauna	• Vegetation loss • Direct impacts on vegetation and soil dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project site and faming land	Minor	• Vegetation clearing shall be limited to the areas within the site needed for the Project. • The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited. • Bush burning shall be avoided. • Use of herbicides for site clearing shall be avoided. • Any cleared areas which are not used will be re- vegetated using plants or seeds of locally occurring species. • Workers should be sensitized on ecological protection.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Soil	• Removal of top soil and soil compaction associated with site clearing • Loss of top soil • Increased erosion potential • Reduction in structural stability.	Minor	• Removal of vegetation and soil cover shall be restricted to the areas required for the Project. • Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas. • Disturbed areas will be rehabilitated as soon as possible to prevent erosion. • The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited. • Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	Negligible
	Air quality and noise	• Increase in ambient noise levels • Air quality impacts due to emission from site clearing equipment	Minor	Site clearing equipment / machinery shall be operated and maintained under optimum fuel-efficient conditions. • Noise suppression equipment shall be fitted on machinery. • Site clearing equipment shall be turned off when not in use. • Equipment/ machinery with lower sound power levels shall be selected and used for site clearing.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor	• Site clearing shall be limited to the daytime as much as possible. • Unregistered labourers and touts shall not be engaged for off-loading materials • 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 them duties.	Negligible
Mobilization of personnel, materials and equipment to site	Air quality and noise	• Air quality impacts from vehicular emissions • Increase in ambient noise levels	Minor	• Construction vehicles with efficient engine performance and with minimal noise and air emissions shall be selected and used. This can be achieved through regular service and maintenance. • All materials with potential to result in dust emissions shall be covered during transport. • Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h to reduce dust generation.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Infrastructure (road)	• Increase in vehicular movement and traffic around the project site; • Potential for road accident.	Minor	• A traffic management plan (TMP) shall be developed by the EPC Contractor and implemented. • Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided. • Project-related vehicles shall be regularly serviced and maintained. • 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. • 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. • Alternative access routes to the Project with less traffic and environmental footprints should be assessed and used.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Workers Safety	• Injuries and accidents to workers during loading and off-loading construction materials.	Minor	• Mobilization of materials shall be limited to the daytime as much as possible. • Provision of adequate PPE, especially gloves and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties. • Unregistered labourers and touts shall not be patronised for off-loading materials. • The site shall be secured with perimeter fencing and/or security. • Sanitary amenities and potable water shall be provided.	Negligible

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Construction Phase					
Civil and Electrical Works/ Installation Activities	Soil	• Increased erosion potential as a result of construction activities such as excavation	Moderate	• Excavation works shall not be executed under aggressive weather conditions. • Stockpiles shall be appropriately covered to reduce soil loss because of wind or water erosion. • Disturbed areas shall be rehabilitated with erosion control plants (using native plant species) as soon as possible to prevent erosion. • Work areas should be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint. • Installation of palisade fence during the construction phase to reduce any erosion potential	Minor

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Air Quality	• Air quality impacts due to emission from construction equipment • Increase in dust from cleared land and windblown stockpiles	Moderate	• Regular maintenance and servicing of construction equipment /machinery shall be ensured. • Only modern and well-maintained equipment and machinery shall be used for construction activities. • Routine water sprinkling shall be carried out to minimize dust generation during construction.	Negligible
	Ambient Noise	• Increase in noise level due to construction activities; • Disturbance to local environment or neighbouring community	Minor	• Construction activities shall be limited to daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). If noisy activities are undertaken outside of the specified working hours, all noise receptors in the Project area shall be informed of such activities in advance. • Construction machinery shall be turned off when not in use. • Machinery/equipment to be used for construction work shall meet industry's best standard in relation to noise attenuation. • Construction equipment should be properly maintained and serviced.	Negligible

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				• Noise complaints related to the construction activities shall be assessed and appropriately addressed. Noise monitoring at locations with persistent noise complaints shall be maintained.	
	Groundwater	• Increased runoff from hard standing areas could result in creation of drainage lines, which could impact on site infrastructure. • Groundwater may be impacted because of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks.	Minor	• The EPC Contractor will be required to design appropriate drainage system that takes due regard of the natural drainage system; • Where roads intersect natural, defined drainage lines, suitably sized pipe culverts or drive through causeways shall be installed or constructed; • Fuel, oil and used oil storage areas will be contained in bunds of 110 per cent capacity of the stored material; • The potential groundwater reserve of the project site will be further assessed by the EPC contractor prior to construction activities; • Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of at a registered landfill site. • Waste receptacles shall be provided within a	Negligible

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				secure area for collection of solid waste. • Construction vehicles and equipment will be serviced regularly and will be serviced off site.	

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Terrestrial Flora and Fauna	• 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. • Loss of fauna as a result of increased human activity and associated noise.	Minor	• Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities. • All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimise introduction of alien species. • Regular monitoring will be undertaken to ensure that alien plants are not increasing because of the disturbance that has taken place. • Hunting or deliberate killing of animals by construction workers shall be prohibited and monitored. • 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

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Infrastructure (road)	• Road damage, traffic and safety impacts.	Minor	• A TMP or Journey Management Guide (JMG) shall be developed by the EPC Contractor and implemented. • Speed limits for all construction-related vehicles should be established and enforced. • Construction-related vehicles shall be regularly serviced and maintained. • Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active. • Drivers' competency shall be assessed and where required training shall be provided. • A procedure for recording all construction related traffic incidents/accidents shall be	Negligible
				developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc. • A Grievance Redress Mechanism (GRM) shall be implemented for receiving complaints arising from damage to infrastructure and private property during construction activities. The EPC contractor shall receive the complaints and repair damages as quickly as possible.	

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working)	Minor	• Equal treatment of workers shall be ensured. • The GBV Action Plan shall be implemented for the Project • All workers on the project shall be required to sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) • GBV sensitive channels for reporting in GRM shall be implemented for the Project • The EPC Contractor shall be required to hire a Gender/GBV officer. • Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured. • All workers shall be required to undergo regular training and refreshers on GBV • The EPC Contractor shall provide separate facilities for men and women and add GBVfree signage at the project site. • All gender-based violence incidents shall be reported and dealt with as per the law.	Negligible

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Construction workers safety	• Injury to construction workers during construction activities.	Moderate	• Health and Safety Plan shall be developed and implemented. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence. • Construction workers shall be sensitized and monitored on the need to be safety conscious. • Daily toolbox talks prior to commencement of work activities shall be carried out. • Construction activities shall be limited to daytime as much as possible. • Onsite safety officers shall be engaged to monitor the compliance of workers to safety rules. • Proper safety signs and signage shall be placed at strategic locations within the site. • PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored. • Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers.	Minor

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				• A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented. • The site shall be secured with perimeter fencing and/or security. • Sanitary amenities and potable water shall be provided	
	Socio-economic and health	• Influx of people, increase in sexual transmitted diseases.	Moderate	• Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible. • No person under the age of 18 shall be engaged to work on the project. The EPC Contractor shall ensure that children and minors are not employed directly or indirectly on the project • An induction and sensitization programme, including a Code of Conduct (CoC), 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. • Awareness education about GBV/ SEA, HIV/	Minor

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				AIDS and other sexually transmitted diseases should be created among the workforce and extended to the local community. • The CoC shall include provisions to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse by workers within the local community. • Public access shall be restricted to construction areas via security fencing and appropriate signage. • Substance abuse prevention and management programs should be implemented for workers. • Sanctions (e.g., suspension and dismissal) should be introduced for workers involved in criminal activities. • Procedure for receiving and addressing community concerns shall be developed and implemented.	

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Waste Disposal and Generation	Soil	• Soil contamination from solid and liquid construction waste streams.	Minor	• Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. • Portable spill containment and clean-up kits shall be available onsite. • Construction workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Negligible
	Infrastructure (waste management facility)	• E-waste generation • Disposal of construction wastes to existing waste management facility in the Project area.	Minor	• A Waste Management Plan developed shall be reviewed and implemented by the EPC Contractor • Training shall be provided for workers on safe storage, use and handling of e-waste on site. • E-waste generated shall be stored in appropriate locations prior to recycling and/or disposal • Waste receptacles shall be provided within a secure area for collection of solid waste. • Construction vehicles and equipment should be serviced regularly.	Negligible

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Groundwater	• Groundwater contamination	Minor	• Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site. • Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. • Portable spill containment and clean-up kits shall be available onsite. • Waste management plan (WMP) shall be implemented. • Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. • Construction waste, as much as practicable, shall be reused or recycled. • Waste that cannot be reused or recycled shall be disposed of at an approved dumpsite.	Negligible
Commissioning Phase					

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Plant Testing	Ambient noise	• Increase in ambient noise level	Minor	• The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer's recommendations. • Strict compliance with the Standard Operating Procedures shall be ensured. • The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation.	Negligible

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Workers	•Occupational and health hazards (eg., electrocution, wrong electrical connection)	Moderate	• Plant testing shall be carried out by experienced personnel. • Adequate PPE shall be worn. • The Project components shall be installed in line with the pre-established standards and as per manufacturer's recommendations. • The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project. • Strict compliance with the Standard Operating Procedures (SOPs) shall be ensured. • Prior to the Plant commissioning, appropriate emergency equipment (such as first aid boxes, fire extinguishers) shall be provided onsite. • Plant testing shall be restricted to the daytime. • The site shall be secured with perimeter fencing and/or security. • Sanitary amenities and potable water shall be provided.	Negligible

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Campus Occupants' safety	• Wrong electrical connection leading to explosion/fire.	Minor	• Plant testing shall be carried out by experienced personnel. • Strict compliance to the SOPs shall be ensured. • Prior to the project commissioning, appropriate emergency equipment (such as first aid boxes, fire extinguishers) shall be provided onsite. • Plant testing shall be restricted to the daytime.	Negligible
Operational Phase					
	Health, safety and welfare of staff during Plant operation	• Electric shock, injuries to personnel associated with the Power Plant operations, • Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions	Moderate	• Appropriate PPE shall be provided for workers. • Training shall be provided to employees on emergency preparedness and responses. • Provision of medical insurance scheme for employees shall be ensured. • Appropriate safety signage shall be placed at strategic locations within the site. • Strict compliance to the SOPs / code of conduct shall be ensured. A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.	Minor

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working)	Moderate	• Equal treatment of workers shall be ensured with Continuous implementation of GBV action plan for the Project. • All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/ Sexual • Exploitation and Abuse (GBV/ SEA) GBV sensitive channels for reporting in • GRM shall be implemented for the Project The O&M Contractor shall be required to hire a Gender/GBV officer. • Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained. • All workers shall be required to undergo regular training and refreshers on GBV • The O&M Contractor shall provide separate facilities for men and women and add GBV free signage at the project site. • All gender-based violence incidents shall be reported and dealt with as per the law.	Minor

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Routine Maintenance, Waste Generation and Disposal	Soil	• Soil contamination from used/spent batteries and inverters.	Minor	• General housekeeping to ensure the site is not overgrown with grasses shall be maintained • Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. • General waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. • WMP shall be developed by the O&M Contractor and implemented. • Burning of waste shall be prohibited. Damaged/ expired Lithium-ion batteries, • solar panels, inverters and electric components shall be returned to the manufacturer based on the EPR model. Prior to returning them to the manufacturers, they will be stored on impermeable surfaces within the site.	Negligible
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor	• Appropriate PPE shall be provided for workers. • Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. • Strict compliance with the SOPs shall be ensured.	Negligible

Project Activities	Receptors	• Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Groundwater	• Groundwater abstraction from cleaning of PV panels	Minor	• Water management plan shall be implemented • Manual cleaning of the PV panels with water shall be regulated as much as practicable. The frequency of cleaning PV panels with water shall be dependent on the rainfall pattern in the project area. • Periodic monitoring of groundwater resources in the Project's area of influence shall be implemented.	Negligible

CHAPTER SEVEN
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 Introduction

This section presents the Environmental and Social Management Plan (ESMP) for the proposed 5 MW Solar Photovoltaic Power Plant Project at the Federal University of Technology (FUT), Babura, Jigawa State. The ESMP outlines the structured framework of mitigation, monitoring, institutional responsibilities, and reporting mechanisms required to manage and control the environmental, occupational health and safety, and social risks associated with the Project throughout its life cycle. The ESMP provides practical measures to avoid, reduce, minimize, or compensate for adverse impacts identified during the Environmental and Social Impact Assessment (ESIA). It establishes institutional arrangements, monitoring schedules, performance indicators, reporting procedures, and estimated budget provisions necessary for effective implementation.

The ESMP addresses the following components:

- Types of identified environmental and social impacts and corresponding mitigation measures;
- Environmental and Social Mitigation Measures;
- Environmental Code of Practice (to be incorporated into bidding documents and contractual agreements);
- Environmental and Social Monitoring Plan;
- Communication, reporting, and documentation procedures;
- Estimated cost of ESMP implementation;
- Integration of ESMP provisions into project contracts and procurement documents;
- Grievance Redress Mechanism (GRM);
- Stakeholder and Community Engagement Plan covering pre-construction, construction, operation, and decommissioning phases, including community mobilization strategies from social and commercial perspectives.

Building upon the acquired baseline data, impact assessment presented in Chapter Five and mitigation strategies outlined in Chapter Six, this section elaborates detailed management measures and monitoring requirements corresponding to each identified impact. Mitigation measures are designed to eliminate or reduce adverse impacts to acceptable levels, while monitoring provides a systematic process for verifying the effectiveness of these measures and ensuring compliance with applicable regulatory standards and safeguard requirements.

7.2 Objectives of the ESMP

The primary purpose of the Environmental and Social Management Plan (ESMP) is to ensure that environmental and social impacts identified during the ESIA process are properly managed during the pre-construction, construction, operation, and decommissioning phases of the proposed 5 MW Solar Photovoltaic Power Plant Project. The ESMP defines the mitigation and management

commitments of the Project Proponent and provides a structured mechanism through which institutional capacity, financial resources, and operational procedures will be mobilized to implement these commitments effectively.

The ESMP is intended to function as a dynamic and adaptive management tool. It will be periodically reviewed and updated during detailed design, construction, and operational stages to support continuous environmental and social performance improvement.

The specific objectives of the ESMP are to:

- Promote sound environmental and social management practices throughout the Project lifecycle and clearly communicate ESMP goals to all stakeholders;
- Ensure that all employees, contractors, subcontractors, and affiliated personnel comply with applicable environmental, occupational health and safety, and social safeguard requirements, including statutory and regulatory obligations;
- Integrate environmental and social considerations into project planning, engineering design, procurement, and operational procedures;
- Provide a structured action plan for implementing mitigation measures identified in the ESIA;
- Establish clear institutional roles and responsibilities for ESMP implementation;
- Provide a monitoring framework for evaluating environmental and social performance;
- Ensure adequate financial provisions are made for ESMP implementation and compliance;
- Facilitate transparent communication with regulators, stakeholders, and affected communities;
- Provide a structured grievance redress mechanism to address complaints and concerns in a timely and transparent manner.

7.3 Environmental and Social Management Measures

The environmental and social management measures proposed for the 5 MW Solar Photovoltaic Power Plant Project at the Federal University of Technology (FUT), Babura, Jigawa State are structured to address the potential impacts identified in Chapter Five and the mitigation hierarchy outlined in Chapter Six. These measures have been designed in accordance with the Federal Ministry of Environment (FMEnv) EIA Procedural Guidelines, relevant national regulations, and applicable international safeguard standards. The management measures presented in Tables 7.1 to 7.8 cover all phases of the Project lifecycle, namely:

- Pre-construction phase
- Construction phase
- Commissioning phase
- Operational phase
- Decommissioning phase

For each phase, the ESMP tables outline:

- The specific project activity;
- The associated environmental and social aspect/impact;
- The prescribed mitigation measure(s);
- Monitoring indicators and performance parameters;
- Frequency of monitoring;
- Responsible party (e.g., Proponent, EPC Contractor, Supervising Engineer, FUT Babura Management);
- Reporting requirements; and
- Estimated cost implications where applicable.

The measures are designed to ensure that adverse impacts are prevented where possible, minimized where unavoidable, and managed in line with good international industry practice. Where residual impacts remain, appropriate monitoring and adaptive management strategies are incorporated to ensure compliance and continuous improvement. Implementation of the Environmental and Social Management Measures will be integrated into contractual obligations of the Engineering, Procurement and Construction (EPC) Contractor. Environmental, Social, Health and Safety (ESHS) clauses will form part of the bidding and contract documentation to ensure that compliance is legally binding and enforceable.

Furthermore, monitoring will be undertaken through a structured system of inspections, audits, performance reporting, and stakeholder engagement to verify that mitigation measures are effectively implemented and that environmental and social performance objectives are achieved throughout the Project lifecycle. The detailed Environmental and Social Management Plan matrices for each project phase are presented in the following tables (Tables 7.1 to 7.8).

Table 7.1: Environmental Management Plan for Pre-Construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Site Clearing and Preparation							
Vegetation loss; direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species	• Vegetation clearing shall be limited to the areas within the site needed for the Project. • Use of herbicides for clearing shall be avoided. Site clearing and preparation shall be done mechanically.	Inspection	Daily	Adherence to measures	EPC Contractor	REA (PMU) POE (Site Engineer)	1,300
	• The total number of trees cleared shall be planted elsewhere in harmonization with the university's plans. as allocated by the Director physical planning using plants or seeds of locally occurring species.	Inspection	Daily	Adherence to measures			
	• Bush burning shall be avoided.	Inspection	Daily	Adherence to Measures			
	• Any cleared areas which are not used will be re- vegetated using plants or seeds of locally occurring species.	Inspection	Monthly	Revegetated land			
	• The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited.	Inspection	Monthly	Adherence measures to			
	• Hunting or deliberate killing of animals by workers shall be prohibited and monitored. • Workers shall be sensitized to ecological protection	Inspection	Daily	Adherence to measures			
Removal of topsoil and soil compaction; loss of topsoil; increased erosion potential;	• Removal of vegetation and soil cover shall be restricted to the areas required for the Project. Soil conservation measures shall be implemented such as stockpiling topsoil or	Inspection	Daily	Revegetated land			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
reduction in structural	for the remediation of disturbed areas.						
stability and percolative ability of soil	• Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	Inspection	Monthly	Adherence to measures			
Air quality impacts due to emission from site clearing equipment; increase in ambient noise Levels	• Site clearing equipment / machinery should be operated and maintained under optimum fuel- efficient conditions.	Maintenance records; Fuel consumption records	Daily	Adherence to measures			
	• Site clearing activities shall be carried out only during the daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr)	Inspection	Daily	Adherence to measures			
Mobilization of Materials and Equipment to Site							
Air quality impacts from vehicular emissions; Increase in ambient noise	• Project 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	Inspection; Maintenance records	Once before vehicle commences journey	Adherence to measures	EPC Contractor	REA (PMU) POE (Site Engineer)	700
	• All materials with potential to result in dust emissions shall be covered during transport.	Inspection	Once before vehicle commences journey	Adherence to measures	EPC Contractor		
	• Site roads and access roads shall be sprinkled as needed to prevent dust entrainment.	Inspection	Daily	Adherence to measures	EPC Contractor		
	• Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h so as to reduce dust generation.	Inspection	Daily	Adherence to measures	EPC Contractor		
	• Unnecessary engine idling shall be avoided.	Inspection	Daily	Adherence to measures	EPC Contractor		
	• Site roads shall be sprinkled as needed to prevent dust entrainment.	Inspection	Daily	Adherence to measures	EPC Contractor		
							Total: 2,000

Table 7.2: Social Management Plan for Pre-Construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Site Selection							
Exposure to infectious diseases	• The EPC contractor shall implement the Nigeria Centre for Disease Control (NCDC) safety Guidelines during site clearing activities.	Implementation of NCDC guidelines	Prior to mobilization to site / site clearing and construction	Adherence to measures	EPC Contractor	REA	(PMU)
	• Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during site clearing works	Hygiene facilities and implementation of infection prevention	Prior to mobilization to site / site clearing and construction	Adherence to measures			
Mobilization of Materials and Equipment to Site							
Injuries and accidents to workers during loading and offloading construction materials.	• Provision of adequate PPE especially gloves, safety shoes, and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.	Availability of PPE	Daily	PPE compliance	EPC Contractor	REA (PMU) POE	5,000
	• Site clearing shall be limited to the day time as much as possible.	Inspection	Daily	Daily time log	EPC Contractor		
	• Unregistered labourers and touts shall not be engaged for off-loading materials.	Employment records of all staff on site	Once before commencement of mobilization	Labour Act	EPC Contractor		
Increase in vehicular movement and traffic	• A TMP shall be developed by the EPC contractor and implemented	TMP implementation records	Daily	Benchmarks stated in the TMP	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
including potential for road accident	• Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided.	Safety signs and barriers	Before and during mobilization	Adherence to measures	EPC Contractor		
	• Drivers' competency shall be assessed and where required, appropriate training shall be provided.	Drivers' competency assessments; training records	Once before commencement of mobilization	Passing of competency assessment or training completion certificates Driver's licence	EPC Contractor		
	• A procedure for recording traffic incidents/accidents associated with the Project shall be developed and implemented.	Incident forms	Daily	Completed incident forms	EPC Contractor		
	• Employee violations of speed limit and other traffic rules will result in disciplinary action ranging from warning to dismissal.	Incident forms, GRM	Daily	Completed incident forms	EPC Contractor		
Injuries and accidents to workers during loading and offloading construction materials.	• Provision of adequate PPE especially gloves, safety shoes, and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.	Availability of PPE	Daily	PPE compliance	EPC Contractor	REA (PMU) POE	
	• Unregistered laborers and touts shall not be engaged for off-loading materials.	Employment records of all staff on site	Once before commencement of mobilization	Labour Act	EPC Contractor		
							TOTAL: 5,000

Table 7.3: Environmental Management Plan for Construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Civil and Electrical Works/ Installation Activities							
Air quality impacts due to emission from construction equipment; Increase in dust from cleared land and windblown stockpiles	• Regular maintenance and servicing of construction equipment /machinery shall be ensured.	Maintenance records	Monthly during construction phase	Adherence to measures	EPC Contractor	REA-PMU POE	650
	• Routine water sprinkling shall be carried out to minimize dust generation during construction.	Inspection	Daily during civil work activities	Adherence to measures	EPC Contractor		
Increase in noise level	• Construction activities shall be limited to day- time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor	REA-PMU POE	800
	• Construction machinery shall be turned off when not in use.	Inspection	Daily during Construction phase	Adherence to measures	EPC Contractor		
	• Construction equipment shall be properly maintained and serviced.	Maintenance records	Monthly during construction phase	Adherence to measures	EPC Contractor		
	• Noise complaints related to the construction activities shall be assessed and appropriately addressed.	Complaint records	Weekly during construction phase	GRM measures	EPC Contractor		
	• Noise monitoring at locations with persistent noise complaints shall be maintained.	Noise monitoring records	Monthly during construction phase	FMEnv Noise limit	EPC Contractor		
	• Machinery/equipment to be used for construction work shall meet industry best standard in relation to noise attenuation	Inspection	Before commencement of construction phase	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Increased soil erosion potential; reduction in structural stability and percolative ability of soil	• Excavation works shall not be executed under aggressive weather conditions.	Inspection	Daily during excavation activities	Adherence to measures	EPC Contractor	REA-PMU POE	500
	• Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion.	Inspection	Daily during civil work activities	Adherence to measures	EPC Contractor		
Loss of plant species as a result of introduction of alien plants; loss of fauna as a result of increased human activity and associated noise.	• Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities.	Training records	Once before start of construction phase	Certificates of Training	EPC Contractor	REA-PMU POE	500
	• All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimise introduction of alien species. If sand or other natural materials for building are required and brought onto site, the stored heaps will be monitored for the growth and germination of alien species and will be regularly cleared during construction.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	• Regular monitoring will be undertaken to ensure that alien plants are not increasing because of the disturbance that has taken place.	Monitoring records	Monthly during construction phase	Adherence to measures	EPC Contractor		
Road damage, traffic and safety impacts	• TMP shall be developed by the EPC Contractor and implemented.	TMP implementation records	Daily during construction phase	Benchmarks stated in the TMP	EPC Contractor	REA-PMU POE	2,000
	• Speed limits for all construction-related vehicles should be established and enforced.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active.	Safety signs and barriers	Once before commencement of construction	Adherence to measures	EPC Contractor		
	• Drivers' competency shall be assessed and where required training shall be provided.	Drivers' competency assessments; training records	Once before commencement of construction	Passing competency assessment or training completion certificates	EPC Contractor		
	• A procedure for recording all construction related traffic incidents/ accidents shall be developed and implemented.	Incident forms	Daily during construction phase	Completed incident forms	EPC Contractor		
	• The EPC contractor shall promptly repair damage to public infrastructure and repair or compensate for damage to private property.	Incident forms, GRM	Daily during construction phase	Completed incident forms	EPC Contractor		
Waste Disposal and Generation							
E-waste generation	• A Waste Management Plan shall be implemented	Waste Management records	Weekly during construction phase	Adherence to measures	EPC Contractor	REA-PMU	650
	• Training shall be provided for workers on safe storage, use and handling of e-waste on site.	Training records	Once before commencement of construction	Certificates of completion of trainings	EPC Contractor	POE	
	• E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal	Waste consignment notes, waste receptacles on Site	Weekly during construction phase	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Soil contamination from solid and liquid construction waste streams.	• Hazardous substances and materials shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. • Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor	REA-PMU POE	3,000
	• Construction workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Training records	Once before commencement of construction	Certificates of completion of trainings	EPC Contractor		
Groundwater contamination of liquid construction waste streams.	• Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site.	Training records	Once before commencement of construction	Certificates of completion of trainings	EPC Contractor	REA-PMU	
	• Hazardous substances and materials shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor	POE FMEnv	
	• Waste management plan (WMP) shall be implemented.	WMP implementation records	Daily during construction phase	Benchmarks stated in WMP	EPC Contractor		
							TOTAL: 8,100

Table 7.4: Social Management Measures for Construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Civil and Electrical Works/ Installation Activities							
Discrimination During employment and training opportunities	• Employment of workers for construction activities shall be open and fair. However, no person under the age of 18 shall be engaged on the project sites.	Employment records	Once before start of construction	Adherence to measures	EPC Contractor	REA-PMU POE	-
Temporary displacement of land users	• Displacement of current adhoc land users shall be managed within the university	Records of Reallocation of land for use	Once before start of construction		University Director Physical Planning	REA-PMU POE	
GBV (sexual harassment, intimate partner violence, poor working conditions)	• The EEP GBV Action Plan shall be implemented for the Project	Implementation by the EPC Contractor	Once before start of construction	Evidence to show implementation of EEP GBV action plan	EPC Contractor	REA-PMU POE	1000
	• All workers shall be required to undergo regular training and refreshers on GBV	Organize regular onsite training and refreshers	Monthly during construction phase	Records of regular training and attendance	EPC Contractor	FMEnv Federal Ministry of Women Affairs	
	• 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)	Develop CoC forms for workers	Once before start of construction	Signed CoC forms	EPC Contractor		
	• GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish accessible GRM reporting channels	Monthly during construction	GRM records	EPC Contractor	GBV/SEA service providers	

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• The EPC Contractor shall be required to hire a Gender/ GBV officer	Employing GRM Officer	Once before start of construction	Employment records and job description	EPC Contractor		
	• Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured	Engagement of GBV service provider	Once before start of construction	Records of ongoing engagement and consultation with GBV service providers	EPC Contractor		
	• The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site	Erection of separate convenience facilities and display of GBV signage	Once before start of construction	Inspection of facilities to ensure adequacy	EPC Contractor		
Influx of people, increase in sexual transmitted diseases.	• Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible. and Labour management plan developed and implemented	Employment records and preparing a labour management plan	Once before start of construction	Adherence to measures	EPC Contractor	REA-PMU POE FMEnv Federal	1,750

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• An induction and sensitization programme, including a Code of 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 / fraternization with the local community.	Induction records and training on the code of conduct	Once before start of construction	Adherence to measures	EPC Contractor	Ministry of women affairs/ GBV/SEA service provider	
	• Awareness education about GBV/ SEA/ HIV/ AIDS and other sexually transmitted diseases shall be created among the workforce and local communities.	Training records	Once before start of construction	Adherence to measures	EPC Contractor		
	• Public access shall be restricted to construction area via security fencing and appropriate signage.	Inspection	As required	Adherence to measures	EPC Contractor		
	• All workers on the project shall be required to sign a code of conduct to prohibit any form of Gender Based Violence/ Sexual Exploitation and Abuse	Signed code of conduct records	Once before start of construction	Adherence to measures	EPC Contractor		
	• Procedure for receiving and addressing community concerns shall be developed and implemented.	Consultations and grievance records	Monthly during construction phase	GRM Measures	EPC Contractor		
Injury to construction workers during construction activities	• Health and Safety Plan shall be developed and implemented.	Health and Safety plan implementation records	Daily during construction phase	Benchmarks stated in Health and Safety Plan	EPC Contractor	REA-PMU POE	4,500

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• Community members and construction workers shall be sensitized and monitored on the need to be safety conscious. Daily toolbox talks prior to commencement of work activities shall be carried out for all workers.	Daily toolbox records	Daily during construction phase for workers and monthly for communities as part of engagement	Benchmarks stated in Health and Safety Plan	EPC Contractor		
	• Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.	Qualified and dedicated safety officer	Once before commencement of construction	Adherence to measures	EPC Contractor		
	• 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.	Availability of PPE	Daily during construction phase	PPE compliance	EPC Contractor		
	• Safety training focused on safe working practices, information on specific hazards, first aid and fire- fighting shall be included in the induction programme for workers.	Training records	Before commencement of construction and weekly	Certificates of completion of trainings	EPC Contractor		
	• A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented.	Completed grievance forms	Weekly during construction phase	Adherence to measures	EPC Contractor		
Influx of infected workers to the community. Exposure to	• The EPC contractor shall implement the NCDC "Guidelines for employers and businesses in Nigeria" during construction works.	Implementation of NCDC guidelines	Prior to operations	Adherence to measures	EPC Contractor	REA-PMU POE	500

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implement ation	Monitoring	
infectious diseases during construction	• A risk assessment of the occupational exposure to infectious diseases during construction shall be conducted, and appropriate control mechanisms shall be implemented.	Hygiene facilities and implementation of infection prevention measures	Continuous during operations	Adherence to measures			
	• The EPC contractor shall develop policies and procedures for the identification and isolation of people with symptoms, as well as testing where appropriate	Conduct risk assessment, implement control measures	Continuous during operations	Adherence to measures			
	• Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during construction.	Policies and procedures	Continuous during operations	Adherence to measures			
							TOTAL: 7,750

Table 7.5: Environmental Management for Commissioning Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Plant testing							
Increase in ambient REA noise level due to Plant POE	• Strict compliance to the Standard Operating Procedures (SOPs) shall be ensured.	SOPs	Once before commissioning	Adherence to measures	EPC Contractor	PMU testing	
	• The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		
	• The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		
							TOTAL: 0

Table 7.6: Social Management Measures for Commissioning Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Plant Testing							
Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	• Plant testing shall be carried out by experienced personnel.	Qualified and dedicated Engineer	Once before commissioning	Adherence to measures	EPC Contractor	PMU – REA POE	750
	• Adequate PPE shall be worn	Availability of PPE	Once before commissioning	Adherence to measures	EPC Contractor		
	• Prior to the Plant commissioning, appropriate emergency equipment.	Availability of emergency response equipment	Once before commissioning	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Wrong electrical connection leading to explosion/fire	• Plant testing shall be carried out by experienced personnel.	Qualified and dedicated Engineer	Once before commissioning	Adherence to measures	EPC Contractor	PMU – REA POE	-
							TOTAL: 750

Table 7.7: Environmental Management Measures for Operational Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Power Generation and Evacuation							
Air emissions from the diesel generators	• Strict compliance to the standard operating procedures for the diesel generators shall be ensured.	Inspection	Monthly during operations	Adherence to measures	O&M Contractor	PMU – REA POE University Staff	1,500
	• Regular maintenance of diesel generators shall be ensured as required by the manufacturer	Inspection	Monthly during operations	Adherence to Measures			
Dust accumulation on the solar panels	• A cleaning schedule shall be developed and implemented for cleaning the panels installed at the project site during operations	Inspection	Monthly during operations	Adherence to measures			
	• The solar panels shall be inspected regularly for dust and rain damage and maintained according to manufacturer's instructions.	Inspection	Monthly during operations	Adherence to measures			
Noise from diesel generators and inverters during power	Inverters shall be maintained as per manufacturer's recommendations and operated as per original specifications.	Inspection	Monthly during operations	Adherence to measures			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
generation and evacuation	• The diesel generators shall be operated with the sound proof covers at all times.	Inspection	Monthly during operations	Adherence to measures			
	• Project personnel shall use appropriate PPE (e.g. ear muffs) to reduce exposure to noise impact.	Inspection	Monthly during operations	Adherence to Measures			
Landscape alterations resulting in unpleasant changes in the visual character of the area	• 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.	Inspection	Monthly during operations	Adherence to measures			
Routine Maintenance, Waste Generation and Disposal							
E-waste generation and Disposal	• Training shall be provided for workers on safe • storage, use and handling of e-waste on site.	Training records	At induction of new staff, and in annual refresher training	Certificates of completion of trainings	O&M Contractor	REA PMU POE University Staff	2,200
	• E-wastes generated shall be stored in appropriate locations prior to recycling; consignment notes will be maintained	Waste consignment notes, waste receptacles on Site	Continuous during operations	Adherence to measures	O&M Contractor		
	• Waste receptacles shall be provided within a secured area for collection of solid waste.	Waste consignment notes, waste receptacles on Site	Weekly during construction phase	Adherence to measures	O&M Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Soil contamination from spilled fuel, used oil, spent batteries and inverters	• Waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. Spent batteries and inverters shall be sent to manufacturers in line with the Extended Producer Responsibility (EPR) policy.	Consignment notes for spent batteries to manufacturers for recycling	Yearly	EHS Guidelines	O&M Contractor	REA PMU POE	1,500
	• WMP shall be implemented.	WMP implementation records	Quarterly during operation phase	Benchmarks stated in WMP EHS Guidelines	O&M Contractor	FMEnv	
	• Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment.	Inspection	Continuously during operations phase	Adherence to measures EHS Guidelines	O&M Contractor		
	• Portable spill containment and clean-up kits shall be available onsite.	Availability of spill response equipment	Quarterly during operation phase	Functional spill equipment Adherence to measures	O&M Contractor		
	• Operation workers shall be provided with adequate training on use, storage and handling hazardous substances.	Training records	Quarterly during operation phase	Certificates of completion of trainings	O&M Contractor		
Electric shock, injuries to personnel during maintenance	• Appropriate PPE shall be provided for workers.	Availability of PPE	Quarterly during operations	Adherence to measures	O&M Contractor	REA PMU POE FMEnv	750
	• Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures	O&M Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Groundwater abstraction from cleaning of PV panels	• Water management / conservation plan shall be implemented	Implementation records of water management plan	Quarterly during operations	Benchmarks in water conservation plan EHS Guidelines	O&M Contractor	REA PMU POE FMEnv	500
							TOTAL: 6,450

Table 7.8: Social Management Measures for Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Power Generation and Evacuation							
GBV (sexual harassment, intimate partner violence, poor working conditions)	• The EEP Gender Action Plan shall be implemented during operations, in addition to the overall Nigeria Electrification Project (NEP).	Implementation by the O&M Contractor	Continuously during operations	Evidence to show implementation of EEP GBV action plan	O&M Contractor	REA PMU University GBV/SEA service provider	2,500
	• All workers shall be required to undergo regular training and refreshers on GBV	Organize regular on-site training and refreshers	Monthly during operation phase	Records of attendance	O&M Contractor		
	• All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence / Sexual	Develop CoC forms for workers	Once before start of operations	Signed CoC forms	O&M Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Exploitation and Abuse (GBV/ SEA)						
	• GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish GRM reporting channels	Once before start of operations	GRM records	O&M Contractor		
	• Separate facilities for men and women will be provided	Erection of separate convenience facilities	Once before start of operations	Inspection of facilities to ensure adequacy	O&M Contractor		
Health, safety and welfare of staff during Plant operation	• Provision of medical insurance scheme for employees shall be ensured.	Employment forms of employees	Quarterly during operations	Adherence to measures	O&M Contractor	REA PMU University POE	3,200
	• Appropriate safety signage shall be placed at strategic locations within the site.	Safety signs	Quarterly during operations	Adherence to measures	O&M Contractor		
	• Strict compliance with the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures	O&M Contractor		
	• A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.	Completed grievance forms	Monthly during operations	Adherence to measures	O&M Contractor		
Exposure to infectious diseases	• The O&M contractor shall implement the Nigeria Centre for Disease Control (NCDC) safety • Guidelines during operations.	Implementation of NCDC guidelines	Prior to operations	Adherence to measures	O&M Contractor	REA PMU University	

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during operations	Hygiene facility and implementation of infection prevention measures	Continuous during operations	Adherence to measures	O&M Contractor	POE	
	• A risk assessment of the occupational exposure to infectious diseases during construction shall be conducted, and appropriate control mechanisms shall be implemented.	Conduct risk assessment implement controls	Continuous during operations	Adherence to measures	O&M Contractor		
	• The O&M contractor shall develop policies and procedures for the identification and isolation of people with symptoms, as well as testing where appropriate.	Implementation of policies and procedures	Continuous during operations	Adherence to measures	O&M Contractor		
Routine Maintenance, Waste Generation and Disposal							
Electric shock, injuries to personnel during maintenance	• Appropriate PPE shall be provided for workers.	Availability of PPE	Quarterly during operations	Adherence to measures	O&M Contractor	REA-PMU POE	2,000
	• Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures			
							TOTAL- 7,700

7.4 Environmental Monitoring Programme

Environmental monitoring for the proposed 5 MW Solar Photovoltaic Power Plant Project at the Federal University of Technology (FUT), Babura, Jigawa State, shall be undertaken to ensure compliance with applicable national environmental regulations, including FMEnv standards, and to assess the effectiveness of mitigation and operational control measures implemented under the ESMP.

The monitoring program is designed to:

- verify compliance with environmental quality standards and safeguard requirements;
- Detect any unforeseen environmental changes during project implementation;
- Evaluate the effectiveness of mitigation measures;
- Provide early warning signals to enable corrective actions;
- Generate data for regulatory reporting and performance evaluation; and
- Support continuons environnemental performance improvement.

Monitoring activities shall be conducted during the pre-construction, construction, commissioning, operational and, where applicable, decommissioning phases of the Project. Parameters to be monitored will be aligned with the baseline conditions established in Chapter Four and the impacts identified in Chapter Five.

The environmental monitoring program will cover, but not be limited to, the following components:

- Ambient air quality (e.g., particulate matter, gaseous emissions);
- Noise levels;
- Soil quality and erosion control effectiveness;
- Groundwater quality and abstraction levels;
- Waste management practices;
- Occupational health and safety indicators; and
- Compliance with biodiversity protection measures.

Monitoring shall be conducted by qualified personnel under the supervision of the Project Proponent and the EPC Contractor's Environmental, Health and Safety (EHS) Unit. Where required, accredited laboratories shall be engaged for sample analysis. Monitoring results shall be documented and reported periodically to the relevant regulatory authorities and project stakeholders as stipulated under the ESMP. Non-compliance or exceedance of regulatory limits shall trigger corrective actions, including investigation of root causes, implementation of remedial measures, and follow-up monitoring to confirm resolution. Table 7.9 presents a summary of the environmental monitoring programme for the Project, including parameters, frequency, responsibility, and reporting requirements.

Table 7.9: Environmental Monitoring Programme for the proposed Project

Environmental Components/ Matrix	Sampling Locations	Sampling Method	Environmental/ Social Parameters to be monitored	Compliance Requirement	Frequency of Monitoring	Responsible Party	Project Development Phase	Estimated Cost ($)
Atmosphere (Air Quality & Noise)	Project Site Power evacuation route	Air Quality Monitoring Equipment Sound level meter	TSP, CO, NO_X, SO_X, Noise Level (dBA)	FMEnv/ WHO/ AfDB	Monthly monitoring; Monthly reporting	EPC Contractor	Construction Phase	750
Groundwater Quality	Borehole within the University	Thermometer, Water sampler, Turbidity meter, pH meter, AAS etc.	Temperature, pH, salinity, TDS, conductivity, DO, BOD, TOC, COD, NO_3, PO_4, Chloride, sulphate, Microbiology, Heavy metals, TSS and Turbidity	FMEnv/ WHO/ AfDB	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	750
Soil	Unpaved sections of the Plant	Composite soils samples for laboratory analysis.	pH, Moisture, TOC, THC, TPH, NO_3, PO_4, Chloride, sulphate, Microbiology, Heavy metals.	NESREA/ AfDB	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	850
Solid Waste	Operational areas	Monitor handling and wastes disposal generated onsite; waste tracking documentation.	Operational solid wastes including used packaging waste.	FMEnv/ NESREA/ AfDB	Monthly monitoring; Quarterly reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	750
Health and Safety	Workers and Operational areas	Observe PPE and monitor unsafe working conditions	Health and Safety Plan	FMEnv/ NESREA/ AfDB	Daily monitoring; Quarterly reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	1,500
Training	Workers	Observe compliance with existing training plan	Training plan and records	FMEnv/ NESREA/ AfDB	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	1,200

Environmental Components/ Matrix	Sampling Locations	Sampling Method	Environmental/ Social Parameters to be monitored	Compliance Requirement	Frequency of Monitoring	Responsible Party	Project Development Phase	Estimated Cost ($)
General Housekeeping	Construction sheds and operational areas	Observe cleanliness and aesthetics of Plant	Cleanliness and aesthetics of Plant	FMEnv/ NESREA/ AfDB	Daily monitoring; Quarterly reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	500
Stakeholder Engagement	Local community Regulatory agencies	Observe evidence of stakeholder consultations	Stakeholder Engagement Plan	FMEnv/ NESREA/ AfDB	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	1,200
								TOTAL: 7,500

7.5 Roles, Responsibilities and Accountabilities

Effective implementation of the Environmental and Social Management Plan (ESMP) for the proposed 5 MW Solar Photovoltaic Power Plant Project at the Federal University of Technology (FUT), Babura, Jigawa State requires clearly defined institutional roles, responsibilities and reporting structures. The Rural Electrification Agency – Project Management Unit (REA-PMU), as the Project Proponent and funding oversight body, shall provide overall supervision and ensure that ESMP requirements are integrated into project execution throughout the entire lifecycle of the Project. The REA-PMU shall be responsible for strategic oversight, compliance assurance, performance review, and coordination with regulatory authorities.

During the construction phase, the Engineering, Procurement and Construction (EPC) Contractor shall bear primary responsibility for implementing the mitigation measures specified in the ESMP. The EPC Contractor shall ensure that all environmental, social, health and safety (ESHS) obligations are complied with in accordance with contractual requirements. The Contractor shall establish an on-site Environmental, Health and Safety (EHS) team responsible for daily monitoring, reporting and enforcement of environmental and social safeguards. During the operational phase, responsibility for environmental and social compliance shall transition to the Operations and Maintenance (O&M) Contractor (or designated facility management entity). The O&M Contractor shall ensure continued implementation of mitigation measures, environmental monitoring, waste management, occupational health and safety practices, and compliance with all applicable standards.

The FUT Babura Management shall also play a key supporting role, particularly in facilitating campus coordination, stakeholder engagement, grievance redress, and integration of the solar facility into institutional operations. The Federal Ministry of Environment (FMEnv) and relevant State environmental authorities shall maintain regulatory oversight, conduct compliance inspections where necessary, and review environmental performance reports. The roles and responsibilities of key stakeholders in the implementation, monitoring and review of the ESMP are summarized in Table 7.10.

- **Key Institutional Responsibilities**

REA–PMU (Project Proponent)

- Overall supervision of ESMP implementation;
- Ensure inclusion of ESHS clauses in bidding and contract documents;
- Review and approve environmental and social performance reports;
- Liaise with FMEnv and other regulatory bodies;
- Ensure adequate budget allocation for ESMP implementation.

EPC Contractor (Construction Phase)

- Implement all ESMP mitigation measures during construction;
- Appoint qualified EHS personnel;
- Conduct routine environmental and safety inspections.
- Maintain records of incidents, accidents and corrective actions;
- Submit periodic compliance reports to REA-PMU.

O&M Contractor (Operational Phase)

- Implement operational-phase mitigation and monitoring measures;
- Ensure safe operation of PV arrays, inverters, batteries and electrical systems;
- Manage waste streams including e-waste under Extended Producer Responsibility (EPR);
- Conduct routine safety training and inspections;
- Submit environmental performance reports.

FUT Babura Management

- Facilitate stakeholder communication and grievance redress;
- Coordinate campus safety integration;
- Support awareness programmes and community engagement.

Regulatory Authorities (FMEnv / State Environmental Agencies)

- Provide statutory oversight and compliance monitoring;
- Conduct inspections and environmental audits where necessary;
- Review environmental monitoring reports.

Table 7.10: The Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP

S/N	Stakeholder	Roles and Responsibilities
1	**FUT Babura Director of Physical Planning**	**Pre-Construction Phase** • Earmark and allocate approved land within the University survey boundary for the Solar PV Plant and Training Centre. • Appoint a qualified Site Engineer. • Facilitate adequate ESMP training for the Site Engineer. • Review and approve the ESMP prepared by the Consultant. • Ensure institutional commitment to ESMP implementation. • Ensure livelihood restoration measures (where applicable) are completed prior to mobilization. **Operational Phase** • Supervise the Site Engineer through review of ESMP compliance reports. • Recommend ESMP improvements to the O&M Contractor and REA-PMU to address non-compliance and emerging issues.
2	**REA – Project Management Unit (REA-PMU)**	**Pre-Construction Phase** • Provide technical support in confirming suitability of allocated land. • Supervise livelihood restoration measures where applicable.• Appoint EPC Contractor. • Review and approve ESMP. • Ensure REA commitment to ESMP implementation. **Construction Phase** • Supervise EPC Contractor's ESMP compliance. • Monitor mitigation implementation.• Review environmental and social compliance reports. • Address non-compliance in collaboration with FUT Babura Management. • Ensure corrective actions are implemented. **Operational Phase** • Appoint O&M Contractor. • Supervise ESMP implementation during plant operations. • Review operational monitoring reports.

S/N	Stakeholder	Roles and Responsibilities
3	**FUT Babura Site Engineer**	**Pre-Construction & Construction Phases** • Attend ESMP training. • Supervise contractor compliance with mitigation measures. • Monitor environmental, social, and safety performance. • Report ESMP compliance and non-compliance issues to Director of Physical Planning. **Operational Phase** • Review environmental and safety reports from O&M Contractor. • Engage on corrective measures where required.
4	**EPC Contractor**	• Familiarize fully with ESMP and contractual ESHS requirements. • Ensure all personnel are trained on environmental and social obligations. • Implement all construction-phase mitigation measures. • Appoint Environmental Officer and Gender/GBV Officer. • Maintain incident and grievance records. • Report ESMP compliance and non-compliance to REA-PMU and Site Engineer.
5	**O&M Contractor**	• Implement ESMP requirements during plant operation. • Appoint Gender/GBV Officer. • Ensure safe operation of PV arrays, inverters, transformers and battery systems. • Conduct routine environmental and safety monitoring. • Report ESMP compliance and non-compliance to REA-PMU and Site Engineer.
6	**Federal Ministry of Environment (FMEnv)**	**Construction Phase** • Conduct impact mitigation monitoring. • Review compliance reports and undertake inspections. **Operational Phase** • Conduct environmental compliance monitoring. • Review monitoring submissions and enforce regulatory standards.
7	**NESREA Representatives**	• Monitor compliance with national environmental standards and regulations.

S/N	Stakeholder	Roles and Responsibilities
		• Conduct inspections and environmental audits. • Engage REA-PMU and University Management on compliance issues.
8	**Jigawa State Ministry of Women Affairs and Social Development (GBV/SEA Service Provider)**	**Construction & Operational Phases** • Monitor implementation of Gender and GBV mitigation measures. • Engage with Gender/GBV Officer and University Management to address grievances. • Provide advisory support on gender inclusion and SEA/SH prevention.
9	**Jigawa State Ministry of Environment and Natural Resources**	**Construction Phase** • Monitor environmental mitigation implementation. • Engage stakeholders on emerging environmental concerns. **Operational Phase** • Conduct environmental compliance inspections and recommend corrective actions.
10	**Environmental and Social Safeguards Unit of the Project Implementation Unit (PIU)**	**Environmental Aspects** • Analyze environmental risks and impacts. • Monitor implementation of mitigation measures. • Liaise with relevant environmental stakeholders. **Social Aspects** • Coordinate implementation of social components of ESMP. • Manage grievance redress mechanism. • Conduct impact evaluation and beneficiary assessments. • Liaise with CBOs and CSOs.
11	**EPC and Works Contractor (Site Level)**	• Implement environmental, health and safety procedures. • Assign dedicated EHS personnel onsite. • Report environmental violations or emerging risks to PMU. • Comply strictly with BOQ specifications and safeguard clauses. • Halt works where directed due to non-compliance. • Provide oversight during construction and decommissioning activities.

S/N	Stakeholder	Roles and Responsibilities
12	**Community Liaison Officer (CLO) and Host Community Representatives**	• Facilitate communication between Project and host community. • Manage community grievances. • Conduct stakeholder engagement meetings. • Support conflict resolution processes. • Participate in stakeholder consultations. • Report grievances or environmental concerns. • Support monitoring of community-related impacts.

7.6 Additional Management Plans

As the Project progresses from pre-construction through construction and into operational phases, additional management plans shall be developed and updated to provide detailed procedural guidance for implementation by project personnel, contractors, subcontractors and relevant institutional stakeholders. These management plans shall be prepared in strict conformity with:

- Applicable national environmental and social regulations;
- FMEnv EIA Procedural Guidelines;
- NESREA regulatory requirements;
- The AfDB ISS
- Good International Industry Practice (GIIP); and
- Occupational Health and Safety best practices.

Each plan shall clearly define objectives, scope, roles and responsibilities, monitoring indicators, reporting structure, and corrective action mechanisms. The following additional management plans shall be prepared and implemented for the 5 MW Solar PV Project:

- **Stakeholder Engagement Plan (SEP):** To guide structured engagement with University management, host communities, regulatory agencies and other stakeholders throughout the project life cycle.
- **Emergency Preparedness and Response Plan (EPRP):** To address fire outbreaks, electrical faults, electrocution risks, battery-related incidents, natural hazards and other emergency scenarios.
- **Traffic Management Plan (TMP):** To manage vehicular movement during construction and equipment mobilization, minimizing road congestion and accident risks.
- **Waste Management Plan (WMP):** To manage solid waste, hazardous waste, e-waste (including batteries and inverters), and wastewater in accordance with regulatory standards and Extended Producer Responsibility (EPR) principles.
- **Occupational Health and Safety Plan (OHSP):** To ensure safe work practices during construction and operation, including electrical safety protocols and PPE compliance.
- **Labour and Employment Management Plan (LEMP):** To regulate workforce recruitment, prevent discrimination, address Gender-Based Violence (GBV), and ensure fair labour practices.

- **Erosion and Sediment Control Management Plan:** To minimize soil erosion during civil works and manage stormwater runoff.
- **Water Conservation Plan:** To regulate groundwater abstraction for panel cleaning and ensure sustainable water use.

These plans shall be annexed to contractor bidding documents where applicable and incorporated into contractual obligations.

7.7 Environmental and Social Monitoring Program

Environmental monitoring for the Project shall be conducted to:

- Ensure compliance with applicable regulatory requirements;
- Evaluate effectiveness of mitigation measures;
- Detect unforeseen environmental or social impacts;
- Support adaptive management and corrective action;
- Provide performance data for reporting and continuous improvement.

The Environmental and Social Monitoring Program for the 5 MW Solar PV Project shall include:

1. Risk and Performance Review

- Identification of high-risk environmental and social issues;
- Periodic review of system weaknesses or implementation gaps;
- Evaluation of operational practices affecting environmental performance.

2. Performance Metrics and Indicators

- Establishment of measurable indicators for:
  - Ambient air quality
  - Noise levels
  - Soil erosion control
  - Groundwater abstraction and quality
  - Waste management efficiency
  - Occupational health and safety performance
- Tracking performance against defined targets and regulatory limits.

3. Document and Record Control

- Maintenance of updated environmental and social monitoring records;
- Proper documentation of inspections, audits, and incident reports;
- Controlled access to ESMP documents and procedures.

4. Audits and Evaluation

- Routine internal inspections;
- Periodic environmental audits;
- Regulatory compliance assessments;
- Independent third-party audits (where required).

7.8 Training, Awareness and Capacity Building

REA shall identify, document, and address training needs for personnel whose work may significantly affect environmental or social performance. All personnel involved in the Project shall:

- Understand potential environmental impacts of their activities;
- Recognize occupational hazards associated with Solar PV construction and operation;
- Understand their roles in ensuring compliance with the ESMP;
- Be aware of grievance reporting channels and Code of Conduct requirements.

A structured training program shall be implemented throughout the Project life cycle.

Staff Training Areas

All employees shall receive training in:

- General operation and functionality of the Solar PV Plant;
- Environmental management procedures;
- Role-specific operational procedures;
- Occupational health and safety requirements;
- Emergency response procedures and contingency planning.
- The AfDB E&S Capacity Building and Training

Types of Training

- **Induction Training:** Upon employment or site mobilization;
- **Specialized Technical Training:** For specific job functions (e.g., electrical safety, battery handling);
- **Refresher Training:** Conducted periodically;
- **Emergency Drills:** Simulated fire and electrical fault response exercises.

Community awareness programs shall also be conducted to:

- Promote environmental protection;
- Improve understanding of Project activities;
- Enhance community safety awareness.

7.8.1 ESMP Capacity Building Plan

Effective ESMP implementation requires capacity strengthening among all stakeholders, including:

- REA-PMU staff;
- FUT Babura Management;
- EPC Contractor personnel;
- O&M Contractor personnel;
- Safeguards Unit;
- Community representatives.

Capacity building will focus on improving understanding of:

- ESMP implementation requirements;
- Occupational Health and Safety (OHS);
- Waste management procedures;
- Environmental monitoring techniques;

- Code of Conduct compliance;
- GBV/SEA prevention mechanisms;
- Grievance Redress Mechanism (GRM) operation.

Table 7.11 outlines, proposed training topics, target audience, frequency of training, responsible institution, and estimated cost. Capacity building shall be reviewed periodically to address emerging risks and regulatory updates.

Table 7.11: ESMP Capacity Building Plan – 5 MW Solar PV Project, FUT Babura

S/N	Training Content	Participants	Delivery Institution	Estimated Cost (USD)
1	Specialized Training on Environmental and Social Management (ESMP oversight, compliance monitoring, reporting requirements)	Environmental & Social Safeguard Officer, FUT Site Engineer	PMU / Environmental Consultant	4,500
2	Training on ESMP Implementation (mitigation measures, institutional roles, monitoring obligations, documentation procedures)	Project Team (REA-PMU, FUT Management, Site Engineer)	PMU / Consultant	1,550
3	ESMP Compliance Training for Contractors (mitigation measures, Code of Conduct, Occupational Health & Safety requirements, incident reporting)	EPC Contractor Management, Supervisors, Construction Workers	PMU / Consultant	1,550
4	Training on Traffic Management and Defensive Driving (fleet management, on-campus traffic control, accident prevention)	Contractor Drivers, HSE Officer, Environmental Officer	FUT Security Unit / Transport Safety Unit	1,550
5	GBV/SEA/SH Prevention and Response Mechanisms (awareness, reporting channels, survivor-centered approach)	Project Team, Safeguard Officers, Gender/GBV Officer	PMU / Gender Specialist Consultant	2,500
6	Grievance Redress Mechanism (GRM) Training (complaint handling procedures, documentation, resolution timelines)	Grievance Redress Committees (Project Level & Management Level)	PMU / Consultant	2,500
Total Estimated Capacity Building Budget				**14,150 USD**

7.9 Implementation Schedule and Reporting

The estimated implementation period for the proposed 5 MW Solar Photovoltaic Power Plant Project at Federal University of Technology (FUT) Babura is between 12–18 months, covering pre-construction, construction, commissioning and early operational activities. All Environmental and

Social Management Plan (ESMP) activities shall be fully integrated into the overall project execution schedule to ensure environmental and social safeguards are implemented concurrently with engineering works.

Table 7.12: ESMP Implementation Schedule

S/No	Activity	Responsibility	1–3 Months	4–6 Months	7–9 Months	10–12 Months	12–18 Months
1	ESMP Disclosure to stakeholders and regulatory authorities	Project Team / REA-PMU	✓				
2	Incorporation of Environmental & Social Requirements into Bid Documents	Project Team	✓				
3	Finalization and Approval of Engineering Designs (including safeguard considerations)	Design Consultant / Project Team	✓	✓			
4	Allocation of Budget for ESMP Implementation and Monitoring	Project Team	✓				
5	Appointment of Environmental & Social Support Staff	Project Team	✓				
6	Review and Approval of Contractor's HSE Plan, Waste Management Plan (WMP), Traffic Management Plan (TMP), etc.	ESO / SSO / REA-PMU		✓			
7	Capacity Building and Training Programs	Project Team / Consultant		✓	✓		
8	Implementation of Environmental and Social Mitigation Measures (Construction Phase)	EPC Contractor		✓	✓	✓	

S/No	Activity	Responsibility	1–3 Months	4–6 Months	7–9 Months	10–12 Months	12–18 Months
9	Supervision of Pre-Construction and Construction Activities	Project Team / Engineering Consultant		✓	✓	✓	
10	Supervision of ESMP Implementation	ESO / SSO / Engineering Consultant		✓	✓	✓	✓
11	Environmental and Social Monitoring & Auditing	FMEnv / State Ministry of Environment / REA-PMU		✓	✓	✓	✓
12	Reporting on ESMP Implementation (Quarterly & Final Reports)	ESO / SSO / REA-PMU		✓	✓	✓	✓

7.9.1 Reporting

Implementation of the Environmental and Social Management Plan (ESMP) for the 5 MW Solar Photovoltaic Power Plant at Federal University of Technology (FUT) Babura shall be fully integrated into the finalized overall project schedule. Environmental and social considerations will be embedded from the planning and design stages through construction, commissioning, operation and eventual decommissioning. The proponent shall share quarterly implementation report with the African Development for review in line with the project financing agreements.

ESMP implementation shall therefore:

- Begin at the planning and design phase to ensure quality equipment and environmentally compliant technologies are selected;
- Continue throughout construction to ensure mitigation measures are effectively applied;
- Extend into commissioning and operational phases to maintain environmental compliance and safeguard performance;
- Remain active during decommissioning to ensure responsible site restoration.

❖ **Reporting and Corrective Action Mechanism**

Once monitoring activities commence, any observation of:

- Environmental non-compliance;
- Exceedance of regulatory limits;
- Occupational health and safety incidents;
- Adverse environmental or social impacts;

Shall be immediately reported by the responsible Environmental and Social Officers to REA-PMU and University Management. Corrective and remedial actions shall be implemented without delay to:

- Restore compliance;

- Prevent recurrence;
- Ensure optimal environmental performance of the Project.

REA shall ensure that regulatory authorities including:

- **Federal Ministry of Environment (FMEnv)**
- **NESREA**
- **Jigawa State Ministry of Environment**

Are kept informed of project environmental and social performance through periodic reporting.

❖ **Documentation Requirements**

REA shall maintain comprehensive documentation including:

- Internal environmental inspection records;
- HSE monitoring records;
- Incident and accident logs;
- Training and capacity-building records;
- Waste tracking and disposal documentation;
- Community grievance records.

❖ **Regulatory Reporting**

Periodic HSE and environmental performance reports shall be submitted to FMEnv and relevant State regulatory authorities as required. Reports shall clearly identify:

- Monitoring results;
- Any parameter exceeding regulatory standards;
- Root cause of non-compliance;
- Corrective actions taken;
- Preventive measures to avoid recurrence.

7.10 ESMP Costing

Table 7.13 presents the estimated budget required for effective implementation of the ESMP mitigation measures and associated management plans for the 5 MW Solar PV Project at FUT Babura. The total estimated ESMP implementation cost is US$ 53,340, calculated at an exchange rate of ₦1600 per US Dollar at the time of preparation. The costing covers a duration of approximately 24 months, corresponding to the EPC construction period and handover protocol.

Table 7.13: Cost of ESMP Implementation

S/N	ESMP Activities	Cost (USD)
1	**Pre-Construction Phase Implementation** (disclosure, staffing, approvals, early monitoring)	6,800
	Construction Phase ESMP Implementation (monitoring, mitigation execution, supervision, reporting)	12,990
	Operational Phase ESMP Implementation (Initial Period) (monitoring, waste management oversight, safety compliance)	12,800
	Commissioning Phase ESMP Activities (inspection, testing oversight, reporting)	500
2	**Direct Mitigation Measures** (environmental controls, erosion measures, safety controls, signage, etc.)	6,100
3	Capacity Building and Training (Table 7.11)	14,150
TOTAL ESTIMATED ESMP COST		**53,340**

7.11 Consultations

Consultations constitute a critical component in identifying and evaluating the major environmental and social issues associated with the proposed 5 MW Solar Photovoltaic Power Plant Project at Federal University of Technology (FUT) Babura, Jigawa State. Stakeholder engagement forms a vital aspect of the Environmental and Social Impact Assessment (ESIA) process, ensuring that concerns, expectations, and inputs of affected and interested parties are adequately incorporated into project planning and implementation. A Stakeholder Engagement Plan (SEP) was developed during the preparation of this ESIA to facilitate effective participation and sustainable implementation of the Project throughout its life cycle, including:

- Pre-construction phase
- Construction phase
- Operational phase
- Decommissioning phase

The SEP describes:

- The process used to identify stakeholders;
- The methods employed in consulting stakeholders;
- The outcomes of consultations conducted; and
- The disclosure mechanisms adopted to ensure transparency and accountability.

The Project has undertaken structured stakeholder consultations in compliance with national and international safeguard requirements to promote inclusive participation and informed decision-making.

7.11.1 Stakeholder Engagement

Stakeholder Engagement is a systematic and continuous process of managing stakeholder expectations and fostering constructive relationships that influence project decisions throughout the project life cycle. It provides a structured framework for effective interaction with stakeholders while supporting

project objectives and ensuring environmental and social sustainability. Proper planning and implementation of stakeholder engagement activities are essential to:

- Recognize and value stakeholder contributions;
- Manage expectations effectively;
- Reduce potential conflicts;
- Enhance transparency and accountability; and
- Strengthen project acceptance and ownership.

A. Free, Prior and Informed Consultation (FPIC)

The stakeholder engagement process for the Project adopts the principle of **Free, Prior and Informed Consultation (FPIC)**. This ensures that:

- Participation is voluntary and free from coercion;
- Information is disclosed prior to key decision-making stages;
- Information provided is accurate, understandable and accessible;
- Stakeholders are given adequate opportunity to express views and concerns.

Special consideration was given to ensuring participation of:

- Vulnerable and marginalized groups;
- Women;
- Youth;
- Persons with disabilities;
- University staff and students;
- Host community representatives.

B. Consultation Methods Employed

The following consultation methods were adopted during preparation of this ESIA:

- Prior disclosure of project information in accessible formats;
- Key Informant Interviews (KIIs);
- Focus Group Discussions (FGDs) (separate sessions for men, women, and youth where applicable);
- Public consultation meetings;
- Stakeholder meetings with regulatory agencies and University Management.

Consultations were documented with:

- Attendance lists including contact details;
- Photograph evidence;
- Records of issues raised and responses provided;
- Minutes of meetings.

C. Regulatory Compliance

The consultation process was conducted in accordance with:

- **Environmental Impact Assessment (EIA) Act No. 86 of 1992**, as amended by **EIA Cap E12 LFN 2004**;

- Applicable FMEnv procedural guidelines;
- Relevant State-level environmental requirements; and
- The **African Development Bank Integrated Safeguards System (ISS)** where applicable.

Information disclosure was carried out in line with national regulatory requirements to ensure transparency and meaningful participation.

7.11.2 Objectives of Stakeholder Engagement

Public participation is a fundamental component of the Environmental and Social Impact Assessment (ESIA) process. The primary objective of stakeholder engagement is to ensure that sufficient, accurate, and accessible information is provided to potentially interested and affected parties in an objective and transparent manner. This enables stakeholders to identify issues of concern, propose alternatives, and suggest measures to enhance the Project's environmental and social benefits.

The stakeholder engagement process for the 5 MW Solar Photovoltaic Power Plant at Federal University of Technology (FUT) Babura was designed in accordance with:

- The Nigerian Environmental Impact Assessment (EIA) Act No. 86 of 1992 (as amended);
- FMEnv procedural guidelines; and
- International best practices, including the African Development Bank (AfDB) Integrated Safeguards System.

For this Project, the key objectives of stakeholder engagement are to:

- Identify key stakeholders who can influence or are likely to be affected by the Project and its activities;
- Inform and educate stakeholders about the scope, components, and anticipated impacts of the proposed Solar PV Project;
- Gather local knowledge and insights to improve understanding of the environmental and social context of the Project area;
- Understand locally significant environmental and social concerns;
- Identify effective communication channels and structures for dissemination of Project information in a regular, accessible, transparent, and culturally appropriate manner;
- Provide stakeholders with meaningful opportunities to contribute to Project planning and decision-making processes;
- Incorporate stakeholder views into the development of mitigation measures and management plans;
- Build trust and establish long-term engagement mechanisms throughout the Project life cycle.

Stakeholder engagement for the Project is not a one-time activity but a continuous process extending from pre-construction through construction, operation, and eventual decommissioning.

7.12 Disclosure and Participation Plan

Information disclosure is a critical component of stakeholder engagement. It ensures that engagement activities are informed, participatory, and transparent. Effective disclosure enhances accountability and strengthens stakeholder confidence in the Project. This section outlines the procedures and mechanisms

adopted for information disclosure and stakeholder participation during the implementation of the Project.

A. Disclosure Principles

The disclosure process for the Project is guided by the following principles:

- Timely provision of relevant and accurate information;
- Accessibility of information in language and formats understandable to stakeholders;
- Transparency in communicating potential impacts and mitigation measures;
- Responsiveness to stakeholder concerns and feedback;
- Continuous communication throughout the Project life cycle.

B. Documentation Requirements

In compliance with the AfDB Operational Safeguards and Nigerian regulatory requirements, the Proponent shall maintain and disclose a documented record of stakeholder engagement activities, including:

- Identification and categorization of stakeholders consulted;
- Dates, venues and methods of consultation;
- Summary of issues raised during consultations;
- Responses provided by the Project Team;
- Description of how stakeholder feedback was incorporated into Project design and ESMP;
- Justification where specific stakeholder recommendations could not be adopted.

These records shall form part of the ESIA documentation and shall be made available to regulatory authorities upon request.

C. Modes of Disclosure

Information may be disclosed through:

- Public consultation meetings;
- University administrative channels;
- Community notice boards;
- Printed executive summaries of ESIA;
- Digital platforms where applicable;
- Regulatory disclosure through FMEnv as required under the EIA Act.

Disclosure activities shall continue during construction and operational phases, particularly where changes in design or scope may affect stakeholders.

7.12.1 Disclosure Mechanism

Information disclosure for the proposed 5 MW Solar Photovoltaic Power Plant Project at Federal University of Technology (FUT) Babura may be undertaken through two primary mechanisms:

1. **Regulatory Disclosure**, and
2. **Voluntary Disclosure**.

1. Regulatory Disclosure

Regulatory disclosure refers to the formal release of ESIA documentation and related environmental and social information as required by statutory authorities under:

- The Environmental Impact Assessment (EIA) Act No. 86 of 1992 (as amended);
- FMEnv procedural guidelines; and
- Relevant international safeguard requirements (e.g., AfDB Integrated Safeguards System).

This includes submission of the ESIA to regulatory bodies and participation in required public review processes or hearings.

2. Voluntary Disclosure

Voluntary disclosure refers to the proactive dissemination of project-related information to stakeholders beyond statutory requirements. This approach enhances transparency and strengthens stakeholder confidence in the Project. Voluntary disclosure enables:

- Early engagement with stakeholders;
- Improved trust-building through transparent communication;
- More constructive participation in consultation processes;
- Effective grievance management through access to accurate and timely information.

Both mechanisms are complementary and will be applied throughout the Project life cycle.

7.12.2 Process for Disclosure of Information

In line with regulatory requirements and international best practice, this ESIA shall be released for public review in accordance with:

- AfDB disclosure procedures; and
- A minimum 21-day public disclosure period as required under the Nigerian regulatory framework.

A. Public Access to Disclosure Materials

The ESIA report shall be made available at locations accessible to stakeholders and the general public, including:

- The Environmental Assessment (EA) Department of the Federal Ministry of Environment (FMEnv);
- Jigawa State Ministry of Environment;
- Federal University of Technology (FUT) Babura;
- Other designated public locations to ensure wide dissemination.

The ESIA is prepared in English, which is the official language of regulatory documentation in Nigeria.

B. Electronic Disclosure

Electronic copies of the ESIA report shall be made available on the website of the African Development Bank (where applicable) and/or other official platforms as required. This allows stakeholders with internet access to review project information and provide feedback.

C. Notification and Communication Channels

To facilitate stakeholder input, the following communication mechanisms may be used:

- Press releases and media announcements;
- Formal notifications to local, state and national regulatory authorities;
- Communication to relevant NGOs and Civil Society Organizations (CSOs);
- Notifications to professional bodies and academic institutions;
- Direct engagement with University staff, students, and host community representatives.

These measures ensure broad awareness and inclusive participation.

7.12.3 Timetable for Disclosure

The disclosure process for the Project's Environmental and Social documentation shall follow the timeline below:

- Placement of the ESIA report in the public domain (FMEnv and relevant platforms) – Dates to be confirmed by REA and FMEnv;
- 21-day public disclosure period – Dates to be confirmed by FMEnv;
- Compilation and addressing of stakeholder feedback received during the disclosure period – Dates to be confirmed by REA and FMEnv.

The ESIA documentation shall remain accessible in the public domain throughout the Project development period. Updates may be made periodically as the Project progresses through its various phases to ensure:

- Timely identification of new stakeholders;
- Continuous involvement of interested parties;
- Effective communication of any material changes in project scope or impacts.

The methods of engagement shall also be reviewed periodically to ensure they remain effective and responsive to evolving project conditions.

Table 7.14: Stakeholder Engagement and Disclosure Methods

Stakeholder Group	Project Information Shared	Means of Communication / Disclosure
Project Beneficiaries (FUT Babura Management, Staff, Students, and Campus Businesses)	• ESIA Report; • Stakeholder Engagement Plan (SEP); • Grievance Redress Mechanism (GRM); • Regular updates on Project implementation (construction progress, commissioning, operational updates); • Environmental and Social Management Plan (ESMP) summary.	• Public disclosure notices within Federal University of Technology (FUT) Babura; • Electronic publications and press releases on REA and University platforms; • Dissemination of hard copies at designated public locations within the University; • Press releases in local and national media; • Town hall meetings and consultation forums;

Stakeholder Group	Project Information Shared	Means of Communication / Disclosure
		• Notice boards and stakeholder briefings.
African Development Bank (AfDB)	• ESIA Report; • Environmental and Social Management Plan (ESMP); • RAP (if applicable); • Monitoring and compliance reports; • Periodic Project implementation updates.	• Electronic disclosure on AfDB website; • Formal submission of hard copies; • Technical reporting and review meetings; • Official correspondence and compliance reporting.
Federal Ministry of Environment (FMEnv)	• ESIA Report; • Environmental compliance documentation; • Monitoring reports; • ESMP implementation updates.	• Submission of hard copies; • Formal regulatory disclosure process; • Public hearing sessions (if required); • Compliance reporting.
Jigawa State Ministry of Environment and Relevant State MDAs	• ESIA Report; • Project implementation updates; • Environmental monitoring reports.	• Official correspondence; • Hard copy submissions; • Stakeholder consultation meetings; • Press announcements where necessary.
Non-Governmental Organizations (NGOs) and Civil Society Organizations (CSOs)	• ESIA Report; • ESMP summary; • Regular updates on Project development and environmental performance.	• Public notices; • Electronic publications on REA platforms; • Dissemination of hard copies at designated locations; • Press releases in local and national media; • Invitation to consultation meetings.
Host Community Representatives (Babura LGA and Surrounding Communities)	• Project description and scope; • Potential environmental and social impacts; • Mitigation measures; • Employment opportunities; • GRM procedures.	• Community meetings and focus group discussions; • Key informant interviews; • Local announcements; • Distribution of summary leaflets; • Engagement through community leaders and local authorities.

7.12.4 Stakeholder Register

A Stakeholder Engagement Register shall be established and maintained for the proposed 5 MW Solar PV Power Plant Project at Federal University of Technology (FUT) Babura, Jigawa State. The register will serve as a structured database for documenting all stakeholder interactions throughout the project life cycle (pre-construction, construction, operation and decommissioning phases).

The Stakeholder Register shall include:

- Name of stakeholder (individual, group or institution);
- Contact details (address, phone number, email where applicable);
- Category of stakeholders (beneficiary, regulator, community representative, NGO, etc.);
- Date and type of engagement (meeting, consultation, site visit, interview, disclosure session);
- Key issues raised;
- Agreed actions or commitments;
- Responsible party for follow-up;
- Status of resolution;
- Date of closure.

The register shall be updated periodically and maintained by the Project Safeguards Unit to ensure transparency, accountability and effective tracking of stakeholder concerns.

7.12.5 Stakeholder Identification and Analysis

Stakeholder identification and analysis for the proposed Solar Power Project at FUT Babura was undertaken to determine individuals, groups and institutions that may influence or be affected by the Project.

Stakeholders were categorized as:

- Project-affected parties (students, staff, campus businesses, seasonal farmers within campus land);
- Government and regulatory authorities;
- Funding agencies and development partners;
- Host community representatives;
- Civil society organizations;
- Contractors and service providers.

The level of influence, interest, vulnerability and potential impact on each stakeholder category was assessed to guide engagement strategies.

7.12.6 Summary of the Socioeconomic Study and Stakeholder Consultation

A comprehensive socioeconomic study was conducted for the proposed 5 MW Solar Project under Phase III of the Energizing Education Program (EEP), implemented by the Government of Nigeria in collaboration with development partners.

The study employed the following methodologies:

- Random administration of structured questionnaires;

- In-depth interviews (IDI) with key informants;
- Literature review of institutional and regional socioeconomic data;
- Community surveys and direct field observations.

Key findings from the socioeconomic study include:

- The proposed Solar Power Project is to be located within the premises of the Federal University of Technology (FUT) Babura, Jigawa State.
- Administratively, the University is headed by the Vice-Chancellor supported by principal officers responsible for academic, administrative and financial management.
- The project site is located on land currently not intensively utilized except for limited seasonal agricultural activities.
- No permanent human settlement, cultural heritage sites, or critical infrastructure will be displaced by the Project.
- Seasonal farmers operating within the site will be adequately informed and alternative land allocation within the University premises will be provided where necessary.
- Economic activities within the University environment include petty trading, small-scale retail businesses and commercial transportation services.
- The selected site satisfies the technical requirements specified for the Solar Hybrid Power Plant development.
- Environmental concerns in the broader area include localized erosion and drainage challenges associated with unpaved access roads.
- No history of youth unrest or security instability is associated with the University.
- Security structures are in place within the University to safeguard lives and property.
- Common public health concerns in the area include malaria and typhoid fever, typical of the regional climatic conditions.
- The proposed Solar Power Project is expected to significantly enhance academic productivity, improve research capacity, reduce reliance on diesel-powered generators, and lower operational energy costs for the University.

Overall, stakeholder consultations indicated broad support for the Project due to its anticipated academic, environmental and economic benefits.

7.12.6.1 Stakeholder Consultation Outcomes

Stakeholder consultation for the proposed 5 MW Solar PV Project was undertaken on 6 February 2026 with representatives of FUT Babura, members of the university community, relevant government and regulatory institutions, and other interested parties. The engagement provided stakeholders with information on the Project and enabled them to express their expectations and concerns. The principal outcomes and the corresponding Project responses are summarized in Table 7.15.

Table 7.15: Summary of Stakeholder Consultation Outcomes and Project Responses

Date	6th February 2026
Venue	Office of the Deputy Vice Chancellor FUT Babura Jigawa State
Time	10:00 am

Stakeholder / issue	Consultation outcome	Project response / agreed action	Responsibility / status
FUT Babura management electricity reliability and institutional development	Broad support was expressed for the Project because reliable electricity is expected to improve teaching, research, laboratory activities, ICT services and campus administration.	The Project will prioritize reliable electricity supply to the University and implement the ESMP throughout construction and operation.	REA-PMU / EPC Contractor / FUT Babura, incorporate into implementation and operational planning.
University staff and students — expected project benefits	Stakeholders welcomed the anticipated reduction in diesel-generator dependence, noise, emissions and operational energy costs, together with improved academic and research productivity.	Energy-performance, air-quality and noise indicators will be monitored in accordance with the ESMP, and stakeholders will be informed of relevant Project performance.	REA-PMU / FUT Babura, ongoing during construction and operation.
Seasonal users of the proposed site, continued access to livelihood resources	The assessment identified limited seasonal agricultural use within the proposed site, although no permanent settlement or critical infrastructure will be displaced.	Affected seasonal farmers will be informed before site handover and, where necessary, FUT Babura will facilitate access to suitable alternative land within the University premises. Any livelihood impact must be documented and managed before displacement or restriction of access.	FUT Babura / REA-PMU Social Safeguards Officer, to be completed before site clearance.
University community and neighbouring area, erosion, drainage and access-road conditions	Localized erosion and drainage challenges associated with unpaved access roads were identified as environmental concerns in the broader Project area.	The engineering design and construction method will provide appropriate drainage and erosion-control measures. The EPC Contractor will prevent sedimentation, maintain access and reinstate areas disturbed by construction.	EPC Contractor under REA-PMU supervision, design and construction stages.
Regulatory and institutional stakeholders, environmental and social compliance	Stakeholders emphasized compliance with applicable environmental, occupational health and safety, labour, community health and disclosure requirements.	REA-PMU and the EPC Contractor will implement the approved ESMP, obtain required permits, conduct monitoring and submit compliance reports to the relevant authorities.	REA-PMU / EPC Contractor, continuous; evidence to be retained in Project records.
All stakeholder groups, information disclosure, participation and grievances	Stakeholders require accessible Project information, continued engagement and a transparent channel for submitting concerns and complaints.	The Stakeholder Engagement Plan and project Grievance Redress Mechanism will remain operational throughout the Project lifecycle. A stakeholder register will record issues, responses, agreed actions, responsible persons and closure status.	REA-PMU Social Safeguards Officer / FUT Babura focal person, continuous.

See appendix V for pictorial evidence of stakeholder consultations…

7.13 Grievance Redress Mechanism (GRM)

This section outlines the Grievance Redress Mechanism (GRM) applicable to both:

- General project-related grievances; and
- Gender-Based Violence (GBV), Sexual Exploitation and Abuse (SEA), and Sexual Harassment (SH) related grievances.

The standard GRM framework of the Rural Electrification Agency (REA) shall support, but not replace, the site-specific grievance mechanism established at the subproject level for FUT Babura.

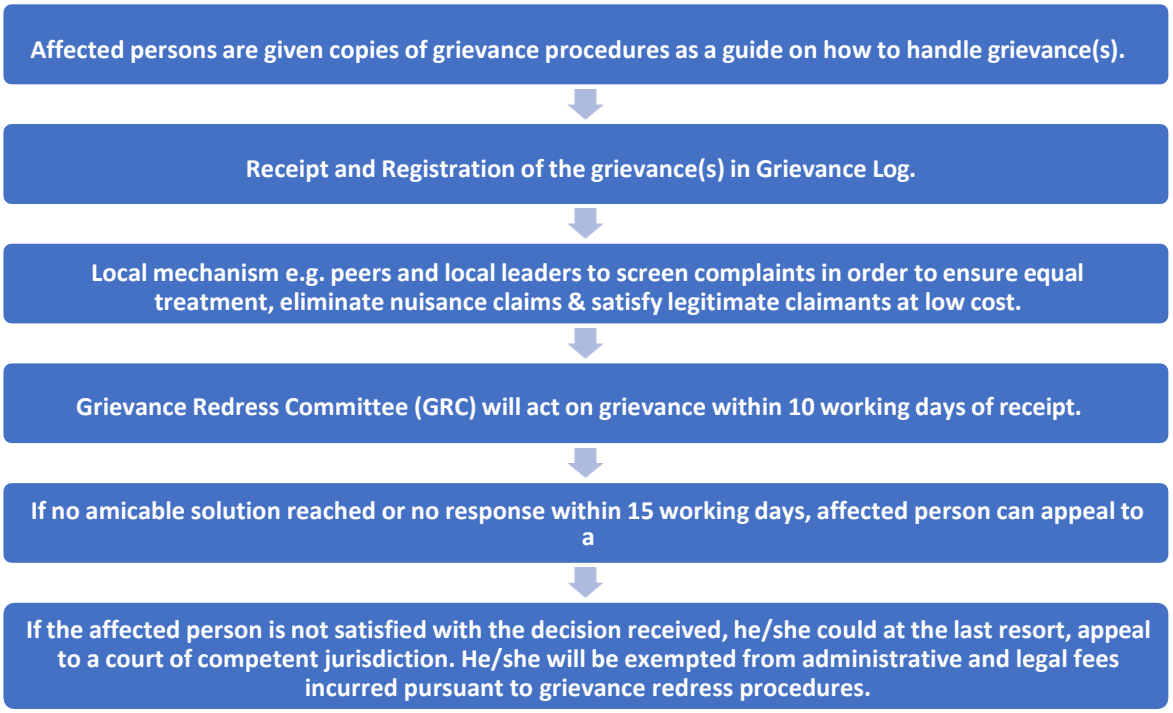

Figure 7.1: GRM process

(Source: AfDB-Nigeria Electrification Project (NEP) Hawthorne Valley Farmscape Ecology Program).

7.13.1 Overview of the GRM

The Grievance Redress Mechanism is a structured process that enables affected communities and stakeholders to:

- Submit complaints or concerns;
- Track grievance status;
- Receive timely feedback;
- Obtain fair and transparent resolution.

The GRM is designed to ensure that grievances related to environmental, social, occupational, safety, land use, employment, or contractor behavior are addressed promptly and effectively.

The GRM shall:

- Be accessible to all stakeholders;
- Be transparent and culturally appropriate;

- Allow anonymous submissions;
- Protect complainants from retaliation;
- Maintain confidentiality, particularly for GBV/SEA/SH cases.

The GRM shall remain operational throughout the entire project life cycle.

7.13.2 GRM Process

The grievance redress process shall involve the following steps:

Step 1: Submission of Complaint

Complaints may be submitted through:

- Written letters;
- Email;
- Telephone hotline;
- Suggestion boxes located within the University;
- Direct reporting to the Safeguards Officer or Site Engineer;
- Community liaison representatives.

Step 2: Registration of Grievance

All grievances shall be logged into a Grievance Register including:

- Date received;
- Complainant details (where provided);
- Nature of complaint;
- Category (environmental, social, labor, GBV-related, etc.);
- Assigned responsible officer.

Step 3: Screening and Classification

The grievance shall be assessed to determine:

- Level of severity;
- Urgency;
- Required response timeframe;
- Whether escalation is necessary.

Step 4: Investigation and Resolution

The responsible unit shall:

- Conduct necessary investigations;
- Engage relevant parties;
- Propose corrective actions;
- Implement agreed resolution measures.

Step 5: Feedback to Complainant

Feedback shall be provided within a defined timeframe (typically 7–14 working days depending on complexity).

Step 6: Closure and Documentation

Once resolved:

- The complainant confirms satisfaction (where applicable);
- The case is formally closed;
- Documentation is archived.

If unresolved at project level, the grievance may be escalated to REA-PMU or relevant regulatory authorities.

7.13.3 GBV/SEA/SH-Specific GRM

Grievances related to GBV, SEA or SH shall follow a survivor-centered approach:

- Confidential reporting channels shall be provided;
- Trained Gender/GBV Officers shall handle cases;
- Immediate referral to appropriate support services (medical, psychosocial, legal);
- No mandatory reporting without survivor consent;
- Strict confidentiality protocols shall be maintained.

These cases shall not be managed through the general grievance committee but through a dedicated confidential pathway in line with international best practice.

7.13.4 Publicizing and Disclosure of the GRM

The Grievance Redress Mechanism (GRM) shall be widely communicated to all stakeholders to ensure accessibility, transparency and effectiveness. Disclosure of the GRM will be undertaken through both written and verbal communication channels, including:

- Public consultation meetings within the University and host community;
- Focus group discussions;
- Stakeholder engagement sessions;
- Notice boards within the University premises;
- Distribution of summary leaflets;
- Inclusion within ESMP and other management plan disclosures.

The GRM shall be disclosed concurrently with the ESIA, ESMP and other relevant management plans to ensure that stakeholders are aware of their rights and available complaint mechanisms before commencement of project activities. Special attention shall be given to ensuring that vulnerable groups, including women and persons with disabilities, are adequately informed about the GRM and how to access it.

7.13.5 Receiving and Recording Grievances

As part of the GRM framework, grievances from stakeholders or their representatives may be submitted through the following channels:

- Verbal submission (in person);
- Telephone communication;
- Written submission;
- Email communication;
- Submission through designated complaint boxes at the Project site;
- Direct reporting to the Grievance Officer (GO) or Social Safeguard Officer.

Where a grievance is received verbally by any project representative, it shall be documented promptly and transferred to the designated Grievance Officer upon return to the project office or site. All grievances shall be recorded using a standardized Grievance Recording Form and entered into the official Grievance Register.

Table 7.16: Grievance Recording Form

GRIEVANCE REGISTRATION	
Field	**Details**
Case No.:	
Date:	
Name of Complainant:	
Office Location / Address:	
Unit / Organization (if applicable):	
Phone Number:	
Details of Grievance:	
Name of Person Recording Grievance:	
Designation of Recording Person:	
Proposed Date of Response:	
Signature of Recording Person:	
Signature of Complainant:	
GRIEVANCE REDRESSAL RESPONSE	
Decision of Grievance Officer (Full Description):	
Claimant Accepts Outcome:	☐ Accepted ☐ Not Accepted
Signature of Claimant:	
Signature of Grievance Officer:	

All project personnel shall be informed that any grievance received must be forwarded immediately to the designated Grievance Officer. The following procedures shall apply:

- The identity and contact details of the complainant (where provided) shall be documented;
- Anonymous complaints shall also be accepted and recorded;

- Each complaint shall be assigned a unique case number;
- The grievance shall be categorized (environmental, social, labor, GBV-related, etc.);
- The grievance shall be logged into the Grievance Register.

The Grievance Officer shall subsequently communicate all recorded grievances to the Social Safeguard Officer and relevant project authorities for appropriate action.

7.13.6 Grievance Register

A formal Grievance Register shall be maintained at:

- The Project Office; and
- The Site Camp.

The Register shall be accessible to stakeholders who wish to lodge complaints in person. The register will track:

- Date of complaint;
- Nature of complaint;
- Responsible unit;
- Action taken;
- Resolution status;
- Date of closure.

The register shall be reviewed periodically by REA-PMU and project management to ensure timely resolution and identification of recurring issues.

7.13.7 Maintaining a Grievance Register

All grievances received under the Project shall be formally recorded in a Grievance Register maintained at the project office and site. The Grievance Register shall serve as an official tracking tool and shall contain, at a minimum:

- Unique case identification number;
- Date of receipt;
- Name and contact details of complainant (where provided);
- Description of grievance;
- Category of grievance (environmental, social, labor, GBV-related, etc.);
- Responsible person/unit assigned;
- Status of grievance (open, under investigation, resolved, closed);
- Actions taken;
- Date of resolution and closure.

The Register shall be updated at every stage of the grievance redress process to ensure traceability and transparency. Upon entry into the Register, a preliminary review shall be conducted by the Social Safeguards Officer (or designated Safeguards Manager) to determine:

- Whether the grievance falls within the scope of the Project GRM;
- The level of severity and urgency;

- The appropriate unit responsible for handling the grievance.

If required, grievances may be escalated to higher project authorities or the REA-PMU depending on their complexity. The Grievance Register shall be periodically reviewed during internal audits and environmental and social monitoring exercises.

7.13.8 Acknowledgment of Grievance

Upon formal registration of a grievance, the complainant shall receive an acknowledgment of receipt within a reasonable timeframe (typically within 48 hours of submission). The acknowledgment shall include:

- Confirmation of receipt;
- Assigned case number;
- Summary of the grievance as recorded;
- Proposed timeline for response;
- Contact details of the responsible officer.

This acknowledgment may be provided:

- In writing;
- Via email;
- Through SMS (where applicable);
- Verbally (if the grievance was submitted verbally), followed by documentation.

Box 9.1: Acknowledgement Receipt for Claimant

Acknowledgment of Grievance Receipt

- Case Number: _____
- Date Received: _____
- Name of Complainant: _____
- Summary of Grievance: _____
- Responsible Officer: _____
- Expected Date of Response: _____

We confirm receipt of your grievance and assure you that it will be reviewed and addressed in accordance with the Project's Grievance Redress Mechanism.

Signature of Grievance Officer: _____
Date: _____

If a grievance is determined to be outside the scope of the Project GRM (for example, matters unrelated to project activities), the complainant shall be formally notified.
In such cases:

- A written explanation shall be provided;
- The complainant shall be advised on alternative redress mechanisms (e.g., appropriate regulatory authority or institutional body);
- The case shall be recorded as "Out of Scope" in the Grievance Register.

This ensures transparency while maintaining the integrity of the GRM.

7.14 Site Inspection and Resolution

For the purpose of verifying and resolving grievances received under the Project, a site inspection may be conducted where necessary. However, site inspection shall not be mandatory in all cases. The requirement for inspection shall depend on:

- The nature of the grievance;
- The level of severity;
- Whether physical verification is required to determine validity.

Where deemed necessary, a site inspection shall be undertaken by:

- The Site-level Community Liaison Officer; or
- A Project team member assigned by the Social Safeguards Officer.

The objective of the site inspection shall be to:

- Verify the authenticity of the grievance;
- Assess its severity;
- Engage with affected stakeholders;
- Collect relevant evidence.

During the inspection process, discussions may be held with the complainant and other relevant external stakeholders to fully understand the issue. The site inspection shall be conducted within ten (10) working days of receiving the grievance. Following the inspection, the assigned officer shall collaborate with relevant Project personnel to investigate the matter and identify appropriate corrective or remedial measures. The personnel involved in grievance resolution shall depend on the category of grievance, as presented in Table 7.16.

Table 7.17: Classification and Categorization of External Grievances

S/N	Nature of Grievance	Responsible Entity / Categorization
1	Compensation-related issues	Environmental and Social Safeguard Officers
2	Resettlement implementation matters (if applicable)	University Management, Project Management, Social Safeguard Officer, Contractor
3	Compensation due to damage to community property, vegetation or infrastructure	Contractor, Environmental and Social Safeguard Officers
4	Environmental impacts, community health concerns, cultural/customary issues, access to land or resources	Project Management, Environmental and Social Safeguard Officer
5	Migrant worker-related issues	Contractor, Social Safeguard Officer

S/N	Nature of Grievance	Responsible Entity / Categorization
6	Sexual Harassment / GBV / SEA / SH	Contractor's HR Representative, Dedicated Gender/GBV Officer, PMU Social Safeguard Officer
7	Other project-related concerns	Contractor, Environmental and Social Safeguard Officers, Project Manager

7.14.1 Resolution, Escalation and Closure

Upon completion of the site inspection and investigation, the Social Safeguards Officer, in consultation with relevant departments, shall determine an appropriate resolution. Resolution measures may include:

- Clarification through provision of additional information;
- Corrective actions to remedy identified problems;
- Financial compensation (where justified);
- Compensation in-kind;
- Implementation of mitigation measures to prevent recurrence.

The proposed resolution shall be communicated to the complainant within ten (10) working days after completion of the investigation.

❖ **Escalation Procedure**

Where the grievance cannot be resolved at the site level:

- The matter shall be escalated to the REA Project Management Unit (REA-PMU).
- The complainant shall be formally informed of the escalation.

The REA-PMU shall endeavour to resolve the grievance within ten (10) working days of escalation. If the grievance remains unresolved after PMU review:

- A written response shall be provided explaining the outcome;
- Alternative dispute resolution mechanisms shall be suggested;
- The complainant shall retain the right to seek redress through legally recognized mediation or judicial channels.

At any stage of the process, the complainant may request escalation to a higher level if dissatisfied with the outcome. Where a grievance is determined to be unfounded after investigation, a clear and documented explanation shall be provided to the complainant.

7.14.2 Update of Records

The Grievance Register shall be updated on a weekly basis to reflect:

- Current status of grievances;
- Actions taken;
- Pending investigations;
- Resolved cases.

Once a grievance has been resolved and the resolution communicated to the complainant, the case shall be formally closed in the Register. The Register shall document:

- How the grievance was addressed;
- Corrective actions implemented;
- Lessons learned.

These records shall serve as references for handling similar grievances in the future. Where recurring grievances or systemic issues are identified, such trends shall be reported to the REA-PMU to determine whether adjustments to project design, mitigation measures, or implementation procedures are required to prevent further occurrence.

CHAPTER EIGHT
SUMMARY AND CONCLUSION

8.1 Summary

The Environmental and Social Impact Assessment (ESIA) of the proposed 5 MW Solar Photovoltaic Hybrid Power Plant at the Federal University of Technology (FUT) Babura, Jigawa State has been undertaken to ensure compliance with applicable government regulations, financier requirements, institutional policies, and stakeholder expectations. The assessment integrates environmental and social considerations into project planning, design and implementation to promote sustainable development.

The study was conducted in accordance with the Nigerian Environmental Impact Assessment Act (Cap E12 LFN 2004), which mandates Environmental Impact Assessment for projects of this nature with the potential to generate significant environmental and social effects. In addition, the ESIA process has been aligned with relevant international safeguard requirements, including the African Development Bank's Integrated Safeguards System.

The primary objective of the ESIA has been to provide adequate, reliable and scientifically sound information to guide informed decision-making and to ensure that the Project is environmentally sustainable and socially responsible throughout its life cycle. Extensive consultations were undertaken with relevant stakeholders including University management, staff, students, regulatory authorities and other interested parties. These consultations facilitated transparent communication, identification of concerns, and incorporation of stakeholder inputs into project planning. Stakeholder engagement shall continue throughout the project lifecycle to ensure sustained participation and accountability.

Baseline environmental and social conditions within the project area were established through detailed field investigations, sampling, stakeholder surveys, and review of secondary data sources. The baseline information generated provides a benchmark against which future environmental and social performance of the Project will be monitored. The interaction between project activities and environmental and socio-economic receptors was systematically assessed using established impact identification and evaluation methodologies. Potential adverse and beneficial impacts were identified, characterized and evaluated across the pre-construction, construction, commissioning, operational and decommissioning phases of the Project.

Appropriate mitigation measures were developed in accordance with best industry practice, applicable standards, available technology and Health, Safety and Environment (HSE) considerations. Where necessary, mitigation measures have been integrated into project design and operational planning. An Environmental and Social Management Plan (ESMP) has been developed as part of this ESIA to provide a structured framework for implementing mitigation measures, monitoring environmental performance, and managing social risks. The ESMP outlines institutional responsibilities, monitoring parameters, reporting requirements and cost implications. Monitoring of key environmental indicators such as air quality, noise levels and groundwater conditions shall be undertaken in compliance with FMEnv standards and applicable international requirements.

Based on the findings of this assessment, and subject to full implementation of the recommended mitigation and management measures, the proposed 5 MW Solar PV Hybrid Power Plant at FUT Babura is not anticipated to result in significant irreversible environmental or social impacts. It is therefore concluded that the Project is environmentally and socially feasible and can proceed to implementation upon acquisition of the necessary regulatory approvals and permits.

8.2 Conclusion

In conclusion, the proposed 5-Megawatt Solar Photovoltaic Power Plant at Federal University of Technology Babura is an environmentally sound, socially beneficial, and strategically important project that will substantially improve electricity reliability, reduce long-term energy costs, eliminate on-site greenhouse gas emissions, enhance campus security, and contribute to Nigeria's national climate commitments. The comprehensive environmental and social assessments, robust mitigation measures, institutional safeguards, and stakeholder engagement processes documented in this ESIA provide a solid foundation for responsible and sustainable implementation.

The Federal Government of Nigeria, through the Rural Electrification Agency, commits to ensuring that the proposed 5-Megawatt Solar Photovoltaic Power Plant at Federal University of Technology Babura is developed and operated in an environmentally sustainable manner, in full compliance with the Environmental Impact Assessment Act (CAP E12 LFN 2004), National Environmental Standards and Regulations Enforcement Agency (NESREA) requirements, and internationally recognized Environmental and Social Safeguard Standards. The project will properly manage all processes that may cause environmental disturbance through implementation of the recommended mitigation measures and the ESMP. The project is therefore recommended for immediate environmental and regulatory approval.

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APPENDIX

APPENDIX I: SOCIO-ECONOMIC QUESTIONNAIRE SAMPLE

SOCIO-ECONOMIC IMPACT ASSESSMENT QUESTIONNAIRE OF THE PROPOSED PREPARATION OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THIRTEEN (13) FEDERAL UNIVERSITIES IN THE PROPOSED NIGERIA ELECTRIFICATION PROJECT (DESERT TO POWER) PHASE II UNDER THE RURAL ELECTRIFICATION AGENCY – LOT 1, AT (FEDERAL UNIVERSITY BIRNIN-KEBBI KEBBI STATE)

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). As part of the exercise, BOLBEN Energy and Environmental Services Limited is saddled with the responsibility of identifying the potential socio-economic impacts of the project on the local communities. Therefore, your assistance is required in filling out this brief survey. The questionnaire can be completed by ticking in the preferred boxes like this √ and providing appropriate answers in the available spaces.

Section A: Background Information

1. Name of Community .....

2.Gender (a) Male ☐ (b) Female ☐

3. Age (a) 18 – 30 yrs.☐ (b) 31 – 45 Yrs. ☐ (c) 46 – 54 Yrs. ☐ (d) 55 Yrs. and above ☐

4.Marital Status: Married ☐ Single ☐ Separated ☐ Widowed ☐

5.Family Pattern: Joint/Extended ☐ Nuclear ☐ Individual ☐

6. Household size: Large (Above 9) ☐ Medium (5-8) ☐ Small (2 – 4) ☐

7. Religion: (a) Christianity ☐ b) Islam ☐ (c) Traditional ☐ (d) Other (specify).....

8. Education: (a) Informal Education ☐ (d) NCE/ND ☐
(b) Primary School ☐ (e) HND/B.Sc. ☐
(c) Secondary School ☐ (f) Others (Specify) .....

9. Occupation: (a) Farming ☐ (b) Trading ☐ (c) Civil Servant ☐ (c) Student ☐
Others (Specify) .....

10. Monthly Income: (a) ₦0 - ₦30, 000☐ (b) ₦31, 000- ₦60,000☐ (c) ₦ 61, 000-₦90, 000 ☐
(d) ₦120,000 and above ☐

11. Duration of stay in the community/institution (a) 1-5 Yrs. ☐ (b) 6–10 Yrs. ☐ (c) 11–19 ☐
(d) 20 and above ☐

12. Types of language spoken in the communities; Hausa ☐ Zarma/Dendi ☐ Cllela, Fulfulde, ☐
Reshe/Cishingini ☐ English, ☐ Others.....

Section B: Health Status

13.What is the health facility available in your community/institution (a) Primary Health Centre ☐
(b) General Hospital ☐ (c) Private Hospitals ☐ (d) Sick bay ☐
(e) Others(Specify).....

1

SOCIO-ECONOMIC QUESTIONNAIRE SAMPLE CONTINUE.....

14. Condition of the health facility within the community/Institution; Very Good ☐ Good ☐
Fair ☐ Poor ☐

15. How do you manage your conditions when you are sick (a) Attend clinic/hospital ☐

(b) Traditional medicine ☐ (c) Buy drugs from nearby chemist ☐

(d) Others (specify) ..... Please tick the health conditions you experience most frequently.

Health Conditions	Tick	Health Conditions	Tick	Others (specify)
Malaria		Tuberculosis		
Typhoid fever		Hypertension		
Cholera		Asthma		
Rheumatism		Meningitis		
Pneumonia		Rashes		

16. Do you think the proposed project will have a negative impact on your health/environment?
(a) YES ☐ (b) NO ☐

If yes, how? (a) Air Pollution ☐ (b) Noise Pollution ☐ (c) Ground water contamination

(d) Surface water contamination ☐ (e) others (specify) .....

17. How do you think these impacts can be averted .....,

.....

Section C: Gender Based Violence

18. Have you or anyone in your household had experienced gender-based violence?
(a) YES ☐ (b) NO ☐

19. Do you think men and women have equal access to economic opportunities in your community/institution? (a) YES ☐ (b) NO ☐

20. Do you believe that cultural norms in your community/institution influence the prevalence of GBV?

(a) YES ☐ (b) NO ☐

21. Are there adequate support services available for survivors of GBV in your community/institution?
(a) YES ☐ (b) NO ☐

Section D: Public Services

22. What is the source of water supply in your community/institution? (a) Well ☐ (b) Borehole ☐ (c) River/Stream ☐
(d) Others (specify) .....
23.Condition of portable water within the community/Institution: Very Good, Good, Fair, Poor

24.What is the available source of power in the community/institution? (a) Discos ☐ (b) Generator ☐
(c) Lantern ☐ (d) Candle ☐ (e) Solar power ☐ (f) Others (specify).....

25.Condition of Public electricity within the community/Institution: Very Good, Good, Fair, Poor
26.Sanitation facility in the community/institution; Water closet, pit latrine, open defecation others

27.What is the most available/affordable source of cooking? (a) Firewood ☐ (b) Gas cooker ☐

2

SOCIO-ECONOMIC QUESTIONNAIRE SAMPLE CONTINUE.....

(c) Stove ☐ (d) Charcoal ☐ (e) Others (specify) .....

28.What are the educational institutions available in your community/institution? (a) Primary school ☐

(b) Secondary school ☐ (c) Tertiary Institution ☐ (d) Others (specify).....

29.Waste disposal method; Bush, Burning, Public open dump, Private Open dump, Organized collection, Burying, others

Section E: Existing Socio-Economic Condition of the Study Area

30. Indicate the traditional economic activity practiced by member so the community/institution:
(a) Traditional Craft Work ☐
(b) Farming ☐
(c) Mining ☐
(d) Fishing ☐
(e) Others (specify) .....

31. Traditional laws/ Spiritual (Sacred) places are still observed strictly in the local communities/institution
(a) YES ☐ (b) NO ☐

32. Do you think the proposed project will affect any valued resources/ cultural assets / archeological sites within the community/institution? (a) YES ☐ (b) NO ☐

If yes, mention the name(s) of the resources.....

33. How will the valued resources / cultural assets/ archeological sites be affected? (a) displacement of such cultural assets ☐ (b) vandalization of sacred items/locations ☐ (c) possible theft of sacred/ archeological items ☐ (d) other (specify).....

Section F: Potential Socio-Economic Impact of the Proposed Project

34. Do you think the community/institution members are fully aware of the new project to be developed in their locality? (a)YES ☐ (b) NO ☐

35. What do you think is the socio-economic benefit of the project? (a) Easy access to Clean, reliable and sustainable electricity ☐ (b) Employment opportunity ☐ (c) Economic growth ☐
(d) Other(specify).....

36.Indicate the social associations existing in your community/institution: (a) Youth Association ☐
(b) Women Association ☐ (c) Farmers Association ☐ (d) Others Specify .....

37.Which neighboring communities/institution do you think will benefit from the new developmental project?

.....

3

APPENDIX II: LABORATORY ANALYSIS RESULTS (WATER SAMPLES)

MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE

POLLUTION CONTROL LABORATORY

Address: Farm Centre, Near Cool FM, Kano State.
Tel: +2347030166686

*Our Ref:*_____ *Your Ref:*_____ *Date:*_____

CLIENT:	RURAL ELECTRICATION AGENCY (REA) ON BEHALF OF FEDERAL GOVERNMENT OF NIGERIA.
PROJECT NAME:	NIGERIAN ELECTRIFICATION PROJECT (NEP) PHASE II (DESERT TO POWER), ESIA FOR THE ENERGIZING EDUCATION PROGRAMMED.
PROJECT ADDRESS:	FEDERAL UNIVERSITY OF TECHNOLOGY (FUT), BABURA, JIGAWA STATE.
DATE:	6TH FEBRUARY, 2026.

LABORATORY ANALYSIS RESULTS CONTINUES……..
(WATER SAMPLES)

WATER QUALITY ASSESSMENT RESULT

Sample Quantity: 65cl **Preservation Method:** ICEING

Please find below the result of water Quality Assessment on your Samples on the Condition submitted to the Laboratory.

S/N	Parameters	Unit	GW_1 S_1	GW_2 S_2	GW_3 S_3	FMENT Limit
a)	**Coordinates**					
1	Latitude	N	12.740908	12.743804	12.744791	-
2	Longitude	E	9.014429	9.010230	9.004455	-
3	Altitude	M	439.3	486.1	486.5	-
a)	**Physicochemical Test**					
4	Colour	TCU	Clear	Clear	Clear	Clear
5	Odour	-	Odourless	Odourless	Odourless	Unobjectionable
6	Taste	-	Tasteless	Tasteless	Tasteless	Unobjectionable
7	Turbidity	NTU	0	0	1	50
8	pH	-	7.13	6.31	5.27	6.5 – 8.5
9	Temperature	^0C	34.5	32.5	29.8	Ambient
10	Dissolve Oxygen	mg/L	4.0	3.7	3.8	2 – 5
11	Total Dissolve Solid	mg/L	56	45	281	500
12	Electrical Conductivity	µs/cm	112	90	562	1000
13	Total Suspended solid	mg/L	0	0	4	20
14	Salinity	mg/L	0.00	0.00	0.07	<1000
15	ORP (MV)	mg/L	98	85	228	200 – 600
16	B.O.D	mg/L	2.1	2.0	2.5	NS
b)	**Chemical Test**					
17	Ammonium (NH_4^+)	mg/L	0.001	0.00	0.002	NS
18	Potassium (K^+)	mg/L	0.0	0.0	0.1	20
19	Calcium (Ca^{2+})	mg/L	2.1	1.8	0.6	200
20	Sodium (Na^+)	mg/L	4	2	9	20

LABORATORY ANALYSIS RESULTS CONTINUES……
(WATER SAMPLES)

21	Magnesium (mg^{2+})	mg/L	0.8	0.3	1.8	20
22	Sulphate (SO_4^{2+})	mg/L	5	7	13	100
23	Nitrate (NO_3^{2-})	mg/L	2.1	3.0	2.2	50
24	Chloride (Cl^-)	mg/L	0.0	0.0	0.1	150
25	Phosphate (PO_4^{2-})	mg/L	0.28	0.22	0.49	NS
26	Nitrite (NO_2^-)	mg/L	0.1	0.0	0.1	0.2
c)	**Heavy Metal**					
27	Zinc (Zn^{2+})	mg/L	0.141	1.201	0.224	3.0
28	Iron (Fe^{2+})	mg/L	0.01	0.01	0.02	0.3
29	Cupper (Cu^{2+})	mg/L	0.01	0.01	0.02	1.5
30	Chromium (Cr^{3+})	mg/L	0.04	0.02	0.04	0.05
31	Lead (Pb^{2+})	mg/L	0.000	0.000	0.000	0.01
32	Cobalt	mg/L	0.05	0.52	0.07	0.2
33	Mercury	µg/L	0.000	0.000	0.000	0.001
34	Nickel	mg/L	0.001	0.000	0.000	0.07
d)	**Organics**					
35	Oil and Grease	mg/L	0	0	0	10
36	Benzene	mg/L	0.00	0.00	0.00	0.01
37	Toluene	mg/L	0	0	0	0.7
38	Ethylbenzene	mg/L	0.000	0.000	0.000	0.30
39	Xylene	mg/L	0.0	0.0	0.0	0.5
40	Phenols	mg/L	0.001	0.000	0.000	0.05
e)	**Microbiological Test**					
41	E. Coli	Cfu/ml	0	0	0	Nil
42	Feacal Coliform	Cfu/ml	0	0	0	Nil
43	Total Coliform	Cfu/ml	1	0	3	10

APPENDIX III: LABORATORY ANALYSIS RESULTS (SOIL SAMPLES)

GENERAL SOIL QUALITY ASSESSMENT RESULT/TEST

Sequel to the Analysis conducted on the soil samples before and After digestion, below are data obtained.

S/N	Parameters	Unit	L_1B	L_1T	L_2B	L_2T	L_3B	L_3T	L_4B	L_4T	L_5B	L_5T
a)	**Coordinates**											
1	Latitude	N	12.72977	12.72977	12.73471	12.73471	12.76243977	12.76243	12.78582	12.78582	12.70071	12.70071
2	Longitude	E	9.00503	9.00503	9.00541	9.00541	9.00555	9.00555	9.00532	9.00532	9.00562	9.00562
3	Elevation	M	474.1	473.1	450.4	450.6	464.0	465.7	465.6	465.3	457.0	457.3
b)	**Physical Test**											
4	Colour	TCU	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
5	pH	-	6.18	5.93	6.61	5.76	5.30	5.84	6.17	5.16	4.88	5.37
6	Electrical Conductivity	µs/cm	808	490	834	978	846	1487	1165	580	727	832
7	Temperature	^0C	32.8	30.8	31.7	30.4	30.2	30.2	30.8	32.1	32.3	31.7
8	ORP	MV	164	148	231	188	208	161	192	206	280	222
9	Salinity	%	0.03	0.02	0.04	0.04	0.04	0.07	0.06	0.02	0.03	0.04
c)	**Exchangeable Cation**											
10	Calcium (Ca^{2+})	mg/kg	0.22	0.82	0.14	0.60	0.45	0.40	0.22	0.60	0.42	0.44
11	Magnesium (mg^{2+})	mg/kg	0.12	0.41	0.08	0.30	0.22	0.19	0.13	0.28	0.19	0.22
12	Sodium (Na^+)	mg/kg										
13	Potassium (K^+)	mg/kg	0.7	1.4	0.2	1.0	0.7	0.7	0.4	1.0	0.7	0.7
14	Ammonium (NH_4^+)	mg/kg	0.0004	0.0032	0.0125	0.0062	0.0031	0.0024	0.000	0.000	0.0140	0.003
d)	**Exchangeable Anion**											
15	Sulphate (SO_4^{2-})	mg/kg	8	23	5	15	13	13	10	20	14	16
16	Phosphate (PO_4^{2-})	mg/kg	0.66	0.47	0.42	0.61	0.58	0.78	0.39	0.55	0.32	0.30
17	Nitrate (NO_3^{2-})	mg/kg	1.7	5.4	1.3	4.0	3.1	3.3	1.7	3.2	2.4	2.8
18	Nitrite (NO_2^-)	mg/kg	0.08	0.23	0.05	0.15	0.13	0.13	0.10	0.20	0.14	0.16
19	Chloride (Cl^-)	mg/kg	0.13	0.5	0.89	0.53	0.55	0.04	0.01	0.56	0.82	0.11
	Organics											
20	Phenols	mg/kg	0.000	0.010	0.006	0.003	0.014	0.006	0.053	0.000	0.001	0.013
21	Calcium Carbon	mg/kg	37	15	64	21	9	33	47	2	18	21
22	Oil & Grease	mg/kg	0	0	0	0	0	0	0	0	0	0

LABORATORY ANALYSIS RESULTS CONTINUES……

(SOIL SAMPLES)

f)	**Heavy Metals**											
23	Iron	mg/kg	0.106	0.142	0.148	0.148	0.193	0.219	0.177	0.234	0.199	0.154
24	Cupper	mg/kg	0.24	0.48	0.37	0.48	0.52	0.47	0.33	0.35	0.27	0.41
25	Chromium	mg/kg	0.01	0.04	0.01	0.02	0.04	0.03	0.05	0.05	0.04	0.05
26	Zinc	mg/kg	0.02	0.11	0.02	0.11	0.12	0.10	0.07	0.14	0.08	0.06
27	Cobalt	mg/kg	0.010	0.030	0.001	0.074	0.016	0.000	0.000	0.000	0.000	0.000
28	Nickel	mg/kg	0.013	0.019	0.011	0.016	0.017	0.012	0.010	0.017	0.013	0.016
29	Mercury	µg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	Lead	µg/kg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
g)	**Soil Characteristic**											
31	Loam	%	37	29	26	23	35	41	33	41	27	29
32	Sandy	%	0	0	3	2	6	2	3	1	6	3
33	Clay	%	38	41	39	42	33	40	43	52	30	39
34	Silt	%	25	30	32	33	32	17	21	6	37	29
h)	**Microbiological Test**											
35	E. Coli	Cfu/ml	4	7	2	6	4	4	2	2	1	2
36	Fungal	Cfu/ml	86	252	75	219	183	165	69	68	56	71

Key:

GWS: Ground Water Sample

Mg/L: Milligram per litre

Mg/kg: milligram per kilogram

µg/L: Microgram per Litre

µg/kg: Microgram Kilogram

TCU: True Colour Unit

µS/cm: Micro Siemens per centimeter

LABORATORY ANALYSIS RESULTS CONTINUES…….
(WATER AND SOIL SAMPLES)

NTU: Nephlometric turbidity Unit

Cfu/ml Coliform Forming Unit per 100ml

Best Regards,

POLLUTION CONTROL
LABORATORY, MRI, E KANO
SIGN
DATE

San. Abdulkadir H. Umar
Asst. Chief Scientific Officer

APPENDIX IV: FIELD ACTIVITIES ATTENDANCES

BOLBEN ENERGY
AND ENVIRONMENTAL SERVICES LTD

SITE VERIFICATION/DATA GATHERING ATTENDANCE SHEET

PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THIRTEEN (13) FEDERAL UNIVERSITIES IN THE PROPOSED NIGERIA ELECTRIFICATION PROJECT (DESERT TO POWER) PHASE II UNDER THE RURAL ELECTRIFICATION AGENCY – LOT 1

LOCATION: FEDERAL UNIVERSITY OF TECHNOLOGY BABURA JIGAWA STATE

DATE: 5/2/2026

S/N	NAME	ORGANIZATION	DESIGNATION	EMAIL ADDRESS	PHONE NO.	SIGN
1.	Prof. Sabo Ibrahim [illegible]	Fed. Univ, Tech, Babura	VC	vc@futb.edu.ng	08033608146	
2.	PROF. BALA SIDI ALIYU	" " " "	DVC	BALASIDI@GMAIL.COM	08028333080	
3.	QS. Shehu Adamu	" "	Director PPU	Shehubaye [illegible]	08064792167	
4.	Jamilah [illegible]	FMEnv	Scientific Officer	[illegible]@gmail.com	08037016742	
5.	Engr. Dr. Nureddeen o. Ahmed	Bolben Ltd.		[illegible].o.ahmed@gmail.com	07063047816	
6	Muhammad Sani Mohd	Bolben Energy Ltd	Field officer	Muhd Sani Muhammad	08032587748	

BOLBEN ENERGY
AND ENVIRONMENTAL SERVICES LTD

SITE VERIFICATION/DATA GATHERING ATTENDANCE SHEET

PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THIRTEEN (13) FEDERAL UNIVERSITIES IN THE PROPOSED NIGERIA ELECTRIFICATION PROJECT (DESERT TO POWER) PHASE II UNDER THE RURAL ELECTRIFICATION AGENCY – LOT 1

LOCATION: FEDERAL UNIVERSITY OF TECHNOLOGY BABURA JIGAWA STATE

DATE: 8/2/2026

S/N	NAME	ORGANIZATION	DESIGNATION	EMAIL ADDRESS	PHONE NO.	SIGN
1	Mustapha Ismail	F.M Environment Jigawa	Field [illegible]	mustaphaismaeel@gmail.com	08033469574	
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4	Musa Clement Ndak	Bolben	Surveyor	clementism83@gmail.com	08139013785	
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6	Misbahu Abdulkarim	Bolben	Geologist [illegible]	misbahuabdulkarim[illegible]@gmail.com	07013359771	
7	Muhammad Sani Mohd	Bolben Energy Ltd	Field manager	Muhdsani[illegible]@gmail.com	08032587748	
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BOLBEN ENERGY
AND ENVIRONMENTAL SERVICES LTD

SITE VERIFICATION/DATA GATHERING ATTENDANCE SHEET

PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THIRTEEN (13) FEDERAL UNIVERSITIES IN THE PROPOSED NIGERIA ELECTRIFICATION PROJECT (DESERT TO POWER) PHASE II UNDER THE RURAL ELECTRIFICATION AGENCY – LOT 1

LOCATION: FEDERAL UNIVERSITY OF TECHNOLOGY BABURA JIGAWA STATE

DATE: 6/2/2026.

S/N	NAME	ORGANIZATION	DESIGNATION	EMAIL ADDRESS	PHONE NO.	SIGN
1.	SAFIYANU MUHD	GGASS, BABURA	VICE PA.	Safiyanumuhammad[illegible]@gmail.com	08032338752	
2.	MAI ANGUWA	YANMABU COMMUNITY				

APPENDIX V: PICTORIAL EVIDENCE OF STAKEHOLDER CONSULTATION

BOLBEN TEAM, The Institution Management and Ministry of Environment Team

PICTORIAL EVIDENCE OF STAKEHOLDER CONSULTATION CONTINUES..... (WITH FUT BABURA STUDENTS)

Consultation with students

PICTORIAL EVIDENCE OF STAKEHOLDER CONSULTATION CONTINUES.

Stakeholders Consultation with the Community.

APPENDIX VI: PICTORIAL EVIDENCE OF DATA GATHERING ACTIVITIES CONTINUES (SOIL EXTRACTION)

APPENDIX VII: PICTORIAL EVIDENCE OF DATA GATHERING ACTIVITIES (AIR/NOISE SAMPLING)

APPENDIX VIII: PICTORIAL EVIDENCE OF DATA GATHERING ACTIVITIES (WATER COLLECTION)