NIGERIAN ELECTRIFICATION PROJECT (NEP)

RURAL ELECTRIFICATION AGENCY

ENERGY = EMPOWERMENT = EFFICIENCY

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

OF THE PROPOSED

1 MW SOLAR-HYBRID POWER PLANT AND ASSOCIATED INFRASTRUCTURE

At

FEDERAL UNIVERSITY BIRNIN-KEBBI (FUBK), KEBBI 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)
Kilovolt	(Kv)
Kilowatt	(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
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
FMC	Federal Medical Centre
FMEnv	Federal Ministry of Environment
GPS	Global Positioning System
HF	High Frequency
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
NSITF	National Social Insurance Trust Fund
NUC	National University Commission
O&M	Operations and maintenance
PAPs	Project Affected Persons

PCT	Plant Community Type
PESCP	Progressive Erosion and Sediment Control Plan (aka ESCP)
PMP	Project Management Plan
POCR	Pre-operation Compliance Report
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 from 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

Nigeria continues to face significant challenges in achieving reliable and sustainable electricity supply to meet growing national demand. Despite substantial installed generation capacity, actual delivered power remains insufficient due to infrastructure deficits, transmission bottlenecks, and distribution inefficiencies. Consequently, institutions and commercial entities rely heavily on self-generation through diesel and petrol generators, resulting in high operational costs, greenhouse gas emissions, noise pollution, and localized air quality deterioration.

In response to these challenges, the Federal Government of Nigeria (FGN) has adopted policies and programmes aimed at promoting renewable energy development and decentralized electrification. A key intervention in this regard is the Nigeria Electrification Programme (NEP), a significant initiative designed to bridge the energy access deficit across the country. The NEP is a private sector-driven programme that seeks to provide reliable electricity services to households, Micro, Small and Medium Enterprises (MSMEs), educational institutions, and healthcare facilities located in underserved and unserved communities. The programme supports increased access to electricity through the deployment of mini-grids, standalone Solar Home Systems (SHS), rooftop solar systems, captive power plants, and productive-use appliances.

The Nigeria Electrification Programme forms part of the African Development Bank (AfDB) broader engagement in Nigeria's power sector and has laid the foundation for subsequent large-scale renewable energy interventions. Notably, the programme serves as a precursor to the Desert to Power Initiative, a transformative regional renewable energy programme aimed at harnessing the abundant solar resources of Northern Nigeria and the wider Sahel region to expand electricity access, stimulate economic growth, and strengthen climate resilience. Building on the achievements of the NEP, the Rural Electrification Agency (REA), under the Desert to Power Initiative (Phase II), proposes the installation of a 1-Megawatt (MW) Solar-Hybrid Photovoltaic (PV) Power Plant and associated infrastructure within the premises of the Federal University Birnin Kebbi (FUBK), Kebbi State.

The Desert to Power Initiative is a strategic renewable energy programme aimed at harnessing the high solar irradiation potential of Northern Nigeria to improve electricity access while contributing to national energy transition and climate commitments. Kebbi State lies within the Sudan Savannah ecological zone and experiences high solar insolation averaging between 5.5 and 6.5 $kWh/m^2/day$, making it technically suitable for utility-scale and institutional solar photovoltaic deployment.

The Energizing Education Programme (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 programme, beneficiary institutions will receive:

- Utility-scale solar-hybrid mini-grid systems with a minimum of 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 1 Megawatt (MW) Solar-Hybrid Power Plant and Associated Infrastructure at the Federal University Birnin-Kebbi (FUBK), Birnin Kebbi, Kebbi State, North-West Nigeria. The proposed Project will occupy approximately 25.2 hectares of land (Site A: 13 hectares for the 1 MW facility; Site B: 12.2 hectares for future expansion) within the permanent campus of FUBK in Birnin Kebbi Local Government Area, Kebbi State.

The 1 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 (244 streetlights: 229 single-arm and 15 double-arm);
- 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 campus safety and security;
- 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, 2023), 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 1 MW Solar-Hybrid Power Plant at the Federal University Birnin-Kebbi (FUBK), Kebbi State, North-West Nigeria, 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) **NESREA-** The National Environmental Standards and Regulations Enforcement Agency (NESREA) were established in 2007 by the FGN as a parastatal of the FMEnv. The Agency is charged with the responsibility of enforcing the environmental laws, guidelines, standards and regulations in Nigeria, specifically during the operational phase of developmental projects.

f) **National Policy on the Environment 2016** – Establishes Nigeria's environmental management principles...

g) **Climate Change Act 2021** – Provides legal framework for achieving low greenhouse gas emissions and climate-resilient development.

h) **Natural Resources Conservation Act CAP 349 LFN 1990** – Protects ecological resources and biodiversity.

i) **Nigeria's Nationally Determined Contribution (NDC 3.0), submitted in 2025 under the Paris Agreement -** sets out the country's current mitigation and adaptation commitments and identifies increased renewable-energy deployment and reduced dependence on carbon-intensive energy sources as important elements of the national transition. The proposed 1 MW solar-hybrid project supports these objectives by increasing renewable electricity generation within FUBK and reducing reliance on diesel-based backup generation to the extent that solar electricity displaces such generation.

   The actual greenhouse-gas reduction attributable to the Project will depend on the final plant configuration, annual electricity generated, dispatch arrangements, battery operation and the proportion and type of electricity displaced. Accordingly, no project-specific annual emissions-reduction figure is claimed at the ESIA stage. During operation, avoided emissions will be calculated using metered electricity generation, documented displaced-energy data and an appropriate, referenced emissions factor.

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

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

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

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

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

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

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

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

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

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

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

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

v) **Kebbi State Ministry of Environment Regulations** – State-level environmental oversight.
w) **Kebbi State Ministry of Lands and Survey Regulations** – Governs land allocation and surveying requirements.
x) **Birnin Kebbi 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 2012** – International benchmark for environmental and social risk management.
c) **International Union for Conservation of Nature (IUCN) Guidelines (2024)** – 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** – Labor standards and workers' rights.

The ESIA for the proposed 1 MW Solar-Hybrid Power Plant at Federal University Birnin-Kebbi (FUBK), Birnin Kebbi 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

The justification for the proposed 1 MW Solar-Hybrid Power Plant at the Federal University Birnin-Kebbi (FUBK), Kebbi 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 Federal University Birnin-Kebbi, 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 Federal University, FUBK 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 (NDCs) 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 1 MW solar-hybrid system at Federal University Birnin-Kebbi 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 Federal University Birnin-Kebbi. 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 (244 streetlights including 229 single-arm and 15 double-arm units) 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 Birnin-Kebbi and Kebbi State.
- **Institutional and Technical Collaboration:** The Project strengthens collaboration between
  - Federal Government of Nigeria (FGN)
  - Rural Electrification Agency (REA)
  - African Development Bank (AfDB)
  - Federal University Birnin-Kebbi
  - Relevant Ministries, Departments and Agencies (MDAs).
- **Climate Change Mitigation Contribution:** The 1 MW solar-hybrid plant is estimated to generate approximately 1.6–1.8 Gigawatt-hours (GWh) annually. The Project is expected to reduce greenhouse-gas emissions to the extent that solar electricity displaces diesel-based or other higher-emission electricity sources.

ES 3 PROJECT DESCRIPTION

The proposed 1 MW Solar-Hybrid Power Plant at the Federal University Birnin-Kebbi will address power challenges by providing a dedicated and cleaner source of electricity. The Project also supports Nigeria's Nationally Determined Contributions (NDCs) 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 Birnin-Kebbi, Birnin-Kebbi Local Government Area, North-West Nigeria. The proposed solar facility will occupy approximately 25.2 hectares of land within the University premises. Site A (13 hectares) is designated for the 1 MW Solar PV facility at coordinates: Longitude 12.338724°N, Latitude 4.149325°E. Site B (12.2 hectares) is designated for future expansion at coordinates: Longitude 12.346217°N, Latitude 4.153691°E.

The site lies within the Sudan/Sahel Savanna ecological zone and is characterized by semi-arid climatic conditions, high solar irradiance (averaging 5.5–6.5 kWh/m²/day), 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 Federal University Birnin-Kebbi will be established as a 1 MW solar-hybrid power system. The Project will consist of solar photovoltaic panels, lithium-ion battery storage, electrical infrastructure, and supporting facilities within the 25.2-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 Kebbi State.

ES 4 DESCRIPTION OF THE PROJECT EXISTING ENVIRONMENT

The description of the environmental and social conditions of the proposed 1 MW Solar-Hybrid Power Plant at the Federal University Birnin-Kebbi 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

A sufficiently complete, site-specific long-term NiMet dataset for the project area was not available for the assessment. Long-term climate trends were therefore characterised using the NASA POWER Data Access Viewer for the project-site coordinates, approximately Latitude 12.338724°N and Longitude 4.149325°E. Monthly data for the period 1995–2025 were extracted using the monthly temporal-resolution option for temperature, relative humidity, rainfall, wind speed and other relevant variables. The data were used to characterise regional climatic trends and were supplemented by field observations and available secondary information. The dataset provided a representative understanding of prevailing climatic trends relevant to the Federal University Birnin-Kebbi 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 Birnin Kebbi 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 (March–April when temperatures may exceed 40°C), while rainfall is moderate and seasonal (averaging 600–1200 mm annually). The high solar irradiance levels associated with this climatic regime (5.5–6.5 kWh/m²/day) 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 general geology of the project area is dominated by two formations; Pre-Cambrian Basement Complex in the south and south east and young sedimentary rocks in the north. The Basement Complex region is composed of very old volcanic and metamorphic rocks such as granites, schists, gneisses, quartzites and migmatites. In addition, there are metasediments such as phyllites and meta-conglomerates. The sedimentary region consists of rocks of the Gwandu, Illo and Rima groups whose ages range from the Cretaceous to the Eocene. The Gwandu group consists of massive clay grits interbedded with sandstone while the Illo and Rima groups consist of pebbly grits, sand stones and clays, mudstones and siltstones respectively. Minerals that can be found in the area include quartz, kaolin, piotolitic bauxite, clay, potassium, silica sand and salt.

Flora

The project site is characterized by a relatively homogeneous vegetation cover typical of the Sudan Savannah ecological zone. Vegetation consists mainly of drought-resistant shrubs and grasses during the dry season, while portions of the site are cultivated with cereal crops during the rainy season. Common plant species observed include *Guiera senegalensis*, *Senegalia mellifera*, and *Senna obtusifolia*. Tree cover is sparse and consists primarily of Neem (*Azadirachta indica*), Doum Palm (*Hyphaene thebaica*), and Baobab (*Adansonia digitata*). The vegetation within the project area is typical of the surrounding landscape and does not indicate the presence of sensitive or unique floral habitats.

Fauna

A comprehensive wildlife assessment was conducted across the proposed project area of influence, with the primary objective of documenting the faunal diversity, distribution, and conservation status prior to project development. Field investigations were carried out between 07:00 and 16:00 hours using a combination of direct and indirect survey techniques aligned with standard ecological methodologies (Moshby 1974; Sutherland 1997). The project site and its nearest community, Ugwan Jeji, have been subjected to prolonged anthropogenic activities, resulting in significant habitat disturbance.

Stakeholder Engagement

Stakeholder Consultation was carried out on the 5th February 2026 as an integral component of the ESIA process for the proposed 1 MW Solar-Hybrid Power Plant at FUBK. 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 1 MW Solar-Hybrid Power Plant at the Federal University Birnin-Kebbi 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.

Impact Evaluation Matrix

RISK MATRIX

1. Risk Assessment Matrix

Consequence ∠ / Likelihood →	Likelihood			
	1 – Improbable	2 – Occasional	3 – Probale	4 – Frequent
	Medium (2)	Medium (2)	High (3)	High (3)
4 – Major	Low (1)	Nedium (2)	High (3)	High (3)
3 – Moderate	Low (1)	Medium (2)	Medium (2)	High (3)
2 – Minor	Low (1)	Low (1)	Low (1)	Low (1)
1 – Negligible	Low (1)	Low (1)	Low (1)	Low (1)

2. Risk Rating Interpretation

Risk Level	Score	Description
High	3	Requires alternative approach/design and mitigation measures to minimize impact.
Medium	2	Requires mitigation measures.
Low	1	Proceed with care; apply standard controls. No additional mitigation required.

ES 6 MITIGATION MEASURES

The proposed mitigation measures for the 1 MW Solar-Hybrid Power Plant at Federal University Birnin-Kebbi address all significant environmental and social impacts identified during the assessment. The Rural Electrification Agency (REA) Project Management Unit (PMU) will supervise implementation of these measures, with the Engineering, Procurement and Construction (EPC) Contractor and later the Operations and Maintenance (O&M) Contractor responsible for execution. Key mitigation measures for high and moderate environmental and social risks anticipated for the project are summarized below:

- **Vegetation loss and disturbance to flora/fauna (High):** Restrict clearing to approved footprint; clearly demarcate work areas; prohibit unnecessary clearing, bush burning and herbicide use; rehabilitate disturbed areas using native species; sensitize workers on biodiversity protection.
- **Air pollution and dust generation (Moderate–High):** Use well-maintained equipment; suppress dust by water spraying; cover haulage trucks; limit vehicle speed; maintain equipment regularly; avoid unnecessary idling; monitor ambient air quality.
- **Noise pollution (High):** Restrict noisy activities to daytime; maintain equipment; install silencers where necessary; provide hearing protection; monitor workplace noise; notify affected campus users of noisy activities.
- **Occupational health and safety risks (High):** Implement comprehensive HSE Plan; provide appropriate PPE; conduct induction and toolbox training; enforce safe work procedures; use competent operators; install warning signs and barriers; prepare emergency response procedures and first-aid facilities.
- **Soil and groundwater contamination (High/Moderate):** Prevent spills using drip trays and secondary containment; safely manage batteries, oils and hazardous materials; provide spill kits; inspect storage areas; conduct groundwater monitoring where necessary; ensure proper disposal through licensed contractors.
- **Fire, explosion and electrical hazards (High):** Install fire detection and suppression systems; maintain emergency shutdown procedures; inspect electrical installations regularly; train personnel in emergency response; maintain firefighting equipment and emergency communication systems.
- **Employment loss during decommissioning (High):** Provide advance notice of closure; offer retraining and redeployment opportunities where possible; ensure prompt payment of all employee entitlements and benefits.
- **Community health and safety, including traffic risks (Moderate):** Implement a Traffic Management Plan; install traffic signs and flagmen; enforce speed limits; restrict heavy vehicle movement during peak university periods; maintain secure work zones and public access controls.
- **Gender-Based Violence (GBV), Sexual Exploitation and Labour Influx (Moderate):** Implement GBV Action Plan; enforce workers' Code of Conduct; appoint a GBV/Gender Officer; conduct awareness training; maintain confidential grievance mechanisms; provide gender-segregated sanitary facilities; collaborate with relevant service providers.
- **Solid and hazardous waste generation (Moderate):** Implement Waste Management Plan; segregate waste using colour-coded containers; recycle where practicable; store hazardous waste safely; use licensed waste contractors; maintain waste records; restore work areas after construction and decommissioning.

In addition, it shall be ensured that:

- The Health, Safety, and Environment (HSE) Policy remains in effect throughout the duration of the project.

- The Grievance Redress Mechanism (GRM) remains operational for the entire project lifecycle to address concerns raised by workers or stakeholders.
- The Gender-Based Violence (GBV) Action Plan continues to be enforced, and all employees adhere to the Code of Conduct. The Operations and Maintenance (O&M) Contractor will appoint a Gender/GBV Officer and maintain collaboration with relevant government institutions or service providers as needed. Gender-segregated sanitary facilities will be provided on-site.
- A robust Waste Management Plan (WMP) will be implemented and periodically reviewed to ensure effective management of operational waste, including battery replacement and end-of-life component disposal.
- Safety signage will be maintained at designated locations.
- All employees comply with established Standard Operating Procedures (SOPs).

Collectively, these mitigation measures are designed to minimize adverse environmental and social impacts associated with the proposed 1 MW Solar-Hybrid Power Plant at FUBK to acceptable levels, in compliance with national regulations and African Development Bank (AfDB) safeguard requirements

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 1 MW Solar-Hybrid Power Plant at the Federal University Birnin-Kebbi.

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;
- Estimated implementation costs.

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 Kebbi 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.

A total budget of US$53,340 has been earmarked for the implementation of the Environmental and Social Management Plan (ESMP). The budget covers pre-construction, construction, commissioning and initial operational phase environmental and social management activities, including monitoring, mitigation implementation, supervision, reporting, direct environmental controls, and capacity building as presented below:

S/N	ESMP Activity	Estimated Cost (USD)
1	Pre-Construction Phase ESMP Implementation (disclosure, staffing, approvals and early monitoring)	6,800
2	Construction Phase ESMP Implementation (environmental and social monitoring, mitigation implementation, supervision and reporting)	12,990
3	Operational Phase ESMP Implementation (environmental monitoring, waste management oversight and safety compliance)	12,800
4	Commissioning Phase ESMP Activities (inspection, testing oversight and reporting)	500
5	Direct Mitigation Measures (environmental controls, erosion protection, occupational safety measures, signage and related controls)	6,100
6	Capacity Building and Training	14,150
Total Estimated Cost		**53,340**

ES 8: REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

This chapter outlines the approach to decommissioning and post-closure remediation of the proposed 1-MW Solar Photovoltaic (PV) Power Plant at Federal University Birnin Kebbi (FUBK). It describes the anticipated decommissioning activities, identifies potential environmental and social impacts associated with such activities, and presents management and remediation measures to ensure that the Project site is restored to a safe and environmentally acceptable condition.

Although solar PV facilities are generally characterized by low operational emissions and limited long-term environmental risks, proper end-of-life planning is essential to prevent contamination, ensure safe dismantling of electrical systems, and promote responsible material recovery and recycling.

This chapter therefore provides:

- An overview of decommissioning activities;
- A framework for managing environmental and social risks during closure;
- Measures for remediation and site restoration;
- Provisions for used battery management;
- Alignment with applicable national regulations and good international practice.

ES 9 SUMMARY AND CONCLUSION

The proposed 1 MW Solar-Hybrid Power Plant under the Energizing Education Programme (EEP) at the Federal University Birnin-Kebbi 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.

Based on the strong environmental, social, economic, and climate benefits associated with the Project, and subject to full implementation of the ESMP, the proposed 1-MW Solar Hybrid Power Plant at Federal University Birnin-Kebbi is recommended for environmental approval and regulatory clearance.

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 1 MW Solar-Hybrid Power Plant at the *Federal University Birnin-Kebbi (FUBK) Kebbi 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 Birnin-Kebbi (FUBK) Kebbi 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 to the Project

Nigeria continues to face significant challenges in achieving reliable and sustainable electricity supply to meet growing national demand. Despite substantial installed generation capacity, actual delivered power remains insufficient due to infrastructure deficits, transmission bottlenecks, and distribution inefficiencies. Consequently, institutions and commercial entities rely heavily on self-generation through diesel and petrol generators, resulting in high operational costs, greenhouse gas emissions, noise pollution, and localized air quality deterioration.

In response to these challenges, the Federal Government of Nigeria (FGN) has adopted policies and programmes aimed at promoting renewable energy development and decentralized electrification. A key intervention in this regard is the Nigeria Electrification Programme (NEP), a significant initiative designed to bridge the energy access deficit across the country. The NEP is a private sector-driven programme that seeks to provide reliable electricity services to households, Micro, Small and Medium Enterprises (MSMEs), educational institutions, and healthcare facilities located in underserved and unserved communities. The programme supports increased access to electricity through the deployment of mini-grids, standalone Solar Home Systems (SHS), rooftop solar systems, captive power plants, and productive-use appliances.

The Nigeria Electrification Programme forms part of the African Development Bank (AfDB) broader engagement in Nigeria's power sector and has laid the foundation for subsequent large-scale renewable energy interventions. Notably, the programme serves as a precursor to the Desert to Power Initiative, a transformative regional renewable energy programme aimed at harnessing the abundant solar resources of Northern Nigeria and the wider Sahel region to expand electricity access, stimulate economic growth, and strengthen climate resilience. Building on the achievements of the NEP, the Rural Electrification Agency (REA), under the Desert to Power Initiative (Phase II), proposes the installation of a 1-Megawatt (MW) Solar-Hybrid Photovoltaic (PV) Power Plant and associated infrastructure within the premises of the Federal University Birnin Kebbi (FUBK), Kebbi State.

The Desert to Power Initiative is a strategic renewable energy programme aimed at harnessing the high solar irradiation potential of Northern Nigeria to improve electricity access while contributing to national energy transition and climate commitments. Kebbi State lies within the Sudan Savannah ecological zone and experiences high solar insolation averaging between 5.5 and 6.5 kWh/m²/day, making it technically suitable for utility-scale and institutional solar photovoltaic deployment.

The Desert to Power Initiative is a strategic renewable energy program aimed at harnessing the high solar irradiation potential of Northern Nigeria to improve electricity access while contributing to national climate commitments. Kebbi State lies within the Sudan Savannah ecological zone, characterized by high solar insolation averaging 5.5 – 6.5 kWh/m²/day *(kebbistate.org,gov)*, making it technically suitable for utility-scale and institutional solar PV deployment.

The proposed 1-MW Solar PV project will:

- Provide reliable electricity supply to FUBK.
- Reduce dependence on fossil-fuel-based generators.
- Lower institutional energy costs.

- Reduce greenhouse gas emissions.
- Enhance research and innovation capacity in renewable energy technologies.

To ensure that the proposed project is in accordance with statutory requirements, Rural Electrification Agency commissioned Bolben Energy and Environmental Services Limited (an established and experienced Environmental Management accredited firm) to conduct the Environmental Impact Assessment (ESIA) Study for the proposed project. Hence, the Environmental and Social Impact Assessment (ESIA) has therefore been undertaken to evaluate the potential environmental and social implications of the proposed development in accordance with applicable national and international regulatory requirements.

1.2 Overview of the Project

The proposed project involves the development, installation, and operation of a 1 -Megawatt (MW) Solar Photovoltaic (PV) Power Plant within the campus of Federal University Birnin Kebbi (FUBK), Birnin Kebbi, Kebbi State. The project is being promoted by the Rural Electrification Agency (REA) under the Desert to Power Initiative (Phase II), a federal renewable energy program aimed at expanding clean electricity access across Northern Nigeria.

The project is designed to provide reliable, sustainable, and cost-effective electricity to the university community while reducing dependence on fossil-fuel-based self-generation and mitigating greenhouse gas emissions. The plant will function either as a grid-connected embedded generation facility within the university's internal distribution network or as a hybrid system (subject to final engineering design), with provision for battery energy storage where technically required.

The main components of the proposed development include:

- Solar PV modules *(approximately 1,700 - 3,000 units depending on wattage rating).*
- Galvanized steel mounting structures (fixed tilt configuration).
- String or central inverters totaling 1 MW capacity.
- Step-up transformer (415V/11kV).
- Power Station - Control room/powerhouse structure.
- DC and AC cabling.
- Smart metering and monitoring system.
- Perimeter security fencing.
- Internal access pathways and drainage system.
- Battery Energy Storage System (BESS).

1.3 Project Proponent

The project proponent is the Rural Electrification Agency (REA), established by the Electric Power Sector Reform Act to promote, support, and provide rural electrification programs across Nigeria. REA's responsibilities include development of renewable energy mini-grids and embedded generation systems, electrification of federal universities and public institutions, implementation of sustainable off-grid energy solutions, and coordination with federal and state regulatory agencies. For this project, REA is responsible for:

- Project conceptualization.
- Procurement of engineering, procurement, and construction (EPC) contractor
- Compliance with environmental and social safeguard requirements.
- Oversight of ESMP implementation.

1.4 Project Location

The proposed project shall be sited within the permanent campus of Federal University Birnin Kebbi along the Kalgo–Bunza Road in Kalgo Local Government Area, Kebbi State. Two sites were identified for the proposed project as follows:

- Site A (13 Hectares) Longitide 12.338724 °N; Latitude 4.149325 °E
- Site B (12.2 Hectares) Longitude 12.346217 °N; Latitude 4.153691 °E

Both sites are located adjacent each other and aligned in a linear configuration within the FUBK, however, Site A is the projected for the 1-MW Solar PV facility.

Birnin Kebbi serves as the capital city of Kebbi State and lies within the semi-arid climatic zone of Northern Nigeria. The project site is situated within institutional land designated for university development. No physical displacement of residential structures or economic assets is anticipated.

Figure 1.1: Map of Nigeria showing the 36 States and FCT (highlighting Kebbi State).
Source - Google Maps

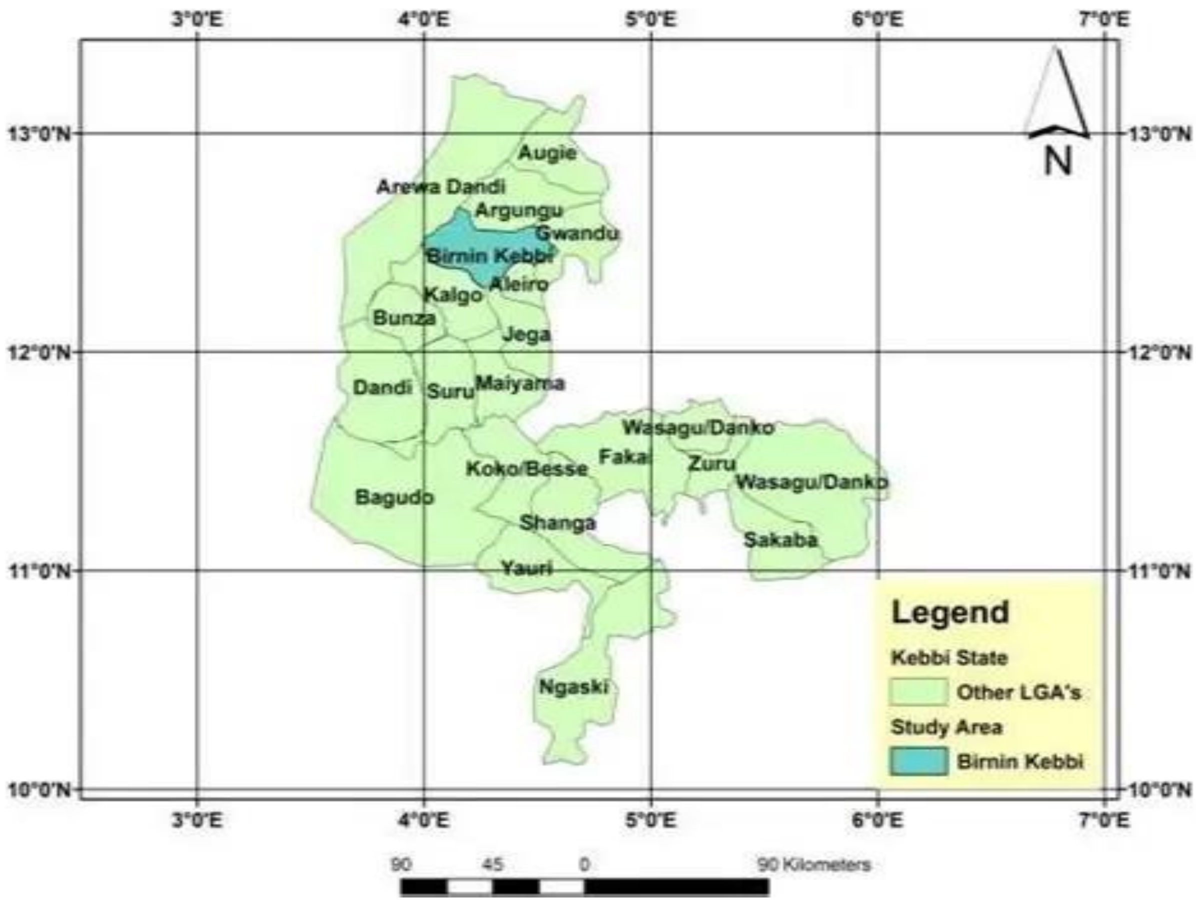

Figure 1.2: Map of Kebbi State highlighting Birnin Kebbi LGA.
Source - Google Maps

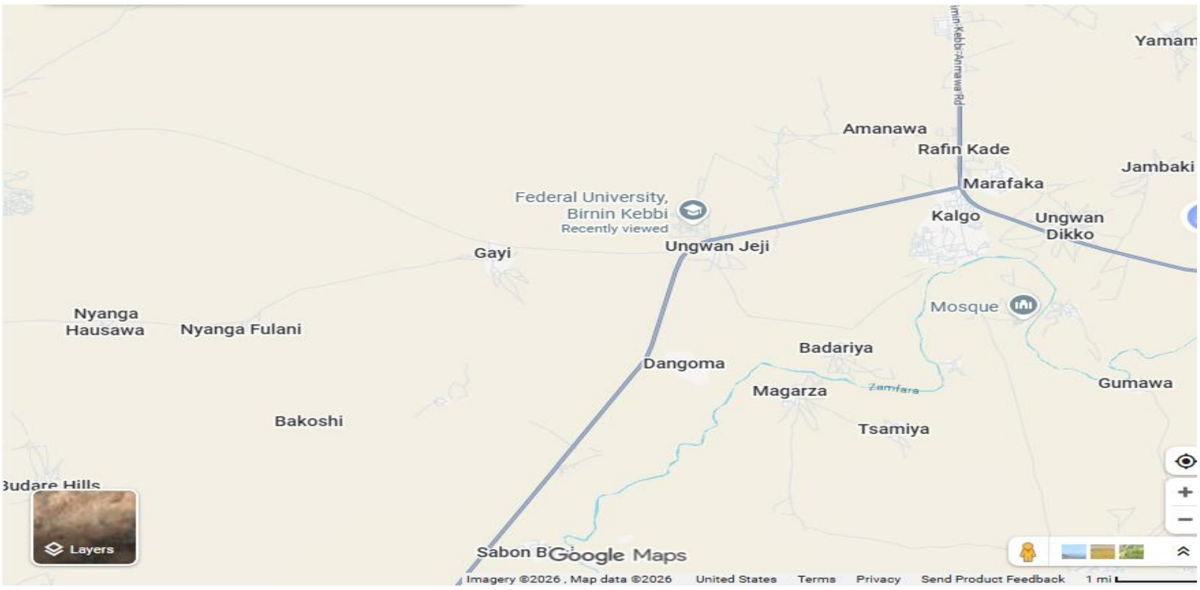

Figure 1.3: Location of Federal University of Birnin Kebbi (FUBK) in Birnin Kebbi.
Source - Google Maps

Figure 1.4: Location of Site A within the FUBK in Birnin Kebbi.
Source - Google Imagery

Figure 1.5: Location of Site B within the FUBK in Birnin Kebbi.
Source - Google Imagery

1.5 Rationale and Objectives for the ESIA

The proposed 1-MW Solar PV project falls under infrastructure developments requiring environmental assessment under the provisions of the Environmental Impact Assessment Act (CAP E12 LFN 2004). The Act mandates that public and private projects likely to have significant environmental effects undergo a comprehensive impact assessment prior to implementation. In addition, compliance is required with Federal Ministry of Environment EIA Procedural Guidelines, National Environmental Standards and Regulations Enforcement Agency Regulations, Climate Change Act, and AfDB Integrated Safeguards System.

The ESIA is therefore undertaken to:

- Establish the existing state of the environment and identify sensitive components of the existing environment within the project area and Area of Potential Project Influence (APPI);
- Identify sensitive components of the existing environment within the project area and its environs;
- Assess the scope of the proposed programme, and the likely impacts associated with same;

- Appraise the project activities and determine any potential negative and positive impacts on the environment;
- Identify existing and expected environmental regulations that will affect the development and advise on standards, consents and targets;
- Bring all relevant information to the stakeholders, including Project Affected Persons (PAPs) and other interested parties and ensure their participation in the Project design;
- Contribute to optimization of the project design and planning by identifying those aspects of the construction location, and operations, which may cause adverse environmental, social, health and economic effects;
- Recommend measures during construction, commissioning and operations to avoid and/or ameliorate these effects and increase beneficial impacts;
- Recommend an environmental and social management program for the project life cycle, including compliance, monitoring, auditing and contingency planning; and
- Provide the basis for co-operation and consultation with regulatory and non-regulatory authorities and the public.

The assessment fully takes into consideration, relevant international safeguard standards, to ensure that environmental and social risks have been anticipated, avoided, mitigated and eventually compensated.

1.6 Scope of the Study/Terms of Reference

The rationale for the ESIA and Scope of this study aligns with the objectives outlined in the ToR documented for this project which includes : -

- Establish the existing state of the environment and identify sensitive components of the existing environment within the project area and area of potential project influence (APPI);
- Recommend an environmental construction, commissioning and operation plan to avoid and ameliorate negative effects and increase beneficial impacts;
- Recommend an environmental management programme for the lifespan of the project including compliance monitoring, audit and contingency planning;
- Provide the basis for co-operation and consultation with regulatory and non-regulatory authorities and the public;
- Appraise the project activities and determine any potential negative and positive impacts on the environment;
- Prepare an ESIA report presenting clear and concise information on the environmental impact of the current state of the project and developing project activities.

In line with the Terms of Reference (TOR), the scope of the ESIA study covers the following:

- Prepare an ESIA report presenting clear and concise information on the environmental impact of the current state of the project and developing project activities.
- Description of all actions/activities that will be carried out in the course of the Project development and implementation.
- Review of applicable local and international laws, regulations, standards and industry codes that apply to the proposed project.
- Desktop review of relevant documents pertaining to the Project and the environment where the Project would be located. These documents include the Nigerian Electrification Project (NEP) environmental and social management framework (ESMF), amongst others.
- Perimeter survey of the Project site, including development of survey maps.
- Field data gathering covering biophysical and socio-economic components of the Project's Area of Influence.

- Consultations with relevant stakeholders including government institutions, project affected persons, University management representatives
- Laboratory analysis of field samples and data analysis
- Impacts identification and evaluation, and development of appropriate and practicable mitigation measures and EMP.
- Report preparation and disclosure.

1.6.1 Spatial Scope

The ESIA covers the project footprint and the Area of Potential Project Influence (APPI), including adjacent academic buildings, boreholes, drainage pathways, and access roads.

1.6.2 Temporal Scope

This covers the all aspects of the project from the Pre-construction, through to the Construction, Operation (25-year lifespan) and Decommissioning phases.

1.6.3 Thematic Scope

This includes the Physical environment (climate, air quality, soil, water, noise); Biological environment (flora and fauna); Socio-economic environment (population, livelihoods, health, land use); Occupational health and safety; Climate change implications; and Cumulative impacts.

The assessment was conducted using one-season (dry season) baseline data and available secondary information. The study covered both suggested sites and no significant limitations were encountered that compromise the integrity of the EIA.

1.7 ESIA Methodology

The ESIA methodology is consistent with FMEnv procedural guidelines. It also considers the requirements of relevant and applicable international standards and best practices such as the AfDB Integrated Safeguard System. The approach and methodology applied for undertaking the environmental and social impact assessment is a combination of multidisciplinary studies (Figure 1.4). These include:

- Project Screening and development of Terms of Reference (ToR) in accordance with regulatory guidelines, as well as project site verification;
- Scoping and consultations with regulators and other relevant stakeholders concerned with the proposed project;
- Review of national and international regulations and project documents specific to the project site to obtain background information on the environmental characteristics of the area; Baseline studies and a one-season field data gathering exercise, as approved by the FMEnv, to establish environmental and social conditions specific to the project area;
- Impact identification, prediction, interpretation, and evaluation from project activities. Information on the project area, project design, as well as past project experience, was also used for impact identification and evaluation, as well as to establish mitigation and enhancement measures;
- Development of effective mitigation/ ameliorative measures and monitoring programmes for significant impacts; and
- Development of a robust Environmental and Social Management Plan covering the project life cycle.

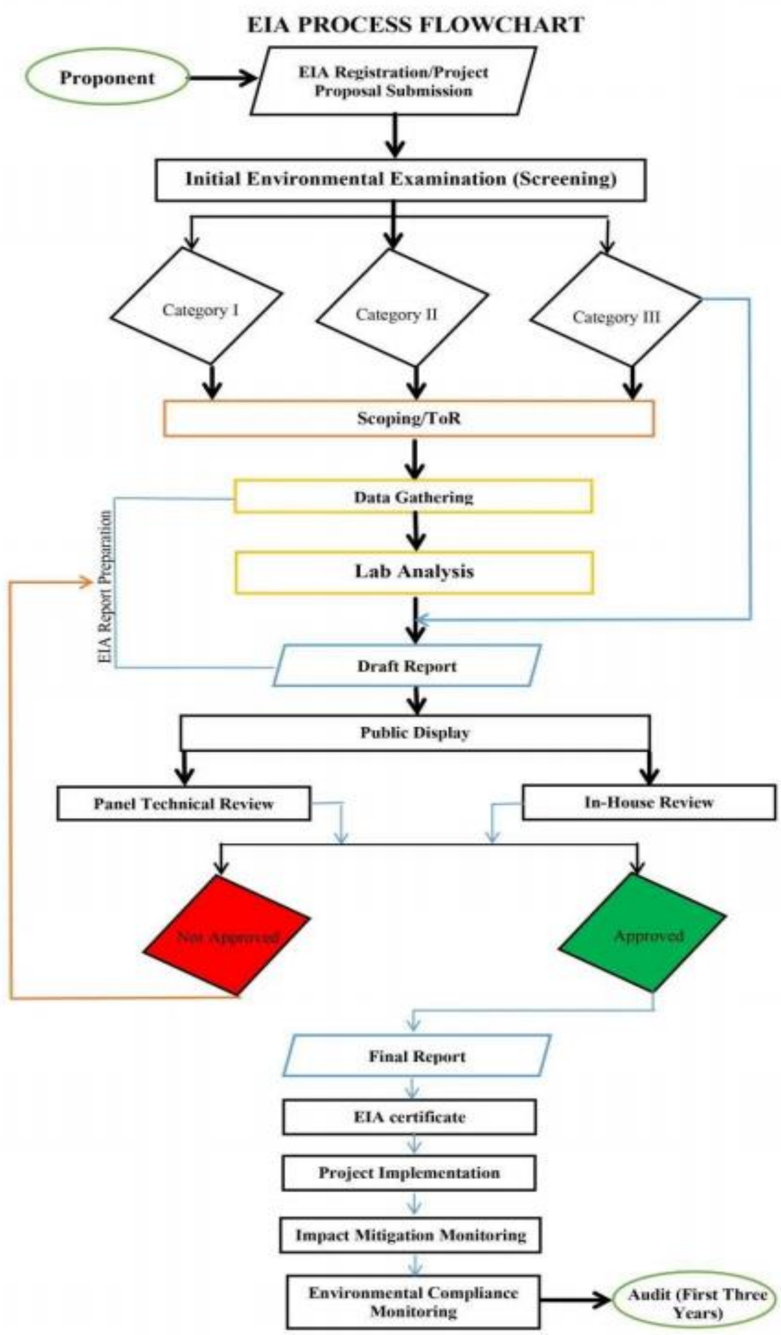

Figure 1.6: Federal Ministry of Environment EIA Flowchart
Source: Environmental Assessment Department, Federal Ministry of Environment

1.8 Policy, Legal and Institutional Framework

The legal and policy instruments presented in this section have been screened for their direct relevance to the proposed Project. Their applicability is determined by the Project's activities, including site preparation, vegetation clearance, construction, employment of workers, operation of a solar PV facility and lithium-ion battery energy storage system, use of an internal 11 kV distribution network, waste generation, groundwater use, stakeholder engagement and eventual repowering or decommissioning. Instruments without a direct regulatory or safeguard relationship to these activities are not treated as governing requirements.

This section provides an overview of the relevant national and international policies, laws, regulations, administrative instruments, and institutional arrangements governing the proposed 1-Megawatt (MW) Solar Photovoltaic (PV) Power Plant at Federal University Birnin Kebbi (FUBK), to be implemented by the Rural Electrification Agency (REA) under the Desert to Power Initiative (Phase II). The section also identifies the statutory basis for the ESIA; establishes environmental approval obligations; clarifies roles of regulatory institutions; demonstrates compliance pathways; and integrates multilateral safeguard requirements where applicable. A number of institutions have been identified and will be involved in the overall implementation of this programme. These include the Federal Government of Nigeria (FGN), Federal Ministry of Environment (FMEnv), Federal Ministry of Power, National Environmental Standards and Regulatory Enforcement Agency (NESREA), Kebbi State Ministry of Environment/Kebbi State Environmental Protection Agency (KESEPA) and Birnin Kebbi LGA.

1.8.1 FGN Requirements and Relevant Legislation

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

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

The proposed solar PV project and the ESIA study are in compliance with these constitutional mandates.

1.8.2 National Policy, Guidelines and Regulations

1.8.2.1 Federal Ministry of Environment (FMEnv)

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

❖ **National Policy on the Environment, 1989 (revised in 1999 and 2016)**

The National Policy on the Environment provides for "a viable national mechanism for cooperation, coordination and regular consultation, as well as harmonious management of the policy formulation and implementation process which requires the establishment of effective institutions and linkages within and among the various tiers of government that is, federal, state and local government". The Policy was formulated and published in 1991, then revised in 1999 to incorporate new environmental concerns such as desertification, biodiversity loss, and industrial pollution. It was further updated in 2016 to incorporate and address issues related to climate change, disasters, biosafety, and modern environmental governance. The project must promote sustainable development, pollution prevention, biodiversity conservation and climate resilience throughout its lifecycle. The objective of the policy is to achieve sustainable development in Nigeria pertaining to:

- Secure a quality environment adequate for good health and well-being;

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

❖ **Environmental Impact Assessment (EIA) Act CAP E12 LFN 2004**

The EIA Act provides the primary legal framework for environmental assessment in Nigeria. It is the primary Act governing the environmental and social assessment of developmental Project or activity in the country. Section 2(1) prohibits the commencement of any project likely to significantly affect the environment without prior environmental assessment and approval while Section 2(2) of the Act requires that where the extent, nature or location of a proposed Project or activity is such that it is likely to significantly affect the environment, an EIA must be undertaken in accordance with the provisions of the Act.

Based on the provisions of the EIA Act, the proposed 1-MW Solar PV plant falls under Category II projects (moderate impacts), This has thus necessitated the development of this ESIA to identify and manage the potential impacts of the project throughout its life cycle. This Act is applicable because the construction of a utility-scale solar power facility is a prescribed activity requiring prior environmental approval before implementation.

❖ **National Environmental Impact Assessment Procedural and Sectoral Guidelines.**

Following the promulgation of the EIA Act, the FMEnv developed National EIA Procedural Guidelines and other set of guidelines on various sectors of the National economy. The ESIA must follow the nationally approved procedures for scoping, baseline studies, public consultation, impact assessment, disclosure and approval. To ensure compliance with the approved EIA process, the following are applicable to the proposed project:

Environmental Impact Assessment (EIA) Procedures and Charges Regulations, 2021 (published in Nigeria's Official Gazette No. 105): The Environmental Impact Assessment (EIA) Procedures and Charges Regulations, 2021, published in Federal Republic of Nigeria Official Gazette No. 105, provide the administrative and procedural framework for implementing the EIA Act. The Regulations prescribe procedures for project registration, screening, scoping, Terms of Reference approval, preparation and submission of EIA reports, public consultation, technical review, certification, environmental auditing, and post-approval monitoring. Compliance with these regulations is mandatory for obtaining environmental approval for the proposed project.

FMEnv EIA Guidelines for Renewable Energy Projects 2017: The Federal Ministry of Environment's EIA Guidelines for Renewable Energy Projects provide sector-specific guidance for assessing the environmental and social impacts associated with renewable energy developments, including solar photovoltaic facilities, hybrid power systems, battery energy storage systems, transmission infrastructure, and associated facilities. These guidelines ensure that renewable energy projects are implemented in an environmentally sustainable and socially responsible manner. This applies because the proposed project falls within the renewable energy sector and the Guidelines provide sector-specific requirements for environmental assessment, impact prediction, mitigation, environmental monitoring, stakeholder consultation and reporting during project planning, construction, operation and decommissioning.

FMEnv Environmental and Social Management Plan (ESMP) Guidelines for Solar Mini-grid Projects in Nigeria 2021: The FMEnv Environmental and Social Management Plan (ESMP) Guidelines for Solar Mini-grid Projects in Nigeria provide detailed guidance for the preparation and implementation of Environmental and Social Management Plans for solar energy projects and associated battery storage facilities. The Environmental and Social Management Plan developed for this Project has been structured to align with the requirements of these Guidelines and shall be implemented throughout the project lifecycle, including construction, operation, maintenance, and decommissioning phases. The Guidelines are applicable as they prescribe a simplified environmental and social assessment process for eligible solar-based projects, including ESMP preparation, stakeholder engagement, environmental monitoring, mitigation measures and post-approval compliance requirements. They were developed as an abridged version of the EIA Procedures Guidelines to streamline approval for lower-risk solar mini-grid projects.

FMEnv EIA Guidelines for the Power Sector, 2013*:* The Federal Ministry of Environment (FMEnv) EIA Guidelines for the Power Sector, 2013 provide sector-specific requirements for the environmental assessment of electricity generation, transmission, distribution, and associated power infrastructure projects in Nigeria. The Guidelines supplement the Environmental Impact Assessment Act and establish procedures for identifying, predicting, evaluating, and mitigating environmental and social impacts associated with power sector developments.

The Guidelines are applicable to conventional and renewable power generation projects, substations, transmission lines, distribution systems, energy storage facilities, and associated infrastructure. Consequently, they are directly relevant to the Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) for the proposed Project which have been prepared to ensure environmentally sustainable development and regulatory compliance throughout the project lifecycle.

1.8.2.2 National Environmental Standards and Regulation Enforcement Agency (NESREA)

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the FGN as a parastatal of the FMEnv. The Agency is charged with the responsibility of enforcing the environmental laws, guidelines, standards and regulations in Nigeria, specifically during the operational phase of development projects. It is expected that during implementation, the project complies with national environmental standards relating to air quality, noise, waste management, pollution control, hazardous substances and environmental monitoring. The applicable NESREA's regulations to the proposed project include:

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

The purpose of this regulation is the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution. This is applicable to wastes generated during project activities including construction waste; packaging waste; scrap materials; domestic.

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

This regulation highlights the permissible noise levels to which a person may be exposed, control and mitigation of noise, permits for noise emissions in excess of permissible levels, and enforcement.

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

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

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

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

- **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.

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❖ **National Environmental (Electrical/Electronic Sector) Regulations, 2022, S.I. 79**

The main purpose of this regulation is to ensure that best practices are applied and maintained in the operation of electrical and electronic equipment in order to safeguard the Nigerian environment against pollution hazards. These regulations are directly relevant due to the installation of PV modules; inverters; transformers; electrical cables; etc. Solar modules, inverters, batteries and electrical equipment become regulated electronic waste during replacement and decommissioning.

❖ **National Environmental (Construction Sector) Regulations, 2011**

These regulations apply to construction activities associated with site clearing, civil works, installation of mounting structures, transformer installation. Key compliance requirements include dust suppression measures, noise control, safe waste handling, occupational health standards, pollution prevention.

❖ **National Environmental (Soil Erosion and Flood Control) Regulations 2011, S. I. 12:**

The overall objective of this regulation is to regulate all earthing-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.

❖ **National Environmental (Air Quality Control) Regulations, S. I. 64, 2013:**

The objective of this regulation is to ensure the control of air pollutants that may affect the ambient environment.

1.8.2.3 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.

❖ **Electric Power Sector Reform Act 2005**

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

❖ **Electricity Act, 2023**

The Electricity Act governs electricity generation and distribution in Nigeria. Although this project is embedded within the university's internal network, compliance obligations include technical interconnection standards; electrical safety standards; and protection systems compliance. It is the principal legislation regulating generation, distribution and supply of electricity and is applicable because the project entails the construction and operation of a 1 MW solar-hybrid power plant and associated distribution infrastructure.

Other National Policies/Acts applicable to the project include:

❖ **Rural Electrification Agency Act 2005**

The REA is legally empowered to promote off-grid and distributed renewable energy; implement rural electrification programs; and mobilize funding for renewable projects. The proposed project is consistent with REA's statutory mandate.

❖ **National Energy Policy (Revised 2013)**

This Policy promotes renewable energy diversification. The project advances energy security; institutional energy independence; as well as decentralized generation.

❖ **Renewable Energy and Energy Efficiency Policy (NREEEP, 2015)**

This policy encourages distributed renewable energy in public institutions. The proposed 1-MW solar plant project directly contributes to national renewable targets. The project contributes directly to renewable electricity generation, increased clean energy penetration and reduced dependence on diesel generation thus the applicability of the Policy.

Other applicable policies are:

❖ **Land Use Act CAP L5 LFN 2004**

Relevant sections of these laws that may relate to this project with respect to land ownership and property rights, resettlement and compensation are summarized in this section. Section 1 of the Act vests the entire land in any state in the Governor of the State. The Act also stipulates the procedures the State must follow to clear the land and define the compensatory measures the State must implement to compensate any affected person. The PV panels of the proposed solar power project will be installed on allocated land within the Federal University of Birnin Kebbi; hence, no compensation or resettlement shall be required.

❖ **Climate Change Act, 2021**

This Act applies to the Ministries, Departments and Agencies (MDAs) of the Application. Federal Government of Nigeria, and to public and private entities within the territorial boundaries of Nigeria for the development and implementation of mechanisms geared towards fostering low carbon emission, environmentally sustainable and climate resilient society. The Act provides a framework for Nigeria to achieve low Green House Gas emissions (GHG) through inclusive green growth and sustainable economic development and the implementation of Nigeria's commitment to net zero emissions declared at COP26 in 2021. It establishes the National Council on Climate Change, which will be tasked with implementing the countries Climate Action Plan. The project contributes to national climate mitigation objectives and supports implementation of Nigeria's Net-Zero commitments.

❖ **Labour Act CAP L1, LFN 2004**

The Labor Act is the primary law protecting the employment rights of individual workers. The Act covers protection of wages, contracts, employment terms and conditions, and recruitment; and classifies types of workers and special workers. This law is applicable to the project because the contractors and REA will employ construction workers and must comply with labour welfare, working conditions and employment requirements.

❖ **Nigerian Urban and Regional Planning Act CAP N138 LFN, 2004**

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

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

The Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN 2004 prohibits, without lawful authority, all activities relating to the purchase, sale, importation, transit, transportation, deposit, storage of harmful wastes. Appropriate penalties for contravention are prescribed. The Regulation is applicable to the project because spent batteries, contaminated oils and hazardous wastes generated during operation or decommissioning require environmentally sound management.

- **Endangered Species Act, CAP E9, LFN 2004**

The Act encapsulates the provisions for the conservation, management and protection of the country's endangered species. Section 1 of the Act prohibits the hunting, capture and trade of endangered species

- **National Policy on Solid Waste Management (NPSWM), 2020**

The National Policy on Solid Waste Management (NPSWM) was approved by the Federal Executive Council of the Nigerian Government on 15th of July 2020 as a shared national vision of how solid waste should be managed more sustainably with relative and loose uniformity across states of the Federation. Developed in close consultation with stakeholders, the policy is expected to increasingly garner the active participation of numerous players in the management of solid waste including governments at all levels, the private sector, NGOs, CBOs, FBOs, and partnerships resulting in projects and programmes implementation.

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

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

- **Employee Compensation Act, 2010**

The Act provides compensation to employees who suffer from occupational diseases or sustain injuries arising from accidents at the workplace or in the course of employment. Payment of compensation (to the worker or his dependents in case of death) by the employer is as enshrined in the accepted principle that the employer has a duty of care to protect the health, welfare, and safety of workers at work. It is necessary as the workers engaged during construction and operation must be insured against occupational injuries and diseases.

- **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 favourable 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 2015.**

This Act prohibits all forms of violence against persons in private and public life and provides maximum protection and effective remedies for victims and punishment of offenders. It is also applicable because labour influx may expose host communities to GBV/SEA/SH risks requiring prevention, reporting and response mechanisms

❖ **National Policy on Occupational Safety and Health 2020**

The National Policy on Occupational Safety and Health (OSH) (2020) was developed by the Federal Ministry of Labour and Employment to establish a national framework for the prevention of occupational injuries, diseases and fatalities across all sectors of the Nigerian economy. This aligns with section 17(3c) of the constitution of the Federal Republic of Nigeria (1999) which stipulates that the health, safety and welfare of all persons in employment must be safeguarded and not endangered or abused. The Policy seeks to promote safe and healthy working environments by integrating occupational safety and health considerations into workplace planning, management and operations. It emphasizes employers' responsibility to provide safe systems of work, adequate training, hazard identification and risk assessment, emergency preparedness, workers' participation in OSH matters, continuous monitoring and compliance with applicable occupational health and safety legislation. The Policy also promotes the prevention of occupational illnesses through appropriate workplace health surveillance, use of personal protective equipment (PPE), incident reporting and investigation, and continuous improvement of OSH performance. With respect to this project, the National Policy on Occupational Safety and Health (2020) is applicable because project activities during construction, commissioning, operation and decommissioning involve occupational hazards associated with civil works, excavation, working at heights, lifting operations, electrical installations, battery energy storage systems, heavy equipment operation, welding,

1.8.3 State Policy, Guidelines and Regulations

1.8.3.1 Kebbi State Ministry of Environment

The Kebbi State Ministry of Environment is the government’s policy-making arm, drafting, coordinating, and overseeing all environmental strategies, regulations, and projects for the state. It was set up to take a holistic approach to planning and managing Kebbi’s environment, with departments for forestry, wildlife, and environmental health services. The Ministry plays a key role in tackling environmental issues and promoting sustainable practices, while also fitting into the broader framework of Nigeria’s Federal Ministry of Environment, which coordinates environmental management nationwide. It helps implement national initiatives, making sure funds are used effectively and projects align with federal objectives.

1.8.3.2 Kebbi State Environmental Protection Agency (KESEPA).

The Kebbi State Environmental Protection Agency was created to back up the mandates of Federal and State Ministries of Environment at State level towards the objective of protecting public health and safety, and to restore and enhance environmental quality and efficient implementation of environmental programs. The Agency gives directions to issues concerning the environment, monitor and control pollution and the disposal of solid, gaseous and liquid wastes generated by various facilities at the local and community levels.

Collaborative Relationship

The Kebbi State Ministry of Environment and the Kebbi State Environmental Protection Agency (KESEPA) work hand-in-hand to safeguard the state’s natural resources. The ministry drafts policies on natural-resource management and overall environmental strategy, while KESEPA acts as the frontline agency that rolls out those policies and runs all donor-funded environmental programs. Together they push for better watershed practices, fight land degradation, and promote sustainable environmental management across Kebbi State.

1.8.3.3 Birnin Kebbi Local Government Area By - laws

Local Government Areas being the constitutionally recognized third tier of government in Nigeria which is also to ensure economic planning and development of the communities under their area of influence. The Local Government By-Law is derived from the Fourth Schedule of 1999 Constitution of the Federal Republic of Nigeria (as amended). Statutory function of refuse management is domiciled with the Local Government Councils under their primary healthcare departments. Birnin Kebbi Local Government Area by - laws applicable to the project especially in the areas of health and waste management shall be adhered to.

1.8.4 Institutional Capacity Assessment

A preliminary capacity assessment was undertaken based on the statutory mandates of the responsible institutions, consultations and anticipated implementation responsibilities. The assessment indicates that the participating institutions possess relevant regulatory, engineering or administrative experience; however, project-specific strengthening will be required for coordinated ESMP supervision, BESS safety, environmental monitoring, GBV/SEA/SH response, grievance management and reporting under the AfDB ISS.

Institution	Existing role/capacity	Identified gap	Strengthening action
REA-PMU	Overall project management and access to environmental and social safeguards specialists.	Need for site-specific coordination, consolidated reporting and follow-up of contractor corrective actions.	Maintain designated environmental and social specialists; undertake monthly/ quarterly supervision; maintain a corrective-action tracker; report material incidents to AfDB.
FMEnv	Statutory ESIA review, approval and environmental compliance monitoring.	Monitoring logistics and coordination with state institutions may be constrained.	Agree an inspection and reporting schedule before mobilisation and provide timely access to monitoring reports and the project site.
NESREA and Kebbi State environmental institutions	Regulatory enforcement, local environmental knowledge and waste-management oversight.	Limited project-specific experience with lithium-ion BESS risks, battery waste and solar-component end-of-life management may exist.	Provide joint orientation on BESS hazards, battery regulations, emergency response, hazardous-waste tracking and licensed waste-service requirements.
FUBK	Site ownership, Works and Physical Planning functions, security, health services and institutional management.	Limited experience in supervising a utility-scale solar-hybrid facility and implementing AfDB safeguard reporting.	Nominate environmental, social, OHS and GRM related focal persons; provide ESMP, BESS emergency-response and monitoring training; undertake periodic drills.
EPC and O&M contractors	To be responsible for day-to-day ESMP implementation.	Capacity cannot be confirmed until contractor appointment.	Include minimum E&S staffing and competence requirements in procurement documents

			and verify personnel before mobilisation.

The identified capacity-strengthening actions are included under the capacity-building provision in Table 7.13 and the relevant pre-construction, supervision and monitoring allocations. The capacity programme shall be reviewed following appointment of the EPC and O&M contractors and adjusted where contractor-specific gaps are identified.

1.8.5 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 agreements have influenced policy, guidelines and regulations and must be complied with during the planning, construction, and operation of the project. Among several of such conventions, treatises and agreement are:

The African Development Bank (AfDB) Integrated Safeguards System (ISS) 2023

African Development Bank Environmental and Social Safeguards Policies:
The African Development Bank (AfDB) has its own set of Environmental and Social Safeguards Policies, which guide how projects financed by the Bank must manage environmental and social risks. is designed to promote the sustainability of project outcomes by protecting the environment and people from the potentially adverse impacts of projects. These policies are consolidated under the Integrated Safeguards System (ISS). It requires that all activities comply with the safeguard requirements of the ISS during project implementation. The safeguards aim to:

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

The revised African Development Bank Integrated Safeguards System (ISS) makes environmental and social sustainability a core requirement of every Bank-funded project, while driving inclusive growth across Africa. It replaces the 2013 version and has been effective since 31 May 2024. The new ISS brings the Bank in line with other multilateral development banks on issues like community health and safety, gender-based violence, and stakeholder engagement for high-risk operations. It also sets out environmental and social standards for value chains, outlines processes for resettlement financing, and defines borrower eligibility for financial assistance. By clarifying the Bank's roles, responsibilities, and accountability to borrowers and clients, the ISS underscores its commitment to responsible development — using Africa's natural capital wisely and protecting community rights and well-being.

This project shall be funded by the African Development Bank (AfDB). Therefore, the AfDB safeguard systems will be integrated in the project cycle as well as other national and international environmental and social protection requirements, in order to comply with the best international practices. Both main environmental and social requirements that the project needs to comply with are described in the following sections. The key Operational Safeguards (OS) that are applicable to the 1-MW Solar PV Project at FUBK are highlighted as follows:

OS1 – Assessment and Management of Environmental and Social Risks and Impacts	Applicable. The Project requires an ESIA, ESMP, monitoring programme, stakeholder engagement and lifecycle management of environmental and social risks.
OS2 – Labour and Working Conditions	Applicable. Construction and operation will involve direct and contracted workers and require labour-management procedures, OHS measures, codes of conduct and a worker GRM.
OS3 – Resource Efficiency and Pollution Prevention and Management	Applicable. The Project will use water and materials and generate dust, noise, wastewater, construction waste, hazardous waste, batteries and end-of-life electrical equipment.
OS4 – Community Health, Safety and Security	Applicable. Relevant risks include construction traffic, public access, electrical hazards, BESS fire and off-gassing, labour influx, communicable disease, GBV/SEA/SH and security personnel conduct.
OS5 – Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement	Not triggered based on current baseline conditions. The site is institutional land and was open and not under active cultivation or livelihood use during the ESIA survey. This conclusion is subject to documented pre-construction verification.
OS6 – Habitat and Biodiversity Conservation and Sustainable Management of Living Natural Resources	Applicable because site preparation will remove modified Sudan Savannah vegetation. No critical habitat or threatened species was identified, but clearance must be minimised and restoration implemented.
OS7 – Vulnerable Groups	Not triggered as a distinct safeguard based on the baseline assessment. No group meeting the OS7 criteria was identified within the project footprint or directly affected population. Inclusive engagement requirements nevertheless apply.
OS8 – Cultural Heritage	No known cultural-heritage resource was identified within the footprint. A chance-find procedure will apply during excavation.
OS9 – Financial Intermediaries	Not applicable because the Project is not being implemented through a financial intermediary.
OS10 – Stakeholder Engagement and Information Disclosure	Applicable. Engagement, disclosure and grievance management are required throughout planning, construction, operation and any future closure activities.

❖ **United Nations (UN) published guiding Principles on the Human Environment in 1972.**

The United Nations Conference on the Human Environment was held in Stockholm, Sweden, from 5 to 16 June 1972. At the end of this conference, the participating states adopted the Stockholm

Declaration, which contained the 26 Guiding Principles on the Human Environment. It was the first major international agreement to place environmental issues at the forefront of global concerns, and it led to the creation of the United Nations Environment Programme (UNEP).
Some of the guiding principles that are relevant to the 1-MW Solar PV Plant at Federal University Birnin Kebbi (FUBK), showing how they apply across the construction, operation, and decommissioning phases of the project are on Table 1.1:

Table 1.1 - Some of the guiding principles applicable to the project and how they apply across the construction, operation, and decommissioning phases.

Principle	Construction Phase	Operation Phase	Decommissioning Phase
2 – Safeguard natural resources	Land clearing and soil disturbance must be minimized.	Efficient use of solar energy reduces fossil fuel reliance.	Recycling of panels and metals protects resources.
5 – Preserve ecosystems	Avoid damage to vegetation and local biodiversity during site prep.	Low ecological sensitivity site ensures minimal disruption.	Site restoration after dismantling ensures ecosystem recovery.
6 – Pollution prevention	Dust, noise, and waste managed via ESMP.	No emissions during operation; major reduction in generator pollution.	Proper disposal of hazardous waste (batteries, panels).
8 – Economic development	Local employment during construction.	Reliable power supply boosts academic productivity.	Reuse/recycling industries benefit economically.
10 – Environmental education	Awareness programs for workers on safe practices.	University research and training in renewable energy.	Lessons learned inform future projects.
12 – Planning	ESIA ensures environmental considerations integrated into project design.	Continuous monitoring of air, noise, and water quality.	Decommissioning plan ensures orderly closure.
13 – Rational management of resources	Efficient procurement and use of construction materials.	Rational use of renewable solar energy.	Recycling ensures rational end-of-life resource use.
15 – Human settlement	Construction avoids disruption to university operations.	Improves living and study conditions on campus.	Restored land can be repurposed for institutional use.
17 – Environmental assessment	ESIA conducted before project approval.	Monitoring ensures compliance with standards.	Decommissioning assessment ensures safe closure.
21 – Sovereignty and responsibility	Nigeria exercises sovereign right to	Responsibility to ensure no harm to	Compliance with Basel Convention on waste disposal.

Principle	Construction Phase	Operation Phase	Decommissioning Phase
	develop solar energy.	neighboring communities.	
23 – Developing countries	Special consideration for Nigeria's energy deficit.	Solar project supports equitable access to clean energy.	Knowledge transfer strengthens local capacity.
24 – International cooperation	IFC and AfDB safeguards applied.	Technology transfer and global best practices in renewable energy.	Recycling partnerships may involve international firms.

❖ **The Paris Agreement 2015**

The Paris Agreement was adopted on 12th December, 2015 at the UN Climate Change Conference (COP21) in Paris. It officially entered into force on 4 November 2016, after the required number of countries ratified it. Nigeria signed the agreement on 22nd September, 2016 and ratified same on 16th May 2017. The Paris Agreement (2015) is a legally binding international treaty on climate change. Its overarching aim is to unite all countries in tackling global warming and its impacts.

The Paris Agreement (2015) aligns very closely with the Solar Power Plant project at FUBK because the project directly supports the Agreement's central goals by reducing emissions through renewable energy use, supporting Nigeria's NDC commitments, enhancing resilience by providing reliable and clean power, as well as attracting climate finance and international cooperation.

❖ **Nationally Determined Contributions (NDCs) 3.0, 2025**

Nationally Determined Contributions (NDCs) made under the Paris Agreement embodies the country's efforts to reduce national emissions and to adapt to the effects of climate change. If fully implemented, these efforts will pave way for a low carbon economy and result in sustainable reduction in emissions. Projects of this nature represent an important milestone in tackling the challenges of climate change. Over the years, these targets have become increasingly ambitious, expanding beyond energy and oil into waste, agriculture, and health.

- NDC 3.0 (2025 Submission) Emissions Target: Commits to a 29% reduction by 2030 and a 32% reduction by 2035 (relative to 2018 levels). It also sets an overarching, economy-wide pathway to reach Net-Zero emissions by 2060. It Encompasses 4 GHGs and 11 pollutants. It pledges a 60% reduction in deforestation, expands electric mobility, and integrates health climate-resilience (e.g., establishing clean energy access in hundreds of primary healthcare facilities by 2030)

The proposed project is directly aligned with Nigeria's Nationally Determined Contribution. By generating electricity from renewable solar energy, displacing fossil-fuel-based generation, improving energy access, reducing greenhouse gas emissions, and enhancing climate resilience, the project contributes to Nigeria's commitments under the Paris Agreement and supports the country's transition towards a low-carbon and climate-resilient economy by:

- Increasing Renewable Energy Generation and Improving Energy Efficiency: The project generates electricity from solar photovoltaic technology, thereby increasing the proportion of renewable energy in Nigeria's electricity mix and supporting the country's transition towards a low-carbon energy system. Modern solar PV systems incorporate efficient inverters, smart controls and battery energy storage systems that reduce transmission losses and improve overall energy efficiency compared with conventional off-grid diesel generation.

- Reducing Greenhouse Gas Emissions and Reducing Air Pollution: Electricity generated from solar PV replaces electricity that would otherwise be supplied by diesel generators or fossil-fuel-based grid generation thereby contributing to Nigeria's national emission reduction targets. Also, by replacing diesel-powered generation, the project contributes to improved general local air quality.
- Supporting Nigeria's Energy Transition Plan (ETP): The project aligns with Nigeria's Energy Transition Plan (2022) by accelerating investment in renewable energy infrastructure, promoting decentralized electricity supply and reducing reliance on fossil fuels in the power sector. The project contributes to the AfDB's objective of improving electricity access, stimulating economic development and supporting climate-resilient growth in participating countries, including Nigeria.

❖ **ILO Conventions and Core Labor Standards**

The International Labor Organization (ILO) is a tripartite organization consisting of trade unions, governments and companies, and is part of the United Nations system. In 1998, the ILO produced the Declaration on Fundamental Principles and Rights at Work. In the Declaration, ILO member states including Nigeria agreed that they should all respect, promote, and realize core labour standards (whether they have been ratified or not). The core labour standards consist of five standards, laid out in eight conventions:

- Freedom of association and the effective recognition of the right to collective bargaining (Convention No. 87 & No. 98)
- The elimination of all forms of forced and compulsory labour (Convention No. 29 & No. 105)
- The effective abolition of child labour (Convention No. 138 & No. 182)
- The elimination of discrimination in respect of employment and occupation (Convention No. 100 & No. 111)

REA as well as its contractors shall comply with these requirements, as well as the following internationally recognized labour rights: the right to a living wage based on a regular working week that does not exceed 48 hours; humane working hours with no forced overtime; a safe and healthy workplace free from harassment; and a recognized employment relationship with labour and social protection.

❖ **Solemn Declaration on Gender Equality in Africa 2004**

The Solemn Declaration on Gender Equality in Africa was adopted by the AU Assembly in 2004, calling for member states' continual action toward achieving gender equality and reinforcing their commitment to international and regional women's rights instruments. In addition to calling for wider ratification of the Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa, it also addresses state responsibility for tackling violence against women and gender-based discrimination.

❖ **Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa, 2003**

The Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa, better known as the Maputo Protocol, is an international human rights instrument established by the African Union was adopted in Maputo in July 2003 and went into effect in 2005. It guarantees comprehensive rights to women including the right to take part in the political process, social and political equality with men, and improved autonomy in their reproductive health decisions.

❖ **Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), 1979**

Adopted December 18, 1979, and entered into force on September 3, 1981, the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) is an international legal instrument that requires countries to eliminate discrimination against women and girls in all areas and promotes women's and girls' equal rights.

❖ **United Nations Convention on Climate Change (UNFCCC):**

The Convention on 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. The UNFCCC is the umbrella treaty under which later agreements like the Kyoto Protocol (1997) and the Paris Agreement (2015) were adopted.

❖ **Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal**

The Basel Convention was adopted on 22 March 1989 in Basel, Switzerland, and opened for signature on 23 March 1989. Nigeria signed the Convention in 1989 and ratified it on 13 March 1991. Nigeria is therefore a legally bound Party to the Convention and obligated to (1) Regulate hazardous waste management; (2) Prevent illegal import/export of hazardous waste; (3) Ensure environmentally sound management (ESM) of hazardous materials; and (4) Prohibit trans-boundary movement without prior informed consent.

Although the proposed project is a renewable energy installation, the Basel Convention becomes relevant as the Solar PV system contains: (i) PV modules (which may contain trace heavy metals); (ii) Inverters and power electronics; (iii) Cabling and electrical control panels; (iv) Batteries, etc which, at their end-of-life, may qualify as Hazardous wastes; or Controlled electronic waste under national regulations aligned with Basel provisions. For this project, REA commits to:

- Procuring certified PV modules compliant with IEC standards;
- Implementing an End-of-Life Management Plan;
- Engaging licensed waste handlers approved by national authorities;
- Preventing uncontrolled disposal of electronic components.
- Use of long-life (25-year) modules;
- Minimizing use hazardous materials;
- Deployment of modular inverter systems to reduce replacement volumes;
- Requiring suppliers to provide take-back guarantees; and
- Inclusion of contractual clauses for recycling·

These satisfy the Convention as it requires environmentally sound waste management and Waste Minimization Principles.

Rural Electrification Agency HSE Policy

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

- Commitment to Safety: The policy emphasizes protecting employees, contractors, and communities from workplace hazards during rural electrification projects.

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- Environmental Protection: It outlines measures to minimize environmental impact, including responsible waste management, pollution prevention, and sustainable use of resources.
- Compliance with Regulations: The agency commits to adhering to Nigerian laws, international standards, and industry best practices in health, safety, and environmental management.
- Risk Management: Procedures are established for identifying, assessing, and mitigating risks associated with electrification projects, including construction and maintenance activities.
- Training and Awareness: Staff and contractors are required to undergo regular HSE training to ensure safe practices and environmental responsibility.
- Emergency Preparedness: The policy includes frameworks for emergency response, accident reporting, and corrective actions to prevent recurrence.
- Continuous Improvement: REA pledges to monitor performance, audit compliance, and update practices to improve safety and sustainability outcomes.

Table 1.2 – Key Policies, Legal and Regulations Applicability Summary

Instrument	Application to the FUBK project
EIA Act, CAP E12 LFN 2004 and EIA Procedures and Charges Regulations, 2021	Require environmental assessment, consultation, review, approval and post-approval monitoring before project implementation.
Electricity Act, 2023 and applicable NERC instruments	Govern the construction and operation of the generation facility, electrical safety, internal distribution infrastructure, licensing or permit requirements and technical compliance.
Climate Change Act, 2021 and NDC 3.0	Require consideration of climate mitigation, adaptation and resilience. The Project contributes through renewable generation and reduced reliance on diesel backup.
Land Use Act, CAP L5 LFN 2004	Relevant to confirmation of institutional ownership and authorised project use of the designated site. No additional land acquisition is proposed.
Labour Act, Employees' Compensation Act and applicable occupational safety legislation	Apply to contractors, subcontractors and O&M personnel, including employment conditions, workers' rights, occupational safety, compensation and worker grievance arrangements.
Applicable NESREA regulations	Apply to noise, air emissions, sanitation, waste, hazardous materials, batteries, e-waste, water quality and environmental compliance during construction and operation.
National Gender Policy and applicable GBV/SEA/SH provisions	Require non-discrimination, equal opportunity, prevention of harassment and exploitation, confidential reporting and survivor-centred response arrangements.
Kebbi State and local requirements	Apply to state environmental oversight, waste management, development control, emergency coordination and local stakeholder engagement.
AfDB ISS 2023	Establishes the lender's environmental and social assessment, labour, pollution prevention, community safety, land-use screening, biodiversity and stakeholder-engagement requirements.

1.9 Structure of EIA Report

The format of this report is essentially in line with the recommended format and guidelines by the Federal Ministry of Environment (FMEnv). Accordingly, the report is organized into the nine main chapters (1-9) as follows:

Chapter One: *Introduction*
This chapter provides background information about the proposed project and highlights objectives, scope of work for the environmental assessment as well as the applicable legal and administrative framework for the project.

Chapter Two: *Project Justification*
This chapter outlines the project justification, including the need; value/benefits of the project and project development options and alternatives.

Chapter Three: *Project Description*
This chapter describes the proposed project location, project activities and processes involved including exploration, construction, project operation, maintenance and schedule.

Chapter Four: *Description of Existing Project Environment*
This chapter describes the existing (baseline) environmental conditions of the project area including the socio-economic and health status of the inhabitants in the area. Also included are records of consultations held with the stakeholders notably the elders, youths and women in the host communities.

Chapter Five: *Potential and Associated Environmental Impacts*
In this chapter, potential and associated environmental impacts of project activities are identified and evaluated.

Chapter Six: *Mitigation Measures*
This chapter proffers mitigation and ameliorative measures that would be adopted to eliminate or reduce to acceptable levels significant adverse impacts identified.

Chapter Seven: *Environmental and Social Management Plan (ESMP)*
This chapter presents the Environmental and Social Management Plan (ESMP) that will be adopted throughout the project life cycle. It also includes the Environmental Management System (EMS) plan that will ensure the effectiveness of the mitigation measures and the remediation plan after decommissioning. It also presents the activities carried out during the ESIA and an overview of the grievance redress mechanism.

Chapter Eight: *Remediation Plan After Decommissioning/Closure*
This chapter briefly presents the details of decommissioning plan at the end of the project life cycle.

Chapter Nine: *Summary and Conclusion*
This chapter presents conclusions and recommendations.

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Introduction

This chapter presents the justification and need for the proposed 1-Megawatt (MW) Solar Photovoltaic (PV) Power Plant at Federal University Birnin Kebbi (FUBK), to be implemented by the Rural Electrification Agency (REA). It articulates the technical, economic, environmental, institutional, and strategic imperatives that necessitate the project, in accordance with the requirements of the Federal Ministry of Environment (FMEnv) ESIA Procedural Guidelines, which require clear demonstration of project rationale and public interest value.

2.2 Justification and Need for the Project

Nigeria continues to experience a significant electricity supply deficit relative to its growing population and economic demand. Despite an installed generation capacity exceeding 12,000 MW, actual delivered capacity remains substantially lower due to transmission constraints, distribution losses, gas supply limitations, and aging infrastructure. The resulting supply gap has led to widespread dependence on self-generation using diesel and petrol generators, particularly within institutions, commercial establishments, and rural communities. This reliance has contributed to high operating costs, greenhouse gas (GHG) emissions, noise pollution, and localized air quality deterioration. In response, the Federal Government Nigeria set targets to expand electricity access to 75% by 2020 and 90% by 2030, and increasing the minimum renewable energy contribution, as outlined in the National Electric Power Policy (NEPP, 2001) and the Rural Electrification Policy (2005) (RESIP, 2016). In line with these goals, the Rural Electrification Agency (REA) proposes the installation of a 1 MW solar photovoltaic power plant at the Federal University Birnin Kebbi, Kebbi State.

Also, access to electricity is a critical driver of poverty reduction and economic development. Nigeria is committed to achieving the 17 Sustainable Development Goals (SDGs) under the United Nations' 2030 Agenda for Sustainable Development, particularly Goal 7, which aims to ensure universal access to affordable, reliable, and clean energy. Unreliable power supply disrupts academic productivity, research output, and institutional efficiency. Diesel backup generation, while necessary, imposes high fuel costs; noise pollution; local air emissions (NO_x, SO_2, particulate matter); as well as the attendant maintenance burdens. The proposed solar PV installation directly addresses these reliability constraints by providing a dedicated, decentralized, and predictable energy source.

The justification for the proposed project is further discussed under the following headings:

- National Energy Transition Imperative.
- Economic Justification.
- Environmental and Climate Justification.
- Social and Developmental Justification.
- Strategic Alignment with Rural Electrification Objectives

2.2.1 National Energy Transition Plan

Nigeria's Energy Transition Plan, officially launched in 2022, provides a national pathway towards achieving net-zero emissions by 2060 while expanding energy access and addressing energy poverty. The Plan identifies the power sector as a major area for transition through increased deployment of renewable energy, improved electricity-system performance and reduced reliance on carbon-intensive generation. The proposed FUBK solar-hybrid project is consistent with this direction because it will add renewable generation within a public institution and reduce dependence on diesel backup to the extent technically achievable.

2.2.2 Economic Justification

2.2.2.1 Diesel Cost Avoidance

The installation of the solar plant project would offset substantial diesel consumption, resulting in:

- Reduced fuel procurement costs as operating diesel generators incur significant recurrent expenditure.
- Lower generator maintenance expenses;
- Reduced foreign exchange exposure linked to fuel price volatility.

Over a 25-year lifespan, the levelized cost of solar energy is significantly lower than diesel generation, making the project economically viable.

Based on the installed 6 Unit diesel generator capacity (855 kVA) which is the total capacity run by the university, an assumed average operating period of 4 hours per day during weekdays (approximately 22 days per month), an average loading of 75%, and a typical fuel consumption rate of 0.27 litres/kWh, the University's generators are estimated to consume approximately 15,000 litres of diesel per month. Actual fuel consumption may vary depending on generator loading, frequency of grid outages, and operational requirements.

The proposed 1 MW solar photovoltaic project is expected to reduce dependence on diesel generation and grid electricity while providing a more stable power supply. Based on current market estimates for comparable solar PV systems with battery storage, the cost of electricity generated by the project is subject to the final system design, financing structure, and operating conditions. The exact cost per kWh will be determined during the detailed engineering and financial feasibility assessment. *See Appendix for the breakdown of the university electricity and generator consumption.*

2.2.2.2 Institutional Financial Sustainability

Energy cost savings improve:

- Budgetary predictability;
- Allocation of resources toward academic development;
- Financial sustainability of campus operations.

The project represents a long-term capital investment with recurring operational savings.

2.2.3 Environmental and Climate Justification

Diesel-based generation produces greenhouse gas emissions and local pollutants. Replacing diesel with solar PV:

- Eliminates on-site combustion emissions;
- Reduces noise pollution;
- Minimizes spill risks associated with fuel handling.

As a renewable energy project, it contributes directly to climate mitigation objectives and enhances environmental stewardship within the academic community.

2.2.4 Social and Developmental Justification

Reliable electricity within a university environment supports:

- Enhanced research capacity;
- Improved learning conditions;
- Digital transformation and ICT expansion;
- Improved campus safety and security;

- Better water and sanitation services powered by electricity.

Additionally, the project will:

- Develop local technical capacity in renewable energy installation and maintenance;
- Provide a live demonstration facility for students in engineering and environmental sciences;
- Create short-term employment during construction.

The project thus yields both direct and indirect social benefits.

2.2.5 Strategic Alignment with Rural Electrification Objectives

The mandate of the Rural Electrification Agency includes expanding reliable electricity access and promoting renewable energy solutions in public institutions. The project:

- Demonstrates scalable institutional renewable deployment;
- Serves as a model for other tertiary institutions;
- Supports decentralized energy systems in northern Nigeria.

It therefore fulfills strategic institutional and national objectives simultaneously.

In summary, the Federal University Birnin Kebbi, like many public institutions in Nigeria, experience irregular grid electricity supply; frequent outages and voltage instability; high reliance on diesel generators; and elevated operational energy costs. Academic institutions require stable power for ICT infrastructure and data centers. The proposed solar PV installation project in FUBK represents a necessary, beneficial, and sustainable intervention that addresses immediate institutional challenges while advancing broader national development priorities as it will directly address these reliability constraints by providing a dedicated, clean, decentralized, and reliable energy source.

2.3 Value of the Project

The project is co-financed by the African Development Bank and the funding covers Engineering, Procurement, and Construction (EPC) as well as Operations & Maintenance (O&M) contracts. These contracts will be awarded to competitively selected EPC contractors who will build, operate, and maintain the power plants at each site.

While the project is primarily for institutional consumption, value is realized through:

- Reduced operating expenditures;
- Reallocation of savings to academic development;
- Potential energy research commercialization; and
- Reduced generator maintenance expenditure

2.4 Expected benefits of the project

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

- Improved electricity reliability (the project is expected to generate 1.6 – 1.8 Gigawatt-hours (GWh) annually)
- Reduction in generator usage leading to avoidance of approximately 900 – 1,200 tonnes of CO_2 equivalent annually.
- Temporary employment during construction i.e civil construction workers, electrical installation technicians, site engineers, security personnel.
- Renewable energy capacity building.

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- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply.
- Increase in social interactions within the University
- Enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.
- Potential improvement in livelihood enhancing activities within the University
- Contributing to the Nigeria's NDC to cut carbon emission by 20% by the year 2030, under the Paris Agreement.

2.5 Sustainability of the Project

The sustainability of this project is discussed under the following: Environmental, Socio-economic (social and economic) and technical sustainability.

2.5.1 Technical Sustainability

Technical sustainability refers to the ability of the project to operate safely, efficiently, and reliably over its intended lifespan (25 years and above). For the proposed 1-MW Solar PV Power Plant at Federal University Birnin Kebbi (FUBK), technical sustainability is embedded in the project's procurement structure (ensuring certified equipment/materials are used), engineering oversight, operational framework, and capacity development strategy led by the Rural Electrification Agency (REA).

The project will be implemented through a qualified and experienced Engineering, Procurement and Construction (EPC) contractor selected by REA through a transparent and competitive procurement process. An Engineering Procurement and Construction (EPC) Framework shall be developed and the selection process will follow pre-established technical, financial, and performance criteria consistent with national procurement standards and international best practices. Under this framework:

- REA's qualified engineers will provide oversight during design and construction;
- The EPC contractor will assume full responsibility for detailed engineering design;
- All equipment procurement will comply with approved technical specifications and international standards (e.g., IEC-certified components);
- Installation will adhere to quality assurance and quality control (QA/QC) protocols;
- Testing and commissioning will follow structured acceptance procedures;
- Performance guarantees will be contractually binding.

This structured EPC approach shall ensure that system design is optimized, construction quality is verified, and long-term performance risks are minimized. Additionally, technical sustainability is reinforced by requiring the EPC contractor to:

- Conduct detailed site-specific engineering studies;
- Prepare structural, electrical, and protection system designs;
- Undertake geo-technical assessments to ensure stable mounting foundations;
- Provide grid interconnection studies;
- Develop protection coordination and earthing designs.
- Develop comprehensive Operation Manuals; Maintenance Manuals; Equipment datasheets; Protection and control schematics; Emergency response procedures; Preventive maintenance schedules etc;
- Ensure that all installations undergo Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT) prior to commissioning as well as conducting Performance Ratio Verification and system output validation before handover.

Equipment Quality Assurance, OEM Standards and Regulatory Compliance

Technical sustainability is strengthened through the use of equipment from reputable Original Equipment Manufacturers (OEMs) with proven performance, warranties, spare parts availability, and technical support to ensure long-term reliability and reduce the risk of failure. All major components, including solar PV modules, inverters, batteries, transformers, switchgear, and protection devices, shall comply with relevant international standards and Nigerian regulatory requirements. Equipment shall be certified by the Standards Organisation of Nigeria (SON) and meet Mandatory Conformity Assessment Programme (MANCAP) requirements, where applicable. Electrical installations shall also be inspected and certified by the Nigerian Electricity Management Services Agency (NEMSA) prior to commissioning to ensure compliance with national safety standards. Installation, testing, commissioning, and maintenance shall be carried out by qualified and certified personnel in accordance with NEMSA requirements and industry best practices to ensure safe and reliable operation.

The capacity building will be provided to university staff who will manage day-to-day operations long-term. After construction, an O&M contractor will operate and maintain the project alongside relevant university departments, with additional training for university personnel working with the O&M contractor. Students from related departments will also receive hands-on training on power plant construction, operation, and maintenance' into discussion on the technical sustainability of the project.

2.5.2 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 relevant stakeholders are given the opportunity to contribute their perspectives at an early stage. This participatory approach enhances inclusiveness, builds trust, and lays a foundation for long-term relationships with the university community, local residents, and other stakeholders.

The preparation of a Stakeholder Engagement Plan (SEP) further reinforces social sustainability by institutionalizing continuous dialogue throughout the project lifecycle. This ensures that stakeholders remain informed, involved, and able to influence decisions that may affect them, thereby promoting transparency, accountability, and project legitimacy.

A Grievance Redress Mechanism (GRM) will also be implemented by the Rural Electrification Agency (REA) to provide a structured platform for receiving and resolving stakeholder concerns in a timely and fair manner. This mechanism will help prevent and manage conflicts, thereby strengthening social cohesion and community trust in the project.

In addition to stakeholder engagement, the project incorporates Occupational Health and Safety (OHS) measures to protect workers during construction and operation phases. These measures include the implementation of a site-specific Health, Safety and Environment (HSE) management plan, routine risk assessments, provision and mandatory use of Personal Protective Equipment (PPE), safety induction and regular training for workers, incident reporting systems, and emergency preparedness and response procedures. Contractors will be required to comply with applicable national regulations and international best practices on occupational safety.

Community Health and Safety (CHS) considerations are also integrated into project planning to protect surrounding communities and university users. Mitigation measures will include control of site access and security, traffic management during construction, dust and noise control, electrical safety precautions, safe handling and storage of materials, and proper waste management practices. These measures are designed to minimize potential risks such as accidents, exposure to construction hazards, and public disturbances.

Overall, the combination of stakeholder engagement, grievance management, occupational health and safety, and community health and safety measures ensures that the project is socially sustainable. These interventions promote inclusiveness, safety, responsiveness, and accountability, while strengthening the project's social license to operate and long-term acceptance within the host community.

2.5.3 Economic Sustainability of the Project

The economic sustainability of the project is founded on its ability to deliver long-term cost savings, predictable energy pricing, reduced operational expenditure, and enhanced institutional financial stability. Implemented by the Rural Electrification Agency (REA), the Project represents a capital investment that generates measurable economic value over its 25-year design life.
The Project is economically sustainable as it offers:

i. Reduction in Recurrent Energy Expenditure: Over its lifecycle, the avoided fuel expenditure is expected to exceed the initial capital investment. Diesel generators require constant fuel purchases and storage thereby exposing institutions like FUBK to volatile oil prices and logistics costs. On the other hand, Solar PV systems use sunlight, which is free and abundant, eliminating recurring fuel costs.;
ii. Predictable Long-Term Energy Costs: Unlike fossil-fuel-based systems, the overall cost of electricity from solar PV is significantly lower than diesel-based generation when evaluated over a 20–25 year period. The economic advantage of solar PV is primarily reflected in its lower levelized cost of electricity (LCOE), leading to cost ratios.
iii. Improved Budgetary Planning and Institutional Stability: The Project strengthens the financial sustainability of the University's operations by means of reduced vulnerability to fuel price shocks;
iv. Low Operating and Maintenance (O&M) Costs: Due to absence of continuous fuel purchase requirements, Solar PV systems have comparatively low O&M costs. At Nigeria's current diesel price (₦1,280 – ₦1,462/L) and the need to power FUBK's diesel generators to generate approximately 0.8 - 1 MW for 40 hours per week, the fuel use would cost around ₦597 million – ₦681 million annually while Solar PV's installation costs are front loaded and predictable and its O&M avoids the recurring burden of fuel procurement, logistics, and maintenance complexity.
v. Local Economic and Capacity Benefits: During construction, the Project will generate short-term employment opportunities for local technicians and skilled workers while on the long term, it shall support capacity building.
vi. Asset Longevity, Residual Value and Battery Storage Options: The proposed Solar PV facility has an expected lifespan of at least 25 years, with inverters and other components replaceable over time, ensuring sustained operational performance and long-term residual value. The project will incorporate a Battery Energy Storage System (BESS) to enhance reliability. Two options are considered: Lithium-Ion and Lead-Acid batteries. Lithium-Ion batteries are preferred and will be utilized due to their longer lifespan, higher efficiency, deeper discharge capability, and lower maintenance requirements, making them more suitable for long-term hybrid solar

applications. Lead-Acid batteries, while cheaper upfront, have shorter life cycles and higher maintenance needs and are therefore less suitable for sustained operation.

2.5.4 Environmental Sustainability

The environmental sustainability of the Project is fundamentally anchored in its reliance on solar energy as a renewable power source. By generating electricity from solar photovoltaic technology, the Project avoids the combustion of fossil fuels and thereby produces negligible greenhouse gas emissions during operation. This significantly reduces the carbon footprint of the facility when compared to conventional diesel or other fossil fuel–based power generation systems. In addition to eliminating operational air emissions, the Project minimizes noise pollution, fuel handling risks, and long-term environmental degradation associated with thermal power generation.

Environmental sustainability is further reinforced through the institutional framework established for Project implementation. The Rural Electrification Agency Project Management Unit (REA-PMU), which includes experienced Environmental and Social Safeguards Specialists, will oversee environmental compliance throughout the project lifespan.

2.6 Project Alternatives

The establishment of the proposed solar power project at Federal University Birnin Kebbi requires careful selection of an environmentally and economically suitable site, taking into account land characteristics, meteorological conditions, existing infrastructure, grid connectivity, water availability, accessibility, and shading considerations. Prior to determining the most appropriate solar-hybrid system for this location capable of matching daily demand with renewable energy generation a comprehensive review of measured data was undertaken by the Front End Engineering Design (FEED) Consultant. Accordingly, this section focuses specifically on the alternatives evaluated for the proposed solar-hybrid power plant. Since the project is conceptualized as a renewable energy source utilizing Solar Photovoltaic Power (SPV) Systems, discussions on conventional power generation options such as coal-fired, oil-fueled, or natural gas plants have been excluded.

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

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

The PV technology is favourable for project financing due to relatively lower costs than other solar technologies. Also, the existing transmission infrastructure is adequate to deliver the energy produced from the plant and the process involves a simple design with few technical components which reduces operation and maintenance costs and in general makes the plant more efficient. Table 2. 1 indicates Potential SPV System Configurations and Design Assumptions based on 4.8 daily hours of peak power output.

Table 2.1: Potential SPV System Configurations and Design Assumptions based on 4.8 daily hours of peak power output.

Description	SPV Systems		SPV Mini-grid	Large Grid-connected
			Power Plants	SPV Power Plant
Module Capacity	50 W_p	300 W_p	25 kW	5 MW
Life Span Modules	20 Years	20 Years	25 Years	25 Years
Life Span Batteries	5 Years	5 Years	5 Years	NA
Capacity Factor	20%	20%	20%	20%

(Source: REA FEED Projections)

The options considered included Alternative Sites considered and Justification for selection, Alternative to Power Generation, Alternative technology and Battery Selection Options, as well as the Do-nothing option.

2.6.1 Alternative Sites Considered for the Project

The following alternatives were considered during site selection:

2.6.1.1 Off-Campus Location: This option would require land acquisition, additional transmission infrastructure, possible environmental disturbance, and additional impacts.
The environmental and administrative risks were considered higher than having an on-campus location, hence rejected.

2.6.1.2 Rooftop Solar Installation: Rooftop installations were evaluated but found limited due to irregular roof geometry, limited available contiguous area, and increased installation complexity.
Ground-mounted installation offers greater efficiency and scalability, rooftop installations were rejected.

2.6.1.3 Distributed Micro-Solar Installations: A dispersed system across multiple buildings was considered but would increase wiring complexity and complicate maintenance.
A centralized ground-mounted configuration was deemed technically superior, hence, the option for a distributed micro-solar installation was rejected.

2.6.1.4 On-Campus Location: Following the alternative sites considered for the project, the best alternative is to site the project within the campus of Federal University Birnin Kebbi in Birnin Kebbi Local Government Area, Kebbi State, Nigeria. Two sites were identified for the proposed project as follows:

- Site A (13 Hectares) Longitide 12.338724 °N; Latitude 4.149325 °E
- Site B (12.2 Hectares) Longitude 12.346217 °N; Latitude 4.153691 °E

The two (2) sites are located adjacent each other within an institutional land legally allocated to the University. The sites share similar physical characteristics such as:

- Relatively flat terrain;
- Non-forested Sudan Savannah vegetation;
- Previously disturbed or open land areas;
- Absence of wetlands, floodplains, or protected habitats;
- Adequate solar irradiation.

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The sites were considered good for the project based on the following factors on Table 2.2:

Table 2.2 - Factors for site consideration and selection

Factors	Suitability
Technical Suitability	Both sites meet the technical design requirements without requiring major civil engineering modifications. These include: ✓ Proximity to existing campus distribution network; ✓ Adequate solar exposure with minimal shading; ✓ Stable soil conditions for mounting structures; ✓ Ease of access for construction and maintenance; ✓ Sufficient contiguous land area for 1-MW installation.
Environmental Sensitivity Screening	The sites are considered environmentally low-risk and suitable for renewable infrastructure as it: ✓ Is not within a protected area or ecological reserve; ✓ Does not affect critical habitats; ✓ Does not involve tree felling of significant ecological value; ✓ Does not interfere with natural drainage systems; ✓ Is outside known erosion-prone or flood-prone zones.
Social and Land-Use Compatibility	The considered locations will not require resettlement, compensation, or livelihood restoration because the sites: ✓ Are within university-owned land; ✓ Does not require land acquisition; ✓ Does not displace communities or livelihoods; ✓ Does not restrict public access to communal resources; ✓ Is compatible with existing institutional land use.
Economic Considerations	✓ Locating the project within the campus: ✓ Eliminates land purchase costs; ✓ Minimizes transmission infrastructure costs; ✓ Reduces right-of-way complications; ✓ Simplifies project permitting; ✓ Lowers overall capital expenditure.
Security and Operational Considerations	Siting the project within the institution guarantees: ✓ Controlled access and perimeter security; ✓ Reduced risk of vandalism; ✓ Ease of monitoring and maintenance; ✓ Long-term land tenure certainty.
Climate and Environmental Resilience Considerations	The selected site supports climate-resilient design because: ✓ Terrain allows proper drainage management; ✓ No floodplain encroachment; ✓ Adequate wind stability for structural anchoring; ✓ Minimal vegetation clearing required; ✓ Soil conditions suitable for non-invasive foundation systems.
Space availability	✓ Depending on the actual number of panels to be installed (approximately 1,700 - 3,000 units depending on wattage rating), and following a rule of thumb, it is anticipated that a total land area of less than 1.5 - 2 hectares will be required to accommodate the solar field itself, excluding additional land for other electrical components and access.

Table 2.3 Environmental Trade-Off Analysis

Option	Environmental Risk	Technical Efficiency	Cost	Social Impact	Overall Suitability
Off-Campus	Moderate	Moderate	High	Moderate	Low
Rooftop	Low	Moderate	Moderate	Low	Moderate
Distributed Micro-Solar Installations	Low	Moderate	High	Low	Moderate
On-Campus (Selected)	Low	High	Moderate	None	High

2.6.2 Power Generation Alternatives

2.6.2.1 Option A – Continued reliance on Back-up Generators and Diesel Generation:

- **Technical Consideration:**

Diesel generators provide dispatchable and reliable power independent of grid performance. However, they require continuous fuel supply, regular maintenance, and periodic engine overhaul.

- **Economic Implications:**

Although capital cost is relatively lower than the other options, lifecycle cost is substantially higher due to recurring fuel expenses and maintenance requirements. Exposure to fuel price volatility poses financial sustainability risks.

- **Environmental Implications:**

Diesel combustion produces significant greenhouse gas emissions (CO_2), nitrogen oxides (NOx), sulphur dioxide (SO_2), particulate matter, and noise pollution. There are also risks associated with fuel storage, spills, and disposal of used oil and filters. Long-term operation would increase the university's carbon footprint and air pollution burden.

2.6.2.2 Option B – Grid-Only Supply: This option assumes reliance solely on electricity supplied through the national grid without dedicated on-site generation.

- **Technical Consideration:**

Grid supply eliminates on-site fuel handling and emissions. However, grid electricity is characterized by voltage fluctuations, load shedding, and outages. Exclusive reliance on the grid may compromise operational reliability for critical academic and research facilities.

- **Economic Implications:**

While capital cost is minimal, the risk of unreliable supply may necessitate continued backup diesel use, thereby reintroducing environmental and economic disadvantages.

- **Environmental Implications:**

Environmental impacts are indirect and depend on the national generation mix, which still includes fossil fuel sources. The institution has limited control over upstream emissions.

2.6.2.3 Installation of Solar Photovoltaic (PV) – Proposed Option: The proposed option involves installation of a 1-MW ground-mounted Solar PV system within the campus in addition to the existing energy infrastructure.

- **Technical Consideration:**

Solar PV provides clean, renewable electricity with minimal mechanical components and low maintenance requirements. While generation is daytime-dependent, it shall be integrated with the grid and battery storage to enhance reliability.

❖ **Economic Implications:**
Though capital-intensive initially, solar PV offers low operating costs, predictable long-term energy pricing, and substantial savings from diesel displacement over its 25-year lifespan.

❖ **Environmental Implications:**
Operational emissions are zero. Noise levels are negligible, and there is no fuel handling risk. Environmental impacts are largely limited to land use footprint and end-of-life component management, which are manageable through proper planning.

Table 2.4: Environmental Trade-Off Analysis

Option	Continued reliance on Back-up Generators and Diesel Generation	Grid Only	Solar PV
Emissions	High	Medium	Minimal
Noise	High	Low	Minimal
Land Use	Minimal	None	Moderate
Waste	Fuel Waste	None	End-of-life panel waste
Reliability	High (fuel dependent)	Moderate - Low	High (with grid/battery)
Climate Alignment	Poor	Moderate	Strong
Lifecycle Cost	High	Moderate	Low
Regulatory Burden	High	Moderate	Low

'Option A – Continued reliance on Back-up Generators and Diesel Generation' is technically feasible but it is environmentally unsustainable, economically burdensome over the long term, and inconsistent with national renewable energy and climate transition objectives, while Grid-only supply reduces on-site environmental impacts but does not resolve reliability challenges. It also does not contribute directly to renewable energy expansion within the institution. However, Solar PV offers the best balance of environmental sustainability, economic viability, regulatory compliance, and alignment with Nigeria's renewable energy and climate commitments.

Based on the above comparative analysis, Option C – Solar PV is the most environmentally sound, economically sustainable, and strategically aligned power generation alternative for the project. It is therefore the preferred alternative.

2.6.3 Panel Technology Alternatives Considered

The panel technologies considered for this project are the mono-crystalline, polycrystalline and thin film panels, this is as a result of its peculiar technology advancement

2.6.3.1 Option A – Monocrystalline Panels:

- Features: Made from single-crystal silicon, giving them a uniform dark coloured appearance.
- Efficiency: Highest: (18–22%), meaning more power per square meter.
- Pros: Space-efficient, long lifespan, better performance in low light.
- Cons: Higher upfront cost compared to other types.

2.6.3.2 Option B – Polycrystalline Panels:

- Features: Made from multiple silicon crystals, with a bluish speckled appearance.
- Efficiency: Moderate (15–17%).
- Pros: Lower cost, simpler manufacturing process.
- Cons: Less efficient, requires more land area for the same capacity.

2.6.3.3 Option C – Thin-film Panels:

- Features: Made by depositing photovoltaic material on glass, plastic, or metal.
- Efficiency: Lower (10–12%), but improving with new materials.
- Pros: Lightweight, flexible, easier installation, good performance in hot climates.
- Cons: Larger area required, shorter lifespan, faster degradation.

Table 2.5: Comparative Analysis between Solar Panel Technology for the project

Panel Type	Monocrystalline	Polycrystalline	Thin Film
Efficiency	High	Medium	Low
Cost	High	Medium	low
Lifespan	Long	Long	Short
Land Requirement	Low	Medium	High

Based on the above comparative analysis, Monocrystalline Solar PV panels is the preferred due to their efficiency, durability, and requiring the least land space. It is therefore the selected alternative.

2.6.4 Solar Batteries Alternatives Considered:

2.6.4.1 Lead-Acid Batteries

Lead-acid batteries are the oldest form of battery with technology dating back more than a century. As a result, lead-acid batteries are a tried-and-true when it comes to storage. Leadacid batteries are categorized into two types: flooded lead-acid and sealed lead-acid batteries. The lead-acid variety are considerably more inexpensive than other solar batteries. These batteries come with some challenges: shorter lifespan (2-6 years) and lower depth of discharge. Lead-acid battery capacity is also comparatively lower than other batteries. These limitations can complicate the installation process.

2.6.4.2 Lithium-Ion Batteries

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

2.6.4.3 Nickel Cadmium Batteries

Nickle Cadmium (Ni-Cd) batteries are not as common as lead-acid or lithium-ion batteries. These batteries are also a century old. They were popular in the aircraft industry. Because of their sturdiness, Ni-Cd batteries are useful for large-scale applications, such as utility solar energy storage. Known for durability, Ni-Cd batteries can operate at higher temperatures. They also don't need complicated battery management systems and are almost maintenance-free. Ni-Cd batteries' biggest drawback is that they are toxic. Even when recycled, they can become a major environmental concern.

2.6.4.4 Flow Batteries

Flow batteries are still in the development phase (just as the Sodium-Ion batteries but different characteristics and deployment), and it may take some time before they are widely available in the market. Knowing about them now is worthwhile because this variety is expected to be a game-changer in future solar panel storage methods. Within these batteries, water-based electrolyte liquid circulates between two different chambers. The chemical reaction of the charging process allows the battery to store and release electrical energy. The biggest advantage of flow batteries is that they offer 100% depth-of-discharge capability. This means you can utilize all the energy stored in the battery without damaging it.

In practical terms, flow batteries stand out because they separate energy capacity from power output. The tanks determine how much energy can be stored, while the cell stacks dictate how quickly it can be delivered. This modular design makes them particularly attractive for solar projects that need flexible, long-duration storage. Unlike lithium-ion systems, which degrade over time and limit usable capacity, flow batteries can cycle thousands of times with minimal wear, offering a more sustainable long-term solution.

Table 2.6: Comparison between battery alternatives for the project

Battery Type	Lifespan (Years)	Efficiency	Cost Trend	Best Use Case
Lead-Acid	3 - 5	Moderate	Low	Small off-grid backup
Lithium-Ion	10 - 15	High	Moderate - High	Utility-scale + residential
Flow	15 - 20	Moderate	High	Large-scale, long-duration storage
Nickel Cadmium	15–20	Moderate	High	Large-scale
Sodium - Ion	8 - 12	Moderate	Low	Utility-scale

Based on the above comparison above, Lithium-ion batteries are the preferred due to their efficiency and applicability (best-use-case). It is therefore the selected alternative.

2.7 Project Development Options:

2.7.1 No Project Option:

The No-Project Alternative assumes that the proposed 1-MW Solar Photovoltaic (PV) Power Plant at Federal University Birnin Kebbi (FUBK), to be implemented by the Rural Electrification Agency (REA), will not be developed. Under this scenario, the university would continue relying on existing grid supply supplemented by diesel-powered generators.

2.7.2 Technical Implications of the No-Project scenario:

- The university would remain dependent on an unstable national grid supply;
- Power outages and voltage fluctuations would persist;
- Diesel generators would continue to serve as backup or primary energy sources;
- Research laboratories, ICT systems, water supply, and security infrastructure would remain vulnerable to power interruptions.

This would compromise energy reliability and constrain academic and operational performance.

2.7.3 Environmental Implications of the No-Project scenario:

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- Continued Greenhouse Gas Emissions: Ongoing diesel generator use would produce substantial CO_2, NOx, SO_2, and particulate matter emissions.
- Air Quality Degradation: Persistent combustion emissions may affect local air quality within the campus environment.
- Noise Pollution: Diesel generators produce high noise levels that may disrupt academic activities.
- Fuel Handling Risks: Continued storage and transfer of diesel fuel present risks of spills, soil contamination, and fire hazards

Although the No-Project option avoids temporary construction-related impacts (e.g., minor land disturbance), it results in significant long-term environmental costs. By contrast, the proposed solar PV system produces negligible operational emissions and eliminates on-site fuel handling.

2.7.4 Economic Implications of the No-Project scenario:

- High and volatile fuel expenditures;
- Generator maintenance and overhaul costs;
- Financial exposure to fuel price fluctuations;
- Unplanned operational costs due to equipment failures.

Over a 20–25 year period, cumulative diesel fuel costs would likely exceed the capital investment required for the solar PV plant. Therefore, the No-Project option is economically inefficient in the long term.

Additionally, failure to implement the project would make the university forgo the opportunity to serve as another demonstration site for renewable energy deployment in northern Nigeria and reduce opportunities for renewable energy training and technical capacity building. Furthermore, the No project scenario does not align with Nigeria's commitment to expanding renewable energy and reducing greenhouse gas emissions.

2.7.5 Go ahead with the Project Option:

The proposed 1-MW Solar PV project at Federal University Birnin Kebbi should proceed because it will significantly improve electricity reliability for academic, research, and essential campus operations. It will reduce long-term energy costs by displacing expensive and fuel-dependent diesel generation, thereby strengthening institutional financial sustainability. The project will substantially lower greenhouse gas emissions and eliminate on-site fuel handling risks, supporting Nigeria's renewable energy and climate commitments. It also incorporates structured capacity building and technical knowledge transfer to ensure long-term operational sustainability. Overall, the project delivers clear environmental, economic, technical, and social benefits that outweigh its minor and manageable impacts

Summarily, while the No-Project Alternative avoids short-term construction disturbances, it perpetuates long-term environmental degradation, economic inefficiency, energy insecurity, and missed sustainability opportunities. From environmental, economic, technical, and policy perspectives, the No-Project Alternative is less desirable than the implementation of the proposed 1-MW Solar PV Power Plant. The assessment therefore justifies project development as the preferred and more sustainable option.

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

This Chapter provides a comprehensive engineering-level description of the proposed 1-Megawatt (MW) Solar Photovoltaic (PV) Power Plant to be developed at Federal University Birnin Kebbi (FUBK) by the Rural Electrification Agency (REA) under the Desert to Power Initiative (Phase II).

The proposed development involves the design, installation, and operation, of a 1-MW (AC) Solar Photovoltaic Power Plant within the premises of the University at Birnin Kebbi. The facility will be integrated into the university's internal distribution network. Based on prevailing solar radiation levels in Kebbi State, the system is projected to generate approximately 1.6 – 1.8 Gigawatt-hours (GWh) annually. This generation capacity will significantly enhance electricity reliability within the university campus while reducing diesel consumption and associated operational cost**s.**

The proposed plant would use a renewable method of generating electrical power by converting solar radiation into direct current electricity using silicon panels that exhibit the photovoltaic effect. 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.

Two sites within the Federal University of Birnin Kebbi (FUBK) have been identified for the proposed project:

- Site A: 13 hectares (Longitude 12.338724° N, Latitude 4.149325° E);
- Site B: 12.2 hectares (Longitude 12.346217° N, Latitude 4.153691° E)

Both sites are adjacently situated and are within each other's Area of Potential Project Influence, but Site A is earmarked for the 1 MW Solar PV facility. The project requires about 1.5–2 hectares of land, which is part of the institutional land set aside for infrastructure development.

Plate 3.1: Proposed Project Site

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

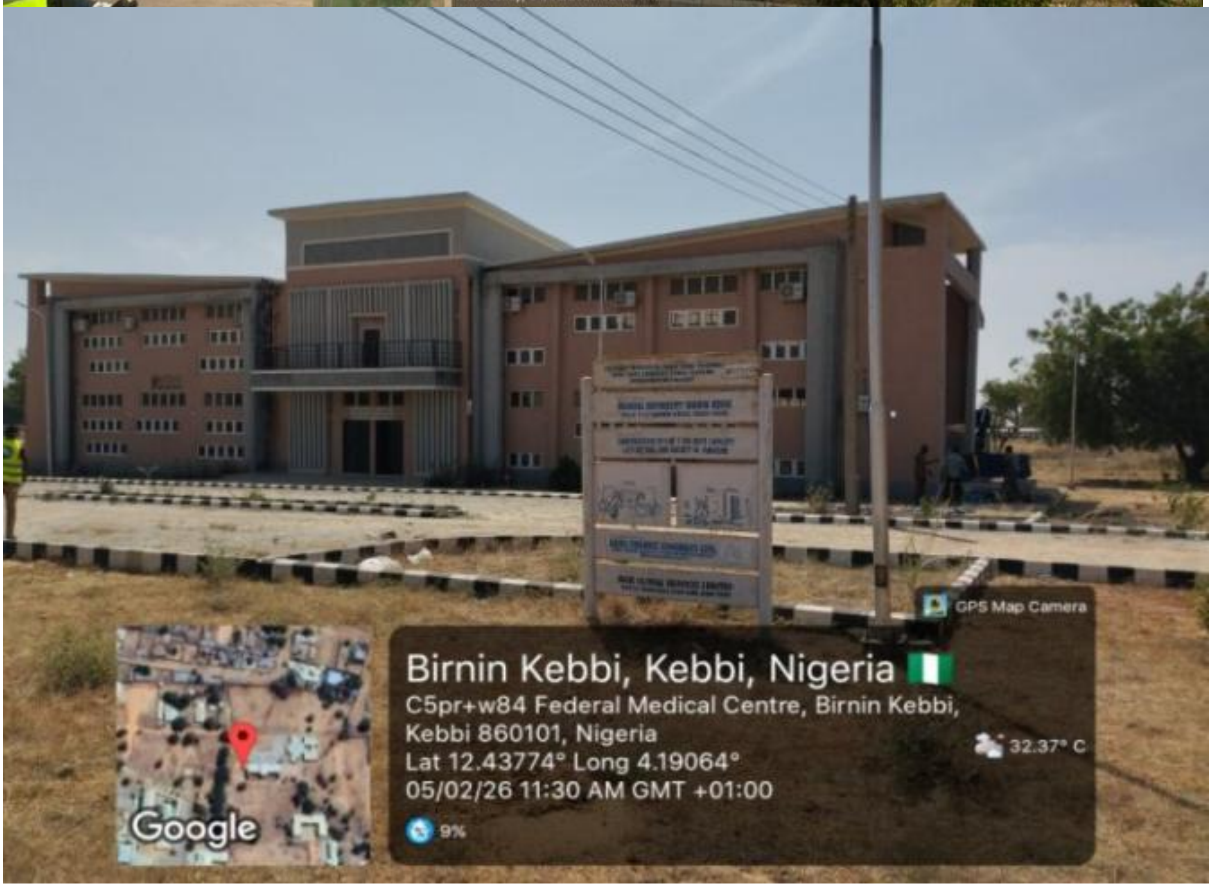

Plate 3.2: Strategic Point within the Institution

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

3.2 Key Project Components

The proposed facility will comprise:

- Solar PV modules (approximately 2,000–2,500 units depending on wattage rating).
- Inverters totaling 1 MW capacity.
- Step-up transformer (approximately 415V/11kV configuration as required).
- Power Station - Control room/powerhouse structure.
- Underground DC and AC armored cabling.
- Smart metering and monitoring systems.
- Perimeter security fencing and access control.
- Drainage infrastructure.
- Battery Energy Storage System (BESS).

The power plant will use solar panels fitted on fixed structures (mounts). Photovoltaic (PV) power generation employs solar panels composed of a number of solar cells containing silicone. The solar panels generate electricity in the form of direct current (DC). This DC power cannot be used directly by most appliances or fed into the grid, which requires alternating current (AC). Inverters are installed to perform the conversion from DC to AC. The DC output from multiple panels is first collected and routed through combiner boxes. From the combiner boxes, the DC power flows into the inverter system. The inverter electronically switches the DC at high speed to create a sinusoidal AC waveform. This AC output is synchronized with grid frequency and voltage standards. The converted AC power is then passed through transformers to step up or step down voltage as required. Once conditioned, the AC electricity is suitable for distribution across the university's internal network. A simple flow diagram Power flow sequence is illustrated as follows:

PV Modules → DC Combiner → Inverters → AC Panel → Step-up Transformer → 11kV Switchgear → Campus Distribution Network.

The main characteristics of the fixed mounted structure is stated in 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
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 Desert to Power Initiative (Phase II) FEED)

Table 3.2 gives a summary of the project's characteristics and Figure 3.1 shows the electrical configuration of the PV plant.

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Table 3.2 Summary of the project's characteristics

Project characteristic	Project description
Rated plant capacity	1,000 kW AC
Indicative DC capacity	Approximately 1,000–1,200 kWp, subject to final design
PV modules	Approximately 2,000–2,500 modules, depending on selected module rating and DC/AC ratio
Inverters	Total combined rated AC capacity of 1 MW; final number and configuration subject to design
Mounting system	Fixed-tilt ground-mounted structures
BESS	Lithium-ion BESS; capacity and duration to be confirmed during final design
Voltage transformation	Approximately 415 V/11 kV, subject to final electrical design
Distribution	Underground 11 kV internal distribution network and associated switchgear
Direct project footprint	Approximately 1.5–2 hectares within Site A
Wider Site A allocation	13 hectares
Site B	12.2 hectares reserved for possible future expansion; excluded from current works
Associated infrastructure	Control room/powerhouse, drainage, security fencing, access control, Renewable Energy Workshop/Training Centre and street lighting

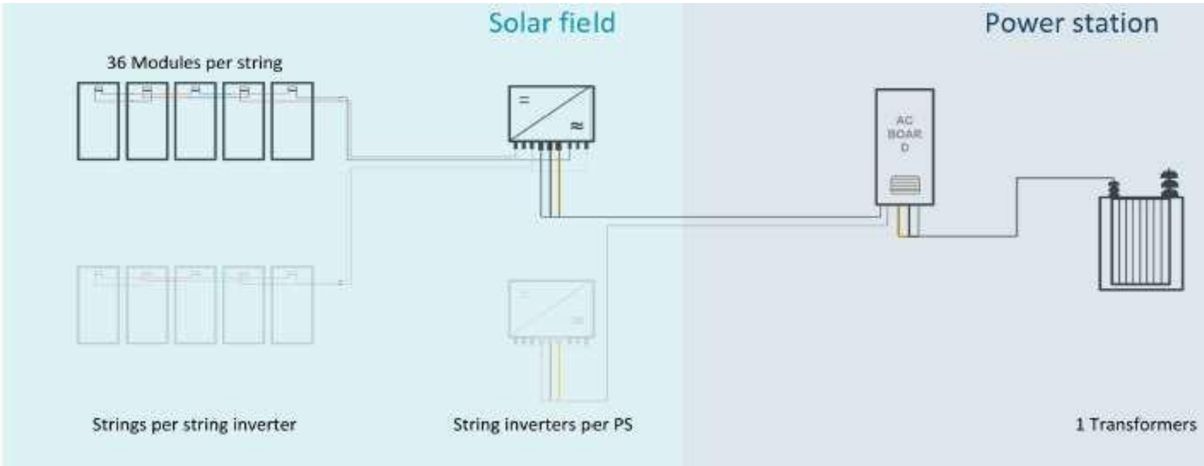

Figure 3.1: Simplified electrical configuration diagram
(Source: REA Desert to Power Initiative (Phase II) Front End and Engineering Design)

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 modules, mounted on fixed structures to obtain a total project capability of about 1,000 (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 25years (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 Figure 3.2.

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

(Source: REA Desert to Power Initiative (Phase II) FEED)

Figure 3. 2: Example of a Monofacial Si-poly photovoltaic module
(Source: REA Desert to Power Initiative (Phase II) 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 (MPPT). In Figure 3.3, a commonly used photovoltaic inverter for utility-scale PV plant is presented, and its characteristics detailed in Table 3.4. The single line diagram for the inverter is shown in Figure 3.4.

Figure 3.3: Example of string photovoltaic inverter
(Source: REA Desert to Power Initiative (Phase II) 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

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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 Desert to Power Initiative (Phase II) FEED)

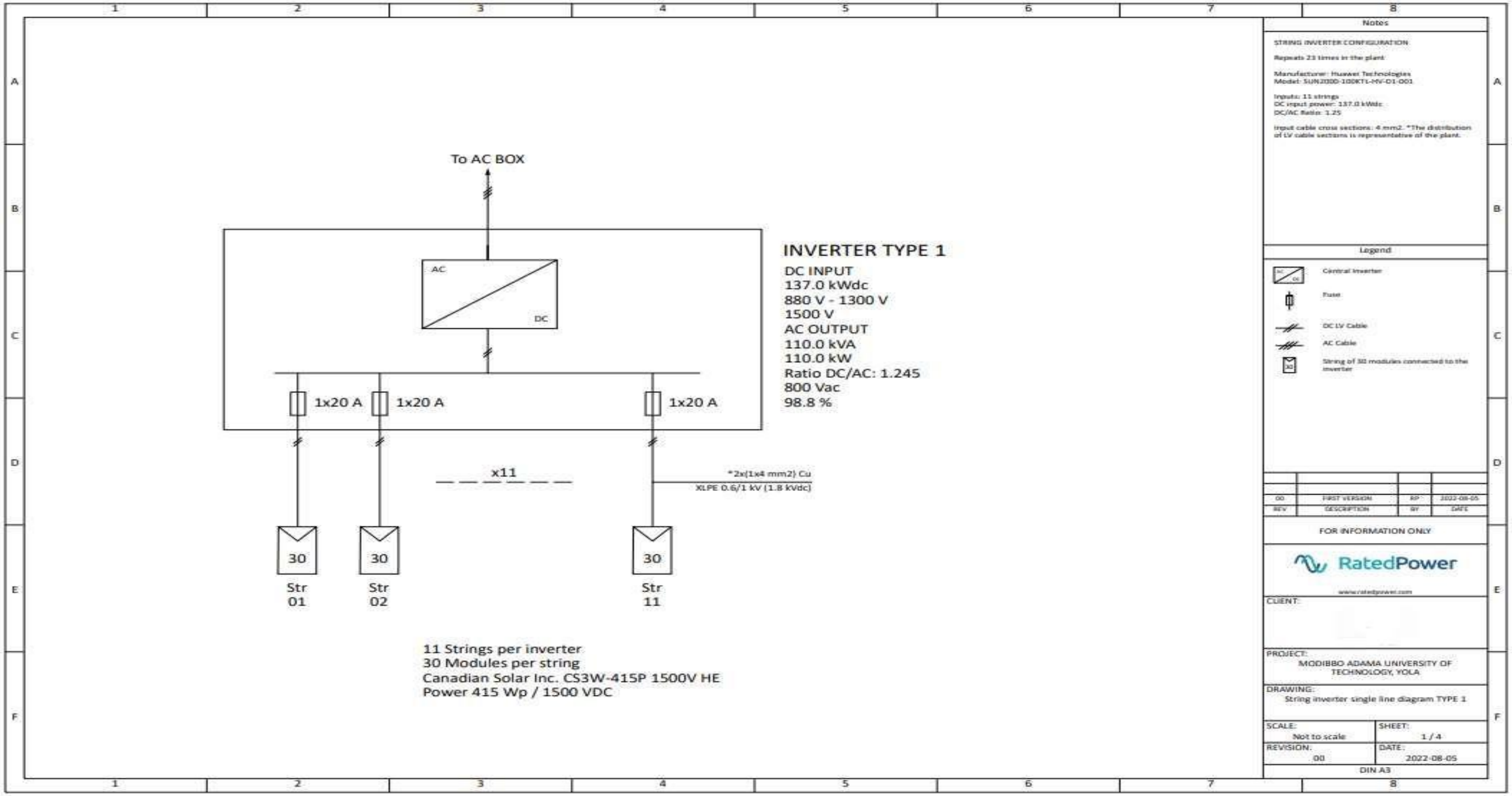

Figure 3.4: String Inverter Single Line Diagram
(Source: Desert to Power Initiative (Phase II) FEED)

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 3.5.

Figure 3.5: Example of Transformer

(Source: REA Desert to Power Initiative (Phase II) 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 Desert to Power Initiative (Phase II) FEED)

Power Station - Control room/powerhouse structure.

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 generated energy. The power transformers will be housed in the power station. An example of an Indoors power station is shown in Figure 3.5.

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Figure 3.6: Example of a power station
(Source: REA Desert to Power Initiative (Phase II) FEED)

The power station shall be supplied with medium voltage switch-gears 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 3.6 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 Desert to Power Initiative (Phase II) FEED)

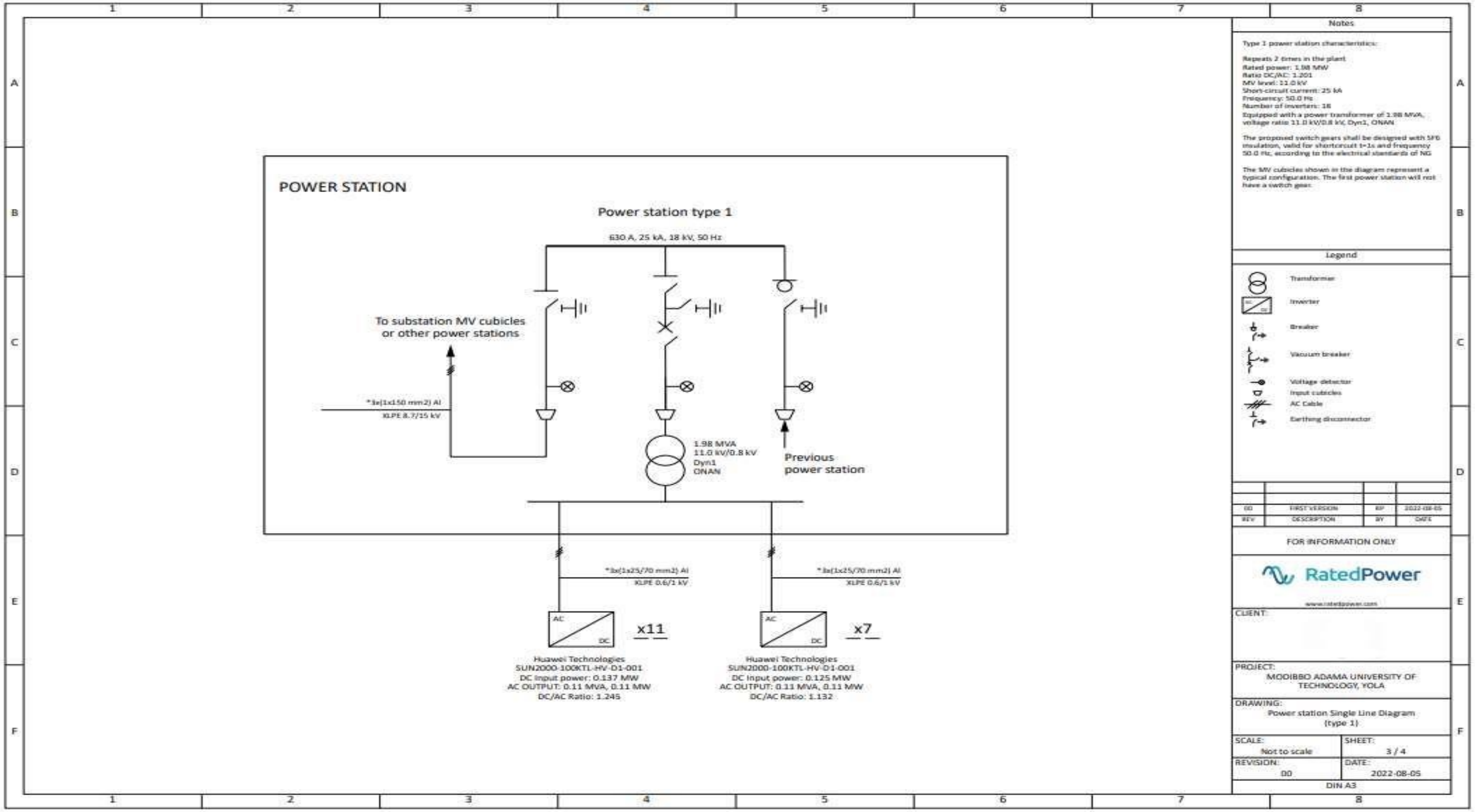

Figure 3.7: Power station Single line Diagram
(Source: Desert to Power Initiative (Phase II) FEED)

Access Roads

Gravel paved earth access roads within the facility will be created. 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 3.8 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 of fence, a light post of 4.0 m of height and a microwave barrier system are installed. For every 100.0 m of fence, a video camera post of 6.0 m of height is installed.

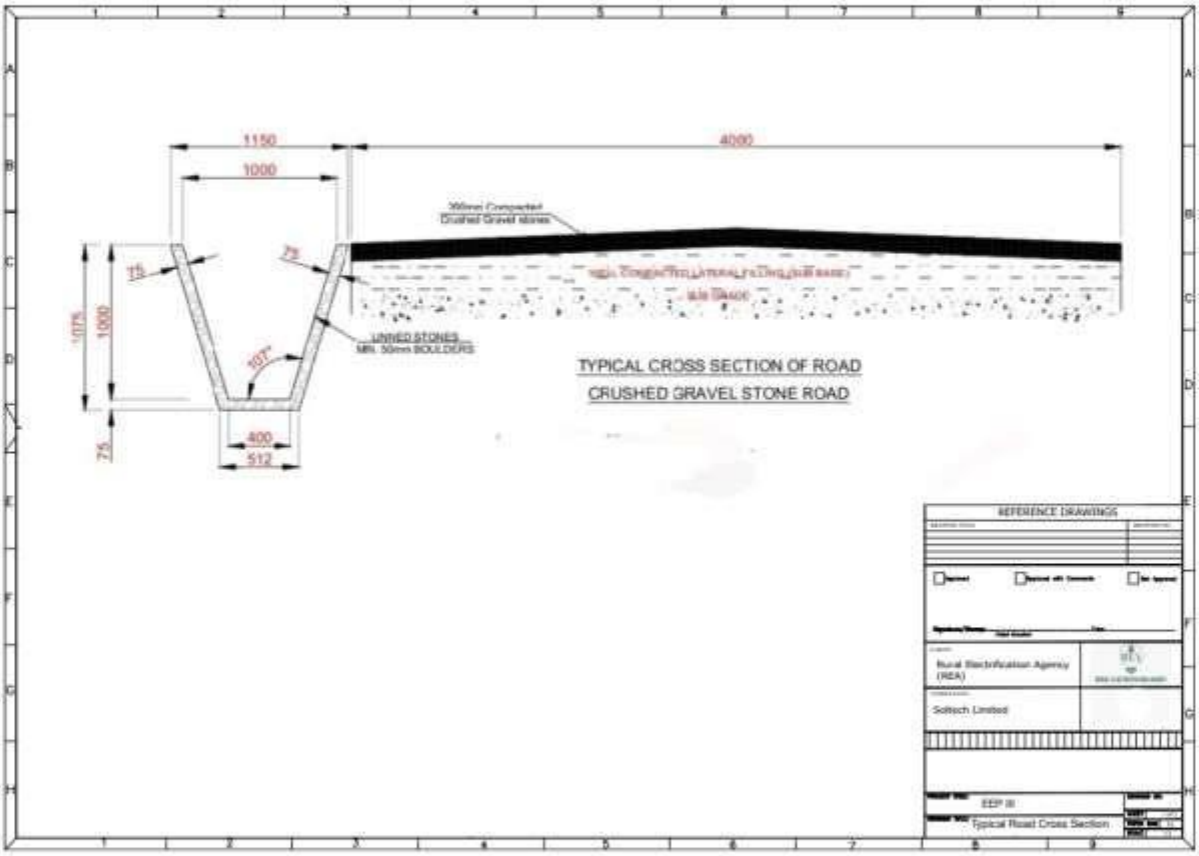

Figure 3.8: Typical Road Cross Section
(Source: REA NEP 3 FEED)

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.

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.

Transmission Line

The power generated from the proposed solar power plant would be evacuated through an 11-kV transmission line to the university load center through underground cable. The path for the underground cable will be beside the existing road. The length of distribution network is 0km upstream and 3km downstream. Figure 3.8 is the Distribution Network Layout for FUBK, while Figure 3.9 is the harmonization of FUBK's Existing/Proposed Distribution Network in a Single Line Diagram.

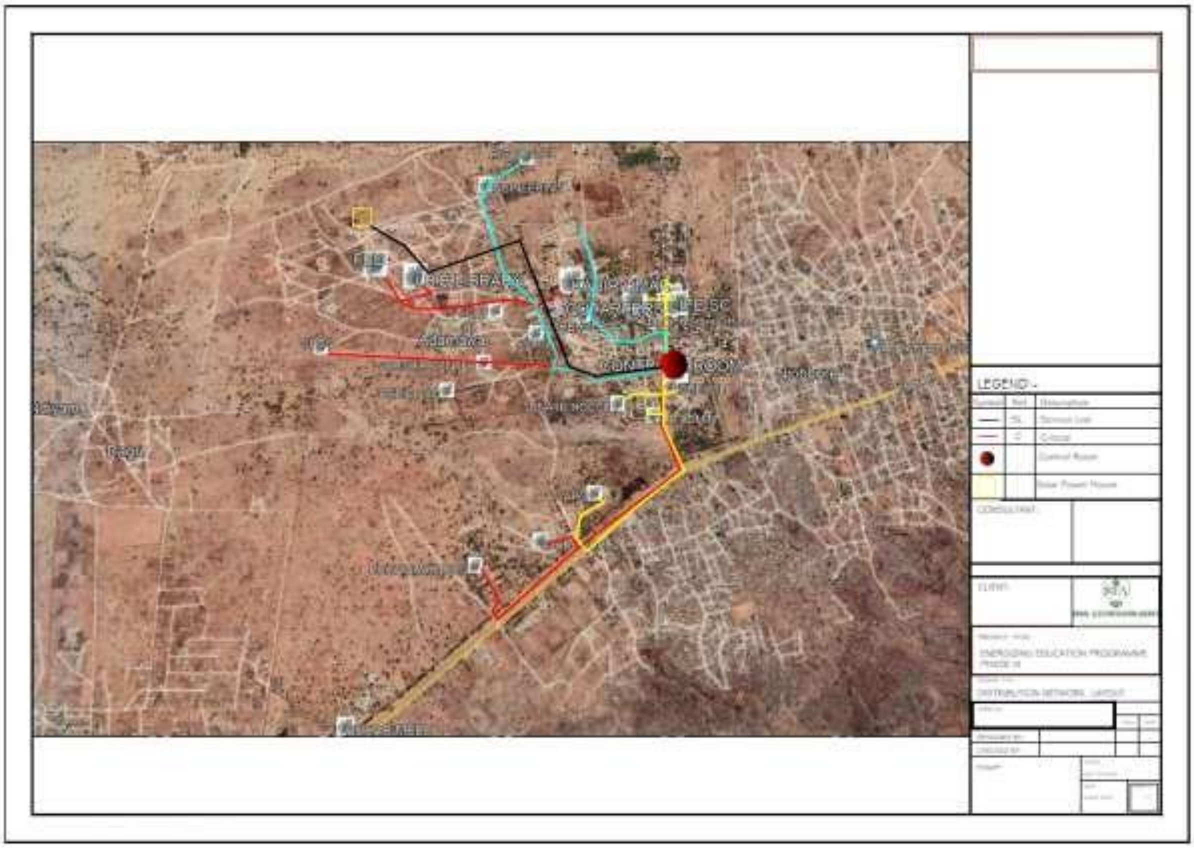

Figure 3.9: FUBK 11kv Distribution Network Layout
(Source: Desert to Power Initiative (Phase II) FEED)

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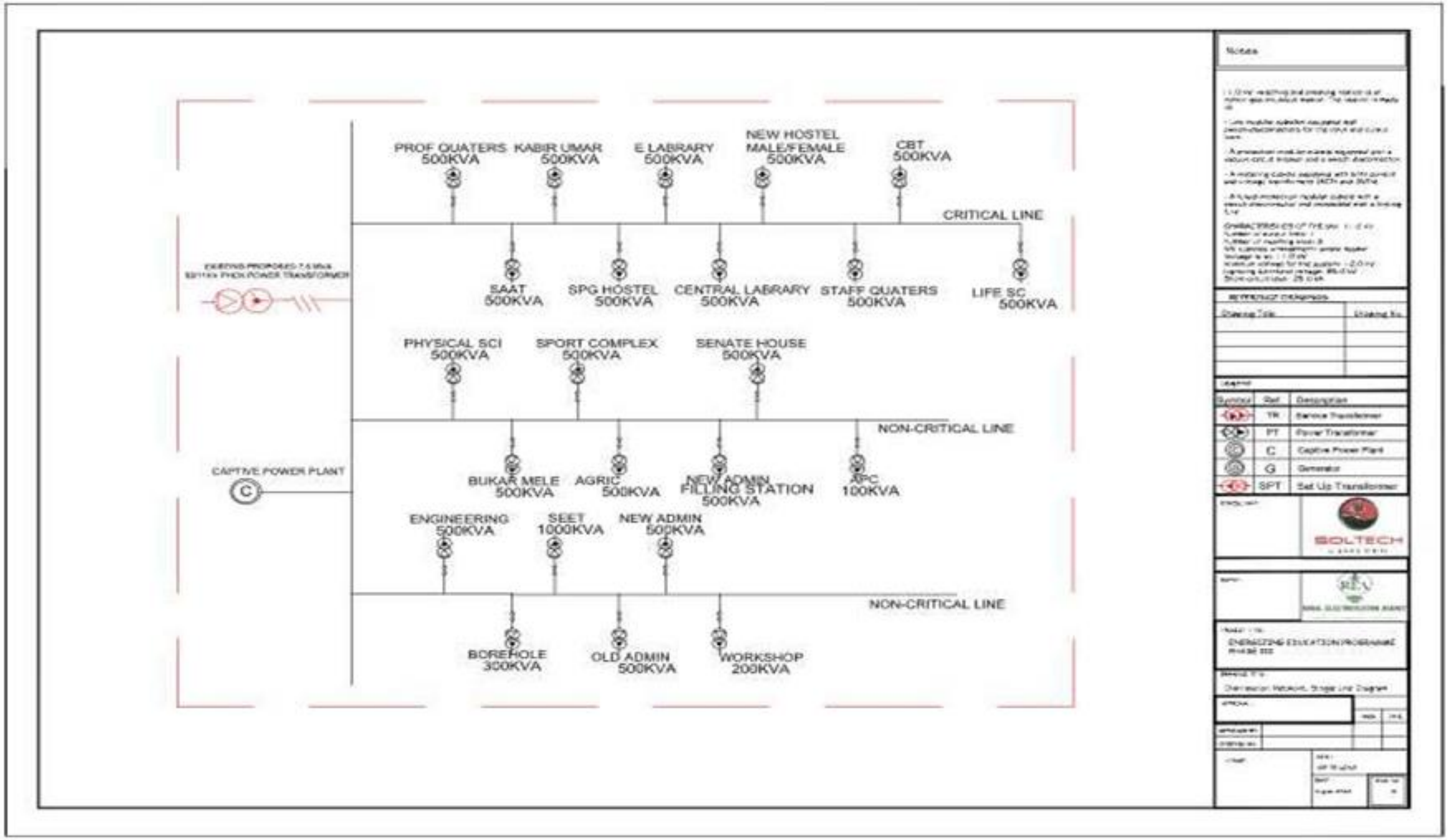

Figure 3.10: FUBK Existing/Proposed Distribution Network Single Line Diagram
(Source: Desert to Power Initiative (Phase II) FEED)

Streetlights Quantity

229 one arm streetlight and 15 double arms streetlights will be provided to the university. Figure 3.10 shows FUBK's Streetlight Layout

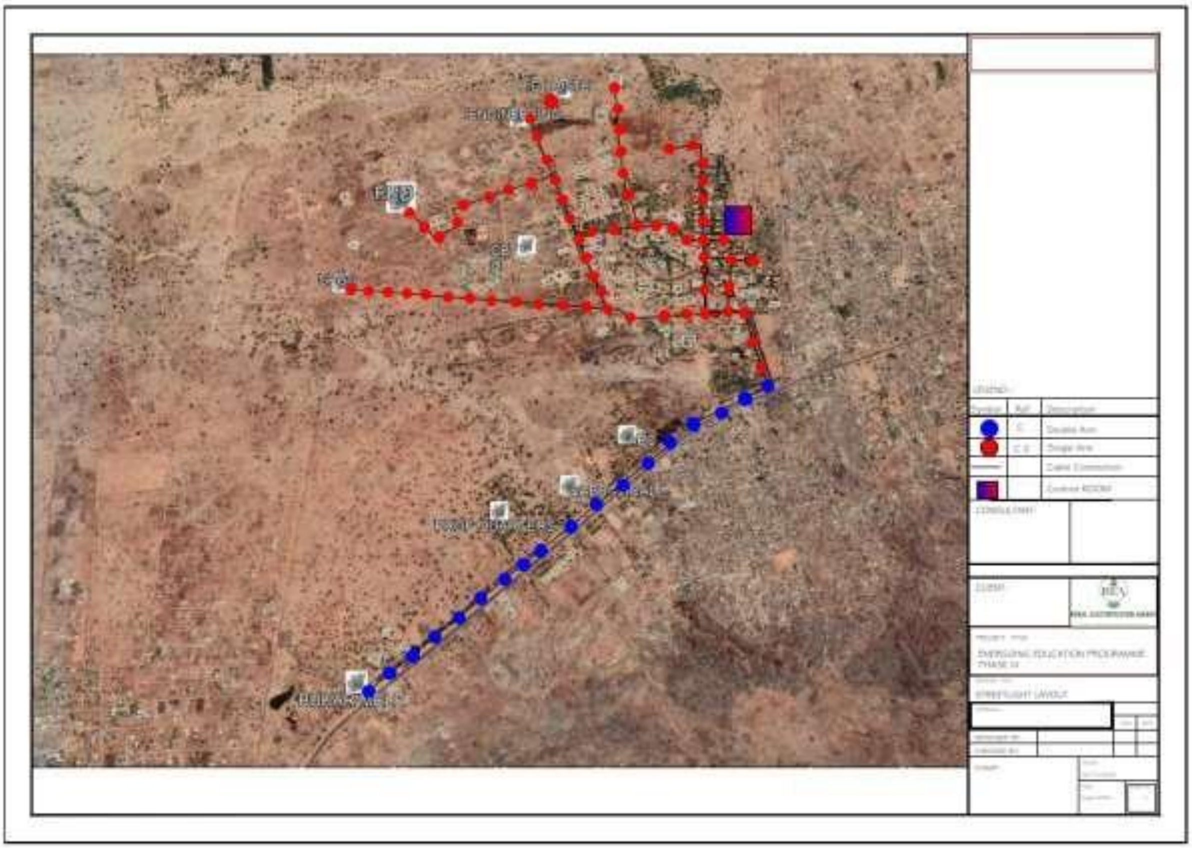

Figure 3.11: FUBK's Streetlight Layout
(Source: Desert to Power Initiative (Phase II) FEED)

3.3 Project Phases for Implementation

The project will be implemented in four major phases:

3.3.1 Pre-Construction Phase

The Pre-construction Phase of the project is a critical planning and preparatory stage that precedes physical site works. This phase ensures that the project is technically sound, environmentally compliant, financially structured, and administratively authorized prior to commencement of civil and electrical installation activities.

Pre-construction works are expected to last for 1 - 2months. The works at this stage will entail activities such as completion of engineering design for the Project and receipt of relevant approvals, mobilization of personnel, equipment and materials to site; and site clearing and grading.

***Detailed engineering design*:**
Following conceptual design and feasibility studies, the EPC contractor will undertake comprehensive detailed engineering design. This will include:
- Final plant layout and string configuration;
- Structural design of mounting systems (fixed-tilt or tracker, as applicable);
- Electrical single-line diagrams (SLD);
- Inverter sizing and transformer specifications;
- Protection and grounding design;
- SCADA/monitoring system architecture;
- Battery energy storage system (if included) integration design.

All engineering designs will comply with applicable IEC standards, Nigerian electricity regulations, and manufacturer specifications. Design outputs will include Issued-for-Construction (IFC) drawings, technical datasheets, and quality control documentation.

Site surveys and geotechnical investigations:
Comprehensive site investigations will be conducted to validate design assumptions and ensure structural stability. These will include:
- Topographical survey using GPS/GIS referencing;
- Soil borehole testing and geotechnical analysis (bearing capacity, soil stratification, groundwater depth);
- Assessment of drainage patterns and erosion risks;
- Electrical resistivity testing for grounding system design.

The geotechnical findings will guide foundation selection (e.g., driven piles vs. shallow concrete foundations) and inform structural safety margins in accordance with engineering best practice.

Procurement and regulatory approvals:
- Procurement will follow transparent competitive bidding procedures in line with REA and applicable development partner guidelines. Equipment procurement will prioritize:
- IEC-certified solar modules;
- High-efficiency inverters;
- Approved transformers and switchgear;
- Compliance with FMEnv and NESREA environmental requirements.

Regulatory approvals to be secured prior to construction include:
- Environmental authorization from the Federal Ministry of Environment;
- Electrical interconnection approvals (where applicable);
- Building and structural approvals from relevant authorities;
- Fire safety clearance.

Construction activities will commence only after all statutory permits and environmental clearance certificates are obtained.

***Mobilization*:**
Mobilization marks the transition from planning to physical implementation. This activity will include:
- Deployment of about ten (10) EPC personnel and technical teams to site;
- Establishment of temporary site offices and storage facilities;
- Delivery of construction equipment and materials;

- Site fencing and security arrangements;
- Implementation of site-specific Health, Safety, and Environmental (HSE) plans.
- Recruitment of 20 low skilled workers (e.g. construction labour who will make up the majority of workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers).

Mobilization activities will be carefully managed to minimize disturbance to ongoing university operations and ensure compliance with environmental and safety requirements.

Table 3.7; List of construction equipment and material for the project

Equipment / Vehicle	Purpose During Mobilization
Excavators & Backhoes	Clearing vegetation, digging trenches for temporary utilities, and digging holes for fence posts.
Bulldozers & Motor Graders	Performing initial profiling and leveling of the site to create a stable and accessible terrain.
Dump Trucks (e.g., 10 yd)	Hauling and spreading gravel for temporary access roads, laydown yards, and site pads.
Water Trucks (e.g., 8,000-gallon)	Controlling dust on unpaved roads and earthworks to comply with environmental regulations.
Heavy-Duty Trucks (Flatbeds/Lowboys)	Transporting the heavy construction equipment (excavators, bulldozers) and initial materials (fencing, office containers) to the site.
Forklifts (e.g., 4-Ton or Rough Terrain Forklifts)	Unloading deliveries, staging materials like fence posts and concrete blocks, and moving heavy items around the site.
Compactor Rollers	Compacting the soil and gravel for access roads and equipment pads to ensure a stable working surface.
Skid Steer Loaders (e.g., with Auger)	A versatile machine for small earthmoving tasks, digging post holes with an auger attachment, and moving materials.
Service Pickup Trucks & ATVs	Providing transportation for management, supervisory staff, and survey crews to move around the site

Site clearing and grading:

Site preparation will involve light vegetation clearing, removal of debris, and minor grading to achieve a stable and level working surface for panel installation. Key considerations shall include:

- Avoidance of unnecessary vegetation removal beyond the project footprint;
- Preservation of topsoil for reuse where applicable;
- Implementation of erosion control measures (e.g., drainage channels);
- Controlled movement of construction equipment (see table 3.7 above) to prevent soil compaction.

Given that the site is located within previously disturbed institutional land, clearing impacts are expected to be minimal and localized.

3.3.2 Construction Phase

The construction phase is expected to last approximately 6–8 months and executed by a qualified EPC contractor under REA supervision. Activities will be carefully sequenced to minimize environmental disturbance and disruption to campus operations. The activities/major civil works/facilities to be constructed for this phase includes - installation of mounting structures and PV panels; electrical works and interconnection; and testing and commissioning.

Installation of mounting structures and PV panels:
Mounting structures (typically galvanized steel or aluminum) will be installed using pile-driving or shallow concrete foundations, depending on geo-technical conditions. Activities will include:

- Layout marking and alignment using survey equipment;
- Driving or anchoring of support piles;
- Assembly and fastening of module racks;
- Installation and securing of PV modules onto mounting frames.

All installations will comply with applicable IEC standards for structural integrity and wind loading requirements. Works will be supervised to ensure proper torque settings and corrosion protection.

Electrical works and interconnection:
Electrical installation will involve:

- DC cable routing and string configuration;
- Installation of combiner boxes and inverters;
- Earthing and lightning protection systems;
- Installation of transformer and protection panels;
- Integration with the campus distribution network.

All electrical works will adhere to Nigerian electrical installation standards and safety protocols, including insulation testing and grounding resistance verification.

***Testing and commissioning*:**
Upon completion of installation, the system will undergo comprehensive testing and commissioning to verify design performance and safety compliance. Commissioning activities will include:

- Visual inspection of all mechanical and electrical components;
- Insulation resistance and continuity testing;
- Inverter configuration and synchronization testing;
- Performance verification against expected output benchmarks;
- Grid interconnection validation and protection relay testing.

A commissioning report will be prepared, and performance guarantees will be validated prior to formal handover to the University and O&M contractor.

3.3.3 Operational Phase

***Electricity generation*:**
During the operation phase, the 1-MW Solar Photovoltaic (PV) facility at Federal University Birnin Kebbi will generate electricity through the direct conversion of solar irradiance into direct current (DC) power by the PV modules. The DC power will be transmitted through combiner boxes to grid-tied inverters, where it will be converted into alternating current (AC) compatible with the university's distribution network. Generated electricity will primarily serve campus loads (academic buildings, laboratories, hostels, and administrative blocks), thereby reducing reliance on diesel generators and supplementing grid supply.

Preventive and corrective maintenance:

To enhance the performance and reliability of the plant during the system's estimated 25-year life cycle, maintenance of the system would be required. The following types of maintenance will be carried out:

- Preventive Maintenance: which involves routine inspection and servicing of plant equipment to prevent breakdowns. This includes panel cleaning, vegetation management, wildlife prevention, water drainage, monitoring of electrical components. It also involves retro- commissioning to improve the efficiency of the PV plant by detecting and solving problems in the system.
- Corrective Maintenance: which involves repair of broken-down equipment. This includes on- site monitoring and mitigation, and critical and non-critical repairs of plant components.
- Condition-based maintenance: which involves monitoring equipment and plant operations real- time and addressing potential problems early on in order to prevent plant downtime. This includes continuous monitoring via remote and on-site methods, warranty enforcement, and planned and unplanned equipment replacement.

Maintenance activities will be carried out by skilled manpower (5nos) 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 need to be checked regularly for damages.
- Panels need to be checked regularly for cracks and breaks.
- Panel testing needs to be conducted annually to ensure they live up to the manufacturer's warranty.

Electrical System

- Inverter components need to be checked to prevent breakdown 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.

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

Performance monitoring:
System performance will be continuously monitored using an integrated monitoring and control platform (e.g., SCADA or web-based monitoring system). Key operational parameters tracked will include energy output (kWh), inverter efficiency, system availability, performance ratio (PR), voltage and frequency stability, and battery state-of-charge. Automated alarms will notify operators of faults such as inverter trips, abnormal temperature rise, or grid synchronization issues. Periodic performance reviews will be conducted to compare actual generation with projected output, enabling early detection of under-performance due to dust accumulation, shading, equipment degradation, or component failure. This monitoring framework ensures optimal system efficiency, rapid fault response, and long-term operational reliability.

3.3.4 Decommissioning Phase

Although the proposed 1-MW Solar PV facility at Federal University Birnin Kebbi is designed for an operational lifespan of approximately 25 years, a structured decommissioning plan will be implemented at end-of-life in accordance with FMEnv guidelines, national waste management regulations, and international best practice for renewable energy infrastructure. The commissioning activities shall include the following activities:

Dismantling of equipment:
Decommissioning will begin with systematic electrical isolation and safe shutdown of all system components. Activities will include:

- Disconnection of PV arrays from inverters and grid interface systems;
- Removal of solar modules from mounting structures;
- Dismantling of inverters, transformers, combiner boxes, and protection systems;
- Removal of battery energy storage systems;
- Disassembly of mounting structures and foundations where required.

All dismantling works will follow electrical safety procedures including hazard control measures to prevent electric shock, fire, or injury. Equipment handling will prioritize prevention of breakage, particularly for PV modules and batteries.

Disposal, Recycling or Reuse of Components:
Decommissioned components will be managed in accordance with applicable environmental regulations and circular economy principles.

- PV Modules: Where, modules may be refurbished and reused. Damaged modules will be sent to certified recycling facilities for recovery of glass, aluminum frames, and semiconductor materials.
- Metal Structures: Steel and aluminum mounting systems will be recycled through licensed scrap metal processors.
- Electrical Equipment: Inverters, transformers, switch-gears and other serviceable units will be assessed for reuse or sent for certified recycling.
- Batteries: Battery systems will be handled as regulated waste streams and returned to authorized recyclers in line with hazardous waste management requirements.

Waste tracking documentation will be maintained to demonstrate regulatory compliance and responsible material handling. This approach minimizes landfill disposal, reduces environmental risk, and aligns with circular economy principles.

Site rehabilitation:
Following equipment removal, the site will be restored to a safe and stable condition that will ensure that the land is structurally and environmentally suitable for alternative institutional uses. The objective of site rehabilitation is to ensure that no long-term environmental liability remains and that the land is suitable for future institutional development or alternative use. Rehabilitation activities will include:

- Removal of concrete pads, foundations, debris and residual materials;
- Back-filling and leveling of disturbed areas;
- Soil stabilization and erosion control;
- Re-vegetation using native grass species where necessary;
- Final site inspection and environmental compliance verification.

3.4 Manpower Requirement

The proposed project will require an estimated workforce of at least 45 workers during the construction and operation phases. A mix of skilled, semi-skilled, and low-skilled labour will be needed, with workforce demand peaking during civil works and equipment installation. Preference will be given to local hires to strengthen community relations and reduce costs. The breakdown of the estimated workforce required for the project is on Table 3.8.

Table 3.8: Breakdown of the estimated workforce the construction and operation phases.

Construction Phase		
Category	**Typical Roles**	**Estimated Number**
Low-Skilled Workers	General labourers, material handlers, security assistants	15–20
Semi-Skilled Workers	Electricians' assistants, panel installers, welders, equipment operators	10–15
Skilled Workers	Electrical engineers, site engineers, certified electricians, HSE officer, project supervisor	6–8
Total (Peak)	—	31–43
Operation Phase		
Category	**Typical Roles**	**Estimated Number**
Semi-Skilled	Plant technician	1–2
Skilled	Electrical engineer / O&M supervisor	1
Support	Security, Cleaners, (shared with campus)	Existing staff

3.5 Water Requirement

Construction water demand is estimated at approximately 3–6 m^3/day, depending on the workforce and stage of civil works. Water will be required for drinking, sanitation, concrete works, equipment cleaning and limited dust suppression. Water shall be obtained from an approved source, and abstraction or supply records shall be maintained.

During operation, water will principally be required for wet cleaning of PV modules. Based on an indicative 2,000–2,500 modules and an upper planning allowance of approximately 5 litres per module per wet-cleaning cycle, operational cleaning demand is estimated at approximately 10–12.5 m^3 per cycle. The final quantity shall be recalculated after confirmation of the module number and selected cleaning system. Dry cleaning or low-water cleaning methods shall be prioritised where practicable. Wet cleaning shall be based on observed soiling and performance loss and should ordinarily not exceed twice per month during the dry season. Rainfall will reduce cleaning requirements during the wet season.

Before operational abstraction begins, the proposed water source shall be tested and its sustainable yield confirmed. A water meter shall be installed, and cleaning frequency and water use shall be recorded. If monitoring indicates declining borehole yield, interference with other campus users or increasing abstraction, cleaning methods and frequency shall be reviewed.

3.6 Solar PV network installation standards and Codes

There are many organizations that develop the standards and codes for PV systems. ASTM mainly known as the American Society of Testing and Materials has developed more than 12,000 international standards to improve the quality of the product and enhance safety. The PV standard developed by ASTM technical committee is E44.09 Photovoltaic electric power conversion. The International Code Council (ICC) is involved mainly with the development of a single set of comprehensive international model construction codes engrossed in building safety and fire prevention. The International Electro-Technical Commission (IEC) has published Technical Specifications IEC 62257, a set of standards covering technical and organizational aspects of mini-grids (design, installation, maintenance, contracting) and a checklist of good practices. The Nigeria Electricity Management Services Agency (NEMSA) through NEMSA Rooftop Solar Safety Guidelines enforce strict standards and guidelines for safe design, installation, and operation of solar Photovoltaic (PV) systems.

3.7 Health and Safety

Engineering, procurement and construction (EPC) contracts are the most common form of contracts for the construction of solar PV power plants. Occupational health and safety (OHS) is an issue shall be properly managed during construction in order to minimize the risk of preventable accidents leading to injuries and/or fatalities. Proper OHS risk identification and management measures should be incorporated in every project's management plan and standard EPC contractual clauses. The EPC contractor shall engage dedicated personnel competent on the basis of appropriate education, training, and experience to manage and oversee the Health, Safety and Environment (HSE) aspects of the Project. The HSE personnel shall ensure that the Project and subcontractors operate in accordance with the applicable regulatory HSE requirements and plans; and also monitor implementation of environmental and social protection measures. Occupational health and safety (OHS) plans shall be developed and maintained by all contractors involved in the implementation of the proposed Project particularly in the following aspects:

Occupational Health and Safety:

- General Facility design and operation.
- Communication and Training.
- Physical Hazards.
- Chemical Hazards.
- Biological Hazards.
- Personal Protective Equipment (PPE).
- Special Hazard Environments.
- Monitoring.

Community Health and Safety:

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

3.8 Emergency 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 necessitates 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

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The facility shall also have:

- 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;
- Smoke Detectors
- 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.

3.9 Waste Management

It has been established that Renewable Energy Technologies (RETs) are environmentally friendly during their useful life, in terms of obnoxious gaseous emissions as do fossil fuels, however, they are not 100% pollution-free at their end-of-life (EoL) period. Generally, PV systems have ways of generating primary and secondary wastes streams. The primary wastes streams are direct components used in PV systems, whereas secondary waste streams comprise pollutants from nonrenewable energy resources used in the production and disposal of PV panels and the rest of the balance of system (BOS) components (wires, batteries, inverters, metallic frames). These large quantities of nonrenewable energy generated wastes (pollutants) are of high environmental impacts. A summary of expected waste stream from the project phases is outlined in Table 3.9.

Table 3.9: Waste Streams of Project Phases

Waste Stream	Sources	Waste Generation Phase			
		Pre-Construction	Construction	Operation and Maintenance	Decommissioning
General rubbish, refuse, and putrescible wastes (Food wastes)	Wood splinter, domestic waste, food packs, used bottles	✓	✓	✓	✓
Vegetal waste	During site clearing and preparation	✓		✓	✓
Scrap metals	Used tubular and casings, used iron rods		✓	✓	✓
Excavated materials	Foundation works		✓		
Damaged/ expired and removal PV panels	PV modules		✓	✓	✓
Expired inverters and Faulty or Damaged cables	Electrical installation			✓	✓
Damaged/ expired Batteries	Power generation			✓	✓

(Source: Adapted from IFC 2015 Project Developer's guide to utility-scale solar photovoltaic power plants)

3.9.1 Types of Wastes: Identification, Categories, and Estimated Quantities

Pre-Construction Phase*:* Wastes for the pre-construction phase will be as a result of mobilization of personnel and equipment, site clearing, grading, and temporary site setup. Waste generation during this phase is expected to be moderate (temporary and localized) and primarily non-hazardous, with small quantities of hazardous waste associated with equipment servicing.

Table 3.10: Pre-Construction Phase Waste Inventory and Handling Strategies

Waste Type	Waste Identification /Source	Category	Estimated Quantity	Proposed Management Measure
Used lubricants/ engine oil	Hydrocarbon-based oil	Hazardous	< 40 litres	Collection in sealed containers; disposal via licensed waste handler
Oily rags/absorbents	Oil-contaminated materials	Hazardous	< 20 kg	Segregation; disposal through approved hazardous waste contractor
Packaging materials (plastic wraps, pallets)	HDPE/wood packaging	Non-hazardous / Recyclable	200–300 kg	Segregation and recycling
Vegetation (grass, shrubs)	Organic biomass	Non-hazardous / Biodegradable	3–5 tonnes	Composting, mulching, or controlled disposal
Excavated soil	Excavation and grading activities	Inert (reusable)	< 50 m^3	On-site reuse for leveling/backfilling
Domestic waste (food packs, bottles)	Municipal solid waste	Non-hazardous	50–100 kg/month	Provision of covered bins; evacuation to approved municipal facility
Empty lubricant containers	Plastic/metal containers	Hazardous (if contaminated)	< 15 units	Triple-rinse (where applicable); disposal through approved contractor

Construction Phase: During the construction phase, waste streams are expected to arise from mounting structure installation, electrical works, equipment packaging, worker activities, etc.

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Table 3.11: Construction Phase Waste Inventory and Handling Strategies

Waste Type	Waste Identification/ Source	Waste Category	Estimated Quantity (Total Construction Period)	Waste Management Approach
Cartons, plastic wraps, wooden crates	PV modules, inverters, electrical components packaging	Non-hazardous recyclable solid waste	1–2 tonnes	Segregate at source; returnable crates returned to supplier; recyclables transferred to licensed recycler
Scrap metal (steel offcuts, mounting remnants)	Mounting structure fabrication & installation	Non-hazardous recyclable waste	0.5–1 tonne	Collected and sold to licensed scrap metal recycler
Cable offcuts and insulation remnants	Electrical installation works	Non-hazardous recyclable (PVC/ copper)	~200–300 kg	Segregation and recovery of copper; disposal via licensed recycler
Concrete debris / excess concrete	Foundation works (if shallow foundations used)	Inert construction waste	<2 m³	Reuse as backfill where feasible; remainder disposed at approved site
Excavated soil	Trenching for cables	Inert material	5–10 m³ (temporary)	Reinstatement and backfilling on-site
Used oil/grease from equipment servicing	Construction equipment maintenance	Hazardous waste	<50 litres	Stored in sealed containers; transferred to licensed hazardous waste handler
Empty paint/chemical containers (if applicable)	Minor protective coating works	Hazardous (if contaminated)	Minimal	Triple-rinsed (where applicable) and disposed through licensed waste contractor
Domestic waste (food waste, bottles, sachets)	Construction workforce activities	Non-hazardous municipal waste	~0.5 tonne	Collected in covered bins; disposed through approved municipal waste system

Waste Type	Waste Identification/ Source	Waste Category	Estimated Quantity (Total Construction Period)	Waste Management Approach
Damaged PV modules	Handling/ transport damage	Electronic waste (potentially hazardous)	<5 units (contingency)	Returned to supplier under warranty or handled by certified e-waste recycler

Operation Phase: During the operational phase, the primary wastes will arise from routine maintenance, component replacement, housekeeping activities, and potential battery servicing. The table below summarizes the expected waste streams, their classification, estimated annual quantities, and corresponding management approach in compliance with applicable environmental regulations and best practice for solar PV installations.

Table 3.12: Operation Phase Waste Inventory and Handling Strategies

Waste Type	Identification / Source	Waste Category	Estimated Quantity (Annual)	Waste Management Approach
Damaged PV modules	Replacement due to breakage or degradation	Electronic waste	<15 modules (<500 kg)	Return-to-supplier program or recycling through licensed e-waste handler
Inverter components (PCB boards, fuses, relays)	Routine maintenance or fault replacement	Electronic waste	<200 kg	Segregation and disposal via certified e-waste recycler
Used electrical cables and connectors	Maintenance replacement	Recyclable solid waste	<100 kg	Sale/transfer to licensed scrap metal recycler
Scrap metal (mounting repairs)	Minor structural maintenance	Recyclable solid waste	<150 kg	Recycling through licensed metal recycler
Used lubricants/ cleaning agents	Equipment servicing	Hazardous waste	<50 litres	Collection in labeled containers; disposal via licensed hazardous waste contractor
Spent batteries	End-of-life battery modules	Hazardous waste	Project-dependent (e.g., 1–2 tonnes at replacement cycle)	Return-to-manufacturer take-back scheme or disposal via certified hazardous waste facility

Waste Type	Identification / Source	Waste Category	Estimated Quantity (Annual)	Waste Management Approach
General office waste (paper, packaging)	O&M administration	Non-hazardous municipal waste	<300 kg	Integration into campus waste management system
Panel cleaning residue (dust runoff)	Periodic cleaning	Non-hazardous	Minimal; evaporative	Controlled drainage/evaporative/dust wash); no chemical additives used

3.10 Project Schedule

The implementation schedule is structured across Pre-Construction Phase, Construction Phase and Operation & Maintenance Phase. As part of measures to save time in the execution of the project, some of the phases and activities in the project implementation will run concurrently. The implementation schedule for the execution of the different project activities for the Solar Power Plant project is indicated in Table 3.13.

Table 3.13 implementation schedule

Phase	Key Activities	Estimated Duration
Phase 1: Pre-Construction	Final design, permitting, procurement, site surveys	2–3 months
Phase 2: Construction	Site preparation, mounting structure installation, module installation, inverter installation, electrical works, testing & commissioning	4–6 months
Phase 3: Operation & Maintenance	Electricity generation, monitoring, preventive and corrective maintenance	25 years (design life)

The proposed Project is planned to be operational by the 4th Quarter (Q4) of 2026/1st Quarter (Q4) of 2027. Figure 3.12 is a typical EPC Construction Phase to Handover Protocol.

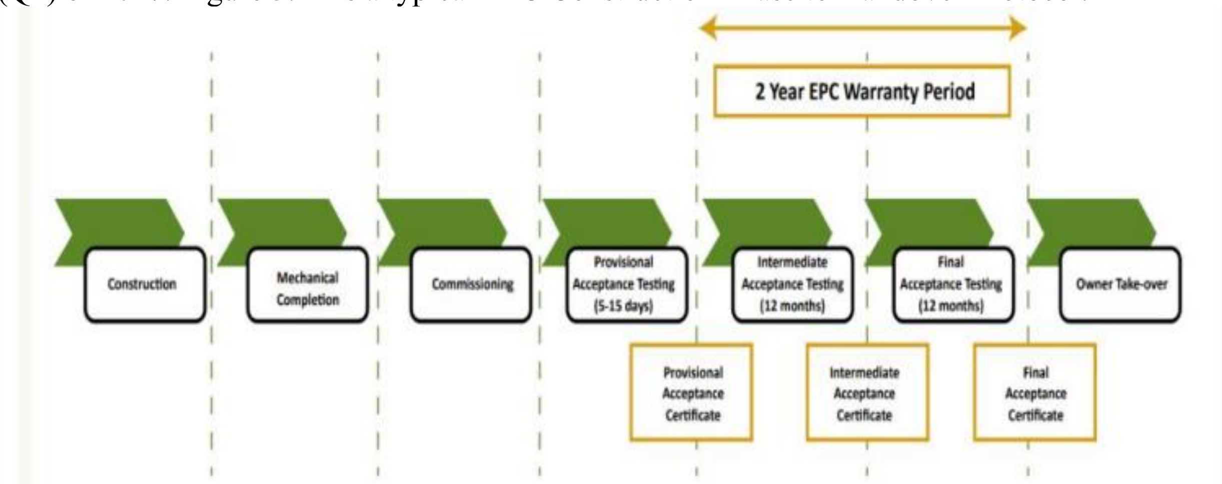


Figure 3. 12: Typical EPC Construction Phase and Handover Protocol
(Source: Desert to Power Initiative (Phase II) FEED)

CHAPTER FOUR

DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 Background

This chapter presents a description of the environmental and social (biophysical, health and social) setting of the study area and its environs for the proposed 1-Megawatt (MW) Solar Photovoltaic (PV) Power Plant project which shall be sited within the premises of Federal University Birnin Kebbi (FUBK), Kebbi State against which the potential and associated impacts of the proposed Project have been assessed. The field and desktop investigations are detailed in each relevant section.

4.2 The ESIA Study Approach

A multi-disciplinary approach was adopted in gathering the environmental and socio-economic data of the proposed project area. The data sources for the environmental and socio-economic characteristics of the proposed project area were obtained using desktop research, field observation, review of online sources and analytical measurement of the soil, water, air and noise components using in situ-measuring instruments and laboratory analysis. Data for the environmental description of the project area were based on field data gathering (primary data) as well as a desk-based review of relevant literature (secondary data). Data from literature review were obtained from the existing reports of environmental studies around the proposed project area

4.2.1 Desktop Research

The desktop research reviewed published literature including grey literature (previous reports, existing studies) sources from websites, data portals by the governments, and academic and research institutions. The research collected recent information on studies and activities in the proposed project area. The demographics of the population and the biodiversity were also complemented by information gathered from literature, the survey that was carried out and focus group discussions (FGD). The data obtained include maps, demographic data and climate data of the area.

4.2.2 Field Visit and Data Gathering Exercise

In line with the activities recommended by the Federal Ministry of Environment and for Environmental & Social Impact Assessment (ESIA), a field visit was planned in order to meet with the stakeholders, view the proposed site and carry out environmental baseline studies of the project area. A socioeconomic survey was conducted in Ungwan Jeji, the host community within the project's 5 km area of influence, to evaluate how the project could affect the local environment and people.

A one-season fieldwork was embarked upon for the biophysical as well as social and health studies. Sampling locations were identified using a satellite imagery of the project area and were selected to cover as much as possible the land area for the proposed project. The basis of the sampling design was informed by a preliminary characterization of the project area through desktop research and nearby sensitive receptors. This was to ensure a proper representativeness of the field samples collected, the sampling approach employed included simple random and systematic sampling, based on the environmental components to be surveyed. The environmental components covered include topography, climate/meteorology, air quality and noise levels, soil, vegetation, geology, socio-economics, health status assessment and waste management. The sampling points were geo-referenced using Global Positioning System (GPS).

Being a 1-MW Solar PV facility, the Area of Influence (AoI) is expected to be limited and localized, given the small footprint and low-impact nature of solar technology. A 1-kilometer radius was established for the bio-physical aspect of the EIA while the spatial boundary for the socio-economic aspect was set within a 5 km radius of the project site.

During the field data gathering exercise, 19 sampling locations inclusive of 7 control stations were established for air quality and noise level measurements; 9 sampling locations inclusive of 2 control stations were established for soil analysis; and 6 sampling locations inclusive of 2 control stations were established for groundwater sample. During the study, there was no surface water observed within the project's AoI. The scoping workshop, site verification and data gathering exercises were conducted from 4th - 5th February, 2026. FMEnv Guidelines and Standards were strictly adhered to in the course of field sampling and measurement.

4.2.3 Laboratory Analysis of Field Samples

Samples were transported to Bio-Metrics Geo Consult, at 4, Rachael T. Owolabi Street, Gaduwa, Abuja, for analyses after the fieldwork exercises. Samples were analyzed using standard analytical methods. The synoptic descriptions of the laboratory analytical methods and procedures employed for the various physical, chemical and biological parameters as well as the detection limits of these parameters are documented in this report. Also documented is a synopsis of the QHSE plan adopted in both field data collection and laboratory analysis.

General Quality Assurance and Quality Control Measures in Field Survey

Quality Control remains an integral part of environmental assessments, reinforcing the credibility of the collected data and subsequent analytical results. The Quality Assurance and Quality Control (QA/QC) procedures adopted in this study were designed to prevent errors arising from improper sampling techniques, inadequate sample preservation, incorrect labelling and transportation issues. These procedures were applied to every stage of the study, including sample collection, handling, laboratory analysis, data coding and processing, statistical analysis, and the presentation and communication of results. The analytical methods used followed Federal Ministry of Environment guidelines and other internationally recognized procedures, ensuring the reliability and integrity of the data obtained.

❖ **Sample Collection and Handling**

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

- Standard field procedures and methods approved FMEnv were adopted.
- All sampling equipment was maintained in excellent condition, calibrated against international standards and adequate steps were taken to ensure that they function normally.
- Only new and thoroughly washed, rinsed and sterilized sampling containers were used.

- For heavy metal determination, sampling bottles were used and were rinsed with a solution of one-part nitric acid to four parts water, followed by copious amounts of distilled water. Water samples for BOD_5 determination were collected in black oxygen bottles and kept away from light source.
- All parameters without holding time were measured in situ on the field. Samples for other parameters were preserved as soon as they were collected. Dissolved oxygen samples were fixed with Winkler's Reagents; while heavy metal samples were acidified to a pH of about 2 with concentrated H_2SO_4 respectively.
- All samples were adequately labeled to preserve their identity. Label included sample reference code number, source, sampling date, etc.
- All samples were safely packed and transported to the laboratory base.

❖ **Sample Preservation**

To prevent sample contamination and deterioration, all sampling tools and containers were pre-sterilized. Samples were pre-treated and kept in ice-cooled chests (<4°C) during transport to the laboratory, then stored at that temperature in refrigerators until analysis. To ensure accuracy and reliability, parameters with short holding times, such as pH and temperature, were measured on-site, while samples for delayed analyses were preserved by refrigeration (for general water chemistry) or by pH adjustment and chemical pre-treatment (for heavy metals, total hydrocarbons, and dissolved oxygen). Dissolved oxygen samples were acidified to pH 2 with concentrated H_2SO_4 and HNO_3, and samples for microbiology and benthos were properly stored. Plankton samples were treated with 4% formalin solution.

4.3 Physical Characteristics of the Proposed Project Area

This section presents an overview of the climate and meteorological (macroclimatic) data for the project area, including relative humidity, temperature, cloud cover, solar irradiation, surface pressure, rainfall, and wind speed and direction. It also includes microclimatic data such as air quality, noise levels, topography, geology, surface water, and groundwater. The macroclimatic data covering the period from 1995 to 2025 was obtained from the National Aeronautics and Space Administration (NASA) Data Access Viewer.

4.3.1 General Overview of Kebbi State's Location, Climate and Weather Patterns

Kebbi State, located in northwestern Nigeria and shares international borders with Niger Republic and Benin Republic, lies within the Sudan Savannah ecological zone and experiences a tropical continental (Sahel–Savannah transitional) climate. Birnin Kebbi is the capital city of Kebbi State and is the administrative, educational, and commercial hub of the state. The region's economy is largely agrarian, with rice, millet, sorghum, and livestock production forming key activities. It is also culturally significant, being closely associated with the historic Argungu Emirate and the internationally known Argungu Fishing Festival. Infrastructure development has expanded in recent years, including road networks and educational institutions. The city hosts major institutions such as the Federal University Birnin Kebbi, contributing to its growing academic profile.

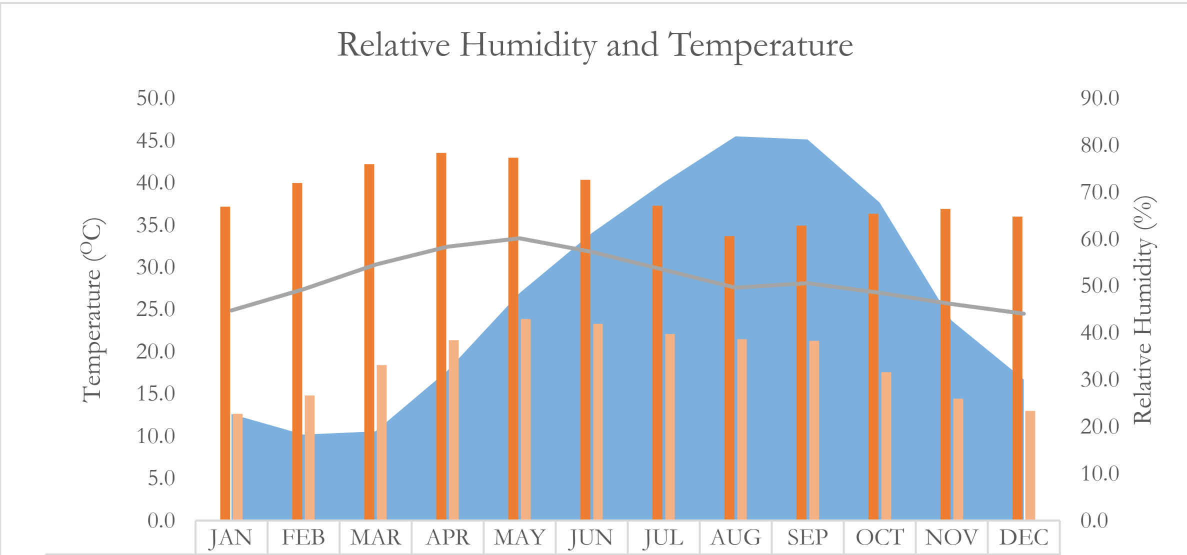
The State has two distinct seasons: a wet season (May–October) dominated by moist south-westerly monsoon winds, and a dry season (November–April) influenced by the north-easterly Harmattan winds from the Sahara. The hottest months are typically March and April, when temperatures may exceed 40°C. Relative humidity is high during the rainy season and significantly lower during the dry Harmattan period. Solar radiation levels are strong, averaging approximately 5.5–6.5 kWh/m²/day, making the area suitable for solar energy development. Wind speeds are moderate, with seasonal variability influenced by regional atmospheric circulation patterns. Evapotranspiration rates are high, particularly during the dry season. Overall, the climate is characterized by high solar intensity, seasonal rainfall variability, and extended dry periods.

4.3.2 Discussions on the Macro-climate of Kebbi State

4.3.2.1 Relative Humidity and Temperature

Relative humidity is defined as the ratio of the amount of water vapour present in the atmosphere to the maximum amount the air can hold at a given temperature. Climatic data for the project site obtained from the National Aeronautics and Space Administration (NASA) Data Access Viewer indicate that monthly average relative humidity values range from a minimum of 22.7% in January to a peak of 81.9% in August. The state is characterized by pronounced diurnal temperature variations, with very high daytime temperatures and comparatively cooler nights. Analysis of the retrieved temperature data shows that the lowest minimum temperatures occur in January (12.6 °C), coinciding with the peak of the Harmattan season, while the maximum temperature is recorded in April (43.5 °C), just before the onset of the rainy season. Mean monthly temperatures range from 24.5 °C in December to 33.4 °C in May.

An inverse relationship exists between temperature and relative humidity, as illustrated in the accompanying graph. Relative humidity increases progressively with the onset and advancement of the rainy season due to increased atmospheric moisture content, while temperatures decline correspondingly. Conversely, during the dry season, particularly the Harmattan period, temperatures increase as relative humidity decreases under the influence of dry continental air masses. This seasonal pattern reflects the dominance of moisture-laden maritime air during the wet season and dry Saharan air during the dry season.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
R. H	22.7	18.4	19.0	32.0	48.5	61.3	72.0	81.9	81.2	67.8	42.6	30.1
T. Max	37.2	40.0	42.2	43.5	43.0	40.3	37.3	33.7	34.9	36.4	36.9	36.0
T. Min	12.6	14.8	18.4	21.4	23.9	23.3	22.1	21.5	21.3	17.6	14.4	13.0
T. Mean	24.9	27.4	30.3	32.4	33.4	31.8	29.7	27.6	28.1	27.0	25.7	24.5

Figure 4.1: A graph illustrating the relative humidity and temperature in Kebbi State (1995 – 2025).

Source: National Aeronautics and Space Administration (NASA) Data Access Viewer 2026

4.3.2.2 Surface Pressure and Rainfall

Surface pressure refers to the atmospheric pressure exerted at the Earth's surface and is measured in kilopascals (kPa). Analysis of climatic data for the project site indicates that surface pressure remains relatively stable throughout most of the year, with values ranging between 98.0 kPa and 98.4 kPa. However, a noticeable decline in surface pressure is observed in April, preceding the onset of the rainy season in May. This reduction in surface pressure reflects the increasing influence of moist maritime air masses and enhanced atmospheric instability associated with the transition from the dry to the wet season.

Rainfall is the predominant form of precipitation in Kebbi State and marks the commencement of the wet season, which typically lasts for approximately five months. Rainfall onset occurs gradually in May, with an average monthly rainfall of about 60.2 mm, increases substantially in June, and reaches its peak in August with an average of 249.8 mm. In contrast, the dry season spans from November to April, during which rainfall is minimal, with average monthly values ranging from 0.1 mm in December and January to about 1.2 mm in November.

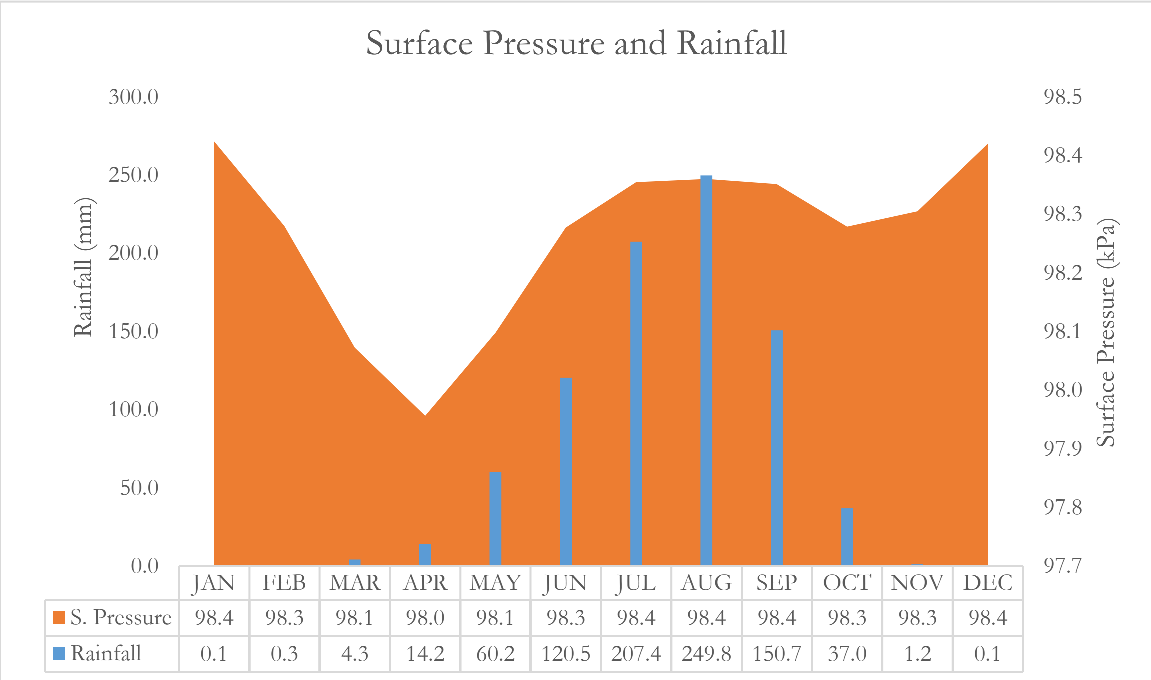
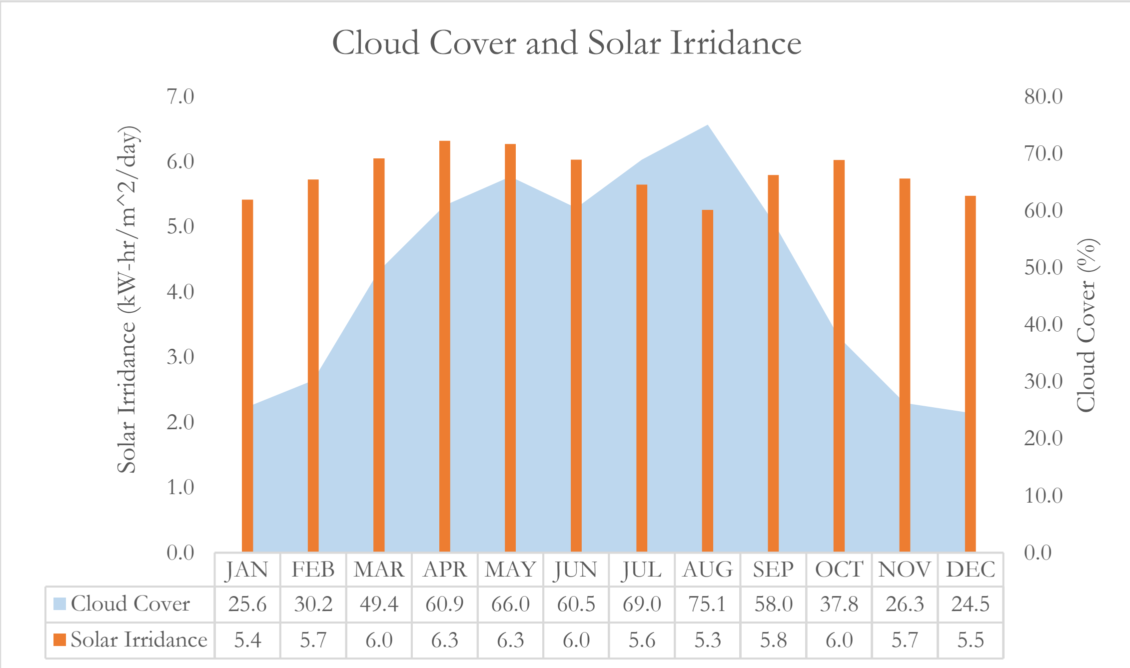


Figure 4.2: A graph illustrating the Surface Pressure and Rainfall in Kebbi State (1995 – 2025).
Source: National Aeronautics and Space Administration (NASA) Data Access Viewer 2026.

4.3.2.3 Cloud Cover and Solar Irradiance

Cloud cover represents the proportion of the sky obscured by clouds and is an important indicator of atmospheric cloudiness. In Kebbi State, cloud cover exhibits a pronounced seasonal pattern that closely aligns with variations in rainfall and temperature. The lowest mean cloud cover is recorded in December (24.5%), corresponding to the dry season, when clear skies, high solar exposure, and minimal precipitation prevail. In contrast, the highest cloud cover occurs in August (75.1%), coinciding with peak rainfall of approximately 248.9 mm, as increased atmospheric moisture and convective activity enhance cloud formation. A marked increase in cloud cover is observed between March (49.4%) and April (60.9%), reflecting the transition from dry to humid atmospheric conditions and signaling the onset of the wet season. Solar irradiance refers to the amount of solar energy received per unit area of the Earth's surface per day and is expressed in kilowatt-hours per square metre per day (kWh/m²/day). Solar irradiance in the project area shows clear seasonal variability, largely controlled by cloud cover, solar angle, and day length. The lowest mean solar irradiance value is recorded in August (5.3 kWh/m²/day), corresponding with peak cloud cover and rainfall during the height of the wet season. Conversely, the highest solar irradiance values occur in April and May (6.3 kWh/m²/day), prior to the full establishment of the rainy season, when cloud cover is relatively lower and solar intensity is higher.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Cloud Cover	25.6	30.2	49.4	60.9	66.0	60.5	69.0	75.1	58.0	37.8	26.3	24.5
Solar Irridance	5.4	5.7	6.0	6.3	6.3	6.0	5.6	5.3	5.8	6.0	5.7	5.5

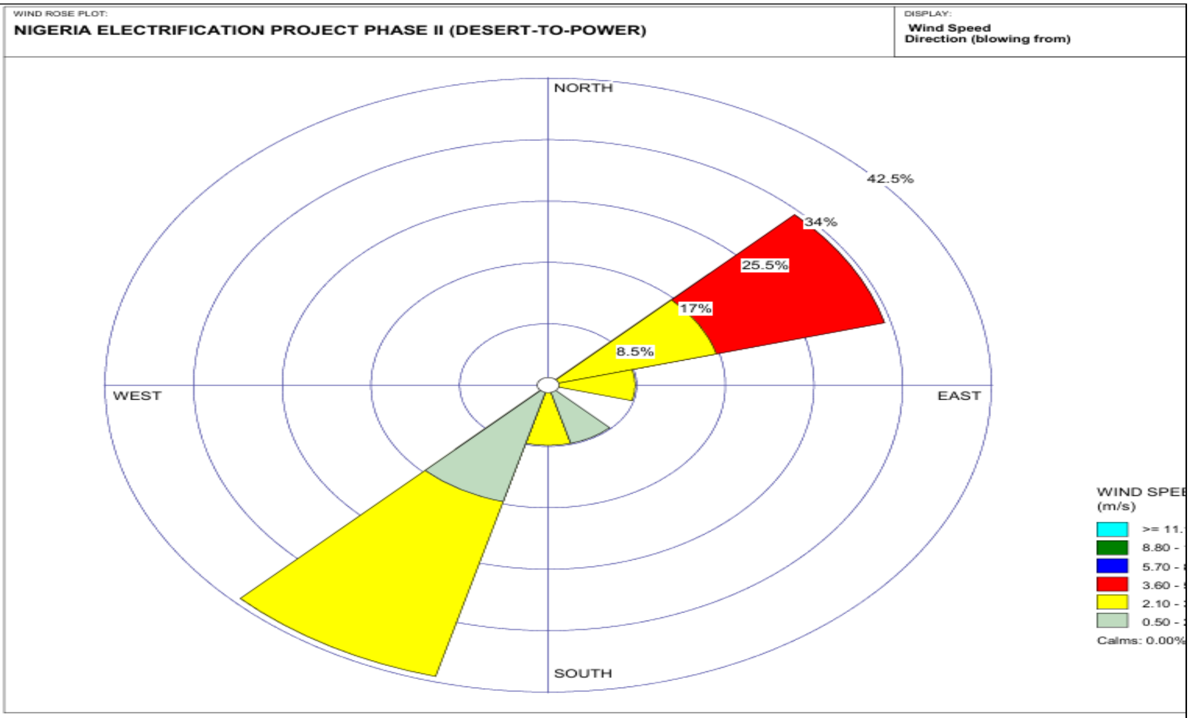
Figure 4.3: A graph illustrating the Cloud Cover and Solar Irradiance in Kebbi State (1995 – 2025).

Source: National Aeronautics and Space Administration (NASA) Data Access Viewer 2026.

4.3.2.4 Wind Speed and Direction

The wind rose diagram for the project site illustrates the distribution of wind speed and direction over the monitoring period. The analysis indicates that the prevailing wind direction is predominantly from the east to east-northeast sector, accounting for the highest proportion of total wind occurrences (approximately 34%), with additional significant contributions from the east-southeast direction. This pattern reflects a dominant easterly wind regime, consistent with the influence of continental air masses that characterize northern Nigeria, particularly during the dry season.

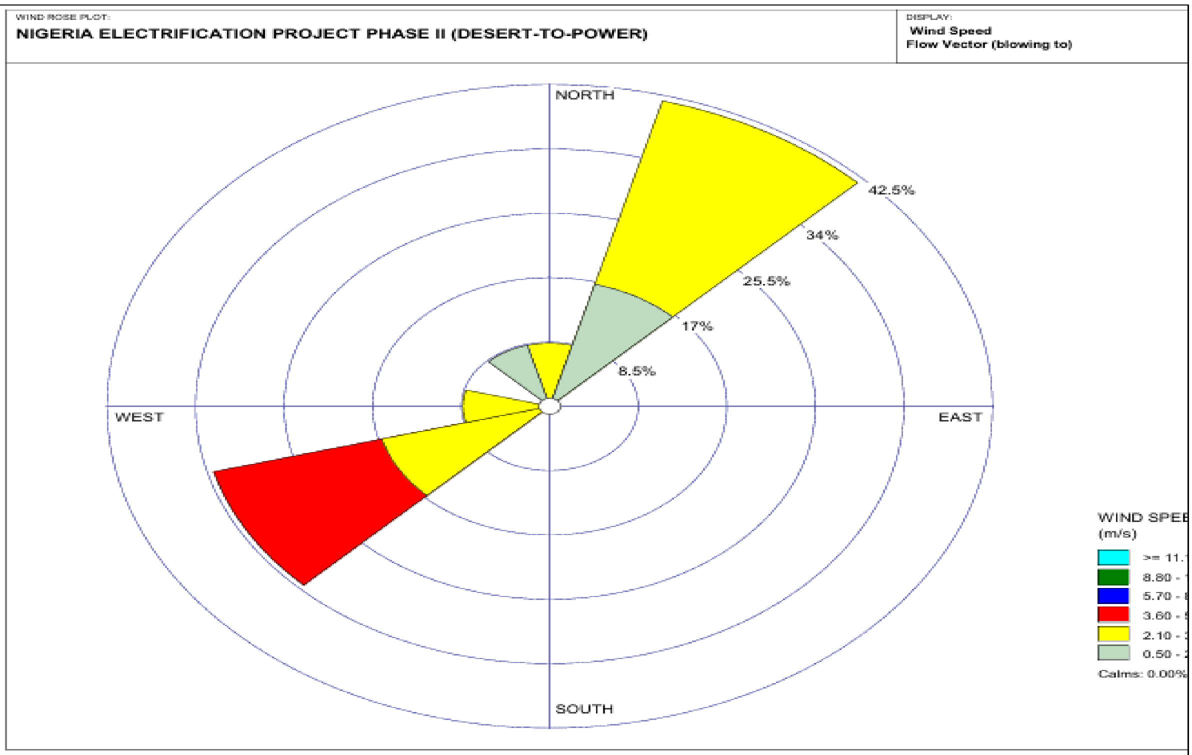
Wind speeds across the site are generally low to moderate, with the majority of occurrences falling within the 2.10–3.60 m/s and 3.60–5.70 m/s ranges, as represented by the dominant yellow and red sectors of the diagram. Higher wind speeds exceeding 5.70 m/s occur less frequently, while very low wind speeds (0.50–2.10 m/s) are also present but not dominant. The wind rose further indicates an absence of calm conditions (0.0%), suggesting that the project area experiences continuous airflow throughout the year, albeit predominantly at moderate intensities.



Wind speed and direction (Blowing from)

Figure 4.4a: Illustration of the frequency of wind speed and direction in Kebbi State (1995 – 2025).

Source: National Aeronautics and Space Administration (NASA) Data Access Viewer 2026.



Wind speed and direction (Blowing to)

Figure 4.4b: Illustration of the frequency of wind speed and direction in Kebbi State (1995 – 2025).

Source: National Aeronautics and Space Administration (NASA) Data Access Viewer 2026.

4.3.3 Findings and Discussions on the Micro Climate of the Study Area.

In addition to meteorological data from literature presented in subsections 4.3.2.1 - 4.3.2.4, on-site measurements of relative humidity and temperature, wind speed, dew point, wet bulb temperature, atmospheric pressure were recorded during fieldwork. The findings are presented as follows.

4.3.3.1 Temperature and Relative Humidity

The daytime temperature characteristics of the project site ranged from 29.2°C – 43.2°C, with an average ambient temperature of 39.1°C ±4.05°C. The dataset implied that the daytime temperature of the project site is moderately within human tolerable limits for outdoor activities. However, during the project construction phase and implementation/operation stage, it is expected that influx of population (site workers) and the use of machines emitting heat may increase the daytime temperature of the project surroundings, but the impact is envisaged not to be significant to affect human health or cause environmental hazard such as heatwave or heat island.

The relative humidity of the project area is inversely related to the daytime temperature. The field data revealed that the relative humidity of the project site ranged from 4.7% - 23.3%, with an average of 12.4 ±4.34% (Fig). This result implied that the atmospheric condition of the project area is characterized by low moisture content.

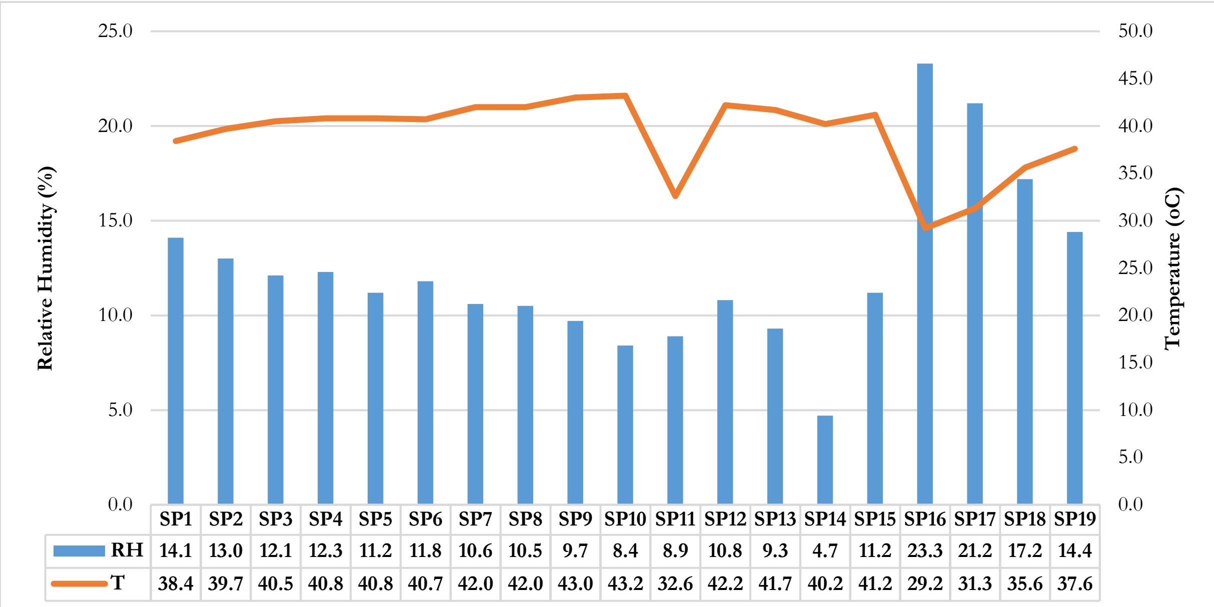


Figure 4.5: Relative humidity and temperature measured in the study area

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

4.3.3.2 Wind Speed and Wind Direction

The prevailing wind characteristics of the project site varied spontaneously. The prevailing wind speed measured in the project area varied from 0 - 3.2, while the average wind speed distribution was 1.6 ±1.01m/s (figure 4.6). Based on the Beaufort scale, the prevailing wind condition can be generalized as light air (0.5-1.6) and light breeze (1.6-3.3m/s), which can easily be detected by smoke drift as well as leave rustle. The prevailing light breeze indicates swift dispersion of gaseous pollutant in the advent of possible air pollution that may result from the project activities

Table 4.1: Wind Direction and Speed

Wind Direction	Wind Speed
60.4	3.7
60.6	3.6
74.5	3.2
171.4	3.0
199.7	3.2
206.3	2.9
214.4	2.3
218.7	1.9
201.8	1.7
148.1	1.8
79.5	2.6
66.7	3.4

Source: Fieldwork for the EIA of the proposed 1-MW Solar PV facility at FUBK, 2026

4.4 Baseline Study of the Project Area

The baseline study of the proposed 1MW solar PV plant site was conducted to establish the existing environmental, ecological, and socio-economic conditions prior to project implementation. Detailed field surveys and sampling were carried out to assess soil quality, vegetation cover, hydrology, and land use patterns within the study area. Maps generated from the sampling exercise provide spatial representation of key features, while photographs document the current state of the terrain and surrounding environment. Findings from this baseline assessment serve as a reference point for predicting and evaluating environmental impacts during construction and operation. The sampling maps and pictures enhances the clarity of the study, ensuring that stakeholders can visualize the existing conditions of the project site.

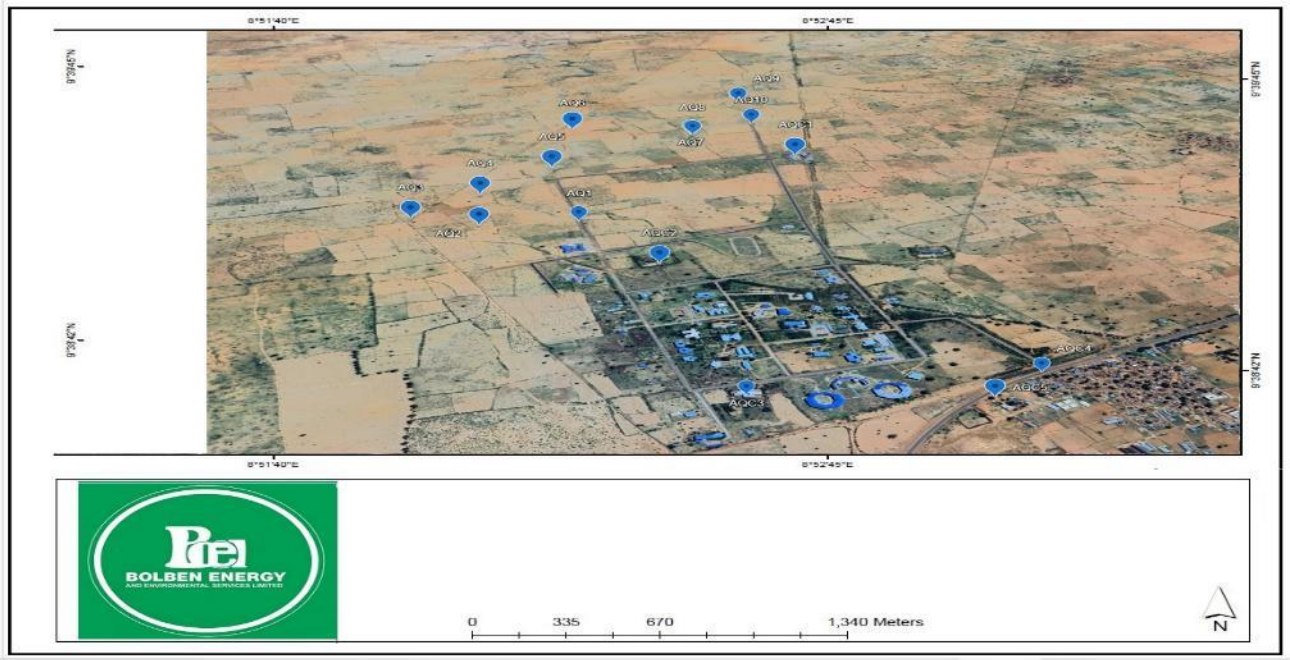


Figure 4.6: Sampling Map Indicating Groundwater Sampling Locations.
Source: Fieldwork for the EIA of the proposed 1-MW Solar PV facility at FUBK, 2026

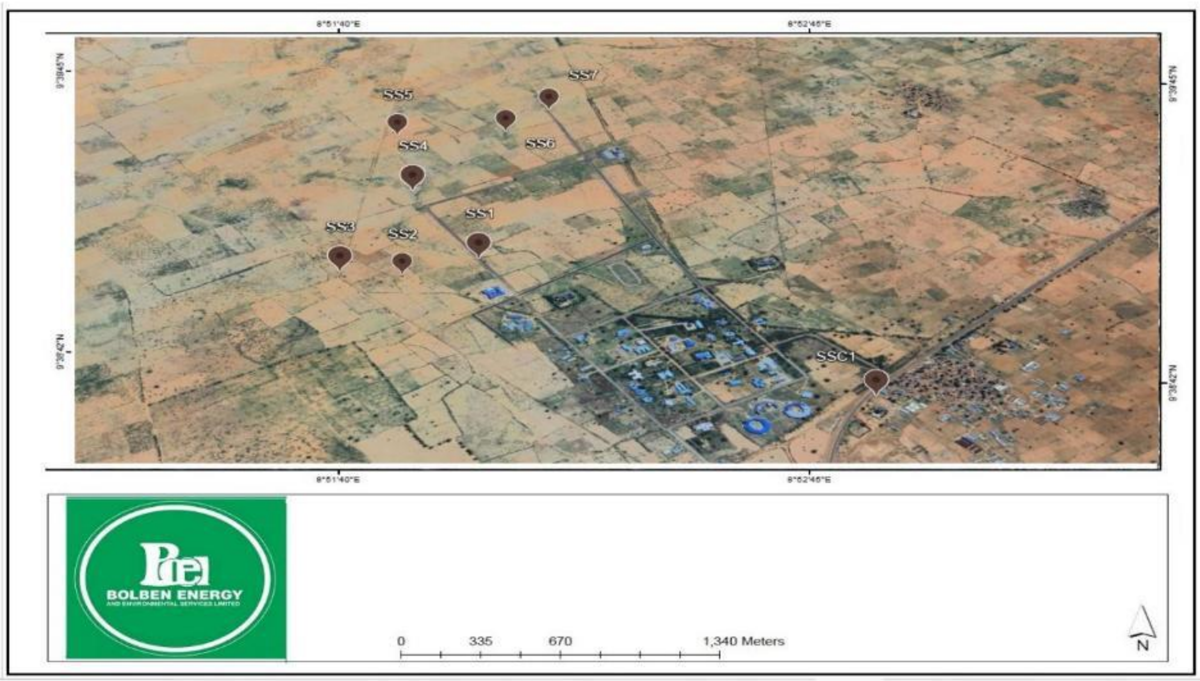


Figure 4.7: Sampling Map Indicating Air Quality and Noise Level Measurement Locations.
Source: Fieldwork for the EIA of the proposed 1-MW Solar PV facility at FUBK, 2026

Figure 4.8: Sampling Map Indicating Soil Sampling Locations.
Source: Fieldwork for the EIA of the proposed 1-MW Solar PV facility at FUBK, 2026

Figure 4.9: Sampling Map Showing Control Stations Established within the Federal Medical Centre (FMC), Birnin Kebbi.
Source: Fieldwork for the EIA of the proposed 1-MW Solar PV facility at FUBK, 2026

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4.4.1 Air Quality and Noise Assessment

The quality of air within the project AoI was measured *in-situ* using the equipment listed on Table 4.2. The equipment was calibrated, and each sensor for measuring specific air gases was attached and held at arm's length facing the prevailing wind at each sampling point. After five minutes, the atmospheric concentration of each gaseous pollutant was recorded directly from the equipment's display.

Table 1.2 Detection limits for air quality instruments

Parameter Measured	Equipment	Detection Limit
Carbon Monoxide (CO)	BW Technologies MicroClip XL Multiple Gas Alert Detector	0 -1500 ppm (1 ppm resolution)
Oxygen (O2)	BW Technologies MicroClip XL Multiple Gas Alert Detector	0 - 30% vol (0.1% vol resolution) (Stone Tucker Instruments)
Hydrogen Sulphide (H2S)	BW Technologies MicroClip XL Multiple Gas Alert Detector	0 - 100 ppm (1 ppm resolution) (Stone Tucker Instruments) (ITM)
Nitrogen Oxides (NOx)	BW Technologies Single Gas Alert Extreme	Detection limits not specified
Ammonia (NH3)	BW Technologies Single Gas Alert Extreme	Detection limits not specified
Sulphur Dioxide (SO2)	BW Technologies Single Gas Alert Extreme	Detection limits not specified
Particulate Matters (PM10)	Temtop M2000 Air Quality Monitor	0 - 999 ug/m³ (1 ug/m³ resolution) (ITM)

Source: BW Technologies; Temtop Inc.

The air quality readings along with the locations and coordinates of each sampling point within the project area and surrounding host communities, are presented on Table 4.3. The ambient ground-level air quality was assessed using the Air Quality Index (AQI) rating equation established by the United States Environmental Protection Agency (USEPA).

Table 4.3: Ambient Air Quality level around the Project Area

S/N	Sampling Location	Northings	Eastings	E	NH_3	NO_2	SO_2	CO	H_2S	PM		LEL	CO_2	O_2
										$PM_{2.5}$	PM_{10}			
AQ1	Point 1	12.338724	4.149325	218	BDL	BDL	BDL	BDL	BDL	4	7	BDL	526	20.9
AQ2	Point 2	12.338891	4.146849	218	BDL	BDL	BDL	BDL	BDL	1	2	BDL	518	20.9
AQ3	Point 3	12.339812	4.145183	219	BDL	BDL	BDL	BDL	BDL	6	12	BDL	511	20.9
AQ4	Point 4	12.341510	4.146982	222	BDL	BDL	BDL	BDL	BDL	6	7	BDL	515	20.9
AQ5	Point 5	12.343554	4.149083	220	BDL	BDL	BDL	BDL	BDL	6	7	BDL	517	20.9
AQ6	Point 6	12.347489	4.150073	221	BDL	BDL	BDL	BDL	BDL	9	19	BDL	513	20.9
AQ7	Point 7	12.346217	4.153645	219	BDL	BDL	BDL	BDL	BDL	1	3	BDL	529	20.9
AQ8	Point 8	12.346217	4.153641	219	BDL	BDL	BDL	BDL	BDL	0	1	BDL	517	20.9
AQ9	Point 9	12.349990	4.156061	219	BDL	BDL	BDL	BDL	BDL	0	3	BDL	531	20.9
AQ10	Point 10	12.347072	4.155821	219	BDL	BDL	BDL	BDL	BDL	1	2	BDL	526	20.9
AQ11	Senate Building	12.343126	4.156166	223	BDL	BDL	BDL	BDL	BDL	9	10	BDL	518	20.9

S/N	Sampling Location	Northings	Eastings	E	NH_3	NO_2	SO_2	CO	H_2S	PM		LEL	CO_2	O_2
										$PM_{2.5}$	PM_{10}			
AQ12	Male Hostel	12.335354	4.150834	216	BDL	BDL	BDL	BDL	BDL	7	9	BDL	511	20.9
AQ13	Student Health Center	12.328455	4.151269	214	BDL	BDL	BDL	BDL	BDL	3	5	BDL	517	20.9
AQ14	Ugwana Jeji	12.328133	4.156918	217	BDL	BDL	BDL	BDL	BDL	9	14	BDL	519	20.9
AQ15	Customs Quarter	12.327342	4.155614	214	BDL	BDL	BDL	BDL	BDL	7	15	BDL	521	20.9
AQ16	FCS Courtyard	12.437700	4.191428	233	BDL	BDL	BDL	BDL	BDL	6	11	BDL	526	20.9
AQ17	FCE Entrance	12.437861	4.190612	233	BDL	BDL	BDL	BDL	BDL	6	10	BDL	520	20.9
AQ18	Main Entrance FMC	12.434633	4.189007	234	BDL	BDL	BDL	BDL	BDL	9	15	BDL	519	20.9
AQ19	Medical Student Hostel	12.435208	4.191992	230	BDL	BDL	BDL	BDL	BDL	3	4	BDL	523	20.9
	Mean				-	-	-	-	-	**4.89**	**8.21**	-	**519.84**	**20.9**
	Standard Deviation				-	-	-	-	-	**3.20**	**5.20**	-	**5.74**	**0**
	FMEnv. Limit					**0.04-0.06**	**0.01**	**10**	**0.008**	**250**	**250**			
	WHO Guideline Value							**25**		**25**	**50**			
	USE-EPA Guideline Value					**0.05**		**9**					**1000**	

Source: Fieldwork for the EIA of the proposed 1-MW Solar PV facility at FUBK, 2026

Results and Discussions on Air Quality Measurement

➢ ***Gaseous Pollutants***

Criteria pollutants such as NO_2, CO, SO_2, NH_3, H_2S and LEL were measured in its ambient state to establish the atmospheric baseline condition of the project environment. The result showed that no trace of the criteria pollutants (NO_2, CO, SO_2, H_2S and LEL) were detected within and around the proposed project site during the field assessment. The absence of NO_2, NH_3, CO, H_2S and SO_2 in the project site is an indication of clean atmosphere, which implied that prior to the project execution (mobilization, preconstruction, construction and operation phase) the project environment is safe for human habitation. However, during project construction, implementation and operation phases there may be increasing level of some pollutants. Increase in the rate of vehicular movement during mobilization of workers and construction materials to the project site will lead to emission of NO_x, which in the presence of O_2, will release NO_2 into the environment. This gas is generated during combustion of fossil fuels from vehicles and power generating plant exhaust. The use of mechanical engines that operates on petroleum products will also emits SO_2 during combustion, thereby introducing this gas into the project environment. Under incomplete combustion, emission of carbon from mechanical devices is inevitable.

The ambient concentration of O_2 (20.9) in the project site and immediate environs is sufficiently enough to support life, while traces of LEL was not detected. The absence of LEL also confirms that the proposed project site and the surrounding environment is free from natural fire incidence, which is a criterial for siting industries.

The concentration of CO_2 in the sampling locations ranged from 511ppm – 531ppm with the mean concentration of 519.84 ±5.74ppm. These values were below the 1000ppm limit for CO_2 emission set by USEPA (talk about why this is low). It is important that the disturbance of the natural carbon pool (soil and plant) within the project area must be limited through planning.

➢ ***Particulates***

The ambient concentration of outdoor particulate matter in the project area ranged from 0 – 9µg/m3, with a mean concentration of 4.89 ±3.20µg/m3 for PM2.5. The ambient concentration of PM10 ranged from 1 – 19µg/m3, with the mean concentration of 8.21 ±5.20µg/m3 across the sampling location. The data set shows that the concentration of PM2.5 and PM10 recorded in all the sampling locations were below the FMEnv (80 and 250 µg/m3) and the WHO (25 and 50 µg/m3) hourly average values for outdoor concentration. The project activities are expected to alter the current state of PM2.5 and PM10 in the project sites and immediate environments particularly during construction phase due to exposure of the earth surface resulting from land clearing and excavation activities. During the project implementation stage, the emission of PM2.5 and PM10 and other related aerosols may be minimal.

Result of Noise Level Measurement

Ambient noise level within the project site ranged from 31.2 dB(A) to 64.7 dB(A) with the mean concentration of 42.4 ±12.95 dB(A). The measured noise levels within the proposed project area were all within natural background status of 30 – 70 dB(A), which is within the FMEnv (90dBA) and WHO (70dB) limit for educational areas (Figure 4.1). The background noise level is expected to soar higher during the project construction and operational phase, due to the presence of mechanical device and vehicular movement. Similarly, during operation phase of the proposed project, the noise level is also expected to rise, but not above human threshold that may cause hearing impairment.

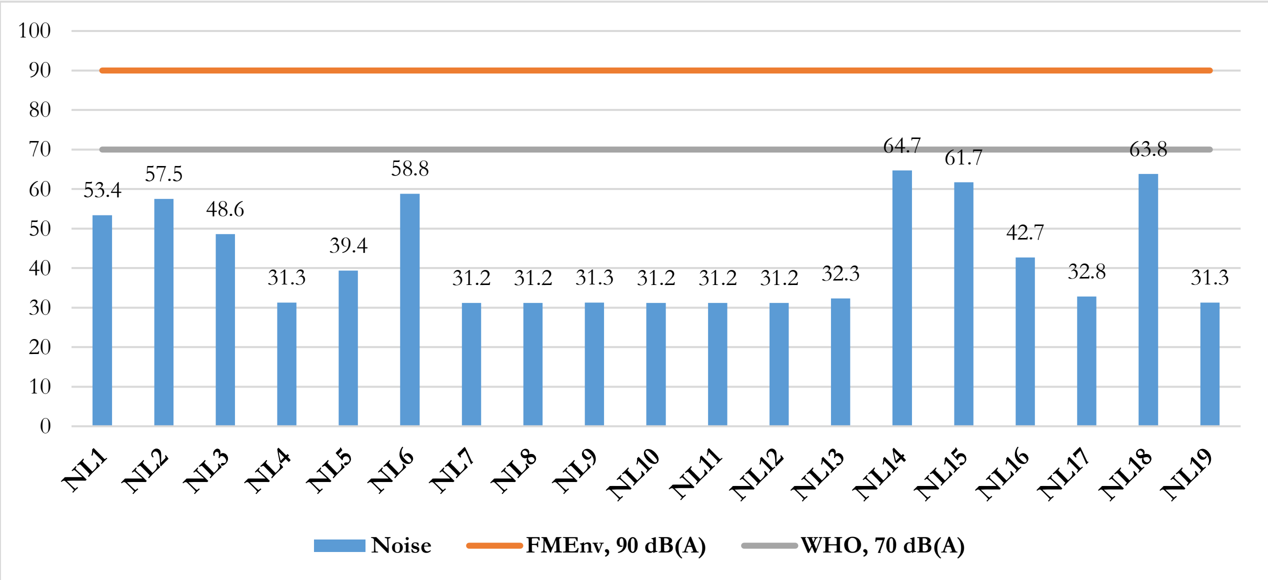

Figure 4.1 Ambient noise level within the project area

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

Air Quality Index (AQI)

The AQI of gaseous pollutants (NO_2, SO_2, CO, H_2S, and PM_{10}) indicates the extents to which the environment is safe for human habitation. The AQI rating and its associated health implication is presented in Table 4.4 while the AQI of the project area is detailed in Table 4.5.

Table 4.4: Air Quality Rating Table

Good	Moderate	Unhealthy for sensitive group	Unhealthy	Very unhealthy	Hazardous
0 - 50	51 - 100	101 - 150	151 - 200	201 - 300	301 - 500

Table 4.5: Air quality index of the project area

Pollutant	Standard	Mean	AQI	Levels of Health Concern
H_2S	0.008	0.0	0.0	Good
NO_2	0.04	0.0	0.0	Good
SO_2	0.01	0.0	0.0	Good
CO	10	0.0	0.0	Good
$PM_{2.5}$	80	4.89	6.1	Good
PM_{10}	250	8.21	3.28	Good
CO_2	1000*	519.84	51.98	Good

AQI = (Pollution Concentration) / (Pollution Standard Level) ×100.

The ambient ground level atmospheric condition of the project area and its immediate surrounding is rated good for all the gaseous pollutant measured during the field data gathering. These facilities must ensure their emission levels is within permissible limits.

4.4.2 Geology

The general geology of the project area is dominated by two formations; Pre-Cambrian Basement Complex in the south and south east and young sedimentary rocks in the north. The Basement Complex region is composed of very old volcanic and metamorphic rocks such as granites, schists, gneisses, quartzites and migmatites. In addition, there are metasediments such as phyllites and meta-conglomerates. The sedimentary region consists of rocks of the Gwandu, Illo and Rima groups whose ages range from the Cretaceous to the Eocene. The Gwandu group consists of massive clay grits interbedded with sandstone while the Illo and Rima groups consist of pebbly grits, sand stones and clays, mudstones and siltstones respectively. Minerals that can be found in the area include quartz, kaolin, piotolitic bauxite, clay, potassium, silica sand and salt.

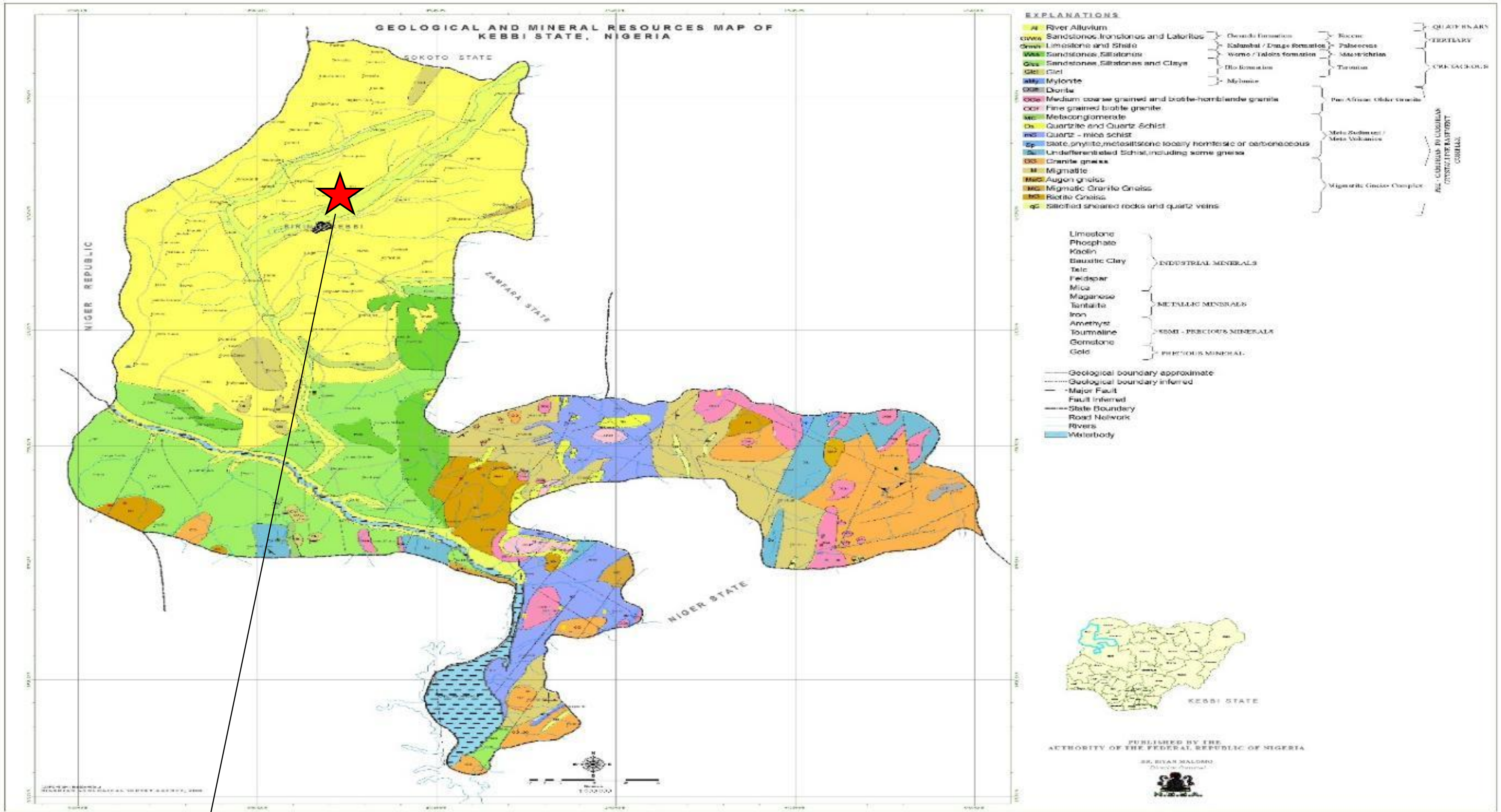

Figure 4.11: Geological map of Kebbi State showing project area

Source: Nigeria Geological Survey Agency

4.4.2.1 Soil studies

Soil samples were collected at 0 – 15cm (top soil) and 15 – 30cm (sub soil) depths respectively using a stainless-steel hand auger and put into clean decontaminated containers and stored for transfer to the laboratory for physico-chemical and microbial analyses. At each of the sample stations (SS) and soil depth levels (T or B), the soil samples were bulked together to give a composite sample. The soil samples from different sample stations and soil depth levels were, on each occasion, collected in polythene bags, labelled accordingly and transported to the laboratory for analysis. Sub samples for microbial analysis were wrapped up using aluminium foil. All samples collected were preserved in ice chest and transported to the laboratory for analysis. The laboratory results of the physico-chemical and microbial analysis of soil samples from the study area are presented in Tables 4.5.

Table 4.6: Laboratory Results for Soil Samples Analysis

S/No.	PARAMETERS	UNIT	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	TEST METHOD
	COORDINATES	**E** **N**	**4.149325** **12.338724**	**4.146849** **12.338891**	**4.145183** **12.339812**	**4.149083** **12.343554**	**4.150073** **12.347489**	**4.153641** **12.346217**	**4.155821** **12.347072**	**4.156166** **12.327599**	**4.190612** **12.437861**	
						PHYSICO- CHEMICAL PARAMETERS						
1	Electrical Conductivity	µS/cm	217.943	236.895	198.991	369.556	189.516	189.610	255.846	198.991	189.516	Electrometric
2	pH		6.660	6.380	6.540	6.720	7.140	6.550	5.930	5.870	5.510	Electrometric
3	Moisture Content	%	2.368	1.441	1.205	2.776	2.029	1.843	1.771	0.878	5.016	Gravimetric
4	Porosity	%	53.930	51.830	50.590	56.887	53.452	54.884	54.025	52.785	50.876	Sieve Analysis
5	Soil Texture	%	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Gravimetric
6	Bulk Density		1.221	1.276	1.309	1.142	1.234	1.196	1.218	1.251	1.302	Gravimetric
7	Total Alkalinity	mg/Kg	10.000	10.000	20.000	10.000	20.000	10.000	20.000	20.000	10.000	Titrimetric
8	Salinity	mg/Kg	0.132	0.143	0.120	0.224	0.115	0.115	0.185	0.120	0.115	Electrometric
9	Ammonium	mg/Kg	16.183	19.902	43.130	18.551	43..42	32.809	34.167	18.696	19.582	Nessler Method
10	Ammonia	mg/Kg	15.281	18.793	40.727	17.517	41.001	30.981	32.263	17.654	18.491	AAS method
11	Exchangeable sodium	Cmol/Kg	1.497	0.816	0.391	3.010	0.824	0.680	1.565	0.992	0.203	AAS method
12	Exchangeable potassium	Cmol/Kg	8.810	4.802	2.303	17.713	4.846	4.003	9.209	5.837	1.193	AAS method
13	Exchangeable Calcium	Cmol/Kg	24.439	9.776	9.824	19.551	9.776	14.663	9.776	19.551	34.215	AAS method
14	Exchangeable Magnesium	Cmol/Kg	48.798	63.437	82.907	97.596	63.437	53.678	78.076	58.537	39.038	KCl Extraction
15	Exchangeable Acidity	Cmol/Kg	50.751	61.484	63.310	68.407	72.773	65.339	69.275	57.581	44.358	Batch Method
16	Exchangeable Bases	Cmol/Kg	83.544	78.831	95.426	137.870	78.883	73.025	98.626	84.936	74.649	Ammonium Acetate method
17	Cation Exchange Cation (CEC)	Cmol/Kg	134.295	140.315	158.736	206.276	151.656	138.423	167.901	142.519	118.907	Summation Method
18	Base saturation	%	62.209	56.181	60.116	66.837	52.014	52.755	58.741	59.598	62.779	Nessler Method

S/No.	PARAMETERS	UNIT	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	TEST METHOD
	COORDINATES	**E** **N**	**4.149325** **12.338724**	**4.146849** **12.338891**	**4.145183** **12.339812**	**4.149083** **12.343554**	**4.150073** **12.347489**	**4.153641** **12.346217**	**4.155821** **12.347072**	**4.156166** **12.327599**	**4.190612** **12.437861**	
19	Sodium Adsorption Ratio (SAR)		0.247	0.135	0.057	0.393	0.136	0.116	0.236	0.159	0.034	Summation Method
20	Exchangeable Sodium Potassium (ESP)		1.792	1.035	0.410	2.183	1.044	0.932	1.587	1.168	0.272	Summation Method
						MACRO NUTRIENTS						
21	Total Nitrogen	mg/Kg	115.666	97.961	119.586	140.039	141.151	109.765	131.346	113.910	109.385	Indophenol (cololimetric)
22	Available Phosphorus	mg/Kg	4.286	2.815	3.078	9.328	4.181	3.866	6.019	4.758	7.332	Extraction Method
23	Total Potassium	mg/Kg	308.844	185.703	118.906	307.188	146.250	142.734	237.656	170.859	56.797	AAS method
						ORGANICS						
24	Total Organic carbon	%	0.115	0.054	0.062	0.113	0.083	0.058	0,075	0.068	0.058	Walkey and Black Oxidation Method
25	Total Organic Matter	%	0.199	0.092	0.106	0.195	0.144	0.099	0.130	0.116	0.099	Gravimetric
26	Total Organic Nitrogen	mg/Kg	0.012	0.005	0.006	0.011	0.008	0.006	0.008	0.007	0.006	Indophenol (cololimetric)
						ANIONS						
27	Chloride	mg/Kg	121.079	131.608	110.551	205.309	105.287	105.339	142.137	110.551	105.287	
28	Nitrite	mg/Kg	94.874	71.765	75.126	117.983	97.395	71.765	89.412	88.992	84.372	Colorimetry
29	Nitrate	mg/Kg	4.597	6.289	1.324	3.494	0.331	5.186	7.760	6.216	5.627	Colorimetry
30	Phosphate	mg/Kg	11.119	8.617	9.421	28.552	12.797	11.832	18.424	14.565	22.443	Colorimetry
31	Sulphate	mg/Kg	237.231	261.846	126.462	255.692	326.462	194.846	481.846	580.308	214.154	Colorimetry
						METALS						
32	Calcium	mg/Kg	488.780	195.512	196.489	391.024	195.510	293.268	195.508	391.020	684.291	AAS Method
33	Magnesium	mg/Kg	592.926	770.803	1007.381	1185.852	770.803	652.218	948.681	711.511	474.341	AAS Method
34	Sodium	mg/Kg	34.414	18.758	8.995	69.191	18.931	15.638	35.973	22.802	4.662	AAS Method
35	Iron	mg/Kg	14.632	4.529	3.697	13.364	6.589	2.508	0.000	4.489	2.151	AAS Method
36	Copper	mg/Kg	0.790	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	AAS Method

S/No.	PARAMETERS	UNIT	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	TEST METHOD
	COORDINATES	E N	4.149325 12.338724	4.146849 12.338891	4.145183 12.339812	4.149083 12.343554	4.150073 12.347489	4.153641 12.346217	4.155821 12.347072	4.156166 12.327599	4.190612 12.437861	
37	Lead	mg/Kg	0.930	0.287	0.000	0.409	0.000	0.559	0.729	0.168	0.484	AAS Method
38	Zinc	mg/Kg	6.229	0.092	4.167	2.190	0.970	0.000	0.000	3.127	0.083	AAS Method
39	Chromium	mg/Kg	4.286	1.469	0.000	0.000	1.741	3.617	3.708	3.074	3.450	AAS Method
MICROBIAL PARAMETERS												
40	Total Heterotrophic Bacterial (THB)	cfu/g	4.6×10^4	1.24×10^5	9.8×10^4	TNTC	1.16×10^5	1.8×10^4	6.4×10^4	7.2×10^4	7.6×10^4	Incubator, Autoclave
41	Total Heterotrophic Fungi (THF)	cfu/g	6.0×10^3	8.0×10^3	1.0×10^4	8.0×10^3	1.6×10^4	8.0×10^3	1.2×10^4	3.0×10^4	6.0×10^3	Incubator, Autoclave
43	Total coliform (TC)	cfu/g	ND	2.0×10^2	4.0×10^2	ND	ND	ND	ND	ND	ND	Incubator, Autoclave

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

NOTE:
mg/Kg = miligram per Kilogram
µS/cm = micro Siemens per centimetre
cfu/g = colony forming unit per gramme
Cmol/Kg = centimole per kilogram
NS = Not stated
ND = Not Detected
TNTC = Too numerous to count

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Physical Properties of the Soil
The nine (9) soil samples collected are predominantly silty sand. Silty sand is a soil type that combines properties of both sand and silt.

Chemical Properties of the Soil

- ***pH***

Soil pH value is a measure of the free hydrogen ion (H+) and hydroxyl ion (OH-) concentration of soil solutions. The pH provides a variety of useful information about soil including the relative availability of plant nutrients amongst others. The average pH value of the soil samples from the Project area is 6.36, which falls within the FAO fertility limit (6-9), where nutrients are most available to plants. The soil pH is lowest at SS9 with pH value 5.510 (slightly acidic) and highest at SS5 with pH value of 7.140 (somewhat neutral) but support plant growths.

- ***Electrical conductivity (EC)***

The Electrical Conductivity of soil is the measure of the soil's capacity to conduct electrical Current. It is measure of the total dissolved salts in a solution, the factor that influences a plant's ability to absorb water. The EC (µS/cm) of the soil samples ranges from 189.16 in (SS5 & 9) where it lowest to 369.56 in (SS4) where it is highest with an average of 227.43 which falls within the optimal range (110 – 570) to provide the available nutrients for plant growth allowable by FAO.

- ***Moisture Content***

Soil moisture in the project area ranges from 0.878 in (SS8) where it is lowest to 5.016 (SS9) where it is highest with an average of 2.14. Soil moisture is an essential variable in controlling the exchange of water and heat energy between land surface or soil and the atmosphere through evaporation and plant transpiration. It plays an important role in the development of weather patterns and production of precipitation.

- ***Total Organic Matter***

Total organic matter contributes to soil productivity. Most of our productive soils have between 3 and 6% organic matter. Total organic matter in the Project area ranges from 0.092 in (SS2) to 0.199 in (SS1) with an average value of 0.131 which falls within FAO range for soil productivity.

- ***Soil Anions***
  - **Chloride (Cl^-)** concentration in the soil samples ranges from 10.287 mg/kg in (SS5&9) where it has the lowest chloride concentration to 205.309 mg/kg in (SS4) where it has the highest concentration of chlorides with an average concentration of 163.98 which is an appreciable concentration. Cl^- is an important micro-element required for plant photosynthesis at considerable limit. The concentration of anions and nutrients in the soil samples from the study area was found to be within the acceptable range for good agricultural performance.
  - **Ammonia (NH_3)** analysed as Nitrogen in the soil samples ranges from 15.281 mg/kg (SS1) where it is lowest to 41.001 mg/kg (SS5) where it is highest with an average of 25.86 which is allowable for plant growth. Ammonia in the soil is a product of microbial activity and source of nitrogen to plants.

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Phosphorus (P_2O_5) concentration in the soil samples is high varying from 2.81 mg/kg (SS2) which is the lowest to 9.328 mg/kg (SS4) which is the highest phosphorus concentration and an average of 5.073. Phosphorus in the soil are essential macro-element required for plants nutrient.

- **Sulphate (SO_4)** concentration varies from 126.462 mg/kg (SS3) where it is lowest to 580.308 mg/kg (SS8) where it is lowest with an average concentration of 297.649 which is far below the FAO permissible limit of 500mg/kg for soil nutrient and plant growth.

➢ ***Cations***

The exchangeable cations in the soil are easily dissolved into solutions making them readily available for uptake by the roots of plants. Their presence in soil is therefore directly related to the nutrient levels and hence, fertility of the soil. Cation nutrients such as, Magnesium (Mg^{2+}), Potassium (K^+) and Sodium (Na^{2+}), also help in cleansing the soil by providing adsorption/exchange sites for potential soil and groundwater pollutants e.g. Lead (Pb^{2+}), Cadmium (Cd^{2+}), etc. First, the pollutants are immobilised and finally form insoluble hydroxides, carbonates, etc, thus, becoming unavailable for plants' use. Magnesium (Mg^{2+}) concentration in the soil varies from 474.341 mg/kg (SS9) where it is lowest to 1185.82 mg/kg (SS4) where it is lowest with an average concentration of 790.925 which is higher than the FAO limit of 50mg/kg. Exchangeable Potassium (K^+) concentration varies from 1.193 mg/kg (SS9) where it is lowest to 17.713 mg/kg (SS4) where it is highest with an average concentration of 6.24 which is far below the FAO limit of 50mg/kg. Exchangeable Sodium (Na^{2+}) concentration varies from 0.203 mg/kg (SS9) where it is lowest to 3.010 mg/kg (SS4) with an average concentration of 1.108 which is far below the FAO limit of 50mg/kg.

➢ ***Trace Elements and Heavy Metals***

- **Copper (Cu)** is an essential element for plants, animals and humans. It is also a component of many metallo-enzymes and respiratory pigments. However, excess concentration of copper in an environment at a given time may cause chronic toxicity. The concentration of analysed copper in the soil sample varies from 0.000 mg/kg (SS 3-9) where it is lowest to 0.790 mg/kg (SS1) where it is highest with an average of 0.08. This value is well above the FAO limit of <1mg/kg for arable soils. Copper in soil can come from both natural (geogenic) and human-caused (anthropogenic) sources. Geogenic sources include copper naturally present in rocks, water, and air. Anthropogenic sources include industrial processes, mining, agriculture, and waste disposal. In the case of the Project site, considering that the site and its immediate surroundings do not have any major industrial activities going on, then it is most likely that the high copper present in the soil will be due to natural (geogenic) source(s).
- **Total Chromium (Cr)** concentration in the soil sample ranges from 0.000 mg/kg in (SS3 & SS4,) where it is lowest to 4.286 mg/kg in (SS1) where it is the highest with an average of 2.371. This value is slightly above the FAO limit of <1mg/kg.
- **Calcium (Ca)** concentration in the soil sample varies from 195.508 mg/kg in (SS7) where it is lowest to 684.291 mg/kg (SS 9) where it is highest with an average concentration of 336.822. This value is well below the FAO limit of 500mg/kg.
- **Total Iron (Fe_2O_3)** concentration from the analysed soil samples varies from 0.000 mg/kg in (SS7) where it is lowest to 14.632 mg/kg (SS1) where it is highest with an average of 5.773 which is far above the FAO permissible limit of <1mg/kg for arable soils.

4.4.2.2 Groundwater Sampling

In-situ Groundwater Analysis

Six (6) groundwater samples were collected from motorized boreholes within the Federal University of Birnin-Kebbi, Kebbi State, Federal Medical Centre (FMC), Birnin-Kebbi and Ungwan Jeji community to establish baseline groundwater quality conditions. The samples were analyzed for physicochemical parameters, heavy metals, microbial load, and hydrocarbon content. Appropriate sampling containers and preservation techniques were adopted to ensure sample integrity: clean plastic bottles were used for physicochemical parameters, nitric acid–preserved containers were used for heavy metal analysis, and pre-sterilized amber glass bottles were used for microbial and hydrocarbon analyses. The boreholes serve as primary sources of water for various domestic purposes and are therefore regarded as sensitive environmental receptors. To properly assess potential project-related impacts, in-situ measurements of temperature, total dissolved solids (TDS), pH, and electrical conductivity were taken at the point of collection. These field measurements provided immediate indicators of groundwater conditions and helped establish the pre-project baseline water quality status against which future changes can be evaluated.

The results of the in-situ measurements are presented in the table below. The pH values ranged from 5.9 to 7.5, indicating slightly acidic to neutral conditions across the sampling locations. Temperature at the time of sampling varied between 27.5°C and 34.4°C, which is consistent with ambient environmental conditions in the area. Electrical conductivity ranged from 0.07 to 0.16 (mS/cm), while total dissolved solids (TDS) values ranged between 51 mg/L and 133 mg/L, reflecting low to moderate levels of dissolved ions in the groundwater. Overall, the measured parameters were within acceptable regulatory limits, except for the pH values recorded at GW2 and GW6, which were below the acceptable range of 6.5–9.2.

Table 4.7: Result of In-situ Water Analysis

S/N	Description	Code	Northing	Easting	pH	Temp.	Cond.	TDS
1	Faculty of Pharmacy	GW1	12.337114	4.189039	7.3	31.5	0.10	83
2	Beside Senate Building Mosque	GW2	12.342675	4.156343	5.9	34.4	0.17	133
3	Student Health Center	GW3	12.328455	4.151269	6.4	31.6	0.07	56
4	Customs Quarters	GW4	12.328133	4.156918	6.3	31.1	0.07	56
5	Faculty of Clinical Sciences	GW5 (Control)	12.437849	4.191155	7.5	27.5	0.06	51
6	Medical Students Hostel	GW6 (Control)	12.435208	4.191992	5.9	32.3	0.16	126

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

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Table 4.8: Laboratory Results of Ground Water

S/N	PARAMETERS	UNIT	MAXIMUM PERMISSIBLE LEVEL FOR GROUNDWATER (NSDWQ)	GW1	GW2	GW3	GW4	GW5 (Control)	GW6 (Control)	TEST METHOD
		E N	COORDINATES	4.189039 12.337114	4.156343 12.342675	4.151269 12.328455	4.156918 12.328133	4.191155 12.437849	4.191992 12.435208	
					PHYSICO- CHEMICAL PARAMETERS					
1	General Appearance		**CLEAR**	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR	VISUAL
2	Odour		**UNOBJECTIONABLE**	UNOBJECTIONABLE	UNOBJECTIONABLE	UNOBJECTIONABLE	UNOBJECTIONABLE	UNOBJECTIONABLE	UNOBJECTIONABLE	SENSORY EVALUATION
2	Temperature	^{O}C	**NS**	27.800	27.800	27.800	27.800	27.800	27.800	APHA 2550 B
3	Electrical Conductivity	µS/cm	**1000**	132.661	75.806	113.709	142.137	94.758	151.613	ELECTROMETRIC
4	pH		**6.50-9.20**	6.190	6.180	6.300	6.450	6.230	6.300	ELECTROMETRIC
5	Turbidity	NTU	**5**	0.000	0.000	0.000	0.000	2.000	10.000	NEPHELOMETRIC TURBIDITY METHOD
6	Colour	Pt.co	**15.00**	0.000	0.000	0.000	0.000	15.000	30.000	PLATINUM COBALT STANDARD METHOD
7	Total Dissolved solid	mg/l	**500**	207.283	118.447	177.671	222.089	148.059	236.895	ELECTROMETRIC
8	Total Suspended Solid	mg/l	**<10**	0.007	0.002	0.001	0.004	0.012	0.018	GRAVIMETRIC

S/N	PARAMETERS	UNIT	MAXIMUM PERMISSIBLE LEVEL FOR GROUNDWATER (NSDWQ)	GW1	GW2	GW3	GW4	GW5 (Control)	GW6 (Control)	TEST METHOD
9	Total Solid	mg/l	**1500.00**	207.290	118.449	177.672	222.093	148.071	236.913	GRAVIMETRIC
10	Total Hardness	mg/l	**500.00**	439.024	487.804	487.800	317.073	414.633	487.804	EDTA TITRATION
11	Magnesium Hardness	mg/l		243.903	121.951	390.243	219.268	317.073	389.755	EDTA TITRATION
12	Calcium Hardness	mg/l	**150**	195.122	365.853	97.561	97.805	97.561	98.049	EDTA TITRATION
13	Total Alkalinity	mg/l	**NS**	40.000	40.010	20.000	40.000	20.080	40.060	METHYL ORANGE TITRATION
14	Salinity	ppt	**NS**	0.080	0.046	0.069	0.086	0.057	0.092	
ORGANICS										
17	Chemical oxygen demand (COD)	mg/l	**NS**	59.400	11.880	95.040	47.520	46.332	47.508	DICHROMATE REFLUX METHOD
18	Biological oxygen demand (BOD)	mg/l	**NS**	35.640	7.128	57.024	28.512	27.999	28.505	WRINKLER'S IODOMETRIC METHOD
ANIONS										
19	Carbonate	mg/l	**NS**	0.000	0.000	0.000	0.000	0.000	0.000	
20	Bicarbonate	mg/l	**NS**	48.800	48.812	24.400	48.800	24.498	48.873	
21	Chloride	mg/l	**250.00**	73.701	42.115	63.172	78.763	52.643	84.229	ARGENTOMETRIC TITRATION

S/N	PARAMETERS	UNIT	MAXIMUM PERMISSIBLE LEVEL FOR GROUNDWATER (NSDWQ)	GW1	GW2	GW3	GW4	GW5 (Control)	GW6 (Control)	TEST METHOD
22	Nitrite	mg/l	**0.2**	0.018	0.000	0.000	0.191	0.029	0.000	COLIMETRIC
23	Nitrate	mg/l	**50.00**	30.874	38.899	22.387	29.950	38.059	51.546	COLIMETRIC
24	Phosphate	mg/l		4.360	2.881	2.527	0.695	6.579	0.566	COLIMETRIC
25	Sulphate	mg/l	**100.00**	7.877	5.415	31.108	2.492	0.646	0.338	COLIMETRIC
				METALS						
26	Calcium	mg/l	**150**	78.205	146.634	39.102	39.200	39.100	39.298	EDTA TITRATION
27	Magnesium	mg/l		39.293	29.646	94.865	53.304	77.250	94.750	EDTA TITRATION
28	Sodium	mg/l	**200**	0.000	0.033	0.000	0.000	0.010	1.608	AAS METHOD
29	Potassium	mg/l		0.367	0.875	0.523	0.719	0.680	1.109	AAS METHOD
30	Lead	mg/l	**0.01**	0.000	0.000	0.000	0.000	0.000	0.000	AAS METHOD
31	Iron	mg/l	**0.3**	0.053	0.000	0.005	0.401	0.000	0.000	AAS METHOD
32	Chromium	mg/l	**1.00**	0.000	1.175	1.451	0.000	0.000	0.000	AAS METHOD
34	Copper	mg/l	**1**	0.067	0.053	0.104	0.047	0.050	0.072	AAS METHOD
35	Manganese	mg/l	**0.2**	0.000	0.000	0.000	0.000	0.000	0.000	AAS METHOD
36	Zinc	mg/l	**3**	0.000	0.046	0.062	0.052	0.013	0.061	AAS METHOD

S/N	PARAMETERS	UNIT	MAXIMUM PERMISSIBLE LEVEL FOR GROUNDWATER (NSDWQ)	GW1	GW2	GW3	GW4	GW5 (Control)	GW6 (Control)	TEST METHOD
37	Arsenic	mg/l		0.018	0.014	0.015	0.015	0.017	0.011	AAS METHOD
MICROBIAL PARAMETERS										
38	Total Bacterial count (TBC)	cfu/ml	**0**	2.3×10^4	1.26×10^4	2.62×10^4	1.44×10^4	1.72×10^4	1.8×10^3	POUR PLATE
39	Total Heterotrophic Fungi (THF)	cfu/ml	**0**	ND	ND	ND	1.0×10^0	ND	ND	POUR PLATE
40	Total coliform (TC)	cfu/ml	**10**	ND	2.8×10^1	1.0×10^1	ND	2.0×10^0	2.0×10^0	POUR PLATE
41	Feacal coliform (FC)	cfu/ml	**0**	ND	ND	ND	ND	ND	ND	POUR PLATE

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

NOTE:
mg/l = miligram per litre
µS/cm = micro Siemens per centimetre
cfu/ml = colony forming unit per milliliter.
NS = Not stated
ND = Not Detected
TNTC = Too numerous to count

Analysis of Groundwater: Physical and Chemical Parameters

Six (6) groundwater samples namely GW1 and GW2 were collected from boreholes at various points within the Federal University Birnin-Kebbi and Ungwan Jeji community. The points where each sample was collected are describes as follows; Faculty of Pharmacy to represent GW1, Beside Senate Mosque to represent GW2, Student health center to represent GW3, Custom Quarters to represent GW4, Faculty of Clinical Sciences to represent GW5 and Medical Student Hostel to represent GW6. Visual observation showed clear appearance in all the samples with unobjectionable odour and taste from sensory evaluation.

- ***pH***

The pH of the collected samples at 25^{o}C was 6.190 at GW1, 6.180 at GW2, 6.300 at GW3, 6.450 at GW4, 6.230 at GW5, and 6.300 at GW6 with an average of 6.275 which falls within the maximum permissible limit of the National Standard for Drinking Water Quality for potable water (NSDWQ) i.e. (6.5 – 9.0). All the samples were slightly acidic, likely to be contaminated with pollutants, making it unsafe for consumption until they have been treated and can also corrode or dissolve metal pipes.

- ***Electrical Conductivity***

Electrical Conductivity of the water samples analysed showed that EC values range from 75.806 µS/cm in GW2 to 151.613 µS/cm in GW6 with an average of 118.447 µS/cm which is lower than the permissible limit of NSDWQ (1000 µS/cm). The EC of all the water samples is entirely lower than the NSDWQ standards indicating that heavy metals from either industrial activities or leaching from sub-soil lithology have not been introduced into the groundwater of the project area where the samples are collected making it safe for drinking.

- ***Turbidity***

Turbidity of the water samples analysed showed that the value ranges from 0.000NTU in GW1, GW2, GW3, and GW4 to 10.000NTU in GW6, with an average of 2.000NTU which is below the permissible limit of NSDWQ (5NTU). However, GW6 (10.000NTU) exceeded the National Standard for Drinking Water Quality limits. This indicates that the water may need be treated before consumption and also stand a risk of pathogenic organisms which could be shielded by the turbidity particles and hence require disinfection.

- ***Total Hardness***

The total hardness of the groundwater samples showed that the value ranged from 317.073mg/L in GW4 to 487.804 mg/L in GW2 and GW6 with an average of 439.023mg/L which is below the NSDWQ standards (500mg/L). The total hardness from both samples showed that the water is ‘hard’ and characterized by high mineral content (primarily calcium and magnesium). This can lead to several issues, including reduced soap lathering, skin and hair dryness, and mineral buildup on appliances and plumbing. Remedies to this problem include using water softeners, boiling the water, and using vinegar or baking soda for cleaning etc.

- ***Temperature***

Temperature of the ground water samples was 27.8^{0}C in all the samples collected, making the average 27.8^{0}C. This falls within permissible limits of NSDWQ (<40^{0}C). The foregoing suggests that the groundwater temperature is generally ambient and good for consumption. It is important that groundwater temperature is not too high in order not to have microbial proliferation.

- ***Total Dissolved Solids (TDS)***

Total Dissolved Solids (TDS) at GW2 was 118.430mg/L, while at GW6, it was 266.8956mg/L, with an average 185.074mg/L, which is entirely below the NSDQW permissible value (500Mg/L) for drinking water. The TDS values analysed from the groundwater samples is an indication that the salinity of the water is relatively low. Water containing TDS lower than 1000mg/L could be considered to be 'Fresh water' and good enough for drinking, irrigational and domestic purposes as this would not affect the osmotic pressure of soil solution.

- ***Total Suspended Solids (TSS)***

Total Suspended Solids (TSS) refers to particulate material in water. TSS values are typically high where there is rapid water flow and in water from uncased wells that has been stirred during purging prior to sample collection, and lower where groundwater flows slowly through porous media such as sand or sandstones. TSS values from the analysed samples were 0.001mg/L at GW3 to 0.018mg/L at GW6 with an average of 0.007mg/L which is far lower than value of TSS on the National Standard for Drinking Water Quality limits (NSDWQ) (10mg/L). TSS lower threshold values in all the analysed samples makes the water safe for drinking.

- ***Total Solids (TS)***

Total solids (TS) value was least at GW5 to be 148.071mg/L, while it was highest at GW6 to be 236.913 mg/L, with an average of 185.081 mg/L which is below the guideline values of National Standard for Drinking Water Quality (NSDQW) (500mg/L). A high total solids value generally indicates the presence of a variety of dissolved and suspended substances, including salts, minerals, and potentially harmful contaminants. It can also indicate that water is hard, which can cause scale buildup.

- ***Nitrate (NO_3)***

Nitrate (NO_3) value ranged from 22.387mg/L in GW3 to 51.546mg/L in GW6, with an average of 35.285mg/L. The measured nitrate values in the groundwater sample collected at the Medical Student Hostel (GW6) was above the NSDWQ limit (50mg/L). Highly concentrated wastes containing nitrogen compounds could have been oxidized to nitrate when discharged into the environment and found its way into groundwater via percolation.

- ***Calcium (Ca)***

Calcium (Ca) concentration in the groundwater varies from 39.100mg/L in (GW5) to 146.634mg/L in (GW2) with an average value of 63.589mg/L which is lower than the specified NSDWQ permissible limit (150mg/L). This indicates that the water is safe for drinking and other domestic purposes. Ca concentration in the groundwater is introduced by weathering of the alluvium and coastal plain sands within and around the project area.

- ***Magnesium (Mg)***

Magnesium (Mg) is the most abundant element in nature, and it is a significant member in water hardness, it gives an unpleasant taste to water. Magnesium (Mg) concentration in the groundwater varies from 29.646mg/L (GW2) to 94.865mg/L (GW3) with an average of 60.400mg/L there is no NSDWQ permissible limit for Mg for drinking. The observed Mg could be due to groundwater contact with dissolved soil, rock and minerals of magnesium in the aquifer for all sample locations, leaching of industrial effluents discharge into the soil for sample locations and leachate from landfill and sewage deposited over time in residential locations.

- ***Sodium (Na)***

Sodium (Na) is a rock constituent which is widely distributed naturally. Sodium (Na) concentration in the groundwater analysed was 0.000mg/L in GW1, 3 and 4, and highest value 1.608mg/L (GW6) with an average of 0.269mg/L. All these values were below the NSDWQ permissible limit. Sodium (Na) is introduced into the groundwater through contact with dissolved soil, rock and minerals of Sodium in the aquifer for all sample locations.

- ***Potassium (K)***

Potassium (K) is rocks constituent which is widely distributed naturally. Potassium (K) concentration in the groundwater analysed was 0.367 mg/L at GW1 and 1.109 mg/L at GW, with an average of 0.712mg/L. There is no specified NSDWQ permissible limit for concentration of K for ground water. Potassium (K) is introduced into the groundwater through contact with dissolved soil, rock and minerals of Potassium in the aquifer for all sample locations and leachates.

- ***Sulphate (SO_4^{2-})***

Sulphate (SO_4^{2-}) concentration ranges from 0.338mg/L in GW6 to 31.108mg/L in GW3 with an average of 7.979mg/L which is entirely below the NSDWQ permissible limit (100mg/L) for drinking. SO_0^{2-} ions exist naturally in water with little or no health implications recorded so far, however, accumulation of sulphate in water may lead to increase in water pH causing acidosis.

- ***Iron (Fe)***

Iron (Fe) exists in its natural form as ores (magnetite, taconite and haematite) in rocks, soil and minerals making about 5% of the Earth's crust. Total Iron (Fe) concentration in the analysed samples ranged from 0.000mg/L in GW 2, 5 and 6 to 0.401 in GW4 with an average of 0.0765. The iron concentration at GW4 is seen to be above the NSDWQ standard 0.3mg/L. High concentration of Fe in groundwater above the permissible level could be linked to weathering of minerals and rocks (mineralogical and piezometry features) of iron in the soil of the project area and dissolution of iron natural deposits into groundwater bodies via leaching.

- ***Copper (Cu)***

Copper (Cu) concentration in the groundwater analysed ranges from 0.047mg/L (GW4) to 0.104mg/L (GW3) with an average of 0.065mg/L which we all below the permissible limit NSDWQ (1mg/L) for consumption. The concentration of Cu in all the samples were below the limit however, when excess copper is present in water (above the permissible level), gastrointestinal disorder occurs after a long period of exposure.
Research has recorded approximately 0.05 g/kg of zinc to be present naturally in the earth crust.

- ***Zinc (Zn)***

Zinc (Zn) concentration in the groundwater samples analysed ranges from as low as 0.000mg/L in (GW1) to 0.062mg/L in (GW3) with an average of 0.039 which is entirely lower than the NSDWQ permissible limit (3mg/l). This could be that the zinc in its natural mineral form (sphalerite) did not dissolve into underground water bodies via leaching in all examined locations. However, medical experts have reported electrolyte imbalance, vomiting, acute renal failures and abdominal pain as symptoms of excessive exposure of human to zinc.

- ***Manganese (Mn)***

Manganese (Mn) is ores and rocks constituent which is widely distributed naturally. It is a vital element for biological systems whose chemical behaviour is a function of pH, oxidation and reduction reactions. Manganese (Mn) concentration in all the groundwater samples collected was 0.000mg/L. Even though there are no records of excess manganese health risk recorded in humans, it is good that the parameter conforms to regulatory standards

- ***Chromium (Cr)***

Chromium (Cr) exists naturally as element in rocks, soil, plants, animals and volcano emissions. Cr concentration in the analysed samples was 0.000 at GW1, 4, 5 and 6 and 1.175 at GW2. The average Cr concentration in the ground water samples was 0.437mg/L which is higher than NSDWQ permissible limits (1.00mg/L). Natural deposits of erosion or weathering of the alluvium sands and coatings removal from water pipes could have been the major causatives of Cr presence in the groundwater samples.

Microbial analysis of Groundwater

The TBC in the collected samples ranged from 1.26 x10^4 cfu/ml in GW1 to 2.62x10^4 cfu/ml IN GW3. Detection of TBC in all the samples collected were above the NSDWQ permissible regulatory limit (0 cfu/ml). For THF, the concentration was not detected (ND) in most of the samples except for 1.0x10^0 in GW4. The concentration at GW4 is above the permissible limit.

Total coliform (TC) was not detected in GW 1, and GW4 while the recorded values in GW2, GW3 GW5 and GW6 were above the permissible limit (10 cfu/ml). the presence of these microorganisms shows contaminations of feacel material which can percolate to the groundwater table. Meanwhile, Feacal coliform was not detected in all the samples.

4.5 Land Use/Land Cover

Birnin-Kebbi Local Government Area in Kebbi State is predominantly characterized by extensive arable rural land covers, reflecting its strong agro-pastoral setting within the Sudan–Sahel savannah ecological zone. The most dominant land use class is rangeland, which occupies approximately 1,043.3 km², representing about 83.6% of the total assessed land area (approximately 1,248.4 km²). This extensive coverage indicates a landscape largely composed of grasses, shrubs, and sparse tree vegetation typical of semi-arid northern Nigeria, supporting grazing and pastoral activities.

Agricultural land (crops) constitutes the second most significant land use category, covering approximately 114 km² (about 9.1% of the total land area). This highlights the importance of farming activities within the LGA, particularly rain-fed agriculture. Built-up areas account for 68.7 km², representing roughly 5.5% of the land area, indicating moderate settlement concentration compared to highly urbanized LGAs. The presence of built-up land reflects Birnin-Kebbi's role as a key administrative and commercial center in Kebbi State.

Other land cover types occur at relatively minor proportions. Trees and forested areas cover about 11.1 km² (approximately 0.9%), suggesting limited dense woody vegetation. Water bodies, including rivers and associated surface water features, occupy 5.6 km² (about 0.45%), while

Flooded Vegetation accounts for 4.6 km² (approximately 0.37%), indicating localized wetland or seasonally inundated areas. Bare Ground covers approximately 1.1 km² (about 0.09%), representing minimal exposed or degraded surfaces within the mapped extent.

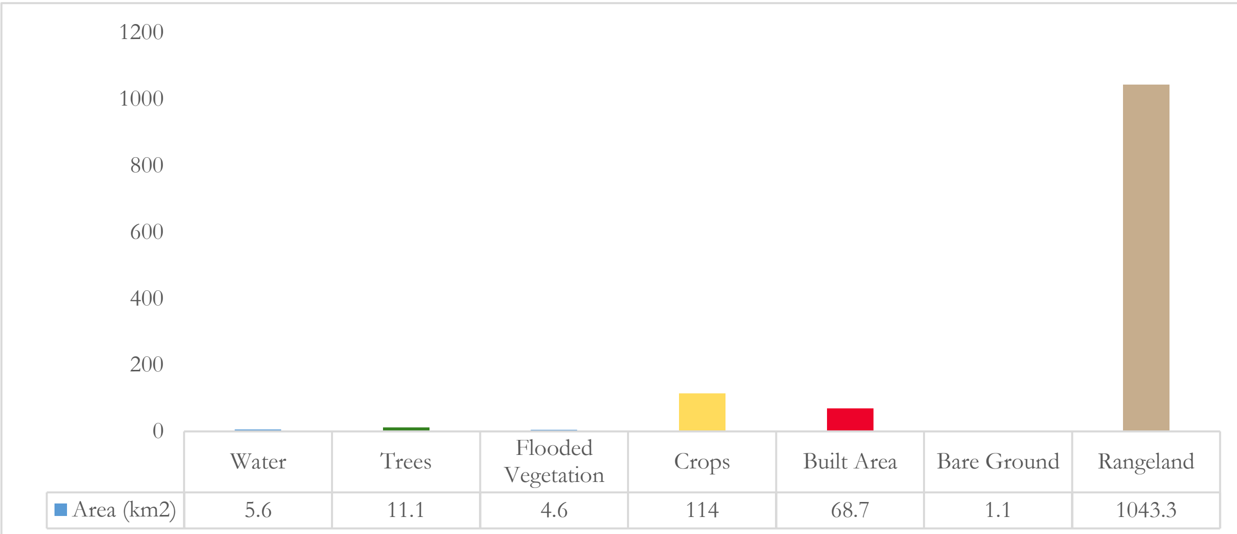

Figure 4.12: Land Use Land Cover graph of Birnin-Kebbi, Kebbi State.

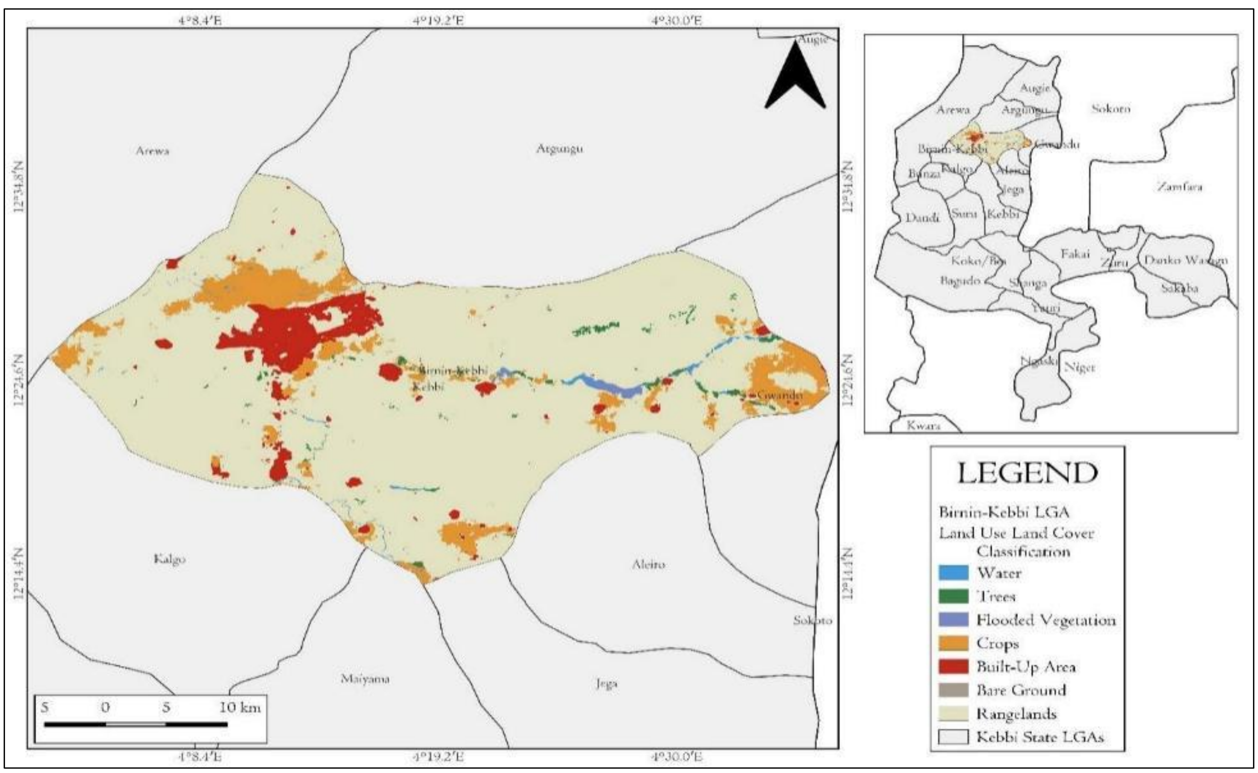

Figure 4.13: Land Use Land Cover map of Birnin-Kebbi, Kebbi State.

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Ecological Study of the Project Area of Influence

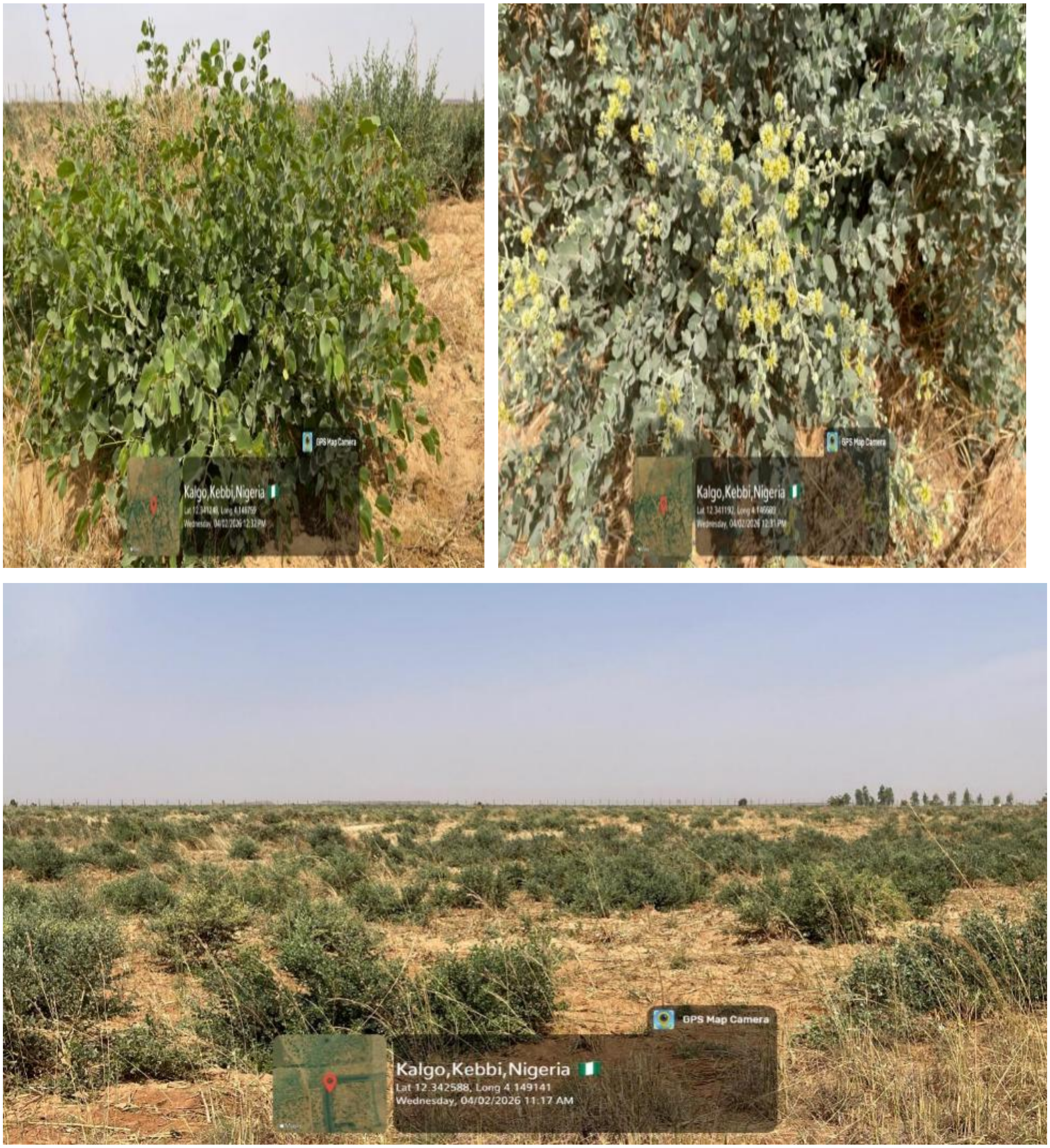

Plate 4.1: An Image Of The Project site

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

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Rodent Borrowing

Grasshopper Sited

Camel sited carrying Farm Produce.

Plate 4.2: Some of the fauna species observed in the study area.

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

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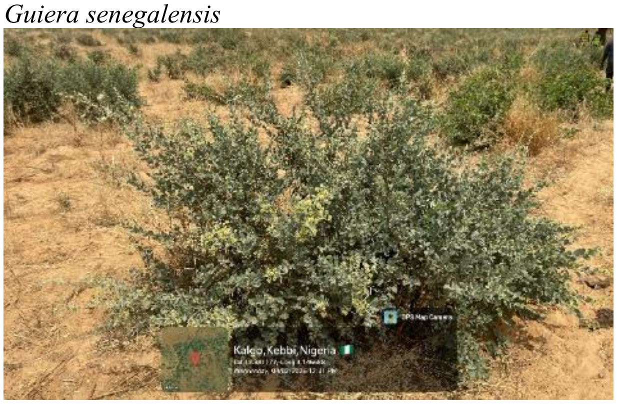
Guiera senegalensis

Guiera senegalensis flower



Senegalia mellifera plant

Senegalia mellifera flower

Piliostigma reticulatum plant

Neem Tree

Plate 4.3: Some of the floral species observed in the study area.
Source: BOLBEN LTD Fieldwork:EIA of the proposed 1-MW Solar PV facility at FUBK by REA, 2026.

4.6 Ecological Description of the Project Site

The ecology of Kebbi State is characterized as a Sudan-Savannah with a hot, semi-arid climate (600–1200 mm annual rainfall) with a long, intense dry season and a short rainy season. Vegetation consists of short, drought-resistant trees (e.g., Acacia, Baobab), shrubs such as Senegal guiera, Black Thorn and scattered grasses for animal grazing. Domesticated animals such as camels, goats and cattle dominate the flat open rangelands. As part of the project site visit activities, a biodiversity survey was undertaken at the project site and surrounding AoI, to provide information on the baseline biodiversity resources including aspects such as floristic and faunal composition, status of habitat as well as economic plants including any crop of medicinal value at the project area.

Flora Sampling

Vegetation is one of the most vital natural resources, providing food, fuelwood, and maintaining soil fertility—making it indispensable for human development. It underpins life for all organisms, as every living being depends on it directly or indirectly. Plants supply essentials such as food, timber, fuel, and shade, which highlights the importance of protecting and managing vegetation to ensure environmental sustainability and continued human progress.

Flora Composition

The flora distribution at the project site within the Federal University, Birnin-Kebbi, Kebbi state is described as a homogenous distribution of drought-resistant shrubs and grasses during the dry season and distributed to farmers to plant cereal grains during the rainy season. Plants such as *Guiera senegalensis, Senegalia mellifera* and *Senna obtusifolia.* Trees species such as Neem Tree, Doum Palm Tree and Baobab Tree are also sparsely distributed within the project area.

Fauna

A comprehensive wildlife assessment was conducted across the proposed project area of influence, with the primary objective of documenting the faunal diversity, distribution, and conservation status prior to project development. Field investigations were carried out between 07:00 and 16:00 hours using a combination of direct and indirect survey techniques aligned with standard ecological methodologies (Moshby 1974; Sutherland 1997).

The project site and its nearest community, Ugwan Jeji, have been subjected to prolonged anthropogenic activities, resulting in significant habitat disturbance. Consequently, native wildlife species have largely migrated to areas less impacted by human interference. The site is predominantly utilized for livestock grazing, indicating a modified terrestrial ecosystem. Evidence of limited faunal presence was observed, including termite activity and rodent burrows, suggesting adaptation of small fauna to the altered environment.

Transects were strategically established across major vegetation types. In each transect, radial searches were conducted along the cardinal axes to increase sighting probability. Evidence such as footprints, droppings, nests, feeding remains, and animal calls were documented and used to confirm species presence. The Conservation Status of all the species and sub-species recorded in the area were evaluated using the using the International Union for Conservation of Nature (IUCN) Red List of Threatened Species and assessed in accordance with the Guidelines for Using the IUCN Red List Categories and Criteria, Version 16 (March 2024). These guidelines provide the current global standard for assessing species' extinction risk. The Fauna species composition observed within and around the Project area is presented in Table 4.9.

Table 4.9: Name, Description and Economic Importances of Flora Resources Found at the Project Site

S/N	Scientific Name	Common Name	Local Name	Description	Economic Importance	IUCN Status
1	*Guiera senegalensis*	Senegal Guiera	Sabara	A hardy, multi-stemmed shrub (1–5m high). It features distinct gray-green leaves, small, fragrant yellowish flowers, and is recognized for its medicinal, agricultural (fencing/forage), and ecological roles, often forming dense thickets in degraded lands.	Used for treating fever, diarrhea, rheumatism, and respiratory issues. It is used as a "cure all" remedy.	**Least Concern**
2	*Senegalia mellifera*	Black Thorn	Sarkakiya	A dense, thorny shrub or small tree/shrub. It typically grows 2–9 meters tall and forms compact thickets due to its numerous branches and hooked or straight thorns. The leaves are small and bipinnate (finely divided), giving the plant a feathery appearance, while the flowers are small, cream to pale yellow, and arranged in rounded clusters.	Human Use: The wood is hard, termite-resistant, and used for fence posts and fuel. It is used for live, impenetrable fencing. Medicinal: Bark is used in traditional medicine to treat pneumonia, malaria, and stomach issues.	**Least Concern**
3	*Piliostigma reticulatum*	Camel's Foot plant	Kargo	A drought-resistant, deciduous shrub or small tree, 5–10 m tall. It has a short, crooked bole, deeply fissured	It boosts rural livelihoods by improving soil fertility, producing fodder for livestock, and	**Not Threatened**

S/N	Scientific Name	Common Name	Local Name	Description	Economic Importance	IUCN Status
				grey-brown bark, and grey-green, leathery bilobed leaves.	offering materials for traditional medicine, dyes, and food.	
4	*Azadirachta indica*	Neem Tree	Dogoyaro	A fast-growing, evergreen tree in the mahogany family, reaching heights of 15 to 30 meters with a wide, rounded crown. It is known for its drought resistance, dark, deeply fissured bark, and pinnate leaves with toothed, bright green leaflets.	It is regarded as a very medicinal plant. Used in traditional medicine to treat infections, malaria and diabetes among other illnesses.	**Least Concern**
5	*Hyphaene thebaica*	Doum Palm Tree/ Gingerbread Tree	Goruba	A drought-resistant tree famous for its dichotomous branching trunk. It produces large, gingerbread-flavored fruit and leathery, fan-shaped leaves.	The leaves are extensively woven into durable baskets, mats, hats, and ropes, which are sold in local and regional markets.	**Least Concern**
6	*Adansonia digitata*	Baobab Tree	Kuka	Baobab trees are large, robust trees that originate from Africa and are found in arid to semi-arid areas. The trees typically grow up to 20-30 meters (m) tall with a diameter of 2-10 m.		

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

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Table 4.10: Fauna species composition within and around the Project area

S/N	*Scientific Name*	*Family*	*Common Name*	*Local Name*	*Description*	*Economic Importance*	*IUCN Status*
1	*Macrotermes bellicosus*	Termitidae	Termites	Tururuwa	Social insects living in organized colonies underground or near trees, stumps, or wood piles. Each colony has a king and queen (brown), soldiers with large mandibles, and thousands of workers performing various roles.	Although considered pests, they recycle nutrients back into the soil, enhancing soil fertility and supporting ecosystem health.	Not Evaluated (NE)
2	*Capra hircus*	Bovidae	West African Dwarf Goat	Akuya	Small, hardy dwarf types in the west and larger, muscular meat breeds in the south, such as the Boer. They are generally characterized by high disease resistance, adaptability to arid environments, and varied colors.	Used for meat production	Not Evaluated (NE)
3	*Camelus dromedarius*	Camelidae	Camel	Raƙumi	Camels are large, hardy, herbivorous mammals (genus *Camelus*) known as "ships of the desert" for their ability to survive harsh, arid climates in Africa and Asia. They are characterized by long legs, a long neck, two toes per foot, and one (dromedary) or two (Bactrian) humps of fat, not water.	Used as a means of transportation for people and farm produce	Not Evaluated (NE)
4	*Schistocerca americana*	Acrididae	American Bird Grasshopper	Fara	Grasshoppers are typically ground-dwelling insects with powerful hind legs which allow them to escape from threats by leaping or flying. Their front legs are shorter and used for grasping food.	They are capable of causing severe agricultural damages to the foliage of agricultural crops.	Not Evaluated (NE)

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

4.7 Socio-economic and Health Conditions of the Study Area

This sub-section presents the baseline socio-economic characteristics of the Federal University Birnin-Kebbi (FUBK) Permanent Site, located along Kalgo Road, Kalgo, Birnin Kebbi, Kebbi State, Nigeria, based on the results of the field survey conducted at the campus and its environs.
Understanding the socio-economic profile of the area provides critical insight into existing livelihood activities, which can inform employment opportunities and social interventions during both the construction and operational phases of development projects. This assessment also

identifies social and economic activities that may be affected by project implementation, specifically the proposed Solar Project under Phase II (Desert-to-Power) of the Energizing Education Program (EEP), initiated by the Federal Government of Nigeria (FGN) through the Rural Electrification Agency (REA), with financial support from the African Development Bank (AfDB).

The baseline socio-economic information serves as a reference point for evaluating the project's impacts on the University community throughout its life cycle. Key themes addressed in the study include population characteristics, socio-cultural organization, ongoing development initiatives, university structure, existing campus facilities, employment patterns, income distribution and stakeholder perspectives regarding the project. Additionally, the study incorporates an analysis of gender-related issues, encompassing gender-specific activities and gender-based violence within the university community.

4.7.1 Study Approach and Methodology

The study was conducted within the Federal University Birnin-Kebbi (FUBK) permanent site and Ungwan Jeji, located along Maidahini-Dangoma-Kalgo Junction Road, Kalgo Local Government Area, Kebbi State, Nigeria. Opposite the university campus (approximate coordinates: 12.3278° N, 4.1584° E), a rural village in the Kalgo district of Kebbi State, in north-western Nigeria, adjacent to settlements such as Ungwan Ardua and Takatsaba.

Although all project components for the 1-Megawatt (MW) Solar Photovoltaic (PV) Power Plant under the Nigeria Electrification Project Phase II (Desert-to-Power) are located entirely within the permanent site of the Federal University Birnin-Kebbi (FUBK), stakeholder consultations and questionnaire administration were extended to the Ungwan Jeji community, which is directly opposite and in proximity to the project site. The inclusion of Ungwan Jeji was considered necessary due to the community's immediate adjacency to the university, which presents potential indirect environmental and social interactions during the construction and operational phases of the project. These interactions may include temporary disturbances such as increased traffic movement, noise, dust generation, labour influx and community–project interface issues.

Accordingly, engagement with Ungwan Jeji residents was undertaken to capture community perceptions, identify potential concerns and ensure that indirect impacts if any are adequately anticipated and managed. This approach is consistent with the precautionary principle, stakeholder inclusiveness and the consultation requirements of the African Development Bank Environmental and Social Safeguards, as well as national ESIA guidelines. It is emphasized that the socio-economic baseline assessment remained focused on the university population, while Ungwan Jeji was included primarily for stakeholder consultation and impact perception assessment rather than as a full host community baseline.

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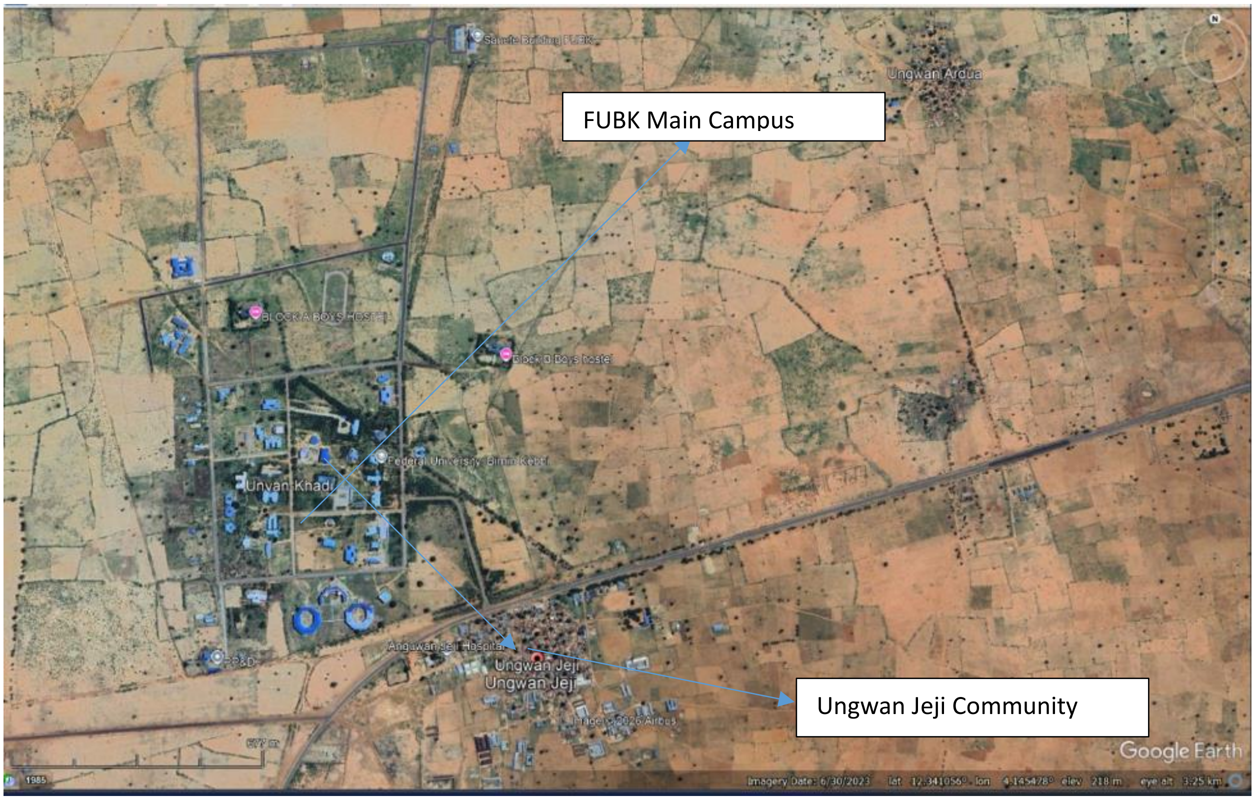

Figures 4.16: Aerial map highlighting FUBK and Ungwan Jeji Community in the study area.
Source: BOLBEN LTD Fieldwork: EIA of the proposed 1-MW Solar PV facility at FUBK By REA, 2026.

4.7.1.1 Study Design

The study employed a sequential mixed methods research design including quantitative and qualitative methods of data gathering, analysis and reporting. Information collected during the study was triangulated to separate perception from reality. The study was carried out on 4th to 5th February, 2026. The study made use of a questionnaire for quantitative data gathering and Key informant interviews, Focus Group Discussions (FGD) and stakeholders' consultation for the qualitative data.

4.7.1.2 Study Population

The study population comprised staff of the Federal University Birnin-Kebbi (FUBK), members of the student community and residents of the Ungwan Jeji community. Participation in the study was voluntary and only individuals who provided informed consent were included in the assessment.

4.7.1.3 Target Population for the Study

The target population and stakeholders for this study include staff of the Federal University Birnin-Kebbi (FUBK), members of the student community and adult residents (18 years and above) of the Ungwan Jeji community. The stakeholder groups further encompass community leaders, healthcare practitioners, youths and women within the study area.

4.7.1.4 Sample Size and Sampling Techniques

The study population comprises members of the Federal University Birnin-Kebbi (FUBK) community, including staff and students, as well as selected residents of the adjacent Ungwan Jeji community, for stakeholder consultation. Given the site-specific nature of the proposed solar power project and the relatively small population within the project area of influence, a statistically representative sample size was determined using the Cochran (1977) formula, expressed as:

$$n = \frac{Z^2 pq}{e^2}$$

Where:

- n = required sample size
- Z = standard normal deviate at 95% confidence level (1.96)
- p = estimated population proportion (0.29)
- $q = 1 - p$ (0.71)
- e = margin of error (0.10)

Substituting the values into the formula:

$$n = \frac{(1.96)^2 \ x \ 0.29 \ x \ 0.71}{(0.10)^2}$$

≈ **79** respondents

To account for non-response, incomplete questionnaires and field contingencies, a 10% allowance was added to the calculated sample size:

$$79+(0.10 \ X \ 79)=86.9 \approx 87$$

To enhance representativeness and account for potential non-response, field constraints and subgroup coverage (staff, students and adjacent community stakeholders), the calculated sample size was conservatively increased. Consequently, a final sample size of 120 respondents was adopted for the study. A systematic sampling technique was employed to ensure equitable representation of respondents across gender and stakeholder categories. This sample size was considered adequate to support reliable baseline socio-economic characterization and stakeholder perception analysis for the proposed project.

4.7.1.4 Data Collection, Analysis and Reporting

Qualitative data were collected through Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). A total of three (3) FGDs were conducted, comprising two male groups (adult men and youths) and one female group. Each FGD consisted of between 6 and 15 participants, in line with standard qualitative research practice. The FGDs were designed to ensure inclusive participation, with representation from diverse respondent categories, including youths and adults, males and females, persons living with disabilities, as well as both educated and non-educated participants. In addition, Key Informant Interviews were conducted with the local traditional leadership (community leaders), while an in-depth interview was held with a healthcare practitioner who has resided and practiced in the community for over ten (10) years, providing valuable insight into long-term community health and social dynamics. To ensure appropriate handling of gender-related issues, a gender specialist facilitated the women's focus group discussions and provided expert input into the assessment of gender dynamics and related concerns within the community.

Quantitative data for this study were collected using structured hardcopy (paper-based) questionnaires, administered through face-to-face interviews by trained and competent enumerators. This traditional data collection approach was adopted to ensure effective engagement with respondents, particularly in areas with limited access to digital infrastructure. Quantitative data obtained from the hardcopy questionnaires were coded and entered into Statistical Package for the Social Sciences (SPSS) Version 27 and Microsoft Excel 2024 for data processing and analysis. Descriptive statistical techniques were employed to summarize the data, while graphical and tabular presentations were used to support the interpretation and reporting of the findings.

4.7.1.5 Ethical Considerations

All interviews were conducted with the prior informed consent of participants. Confidentiality and anonymity were strictly maintained through secure storage of all data in password-protected computers and locked physical files. Participation in the study was entirely voluntary and respondents were informed of their right to withdraw from the study at any stage without any consequence or discomfort.

4.7.2 Background of the Federal University Birnin-Kebbi (FUBK)

The Federal University Birnin-Kebbi (FUBK) is located in Birnin Kebbi, the capital of Kebbi State, Nigeria. The University was established by the Federal Government of Nigeria in 2013 as part of the federal government's initiative to expand access to higher education and promote human capital development, particularly in the north-western region of the country. Academic activities commenced shortly thereafter.

FUBK operates from its Permanent Site along Kalgo Road, Birnin Kebbi, which serves as the main campus and houses the central administration, academic faculties, lecture halls, laboratories, staff offices, student facilities and other essential infrastructure. The University has continued to expand in terms of physical development, academic programmes, staff strength and student enrolment since its establishment. The University comprises 7 faculties and 37 undergraduate programmes, including faculties in the natural sciences, social sciences, humanities, management sciences, agriculture, alongside 16 postgraduate programmes and other specialized programmes. These faculties support the University's mandate of teaching, research and community service. With a growing population of academic and non-academic staff as well as students as displayed in Figure 4.14, the Federal University Birnin-Kebbi plays a significant role in the socio-economic development of Birnin Kebbi and its surrounding communities. The institution is accessible by road and is strategically positioned to serve as an educational and research hub within Kebbi State and the wider north-western region of Nigeria.

Figure 4.14: A Snapshot of the University's Growth
Source: FUBK Portal

4.7.3 University Community Administrative Structure

The administrative leadership structure of the Federal University Birnin-Kebbi (FUBK) is presented in Figure 4.15. Administratively, the University is headed by the Vice-Chancellor (VC), who serves as the Chief Executive and is responsible for the day-to-day management and overall administration of the institution. The Vice-Chancellor is supported by other principal officers in the administration of university affairs. These principal officers include the Deputy Vice-Chancellors (DVC), the Registrar, the Bursar and the University Librarian, who collectively oversee academic administration, financial management, registry services and library operations, respectively.

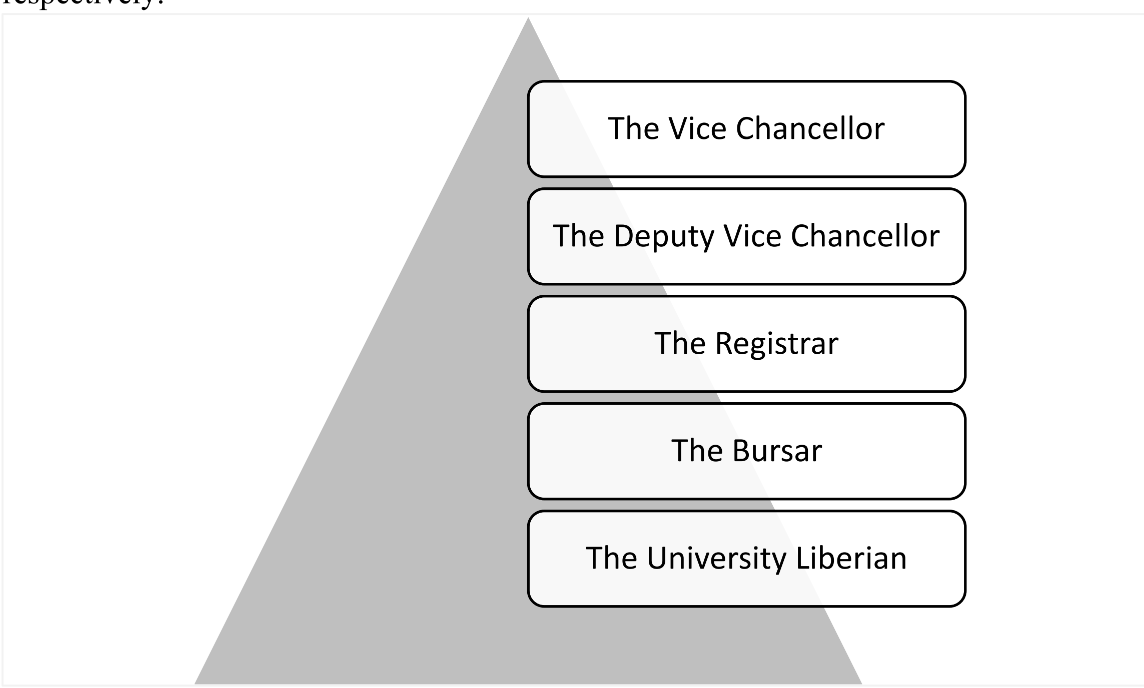

Figure 4.15: Administrative Structure of FUBK
Source: BOLBEN LTD Fieldwork:EIA of the proposed 1-MW Solar PV facility at FUBK By REA, 2026.

4.7.4 Governing Council

The Governing Council is the highest decision-making body of the Federal University Birnin-Kebbi (FUBK). The Council is chaired by a Chairman/Pro-Chancellor, who is appointed by the Federal Government of Nigeria through the Federal Ministry of Education. Membership of the Governing Council comprises the Vice-Chancellor, Deputy Vice-Chancellors, representatives of the University Senate, external members and a representative of the Federal Ministry of Education, among others, in accordance with applicable university statutes. The Governing Council is responsible for taking critical policy and administrative decisions affecting the University, including approvals relating to major infrastructure developments, such as the siting of the proposed solar power project, as well as the appointment and recruitment of principal officers. Membership of the Council is tenure-based, in line with federal university governance regulations.

4.7.5 Land Tenure and Ownership

Land tenure refers to the systems and arrangements through which land is acquired, held, used and transferred. In Nigeria, land rights and administration are governed by the Land Use Act of 1978, which vests all land within the territorial boundaries of a State in the Governor, to be held in trust for the use and benefit of the people for socio-economic development. In practice, land may be held by individuals, communities, or institutions through recognized tenure arrangements.

Land tenure therefore, constitutes the legal regime under which land is possessed or occupied. The principal modes of land acquisition in Nigeria include inheritance, purchase, lease, pledge, exchange and gift, through which land rights may be lawfully exercised. Findings from the field survey and data-gathering activities indicate that the land proposed for the project is located entirely within the Permanent Site of the Federal University Birnin-Kebbi (FUBK). The land forming the University's permanent site was acquired by the Government and allocated for institutional use and is legally held by the University. Consequently, the proposed project site falls within land already designated for university purposes and no additional land acquisition, displacement, or resettlement is anticipated as a result of project implementation.

4.7.6 Sampled Population/FUBK Socioeconomic Characteristics

This assessment examines the economic and human dimensions of the host institution, with particular emphasis on sources of power and other relevant socioeconomic variables. The parameters considered include gender and age distribution, marital status, ethnic affiliation, religion, literacy level, occupation, household size, residential status and duration of stay within the project area, income level and general health status.

These key socioeconomic characteristics provide valuable insight into the structure and dynamics of the university community and are essential for effective stakeholder engagement. The information will support the project proponent and facility operators in designing appropriate communication, employment and participation strategies during both the construction and operational phases of the proposed project. In addition, the findings will assist the beneficiary school authority in informed decision-making, planning and management related to the proposed development.

4.7.6.1 Respondents' Socio-Economic Characteristics:

Table 4.11: Socioeconomic/Demographic Profiling

Gender			Findings
Options	Frequency	Percent	The respondents were predominantly female, with 75% (90) females and 25% (30) males. This high female participation ensures that women's perspectives on electricity access, safety and project impacts are well represented, supporting gender-responsive planning in both the construction and operational phases.
Male	30	25	
Female	90	75	
Total	**120**	**100**	
Age of Respondents			The majority of respondents (70.8%) were between 18–30 years, while 29.2% were aged 31–45 years. This indicates a relatively young population, likely reflecting the university student body and younger staff in the surrounding community. The youthful demographic suggests a high potential for adaptation to new technologies, such as the proposed solar system.
Options	Frequency	Percent	
18-30years	85	70.8	
31-45 years	35	29.2	
Total	**120**	**100**	
Marital Status			
Options	Frequency	Percent	Most respondents were married (58.3%), followed by single (37.5%) and a small proportion widowed (4.2%).
Married	70	58.3	
Single	45	37.5	
Widowed	5	4.2	
Total	**120**	**100**	
Family Pattern			
Options	Frequency	Percent	Respondents reported diverse family arrangements, with 50% living in nuclear families, 45.8% in joint or extended households and 4.2% living individually. This distribution reflects varied household structures, which may influence the benefits derived from the proposed project.
Joint/Extended	55	45.8	
Nuclear	60	50	
Individual	5	4.2	
Total	**120**	**100**	
House size			
Options	Frequency	Percent	A majority of households (62.5%) were large, with more than nine members, while 37.5% were medium-sized (5–8 members). The predominance of large households highlights the potential for the solar project to positively impact multiple beneficiaries within each household.
Large (Above 9)	75	62.5	
Medium (5-8)	45	37.5	
Total	**120**	**100**	

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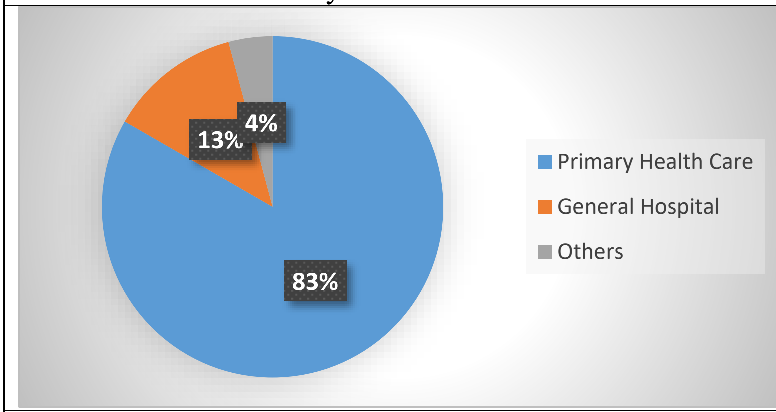
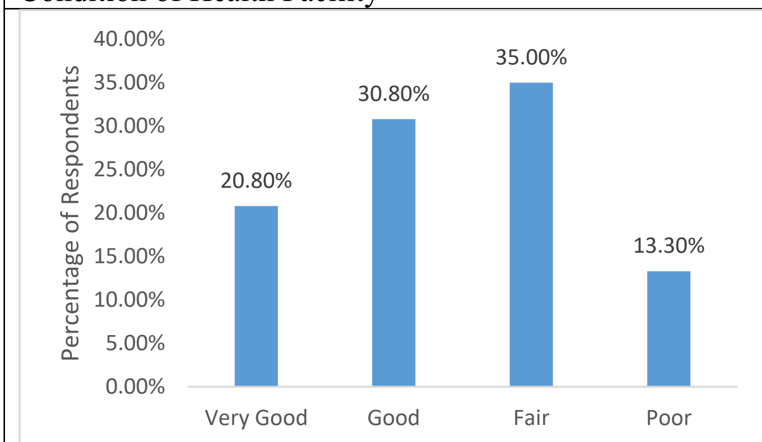
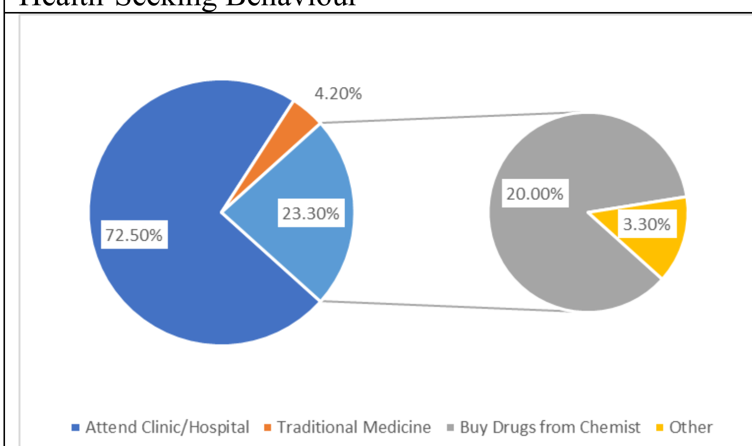
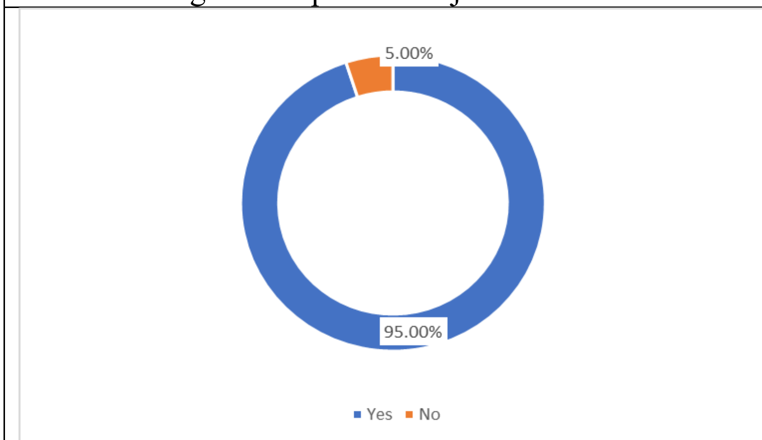
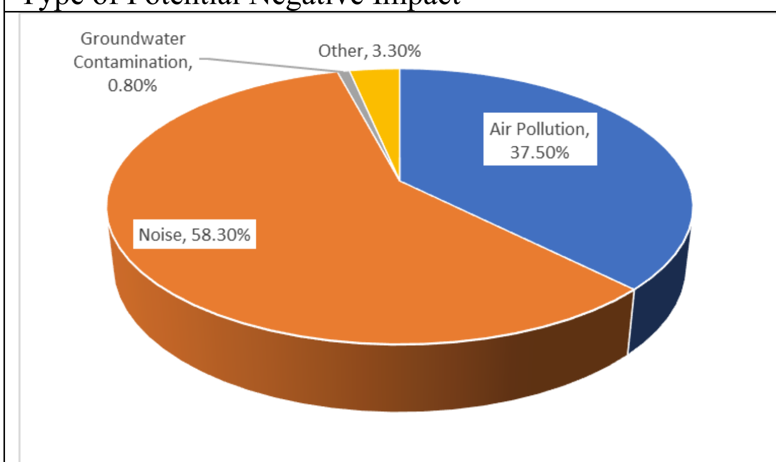
Gender			Findings
Religion			
Options	Frequency	Percent	Religious affiliation among respondents included Islam (54.2%), Christianity (37.5%) and Traditional beliefs (8.3%). Awareness of religious diversity is important for culturally sensitive engagement and community mobilization during project implementation.
Christianity	45	37.5	
Isam	65	54.2	
Traditional	10	8.3	
Total	**120**	**100**	
Education			
Options	Frequency	Percent	Most respondents (91.7%) had at least primary education, while 8.3% had informal education. This high literacy level facilitates effective communication about project objectives, benefits and safety measures.
Informal Education	10	8.3	
Primary	110	91.7	
Total	**120**	**100**	
Occupation			
Options	Frequency	Percent	Respondents' occupations were varied, with the largest group categorized as "Others" (42.5%), followed by students (15.8%), traders (15%), civil servants (14.2%) and farmers (12.5%). This diversity reflects a mix of formal and informal economic activities within the university and surrounding community, which may influence electricity usage patterns and engagement strategies.
Farming	15	12.5	
Trading	18	15	
Student	19	15.8	
Civil Servant	17	14.2	
Others	51	42.5	
Total	**120**	**100**	
Monthly Income			
Options	Frequency	Percent	Monthly income distribution showed that most respondents earned between ₦60,000 and ₦120,000 (84.2%), while only a small fraction earned below ₦30,000 or above ₦120,000.
#0 to #30,000	5	4.2	
#31,000 to #60,000	10	8.3	
#60,000 to #90,000	50	41.7	
#91,000 to #120,000	51	42.5	
#120,000 +	4	3.3	
Total	**120**	**100**	
Duration of stay in the Community/institution			Half of the respondents (50%) had resided in the community or institution for 20 years or more, while 41.7% had stayed 1–5 years. This indicates a mix of long-term residents and newer arrivals, which may affect community engagement approaches and local knowledge about electricity needs.
Options	Frequency	Percent	
1-5yrs	50	41.7	
6-10yrs	5	4.2	
11-19yrs	5	4.2	
20 and above	60	50	
Total	**120**	**100**	
Types of language spoken in the community			

Gender			**Findings**
Options	Frequency	Percent	The community is linguistically diverse, with Zarma/Dendi (50%), Reshe/C'ishingini (16.7%), Hausa (15.8%), Clela/Fulfulde (15%) and small numbers speaking English or other languages. Effective communication for the solar project will need to consider this diversity to ensure all groups are reached.
Hausa	19	15.8	
Zarma/Dendi	60	50	
Clela/Fulfulde	18	15	
Reshe/C'ishingini	20	16.7	
English	2	1.7	
Other	1	0.8	
Total	**120**	**100**	

4.7.6.2 Health Status

<table>
<tr><th>Category</th><th>Frequency</th><th>Percent</th><th>Key Observations</th></tr>
<tr><td colspan="4">Available Health Facility</td></tr>
<tr><td colspan="3"></td><td>Most respondents access primary healthcare, indicating basic health service availability. Limited alternative facilities are available in the community/university.</td></tr>
<tr><td colspan="4">Condition of Health Facility</td></tr>
<tr><td colspan="3"></td><td>The majority of facilities were rated from fair to good; only 13.3% rated poor.</td></tr>
<tr><td colspan="4">Health-Seeking Behaviour</td></tr>
<tr><td colspan="3"></td><td>Majority of respondents seek medical care at clinics/hospitals when they are ill.
A smaller proportion buys drugs from chemists for self-treatment, while only a very small number rely on traditional medicine. This indicates a strong preference for formal healthcare services, with self-medication being more common than the use of traditional remedies.</td></tr>
<tr><td colspan="4">Common Community Diseases</td></tr>
<tr><td>Malaria</td><td>120</td><td>25.1%</td><td rowspan="3">Malaria is the most prevalent condition reported.</td></tr>
<tr><td>Typhoid Fever</td><td>99</td><td>20.7%</td></tr>
<tr><td>Cholera</td><td>20</td><td>4.2%</td></tr>
</table>

<table>
<tr><th>Category</th><th>Frequency</th><th>Percent</th><th>Key Observations</th></tr>
<tr><td>Rheumatism</td><td>10</td><td>2.1%</td><td rowspan="7">Total responses >120 due to multiple conditions per respondent.</td></tr>
<tr><td>Tuberculosis</td><td>15</td><td>3.1%</td></tr>
<tr><td>Hypertension</td><td>80</td><td>16.7%</td></tr>
<tr><td>Asthma</td><td>35</td><td>7.3%</td></tr>
<tr><td>Meningitis</td><td>65</td><td>13.6%</td></tr>
<tr><td>Rashes</td><td>25</td><td>5.2%</td></tr>
<tr><td>Others</td><td>10</td><td>2.1%</td></tr>
<tr><td colspan="4">Perceived Negative Impact of Project</td></tr>
<tr><td colspan="3">
</td><td>Almost all respondents expect some potential negative impact.</td></tr>
<tr><td colspan="4">Type of Potential Negative Impact</td></tr>
<tr><td colspan="3">
</td><td>Concerns mainly about dust and emissions during construction. Construction noise was identified as the most likely impact. Minimal concern for water contamination.</td></tr>
</table>

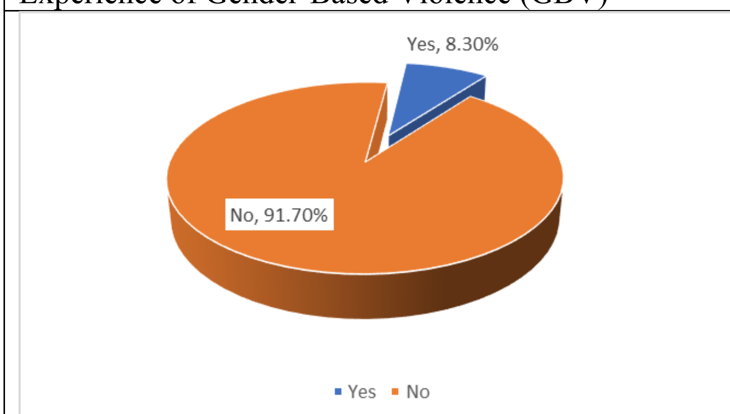
4.7.6.3 Gender-Based Violence and Gender Equality Indicators

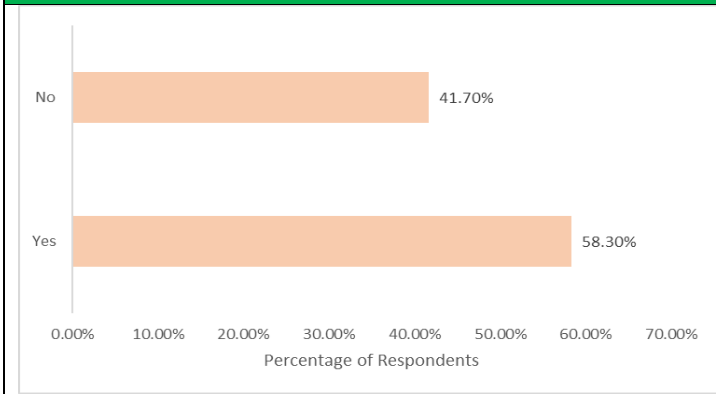
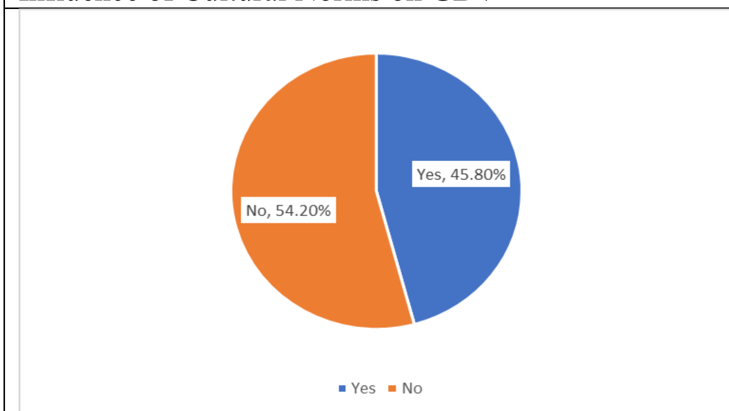
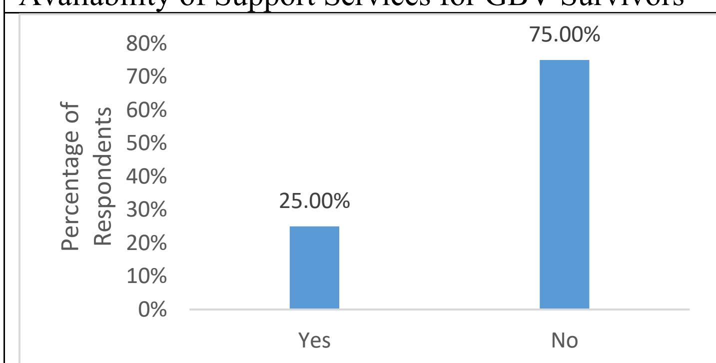
The socioeconomic survey included questions relating to gender equality and experience of gender-based violence. A small proportion of respondents indicated experience of GBV; however, the survey did not collect sufficiently detailed or safely disclosed information to classify the reported incidents by type. The results should therefore not be interpreted as a definitive measure of GBV prevalence or the specific forms of GBV occurring within the University or neighbouring community.

Project-relevant risks may include sexual harassment in the workplace, sexual exploitation and abuse, discrimination, intimidation and other misconduct associated with worker–community or worker–student interaction. These risks will be managed through codes of conduct, worker induction, confidential reporting channels, sanctions, awareness activities and survivor-centred referral procedures.

Potential external referral platforms identified for verification include the Kebbi State Ministry of Women Affairs and Social Development and the Mai Talle Tara Sexual Assault Referral Centre at Kebbi Medical Centre, Kalgo. Before mobilisation, REA-PMU shall verify the current functionality, contact details, operating hours and services of these and other qualified medical, psychosocial, protection and legal-support providers and prepare a confidential referral directory.

GBV/SEA/SH complaints shall not be investigated by the ordinary Grievance Redress Committee. Information shall be recorded only with the survivor's informed consent, confidentiality shall be maintained and referrals shall follow a survivor-centred approach.

	Key Observations
Experience of Gender-Based Violence (GBV)	
	The majority of respondents reported that they have never experienced any form of gender-based violence (GBV), while a minority indicated that they had previously experienced GBV, although the specific forms were not identified during the survey.
Perception of Equal Economic Opportunities	

	Key Observations
	Over half believe men and women have equal access to economic opportunities, suggesting moderate gender inclusivity. A significant minority perceive inequality, indicating potential barriers for women in employment or income-generating activities.
Influence of Cultural Norms on GBV	
	Nearly half of the respondents believe cultural norms affect GBV prevalence, highlighting social and behavioural factors that could influence gender dynamics. The slight majority do not attribute GBV to cultural norms.
Availability of Support Services for GBV Survivors	
	Only a quarter of respondents reported adequate support services, indicating a critical gap in GBV response mechanisms.
	The majority of respondents perceive insufficient GBV support services in the community or institution.

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4.7.6.4 Community/Institutional Utilities and Services Profile

			Key Observations
Source of Water Supply			
Well	15	12.5%	Water supply within the community and the University is predominantly sourced from boreholes, which serve as the primary and most reliable water source. Wells play a minor supplementary role, reflecting limited reliance on shallow groundwater sources for domestic and institutional water needs.
Borehole	105	87.5%	
Condition of Potable Water			
Very Good	10	8.3%	Only a small proportion of respondents rated the quality of potable water as very good, while the majority perceived it to be fair, indicating the need for improvements in water quality management and treatment. Very few respondents reported poor water quality, suggesting that although water is generally usable, its overall quality remains sub-optimal.
Good	45	37.5%	
Fair	60	50%	
Poor	5	4.2%	
Available Source of Electricity			
KAEDCO (*Kaduna Electric Distribution Company)*	104	36.6%	Public grid electricity is available but limited in reliability, leading to reliance on backup generators. A significant proportion of respondents continue to depend on candles as a primary source of lighting, reflecting persistent challenges with electricity supply. Adoption of solar energy remains minimal, while a small proportion of respondents utilize alternative or informal energy sources to meet their basic energy needs.
Generator	25	8.8%	
Candle	120	42.3%	
Solar Power	5	1.8%	
Others	30	10.6%	
Condition of Public Electricity			
Very Good	55	45.8%	Grid supply is functional; the majority rate it as good.
Good	65	54.2%	
Sanitation Facilities			
Water Closet	30	25%	Few households have modern sanitation. The majority rely on pit latrines. A small fraction practices open defecation.
Pit Latrine	85	70.8%	
Open Defecation	5	4.2%	
Cooking Fuel			
Firewood	65	26%	Firewood remains a primary cooking fuel, reflecting continued reliance on traditional biomass energy sources. There is moderate adoption of cleaner fuels, including gas, while the use of kerosene or multi-fuel stoves is also evident. Charcoal is used to a lesser extent and a small proportion of households rely on other improvised or mixed fuel sources, highlighting energy insecurity and limited access to clean cooking options.
Gas Cooker	45	18%	
Stove	75	30%	
Charcoal	25	10%	
Others	40	16%	
Educational Institutions			
Primary School	120	88.9%	

			Key Observations
Secondary School	10	7.4%	The baseline assessment indicates a strong presence of primary education facilities within the study area, while access to secondary education is limited. In addition, the presence of informal learning centres was reported, reflecting supplementary educational opportunities alongside formal institutions.
Others	5	3.7%	
Waste Disposal Method			
Bush	25	20.8%	The result indicates that waste disposal practices are predominantly informal, with open dumping and open burning widely practiced within the study area. The majority of households rely on uncontrolled public dumping sites, while a smaller proportion utilize private dumping areas. Organized waste collection services are largely absent, benefiting only a very limited number of households.
Burning	30	25%	
Public Open Dump	45	37.5%	
Private Open Dump	10	8.3%	
Organized Collection	10	8.3%	

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4.7.6.5 Traditional Practices and Cultural Heritage

Category	Frequency	Percent	Key Observations
Traditional Economic Activities Practiced			
Farming	115	53.5%	The baseline assessment indicates that farming is the dominant traditional economic activity, reflecting prevailing subsistence livelihoods within the study area. Handicrafts and other local artisanal practices contribute to the preservation of cultural heritage, while fishing represents a significant activity supporting both livelihoods and cultural identity. Mining activities are minimal and a small proportion of respondents engage in other miscellaneous traditional trades and economic activities.
Traditional Craft Work	40	18.6%	
Fishing	35	16.3%	
Mining	5	2.3%	
Others	20	9.3%	
Observance of Traditional Laws/Spiritual Sites			
Yes	70	58.3%	The majority of respondents observe sacred/traditional laws or places, highlighting the cultural importance of these sites. A minor proportion does not strictly follow traditional practices.
No	50	41.7%	
Perception of Project Impact on Cultural/Archaeological Sites			
Yes	10	8.3%	A small fraction perceives the potential negative impact of the proposed solar project on cultural assets. Most respondents do not anticipate any adverse effects.
No	110	91.7%	
Knowledge of Named Cultural/Valued Resources			
Yes	70	58.3%	More than half are aware of specific cultural or sacred sites, which could guide protective measures.
No	50	41.7%	

4.7.6.6 Community Awareness, Perceived Benefits and Social Associations

Category	Frequency	Percent	Key Observations
Awareness of Proposed Project			
Yes	100	83.3%	The majority of community and institution members are aware of the upcoming solar project, suggesting effective prior engagement or communication. A minority remains unaware, indicating a potential need for additional awareness campaigns.
No	20	16.7%	
Perceived Socio-Economic Benefits of the Project			
Constant Power Supply	115	51.1%	Reliable electricity is viewed as the most important benefit, aligning with project objectives. Provides local employment potential during construction and operation. Expected to stimulate wider economic development in the community and institution. Includes miscellaneous anticipated benefits such as improved infrastructure or social services.
Employment Opportunity	40	17.8%	
Economic Growth	50	22.2%	
Other	20	8.9%	
Membership in Social Associations			

Category	Frequency	Percent	Key Observations
Youth Association	10	4.0%	Low participation in youth groups, though they can be mobilized for engagement. The majority of respondents are involved in women's groups, highlighting potential channels for gender-responsive engagement. Represents significant portion of local agricultural stakeholders. Includes community, religious, or cultural associations, offering additional engagement pathways.
Women Association	95	38.0%	
Farmers Association	75	30.0%	
Other	70	28.0%	

4.7.7 Estimated Traffic Count Results

The traffic survey was conducted over 12 hours, from 6:00 am to 6:00 pm, to capture typical daytime traffic conditions along the project corridor. The surveyed route, Maidahini-Dangoma-Kalgo Junction Road (Figure 4.16), is a single-lane rural collector road, serving local and inter-community movements. Traffic flow along the road is predominantly composed of motorcycles and light vehicles, reflecting the prevailing mode of transportation within the area. Peak traffic conditions were observed during the morning hours (7:00–9:00 am) and the evening hours (4:00–6:00 pm), corresponding to periods of heightened commuting and commercial activities.

Figure 4.16: Maidahini-Dangoma-Kalgo Junction Road

Table 4.12: Estimated Traffic Volume by Vehicle Category

Vehicle Type	Estimated Daily Count	Percentage (%)
Motorcycles	65	35.3
Passenger Cars / Taxis	58	31.5
Mini Buses	12	6.6
Light Trucks / Pickups	35	19.0
Heavy Trucks	14	7.6
Total	**184 vehicles/day**	**100**

As reported in Table 2 Motorcycles and passenger cars constitute the dominant traffic during peak periods, reflecting commuting and local commercial activities.

The estimated traffic volume along the Maidahini–Dangoma–Kalgo Junction Road indicates **low traffic intensity**, characteristic of rural and semi-urban corridors in Kebbi State. Motorcycles account for the highest proportion of road users, highlighting reliance on informal and low-cost transport modes.

During the construction phase of the proposed 1 MW Solar Power Project, temporary increases in traffic, particularly light trucks and construction vehicles, are expected. However, given the existing traffic levels, the road network is considered adequate to accommodate project-related traffic, provided appropriate traffic management measures are implemented. These include speed control, warning signage and scheduling of material delivery outside peak hours.

4.7.8 Consultation Process

4.7.8.1 Institutional Consultation

The Federal Ministry of Environment serves as the primary regulatory authority for the proposed project, while the Kebbi State Ministry of Environment functions as the secondary regulatory authority. Both institutions were duly notified of and appropriately engaged in, the Environmental Impact Assessment (EIA) studies in line with applicable regulatory requirements.

4.7.8.2 Public Involvement

Members of the public, particularly communities and individuals likely to be affected by the proposed project, were accorded the opportunity to participate actively in the consultation process. The preliminary consultation phase was undertaken during initial engagements conducted by representatives of the ESIA consultants on behalf of the project proponent, as well as during reconnaissance visits to the proposed project sites. In addition, a series of pre-entry meetings and Focus Group Discussions (FGDs) were organized and held with relevant stakeholders to obtain baseline information, identify potential concerns and incorporate local perspectives into the ESIA process.

4.7.8.3 Stakeholder Consultation

4.7.8.3 Introduction

Stakeholder engagement is a two-way process of communication between the project proponent, his EIA Consultants and key stakeholders. It is a key aspect of the EIA process, allowing stakeholders to express their views about the project. It involves sharing information and knowledge, seeking to understand the apprehensions 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. The underlying principles for stakeholder engagement are as follows:

- Inclusive of all the relevant groups within the community, including the vulnerable and marginalized;
- Culturally appropriate (i.e., using appropriate materials and local languages where possible, etc.);
- Held in venues that are accessible to all groups, e.g., women, people with disability and other vulnerable groups;
- Free of external manipulation, interference, coercion, or intimidation;
- In-depth exchange of views and information constituting ‘free, prior and informed consent’.

4.7.8.4 Stakeholder Engagement Requirements and Approach

The stakeholders' engagement process followed the requirements of the Nigerian Environmental Impact Assessment Act, CAP E12 LFN 2004. To fulfil the requirements for stakeholder engagement described above, the project developed a plan for engagement with stakeholders through the project life cycle. 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 dissemination, including the community presentation; and
- Identification of where, in the ESIA cycle, certain stakeholders should be contacted and how.

The four stages of the stakeholder consultation plan for the study are as follows:

- Scoping
- ESIA Study.
- ESIA Disclosure; and
- Project Execution (Construction and Operations).

This section specifically relates to stakeholder engagement completed during scoping and the ESIA study.

4.7.8.5 Stakeholder Identification

The stakeholder identification process for the REA Desert to Power Project (Phase II) – 1MW Solar PV at FUBK is designed to identify all individuals and groups potentially affected, positively or negatively, by the project. It is a continuous process, regularly reviewed and updated throughout the project lifecycle. Engagement activities include community consultation meetings, focus group discussions, key informant interviews and household surveys, guided by structured tools and questionnaires to capture a wide range of perspectives. This approach ensures that stakeholder concerns, risks, impacts and opportunities are systematically addressed, supporting informed decision-making and positive project outcomes.

The stakeholders for the proposed project include primary stakeholders, such as university management, staff, host community members and project employees directly affected by the project and secondary stakeholders, including the Federal Ministry of Environment, Rural Electrification Agency, development partners, donors and civil society organizations with an indirect interest.

See Appendix IV for the attendances of the consultation and field activities.

See Appendix V for the pictorial evidence of the consultations

Table 4.13: Stakeholder for the Project:

S/N	Stakeholders	Type	Relevance to the Project
A	***Primary Stakeholders***		
1	Federal University Birnin Kebbi (FUBK) – Management Staff and students	Affected	Provides access to the university campus for project siting and construction. Coordinates operational integration with existing university infrastructure and Facilitates project activities such as site security, utilities and field monitoring.
2	Host community leaders Individuals, vulnerable social groups etc.	Indirectly Affected	Directly affected by construction activities and potential socio-economic impacts, their acceptance and cooperation are crucial for smooth project implementation and can provide local knowledge and support for community engagement and monitoring.
3	Traditional Authorities of the invited communities	Affected	Ungwan Jeji is indirectly affected by the proposed project through increased noise levels, traffic movement and related activities. At the same time, the project presents potential socio-economic benefits, including employment opportunities and improved livelihoods for vendors and small-scale businesses operating within and around the campus. The main function of the Mai Angwa of Ungwan Jeji is to take care of his people, including their safety, well-being and ensure that Peace, harmony and unity is maintained at all times. Therefore, the Mai Angwa were informed about the Project, particularly on the envisaged impacts and benefits that the Project will generate for their communities.
4	Project employees and contractors	Affected	Responsible for implementing construction, installation and maintenance activities. Ensure adherence to project timelines, technical standards and safety protocols and serve as key personnel for monitoring environmental and occupational health compliance.
B	***Secondary Stakeholders***		
4	Rural Electrification Agency (REA)	Interested	Supervises project execution and ensures alignment with national electrification policies. Coordinates funding, reporting and project

S/N	Stakeholders	Type	Relevance to the Project
			performance monitoring. Acts as a link between government policies and field-level implementation.
5	African Development Bank (AfDB)	Interested	The AfDB provides technical assistance to help with the preparation and execution of development projects and programs. • Provide financing for projects that will effectively contribute to their economic and social development. • Recommend additional measures for strengthening the management framework and implementation performance.
6	The Federal and State Ministries of Environment.	Interested	The Federal Ministry of Environment (FMEnv.) and Kebbi State Ministry of Environment are statutorily mandated to ensure the protection and conservation of Kebbi's state terrestrial and maritime biodiversity. The FMEnv manages the local Environmental Impact Assessment (EIA) process, for instance, consenting environmental permits under the EIA Act (Cap E12 LFN 2004).
7	Kebbi State Ministry of Health (KSMOH)	Interested	Guides public health and safety standards to ensure that project activities do not negatively impact the health of workers or the host community, supports the monitoring of potential environmental and health risks related to the construction and operation of the solar PV plant and acts as a liaison with local health facilities to facilitate health interventions, capacity building and awareness campaigns for the host community.
8	Kalgo Local Government Council	Interested	The Council will take part in reviewing the ESIA report and advise the Minister to make decisions on the project. Importantly, the Council will facilitate access to the traditional governance system in the project area.
9	Local NGOs, including gender organizations (men, women and youth groups) representing members of the invited communities.	Affected	These include men, women and youth groups.

4.7.9 Outcome of Focus Group Discussion and Key Informant Interview

Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were conducted during the socio-economic assessment of the proposed project, involving the development of a 1MW Solar PV plant. These methods were used to collect important socio-cultural, economic and historical information from Project Affected Persons (PAPs). FGDs included men, women and youths to ensure inclusive participation, while KIIs were conducted with the principal and key staff of the university and the Student Union Government (SUG) President to gather in-depth community insights for informed project planning and decision-making.

4.7.10 Highlights of the FGD/KII

Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were conducted in Ungwan Jeji community, Kalgo Local Government Area of Kebbi State, which constitutes the Project Affected Community (PAC) for the proposed project. The FGDs were organized separately for men, women and youths to ensure inclusive representation of community perspectives. KIIs were conducted with key stakeholders, including traditional leaders and livelihood representatives, to obtain in-depth information on local socio-economic conditions and cultural dynamics. These engagements provided valuable insights into potential project impacts and supported informed decision-making during the ESIA process. *See appendix V for the pictorial evidence.*

Table 4.14: Highlights of the FGD/KII

Format of Survey	Representative Respondents	Date/Time/Location	Outcome
FGD (Men)	Elders in Council and (Mai Ungwa) of Ungwan Jeji community	4th of February 2026 12:05 pm Ungwan Jeji community, Kalgo LGA	**Socio-cultural**: Ungwa Jeji, located in Kalgo Local Government Area near Birnin Kebbi, Kebbi State, is part of the historic Gwandu Emirate established around 1815 following the Islamic reform movement led by Shaykh Usman dan Fodio. Predominantly inhabited by Hausa and Fulani people, the community's socio-cultural life is deeply rooted in Islamic traditions, strong communal values, and traditional leadership structures. Agriculture is the main economic activity, with crops such as rice, millet, sorghum, and wheat commonly cultivated. Its proximity to Birnin Kebbi allows the community to maintain its cultural heritage while gradually benefiting from modern development initiatives in the state. **Socio-economic**: The socio-economic life of the community is primarily centred on agriculture, which serves as the main source of livelihood, predominantly undertaken by men. Major crops cultivated include rice, millet, sorghum, and wheat, contributing to both household consumption and sales in local markets. Women actively support the local economy through tailoring and small-scale home-based businesses, such as the sale of palm oil and ice blocks. In addition to farming and petty trading, other small-scale commercial activities contribute to income generation within the community. The area is served by a primary healthcare centre and one primary school, while its proximity to Birnin Kebbi further enhances economic opportunities through improved access to markets, infrastructure, and ongoing development initiatives.

Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			Project Awareness and Acceptance: The findings indicate that the majority of respondents are not fully informed about the details, scope, and potential impacts of the proposed project. Nevertheless, the overall perception within the community remains positive, with residents expressing general acceptance and a willingness to cooperate with the project proponents. Community members demonstrated openness and readiness to support the initiative, particularly in anticipation of its potential contribution to local development and socio-economic advancement. Furthermore, the Mai Unguwa of Ungwan Jeji community appealed to the developers to prioritize environmental sustainability and ensure the social inclusion of community members, especially in terms of employment opportunities for his subjects. **Fears and Concerns**: Community members expressed minimal direct concerns since the proposed project is situated within the university premises and does not require community land acquisition or physical displacement. However, some respondents raised indirect concerns relating to potential environmental impacts, increased traffic, pressure on local infrastructure, and possible exclusion of community members from employment and other project benefits. There were also concerns about ensuring peaceful coexistence between the university environment and the host community. Overall, the concerns were moderate and centred mainly on inclusiveness, environmental management, and equitable benefit-sharing rather than direct adverse impacts.

Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			Community Needs and Expectations: Community members expressed expectations that it should contribute positively to the socio-economic development of the host area. Key expectations include the provision of employment opportunities for qualified youths, engagement of local contractors and suppliers where possible, and the implementation of corporate social responsibility initiatives such as support for education, healthcare, and basic infrastructure. The community also emphasized the need for continuous stakeholder engagement, transparent communication, and the promotion of peaceful coexistence between the university and the host community to ensure mutual benefit and sustainable development. **Consultant's response:** The Consultant acknowledges the community's expectations and emphasizes the importance of promoting inclusiveness and mutual benefits, despite the project being located within the university premises. Efforts will be made to encourage the engagement of qualified local labour and service providers in line with existing policies. The Consultant also recommends continuous stakeholder engagement, transparent communication, and proper environmental and social management, while encouraging consideration of corporate social responsibility initiatives to support sustainable community development.
FDG (Women)	Women of Ungwan Jeji Community	4th of February 2026 1:05 pm Ungwan Jeji community Kalgo LGA	**Project Awareness and Acceptance**: The responses indicate that many women in the community are not fully aware of the details of the proposed project. However, they generally expressed acceptance and support for the initiative, provided that it brings tangible benefits to the community

Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			Fears and Concerns: women expressed concerns about non-inclusiveness in stakeholder engagement, noting that cultural and religious practices often limit their ability to participate openly in meetings. While the project is primarily situated within the university and poses minimal direct physical impact on the community, these concerns highlight the need to ensure that all segments of the community, including women, have opportunities to be consulted and represented in decision-making processes. **Issues affecting women**: The women of the Ungwan Jeji community face several health-related challenges largely due to inadequate basic amenities, including unreliable electricity and limited access to potable water. These deficiencies contribute to the prevalence of diseases such as malaria and typhoid fever. Additionally, women experience significant prenatal and postnatal health issues, highlighting the need for improved healthcare services **Women's Needs and Expectations:** women in Unguwar Jeje, their primary needs and expectations centre on improved access to healthcare services, including maternal and child health care, to address prenatal, postnatal, and general health concerns. In addition, women emphasized the importance of reliable access to potable water and electricity, as these basic amenities are critical for improving living conditions and reducing health risks such as malaria and typhoid.

Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			Consultant's Response: The Consultant acknowledges the concerns and expectations of women in Ungwan Jejiregarding healthcare and basic amenities. It is recommended that the project proponents consider measures to support improved access to healthcare services, including maternal and child health, and explore opportunities to enhance the provision of potable water and reliable electricity within the community. While the project is primarily located within the university premises, the Consultant encourages the integration of community-focused initiatives and engagement programs that address women's needs, promote health and well-being, and ensure inclusive socio-economic benefits.
KII	Management staff of FUBK	4h of February 2026 10:00 am Senate Building FUBK	**Project Awareness and Acceptance**: Regarding the proposed project at FUBK University, most respondents are aware of its existence and objectives. Their expectations focus on enhancing the university's overall standards, particularly in terms of research capacity and the learning environment. They also anticipate that the project will address current power supply challenges during grid downtime and improve security and visibility across the campus, thereby creating a safer and more conducive environment for academic staff and Students. **Socio-Economy**: The project will enhance academic productivity and operational efficiency. Employment opportunities may be created for university staff, local contractors, and service providers during both construction and operational phases. Additionally, improved infrastructure and security will attract more students and researchers, boosting ancillary economic activities such as catering and small-scale businesses within and around the campus.

Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			Socio-cultural: The proposed project at FUBK University is expected to have socio-cultural implications. According to respondents a community where farming predominates, the project may foster stronger interaction between university staff and the local population through labour exchange, collaborative initiatives, and mutual support, strengthening social cohesion. Employment and business opportunities created by the project can enhance income for both staff and local community members, while the improved infrastructure and research facilities at the university may encourage knowledge sharing and skill development. **Fears and Concerns**: concerns include potential disruptions to university activities during construction, such as noise, dust, and limited access to certain campus areas. There are also apprehensions about security, both for the campus and the neighbouring community directly opposite the university, particularly regarding equipment and infrastructure protection. Stakeholders emphasized the need for fair inclusion of local community members in employment and service opportunities to prevent social tension. Additionally, concerns were raised about environmental impacts, including vegetation disturbance and proper waste management **University Needs and Expectation**: The university community expects the proposed 1-Megawatt (MW) Solar Photovoltaic (PV) power plant under the REA Desert to Power Project (Phase II) to enhance the institution's energy reliability, particularly during periods of grid downtime, ensuring a stable and uninterrupted

Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			power supply for academic, research, and administrative activities. also anticipate improvements to campus infrastructure, including security enhancements and better lighting, to create a safer and more conducive learning environment. **Consultant's response:** The Consultant acknowledges the university's needs and expectations regarding the proposed 1-Megawatt (MW) Solar PV power plant under the REA Desert to Power Project (Phase II). It is recommended that the project be designed and implemented to ensure a reliable and uninterrupted power supply to support academic, research, and administrative activities. The Consultant also encourages the integration of security enhancements, improved campus lighting, and sustainable energy solutions that align with the university's long-term development objectives.
FGD	Student Union FUBK	4th of February 2026 10:00 am Senate building conference hall	**Project Awareness and Acceptance**: Students at FUBK University are generally aware of the proposed 1-Megawatt (MW) Solar PV power plant, having been informed by the university management. They view the project positively and consider it a welcome development, anticipating that it will improve power reliability, enhance the learning environment, and contribute to the overall growth and sustainability of the university. **Fears and Concerns**: According to respondents Students at FUBK University expressed concerns about potential disruptions to their academic and campus life during the construction of the 1-Megawatt (MW) Solar PV power plant. Key issues include noise, dust, and limited access to lecture halls, laboratories, and hostel

Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			facilities. Some students also highlighted security concerns regarding project equipment and campus infrastructure **Students' concerns about workers/contractors:** Students at FUBK University expressed concerns regarding the potential presence of workers and contractors from outside the university during the construction of the 1-Megawatt (MW) Solar PV power plant. They worry that an influx of external personnel could pose security risks, disrupt campus life, and affect safety within hostels, lecture halls, and other campus areas. **Economic Impact on Students:** Stable power can reduce students' reliance on costly alternative sources such as generators or fuel-powered devices, lowering personal expenses for electricity. It may also indirectly reduce the cost of basic services on campus, including hostel utilities, internet access, barbing, and small-scale food or service businesses that currently face high operational costs due to inconsistent power supply. Overall, improved electricity availability is anticipated to enhance affordability, ease students' daily living expenses, and support a more conducive environment for academic and residential life. **Consultant Response**: The Consultant recommends that the project be implemented in a manner that maximizes these benefits for students, ensuring uninterrupted power supply, minimizing disruptions during construction, and supporting a conducive environment for both academic and residential activities. Additionally, opportunities for student engagement in project

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Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			awareness and energy management initiatives could further enhance socio-economic and educational outcomes.
KII	SUG President (shafiu Muhammad Abdullahi)	04th February 2026 Senate building FUBK	**Project Awareness and Acceptance:** As the Student Union President, I am aware of the proposed installation project. The university management has informed me about the 1-Megawatt (MW) Solar PV power plant, which is expected to provide reliable electricity within the school premises. This initiative is welcomed by the student body, as it is anticipated to enhance the campus environment, support academic and residential activities, and contribute to the overall development of the university. **Social context:** The university and the neighbouring community maintain a positive and cooperative relationship. Agriculture is the primary economic activity within the community, with some small-scale trading also taking place. The proposed 1-Megawatt (MW) Solar PV power plant is expected to bring tangible benefits to both the university and the surrounding community, including improved lighting, enhanced water supply, and better support for research and practical activities within the university. **Economic Impact on Students and the University:** The 1-Megawatt Solar PV project is expected to reduce students' living costs by providing reliable electricity and lowering reliance on alternative power sources, while also lowering operational energy costs for the university. This will enhance research, academic, and residential activities, creating a more affordable and efficient campus environment.

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Format of Survey	Representative Respondents	Date/Time/Location	Outcome
			Fears and Concerns: As the Student Union President, I recognize the benefits of the proposed 1-Megawatt (MW) Solar PV power plant; however, several concerns have been highlighted, which include potential disruptions to academic activities during construction, such as noise, dust, and restricted access to lecture halls, laboratories, and hostels. There are also security concerns regarding the presence of external workers and contractors on campus, particularly in relation to student safety and the protection of university facilities. **Consultant's Response:** The Consultant acknowledges the Student Union President's concerns and recommends careful planning to minimize construction disruptions, ensure student safety, and protect campus facilities. Emphasis is placed on prioritizing project benefits such as reliable electricity, improved lighting, and water supply for students, alongside ongoing communication and engagement with the Student Union to maintain a safe and conducive campus environment.

CHAPTER FIVE
POTENTIAL AND ASSOCIATED IMPACTS

5.1 Introduction

This chapter undertakes an evaluation of the biophysical, health, and socioeconomic implications across all project phases, including pre-construction, construction, operation, and decommissioning. It presents the findings from a comprehensive assessment of the potential environmental impacts associated with the proposed 1.0 MW solar-hybrid power plant project to be situated and operated within the Federal University Birnin-Kebbi, Kebbi State. The assessment considers both normal operational impacts and potential effects arising from abnormal occurrences.

The identified impacts are categorized as either threats or opportunities to human and environmental wellbeing. Project activities and their environmental interfaces encompass a wide array of concerns, such as air and water pollution, impacts on employment, and land use change, among others. These concerns have been thoroughly examined to determine the potential impacts of the proposed project on environmental receptors. This section outlines the overall approach to impact assessment and mitigation. The impact evaluation methodology is based on sectoral guidelines provided by FMEnv, African Development Bank (AfDB) operating system, and all other relevant regulatory frameworks. It involves:

- Screening of potential impacts associated with each project phase using a Risk Assessment Matrix.
- Detailed evaluation of impact-producing factors within each project phase, with the significance of potential impacts quantified using consistent criteria.

The assessment approach involves aligning the proposed project's activities with the existing environmental components, identifying, and evaluating potential changes in the environment resulting from these interactions, and proposing mitigation measures to address such changes. At this stage of the Environmental and Social Impact Assessment (ESIA), both negative and positive impacts of the proposed solar-hybrid power plant project on the existing environment have been identified. Various references, including the EIA Procedural Guidelines, the ISO 14001 approach, and the Hazard and Effect Management Process (HEMP), AfDB OS were utilized in the identification process. The Risk Assessment Matrix (RAM) was employed to determine risks posed by identified potential impacts and to propose appropriate mitigation measures. In predicting impacts, a practical 'worst-case scenario' approach was utilized to assess extreme effects, while a 'consensus of opinions' method was employed to determine the importance of affected environmental components. Evaluation of impacts was conducted using specific criteria such as legal/regulatory requirements, magnitude of impact, risk posed, public perception, and importance of affected environmental components. This section of the report presents the outcomes of the identification and evaluation processes.

5.2 Impact Methodology Description

Figure 5.1 below depicts the steps taken in identifying, assessing, and evaluating the potential and associated impacts of the proposed project.

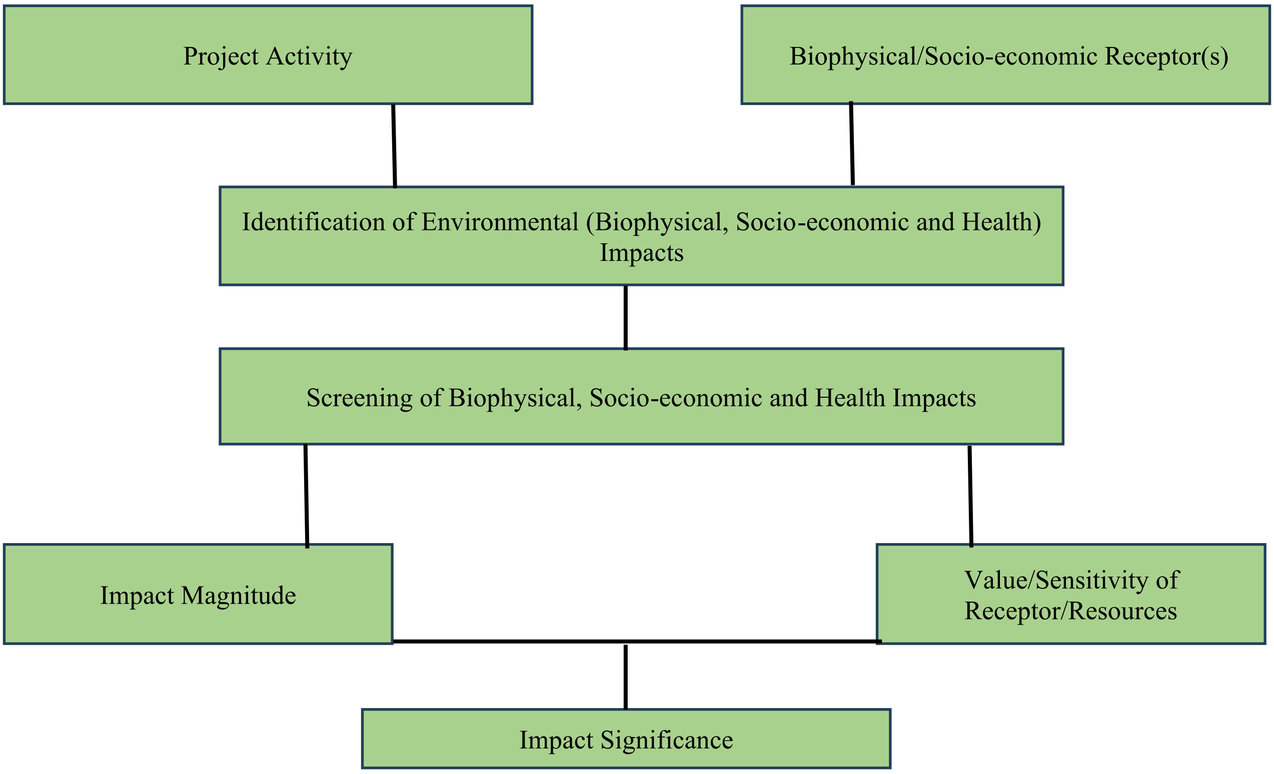

Figure 5.1: Impact Methodology Overview

5.2.1 Environmental and Social Indicators

The activities described in Section Three of this report are expected to interact with various components of the environment. These interactions may generate impacts that require systematic monitoring and evaluation. To effectively track and manage these impacts, specific environmental indicators will be applied. These indicators include:

a. Noise and Vibrations

Measurement Unit: Decibels (dB)

Indicators:

- **Baseline Noise Levels:** Pre-construction measurements within the institution and its environment.
- **Construction Noise:** Monitoring of equipment and vehicle noise during installation works.
- **Operational Noise:** Assessment of inverter and transformer noise during operation (expected to be minimal).
- **Vibration Levels:** Monitoring during civil works, particularly near lecture halls, laboratories, offices, and student residential areas.

Note: Given the 1MW scale, noise impacts are expected to be temporary and localized.

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b. Ecological Impacts
Since FUBK is an institutional environment (not a natural forest ecosystem), ecological impacts are expected to be limited.
Floral Abundance and Diversity
- **Species Inventory:** Identification of grasses, shrubs, ornamental plants, and campus vegetation within the project footprint.
- **Vegetation Cover:** Monitoring clearing activities and post-construction restoration.
- **Invasive Species Monitoring:** Observation of potential introduction of non-native species during landscaping.

Fauna Abundance and Diversity
- **Species Inventory:** Identification of small mammals, reptiles, birds, and insects within the site.
- **Population Monitoring:** Observation of any displacement during construction.
- **Habitat Quality:** Assessment of habitat alteration within the limited project area.

c. Hydrology and Water Quality
Groundwater:
- Dissolved and Suspended Solids: Measurement to assess water clarity and pollution levels.
- pH Levels: Monitoring to ensure water remains within safe limits for aquatic life and human use.
- Biochemical Oxygen Demand (BOD): Evaluation of organic pollution by measuring oxygen consumption.
- Chemical Oxygen Demand (COD): Measurement of total oxygen required to oxidize both organic and inorganic matter.
- Turbidity: Assessment of water clarity, indicating the presence of suspended particles.
- Toxicity: Testing for the presence of harmful substances.
- Heavy Metals: Analysis for metals like lead, mercury, and cadmium that can have severe health impacts.
- Microbial Loads: Checking for pathogens and indicator organisms such as coliform bacteria.

d. Soil
Type and Composition:
- **Soil Type Classification:** Identification of existing soil conditions within the site.
- **Physicochemical Properties:** pH, nutrient content, and organic matter.
- **Soil Compaction:** Especially due to construction equipment.
- **Erosion Monitoring:** Particularly during rainy seasons.
- **Contamination Monitoring:** From accidental oil or chemical spills.

e. Socio-Economic and Health Impacts
Since the project is within a university campus, impacts relate primarily to staff and students.
Community Needs and Concerns
- **Stakeholder Engagement:** Consultations with university management, staff, and student representatives.
- **Grievance Redress Mechanism:** Functional complaint handling system.

Livelihood and Employment
- **Local Employment Opportunities:** Monitoring short-term construction employment.
- **Fair Labor Practices:** Compliance with labor standards.

Health and Safety
- **Occupational Health & Safety (OHS):** PPE usage and contractor safety compliance.
- **Public Safety:** Ensuring safe movement around construction zones.
- **Emergency Preparedness:** Fire and electrical safety measures.

Waste and Sanitation
- **Construction Waste Management**
- **E-waste Handling**
- **Proper disposal of packaging materials**

Land Use
- **Land Use Compatibility:** Ensuring alignment with university master plan.
- **Zoning Compliance:** Compliance with institutional land use planning.

These indicators are essential for ensuring that the solar power project is conducted responsibly, with minimal adverse impacts on the environment and local communities. Monitoring these indicators will help in making informed decisions and implementing necessary mitigation measures.

5.2.2 Impact Identification and Characterization Technique

Impact identification is a crucial process that ensures the comprehensive identification and consideration of all potentially significant impacts during project design and implementation. These impacts are categorized into two types: positive and negative. Assessment of these impacts occurs at different stages of the project's life cycle, encompassing mobilization/construction, operation, and decommissioning phases. To assess the overall significance of the impacts, the adopted techniques consider factors such as the nature, type, and reversibility of the impact, the magnitude of the change, and the current status and sensitivity of the resource/receptor. This process is illustrated in Figure 5.2.

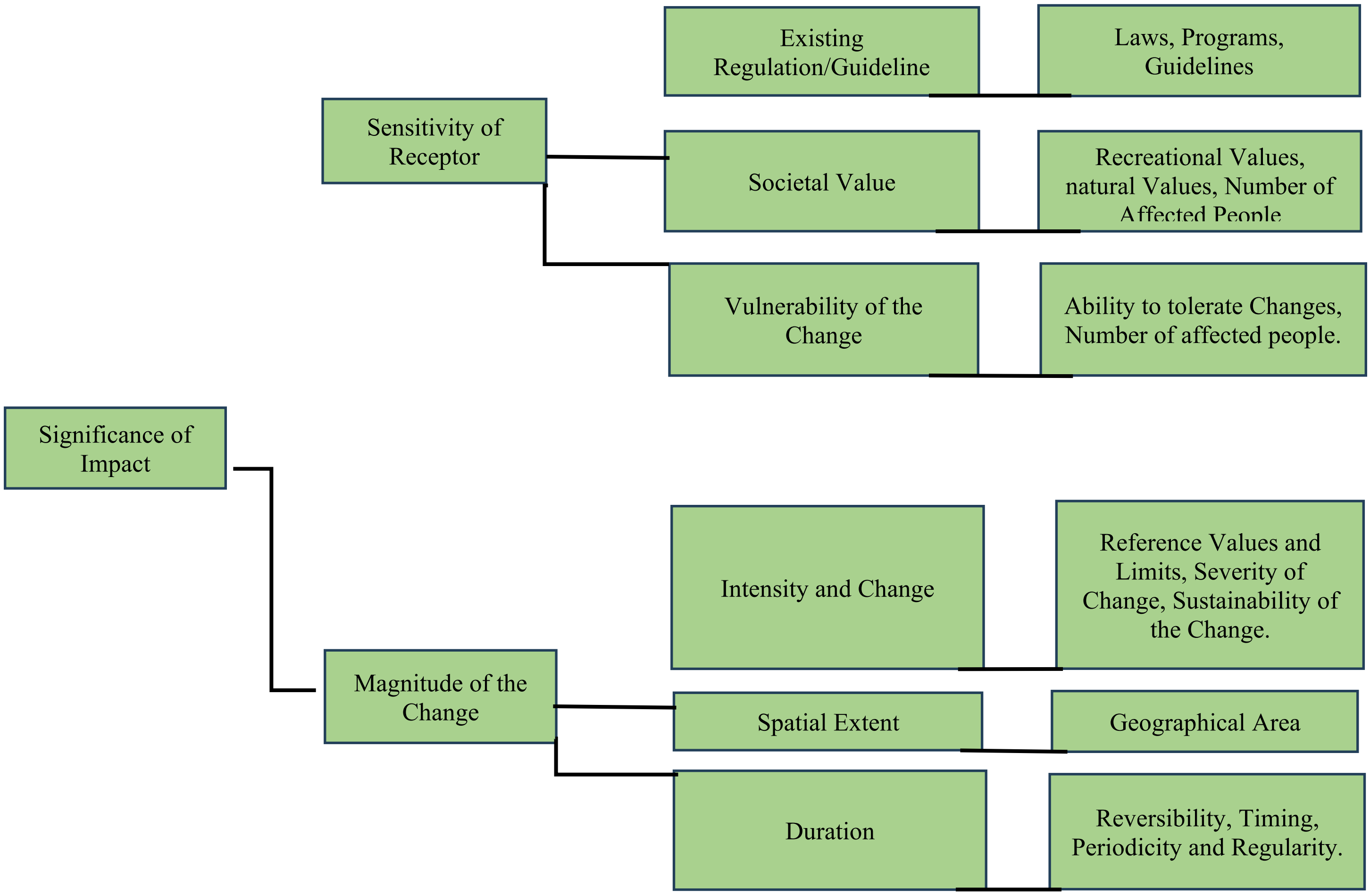

Figure 5.2: Impact Characterization

Table 5.1: Impact Descriptions

NATURE OF IMPACTS	
Positive Impacts	These are significant benefits that result from an improvement to the baseline or the inclusion of new, desirable factor.
Negative Impacts	These are negative consequences caused by an antagonistic change from the baseline or introduction of a new, undesirable factor.
Direct Impacts	These are inevitable consequences that are directly related to the project's proposed activities.
Indirect Impacts	These are the changes that are less obvious, or impacts are further away from the impact source.
Cumulative Impacts	Impacts resulting from the interaction of project components or activities with other activities in past, concurrently, or in the future.
Residual Impacts	These are the effects that persist even after mitigation measures have been implemented.
REVERSIBILITY / IRREVERSIBILITY	
Reversible Impacts	These are impacts that do not cause permanent change to the components of the environment.
Irreversible Impacts	These impacts cause permanent impairment to the environmental

	component of the area.
DURATION OF IMPACTS	
Temporary	Lasts no more than 30 days and ceases when the relevant activity ends.
Short term	Lasts more than 30 days but no longer than 12 months, generally within the construction period.
Medium Term	Lasts more than one year but no longer than five years and is reversible within that period.
Long Term	Lasts more than five years or continues for a substantial part of the operational life of the Project.
Permanent	Irreversible or expected to remain after project closure despite practicable restoration.

5.2.3 Determination of Impact Significance

Determination of impact significance is based on two key criteria namely;

- Impact Significance Criteria
- Impact likelihood Criteria

Table 5.2: Impact Significance Criteria

CONSEQUENCE LEVEL	SIGNIFICANCE CRITERIA
Major (3)	**Workers Health and Safety:** one or more fatalities or life-threatening injuries/illness. **Environmental and Social**: widespread modification or extraordinary severity in physical environment or economic resources or social structure lasting more than one year, with an area extent of impact > 1 percent of study area.
Moderate (2)	**Workers Health and Safety:** injury requiring medical attention, or illness requiring long-term medical care or > 2 lost time instances for same or recurring incident/illness during phase of work. **Environmental and Social:** local modification of measurable severity in physical environment or economic resources, lasting from a few months up to one year before recovery, with an area extent of impact extending from 0.1 to 1 percent of study area; or more widespread modification of lesser severity.
Minor (1)	**Workers Health and Safety:** 1-2 lost time instances for same or recurring illness/injury. **Environmental and Safety**: localized, relatively isolated change in physical environment or economic resources, lasting only a few days to a few months before recovery, with no observable residual effects; and with an area extending from 0.01 to 0.1 percent of study area; impacts less significant than exerted by nature.
Negligible (0)	**Workers Health and Safety**: Negligible first-aid case (no lost time) or near miss. **Environmental and Social**: Little or no change in physical environment, even temporarily, conditions consistent with background conditions.

Table 5.3: Impact Likelihood Criteria

CONSEQUENCE LEVEL	SIGNIFICANCE CRITERIA
Probable (3)	Impact or event can reasonably be expected to result from project, occur routinely for similar operations.
Occasional (2)	The Impact or event has occurred in similar operations in this country or conditions could allow the impact/event to reoccur.
Seldom (1)	The impact or event has occurred once or twice in the company/industry, but conditions in this program are unlikely to allow the impact/event to occur.
Improbable (0)	The impact or event has never occurred.

RISK MATRIX

1. Risk Assessment Matrix

Consequence ∠ / Likelihood →	Likelihood			
	1 – Improbable	2 – Occasional	3 – Probale	4 – Frequent
	Medium (2)	Medium (2)	High (3)	High (3)
4 – Major	Low (1)	Nedium (2)	High (3)	High (3)
3 – Moderate	Low (1)	Medium (2)	Medium (2)	High (3)
2 – Minor	Low (1)	Low (1)	Low (1)	Low (1)
1 – Negligible	Low (1)	Low (1)	Low (1)	Low (1)

2. Risk Rating Interpretation

Risk Level	Score	Description
High	3	Requires alternative approach/design and mitigation measures to minimize impact.
Medium	2	Requires mitigation measures.
Low	1	Proceed with care; apply standard controls. No additional mitigation required.

Figure 5.3: Impact Evaluation Matrix

5.3 Impact Methodology Description

The Impact Methodology Description provides a structured framework for assessing and evaluating the potential environmental and social impacts of proposed projects. This document outlines the methodologies, criteria, and tools utilized in conducting the Environmental and Social Impact Assessment (ESIA). The primary goal is to identify, predict, and mitigate adverse impacts while maximizing positive outcomes. The methodology overview includes:

Baseline Data Collection:
The assessment begins with comprehensive data collection to establish baseline conditions of the project area. This includes gathering information on environmental, social, economic, and cultural aspects through field surveys, interviews, and literature reviews.

Impact Identification:
Utilizing the collected baseline data, potential impacts associated with the project are identified. These impacts are categorized into environmental (e.g., air quality, water quality, biodiversity), social (e.g., community displacement, cultural heritage), and economic (e.g., employment opportunities, income generation).

Impact Prediction:
Various tools and models are employed to predict the magnitude, extent, and significance of identified impacts. Techniques such as Geographic Information Systems (GIS), environmental modeling, and stakeholder consultations are utilized to forecast potential impacts under different scenarios.

Impact Assessment:
Impacts are assessed based on predetermined criteria including severity, duration, reversibility, and spatial extent. Qualitative and quantitative methods are employed to evaluate both positive and negative impacts, considering their significance on the affected environment and communities.

Risk Assessment:
Risks associated with project activities are identified and analyzed, considering the likelihood and potential consequences of adverse events. This includes assessing risks related to natural hazards, project operations, and socio-economic factors.

Mitigation and Management Measures:
Based on the identified impacts and risks, appropriate mitigation and management measures will be developed to avoid, minimize, or compensate for adverse effects. These measures aim to enhance sustainability of the solar power project and promote environmental and social responsibility.

Monitoring and Evaluation:
A monitoring and evaluation plan will be established to track the implementation of mitigation measures and assess the effectiveness of impact management strategies. Regular monitoring ensures compliance with regulatory requirements and enables adaptive management based on real-time data and feedback.

5.4 Impact Severity and Profiling

Table 5.4 illustrates the potential impacts and receptors throughout all stages/phases of project execution. It outlines the sources of impacts/risk, affected resources, intensity, scope, duration, consequence level and score, likelihood level and scope, as well as significance and residual impacts. These parameters facilitate the assessment of impact severity and the profiling of project activities.

Table 5.4: Summary of Key Impacts and Receptors for all Development Phases

Project Activity	Affected Resource / Outcome	Identified Impact	Scope	Impact Significance
Pre-Construction Phase				
Site Selection/ land	Land Retrieval	Loss of land for activities due to land retrieval for the project by the institution management	Localized	Low
Site clearing and preparation	Air Quality and Noise	- Increased suspended particulate in ambient air and degradation of ambient air quality by emission from site clearing equipment. - Increase in ambient noise levels	Localized	Medium
	Soil	The key impacts of site clearing and preparation on soil are denudation and subsequent exposure to erosion	Localized	Medium
	Terrestrial flora and fauna	Loss of vegetation and migration of faunas from the area, leading to alteration of species composition and abundance	Dispersed	High
	Infrastructure (road)			
	Waste Generation	Potential soil contamination from mishandling of clearing equipment's, generated solid/liquid waste, i.e engine oil from the clearing vehicle.	Dispersed	Minor
	Health (Workers Safety)	Negative health effects on health of project workers/students/institution staff by emissions and dust released from site clearing and preparation activities.	Localized	Minor
Construction Phase				
Equipment, Personnel and Plant Material Movement	Soil	Heavy duty trucks used for mobilization could cause soil compaction, leading to structural changes. Wastes from construction camps could also cause soil contamination	Localized	Medium
	Terrestrial	Loss of vegetation during setting up		

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Project Activity	Affected Resource / Outcome	Identified Impact	Scope	Impact Significance
	flora and fauna	of construction camp as well as scaring wildlife species away with noise from vehicles and equipment used during construction.	Dispersed	Medium
	Air Quality and Noise	- Emissions and noise from vehicles, machinery, and equipment used for mobilization and site lighting generators could degrade ambient air quality and elevate noise levels. -Increased traffic movement of heavy-duty truck en-route project site	Localized	High
Civil and Electrical Works, and Installation of Plant Facilities	Air Quality	Emissions from vehicles and machinery, as well as dust and suspended particulates generated from trenching activities and machinery such as concrete mixers and piling machines, could lead to degradation of air quality and elevation of ambient noise levels.	Localized	Medium
	Noise Level	Civil work and installation activities, vehicular movement and operation of construction equipment may lead to elevated noise levels beyond baseline concentration. Noise may cause a major disturbance to fauna species such as birds and mammals in the area. These would move further into the forest to avoid the disturbance.	Localized	Medium
	Infrastructure (road)	Road damage, traffic and safety impacts, due to movement of heavy vehicles and machinery within the university premises	Localized	Minor
		Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of		Low

Project Activity	Affected Resource / Outcome	Identified Impact	Scope	Impact Significance
	Groundwater	fuels, oils and lubricants from construction vehicles or storage tanks.	Localized	
	Soil	Excavation, loosening of soil, stockpiling, mixing, filling, etc. These activities can directly impact soil environment negatively contributing to soil degradation and possibly accelerated erosion.	Localized	Medium
	Terrestrial Flora and Fauna	Increase in human activity, noise level, creation of areas of bare soil would create a resulting effect which would be the altering of the composition and diversity of flora species in the site as well as migration of fauna species that make use of the plants for food and shelter further away into the forest.	Dispersed	Medium
	Socio-economic and Health	The potential behaviour of workers, most especially male construction workers, may lead to an increase in levels of drugs and alcohol abuse, and an increase in incidence of casual sexual relations, which may result in increase in sexually transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies.	Localized	Medium
	Gender	- Discrimination of women during employment. - GBV (sexual harassment, assault and poor working condition)	Localized	Moderate
Waste Generation and Disposal	Soil	**Non-Hazardous Waste** include cartons, pallets, plastics, scrap metals, electrical cables offcuts, excavated soil, concrete debris Hazardous Waste include; Used	Localized	Low

Project Activity	Affected Resource / Outcome	Identified Impact	Scope	Impact Significance
		engine oil. Lubricants, oil contaminated rags, paint container, chemical containers		
	Groundwater	Groundwater may be impacted because of infiltration of contaminants associated with liquid wastes especially from used or vehicle oils.	Dispersed	Minor
	Infrastructure (Waste Management Facility)	Disposal of construction wastes to existing waste management facility in the Project area.	Localized	Low
Operation and Maintenance Phase				
Power Generation and distribution	Noise	Noise from batteries and inverters during power generation and evacuation	Localized	Low
	Gender	- Discrimination of women during employment. - GBV (sexual harassment, assault and poor working condition)	Localized	Moderate
	Socio-economic (Visual prominence)	- Landscape alterations resulting in unpleasant changes in the visual character of the area	Public	Low
	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	Localized	Moderate
	Socio-economic (Health issues)	- Community health and safety impact due to electromagnetic field (EMF) radiation from the Solar Power Plant	Localized	Low
	Groundwater	- During routine maintenance, the generation of hazardous materials		Minor

Project Activity	**Affected Resource / Outcome**	**Identified Impact**	**Scope**	**Impact Significance**
Routine maintenance of the plant and facilities generation and disposal		such as spent lube oils, and spent batteries is possible. If not managed appropriately, these wastes could be washed or infiltrate into the soil and groundwater, leading to contamination and pollution. - Groundwater abstraction from cleaning of PV panels	Dispersed	
	Soil	- Soil contamination from spent batteries and inverters - Accidental release of hazardous materials generated from routine maintenance activities could lead to contamination of the soils, thus altering soil quality status	Localized	Moderate
	Ground water	Groundwater and soil contamination	Public	Minor
	Health, safety and welfare of staff during maintenance	Electric shock, injuries to personnel during maintenance	Localized	Minor
Decommissioning and Closure Phase				
Dismantling of facilities, buildings, utility and ancillary facilities	Livelihood	Employees involved in the project may face job loss when decommissioning activities begin, impacting their employment and livelihood.	Localized	High
	Groundwater	Possible contamination from dismantling activities and battery water infiltration groundwater, leading to contamination.	Dispersed	Low
	Air and Noise Quality	The use of vehicles, machinery, equipment for mobilization, on site may emit gaseous emissions, particulates, and noise. These emissions and noise levels could contribute to the degradation of	Localized / Public	High

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Project Activity	Affected Resource / Outcome	Identified Impact	Scope	Impact Significance
		ambient air quality and an increase in ambient noise levels.		
	Terrestrial Flora and Fauna	Noise generated by machinery may disturb flora species, causing them to flee the site and potentially leading to changes in species composition and abundance due to migration from the area.	Dispersed	Low
	Waste Generation	Potential soil and /or water contamination form mishandling of generated solid and liquid wastes, and other decommissioning and closure procedures related waste.	Dispersed	Medium

The primary objective of the ESIA study was to comprehensively identify and characterize all associated environmental impacts or effects resulting from the proposed university Solar Power Plant. While various approaches exist for predicting and evaluating project environmental impacts, the EIA Procedural Guidelines, the ISO 14001 approach, and the Hazard and Effect Management Process (HEMP), were mainly referenced in the impact identification process chosen for this study. Using this method, impacts ranging from low to severe significance were identified, assessed, and quantified. Notably, among the impacts with high significance ranking are:

a) Injury and personnel entrapment resulting from heavy lifting during construction.
b) Air pollution and potential climate change effects caused by fugitive emissions.
c) Contamination of ground water due to wastewater and effluent discharges.
d) Risk of explosions and fires resulting from routine activities and accidental incidents.
e) Noise pollution generated by process equipment.
f) Pollution of land and water from potential oil spill incidents.

5.5 Project Phases, Associated Activities and Potential Impacts

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

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

Construction phase: It involves activities such as mobilisation of workforce and equipment to site, digging, trenching, bulldozing, grading, soil compaction; and installation of temporary camp and power plant components. This phase is usually a short term one.

Commissioning phase: It involves the integrated application of a set of engineering techniques and procedures to check, inspect and test every operational component of the project, from individual functions, such as instruments and equipment, up to complex amalgamations such as modules, subsystems and systems.

Operational phase: This is usually 'long term', involving activities from post construction to pre-decommissioning. It commences once the power plant has been commissioned for use. Activities include use of natural resources (water for domestic uses and cleaning of solar modules), plant and equipment operations, routine maintenance of equipment and plant.

Decommissioning phase: It begins once the power plant use is discontinued or project life span has come to an end.

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

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

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

The FMEnv EIA Procedural Guidelines and the 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 project (as described in chapter 3 of this report) with the components of the existing environment. Consequently, the possible changes (and extent of changes) in the environment as a result of the interactions have been identified/ evaluated, hence mitigation measures proffered in order to reduce, offset or ameliorate such changes. The potential/ associated adverse and beneficial impacts of the proposed power plant project on the existing environment were identified at this stage of the ESIA.

The Risk Assessment Matrix (RAM) has been employed in determining risks posed by the identified potential/associated impacts of the project in order 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. The impact evaluation results make up the pedestal for developing the ESMP of the proposed project.

5.5.1 Identified Impacts for Pre-Construction Phase

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

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

Approximately 25.2 ha of land within the Federal University Birnin-Kebbi (FUBK) property has been earmarked and allocated by the University management for the proposed 1 MW solar-hybrid power plant and the training center. No additional land either from private or public property outside the University campus will be expropriated for the Project.

The Project site is characterized by fallow lands and vegetation which includes grasses, shrubs, and a few trees. There are no physical structures on the site. The proposed project footprint is located on institutional land legally held by FUBK. Parts of the wider University landholding have historically been made available under temporary arrangements for seasonal cultivation. However, during the ESIA field survey, the designated project footprint was not under active cultivation, occupation or livelihood use. No standing crops, farm structures, livelihood assets or identifiable users were recorded within the footprint. Consequently, no physical or economic displacement is anticipated based on current conditions.

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

- ❖ **Potential Impact on Terrestrial Flora and Fauna**

Site clearing activities associated with the proposed Project will lead to loss of terrestrial flora on the Project site. The potential impact on the terrestrial flora is considered to be negative, direct, site specific and largely irreversible. The impact magnitude is considered to be medium considering that not all the land area (25.2 ha) will be cleared for the Project. However, the sensitivity /importance of the receptor is regarded as low since the Project Site is a modified habitat, and none of the plant species identified within the Project Site during the baseline survey was found to be endangered or threatened based on the International Union for Conservation of Nature (IUCN)-2024 classification scheme. Also, the local community has no direct or indirect ecosystem services that benefit from the site. Furthermore, there are no protected/conservation areas within the site. The significance of the potential impact of site clearing on the existing terrestrial flora species of the Project site is therefore regarded as **minor**.
While the plant species are unable to avoid the point of impact, most fauna species may be able to migrate away from unfavourable areas. Animals are generally mobile and, in most cases, can move away from a potential threat. The tolerance levels of some animal species are of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from areas of impact.

- ❖ **Potential Impact on Soil**

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

- **Potential Impact on Air Quality and Ambient Noise**

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

- **Potential Impact on Workers Safety**

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

Mobilization of equipment, materials and personnel to site

In executing the proposed project, a great deal of haulage/ movement would be undertaken all through the phases of the project. Movements would include transportation of equipment and personnel for construction and operational phases; and movement of plant components to project site for construction and installation. Anticipated impacts during the mobilization of equipment and personnel to site will include:

- **Potential Impact on Air Quality and Ambient Noise**

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

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

- **Potential Impact on Infrastructure (Road)**

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

- **Potential Impact on Workers Safety**

Mobilization of construction materials will involve off-loading of heavy consumables such as cement, gravel, etc. Injuries and accidents may occur especially when those involved are unskilled. It is expected that the potential impacts will be similar to those experienced during site clearing and preparation activities. The impact significance is considered to be **minor**.

5.5.2 Identified Impacts for Construction Phase

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

During the construction phase, waste generated would also include cleared vegetation, excavated soil, packaging materials such as plastics and cartons, scrap metal, concrete debris, used oil and lubricants from equipment, and domestic waste from workers. The potential environmental and social impacts associated with the construction phase of the proposed Project are assessed and discussed as follows:

Equipment, Personnel and Plant Material Movement

As part of the construction phase, personnel and materials would be transported to site on need basis. Transportation could be from workers or visitors to the site. Vehicles to be deployed for construction purposes would include saloon, SUVs and heavy-duty vehicles (such as trucks, excavators, etc). Movement of vehicles during this phase is important and cannot be avoided as such would impact significantly on the environment as well as on people living within the area in the following ways:

Vehicular emission of pollutant gases (such as CO, SO2 and NO2) from vehicle exhaust contribution to global gas warming and ozone layer depletion from pollutant gases emitted from vehicles.

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

Civil and Electrical Works, and Installation of Plant Facilities

- **Potential Impact on Air Quality**

At installation and construction phases of the project, the potential sources of emissions would include dust, particulate matter (PM), emissions from heavy trucks and earthmoving equipment that will be operated on the project site. Exhaust emissions during material transportation, stockpiling and equipment transfer during construction activities. It is proposed that the construction phase of the Project would take up to 3- months. These emissions will be localized to the construction site area and will be short-term, the extent of impact would therefore be **medium** and its significance is rated **minor**

- **Potential Impact on Noise Levels**

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

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

❖ **Potential Impact on Soil**

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

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

❖ **Potential Impact on Terrestrial Flora and Fauna**

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

❖ **Potential Impact on Groundwater**

The construction activities for the Project could lead to potential impacts on Groundwater of the Project area. These include increased sediment load in the drainage channels as a result of erosion; increased stormwater runoff from a decrease in infiltration; increased runoff from hard standing areas which could result in creation of drainage lines. Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks.

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There could also be decrease in amount of groundwater as a result of groundwater abstraction for project activities. It is planned that at least one borehole will be dug onsite to serve as source of water supply for the project activities. Currently, though there are boreholes within the University, there is no borehole on the project site. Also, the quality of the existing groundwater resources in the study area is considered to be good. It is not anticipated that construction activities will have any direct impact on the underground aquifer in the project area. Therefore, the potential for groundwater contamination as result of construction activities is rated **minor**.
The potential impact on the existing underground aquifer (water reserve) of the study area as a result of water abstraction for construction activities such as concrete mixing and washing of construction equipment is considered to be negligible because the activities are very minimal. There are several boreholes within the University campus as noted during the site visit. During the rainy season, the underground water aquifer increases; thus, boreholes yield improves significantly.

- **Potential Impact on Socio-economic and Health**

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

With regard to the presence of construction workers on site, the manner in which the workers conduct themselves can affect the University environment and local community in terms of disruption of existing structures due to influx of people. The potential behaviour of workers, most especially male construction workers, may lead to an increase in levels of crime and drug and alcohol abuse, and an increase in incidence of casual sexual relations, which may result in increase in sexually transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies.
Additional pressure may also be placed on existing social infrastructure. Considering that the proposed number of workers for the construction phase of the Project may be relatively high, the potential risk to social structures is regarded as high. However, given that the majority of the construction workers, especially unskilled labour force would be drawn from the local community, the impact significance is considered to be moderate.

- **Potential Impact on Construction Workers Safety**

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

Waste Generation and Disposal

Construction Phase Waste can be categorized into **Hazardous** and **Non-hazardous** wastes. **Hazardous Waste** are; Scrap Metals, Packaging Materials (such as cartons, pallets, and plastics), Cable offcuts, Excavated Soil, Concrete Debris. While **Non-hazardous** Waste are; used engine oil, Lubricants, Oil-contaminated rags, Paint Containers, Chemical Containers from the project are Waste generation can also be grouped into solid wastes, liquid (wastewater) and air emissions.

Solid wastes would include; wood, metals, food remains, glass, and refuse etc. Liquid wastes include sewage, while gaseous air pollutants (NOx, SOx and CO) would be from exhausts of vehicles. Table 2 present a simplified system is practical and cost-effective while maintaining compliance and safety.

Table 5.5: Waste Colour Coding System

S/N	Colour Code	Waste Category	Examples	Handling / Disposal Method
1	**Red**	Hazardous Waste	Used oil, lubricants, oily rags, contaminated PPE, chemical containers, batteries, contaminated soil	Store in sealed, labeled containers; handled by licensed hazardous waste contractor
2	**Yellow**	Electronic waste (potentially hazardous)	Damaged PV modules (E-waste), electrical components, fluorescent lamps, used filters	Segregate and transfer to approved recycling or controlled disposal facility
3	**Green**	Non-Hazardous Recyclable Waste	Scrap metal, cardboard, plastics, paper, clean wood	Segregate for recycling through authorized recyclers
4	**Blue**	General (Non-Hazardous) Waste	Food waste, office waste, non-contaminated packaging	Dispose through approved municipal waste system
5	**Brown**	Organic / Biodegradable Waste	Food remains, plant trimmings, landscaping waste	Composting or disposal via approved waste contractor

For simplicity and practicality, the project may adopt at least:

- **Red** – Hazardous Waste
- **Green** – Recyclables
- **Blue** – General Waste

It should be noted however that during their normal operation, photovoltaic (PV) systems emit no gaseous or liquid pollutants, and no radioactive substances.

- ❖ **Potential Impact on Soil**

The proposed construction activities will lead to the generation of wastes. Improper handling of these wastes or their discharge into the surrounding environment without proper treatment would increase the level of micro-organisms (bacteria, viruses and fungi) that could be pathogenic to students and staff working in the area. The impact magnitude of the wastes on the soil is considered to be low. Thus, the impact significance is considered to be **minor**.

- ❖ **Potential Impact on Groundwater**

Groundwater may be impacted as a result of infiltration of contaminants associated with liquid wastes especially from spent oils. The impact magnitude is considered low. The impact sensitivity is medium because groundwater is a major source of potable water within the Project AoI. The potential for groundwater contamination as result of waste disposal is rated **minor**.

❖ **Potential Impact on Infrastructure**

Construction waste can potentially have impact on the existing waste management facility of the institution and the surroundings if not properly managed. Domestic wastes in FUBK are collected in the University and disposed through the State's waste collection system. Construction wastes such as scrap electrical components, batteries, damaged/defective panels and electrical cables (e-waste) cannot be disposed of in such manner. These wastes should be properly segregated and recycled accordingly. The quantity of domestic wastes designated for the dumping site will thus be **low**. The impact of the waste on the waste management facility of the project area is considered **negligible**.

5.5.3 Identified Impacts for Operations and Maintenance Phase

Power Generation and Distribution

Potential Impact on Noise

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

❖ **Potential Impact on Gender**

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

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

❖ **Potential Impact on Socio-economic and Health**

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

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

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

❖ **Potential Impact on Occupational Health, Safety and Welfare of Workers**

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

Routine Maintenance, Waste Generation and Disposal

During operation, waste may consist of damaged solar panels, replaced electrical components, transformer oil, battery waste (where storage systems are installed), maintenance materials such as oily rags, and general office and sanitary waste.

- **Potential Impact on Soil**

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

- **Potential Impact on Groundwater**

Potential impacts may include decrease in amount of groundwater reservoir as a result of water abstraction for cleaning of the PV panels. Cleaning of the PV panels is envisaged to be carried out more during the dry season than in the rainy season.

Based on internet research, each 1 MW of solar PV panels typically requires approximately 2,000–6,000 litres of water per cleaning cycle, depending on cleaning method and site conditions. The water required for the cleaning purpose would be obtained from the borehole proposed to be dug at the project site. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have serious effect on the existing groundwater aquifer of the Project area as well as the local water use. Thus, the impact significance is considered minor.

- **Potential Impact on Occupational Health, and Safety of Workers**

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

5.5.4 Identified Impacts for Decommissioning and Abandonment Phase

At the decommissioning stage, waste generated may include end-of-life solar panels, metal mounting structures, underground cables, concrete foundation debris, transformers with residual oil, battery systems (if applicable), and other demolition-related waste.

A. Environmental Impact

Positive

- Regrowth of new vegetation and return of species that have migrated away from the area.
- Restoration of the project land to the state close to its original state.

Negative

- Disturbance to soil profile, and potential contamination from surface runoff during abandonment.
- Ground water contamination from Site runoff resulting from dust suppression sprays, oils and grease from machinery and vehicles as well as wastewater from dismantling works.
- Pollution resulting from improper management of waste.
- Air quality pollution because of dust and heavy equipment dismantling movement.
- Increased noise levels within community during dismantling activities.

B. Socio-Economic Impacts

Negative

- Loss of employment/source of income due to activity closure.
- Disruption to academic and research activities previously supported by reliable solar power.
- Increased electricity costs if the university reverts fully to grid or diesel power supply.

C. Occupational Health Impacts

Negative

- Risk of injury from dismantling solar panels, mounting structures, and electrical components.
- Electrical shock and arc flash hazards during disconnection of live systems.
- Exposure to dust and hazardous materials during removal and disposal activities.
- Cuts, fractures, and musculoskeletal injuries from handling heavy equipment.
- Increased stress and fatigue due to intensive manual work and tight schedules.

5.6 Risk Assessment

Table 5.6 presents a comprehensive risk assessment for the solar-hybrid power plant project, identifying key environmental and socio-economic risks associated with the project activities. Each risk is evaluated based on several criteria: the likelihood of occurrence (L), frequency of occurrence (F), and potential impact (I). The table also assesses the significance of these impacts, providing a risk rating (R) and corresponding mitigation plans (P) to manage and mitigate these risks effectively.

The table covers a wide range of potential risks, from environmental concerns like air pollution and water contamination to socio-economic impacts such as employment opportunities and local economic growth. Each risk is categorized to provide a clear understanding of its potential effects and the steps required to mitigate these impacts, ensuring the project is conducted in a sustainable and responsible manner.

Key Elements of the Risk Assessment:

- Risk Description: Brief description of the identified risk.
- **Likelihood (L):** The probability of the risk occurring (Low, Medium, High).
- **Frequency (F):** How often the risk is likely to occur (Low, Medium, High).
- **Impact (I):** The potential severity of the risk's impact (Low, Medium, High).
- **Impact Significance:** Qualitative assessment of the impact's significance, considering both the duration and reversibility (e.g., Moderate, Short Term; Irreversible, Long Term).

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- **Risk Rating (R):** Overall assessment of the risk, combining likelihood, frequency, and impact (Low, Medium, High).
- **Mitigation Plan (P):** Recommended strategies and actions to mitigate or manage the identified risk.

The detailed risk assessment aims to ensure that all significant risks are identified, evaluated, and managed through effective mitigation strategies, thereby minimizing negative impacts on the environment and local communities while maximizing the positive outcomes of the project.

Table 5.6: Risk Assessment

Risk Description	Likelihood (L)	Frequency (F)	Impact (I)	Impact Significance	Risk Rating(R)	Mitigation Plan (P)
Air Pollution	Medium	Medium	Medium	Moderate, Short Term	Low	Install emission control systems, regular monitoring
Water Contamination	Low	Low	Medium	Irreversible, Long Term	Low	Implement water treatment facilities, strict waste management
Soil Degradation	Medium	Medium	Medium	Revisable, Long Term	Medium	Minimize land disturbance and restore affected areas.
Deforestation	Low	Low	Medium	Irreversible, Long Term	Medium	Reforestation efforts by limiting vegetation clearing and implement tree replanting.
Loss of Vegetation	High	Medium	High	Irreversible, Long Term	High	Create conservation areas, monitor biodiversity regularly
Noise Pollution	Medium	Low	Medium	Short Term, Moderate	Low	Restrict noisy activities to daytime hours.
Employment Opportunities	Medium	Low	Medium	Long Term, Significant	Medium	Prioritize local hires, provide training and skill development

Risk Description	Likelihood (L)	Frequency (F)	Impact (I)	Impact Significance	Risk Rating(R)	Mitigation Plan (P)
Local Economic Growth	Medium	Medium	Medium	Long Term, Significant	Medium	Support local businesses, invest in community infrastructure
Community Health Risks	Medium	Medium	Medium	Long Term, Significant	Medium	Enforce site safety and restrict public access.
Visual Impact	Medium	Medium	Low	Long Term, Significant	Low	Use proper site layout and vegetative screening.
PV Panel Waste (End-of-Life)	Medium	Medium	Low	Long Term, Significant	Medium	Implement recycling and proper disposal plans.

5.7.1 Environmental Residual Impacts

Environmental residual impacts refer to the impacts that remain after the implementation of mitigation measures. Despite applying recommended mitigation strategies during project implementation and operation, some environmental effects may persist. These residual impacts may include minor air emissions from equipment operation, limited noise generation during construction or operation, and minimal disturbance to soil and vegetation. Continuous monitoring and adaptive management measures are required to ensure that such impacts remain within acceptable regulatory limits and do not significantly affect the surrounding environment.

5.7.2 Social Residual Impacts

Social residual impacts are the effects that remain on local communities after mitigation measures have been implemented. Although mitigation strategies such as community engagement, employment opportunities, and stakeholder consultation reduce negative social impacts, some residual effects may persist. These may include temporary disruptions during construction activities, changes in local traffic patterns, or minor socio-economic adjustments within the institution premises. Proper stakeholder communication and grievance redress mechanisms should remain active to manage these residual effects effectively.

5.7.3 Cumulative Impacts

Cumulative impacts were considered within the FUBK permanent campus, the project's internal distribution corridor and the immediately adjoining community, with emphasis on the proposed construction period and early operational phase. The review considered existing campus activities and reasonably foreseeable developments that could interact with the Project through traffic, noise, dust, waste generation, groundwater abstraction, vegetation clearance or pressure on institutional services.

Based on site reconnaissance and information available during the ESIA, no major concurrent development with a confirmed overlapping footprint and construction schedule was identified. Nevertheless, routine campus construction, road maintenance, expansion of university facilities and other infrastructure works could produce temporary combined effects if undertaken simultaneously.

Before mobilisation, the EPC Contractor shall consult the FUBK Directorate of Works and Physical Planning to identify projects scheduled for the same period. Construction schedules, traffic routes, working hours, water use and waste arrangements shall be coordinated. Cumulative conditions shall be reviewed during monthly ESMP meetings and mitigation adjusted where overlapping activities are identified.

CHAPTER SIX
MITIGATION MEASURES

6.1 Introduction

This chapter presents appropriate and cost-effective mitigation measures to prevent, reduce, control, remedy, or compensate for adverse impacts and enhance the positive benefits of the proposed solar based power plant project in Federal University Birnin-Kebbi, Kebbi State. These measures aim to reduce impacts to As Low as Reasonably Practicable (ALARP). Residual impacts that may occur despite these mitigation measures are also acknowledged. Subsequently, Chapter Seven will detail management plans to oversee and monitor these mitigation measures through an effective Environmental and Social Management Plan (ESMP). The acceptability or suitability of a project is contingent on various factors, one of which is the mitigation of negative environmental and social impacts to tolerable levels. Typically, reducing impact significance involves implementing mitigation measures to address identified negative impacts.

6.2 Mitigation Objectives and Approach

The primary objectives of mitigation measures are prevention, reduction, and possible control of impacts. For clarity, the following definitions are provided:

- **Avoidance:** Methods aimed at preventing the occurrence of negative impacts or impeding such occurrences from resulting in harmful environmental or social outcomes.
- **Minimization:** Limiting or reducing the degree, extent, magnitude, or duration of adverse impacts. Reduction can be achieved by scaling down, relocating, or redesigning project elements.
- **Control:** Ensuring that occurring impacts are reduced to a level as low as reasonably practicable.
- **Restoration and rehabilitation:** Recompense for residual impacts through offsets, where technically and financially feasible.

Table 6.1: Summary of Mitigation Approach.

Project Phase	Mitigation Hierarchy	Approach
Project Design Phase	Avoidance and minimization	• Micro-siting: changing the layout of project infrastructure to avoid sensitive areas • Re-routing, marking or burying powerlines to avoid collision risks and barrier effects • avoiding sites where university staff cultivate crops in order to avoid economic displacement
Construction Phase	Avoidance	• Scheduling: changing the timing of construction activities to avoid disturbing biodiversity during sensitive periods • scheduling to avoid high traffic period in the university, especially during exams

Project Phase	Mitigation Hierarchy	Approach
	Minimization	• Abatement controls to reduce emissions and pollutants (noise, erosion, waste) created during construction • Operational controls to manage and regulate contractor activity, such as exclusion of fencing around sensitive areas, designated machinery and lay-down areas, minimizing vegetation loss and disturbance to soil
	Restoration and rehabilitation	• Repair of degradation or damage to biodiversity features and ecosystem services from project-related impacts that cannot be completely avoided and/or minimized by revegetating of temporary-use and lay down areas as soon as reasonably practicable after construction activities are complete
Operational Phase	Minimization	• Physical controls involving modification to infrastructure, or its operation, to reduce impacts (e.g. modifications to solar technology and their associated foundations, and modifying security perimeter fencing and overhead transmission lines) • Abatement controls including wastewater management and water conservation measures • Operational controls to manage and regulate contractor activity such as managing the timing of vegetation control activities at suitable intervals
Decommissioning Phase	Avoidance	• Scheduling: changing the timing of decommissioning activities to avoid disturbing biodiversity during sensitive periods (e.g. during breeding seasons)
	Minimization	• Abatement controls to reduce emissions and pollutants (noise, erosion, waste) during decommissioning and repowering • Operational controls to manage and regulate contractor activity through, for example, exclusion fencing around sensitive areas, designated machinery and lay-down areas)

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

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Table 6. 2: Mitigation Measures for the Potential Negative Impacts of the proposed Project

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
Pre-construction Phase					
Site selection/ land	Land Retrieval	Minor loss of access to institutional land within the project footprint.	Moderate	• Before mobilisation, REA-PMU, FUBK and the EPC Contractor shall undertake a joint inspection of the approved project footprint to confirm that it remains free of cultivation, occupation, structures and livelihood use. The inspection shall be documented through a signed land-use verification form, dated photographs and site coordinates. Site clearing shall be restricted to the verified and approved footprint. If active cultivation, occupation or livelihood use is identified, the affected area shall be demarcated and excluded from works pending assessment under AfDB OS5. No land access or site clearing shall occur in that area until the appropriate proportionate safeguard measures have been completed.	Low

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Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
Site clearing and preparation	Terrestrial flora and fauna	• Loss of vegetation and migration of faunas from the area, leading to alteration of species composition and abundance	High	• 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 shall be sensitized on ecological protection.	Moderate
	Health (Workers Safety)	• Injuries and accidents to workers during site clearing and preparation. • Negative health effects on health of project workers/students/institution staff by emissions and dust	Minor	• Site clearing shall be limited to the day time as much as possible. • Unregistered labourers and touts shall not be engaged for off-loading materials • Provision of adequate personal protective equipment (PPE) such as nose masks shall be ensured. All employees will be required to wear the appropriate PPE whilst	Negligible

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
		released from site clearing and preparation activities.		performing their duties.	
	Air quality and noise	- Increased suspended particulate in ambient air and degradation of ambient air quality by emission from site clearing equipment. - Increase in ambient noise levels	Medium	• Construction vehicles with efficient engine performance and with minimal noise and air emissions shall be selected and used. This can be achieved through regular servicing and maintenance. • All materials with potential to result in dust emissions shall be covered during transport. • Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – • 20km/h so as to reduce dust generation.	Negligible
	Infrastructure (road)	Increase in vehicular movement and traffic around the project site potential for road accident.	Medium	• 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.	Negligible

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
	Waste Generation	Potential soil contamination from mishandling of clearing equipment's, generated solid/liquid waste, i.e engine oil from the clearing vehicle.	Minor	• Mobilization of materials shall be limited to the day time 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.	Negligible
Construction Phase					
Civil and Electrical Works, and Installation of Plant Facilities	Soil	• Excavation, loosening of soil, stockpiling, mixing, filling, etc. These activities can directly impact soil environment negatively contributing to soil degradation and possibly accelerated	Moderate	• Stockpiles shall be appropriately covered to reduce soil loss as a result 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 shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development	Minor

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
		erosion.		footprint. • Installation of palisade fence during the construction phase to reduce any erosion potential	
	Air Quality	• Air quality impacts due to emission from construction equipment • Increase in dust from cleared land and windblown stockpiles	Minor	• 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 Level	• Civil work and installation activities, vehicular movement and operation of construction equipment may lead to elevated noise levels beyond baseline concentration. Noise may cause a major disturbance to fauna species such as birds	Minor	• Construction activities shall be limited to day- time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). In the event that noisy activities are undertaken outside of the specified working hours, all noise receptors in the Project area shall be informed of such activities in advance. • Construction machinery shall be turned off when not in use. • Machinery/equipment to be used for construction work shall meet industry	Negligible

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Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
		and mammals in the area. These would move further into the forest to avoid the disturbance.		best standard in relation to noise attenuation. • Construction equipment shall be properly maintained and serviced. • 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	• Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks. • Decreased amount of groundwater as a result of groundwater abstraction for project activities.	Minor	• The EPC Contractor will be required to design appropriate drainage system that takes due regards 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; • 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.	Negligible

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Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
				• Waste receptacles shall be provided within a secure area for collection of solid waste. • Construction vehicles and equipment will be serviced regularly and will be serviced off site.	
	Terrestrial Flora and Fauna	Increase in human activity, noise level, creation of areas of bare soil would create a resulting effect which would be the altering of the composition and diversity of flora species in the site as well as migration of fauna species that make use of the plants for food and shelter further away into the forest..	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 as a result of the disturbance that has taken place. • Hunting or deliberate killing of animals by construction workers shall be prohibited and monitored.	Negligible
	Infrastructure (road)	Road damage, traffic and safety impacts, due to movement of heavy vehicles and machinery	Minor	• Speed limits for all construction-related vehicles shall be established and enforced. • Construction related vehicles shall be	Negligible

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
		within the university premises		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 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.	
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate	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	Negligible

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
		partner violence, poor working)		required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) • GBV sensitive channels for reporting in GRM shall be implemented for the Project • The EPC Contractor shall be required to hire a Gender/GBV officer. • All workers shall be required to undergo regular training and refreshers on GBV • All gender-based violence incidents shall be reported and dealt with as per the law.	
	Socio-economic and health	The potential behaviour of workers, most especially male construction workers, may lead to an increase in levels of drugs and alcohol abuse, and an increase in incidence of casual sexual relations, which may result in increase in sexually	Moderate	• Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the Students area 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	Minor

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
		transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies.		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/AIDS and other sexually transmitted diseases shall be created among the workforce and extended to the local community. • Public access shall be restricted to construction area via security fencing and appropriate signage. • Substance abuse prevention and management programs shall be implemented for workers. Sanctions (e.g., suspension and dismissal) shall be introduced for workers involved in criminal activities • Procedure for receiving and addressing community concerns shall be developed and implemented.	

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
Waste Generation and Disposal	Soil	**Non-Hazardous Waste** include cartons, pallets, plastics, scrap metals, electrical cables offcuts, excavated soil, concrete debris. Hazardous Waste include; Used engine oil. Lubricants, oil contaminated rags, paint container, chemical containers	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)	Disposal of construction wastes to existing waste management facility in the Project area.	Minor	• Training shall be provided for workers on safe storage, use and handling of e-waste on site. • E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal • Waste receptacles shall be provided within a secured area for collection of solid waste.	Negligible
	Groundwater	Groundwater may be impacted because of infiltration of contaminants associated	Minor	• Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site.	Negligible

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
		with liquid wastes especially from used or vehicle oils.		• Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. • Portable spill containment and clean-up kits shall be available onsite. • Waste management plan (WMP) 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.	
Operation and Maintenance Phase					
Power Generation and distribution	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	Moderate	• Engineering controls shall be ensured through equipment selection and installation fidelity • Appropriate PPE shall be provided for workers. • Training shall be provided to employees on emergency	Minor

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Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
		discrimination, denial of rights, unfair treatment, poor working conditions		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.	
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working)	Moderate	• Equal treatment of workers shall be ensured. • 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.	Minor

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
				• All workers shall be required to undergo regular training and refreshers on GBV • All gender-based violence incidents shall be reported and dealt with as per the law.	
Routine Maintenance, Waste Generation and Disposal	Soil	• Soil contamination from spent batteries and inverters. • Accidental release of hazardous materials generated from routine maintenance activities could lead to contamination of the soils, thus altering soil quality status	Moderate	• 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. • 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

Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Low	• Appropriate PPE shall be provided for workers. • Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. • Strict compliance to the SOPs shall be ensured.	Negligible
	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 of PV panels with water is 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
Decommissioning and Closure Phase					
Dismantling of facilities, buildings, utility and	Livelihood	Loss of employment for workers during decommissioning	High	Provide early notice of project closure; offer retraining and redeployment opportunities within the university or contractor network; ensure payment of all entitlements and benefits.	Minor

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Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
ancillary facilities	Groundwater	Possible contamination from dismantling activities and battery water infiltration	Low	Implement controlled dismantling procedures; prevent spillages; use drip trays; safely collect and dispose of battery fluids and hazardous materials through licensed waste contractors; conduct post-decommissioning water quality testing.	Negligible
	Air and Noise Quality	Emissions and noise from vehicles and dismantling equipment	High	Restrict work to daytime hours; maintain machinery to reduce emissions; use low-noise equipment; apply dust suppression (water spraying); enforce use of PPE.	Minor
	Terrestrial Flora and Fauna	Noise generated by machinery may disturb flora species, causing them to flee the site and potentially leading to changes in species composition and abundance due to migration from the area.	Low	Limit vegetation clearing; schedule activities to minimize disturbance; restore disturbed areas through re-vegetation; monitor site recovery.	Negligible

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Project Activities	Receptors	Summary of Associated Potential Impacts	Impact Category Before Mitigation	Mitigation Measures	Impact Category After Mitigation
	Waste Generation	Soil and/or water contamination from improper waste handling	Medium	Segregate waste using approved colour-coded system; store hazardous waste properly; recycle recyclable materials; dispose of waste through authorized contractors; conduct site clean-up and environmental restoration after decommissioning.	Minor

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CHAPTER SEVEN
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction

The potential environmental and social impacts associated with the proposed 1.0 MW Solar Photovoltaic (PV) Power Plant to be developed within the permanent site of the Federal University Birnin Kebbi (FUBK), Kebbi State, under the Rural Electrification Agency (REA) Desert-to-Power Initiative (Nigeria Electrification Project Phase II), have been evaluated in Chapter Five of this ESIA.

The assessment confirms that most identified impacts are localized, temporary (during construction), and manageable. These include:

- Short-term dust emissions and elevated noise levels during construction;
- Minor vegetation clearance within the approved project footprint;
- Temporary traffic increase along the Maidahini–Dangoma–Kalgo Junction corridor;
- Occupational health and safety risks to workers;
- Community health and safety concerns, including GBV risk and labour influx considerations;
- Generation of construction and operational waste streams.

The analysis further shows that with the implementation of the mitigation measures outlined in Chapter Six, the adverse impacts will not be significant and can be reduced to as low as reasonably practicable (ALARP). However, mitigation commitments alone are insufficient unless they are translated into structured management actions, clearly assigned responsibilities, supported by financial resources, and integrated into each phase of Project implementation.

This Chapter therefore presents the Environmental and Social Management Plan (ESMP) for the proposed Project. It provides:

- Phase-specific management measures;
- Monitoring requirements and performance indicators;
- Institutional roles and responsibilities;
- Implementation timelines; and
- Cost provisions for mitigation and monitoring.

In addition, it outlines the framework for supplementary management plans (e.g., Occupational Health and Safety Plan, Waste Management Plan, Traffic Management Plan, and GBV Action Plan) to be developed and implemented under this ESMP.

7.2 Objectives of the ESMP

The ESMP serves as the operational framework for ensuring that environmental and social considerations are effectively integrated into the planning, construction, operation, and eventual decommissioning of the Project. It promotes proactive risk management rather than reactive correction and ensures that environmental performance and social safeguards are embedded in day-to-day decision-making.

The ESMP specifically aims to:

- Promote sound environmental stewardship and social responsibility throughout the Project lifecycle;
- Ensure compliance with applicable Nigerian environmental regulations, safeguard policies, and institutional requirements;
- Integrate environmental and social considerations into engineering design, procurement, contractor obligations, and operational procedures;
- Provide a clear action plan for implementing mitigation and enhancement measures identified in the ESIA;
- Define roles and responsibilities of REA, FUBK management, contractors, and supervising authorities;
- Establish a structured monitoring and reporting system for environmental and social performance;
- Ensure proper documentation of monitoring results, audits, incidents, corrective actions, and non-compliance management;
- Facilitate transparency and accountability through stakeholder engagement and grievance redress mechanisms.

Through these objectives, the ESMP provides assurance that environmental risks, health and safety hazards, and social concerns are systematically identified, minimized, and managed within acceptable thresholds.

7.3 Environmental and Social Management Measures

The environmental and social management measures required to mitigate the identified impacts of the Project during development and operation are presented in Tables 7.1 to 7.8. These measures are structured according to the major phases of the Project:

- Pre-construction phase (site preparation, mobilization, stakeholder engagement);
- Construction phase (civil works, installation, electrical integration);
- Operation phase (power generation, maintenance, monitoring).

The tables outline for each identified impact:

- The specific mitigation or enhancement measure;
- The responsible implementing entity;
- Monitoring indicators and verification methods;
- Frequency or timeframe of implementation; and
- Estimated cost provisions.

It is important to note that environmental and social management during decommissioning is treated separately and comprehensively addressed in Chapter Eight of this report.

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Table 7.1: Environmental Management Measures 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							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Vegetation loss; direct impacts on vegetation and soil organisms; indirect disturbance to fauna	Vegetation clearing shall be strictly limited to the approved footprint within the FUBK project site.	Site inspection reports	Daily	Compliance with approved clearing boundary	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Use of herbicides shall be prohibited. Mechanical clearing methods only shall be adopted.	Inspection records	Daily	No evidence of chemical clearing	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Bush burning shall be strictly prohibited.	Inspection	Daily	No evidence of burning	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Areas cleared but not used for installations shall be restored and re-vegetated using locally occurring Sudan-Savannah species.	Visual inspection	Monthly (post-clearing)	Evidence of vegetation regrowth	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	The extent of vegetation to be cleared shall be clearly demarcated prior to commencement of works. Clearing beyond approved limits shall not be permitted.	Boundary demarcation verification	Before and during clearing	Demarcated site boundary	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL

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	Hunting, trapping, or deliberate killing of wildlife by workers shall be prohibited. Environmental awareness sensitization shall be conducted for workers.	Worker induction records; Inspection	Daily during clearing	No reported wildlife incidents	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL

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Topsoil Removal, Soil Compaction and Erosion Risk							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Loss of topsoil; increased erosion potential; soil compaction; reduced infiltration capacity	Vegetation removal and soil stripping shall be restricted to required construction areas only.	Site inspection	Daily	No unnecessary land disturbance	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Topsoil (0–30 cm) shall be stripped, stockpiled separately, and preserved for site restoration.	Stockpile inspection	Daily	Properly stored topsoil	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Soil conservation measures such as silt traps, temporary drainage channels, and erosion barriers shall be installed where necessary.	Inspection of erosion control structures	Daily	Functional erosion control measures	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Disturbed areas not permanently occupied by infrastructure shall be reinstated and stabilized.	Visual inspection	Monthly	Stabilized ground surface	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL

Air Quality and Noise Impacts from Site Clearing Equipment							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Air emissions from machinery; temporary increase in noise levels	Site clearing equipment shall be maintained in optimal operating condition to ensure fuel efficiency and reduced emissions.	Maintenance records; Fuel logs	Daily	Updated servicing records	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Machinery shall be fitted with functional noise suppression systems. Unnecessary engine idling shall be avoided.	Inspection	Daily	Reduced idling time	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Clearing activities shall be conducted during designated daytime hours only	Work schedule verification	Daily	Compliance with approved work hours	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL

Air Quality and Noise Impacts from Site Clearing Equipment							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
	(08:00–17:00 on weekdays; 09:00–13:00 on weekends where necessary).						
Mobilization of Materials and Equipment to Site							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Air emissions and noise from vehicular movement	Only vehicles with efficient engine performance and low emission profiles shall be deployed. Regular servicing shall be ensured.	Vehicle inspection; Maintenance records	Prior to deployment and periodic	Roadworthy vehicle certification	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Materials likely to generate dust during transport shall be properly covered.	Inspection before departure	Prior to each trip	Covered materials observed	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Vehicle speed within the project site and on unpaved campus roads shall be limited to 15–20 km/h to minimize dust generation and ensure campus safety.	Speed monitoring; Visual inspection	Daily	Compliance with speed limit	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL

Table 7.2: Social Management Measures 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							
Land Use Change							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Risk that land-use conditions may change between the ESIA survey and mobilisation	Conduct joint pre-construction land-use verification; document site condition using signed inspection form, photographs and coordinates; restrict works to verified open land; stop and screen any area where cultivation, occupation or livelihood use is identified.	Signed land-use verification report; geotagged photographs.	At least 30 days before mobilisation and again immediately before site handover	approved site-handover record; absence of unresolved land-use claims	REA-PMU, FUBK and EPC Contractor	REA (PMU)	NIL

Relocation of Existing Infrastructure							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Relocation of any existing campus trench, utility, or security infrastructure within the approved Project footprint	Relevant campus authorities shall be consulted before relocation or modification of any trench or underground infrastructure.	Evidence of consultation	Prior to site clearing	Consultation records	FUBK Management / EPC Contractor	REA (PMU)	2,000
	Alternative location shall be agreed upon and approved by FUBK before relocation.	Site inspection	Prior to relocation	Approved relocation site	EPC Contractor	REA (PMU)	

Disruption of Campus Commercial Activities							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Temporary disruption of campus vendors or commercial activities during trenching or cable laying (if required)	Consultations shall be held with affected vendors and campus stakeholders prior to trenching and underground cable works.	Evidence of consultation	Prior to trenching	Consultation records	FUBK Management / EPC Contractor	REA (PMU)	200
	A Grievance Redress Mechanism (GRM) shall be developed, implemented, and communicated to affected stakeholders.	GRM records	Prior to trenching and ongoing	Records of complaints received and resolved	EPC Contractor	REA (PMU)	NIL

Worker Injuries During Loading and Off-Loading							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Injuries and accidents during material handling	Adequate Personal Protective Equipment (PPE) including gloves, safety shoes, reflective jackets, and hard hats shall be provided and enforced.	Availability of PPE; Site inspection	Daily	PPE compliance rate	EPC Contractor	REA (PMU); FUBK Site Engineer	500
	Only registered and trained workers shall be engaged for loading and off-loading activities.	Employment records	Before mobilization	Verified staff list	EPC Contractor	REA (PMU)	NIL

Increase in Vehicular Movement and Traffic Risks							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Increased traffic and potential road accidents within campus and access roads	A Traffic Management Plan (TMP) shall be developed and implemented prior to mobilization.	TMP implementation records	Daily during mobilization	Compliance with TMP benchmarks	EPC Contractor	REA (PMU); FUBK Site Engineer	1,000
	Appropriate signage, barriers, and designated crossing points shall be installed within the Project area.	Site inspection	Before and during mobilization	Safety measures in place	EPC Contractor	REA (PMU)	NIL
	Speed limits within campus and community areas shall not exceed 20 km/hr.	Speed monitoring records	Daily	Compliance with speed limit	EPC Contractor	REA (PMU)	NIL
	Drivers' competency shall be assessed prior to deployment; additional training shall be provided where necessary.	Driver assessment records	Before mobilization	Competency certification	EPC Contractor	REA (PMU)	NIL
	A procedure for recording traffic incidents shall be developed and implemented.	Incident report forms	Daily	Completed incident forms	EPC Contractor	REA (PMU)	NIL
	Employee violations of traffic rules shall attract disciplinary action in line with contractor policy.	Incident records; Disciplinary log	As required	Documented disciplinary actions	EPC Contractor	REA (PMU)	NIL

Table 7.3: Environmental 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							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**

Air emissions from construction equipment; dust from exposed soil and stockpiles	Regular servicing and preventive maintenance of all construction machinery shall be ensured.	Maintenance records	Monthly during construction	Compliance with maintenance schedule	EPC Contractor	REA (PMU); FUBK Site Engineer; FMEnv; Kebbi State Ministry of Environment	1,000
	Routine water sprinkling shall be undertaken during civil works to suppress dust.	Site inspection	Daily during civil works	Visible dust control measures implemented	EPC Contractor	REA (PMU)	NIL

Increase in Noise Levels							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Elevated noise from machinery and installation works	Construction activities shall be restricted to daytime hours (08:00–17:00 weekdays; 09:00–13:00 weekends).	Inspection	Daily during construction	Compliance with working hours	EPC Contractor	REA (PMU); FUBK Site Engineer	NIL
	Machinery shall be switched off when not in use.	Inspection	Daily	Reduced idling observed	EPC Contractor	FMEnv	NIL
	Equipment shall be properly maintained to reduce excessive noise.	Maintenance records	Monthly	Equipment in good condition	EPC Contractor	Kebbi State Ministry of Environment	NIL
	Noise complaints shall be logged and addressed promptly.	Complaint records	Weekly	Complaint resolution records	EPC Contractor	REA (PMU)	NIL
	Noise monitoring shall be conducted at locations with repeated complaints.	Noise monitoring records	Monthly	Compliance with FMEnv/ NESREA permissible noise limits	EPC Contractor	REA (PMU); FMEnv	NIL

Soil Disturbance and Erosion							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Increased erosion and reduced soil stability from excavation and trenching	Excavation shall not be carried out during extreme weather conditions.	Inspection	Daily during excavation	Compliance with requirement	EPC Contractor	REA (PMU); FUBK Site Engineer; FMEnv	-
	Soil stockpiles shall be covered to minimize erosion by wind or runoff.	Inspection	Daily during civil works	Covered stockpiles observed	EPC Contractor	Kebbi State Ministry of Environment	-

Loss of Flora and Fauna / Introduction of Alien Species							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Disturbance to vegetation and fauna; introduction of alien species	Workers shall receive ecological awareness training prior to construction.	Training records	Once before construction	Training certificates	EPC Contractor	REA (PMU); FUBK Site Engineer	200
	Construction equipment shall be cleaned before entering site to prevent introduction of invasive species.	Inspection	Daily	Clean equipment records	EPC Contractor	FMEnv; Kebbi State Ministry of Environment	-
	Monitoring shall be conducted to ensure alien plants do not establish on disturbed land.	Monitoring records	Monthly	No spread of invasive species	EPC Contractor	REA (PMU)	-

Road Damage, Traffic and Safety							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Road damage and increased accident risk due to construction traffic	Traffic Management Plan (TMP) shall be implemented throughout construction.	TMP records	Daily	Compliance with TMP benchmarks	EPC Contractor	REA (PMU); FUBK Site Engineer	1,000
	Speed limits for construction vehicles shall be enforced.	Inspection	Daily	Compliance with speed limits	EPC Contractor	FMEnv	-
	Appropriate barriers and signage shall demarcate active construction areas.	Safety signs and barriers	Before and during construction	Safety installations in place	EPC Contractor	Kebbi State Ministry of Environment	-
	Drivers' competency shall be assessed prior to deployment.	Driver assessment records	Before construction	Certified drivers	EPC Contractor	REA (PMU)	-
	Traffic incident reporting procedure shall be implemented.	Incident forms	Daily	Completed incident logs	EPC Contractor	REA (PMU)	-
	Damage to public or private property shall be repaired or compensated promptly.	GRM and incident records	As required	Documented corrective action	EPC Contractor	REA (PMU)	-

Waste Disposal and Generation							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Generation of electrical and electronic waste during installation	Waste Management Plan (WMP) shall be developed and implemented.	WMP records	Weekly	Compliance with WMP	EPC Contractor	REA (PMU); FUBK Site Engineer; FMEnv	2,000
	Workers shall be trained on safe handling of e-waste.	Training records	Once before construction	Training certificates	EPC Contractor	Kebbi State Ministry of Environment	-

Waste Disposal and Generation							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
	E-waste shall be stored in designated areas prior to recycling or disposal.	Waste consignment notes; inspection	Weekly	Proper waste storage observed	EPC Contractor	REA (PMU)	-

Soil and Groundwater Contamination							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Soil contamination from hazardous substances	Hazardous materials shall be stored on impervious surfaces with secondary containment; spill kits shall be available onsite.	Inspection	Daily	Compliance with AfDB OS3 and applicable NESREA regulations.	EPC Contractor	REA (PMU); FUBK Site Engineer; FMEnv	500
	Workers shall receive training on handling hazardous substances.	Training records	Once before construction	Training certificates	EPC Contractor	Kebbi State Ministry of Environment	-

Groundwater Contamination from Liquid Construction Waste Streams							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Potential groundwater contamination from fuels, lubricants, and other liquid waste streams during construction activities	Construction workers shall receive training on safe storage, handling, and use of fuels, lubricating oils, and other hazardous liquids.	Training records	Once prior to commencement of construction	Certificates of training completion	EPC Contractor	REA (PMU); FUBK Site Engineer	500

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Groundwater Contamination from Liquid Construction Waste Streams							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
	Hazardous substances shall be stored on impervious hardstanding surfaces with adequate secondary containment. Spill containment and clean-up kits shall be maintained onsite at all times.	Site inspection; storage facility verification	Daily during construction phase	Compliance with AfDB OS3 and applicable NESREA regulations.	EPC Contractor	FMEnv; Kebbi State Ministry of Environment	-
	A Waste Management Plan (WMP) shall be implemented throughout the construction phase to ensure proper segregation, storage, and disposal of liquid and hazardous wastes.	WMP implementation records	Daily during construction phase	Compliance with WMP benchmarks	EPC Contractor	REA (PMU)	-

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							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Discrimination in employment and	Employment for construction activities shall be transparent and non-discriminatory. No	Employment records	Once before commencement of construction	Compliance with Labour Act and	EPC Contractor	REA (PMU); FUBK Site Engineer; FMEnv; Kebbi State	2,000

training; potential child labour	person under the age of 18 shall be engaged on the Project.			recruitment procedures		Ministry of Environment	

Gender-Based Violence (GBV), Sexual Exploitation and Abuse (SEA), and Harassment							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Risk of GBV/SEA, workplace harassment, and poor working conditions	The Project GBV Action Plan shall be implemented by the EPC Contractor.	Evidence of implementation	Once before commencement of construction	Documented implementation of GBV Action Plan	EPC Contractor	REA (PMU); FUBK Site Engineer	-
	Workers shall undergo regular GBV awareness training and refreshers.	Training attendance records	Monthly during construction	Records of training and attendance	EPC Contractor	FMEnv	-
	All workers shall sign a Code of Conduct (CoC) prohibiting GBV/SEA.	Signed CoC forms	Once before construction	Signed CoC forms on file	EPC Contractor	Kebbi State Ministry of Women Affairs and Social Development	-
	GBV-sensitive reporting channels shall be integrated into the GRM.	GRM records	Monthly during construction	Confidential complaints recorded and addressed	EPC Contractor	REA (PMU)	-
	A Gender/GBV Officer shall be engaged by the EPC Contractor.	Employment records	Before construction	Appointment letter and job description	EPC Contractor	REA (PMU)	-
	Collaboration with relevant government institutions and GBV service providers shall be ensured for case management.	Engagement records	Once before construction and ongoing	Evidence of engagement and referral pathways	EPC Contractor	REA (PMU)	-
	Separate sanitary facilities for men and women shall be	Site inspection	Once before construction	Adequate facilities and signage in place	EPC Contractor	REA (PMU)	-

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Gender-Based Violence (GBV), Sexual Exploitation and Abuse (SEA), and Harassment							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
	provided and GBV-free signage displayed onsite.						

Influx of Workers and Risk of Sexually Transmitted Diseases (STDs)							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Influx of workers; increased risk of STDs including HIV/AIDS	As much as possible, semi-skilled and unskilled labour shall be sourced locally.	Employment records; Labour Management Plan	Once before construction	Compliance with local hiring commitment	EPC Contractor	REA (PMU); FUBK Site Engineer	3,000
	The local community shall be informed of construction activities before commencement.	Consultation records	Once before construction	Evidence of stakeholder engagement	EPC Contractor	FMEnv	-
	Induction programme including Code of Conduct shall be conducted for all workers.	Induction records	Before construction	Completed induction sessions	EPC Contractor	Kebbi State Ministry of Environment	-
	Awareness on HIV/AIDS and other STDs shall be provided to workers and nearby campus community.	Training records	Once before construction	Evidence of sensitization	EPC Contractor	REA (PMU)	-
	Public access to the construction area shall be restricted using fencing and signage.	Site inspection	Daily during construction	Restricted access observed	EPC Contractor	REA (PMU)	-
	A procedure for receiving and addressing community grievances shall be implemented.	GRM records	Weekly during construction	Compliance with AfDB Good Practice Note on Addressing Grievances	EPC Contractor	REA (PMU)	-

Temporary Loss of Space for Vendors							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Occupational injuries and accidents during construction activities	A Health and Safety Plan shall be developed and implemented.	HSE implementation records	Daily during construction	Compliance with HSE Plan benchmarks	EPC Contractor	REA (PMU); FUBK Site Engineer; FMEnv; Kebbi State Ministry of Environment	4,000
	Daily toolbox talks shall be conducted prior to work commencement.	Toolbox talk records	Daily	Documented toolbox sessions	EPC Contractor	REA (PMU)	-
	A qualified Safety Officer shall be engaged to monitor compliance.	Employment record	Before construction	Safety Officer in place	EPC Contractor	REA (PMU)	-
	PPE (boots, helmets, coveralls, goggles, reflective vests, etc.) shall be provided and compliance monitored.	PPE inspection records	Daily	PPE compliance rate	EPC Contractor	REA (PMU)	-
	Safety training including first aid and fire-fighting shall be provided.	Training records	Before and weekly during construction	Certificates of completion	EPC Contractor	REA (PMU)	-
	Worker grievance mechanism shall be implemented.	Grievance records	Weekly	Documented worker complaints addressed	EPC Contractor	REA (PMU)	-
	Hazardous substances shall be stored in accordance with AfDB OS3 and applicable NESREA regulations.	Inspection	Daily	Compliance with EHS Guidelines	EPC Contractor	FMEnv	-
	Waste Management Plan shall be implemented.	WMP records	Daily	Compliance with WMP benchmarks	EPC Contractor	REA (PMU)	-

Table 7.5: Environmental 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 / Commissioning Activities							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Temporary increase in ambient noise levels during plant testing and commissioning activities (e.g., inverter testing, transformer energization)	Strict compliance with approved Standard Operating Procedures (SOPs) during commissioning shall be ensured to minimize noise and operational risks.	Approved SOP documents	Once prior to commissioning	Compliance with SOP requirements	EPC Contractor	REA (PMU); FUBK Site Engineer	500
	The EPC Contractor shall prepare and finalize comprehensive Standard Operating Procedures (SOPs) for the operational phase of the Project prior to commissioning.	Approved SOPs for operation and maintenance	Once prior to commissioning	SOPs reviewed and approved	EPC Contractor	FMEnv; Kebbi State Ministry of Environment	-

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 / Commissioning Activities							
Occupational health and safety hazards (e.g., injury, electrocution) due to improper electrical	Plant testing and commissioning shall be carried out strictly by qualified and experienced electrical engineers.	Evidence of qualified and dedicated engineer	Once prior to commissioning	Certified personnel assigned	EPC Contractor	REA (PMU); FUBK Site Engineer; FMEnv; Kebbi State Ministry of Environment	200

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Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
connections during plant testing	Appropriate Personal Protective Equipment (PPE) shall be worn by all personnel involved in testing.	Availability and inspection of PPE	Prior to and during commissioning	Compliance with PPE requirements	EPC Contractor	REA (PMU)	NIL
	Prior to commissioning, emergency response equipment (e.g., fire extinguishers, insulated tools, first aid kits) shall be made available onsite.	Inspection of emergency equipment	Once before commissioning	Emergency equipment in place and functional	EPC Contractor	REA (PMU)	NIL
Explosion or fire resulting from faulty wiring or incorrect electrical connections during energization	Testing, energization, and synchronization procedures shall be carried out strictly by qualified and dedicated engineers in accordance with approved commissioning protocols.	Qualified personnel records; commissioning checklist	Once prior to commissioning	Compliance with commissioning procedures	EPC Contractor	REA (PMU); FUBK Site Engineer; FMEnv; Kebbi State Ministry of Environment	NIL

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							
Landscape Alteration / Visual Impact							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Landscape alterations resulting in visual changes within the campus environment	Lighting shall be kept to the minimum required for safety and operational efficiency. Where necessary, low-level, shielded, downward-directed lighting shall be used to prevent light spill.	Site inspection	Monthly during operation	Compliance with lighting design	O&M Contractor	REA (PMU); FUBK Site Engineer; FMEnv; Kebbi State Ministry of Environment	NIL

	Site fencing shall be maintained (where required) to ensure safety and visual order.	Inspection	Once before operations and periodic review	Fence integrity maintained	O&M Contractor	REA (PMU)	NIL

Routine Maintenance, Waste Generation and Disposal							
E-Waste Generation and Disposal							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Generation of e-waste (damaged PV modules, inverter components, cables, etc.)	Workers shall receive training on safe storage, handling, and management of e-waste.	Training records	At induction of new staff and annual refresher	Certificates of training completion	O&M Contractor	REA (PMU); FUBK Site Engineer	2,000
	E-waste shall be stored in designated areas prior to recycling; waste consignment notes shall be maintained.	Waste consignment notes; inspection of storage area	Continuous during operations	Proper storage and documentation maintained	O&M Contractor	FMEnv; Kebbi State Ministry of Environment	NIL
	Secure waste receptacles shall be provided for collection of solid waste within the site.	Inspection of waste receptacles	Continuous during operations	Waste receptacles in place and functional	O&M Contractor	REA (PMU)	NIL

Soil Contamination from Spent Batteries and Inverters							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Soil contamination risks from improper disposal of spent batteries and electrical components	Waste that cannot be reused or recycled shall be disposed of at approved facilities. Spent batteries and inverters shall be returned to manufacturers or licensed recyclers	Consignment notes for spent batteries and inverters	Annually or at replacement cycle	Compliance with AfDB OS3 and applicable NESREA regulations.	O&M Contractor	REA (PMU); FUBK Site Engineer; FMEnv; Kebbi State Ministry of Environment	500

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Soil Contamination from Spent Batteries and Inverters							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
	in line with Extended Producer Responsibility (EPR) principles.						
	Waste Management Plan (WMP) shall be implemented throughout the operational phase.	WMP implementation records	Quarterly during operation	Compliance with WMP benchmarks	O&M Contractor	REA (PMU)	NIL

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Groundwater Abstraction from PV Panel Cleaning							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Groundwater abstraction for periodic cleaning of PV modules	A Water Management and Conservation Plan shall be implemented to regulate water use during panel cleaning.	Implementation records of water management plan	Quarterly during operation	Compliance with water conservation benchmarks	O&M Contractor	REA (PMU); FUBK Site Engineer; FMEnv; Kebbi State Ministry of Environment	NIL

Table 7.8: Social 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							
Gender-Based Violence (GBV), Sexual Exploitation and Abuse (SEA), Workplace Harassment							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
GBV risks during operational phase (sexual harassment, intimate partner violence, poor working conditions)	The Project GBV Action Plan shall be implemented throughout the operational phase.	Evidence of implementation	Continuous during operations	Documented implementation of GBV Action Plan	O&M Contractor	REA (PMU); FUBK Site Engineer	2,000
	All workers shall undergo regular GBV awareness training and refresher courses.	Training attendance records	Monthly during operations	Records of attendance and training materials	O&M Contractor	REA (PMU)	NIL
	All operational staff shall sign a Code of Conduct (CoC) prohibiting GBV/SEA.	Signed CoC forms	Once before commencement of operations	Signed CoC forms on file	O&M Contractor	REA (PMU)	NIL

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Gender-Based Violence (GBV), Sexual Exploitation and Abuse (SEA), Workplace Harassment							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
	GBV-sensitive reporting channels shall be integrated into the Project GRM.	GRM records	Once before operations and ongoing	Confidential complaints recorded and addressed	O&M Contractor	REA (PMU)	NIL
	A Gender/GBV Officer shall be engaged during operations.	Employment record; job description	Once before operations	Appointment documentation available	O&M Contractor	REA (PMU)	NIL
	Collaboration with relevant government institutions and GBV service providers shall be maintained for case management.	Engagement and consultation records	Continuous	Evidence of engagement and referral mechanisms	O&M Contractor	REA (PMU)	NIL
	Separate sanitary facilities for male and female staff shall be maintained, with GBV-free signage displayed onsite.	Site inspection	Once before operations and periodic checks	Adequate facilities and signage in place	O&M Contractor	REA (PMU)	NIL

Health, Safety and Welfare of Operational Staff							
Summary of Potential Impact	**Mitigation Measures**	**Monitoring Requirements / Parameters**	**Frequency**	**Performance Indicator**	**Responsible Party (Implementation)**	**Responsible Party (Monitoring)**	**Cost (US$)**
Health and safety risks during plant operation and maintenance activities	Provision of medical insurance scheme for employees shall be ensured.	Employee insurance documentation	Quarterly during operations	Evidence of active insurance coverage	O&M Contractor	REA (PMU); FUBK Site Engineer	3,000
	Appropriate safety signage (electrical hazard, restricted access, high voltage warning, emergency contact details) shall be installed and maintained at strategic locations.	Site inspection of safety signs	Quarterly during operations	Compliance with safety signage requirements	O&M Contractor	REA (PMU)	NIL

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7.4 Roles, Responsibilities and Accountabilities

The overall responsibility for oversight and coordination of ESMP implementation throughout the project life cycle lies with the Rural Electrification Agency – Project Management Unit (REA-PMU). However, direct implementation of specific environmental and social mitigation measures shall be:

- Undertaken by the EPC Contractor during the pre-construction and construction phases; and
- Undertaken by the Operations and Maintenance (O&M) Contractor during the operational phase.

Regulatory monitoring and compliance oversight shall be carried out by the Federal Ministry of Environment (FMEnv) and the Kebbi State Ministry of Environment, in accordance with applicable environmental regulations.

7.4.1 Pre-Construction Phase

The key personnel and institutions with major roles in ESMP implementation during the pre-construction phase are as follows:

❖ **Federal University Birnin Kebbi (FUBK) – Director of Physical Planning**

- Select and confirm the land designated for the proposed Project within the University.
- Appoint a qualified Site Engineer for project oversight.
- Ensure the Site Engineer receives adequate training on ESMP implementation.
- Review and endorse the ESMP prepared by the Consultant.
- Ensure institutional commitment to ESMP implementation throughout the project lifecycle.

❖ **REA – Project Management Unit (REA-PMU)**

- Provide technical support to FUBK in confirming suitability of land for the Solar PV installation.
- Appoint a qualified EPC Contractor.
- Supervise pre-construction activities of the EPC Contractor.
- Review and approve the ESMP submitted by the Consultant.
- Ensure REA's institutional commitment to ESMP compliance.

❖ **FUBK Site Engineer**

- Attend required training on ESMP implementation and monitoring.
- Supervise EPC Contractor activities to ensure compliance with ESMP mitigation measures.
- Report ESMP compliance and non-compliance issues to the Director of Physical Planning.
- Liaise with REA-PMU on environmental and social performance matters.

❖ **EPC Contractor**

- Familiarize fully with ESMP requirements and mitigation measures.
- Ensure all personnel are informed and trained on applicable environmental and social management measures.
- Implement ESMP requirements relevant to assigned activities.
- Report ESMP compliance and non-compliance issues to REA-PMU and FUBK Site Engineer.

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7.4.2 Construction Phase

The following institutions and personnel shall play key roles during the construction phase:

❖ **FUBK Director of Physical Planning**
- Supervise the activities of the Site Engineer through periodic review of ESMP compliance reports.
- Provide recommendations to REA-PMU on ESMP improvements and corrective actions.

❖ **REA – Project Management Unit (REA-PMU)**
- Supervise EPC Contractor activities through review of ESMP performance reports.
- Monitor ESMP implementation across environmental and social components.
- Engage with FUBK management to address non-compliance and emerging issues.
- Ensure timely corrective actions are implemented.

❖ **FUBK Site Engineer**
- Conduct routine supervision of EPC Contractor activities.
- Ensure compliance with environmental and social mitigation measures.
- Report compliance status and emerging risks to the Director of Physical Planning and REA-PMU.

❖ **EPC Contractor**
- Implement all ESMP mitigation measures relevant to construction activities.
- Appoint and retain a Gender/GBV Officer.
- Ensure compliance with Labour, Health and Safety, and Environmental regulations.
- Maintain records of environmental monitoring, grievances, incidents, and corrective actions.
- Submit periodic ESMP compliance reports to REA-PMU and FUBK Site Engineer.

❖ **Federal Ministry of Environment (FMEnv) Representatives**
- Monitor ESMP implementation and environmental compliance.
- Conduct periodic inspections and impact mitigation verification.
- Engage REA-PMU and FUBK management to address non-compliance issues.

❖ **Kebbi State Ministry of Environment Representatives**
- Monitor implementation of environmental mitigation measures at state level.
- Conduct compliance inspections and provide regulatory guidance.
- Engage REA-PMU and FUBK on corrective actions where necessary.

❖ **Kebbi State Ministry of Women Affairs and Social Development / GBV Service Providers**
- Monitor implementation of GBV mitigation measures.
- Provide advisory support on gender-related issues.
- Collaborate with the Gender/GBV Officer, FUBK management, and REA-PMU on case management and compliance improvement.

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7.4.3 Operational Phase

During the operational phase, ESMP implementation shall be led by the **O&M Contractor**, under the oversight of REA-PMU and FUBK management, with regulatory monitoring by relevant federal and state authorities.

❖ **Federal University Birnin Kebbi (FUBK) – Director of Physical Planning**
- Supervise the activities of the Site Engineer through periodic review of ESMP compliance reports.
- Recommend ESMP improvements to the O&M Contractor and REA-PMU to address non-compliance and emerging environmental or social risks.
- Ensure continued institutional commitment to environmental and social performance throughout operations.

❖ **REA – Project Management Unit (REA-PMU)**
- Appoint a qualified Operations and Maintenance (O&M) Contractor.
- Supervise the activities of the O&M Contractor through review of ESMP performance reports.
- Engage with FUBK management to address non-compliance and emerging operational risks.
- Ensure corrective actions are implemented in a timely manner.
- Maintain overall accountability for ESMP oversight during operations.

❖ **FUBK Site Engineer**
- Supervise the activities of the O&M Contractor and ensure compliance with ESMP mitigation measures.
- Conduct routine inspections of environmental and social management practices.
- Report ESMP compliance and non-compliance issues to the Director of Physical Planning and REA-PMU.
- Liaise with regulatory agencies during inspections and audits.

❖ **Operations and Maintenance (O&M) Contractor**
- Implement all ESMP requirements relevant to operational activities, including waste management, occupational health and safety, GBV mitigation, and environmental monitoring.
- Appoint and retain a Gender/GBV Officer during operations.
- Maintain environmental and social monitoring records.
- Report ESMP compliance and non-compliance issues to REA-PMU and FUBK Site Engineer.
- Ensure compliance with applicable federal and state environmental regulations and AfDB ISS.

❖ **Federal Ministry of Environment (FMEnv) Representatives**
- Monitor implementation of ESMP requirements (environmental compliance monitoring).
- Conduct periodic environmental inspections.

- Engage REA-PMU and FUBK management on corrective actions and improvements where required.

❖ **National Environmental Standards and Regulations Enforcement Agency (NESREA) Representatives**
- Monitor compliance with applicable national environmental standards and regulations.
- Conduct regulatory inspections and compliance verification.
- Discuss ESMP improvements with FUBK Director of Physical Planning and REA-PMU where necessary.

❖ **Kebbi State Ministry of Women Affairs and Social Development and GBV/SEA Service Providers**
- Monitor implementation of gender and GBV mitigation measures during operations.
- Provide advisory support and referral pathways for GBV case management.
- Engage with the Gender/GBV Officer, FUBK management, and REA-PMU on compliance improvements.

❖ **Kebbi State Ministry of Environment Representatives**
- Monitor implementation of ESMP requirements at the state level.
- Conduct environmental compliance inspections.
- Engage O&M Contractor, FUBK management, and REA-PMU on corrective actions where necessary.

Table 7.9: Roles, Responsibilities and Accountabilities for ESMP Implementation

Institution / Personnel	Project Phase	Key Responsibilities
REA – Project Management Unit (REA-PMU)	All Phases	Overall oversight and coordination of ESMP implementation; supervise Contractors; review ESMP performance reports; ensure corrective actions are implemented; maintain institutional accountability for environmental and social compliance.
Federal Ministry of Environment (FMEnv)	All Phases	Conduct regulatory inspections; monitor environmental compliance; verify implementation of mitigation measures; engage REA-PMU and FUBK on corrective actions.
Kebbi State Ministry of Environment	All Phases	Conduct state-level environmental compliance monitoring; provide regulatory guidance; support enforcement of environmental standards.
FUBK – Director of Physical Planning	Pre-Construction	Confirm and designate Project land; appoint qualified Site Engineer; ensure ESMP training; review and endorse ESMP; ensure institutional commitment to ESMP implementation.
	Construction	Review ESMP compliance reports from Site Engineer; recommend improvements and corrective measures to REA-PMU.
	Operation	Review operational ESMP reports; recommend improvements to O&M Contractor and REA-PMU; ensure continued institutional environmental and social performance.
FUBK Site Engineer	Pre-Construction	Attend ESMP training; supervise EPC Contractor; monitor compliance; report to Director of Physical Planning and REA-PMU; liaise on environmental and social matters.
	Construction	Conduct routine supervision; ensure mitigation measures are implemented; report compliance status and emerging risks.
	Operation	Supervise O&M Contractor; conduct routine inspections; report compliance and non-compliance; liaise with regulatory agencies during inspections.

Institution / Personnel	Project Phase	Key Responsibilities
EPC Contractor	Pre-Construction	Familiarize with ESMP; train personnel on mitigation measures; implement relevant ESMP requirements; report compliance status.
	Construction	Implement all ESMP mitigation measures; appoint Gender/GBV Officer; comply with Labour, Health & Safety, and Environmental regulations; maintain monitoring and grievance records; submit periodic ESMP reports.
Operations & Maintenance (O&M) Contractor	Operation	Implement ESMP requirements during operations; hire and retain Gender/GBV Officer; maintain environmental and social monitoring records; report compliance status; ensure adherence to federal/state regulations and AfDB ISS.
Kebbi State Ministry of Women Affairs & GBV/SEA Service Providers	Construction & Operation	Monitor GBV mitigation implementation; provide advisory and referral support; collaborate with Gender/GBV Officer, FUBK management, and REA-PMU on compliance improvements.
NESREA Representatives	Operation	Monitor compliance with national environmental standards; conduct inspections; engage REA-PMU and FUBK on corrective measures where necessary.

7.5 Additional Management Plans

This section provides a framework for additional management plans to be developed and implemented in support of this ESMP for the proposed 1-MW Solar PV Project at Federal University Birnin Kebbi (FUBK). As the Project progresses from pre-construction to operation, these management plans shall be expanded to include detailed procedures and implementation guidelines to be followed by relevant Project personnel, including the EPC Contractor, O&M Contractor, subcontractors, and University representatives.

All supporting management documents shall be prepared in accordance with:

- Afreican Development Bank Integrated Safeguard System;
- Applicable Nigerian environmental regulations;
- Federal Ministry of Environment (FMEnv) requirements;
- NESREA regulations;
- Kebbi State environmental and social regulatory requirements;
- Other applicable national and local standards.

An overview of the key additional management plans is presented below.

7.5.1 Stakeholder Engagement Plan (SEP)

A Stakeholder Engagement Plan (SEP) shall be developed and implemented throughout the lifecycle of the proposed Project. The SEP will serve as a structured mechanism for ensuring transparent, inclusive, and continuous engagement between REA, FUBK, contractors, and relevant stakeholders.

❖ **Objectives of the SEP**

The key objectives of the Stakeholder Engagement Plan include:

- Ensuring stakeholder inclusion and participation across all phases of the Project (pre-construction, construction, operation, and decommissioning);
- Promoting open, transparent, and culturally appropriate communication processes;
- Ensuring stakeholders are adequately informed about Project activities, timelines, risks, and benefits;

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- Building and maintaining productive relationships between REA, FUBK, contractors, and stakeholders;
- Engaging vulnerable groups using inclusive consultation approaches;
- Providing opportunities for stakeholders to express concerns and provide feedback;
- Managing stakeholder expectations to avoid misinformation or unrealistic assumptions regarding Project benefits;
- Ensuring compliance with local regulatory requirements and international best practices;
- Ensuring stakeholder participation is free from coercion, intimidation, or manipulation.

❖ **REA's Commitment to Stakeholder Engagement**

REA is committed to implementing stakeholder engagement as an integral part of Project delivery. To this end:

- Responsibility for SEP implementation shall be clearly assigned within REA-PMU and the Contractor's management structure;
- Adequate human and financial resources shall be allocated for stakeholder engagement activities;
- Stakeholder engagement activities shall be documented and periodically reviewed;
- Engagement outcomes shall inform decision-making and Project implementation adjustments where necessary.

❖ **Key Components of the SEP**

In line with the Environmental and Social Management Framework (ESMF) applicable to REA-supported projects, an effective SEP shall:

1. Describe regulatory, lender, and institutional requirements for consultation and disclosure;
2. Identify and prioritize key stakeholder groups, with emphasis on:
   - Affected University communities,
   - Campus staff and students,
   - Nearby residents (if applicable),
   - Vendors or users of affected areas,
   - Regulatory agencies;
3. Provide a structured engagement strategy and timetable for information sharing and consultation;
4. Define roles, responsibilities, and resources required for implementation;
5. Outline grievance redress mechanisms (GRM) and reporting channels;
6. Describe how stakeholder engagement is integrated into the overall ESMP and Project management system.

A model SEP framework is available within REA's Environmental and Social Management Framework (ESMF) and shall be adapted to suit the FUBK Project context.

7.5.1.1 Grievance Redress Mechanism (GRM)

A Grievance Redress Mechanism (GRM) has been developed under REA's Environmental and Social Management Framework (ESMF), and the proposed 1-MW Solar PV Power Plant at Federal University Birnin Kebbi (FUBK) shall adopt and operationalize this framework for the current Project. The GRM provides a structured, transparent, and accessible system for receiving and resolving Project-related complaints in a timely and fair manner. It establishes a formal process for:

- Receiving complaints from affected stakeholders;
- Registering and acknowledging grievances;
- Investigating issues raised;
- Proposing and implementing corrective actions;
- Providing feedback to complainants; and
- Documenting resolution outcomes.

The GRM shall be communicated clearly to all relevant stakeholders including University staff, students, contractors, vendors, and surrounding communities (where applicable). Information on how to submit complaints shall be displayed at strategic locations within the Project area and campus.

The mechanism shall:

- Provide multiple reporting channels (in-person submission, phone contact, email, grievance forms, suggestion boxes);
- Ensure confidentiality for sensitive grievances, particularly those related to GBV/SEA;
- Maintain a grievance register to track the status and resolution timeline of complaints;
- Establish defined response timelines to ensure timely resolution;
- Remain functional throughout the Project lifecycle, including pre-construction, construction, operation, and decommissioning.

Periodic summaries of grievances received and resolved shall form part of ESMP monitoring reports and be reviewed by REA-PMU and FUBK management.

7.5.2 Traffic Management Plan (TMP)

The Traffic Management Plan (TMP) shall be developed to ensure safe movement of vehicles, equipment, and personnel associated with the Project, particularly during mobilization and construction activities within the FUBK campus. Given that the Project is located within an academic environment with high pedestrian activity, special emphasis shall be placed on protecting students, staff, and visitors from traffic-related risks.

The TMP shall aim to:

- Prevent road traffic accidents;
- Minimize disruption to normal campus activities;
- Protect public and University road infrastructure;
- Reduce dust and noise generated by vehicular movement.

Key measures to be included in the TMP shall include:

- Emphasizing defensive driving and safety awareness among all Project drivers;
- Ensuring that drivers possess valid licenses and have demonstrated competency;
- Establishing and enforcing a maximum speed limit of 20 km/hr within campus areas;
- Scheduling deliveries to avoid peak academic hours where feasible;
- Limiting trip duration and arranging driver rosters to prevent fatigue;
- Installing warning signs, barriers, and temporary traffic control measures;

- Establishing a documented procedure for reporting, investigating, and addressing traffic incidents.

The TMP shall be reviewed periodically to reflect site conditions and operational realities.

7.5.3 Waste Management Plan (WMP)

The Waste Management Plan (WMP) shall ensure that all wastes generated during Project implementation and operation are managed in accordance with national regulations and international best practice. The WMP shall apply to both hazardous and non-hazardous waste streams and shall aim to minimize environmental pollution, prevent soil and groundwater contamination, and promote resource efficiency.

The Plan shall follow the waste management hierarchy:

1. **Prevention** – Avoid generation of waste through efficient procurement and proper planning.
2. **Reduction** – Minimize waste through improved material handling and storage.
3. **Reuse** – Reuse materials where technically and economically feasible.
4. **Recycling** – Segregate recyclable materials (e.g., scrap metals, cables, packaging materials) and transfer them to licensed recyclers.
5. **Disposal** – Dispose of non-recyclable waste at approved and licensed disposal facilities.

The WMP shall specifically address:

- Management of packaging materials from PV modules and electrical components;
- Storage and disposal of e-waste (e.g., damaged PV panels, inverter components);
- Handling and recycling of spent batteries under Extended Producer Responsibility (EPR) principles;
- Safe storage of hazardous materials on impervious surfaces with secondary containment;
- Maintenance of waste tracking documentation and consignment records.

Regular inspections shall be conducted to verify compliance with the WMP.

7.5.4 Occupational Health and Safety (OHS) Plan

The Occupational Health and Safety (OHS) Plan shall establish a comprehensive framework to safeguard workers, contractors, and authorized visitors throughout the Project lifecycle. The OHS Plan shall be aligned with the Nigerian occupational requirements, ILO principles and AfDB OS2.

Key elements of the OHS Plan shall include:

- Systematic identification of potential hazards such as electrical risks, working at height, equipment handling, fire hazards, and manual lifting injuries;
- Risk assessment procedures and implementation of mitigation measures to eliminate or minimize exposure;
- Provision of appropriate Personal Protective Equipment (PPE) at no cost to workers;
- Mandatory induction training and periodic refresher training on safety procedures;
- Emergency preparedness and response procedures, including fire drills and evacuation protocols;

- Availability of first aid kits and trained first aid personnel;
- Incident reporting, investigation, and corrective action procedures;
- Safety briefing requirements for third parties accessing the site.

The OHS Plan shall promote a safety-first culture and continuous improvement in health and safety performance.

7.5.5 Local Employment Management Plan (LEMP)

The Local Employment Management Plan (LEMP) shall aim to maximize local economic benefits arising from the Project while promoting fairness and non-discrimination in recruitment processes.

The LEMP shall:

- Establish realistic targets for engagement of local labour, particularly for semi-skilled and unskilled roles;
- Encourage internship or training opportunities for FUBK students where feasible;
- Ensure employment opportunities are first communicated within the University and local community before wider advertisement;
- Promote equal opportunity employment and prohibit discrimination;
- Maintain verifiable employment and training records;
- Monitor workforce composition and report periodically on local employment performance.

The Plan shall support skills transfer, capacity development, and positive community relations.

7.5.6 Erosion Control Management Plan

The Erosion Control Management Plan shall provide measures to prevent soil erosion, sedimentation, and stormwater-related impacts during construction activities. Given the site's drainage characteristics and seasonal rainfall patterns, proactive erosion control shall be integrated into construction planning.

The Plan shall include:

- Limiting vegetation clearing strictly to approved Project footprints;
- Controlling slopes of cut and fill areas in accordance with final design specifications;
- Locating temporary stockpiles in stable, flat areas away from drainage channels;
- Installing silt traps, sediment barriers, or similar control measures where necessary;
- Protecting exposed soils using temporary coverings such as bio-membranes or plastic sheeting;
- Prompt stabilization and re-vegetation of disturbed areas.

Regular site inspections shall ensure erosion control measures remain effective, particularly after rainfall events.

7.5.7 Water Conservation Plan

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The Water Conservation Plan shall ensure efficient and sustainable use of water resources during both construction and operational phases of the Project. Although water demand for the Project is relatively low, responsible water management shall be maintained to avoid unnecessary abstraction and wastage.

The Plan shall include:

- Minimization of water use during construction activities;
- Controlled abstraction of groundwater for PV panel cleaning;
- Monitoring and documentation of water usage volumes;
- Adoption of efficient cleaning techniques to reduce water consumption;
- Prohibition of chemical cleaning agents that could contaminate soil or groundwater;
- Periodic review of water use efficiency and conservation performance.

The Plan shall ensure that groundwater abstraction remains within sustainable limits and does not adversely affect local aquifer conditions.

7.5.8 Emergency Preparedness and Response Plan (EPRP)

An Emergency Preparedness and Response Plan (EPRP) shall be developed and implemented for the proposed 1-MW Solar PV Power Plant at FUBK to ensure readiness and effective response to emergency situations that may arise during construction and operation. The EPRP shall establish a structured framework for preventing, managing, and responding to emergencies in a manner that safeguards human life, property, and the environment. The Plan shall be aligned with applicable national regulations, the AfDB Integrated Safeguards System 2023, and recognized international best practices.

As part of the EPRP:

- The fire protection system for the Project shall be designed in accordance with applicable national fire safety regulations and relevant standards comparable to the National Fire Protection Association (NFPA) requirements.
- Grounding and lightning protection systems shall be installed and tested to ensure that ground potential gradients are maintained within safe limits under both normal and fault conditions.
- Electrical isolation and emergency shutdown procedures shall be clearly defined and displayed within the control room and inverter stations.

The EPRP shall include procedures for addressing reasonably foreseeable emergency scenarios, including but not limited to:

- Fire outbreaks (in inverter stations, battery storage systems, control room);
- Electrical faults and arc flash incidents;
- Spill or release of hazardous substances (e.g., lubricants, fuels, battery electrolyte);
- Medical emergencies;
- Extreme weather events (e.g., heavy rainfall, windstorms);
- Security-related incidents.

The Plan shall address the following aspects:

- Identification of potential emergency scenarios and development of specific response procedures for each scenario;

- Designation and training of emergency response personnel;
- Identification of emergency contact numbers (fire service, medical services, University security, REA-PMU);
- Establishment of clear communication and reporting protocols;
- Provision of emergency equipment and facilities (fire extinguishers, first aid kits, spill kits, PPE, emergency signage);
- Development of decontamination and site clean-up procedures to contain and reduce environmental impacts;
- Identification of risks associated with uncontrolled release of hazardous materials and preparation of spill prevention and response procedures.

The spill prevention, control, and response component shall include:

- Training of personnel on spill prevention and response;
- Routine inspection of secondary containment structures;
- Standard operating procedures (SOPs) for transfer and storage of hazardous materials;
- Availability of appropriate PPE and spill response equipment at designated locations.

Regular drills and simulation exercises shall be conducted to test the effectiveness of the EPRP and improve response capacity.

7.5.9 REA Gender-Based Violence (GBV) Action Plan

The GBV Action Plan shall be implemented throughout the Project lifecycle to prevent, mitigate, and respond to potential GBV/SEA risks associated with Project activities. The Plan builds upon the GBV risk assessment conducted as part of this ESIA and integrates mitigation measures within the ESMP framework.

Key components of the GBV Action Plan include:

- Conducting and updating a GBV risk assessment as necessary;
- Integrating GBV risk management measures into contractual obligations;
- Requiring REA-PMU to define GBV compliance requirements in contractor bidding documents, including mandatory hiring of a Gender/GBV Officer;
- Evaluating contractor GBV response protocols prior to contract award;
- Ensuring GBV-sensitive reporting channels are embedded within the Project GRM;
- Informing Project-affected stakeholders (University community and nearby users) about GBV risks and reporting mechanisms;
- Ensuring all workers sign and understand a Code of Conduct (CoC) prohibiting GBV/SEA;
- Conducting mandatory induction and periodic refresher training on acceptable behavior and workplace ethics;
- Providing separate sanitation facilities for men and women and installing GBV-free signage at the Project site.

Timely and consistent implementation of the GBV Action Plan shall significantly reduce the likelihood of GBV/SEA risks during both construction and operation phases and promote a safe working and learning environment within FUBK.

7.5.9 Summary of Additional Management Plans

Table 7.10 presents a summary of the additional management plans required to support effective implementation of the ESMP. These plans shall be developed primarily during the pre-construction phase to ensure that adequate systems, procedures, and institutional arrangements are in place before commencement of physical works. The estimated costs reflect preparation, documentation, stakeholder consultation (where required), and initial training/awareness activities associated with each plan.

Table 7.10: Summary of Additional Management Plans

S/N	Management Plan	Timing for Development	Estimated Cost (US$)
1	Emergency Preparedness and Response Plan (EPRP)	Pre-Construction	2,500
2	Traffic Management Plan (TMP)	Pre-Construction	2,500
3	Waste Management Plan (WMP)	Pre-Construction	3,500
4	Occupational Health and Safety (OHS) Plan	Pre-Construction	2,500
5	Local Employment Management Plan (LEMP)	Pre-Construction	2,000
6	Erosion and Sediment Control Plan	Pre-Construction	2,500
7	Water Conservation Plan	Pre-Construction	1,500
8	Gender-Based Violence (GBV) Action Plan	Pre-Construction	2,500
9	Land Use Change Risk Plan	Pre-Construction	2,500
Total Estimated Cost			**22,000**

7.6 Environmental Monitoring Programme

Environmental and social monitoring shall be undertaken to ensure compliance with applicable regulatory requirements and to assess the effectiveness of mitigation and management measures outlined in this ESMP.

Monitoring will serve the following purposes:

- Verify compliance with FMEnv, NESREA, and Kebbi State environmental regulations;
- Assess the performance of mitigation measures implemented by the EPC and O&M Contractors;
- Detect any emerging environmental or social risks at an early stage;
- Provide documented evidence of environmental and social performance;
- Support continuous improvement in Project environmental management.

Monitoring activities shall be conducted during the construction and operational phases, as applicable. The estimated cost of implementing the environmental monitoring programme is summarized in Table 7.11.

Table 7.11: Environmental Monitoring Programme for the proposed Project

Environmental Component / Matrix	Sampling Location(s)	Monitoring Method	Parameters to be Monitored	Compliance Requirement	Frequency	Responsible Party	Project Phase	Estimated Cost (US$)
Atmosphere (Air Quality & Noise)	• Project site• Power evacuation route	• Air quality monitoring equipment• Sound level meter	TSP, CO, NOx, SOx, Noise level (dBA)	FMEnv / WHO	Monthly monitoring; Monthly reporting	EPC Contractor	Construction Phase	1,000
Groundwater Quality	University borehole(s)	Thermometer, water sampler, turbidity meter, pH meter, AAS	Temperature, pH, salinity, TDS, conductivity, DO, BOD, TOC, COD, NO_3, PO_4, chloride, sulphate, microbiology, heavy metals, TSS, turbidity	FMEnv / WHO Standards	Quarterly monitoring and reporting	EPC Contractor (Construction)O&M Contractor (Operation)	Construction & Operation Phases	4,000
Soil Quality	Unpaved areas within plant site	Composite soil sampling and laboratory analysis	pH, moisture, TOC, THC, TPH, NO_3, PO_4, chloride, sulphate, microbiology, heavy metals	NESREA / FMEnv	Quarterly monitoring and reporting	EPC Contractor (Construction)O&M Contractor (Operation)	Construction & Operation Phases	4,000
Solid Waste Management	Construction and operational areas	Waste tracking documentation; inspection of storage and disposal practices	Packaging waste, scrap metals, e-waste, general solid waste	FMEnv / NESREA AfDB OS3	Monthly monitoring; Quarterly reporting	EPC Contractor (Construction)O&M Contractor (Operation)	Construction & Operation Phases	2,000
Health and Safety Compliance	Workers and operational areas	Site inspection; PPE compliance observation	Compliance with OHS Plan; use of PPE; unsafe conditions	FMEnv / NESREA / AfDB OS2	Daily monitoring; Quarterly reporting	EPC Contractor (Construction)O&M Contractor (Operation)	Construction & Operation Phases	2,000
Training and Capacity Building	Workforce	Review of training records and attendance registers	Compliance with Training Plan; induction and refresher training	AFDB OS10	Quarterly monitoring and reporting	EPC Contractor (Construction)O&M Contractor (Operation)	Construction & Operation Phases	2,000
General Housekeeping	Construction sheds and plant areas	Visual inspection	Cleanliness, waste segregation, site aesthetics	FMEnv / NESREA / AfDB OS3	Daily monitoring; Quarterly reporting	EPC Contractor (Construction)O&M Contractor (Operation)	Construction & Operation Phases	2,000
Stakeholder Engagement	• University community• Regulatory agencies	Review of consultation records; grievance log review	Implementation of Stakeholder Engagement Plan and GRM	FMEnv / NESREA / AfDB OS10	Quarterly monitoring and reporting	EPC Contractor (Construction)O&M Contractor (Operation)	Construction & Operation Phases	2,000

7.7 Training, Awareness and Capacity Building

Effective implementation of the Environmental and Social Management Plan (ESMP) depends not only on the existence of mitigation measures but also on the competence, awareness, and commitment of personnel responsible for executing them. Therefore, structured training, awareness creation, and institutional capacity strengthening shall form a core component of Project implementation. REA-PMU, in collaboration with FUBK management and the Contractors, shall identify, plan, implement, and document training needs for personnel whose activities may significantly influence environmental and social performance. Training programmes shall be tailored to the specific responsibilities of staff during the pre-construction, construction, commissioning, and operational phases.

The objectives of the training and capacity-building programme include:

- Ensuring clear understanding of ESMP mitigation measures;
- Strengthening institutional capacity for environmental and social monitoring;
- Promoting occupational health and safety compliance;
- Enhancing emergency preparedness and response capability;
- Improving record-keeping and reporting practices;
- Promoting responsible behavior and ethical conduct among workers.

Training shall be delivered through induction sessions, refresher courses, toolbox talks, workshops, and practical demonstrations, depending on the subject matter and target audience. In addition to Project personnel, members of the University community and relevant stakeholders shall receive awareness training on environmental protection, safety, grievance redress mechanisms, and GBV risk mitigation. This shall promote shared responsibility and transparency in ESMP implementation.

Table 7.12: Institutional Capacity Strengthening Plan

Target Audience	Training Overview	Estimated Cost (US$)
FUBK Site Engineer, EPC Contractor and Sub-contractors, O&M Contractor	• Capacity building at the PMU In-depth understanding of ESMP mitigation measures. • Training on emergency response procedures. • Training on Health, Environment, Safety and Security (HESS) Management Plan. • Reporting, monitoring, and documentation requirements.	1,200
University Community / Local Stakeholders	• General environmental awareness. • Community health and safety measures. • Overview of grievance redress procedures. • Awareness on GBV/SEA risk mitigation measures.	700
Total		**1,900**

7.8 Implementation Schedule and Reporting

The ESMP shall be implemented as an integrated component of Project execution, beginning from the planning and design stage and continuing through construction, commissioning, operation, and eventual decommissioning. Implementation at early planning stages ensures that environmental and social considerations are incorporated into procurement decisions, contractor mobilization, and engineering design. This proactive approach reduces risks, enhances compliance, and promotes sustainable project outcomes.

During Project implementation, designated environmental and social officers shall conduct routine inspections and monitoring activities in accordance with the Environmental Monitoring Programme outlined in Section 7.7. Findings from these inspections shall be documented and communicated to relevant authorities within REA-PMU and FUBK management.

Where non-compliance or emerging risks are identified:

- Immediate corrective actions shall be initiated;
- Root causes shall be investigated;
- Preventive measures shall be implemented to avoid recurrence.

REA shall maintain open communication with regulatory authorities, including:

- Federal Ministry of Environment (FMEnv);
- National Environmental Standards and Regulations Enforcement Agency (NESREA);
- Kebbi State Ministry of Environment.

Periodic reports shall be submitted to regulators as required, and documentation shall be maintained to demonstrate compliance with applicable environmental and social obligations.

Key documentation to be maintained includes:

- Environmental monitoring records;
- Health and safety inspection reports;
- Training attendance registers;
- Incident and accident logs;
- Grievance registers and resolution records;
- Waste tracking documentation;
- Corrective action reports.

Proper reporting and documentation will ensure transparency, accountability, and continuous improvement in environmental and social performance.

7.9 ESMP Costing

Effective implementation of the ESMP requires adequate financial provision to support mitigation measures, monitoring activities, management plan preparation, training programmes, and institutional strengthening.
The estimated ESMP cost covers:

- Environmental and social mitigation during all Project phases;
- Development of additional management plans;
- Capacity building and awareness programmes;
- Environmental and social monitoring activities.

These cost estimates are based on anticipated resource requirements, monitoring frequency, regulatory compliance obligations, and administrative support needs. The costs shall be

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incorporated into the overall Project budget to ensure availability of funds for timely implementation.

Table 7.13: Cost of ESMP Implementation

S/N	ESMP Activities	Cost (USD)
1	**Pre-construction compliance -** staffing, approvals and early monitoring	3,800
	SEP and GRM implementation - disclosure, consultation materials, communication channels, grievance registers, meetings and reporting	3,000
	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**

7.10 Stakeholder Engagement

Stakeholder engagement is a continuous, systematic, and inclusive process of information sharing, consultation, and collaboration between the Project Proponent and stakeholders who may be affected by or have an interest in the Project. It involves proactive disclosure of relevant information, active listening, meaningful dialogue, and incorporation of stakeholder feedback into project planning and decision-making.

Effective stakeholder engagement ensures that:

- Stakeholders are adequately informed about the nature, scope, and objectives of the Project;
- Environmental and social risks are clearly communicated;
- Potential impacts are understood by affected communities;
- Concerns are identified early and addressed appropriately;

- Trust and constructive relationships are built over time.

Consultation is a critical element of engagement and must go beyond one-time meetings. It should be conducted in a manner that is culturally appropriate, inclusive, gender-sensitive, and accessible to vulnerable groups. Information disclosed must be understandable, using clear language and suitable formats. In line with AfDB guidance, stakeholder engagement must ensure that: "Appropriate project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible and appropriate manner and format." This means that stakeholders must receive sufficient information prior to consultation sessions to allow them to meaningfully participate in discussions and provide informed input.

For the proposed Project at FUBK, stakeholder engagement was designed to:

- Facilitate early dialogue during the ESIA process;
- Identify community expectations and potential concerns;
- Integrate local knowledge into environmental and social baseline assessments;
- Strengthen transparency and accountability in project development.

Engagement activities shall continue throughout construction, operation, and decommissioning phases to ensure sustained communication and responsiveness.

7.10.3 Objectives of Stakeholder Engagement

The stakeholder engagement process for the proposed Project at FUBK was structured to align with Nigerian regulatory requirements and international best practice.
The specific objectives include:

- Informing and educating stakeholders about the proposed Solar PV Project, including its technical scope and anticipated benefits;
- Gathering local knowledge and context-specific information to strengthen baseline environmental and social assessments;
- Identifying locally important environmental and social concerns;
- Providing stakeholders with an opportunity to influence Project planning and mitigation measures;
- Ensuring transparency in environmental and social decision-making;
- Laying the foundation for long-term collaboration and communication.

The engagement process is not limited to the ESIA stage but shall continue throughout the Project lifecycle to ensure sustained stakeholder involvement and responsiveness.

7.10.4 Stakeholder Identification and Analysis

Stakeholders are defined as individuals, groups, or institutions who:

- Are directly or indirectly affected by the Project;
- Have interests in the Project's outcomes; or
- Have the ability to influence Project implementation, either positively or negatively.

Stakeholders for the proposed Project may include:

- University management and staff;
- Students and campus residents;
- Host community members;

- Traditional leaders and community representatives;
- Local government authorities;
- Regulatory agencies;
- Civil society organizations;
- Contractors and service providers;
- Vulnerable groups, including women, youth, elderly persons, and persons with disabilities.

Stakeholder identification was undertaken systematically to ensure that no relevant group was excluded. Stakeholders were analyzed based on:

- Level of influence over Project decisions;
- Degree of interest in Project outcomes;
- Proximity to Project activities;
- Potential vulnerability to adverse impacts.

This analytical approach ensures that engagement strategies are tailored appropriately, with greater emphasis placed on groups that are highly affected or particularly vulnerable.

The EPC Contractor shall develop and implement a comprehensive Stakeholder Engagement Plan (SEP), which shall:

- Identify key stakeholder groups;
- Define engagement methods and frequency;
- Assign responsibilities for engagement activities;
- Establish monitoring and reporting procedures.

The SEP shall be maintained and updated throughout the Project lifecycle to reflect changing circumstances or stakeholder dynamics. A detailed list of identified stakeholders for the Project is presented in Table 7.14

Table 7.14: Identified Stakeholders Associated with the Proposed Project

Stakeholder Group and Interest in the Proposed Project	Stakeholder Name	International	National	State	Local	Connection to the Proposed Project
Project Sponsor / Financier	AfDB	✓				Provides financial and technical support for Project implementation under the Energizing Education Programme (EEP). Ensures compliance with AfDB safeguard systems.
Regulatory Authorities	Federal Ministry of Environment (FMEnv)		✓			Oversees ESIA process; ensures compliance with national environmental regulations; reviews and approves environmental documentation.
	National Environmental Standards and Regulations		✓			Monitors compliance with national environmental standards during operation;

Stakeholder Group and Interest in the Proposed Project	Stakeholder Name	International	National	State	Local	Connection to the Proposed Project
	Enforcement Agency (NESREA)					enforces environmental regulations.
	Federal Ministry of Power (Department of Renewable Energy)		✓			Coordinates renewable energy policy implementation and supports federal renewable energy initiatives.
	Nigerian Electricity Regulatory Commission (NERC)		✓			Regulates electricity generation and distribution; responsible for licensing and regulatory oversight where applicable.
	Kebbi State Ministry of Environment			✓		Oversees environmental protection and compliance at state level; conducts inspections and monitoring.
	Kebbi State Environmental Protection Agency (KEPA)			✓		Responsible for waste management regulation and environmental sanitation oversight within the State.
	Kebbi State Ministry of Women Affairs and Social Development			✓		Promotes gender inclusion and social welfare; monitors GBV mitigation measures.
	Kebbi State Ministry of Youth and Sports Development			✓		Responsible for youth inclusion and development initiatives within the State.
	Birnin Kebbi Local Government Authority				✓	Local administrative authority within whose jurisdiction the Project site is located.
Host Communities	Host Community around FUBK Campus				✓	Households, residents, and local groups that may be directly or indirectly affected by Project activities.

Stakeholder Group and Interest in the Proposed Project	Stakeholder Name	International	National	State	Local	Connection to the Proposed Project
University Representatives	FUBK Management				✓	Direct Project beneficiaries institutional host of th Solar PV plant.
	Department of Works and Physical Planning (FUBK)				✓	Responsible for infrastructure planning, site oversight, and ESMP supervision.
	FUBK Student Union Government				✓	Represents student body; direct beneficiary of improved electricity supply.
Project Affected Persons (PAPs)	Farmers or land users within Project footprint (if applicable)				✓	Individuals potentially affected by land use changes during construction.
	Traders or vendors along cable routing (if applicable)				✓	May experience temporary disruption during trenching and cable installation activities.

7.10.5 Stakeholder Register

A comprehensive Stakeholder Register shall be developed and maintained for the Project as part of the Stakeholder Engagement Plan (SEP). The Stakeholder Register will serve as a structured database for documenting all stakeholder-related information and engagement activities throughout the Project lifecycle.

The register shall include, at a minimum:

- Name of stakeholder (individual, group, or institution);
- Stakeholder category and level (international, national, state, local);
- Contact details (where appropriate);
- Date and method of engagement (meeting, consultation, email, workshop, etc.);
- Key issues raised or concerns expressed;
- Agreed follow-up actions;
- Responsible party for follow-up;
- Status of resolution or response.

The Stakeholder Register will ensure systematic tracking of stakeholder interactions and provide evidence of compliance with engagement requirements under both national regulations and AfDB Integrated safeguard systems.
The register shall be updated regularly during:

- Pre-construction;

- Construction;
- Operation; and
- Decommissioning phases.

It shall also serve as an internal monitoring tool to evaluate the effectiveness of engagement activities and to ensure that stakeholder concerns are addressed in a timely and transparent manner.

7.10.6 Stakeholder Engagement Process

REA-PMU shall adopt a proactive, structured, and continuous approach to stakeholder engagement, aimed at building and maintaining mutually beneficial relationships with all relevant stakeholders throughout the Project lifecycle.

The engagement process shall:

- Comply with applicable Nigerian laws and regulations;
- Align with AfDB ISS OS10;
- Be transparent, inclusive, and culturally appropriate;
- Be free of manipulation, interference, coercion, and intimidation;
- Be conducted using information that is timely, relevant, understandable, and accessible.

Stakeholder engagement shall be undertaken using various methods, including:

- Public meetings and consultation sessions;
- Focus group discussions;
- Workshops and technical briefings;
- Disclosure of Project information through appropriate media;
- Continuous communication through designated focal persons.

Effective stakeholder engagement is built on mutual trust, respect, and open communication. It strengthens Project governance and improves environmental and social performance. The engagement process enhances Project implementation in the following ways:

• Managing Costs

Early and effective engagement helps REA anticipate concerns and resolve issues before they escalate into disputes, project delays, or reputational risks. By proactively addressing stakeholder concerns, the Project can avoid potential financial losses and administrative burdens.

• Managing Risk

Engagement allows REA and affected communities to identify environmental and social risks at an early stage. This enables the development of appropriate mitigation measures, reducing the likelihood of conflict, regulatory penalties, or operational disruptions.

• Enhancing Institutional Reputation

Transparent engagement and adherence to environmental and social safeguards strengthen REA's institutional credibility. Demonstrating commitment to environmental protection, social responsibility, and human rights enhances public trust and supports continued collaboration with development partners such as the AfDB.

• Avoiding Conflict
Open dialogue fosters understanding of local priorities, land-use concerns, and community expectations. Addressing these issues early reduces the risk of misunderstandings, grievances, and disputes.

• Improving Policy and Decision-Making
Stakeholder feedback provides valuable insights into community perceptions and local realities. This information can inform improvements in Project design, mitigation measures, and corporate policies.

• Identifying, Monitoring, and Reporting Impacts
Engagement facilitates ongoing monitoring of Project impacts and ensures that mitigation measures remain responsive to stakeholder concerns. It also supports transparent reporting on environmental and social performance.

• Managing Stakeholder Expectations
Continuous consultation enables REA to clarify Project scope, benefits, and limitations, thereby preventing unrealistic expectations. Clear communication helps align stakeholder understanding with Project realities. Through this structured and inclusive engagement approach, REA aims to promote long-term cooperation, minimize risks, and enhance the sustainability of the 1-MW Solar PV Project at FUBK.

Table 7.15 presents the key elements of the Stakeholder Engagement Programme to be implemented by REA-PMU for the proposed Project. The engagement programme is designed to ensure continuous, structured, and transparent interaction with stakeholders throughout the Project lifecycle. The programme incorporates identification, consultation, disclosure, grievance management, and reporting mechanisms to ensure compliance with both national regulatory requirements and international best practice standards.

Table 7.15: Stakeholder Engagement Process

Stakeholder Engagement Activity	Approach
Stakeholder Identification and Analysis	An initial stakeholder identification and analysis has been conducted as part of this ESIA. REA shall maintain and periodically update a Stakeholder Register throughout the Project lifecycle. Stakeholder mapping shall be reviewed on a need basis, particularly when new stakeholders emerge or when Project activities expand or change.
Information Disclosure	REA shall ensure that relevant environmental and social information is disclosed to stakeholders in a timely, understandable, and accessible manner. Information shall be communicated through appropriate channels such as meetings, notices, reports, and digital platforms. Continuous communication shall be maintained throughout Project implementation.
Stakeholder Consultation	REA shall conduct consultations with stakeholders on issues of mutual concern, including environmental and social risks, mitigation measures, and Project progress. Consultations shall be documented, and records shall be maintained as evidence of engagement. Feedback received shall be considered in decision-making processes.
Negotiation and Partnerships	REA shall adopt a stakeholder management approach that promotes mutual respect and shared value creation. Where appropriate, partnerships shall be established with institutions, community groups, and regulatory bodies to enhance Project sustainability and social acceptance.

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Stakeholder Engagement Activity	Approach
Grievance Management	REA shall establish and maintain appropriate channels through which stakeholders can raise concerns or grievances. The Grievance Redress Mechanism (GRM) shall be transparent, accessible, and responsive. All grievances shall be documented, tracked, and resolved within defined timelines.
Stakeholder Involvement	REA shall promote procedures that enable direct stakeholder involvement in relevant Project-related activities, particularly those affecting community welfare. This may include participatory consultations, feedback sessions, and community monitoring activities to foster transparency and credibility.
Reporting to Stakeholders	REA shall establish a structured reporting system to disclose information on environmental, social, and economic performance. Reports may include monitoring results, implementation progress, and corrective actions taken. Information shall be shared periodically and upon request where appropriate.
Management Functions	REA shall build and maintain adequate internal capacity to manage stakeholder engagement effectively. This includes assigning clear responsibilities, tracking commitments, maintaining documentation, and reporting on engagement outcomes. Continuous improvement of engagement processes shall be encouraged.

7.10.7 Stakeholder Engagement Tools and Communication

REA recognizes that effective stakeholder engagement requires tailored communication strategies that reflect the interests, level of influence, and information needs of different stakeholder groups. A "one-size-fits-all" approach is not appropriate for a project of this nature. Therefore, REA shall adopt a flexible and inclusive communication framework designed to promote transparency, participation, and trust throughout the Project lifecycle. The engagement approach shall ensure that information is disclosed in a timely, understandable, and culturally appropriate manner. Communication channels will be selected based on stakeholder characteristics, literacy levels, accessibility considerations, and the sensitivity of the subject matter. Special consideration shall be given to vulnerable groups to ensure equitable access to information and participation opportunities. Table 7.16 presents the engagement tools and communication methods that may be adopted by REA during the Project lifecycle.

Table 7.16: Stakeholder Engagement Tools and Communication

Medium	Most Appropriate Application
Stakeholder Meetings / One-on-One Consultations	REA shall, on a need basis, hold individual consultation meetings with key stakeholders including regulatory authorities, university management, and community representatives. These meetings will be used to: • Solicit views and opinions; • Discuss stakeholder concerns confidentially where necessary; • Provide feedback on Project developments; • Build and maintain constructive working relationships.
Focus Group Discussions (FGDs)	REA shall organize FGDs to bring together small groups of stakeholders with shared interests (e.g., students, local traders, women groups, youth representatives). FGDs will have clearly defined objectives and will be structured to generate meaningful dialogue on specific environmental or social issues.
Workshops	Workshops shall be conducted to address specific environmental and social themes such as waste management, GBV awareness, occupational health and safety, and stakeholder participation. Participatory tools will be used to

Medium	Most Appropriate Application
	facilitate brainstorming, problem-solving, and development of practical recommendations.
Forums / Town Hall Meetings	REA may organize broader stakeholder forums where multiple stakeholder categories are represented. These forums promote transparency, collective dialogue, and consensus building, particularly where issues are complex or potentially contentious.
Written / Visual / Electronic Communication	REA shall use appropriate written and digital channels to disseminate information. These may include: • Project newsletters; • Emails and official correspondence; • Executive Summary of the ESIA; • Notices and print media publications; • Surveys and feedback forms; • Institutional websites and digital platforms where applicable.

Table 7.17 presents the consultation approaches applicable to major stakeholder groups. The frequency and depth of engagement shall be determined based on Project phase, stakeholder interest, and regulatory requirements.

Table 7.17: Stakeholder Group Consultation Methods

Stakeholder Group	Consultation Method
Government and Regulators	• Email exchanges and formal correspondence • One-on-one consultations • Formal review meetings • Compliance reporting • Environmental and social performance reports • Audit submissions
Project Financiers (AFDB)	Formal review meetings • Compliance reporting Environmental and social performance reports
Project Beneficiaries (FUBK Management, Physical Planning Department, Students)	• Formal meetings • One-on-one consultations • Information circulars and notices • Strategic collaboration sessions • Information Centre/Help Desk (where applicable)
Employees (EPC and O&M Contractors)	• Phone / email / text messaging / digital platforms • Workshops and toolbox meetings • Focus group discussions • Surveys and feedback mechanisms • Departmental meetings • Performance appraisals • Capacity-building trainings
Non-Governmental Organizations (NGOs) and Civil Society Groups	• Email and formal correspondence • One-on-one interviews • Town hall meetings • Focus group meetings • Information Centre engagement

7.10.8 Principles for Effective Stakeholder Engagement

Stakeholder engagement for the proposed Project is guided by internationally recognized best practice principles. These principles define the core values that underpin all interactions with stakeholders and ensure that engagement is meaningful, ethical, and outcome-oriented. For the 1-MW Solar PV Project at FUBK, stakeholder engagement shall be implemented in accordance with the following principles:

- **Commitment:**
  REA-PMU demonstrates commitment by recognizing the importance of identifying, understanding, and engaging relevant stakeholders throughout the Project lifecycle. Engagement activities shall not be treated as a one-off requirement but as a continuous process integrated into Project planning and implementation.

- **Integrity:**
  Engagement shall be conducted in good faith, with honesty and consistency. Information provided to stakeholders shall be accurate, reliable, and not misleading. This approach fosters mutual respect and strengthens long-term relationships.

- **Respect:**
  The rights, values, cultural norms, and interests of stakeholders shall be acknowledged and respected. Special attention shall be given to vulnerable groups to ensure that their voices are heard and considered in decision-making processes.

- **Transparency:**
  Stakeholder concerns shall be addressed in a timely, open, and clear manner. Decisions affecting stakeholders shall be communicated promptly, and justification for such decisions shall be provided where necessary.

- **Inclusiveness:**
  Broad participation shall be encouraged by providing accessible and appropriate consultation opportunities. Engagement methods shall be adapted to ensure effective participation across different literacy levels, gender groups, and socio-economic categories.

- **Trust:**
  Trust shall be built and maintained through open dialogue, consistent communication, responsiveness to concerns, and visible implementation of agreed mitigation measures.

These guiding principles will ensure that stakeholder engagement for the Project remains constructive, transparent, and aligned with both national requirements and international standards.

7.10.9 Summary of Previous Stakeholder Engagement Activities

As part of the ESIA process, initial stakeholder consultations were conducted to introduce the Project, gather relevant information, and identify potential environmental and social concerns at an early stage. These early consultations helped shape the impact assessment process and informed the development of mitigation measures and management plans. For the proposed Project, consultations were undertaken with key institutional stakeholders, and community representatives.

Engagement activities included formal meetings, one-on-one consultations, and interactive discussions designed to encourage stakeholder participation and feedback.
Stakeholders consulted during the ESIA included representatives from:

- Kebbi State Ministry of Environment
- National Environmental Standards and Regulations Enforcement Agency (NESREA) – State Office
- Kebbi State Ministry of Women Affairs and Social Development
- Kebbi State Ministry of Youth and Sports
- Federal University Birnin Kebbi (FUBK) Vice Chancellor
- FUBK Director of Works, Physical Planning and Development
- FUBK Student Union Representatives
- Relevant Local Government Authority Representatives
- Host community leaders

The consultations served multiple objectives, including:

- Providing stakeholders with background information on the proposed Solar PV Project;
- Explaining the scope, objectives, and anticipated benefits of the Project;
- Identifying key environmental and social concerns;
- Gathering local knowledge to support the ESIA baseline assessment; and
- Establishing an early foundation for ongoing stakeholder engagement.

Prior to consultations, notification letters and Background Information Documents (BIDs) were issued to relevant stakeholders to ensure informed participation. Stakeholder feedback received during these consultations was documented and incorporated into the ESIA process, particularly in the identification of potential impacts and development of mitigation measures. The engagement process demonstrated stakeholder interest in the Project and highlighted the importance of continued communication throughout construction and operational phases.

Stakeholder engagement was undertaken over more than one session. Community-level FGDs and selected university engagements were conducted on 4 February 2026, while institutional and regulatory scoping meetings recorded in Table 7.18 were conducted on 5 February 2026. The specific date, time, location and stakeholder group for each session are presented in the respective tables and supported by attendance records and photographic evidence.

Table 7.18: Initial Stakeholder Consultation Findings Conducted on 05/02/2026 at FUBK

Stakeholder	Priority Issues	Key Comments during Scoping	Response during Scoping Meetings
Kebbi State Ministry of Environment **(05/02/2026)**	ESIA process and stakeholder consultation	• The Project is a welcome development. • All relevant Project information should be clearly presented in the ESIA report. • All relevant stakeholders must be identified and consulted. • Impact identification and analysis must be comprehensive. • Interactions with biophysical and socio-economic components must be assessed. • Youth employment opportunities should be considered.	• All relevant stakeholders have been identified and will continue to be consulted throughout the ESIA process. • The ESIA includes a detailed impact assessment covering physical, biological, and socio-economic components. • Mitigation measures have been developed to address identified impacts. • A percentage of the workforce will be drawn from the host community. • A Waste Management Plan, including e-waste management, will be developed and implemented.
NESREA (State Office) **(05/02/2026)**	ESIA compliance and waste management	• Proper environmental compliance must be ensured. • Waste disposal should follow national regulations. • E-waste management must be adequately addressed.	• Waste Management Plan (WMP) including e-waste provisions will be implemented. • Only accredited and licensed waste management companies will be engaged. • Compliance with national environmental standards will be ensured.
FUBK Vice Chancellor **(05/02/2026)**	Sustainability and institutional commitment	• The University is committed to ensuring sustainability of the Project. • Adequate security arrangements will be provided. • Female students should not be marginalized.	• All concerns noted and integrated into planning. • Gender inclusion measures are incorporated into the ESMP and GBV Action Plan. • Sustainability measures will be implemented through proper O&M arrangements.
FUBK Director of Works, Physical Planning and Development **(05/02/2026)**	Land availability, infrastructure and waste management	• The selected site has been approved by the University. • No security concerns associated with the site. • Waste is currently managed through designated disposal systems.	• Waste Management Plan will include e-waste provisions. • Skill acquisition opportunities will be integrated during Project development.
FUBK Teaching Hospital Representatives **(05/02/2026)**	Reliable power supply and technical sustainability	• The Hospital requires steady 24-hour electricity. • Equipment must be of high quality. • Engineers should be trained for operation and maintenance. • Voltage supply must meet demand.	• The Project is designed to provide reliable and stable electricity. • Only certified and quality-assured components will be installed. • Training opportunities will be provided.

Stakeholder	Priority Issues	Key Comments during Scoping	Response during Scoping Meetings
			• An energy audit was conducted to determine appropriate capacity and voltage requirements.
FUBK Student Union Representatives **(05/02/2026)**	Improved power supply and student involvement	• Current electricity supply is inadequate. • The Project is welcomed by students. • Students are willing to participate where necessary.	• Student engagement will continue during Project implementation. • Concerns have been noted and integrated into ESMP commitments.
Local Government Authority Representatives **(05/02/2026)**	Community benefits and employment	• The Project is a welcome development. • Local employment opportunities are expected.	• A percentage of the workforce will be sourced from the host community. • Local content considerations will be applied where feasible.
Host Community Leaders **(05/02/2026)**	Employment and community inclusion	• Youth employment opportunities should be provided. • The community acknowledges that the land belongs to the University.	• Local labour participation will be encouraged. • Continued engagement with community leaders will be maintained.
Market Leaders along Transmission Route (if applicable) **(05/02/2026)**	Construction disturbance	• Trenching and cable laying activities may temporarily disrupt business activities.	• Construction works will be phased and completed within the shortest practicable time. • Grievance Redress Mechanism (GRM) will be operational to address concerns promptly.

7.11 Management Function and Grievance Mechanism

Effective stakeholder engagement requires a clearly defined management structure supported by institutional commitment, adequate resources, and accountability mechanisms. For the proposed Project, REA-PMU shall ensure that stakeholder engagement and grievance management are fully integrated into the overall Project governance framework.

7.11.1 Management Commitment

REA is committed to implementing stakeholder engagement as an integral component of Project planning, construction, operation, and eventual decommissioning. Stakeholder engagement shall not be treated as a compliance formality, but as a strategic management tool to promote transparency, reduce risks, and enhance Project sustainability. To ensure effective implementation of the Stakeholder Engagement Plan (SEP), REA shall:

- Assign clear responsibilities for stakeholder engagement within its organizational structure;
- Define reporting lines and decision-making authority for stakeholder-related matters;
- Allocate adequate financial and human resources for SEP implementation; and
- Integrate stakeholder engagement into routine Project management processes.

The management structure for implementing the SEP shall include the following key elements:

Systems
REA shall implement stakeholder engagement activities in a structured and systematic manner. Engagement schedules, documentation procedures, and grievance tracking systems shall be maintained to ensure predictability, transparency, and accountability. This systematic approach is intended to foster long-term trust between the Project and its stakeholders.

Structure
REA shall establish a stakeholder-focused structure within the Project Management Unit (PMU). This structure will ensure that stakeholder concerns and grievances are addressed promptly and efficiently. Clear authority shall be granted to designated officers to facilitate timely decision-making and feedback.

Skills
REA shall ensure that personnel responsible for stakeholder engagement possess the necessary technical, communication, and conflict-resolution skills. Where required, capacity-building programmes shall be conducted to strengthen internal capacity in stakeholder management, grievance handling, gender-sensitive communication, and community relations.

7.11.2 Roles and Responsibilities

REA shall assign responsibility for organizing and conducting stakeholder consultation to competent individuals with relevant qualifications and experience in environmental and social management. The key responsibilities shall include:

- The **REA Project Management Unit (PMU)** shall have overall responsibility for oversight of the SEP implementation and grievance management framework.
- The **FUBK Community Liaison Officer (CLO)** shall serve as the primary focal point for stakeholder engagement at the University level.
- The CLO shall: Facilitate stakeholder meetings and consultations; Maintain the stakeholder engagement register; Receive and document grievances at the University level; Monitor implementation of stakeholder engagement activities; and Report periodically to the REA-PMU on stakeholder concerns and grievance resolution status.

This defined structure ensures clear accountability and an effective communication channel between stakeholders, the University, and REA-PMU.

7.11.3 Grievance Redress Mechanism (GRM)

A Grievance Redress Mechanism (GRM) has been developed by REA for implementation across all components of the Nigeria Electrification Project (NEP), including the Energizing Education Programme (EEP) under which this Project falls. The GRM provides a formal, structured process through which Project Affected Persons (PAPs), community members, workers, and other stakeholders may raise concerns or complaints related to Project activities.

The objectives of the GRM are to:

- Provide accessible and transparent channels for grievance submission;
- Ensure grievances are addressed in a fair, timely, and cost-effective manner;
- Prevent minor issues from escalating into major disputes;
- Strengthen stakeholder trust and accountability; and
- Promote continuous improvement in Project implementation.

The GRM is designed to be:

- Legitimate and transparent;
- Culturally appropriate and easily accessible;
- Inclusive of vulnerable groups and persons living with disabilities;
- Free of intimidation, retaliation, or discrimination.

❖ **Key Components of the GRM**

The GRM framework includes the following elements:

- **Identification of Core Institutional Structures** for the EEP, including roles of REA-PMU, University representatives, and community-based structures;
- **Grievance Uptake Points**, including clearly defined communication channels such as: Physical complaint registers; Email and telephone contacts; Community Liaison Officer (CLO); Dedicated grievance boxes where applicable;
- **Defined Timelines** for acknowledgment, investigation, and resolution of grievances;
- **PMU-Level Grievance Redress Committee (GRC)** with clearly defined membership and responsibilities;
- **Community-Based Grievance Redress Committee**, where applicable, to address grievances at the lowest possible level before escalation;
- A structured **GRM process flow** outlining escalation procedures where grievances cannot be resolved at the initial level.

The GRM shall be communicated to stakeholders during consultation meetings and displayed at appropriate locations within the Project area to ensure accessibility. - (Kindly refer REA-NEP in-house explicit budget implementation)

All grievances received shall be:

- Logged in a grievance register;
- Categorized based on type and severity;
- Investigated in a timely manner;
- Resolved within established timeframes; and
- Documented with evidence of closure.

Periodic reports on grievance trends and resolution status shall be submitted to REA-PMU and made available to regulatory authorities upon request.

Grievance Handling Process

The GRM process follows a structured sequence to ensure consistency, fairness, and timeliness. See Table 7.19 for Intergrated GRM process, responsibilities, and timelines.

Table 7.19: Integrated GRM Process, Responsibilities, and Timelines

Step	Stage	Description	Responsibility	Timeline
1	Submission	Grievance submitted via any channel	Complainant / CLO	Immediate
2	Acknowledgement	Receipt acknowledged to complainant	GRM Officer	Within 5 working days
3	Registration	Grievance logged with unique ID	REA-PMU / CLO	Within 2–3 days
4	Assessment	Classification by type and urgency	GRC	Within 5 days
5	Local Resolution	Attempt resolution at community level	Community GRC	Within 15 working days
6	Escalation	Unresolved cases forwarded to SPIU	CLO / GRC	Immediate
7	Investigation	Detailed review and stakeholder engagement	REA-PMU GRC	Within 30 working days
8	Resolution	Decision communicated and implemented	PMU / MDAs	Within 30 days
9	Closure	Case closed upon satisfaction	GRM Officer	Upon agreement
10	Documentation	Record and report grievance details	PMU/ EPC	Continuous

Monitoring and Evaluation of the GRM

The effectiveness of the GRM will be continuously monitored through:

- Regular audits of grievance logs;
- Tracking resolution timelines;
- Stakeholder satisfaction assessments;
- Identification of recurring issues and trends;
- Annual performance reviews.

Reporting and Documentation

All grievances will be systematically documented in a centralized database, including:

- Nature and category of grievance;
- Complainant details (confidential where required);
- Actions taken and resolution status;
- Feedback from complainants.

Reports will be shared with:

- National Project Coordinating Unit (NPCU);
- Relevant regulatory authorities;
- Development partners (REA, AfDB).

S / N	Grievance ID	Date Received	Complain Category *(PAP, Community Member, Worker, Other)*	Gender/Vulnerability *(M/F, Elderly, PWD, Widow, Youth)*	Contact/ Reference Info	Description of Grievance	Category of Issue *(e.g. Land, Compensation, Employment, GBV/SEA, Livelihood, Environment)*	Location (Community/ GPS)	Received By/Entry Point *(Community GRC, PIU, Hotline, etc.)*	Action Taken / Investigation Summary	Resolution Proposed	Resolution Status (*Open/Resolved/ Escalate ed)*	Date Resolved	Remarks / Follow-up Required	Signature of Complainant	Signature of GRC Secretary
1																
2																

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CHAPTER EIGHT

REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

8.1 Introduction

This chapter outlines the approach to decommissioning and post-closure remediation of the proposed 1-MW Solar Photovoltaic (PV) Power Plant at Federal University Birnin Kebbi (FUBK). It describes the anticipated decommissioning activities, identifies potential environmental and social impacts associated with such activities, and presents management and remediation measures to ensure that the Project site is restored to a safe and environmentally acceptable condition.

Although solar PV facilities are generally characterized by low operational emissions and limited long-term environmental risks, proper end-of-life planning is essential to prevent contamination, ensure safe dismantling of electrical systems, and promote responsible material recovery and recycling.

This chapter therefore provides:

- An overview of decommissioning activities;
- A framework for managing environmental and social risks during closure;
- Measures for remediation and site restoration;
- Provisions for used battery management;
- Alignment with applicable national regulations and international good practice.

8.2 Decommissioning Activities

Decommissioning refers to the structured and systematic process of shutting down operations and removing all operational assets at the end of a project's useful life. The design life of the proposed Solar PV power plant is approximately **25 years**, which may be extended depending on maintenance, component upgrades, and technological improvements. Even after 25 years, PV modules may retain up to 80–90% of their rated generation capacity; however, economic, technical, and institutional considerations may necessitate full decommissioning. The associated renewable energy training facilities may have a longer structural lifespan (up to 40 years or more), subject to maintenance and continued institutional use.

Decommissioning activities will typically include the following:

- **Dismantling and removal of PV panels and associated infrastructure**, including mounting structures, DC/AC cabling, inverters, transformers, combiner boxes, batteries (where applicable), and control systems;
- **Removal of sub-surface installations**, such as underground cables, conduits, and foundations where required;
- **Management of waste streams** generated during dismantling;
- **Site rehabilitation and restoration**, including remediation of any impacted environmental components (e.g., soil disturbance areas).

All decommissioning activities shall be conducted in accordance with applicable environmental, occupational health and safety, and waste management regulations to prevent injury, contamination, or residual environmental liability.

8.3 Management of Decommissioning Activities

In the event of decommissioning, the Rural Electrification Agency – Project Management Unit (REA-PMU), in conjunction with the leadership of FUBK, shall ensure that the Project site is left in a safe, stable, and environmentally acceptable condition. A formal Decommissioning, Abandonment, and Closure Programme shall be developed and implemented. Key tasks will include:

- Evacuation of dismantled PV panels and associated electrical components (e.g., inverters, control devices) to manufacturers or licensed recycling facilities;
- Transportation of spent batteries to certified recycling or take-back facilities;
- Restoration of the Project site to baseline conditions as far as practicable, in compliance with legislative and regulatory requirements;
- Assessment of any residual environmental impacts;
- Post-decommissioning environmental monitoring where necessary.

Decommissioning activities shall only commence after consultation with relevant stakeholders, including regulatory authorities. Activities shall be implemented in line with the National Guidelines for Decommissioning of Facilities in Nigeria (2017) issued by the Federal Ministry of Environment (FMEnv).

8.3.1 Decommissioning Planning Requirements

An updated Decommissioning Plan shall be developed prior to closure. The plan shall reflect prevailing legal requirements, best practicable environmental options, technological advancements, and cost considerations at the time of closure.

The Decommissioning Plan shall include, at a minimum:

- Description of the site and infrastructure to be decommissioned;
- Scope, objectives, intended end-state, and strategy;
- Detailed schedule of decommissioning activities;
- Estimated decommissioning cost;
- Inventory of anticipated waste streams and proposed handling methods;
- Roles, responsibilities, and qualifications of the decommissioning team;
- Health, Safety and Environment (HSE) management procedures.

The Plan shall be submitted to FMEnv and other relevant regulatory authorities for approval prior to implementation.

8.3.2 Evaluation of Decommissioning Options

A detailed evaluation of decommissioning alternatives shall be undertaken to determine the most environmentally sound and cost-effective option. Options may include:

- Facility mothballing (temporary suspension);
- Partial decommissioning;
- Complete removal and site restoration.

The evaluation shall consider environmental, safety, technical, and socio-economic factors before selecting the preferred option.

8.3.3 Risk Assessment and Safety

A comprehensive risk assessment shall be conducted to ensure that no hazardous materials, unstable structures, or environmental liabilities remain on site.

This shall include:

- Hazard identification and analysis;
- Electrical safety risk assessment;
- Soil and groundwater contamination risk evaluation;
- Structural stability assessment.

An appropriate Health, Safety and Environment (HSE) Plan shall be implemented to ensure that decommissioning activities are conducted safely and in compliance with relevant laws and international standards. Third-party notifications shall be undertaken prior to demolition activities, and dismantling shall be executed in a phased and controlled manner.

8.3.4 Socio-Economic Considerations

Decommissioning may have socio-economic implications, particularly related to the termination of employment at the end of the operational phase.

To minimize adverse effects:

- Employees shall be informed well in advance about decommissioning timelines and implications;
- Capacity-building programmes shall be implemented to prepare staff for alternative employment opportunities;
- Training shall be provided in areas such as equipment dismantling, environmental monitoring, and rehabilitation activities;
- Skills acquired during Project implementation shall be transferable to other sectors.

Community engagement shall continue during decommissioning to manage expectations and maintain transparency.

8.3.5 Waste Management During Decommissioning

A dedicated Waste Management Plan for decommissioning shall be developed.
Options for redundant structures and equipment will include:

- Complete dismantling and recycling;
- Return of components to manufacturers under take-back schemes;
- Disposal through licensed waste handlers.

A detailed inventory of recyclable materials shall be maintained, and waste tracking documentation shall be recorded. Environmental and social management measures for decommissioning impacts are presented in Table 8.1.

8.3.6 Used Battery Management at Decommissioning Phase

Lithium-ion batteries reaching end-of-life are classified as hazardous waste due to their chemical composition and potential fire risk. During decommissioning, used batteries shall be:

- Disconnected safely by qualified personnel;
- Fully discharged in accordance with manufacturer instructions;
- Stored separately from other dismantled materials;
- Packaged in approved, fire-resistant containers;
- Labelled appropriately for transport.

Damaged or thermally unstable batteries require specialized handling procedures due to flammability risks. Currently, lithium-ion battery recycling capacity in Nigeria remains limited, as most domestic recyclers focus on lead-acid batteries. This presents a logistical and regulatory challenge. To address this, the Project shall adopt the Extended Producer Responsibility (EPR) approach. Under this arrangement:

- Battery manufacturers or suppliers shall be responsible for take-back, recycling, and final disposal;
- Recycling costs shall be internalized within procurement agreements;
- Take-back clauses shall be included in supply contracts.

During decommissioning, batteries shall be removed, discharged, packaged, and transported in accordance with manufacturer guidelines and regulatory requirements. Furthermore, FUBK shall be encouraged to develop an End-of-Life Electrical Components Management Plan, which will include:

- Procedures for safe handling and temporary storage;
- Identification of certified recycling companies (including NESREA-certified operators);
- Documentation and tracking of all battery disposals;
- Compliance with national hazardous waste regulations.

This approach ensures environmentally sound disposal while minimizing environmental liability and fire risk.

8.4 Abandonment Plan

Prior to site abandonment, the Rural Electrification Agency – Project Management Unit (REA-PMU) shall develop and implement a structured Abandonment Plan to ensure that the Project site is left in a safe, stable, and environmentally acceptable condition. The Abandonment Plan shall form part of the overall Decommissioning, Abandonment and Closure Programme and shall be implemented only after regulatory notification and approval where required.

The Plan shall incorporate, at a minimum, the following elements:

a. **Identification of components to be abandoned and/or removed**, including PV modules, mounting structures, underground cables, transformers, inverters, battery storage systems, fencing, and ancillary facilities;

b. **Specification of proposed abandonment or reuse methods**, including:
    - Reuse of serviceable components within the University where feasible;

- Recycling of recoverable materials (e.g., aluminum frames, steel structures, copper cables);
- Safe disposal of non-recyclable materials through licensed waste management facilities;

c. **Implementation of environmental mitigation measures** to address potential impacts associated with abandonment activities, including:
   - Prevention of soil contamination during removal of equipment;
   - Control of dust and noise during dismantling;
   - Safe handling of hazardous materials such as oils, lubricants, and batteries;

d. **Site rehabilitation and restoration measures**, including:
   - Removal of residual debris and concrete foundations where required;
   - Backfilling and compaction of excavated areas;
   - Re-grading of disturbed land surfaces;
   - Re-vegetation using native plant species to promote ecological recovery;
   - Stabilization of soils to prevent erosion.

The objective of the Abandonment Plan is to return the Project site to its original or an agreed post-project land use condition, as far as reasonably practicable.

8.5 Roles, Responsibilities and Accountabilities for Decommissioning Phase

Effective implementation of environmental and social measures during the decommissioning phase requires clear allocation of responsibilities and well-defined reporting lines. The decommissioning phase shall be managed through coordinated oversight between REA-PMU, FUBK management, regulatory authorities, and the appointed decommissioning contractor(s). The key personnel and institutions with major roles in the implementation and monitoring of environmental and social measures during decommissioning are outlined below.

A. Contractor(s) Engaged for Decommissioning Activities

The appointed contractor(s) shall be directly responsible for executing decommissioning works in compliance with the approved Decommissioning and Abandonment Plan.
Responsibilities shall include:

- Implementing all environmental and social mitigation measures identified in the Decommissioning Plan;
- Ensuring safe dismantling, handling, packaging, and transportation of all project components;
- Managing waste streams in accordance with national regulations and approved waste management procedures;
- Maintaining records of waste disposal, recycling, and material recovery;
- Ensuring compliance with occupational health and safety requirements;
- Reporting environmental incidents, near misses, and non-compliance issues to REA-PMU and FUBK management;
- Preparing periodic progress reports on decommissioning environmental and social performance.

B. REA – Project Management Unit (REA-PMU)

REA-PMU shall retain overall oversight responsibility for the decommissioning phase.
Its responsibilities shall include:

- Supervising the activities of the contractor(s) engaged for decommissioning;
- Ensuring that all recommended environmental and social mitigation measures are implemented;
- Reviewing decommissioning progress reports and environmental monitoring results;
- Coordinating engagement with regulatory authorities;
- Discussing environmental and social management improvements with FUBK management to address non-compliance and emerging issues;
- Ensuring that the Project site is restored in accordance with approved regulatory standards.

C. FUBK Site Engineer / Project Manager

The FUBK Site Engineer (or designated Project Manager) shall provide on-site monitoring and coordination support during decommissioning.
Responsibilities shall include:

- Directly monitoring contractor activities to ensure compliance with approved environmental and social management measures;
- Conducting routine site inspections;
- Verifying safe handling and removal of equipment and hazardous materials;
- Reporting contractor performance and compliance status to the Director of Works and Physical Planning;
- Liaising with REA-PMU on environmental and social performance matters.

D. Director of Works and Physical Planning – FUBK

The Director of Works and Physical Planning shall provide institutional oversight on behalf of the University.
Responsibilities shall include:

- Joint supervision of contractor activities during decommissioning;
- Reviewing compliance reports submitted by the Site Engineer;
- Advising REA-PMU on corrective actions and improvement measures;
- Ensuring that post-decommissioning land use aligns with University development plans;
- Confirming that site restoration meets acceptable standards before formal closure.

E. Federal Ministry of Environment (FMEnv) and Kebbi State Ministry of Environment Representatives

Regulatory authorities shall provide independent oversight and approval functions.
Their responsibilities shall include:

- Reviewing and approving the Decommissioning and Abandonment Plan prior to implementation;
- Conducting compliance inspections during decommissioning activities;
- Monitoring implementation of environmental and social mitigation measures;
- Reviewing environmental monitoring results and waste disposal documentation;
- Recommending corrective measures in cases of non-compliance;
- Providing regulatory clearance for final site closure, where required.

F. Reporting and Accountability Framework

The reporting structure during decommissioning shall generally follow this hierarchy:

1. Decommissioning Contractor → Reports to REA-PMU and FUBK Site Engineer
2. FUBK Site Engineer → Reports to Director of Works and Physical Planning
3. REA-PMU → Coordinates with FUBK Management and Regulatory Authorities
4. FMEnv and Kebbi State Ministry of Environment → Provide regulatory oversight and approval

This structured accountability framework ensures transparency, regulatory compliance, and effective management of environmental and social risks during Project closure.

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Table 8.1: Environmental and Social Management Measures for Decommissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Responsible Party (Implementation)	Responsible Party (Monitoring)	Estimated Cost (US$)
Removal of PV panels, batteries, inverters and demolition of associated facilities							
Soil contamination due to waste generation and soil compaction during dismantling and excavation	Excavation works shall not be executed under adverse or aggressive weather conditions to minimize erosion and runoff.	Site inspection records	Daily during decommissioning	Adherence to approved procedures	Decommissioning Contractor(s)	REA-PMU; FUBK Site Engineer/Manager; Director of Works & Physical Planning	5,000
	Stockpiles shall be appropriately covered to reduce soil loss due to wind or water erosion.	Inspection	Daily	Compliance with erosion control measures	Decommissioning Contractor(s)	FMEnv; Kebbi State Ministry of Environment	-
	Hazardous substances (e.g., fuels, lubricating oil) shall be stored on impervious surfaces with adequate secondary containment (bund walls). Portable spill containment and clean-up kits shall be available onsite.	Inspection; spill response equipment availability	Daily	Compliance with AfDB OS3 and applicable NESREA regulations.	Decommissioning Contractor(s)	REA-PMU; FMEnv; Kebbi State Ministry of Environment	-
	PV panels, batteries, and inverters shall be collected and returned to manufacturers or licensed recycling facilities in line with Extended Producer Responsibility (EPR) requirements.	Waste consignment notes; recycling documentation	Daily during dismantling	Compliance with AfDB OS3 and national waste regulations	Decommissioning Contractor(s)	REA-PMU; FMEnv	-
	All disturbed and impacted soil areas shall be restored and re-vegetated using native plant species.	Site inspection; photographic documentation	Upon completion of restoration activities	Re-vegetated and stabilized land	Decommissioning Contractor(s)	REA-PMU; FUBK Management	-
	An approved Decommissioning Plan shall be developed, submitted to regulatory	Approved Decommissioning Plan;	Prior to and throughout decommissioning	Compliance with approved plan benchmarks	REA-PMU; Decommissioning Contractor(s)	FMEnv; Kebbi State Ministry of Environment	-

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Responsible Party (Implementation)	Responsible Party (Monitoring)	Estimated Cost (US$)
	authorities, and implemented prior to commencement of closure activities.	implementation records					
Air quality impacts; increased dust levels during dismantling and demolition activities	Dust suppression measures (e.g., water sprinkling on exposed surfaces and access roads) shall be implemented throughout decommissioning.	Site inspection records	Daily during decommissioning	Adherence to dust control measures	Decommissioning Contractor(s)	REA-PMU; FUBK Site Manager; Director of Works & Physical Planning; FMEnv; Kebbi State Ministry of Environment	1,000
	Decommissioning equipment shall be properly serviced and maintained to minimize exhaust emissions.	Inspection; Maintenance records	Prior to commencement and periodically during decommissioning	Compliance with maintenance schedule	Decommissioning Contractor(s)	REA-PMU; FMEnv	-
Noise impacts from decommissioning equipment and related activities	Noise suppression equipment (e.g., mufflers, silencers) shall be fitted on decommissioning machinery.	Inspection	Daily	Adherence to noise control measures	Decommissioning Contractor(s)	REA-PMU; FUBK Site Manager; FMEnv; Kebbi State Ministry of Environment	2,000
	Decommissioning activities shall be restricted to daytime hours (08:00–17:00 weekdays; 09:00–13:00 weekends).	Site inspection	Daily	Compliance with approved working hours	Decommissioning Contractor(s)	REA-PMU; FUBK Management	-
	Equipment shall be turned off when not in use to reduce unnecessary noise.	Inspection	Daily	Reduced idle time of machinery	Decommissioning Contractor(s)	FUBK Site Manager	-
	Equipment shall be properly maintained and serviced before commencement of decommissioning.	Maintenance records	Once prior to commencement	Verified service records	Decommissioning Contractor(s)	REA-PMU	-

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Responsible Party (Implementation)	Responsible Party (Monitoring)	Estimated Cost (US$)
	Noise complaints shall be documented, assessed, and appropriately addressed through the established Grievance Redress Mechanism (GRM).	Complaint records; GRM log	Weekly	Compliance with International Good Practice Note on Addressing Grievances	Decommissioning Contractor(s)	REA-PMU; FUBK Management	-
	Noise monitoring shall be conducted at locations with persistent complaints to ensure compliance with FMEnv/ NESREA noise limits.	Noise monitoring records	Monthly (where required)	Compliance with FMEnv noise standards	Decommissioning Contractor(s)	FMEnv; Kebbi State Ministry of Environment	-
Groundwater and surface water contamination due to waste generation and improper handling of hazardous materials	Training shall be provided for workers on safe storage, use, and handling of hazardous materials (e.g., fuel, lubricating oil).	Training records	Once prior to commencement of decommissioning	Certificates of completion of training	Decommissioning Contractor(s)	REA-PMU; FUBK Site Manager; Director of Works & Physical Planning; FMEnv; Kebbi State Ministry of Environment	1,500
	Hazardous substances shall be stored on impervious hard standing with adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Site inspection; spill kit availability	Daily during decommissioning	Compliance with AfDB OS3 and applicable NESREA regulations.	Decommissioning Contractor(s)	REA-PMU; FMEnv; Kebbi State Ministry of Environment	-
	Waste Management Plan (WMP) shall be implemented throughout decommissioning activities.	WMP implementation records	Daily	Compliance with WMP benchmarks and AfDB OS3 and applicable NESREA regulations.	Decommissioning Contractor(s)	REA-PMU; FMEnv	-

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Responsible Party (Implementation)	Responsible Party (Monitoring)	Estimated Cost (US$)
Traffic impacts due to transportation of dismantled equipment and waste materials	Traffic Management Plan (TMP) shall be implemented during decommissioning.	TMP implementation records	Daily	Compliance with TMP benchmarks	Decommissioning Contractor(s)	REA-PMU; FUBK Site Manager; FMEnv; Kebbi State Ministry of Environment	2,500
	Appropriate barriers and signage shall be provided to demarcate active traffic areas.	Inspection of safety signage and barriers	Once prior to commencement and maintained throughout	Adherence to safety measures	Decommissioning Contractor(s)	FUBK Site Manager	-
	Drivers' competency shall be assessed and, where required, appropriate training shall be provided.	Driver competency assessments; training records	Once prior to commencement	Valid competency assessment or training certificates	Decommissioning Contractor(s)	REA-PMU	-
	A procedure for recording all traffic-related incidents shall be developed and implemented.	Incident forms; traffic logbook	Daily	Completed and documented incident records	Decommissioning Contractor(s)	REA-PMU; FUBK Management	-
Exposure to injuries, electrical shock, slips, trips, and falls during dismantling activities	All workers involved in decommissioning shall be sensitized on occupational health and safety requirements. Daily toolbox talks shall be conducted prior to commencement of work activities.	Daily toolbox talk records	Daily during decommissioning	Compliance with Health and Safety Plan benchmarks	Decommissioning Contractor(s)	REA-PMU; FUBK Site Manager; Director of Works & Physical Planning; FMEnv; Kebbi State Ministry of Environment	2,500
	Appropriate Personal Protective Equipment (PPE) shall be provided to all workers (e.g., safety boots, gloves, helmets, reflective vests, eye protection).	PPE availability and inspection records	Daily	PPE compliance rate	Decommissioning Contractor(s)	REA-PMU; FUBK Site Manager	-
	A qualified and dedicated onsite Safety Officer shall be engaged to monitor compliance with safety procedures and electrical isolation protocols.	Evidence of qualified safety officer	Once prior to commencement and throughout decommissioning	Compliance with safety supervision requirements	Decommissioning Contractor(s)	REA-PMU	-

Summary of Potential Impact	Mitigation Measures	Monitoring Requirements / Parameters	Frequency	Performance Indicator	Responsible Party (Implementation)	Responsible Party (Monitoring)	Estimated Cost (US$)
	An approved Health and Safety Plan shall be implemented throughout decommissioning activities.	Health and Safety Plan implementation records	Daily during decommissioning	Compliance with approved Health and Safety Plan	Decommissioning Contractor(s)	REA-PMU; FMEnv	-

CHAPTER NINE

SUMMARY AND CONCLUSION

9.1 Summary

This Environmental and Social Impact Assessment (ESIA) was conducted for the proposed 1-Megawatt (1-MW) Solar Photovoltaic (PV) Power Plant at the Federal University Birnin Kebbi (FUBK), Kebbi State. The study comprehensively evaluated the potential environmental, social, and health impacts associated with the Project across its entire lifecycle, namely: pre-construction, construction, operation, and decommissioning phases. The findings of the assessment confirm that the Project will result in minimal adverse environmental and social impacts while delivering significant long-term environmental, institutional, and socio-economic benefits. The proposed facility is strategically aligned with Nigeria's renewable energy transition objectives and climate commitments.

The Project is expected to reduce greenhouse-gas emissions to the extent that solar electricity displaces diesel-based or other higher-emission electricity sources. The quantity of avoided emissions has not been estimated at the ESIA stage because the final annual generation, dispatch profile, displaced-energy mix and applicable emissions factors have not been confirmed. During operation, REA-PMU and FUBK shall calculate and report avoided emissions using metered net electricity generation and a documented, referenced emissions factor for the electricity source displaced. Consequently, the Project contributes directly to:

- Nigeria's renewable energy development targets;
- Nationally Determined Contributions (NDCs) under the Paris Agreement; and
- The Federal Government's commitment to achieving net-zero greenhouse gas emissions by 2060.

The total land area allocated for the Project is approximately 25.2 hectares, comprising two designated sites. Site A (13 hectares) will accommodate the 1-MW Solar PV installation, while Site B (12.2 hectares) is reserved for potential future expansion. The site is located within institutional land inside the University campus and is characterized by previously disturbed Sudan Savannah vegetation. Baseline environmental studies conducted in accordance with Federal Ministry of Environment (FMEnv) guidelines revealed the following key conditions:

- Clean ambient air quality with no detectable concentrations of NO_2, CO, SO_2, or H_2S;
- Stable soil characteristics without significant contamination;
- Slightly acidic groundwater conditions within acceptable institutional usage limits;
- Absence of endangered species, critical habitats, or ecologically sensitive receptors;
- No identified cultural heritage or archaeological resources within the Project footprint.

Environmental impacts during construction are localized, temporary, and manageable. These include minor vegetation clearing, dust emissions, temporary increase in ambient noise levels, and increased vehicular movement within the campus. No impacts of sufficient magnitude were identified that would prevent Project implementation. During operation, the Solar PV facility will operate without combustion processes, without fuel storage risks, and without routine atmospheric emissions. Operational noise levels will be minimal. The Project will also enhance campus infrastructure and security through the installation of 244 additional streetlights, thereby improving illumination and reducing vulnerability to opportunistic crime. Furthermore, the facility will support academic development, research activities, and renewable energy capacity building within the University.

The ESIA identified both positive and negative interactions with the receiving environment. The key positive impacts include improved electricity reliability, reduced operational costs, enhanced security, climate mitigation benefits, institutional capacity strengthening, and local employment generation. The identified negative impacts are limited to minor and moderate risks such as temporary dust and noise, occupational health and safety risks, minor vegetation disturbance, and potential waste management concerns. All such impacts can be effectively mitigated through the implementation of appropriate control measures. An Environmental and Social Management Plan (ESMP) has been developed to guide mitigation, monitoring, reporting, and institutional oversight. The Rural Electrification Agency (REA) Project Management Unit, supported by Environmental and Social Safeguards Specialists, will oversee ESMP implementation. Stakeholder consultations conducted with University management, staff, students, regulatory authorities, and community representatives demonstrated broad institutional and community support for the Project. Overall, the ESIA confirms that the proposed 1-MW Solar PV Power Plant represents a technically viable, environmentally sustainable, and socially beneficial investment.

Bolben Energy and Environmental Services Limited assert that all environmental and social impacts have been comprehensively identified and assessed. The mitigation measures outlined in the ESMP are sufficient to address identified impacts when implemented accordingly. The proposed 1-MW Solar Photovoltaic facility represents a strategic investment in renewable energy, institutional sustainability, and climate resilience that merits approval and implementation.

9.2 Conclusion

Based on the assessment undertaken, the proposed 1 MW Solar-Hybrid Power Plant at Federal University Birnin Kebbi is considered environmentally and socially acceptable, subject to implementation of the mitigation measures, management plans, monitoring requirements and institutional responsibilities contained in the ESMP. The Project is expected to improve electricity reliability, reduce dependence on diesel backup, support institutional energy sustainability and provide potential temporary employment and capacity-development opportunities.

The principal adverse risks relate to vegetation clearance, soil disturbance, dust, noise, construction traffic, waste, occupational health and safety, worker conduct, GBV/SEA/SH, electrical safety, BESS fire and thermal-runaway hazards, hazardous waste and emergency response. These risks can be managed through the measures specified in this ESIA and through contractor-specific management plans.

The project footprint is institutional land belonging to FUBK and was open and not under active cultivation, occupation or livelihood use during the ESIA survey. No physical or economic displacement was identified. This condition shall be confirmed through documented pre-construction land-use verification. If any previously unidentified use is found, the relevant area shall be excluded from works pending assessment and completion of any proportionate requirements under AfDB OS5.

Project implementation shall comply with the Environmental Impact Assessment Act, applicable FMEnv and NESREA requirements, the Electricity Act 2023 and the African Development Bank Integrated Safeguards System 2023. The applicable AfDB safeguards include OS1 on environmental and social assessment, OS2 on labour and working conditions, OS3 on resource efficiency and pollution prevention, OS4 on community health and safety, OS5 screening for land-use impacts, OS6 on biodiversity and OS10 on stakeholder engagement. Relevant national standards and good international industry practice will apply as supplementary technical benchmarks.

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REFERENCE

Adelaide Hills Council. (2017). *Example risk assessment template*. https://www.ahc.sa.gov.au/assets/downloads/services/event-support/COUNCIL-EventsToolkit-Risk-Assessment-template-Feb-2017.pdf

African Development Bank Group. (2023). *Integrated Safeguards System: Updated Policy Statement and Operational Safeguards*. Abidjan: African Development Bank Group.

African Development Bank (AfDB). (2022). *Grievance Redress Mechanism (GRM) Framework for the Nigeria Electrification Project (NEP)*. African Development Bank.

Argonne National Laboratory. (2013). *An overview of potential environmental, cultural and socioeconomic impacts and mitigation measures for utility-scale solar energy development*. U.S. Department of Energy. http://www.evs.anl.gov/downloads/Solar_Environmental_Impact_Summary.pdf

Association of New Jersey Environmental Commissions (ANJEC). (2012). *Solar siting and sustainable land use: A white paper*. http://www.anjec.org/pdfs/SolarWhitePaper2012.pdf

BRE National Solar Centre. (2014). *Biodiversity guidance for solar developments*. Building Research Establishment (BRE). http://www.bre.co.uk/filelibrary/pdf/Brochures/NSCBiodiversityGuidance.pdf

California Department of Fish and Wildlife. (n.d.). *Habitat description: Wet meadow (WTM)*. https://nrm.dfg.ca.gov

Clancy, H. (2015, August 7). Solar farms could make fertile habitats for bees and butterflies. *GreenBiz*. https://www.greenbiz.com

Department of Public Service. (2016). *Comprehensive energy plan*. Government of Vermont.

DCE Solar. (n.d.). *A guide to safely installing solar panel arrays to any property type*. http://www.dcesolar.com/docs/InstallingSolarPanelArrays.pdf

Federal Government of Nigeria. (2004). *Environmental Impact Assessment Act, Cap E12 Laws of the Federation of Nigeria 2004*. Abuja: Government Printer.

Federal Ministry of Environment (FMEnv). (2020). *National Environmental (Permitting and Licensing System) Regulations*. Abuja: FMEnv.

Federal Ministry of Environment (FMEnv). (2023). *Environmental Impact Assessment procedural guidelines*. Environmental Assessment Department. https://ead.gov.ng

Federal Ministry of Power. (2022). *Nigeria energy transition plan*. Government of Nigeria.

Green Mountain Power. (2023). *About solar power*. http://www.greenmountainpower.com

Maryland Department of the Environment. (2000). *Stormwater design guidance: Solar panel installations*.

Mondal, A. K., & Bansal, K. (2015). Structural analysis of solar panel cleaning robotic arm. *Current Science, 108*(6), 1047–1052.

Natural Resources Board. (2010). *Vermont wetland rules*.

New York State Department of Agriculture and Markets. (2019). *Guidelines for solar energy projects: Construction mitigation for agricultural lands*.

Nigeria Zip Codes. (2023). *Kebbi State postal codes*. https://nigeriazipcodes.com

Nigerian Electricity Regulatory Commission (NERC). (2022). *Mini-grid regulation and renewable energy guidelines*. Abuja: NERC.

Parker, G., & Greene, L. (2014). *Biodiversity guidance for solar developments*. BRE National Solar Centre.

Rural Electrification Agency (REA). (2023). *Energizing Education Programme (EEP) Phase III project documentation*. Abuja: REA.

Solar Siting Task Force. (2016). *Solar siting task force report*.

The Nature Conservancy. (2015). *Laurentian-Acadian wet meadow shrub swamp*.

U.S. Energy Information Administration. (2023). *Electric power monthly*. https://www.eia.gov

Vermont Department of Environmental Conservation. (2010). *Vermont wetland evaluation form*.

Vermont Public Service Board. (2012). *Citizens' guide to Section 248 process*.

Watershed Management Division. (2011). *Wetlands: Open space and aesthetics*.

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 ☐ C'lela, Fulfulde, ☐
Resha/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)............................

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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 ☐

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SOCIO-ECONOMIC 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?
....

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APPENDIX II : LABORATORY ANALYSIS RESULTS. (WATER SAMPLES)

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EMAIL: biometricsgeo@gmail.com, TEL: 09161440089, +2348032153422.

CERTICATE OF ANALYSIS

SAMPLE TYPE: GROUNDWATER

SAMPLE LOCATION:BIRNI KEBBI, KEBBI STATE.

TOTAL SAMPLE COLLECTED:SIX (6)

SAMPLING DATE: 5TH-6TH FEBRUARY, 2026.

CLIENT: ECOSPHERE CONSULTING LIMITED

DATE OF ANALYSIS:9TH -16TH FEBRAYARY, 2026.

SAMPLE SUBMISSION DATE: 7TH FEBRUARY, 2026.

LABORATORY CODE: BMGCL/EAL/26/02/057-062

PROJECT: ESIA OF THE NIGERIAN ELECTRIFICATION PROJECT PHASE II (DESERT TO POWER PROJECT) AT BIRNIN KEBBI, KEBBI STATE

I hereby certify that the above described samples were analysed in the same condition received by us and stated here under, are our findings.

S/N	PARAMETERS	UNIT	MAXIMUM PERMISSIBLE LEVEL FOR GROUNDWATER	GW1	GW2	GW3	GW4	GW5	GW6
PHYSICO- CHEMICAL PARAMETERS									
1	General Appearance		CLEAR	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR
2	Odour		UNOBJECTIONABLE	UNOBJECTIONABL	UNOBJECTIONABL	UNOBJECTIONABL	UNOBJECTIONABL	UNOBJECTIONABL	UNOBJECTIONABLE
2	Temperature	^oC	NS	27.800	27.800	27.800	27.800	27.800	27.800
3	Electrical Conductivity	µS/cm	NS	132.661	75.806	113.709	142.137	94.758	151.613
4	pH		6.50-9.20	61.900	6.180	6.300	6.450	6.230	6.300
5	Turbidity	NTU	NS	0.000	0.000	0.000	0.000	2.000	10.000
6	Colour	Pt.co	50.00	0.000	0.000	0.000	0.000	15.000	30.000
7	Total Dissolved solid	mg/l	NS	207.283	118.447	177.671	222.089	148.059	236.895
8	Total Suspended Solid	mg/l	NS	0.007	0.002	0.001	0.004	0.012	0.018
9	Total Solid	mg/l	1500.00	207.290	118.449	177.672	222.093	148.071	236.913
10	Total Hardness	mg/l	500.00	439.024	487.804	487.800	317.073	414.633	487.804
11	Magnesium Hardness	mg/l	NS	243.903	121.951	390.243	219.268	317.073	389.755
12	Calcium Hardness	mg/l	NS	195.122	365.853	97.561	97.805	97.561	98.049
13	Total Alkalinity	mg/l	NS	40.000	40.010	20.000	40.000	20.080	40.060
14	Salinity	ppt	NS	0.080	0.046	0.069	0.086	0.057	0.092
ORGANICS									
17	Chemical oxygen demand (COD)	mg/l	NS	59.400	11.880	95.040	47.520	46.332	47.506
18	Biological oxygen demand (BOD)	mg/l	NS	35.640	7.128	57.024	28.512	27.999	28.505

LABORATORY ANALYSIS RESULTS CONTINUES…. (WATER SAMPLES)

ANIONS									
19	Carbonate	mg/l	NS	0.000	0.000	0.000	0.000	0.000	0.000
20	Bicarbonate	mg/l	NS	48.800	48.812	24.400	48.800	24.498	48.873
21	Chloride	mg/l	600.00	73.701	42.115	63.172	78.763	52.643	84.229
22	Nitrite	mg/l	2.00	0.018	0.000	0.000	0.191	0.029	0.000
23	Nitrate	mg/l	50.00	30.874	38.899	22.387	29.950	38.059	51.546
24	Phosphate	mg/l	NS	4.360	2.881	2.527	0.695	6.579	0.566
25	Sulphate	mg/l	400.00	7.877	5.415	31.108	2.492	0.646	0.338
METALS									
26	Calcium	mg/l	200.00	78.208	146634.000	39.102	39.200	39.100	39.298
27	Magnesium	mg/l	150.00	39.293	29.646	94.865	53.304	77.250	94.750
28	Sodium	mg/l	NS	0.000	0.033	0.000	0.000	0.010	1.608
29	Potassium	mg/l	NS	0.367	0.875	0.523	0.719	0.680	1.109
30	Lead	mg/l	15.000	0.000	0.000	0.000	0.000	0.000	0.000
31	Iron	mg/l	1.000	0.053	0.000	0.005	0.401	0.000	0.000
32	Chromium	mg/l	1.00	0.000	1.175	1.451	0.000	0.000	0.000
34	Copper	mg/l	1.500	0.067	0.053	0.104	0.047	0.050	0.072
35	Manganese	mg/l	0.500	0.000	0.000	0.000	0.000	0.000	0.000
36	Zinc	mg/l	15.000	0.000	0.046	0.062	0.052	0.013	0.061
37	Arsenic	mg/l	10.000	0.018	0.014	0.015	0.015	0.017	0.011
MICROBIAL PARAMETERS									
38	Total Bacterial count (TBC))	cfu/ml	0	$2.3 X 10^4$	$1.26 X 10^4$	$2.62 X 10^4$	$1.44 X 10^4$	$1.72 X 10^4$	$1.8 X 10^3$
39	Total Heterotrophic Fungi (THF)	cfu/ml	0	ND	ND	ND	$1.0 X 10^0$	ND	ND
40	Total coliform (TC)	cfu/ml	10	ND	$2.8 X 10^1$	$1.0 X 10^1$	ND	$2.0 X 10^0$	$2.0 X 10^0$
41	Feacal coliform (FC)	cfu/ml	0	ND	ND	ND	ND	ND	ND

STANDARD : NATIONAL ENVIRONMENTAL (SURFACE AND GROUND WATER QUALITY CONTROL) REGULATIONS, 2011.

NOTE:

LABORATORY ANALYSIS RESULTS CONTINUES…. (WATER SAMPLES)

mg/l = milligram per litre
µS/cm = micro Siemens per centimetre
cfu/ml = colony forming unit per millilitre
NS = Not stated
ND = Not Detected
TNTC = Too numerous to count

FUNMI SUNDAY
ANALYST

CHECKED AND APPROVED BY

DR. EUNICE AJAYI
MD

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APPENDIX III: LABORATORY ANALYSIS RESULT (SOIL SAMPLES)

BIO-METRICS GEO CONSULT

ADDRESS: ADDRESS; Plot 12, Bacheal T. Owolabi Street Gaduwa Abuja.
EMAIL: biometricsgeo@gmail.com, TEL: 09161440089, +2348033153422.

CERTIFICATE OF ANALYSIS

SAMPLE TYPE: SOIL

SAMPLE LOCATION: BIRNI KEBBI, KEBBI STATE.

TOTAL SAMPLE COLLECTED: NINE (9).

SAMPLING DATE: FEBRUARY 5TH- 6TH , 2026.

CLIENT: ECOSPHERE CONSULTING LIMITED

DATE OF ANALYSIS: 9TH -15TH FEBRUARY, 2026

SAMPLE SUBMISSION DATE: 7TH FEBRUARY, 2026

LABORATORY CODE: BMGCL/EAL/26/02/063-071

PROJECT: ESIA OF THE NIGERIAN ELECTRIFICATION PROJECT PHASE II (DESERT TO POWER PROJECT) AT BIRNIN KEBBI, KEBBI STATE

I hereby certify that the above described samples were analysed in the same condition received by us and stated here under, are our findings.

S/N	PARAMETERS	UNIT	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9
PHYSICO- CHEMICAL PARAMETERS											
1	Electrical Conductivity	µS/cm	217.943	236.895	198.991	369.556	189.516	189.610	255.846	198.991	189.516
2	pH	6.800	6.660	6.380	6.540	6.720	7.140	6.550	5.930	5.870	5.510
3	Moisture Content	%	2.368	1.441	1.205	2.776	2.029	1.843	1.771	0.878	5.016
4	Porosity	%	53.930	51.830	50.590	56.887	53.452	54.884	54.025	52.785	50.876
5	Soil Texture		Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand	Silty Sand
6	Bulk Density		1.221	1.276	1.309	1.142	1.234	1.196	1.218	1.251	1.302
7	Total Alkalinity	mg/Kg	10.000	10.000	20.000	10.000	20.000	10.000	20.000	20.000	10.000
8	Salinity	ppt	0.132	0.143	0.120	0.224	0.115	0.115	0.185	0.120	0.115
9	Ammonium	mg/Kg	16.183	19.902	43.130	18.551	43..42	32.809	34.167	18.696	19.582
10	Ammonia	mg/Kg	15.281	18.793	40.727	17.517	41.001	30.981	32.263	17.654	18.491
11	Exchangeable sodium	Cmol/Kg	1.497	0.816	0.391	3.010	0.824	0.680	1.565	0.992	0.203
12	Exchangeable potassium	Cmol/Kg	8.810	4.802	2.303	17.713	4.846	4.003	9.209	5.837	1.193
13	Exchangeable Calcium	Cmol/Kg	24.439	9.776	9.824	19.551	9.776	14.663	9.776	19.551	34.215
14	Exchangeable Magnesium	Cmol/Kg	48.798	63.437	82.907	97.596	63.437	53.678	78.076	58.537	39.038
15	Exchangeable Acidity	Cmol/Kg	50.751	61.484	63.310	68.407	72.773	65.339	69.275	57.581	44.358
16	Exchangeable Bases	Cmol/Kg	83.544	78.831	95.426	137.870	78.883	73.025	98.626	84.936	74.649
17	Cation Exchange Cation (CEC)	Cmol/Kg	134.295	140.315	158.736	206.276	151.656	138.423	167.901	142.519	118.907
18	Base saturation	%	62.209	56.181	60.116	66.837	52.014	52.755	58.741	59.598	62.779
19	Sodium Adsorption Ratio (SAR)		0.247	0.135	0.057	0.393	0.136	0.116	0.236	0.159	0.034

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LABORATORY ANALYSIS RESULT CONTINUES…(SOIL SAMPLES)

20	Exchangeable Sodium Potassium (ESP)	%	1.792	1.035	0.410	2.183	1.044	0.932	1.587	1.168	0.272
MACRO NUTRIENTS											
21	Total Nitrogen	mg/Kg	115.666	97.961	119.586	140.039	141.151	109.765	131.346	113.910	109.385
22	Available Phosphorus	mg/Kg	4.286	2.815	3.078	9.328	4.181	3.866	6.019	4.758	7.332
23	Total Potassium	mg/Kg	308.844	185.703	118.906	307.188	146.250	142.734	237.656	170.859	56.797
ORGANICS											
24	Total Organic carbon	%	0.115	0.054	0.062	0.113	0.083	0.058	0,075	0.068	0.058
25	Total Organic Matter	%	0.199	0.092	0.106	0.195	0.144	0.099	0.130	0.116	0.099
26	Total Organic Nitrogen	mg/Kg	0.012	0.005	0.006	0.011	0.008	0.006	0.008	0.007	0.006
ANIONS											
27	Chloride	mg/Kg	121.079	131.608	110.551	205.309	105.287	105.339	142.137	110.551	105.287
28	Nitrate	mg/Kg	94.874	71.765	75.126	117.983	97.395	71.765	89.412	88.992	84.372
29	Nitrite	mg/Kg	4.597	6.289	1.324	3.494	0.331	5.186	7.760	6.216	5.627
30	Phosphate	mg/Kg	11.119	8.617	9.421	28.552	12.797	11.832	18.424	14.565	22.443
31	Sulphate	mg/Kg	237.231	261.846	126.462	255.692	326.462	194.846	481.846	580.308	214.154
METALS											
32	Calcium	mg/Kg	488.780	195.512	196.489	391.024	195.510	293.268	195.508	391.020	684.291
33	Magnesium	mg/Kg	592.926	770.803	1007.381	1185.852	770.803	652.218	948.681	711.511	474.341
34	Sodium	mg/Kg	34.414	18.758	8.995	69.191	18.931	15.638	35.973	22.802	4.662
35	Iron	mg/Kg	14.632	4.529	3.697	13.364	6.589	2.508	0.000	4.489	2.151
36	Copper	mg/Kg	0.790	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	Lead	mg/Kg	0.930	0.287	0.000	0.409	0.000	0.559	0.729	0.168	0.484
38	Zinc	mg/Kg	6.229	0.092	4.167	2.190	0.970	0.000	0.000	3.127	0.083
39	Chromium	mg/Kg	4.286	1.469	0.000	0.000	1.741	3.617	3.708	3.074	3.450
MICROBIAL ANALYSIS											
40	Total Heterotrophic Bacterial (THB)	cfu/g	$4.6 X 10^4$	$1.24 X 10^5$	$9.8 X 10^4$	TNTC	$1.16 X 10^5$	$1.8 X 10^4$	$6.4 X 10^4$	$7.2 X 10^4$	$7.6 X 10^4$
41	Total Heterotrophic Fungi (THF)	cfu/g	$6.0 X 10^3$	$8.0 X 10^3$	$1.0 X 10^4$	$8.0 X 10^3$	$1.6 X 10^4$	$8.0 X 10^3$	$1.2 X 10^4$	$3.0 X 10^4$	$6.0X 10^3$

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LABORATORY ANALYSIS RESULT CONTINUES…(SOIL SAMPLES)

43	Total coliform (TC)	cfu/g	ND	$2.0 X 10^2$	$4.0 X 10^2$	ND	ND	ND	ND	ND	ND

NOTE:

mg/Kg = miligram per Kilogram
uS/cm = micro Siemens per centimetre
cfu/g = colony forming unit per gramme
Cmol/Kg = centimole per kilogram
NS = Not stated
ND = Not Detected
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DR. EUNICE AJAYI
MD

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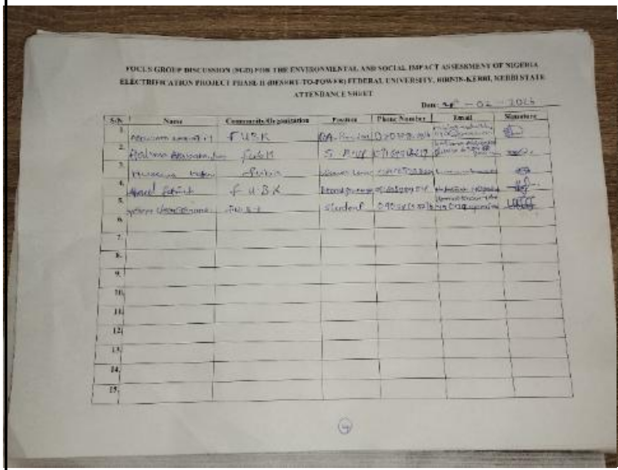
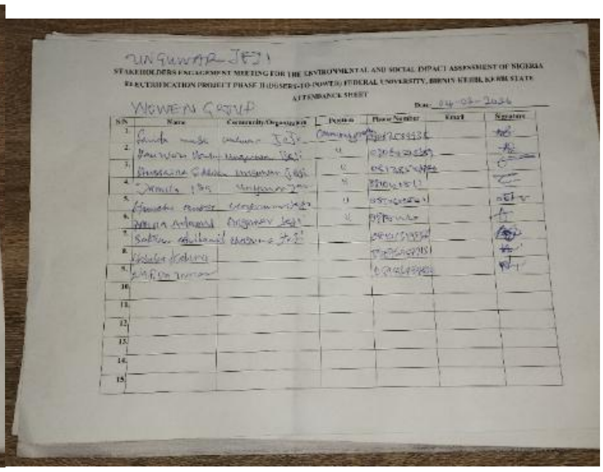
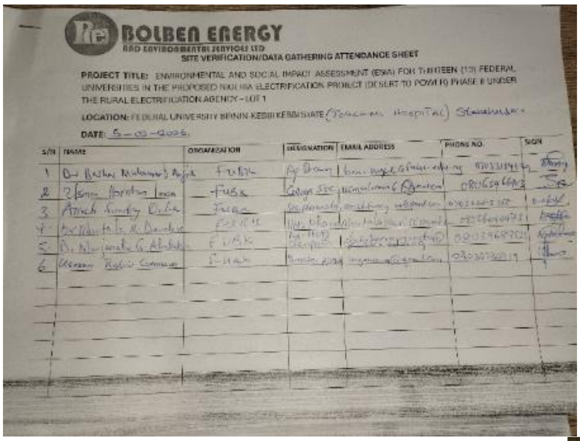
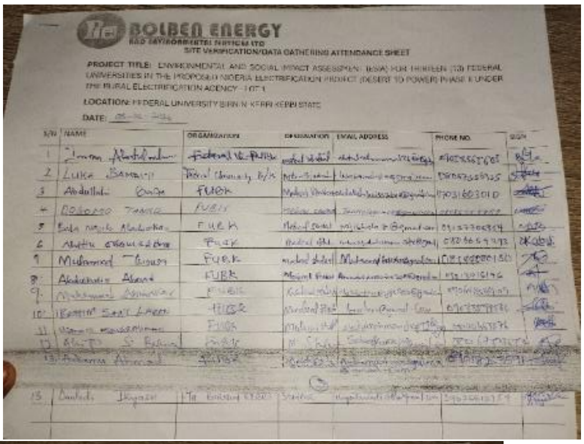
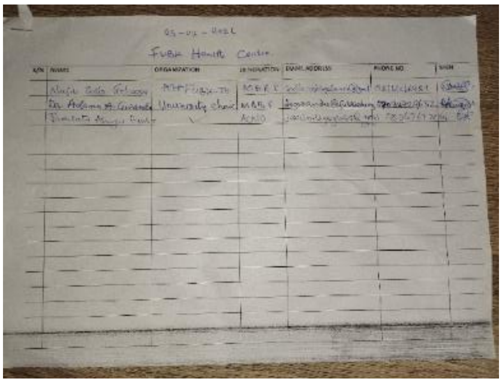
APPENDIX IV: FIELD ACTIVITIES ATTENDANCE.

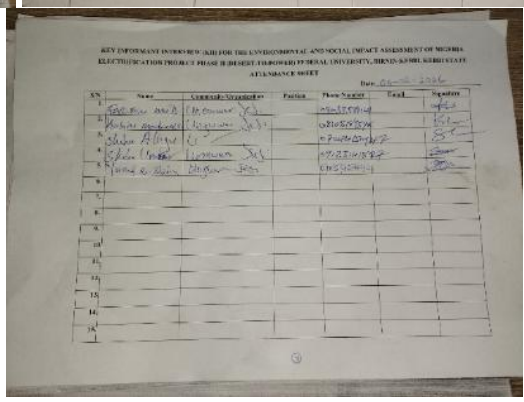












FEDERAL UNIVERSITY BIRNIN KEBBI

P.M.B 1157, BIRNIN KEBBI, KEBBI STATE

OFFICE OF THE DIRECTOR

DEPARTMENT OF PHYSICAL PLANNING & DEVELOPMENT

SUBMISSION OF INFORMATION/ DOCUMENTS FOR PRE-FEASIBILITY STUDIES TO BE CONDUCTED AT FUBK MAIN CAMPUS BY RURAL ELECTRIFICATION AGENCY (REA) AS PART OF THE AFRICAN DEVELOPMENT BANK (AFDB) DESERT TO POWER INITIATIVE

TABLE 1: Technical Information (Item 7/II)

S/N	Technical Parameter	Description / Data Provided	Remarks
1	Energy consumption from national grid	248,200 Kwh	Monthly
2	Energy generated through self-generation (diesel generators)	Fuel-based generation records attached	Deisel fuel-based generation
3	Single-line drawings of power supply network	Attached	Drawing reference numbers as Apendex I
4	Number of feeders	Incomer = 1	from Grid (33KV/11KV)
		Outgoing = 2	internal feeders (11KV/415V)
5	Distribution voltage level(s)	11kV / 415V	e.g. 11kV / 415V
6	Capacity of main injection substation	5 MVA	at FUBK Main Campus Substation
7	Central generating sets (where applicable)	N/A	N/A

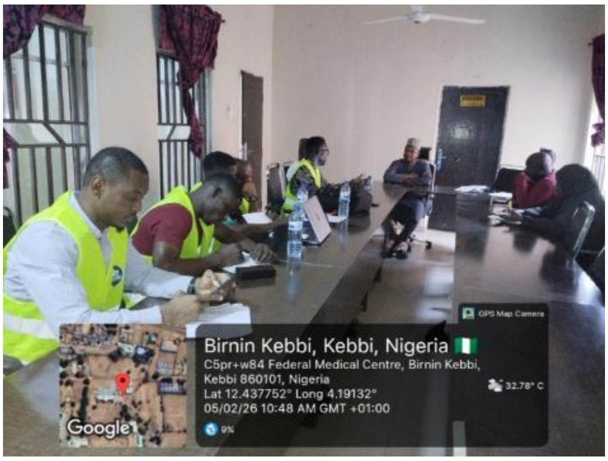
TABLE 2: Energy generated through self-generation (diesel generators)

S/N	Location	Generator Make / Model	Capacity (kVA)	Fuel Type	Status
1	Senate Building	PARKINS	165KVA	Diesel	Operational
2	Faculty of Science Laboratories	DANYO	60KVA	Diesel	Operational
3	University Library	PARKINS	110KVA	Diesel	Operational
4	Physical Planning & Development/ Faculty of Education	PARKINS	20KVA	Diesel	Operational
5	Male Hotel Block A	PARKINS	250KVA	Diesel	Operational
6	Male Hotel Block B	PARKINS	250KVA	Diesel	Operational

Muhammad Zulkarnaini
(Head electricity Control Unit)
For: Ag. Director, PP&D

Ag. Director: QS. U.R Gamawa *Phone No:08030730719* *Email:* rabiu.gamawa@fubk.edu.ng

APPENDIX V: PICTORIAL EVIDENCE OF STAKEHOLDER CONSULTATION.



Consultation with the Institution Management

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PICTORIAL EVIDENCE OF STAKEHOLDER CONSULTATION CONTINUES…..

Engagement with the Community member within the Area Of Influence

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APPENDIX VI: PICTORIAL EVIDENCE OF DATA GATHERING ACTIVITIES (SOIL EXTRACTION)

APPENDIX VII: PICTORIAL EVIDENCE OF DATA GATHERING ACTIVITIES (AIR/NOISE SAMPLING)

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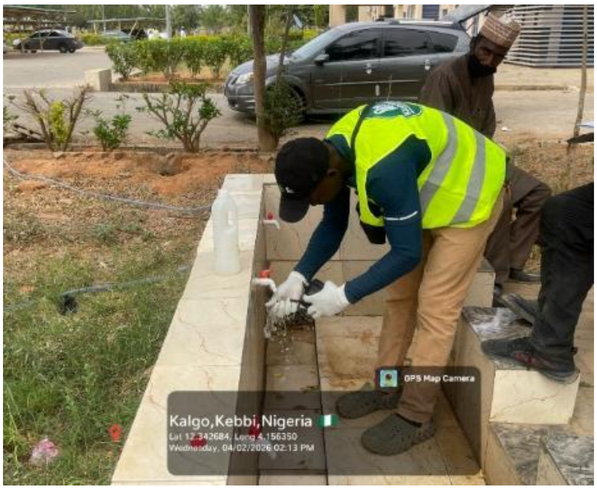
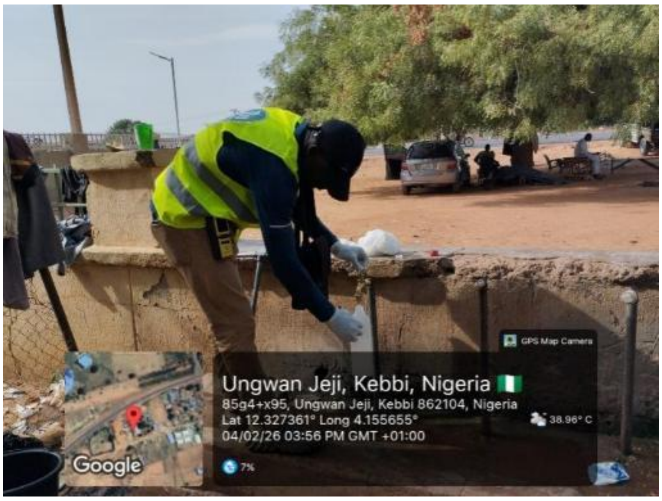
Final-Draft Report, July 2026

APPENDIX VIII: PICTORIAL EVIDENCE OF DATA GATHERING ACTIVITIES (WATER COLLECTIONS AT DIFFERENT POINTS)





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