NIGERIA ELECTRIFICATION PROJECT

RURAL ELECTRIFICATION AGENCY

ENERGY = EMPOWERMENT = EFFICIENCY

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA[1])

OF

THE PROPOSED 3.0 MW SOLAR-HYBRID POWER PLANT AND ASSOCIATED INFRASTRUCTURE IN NIGERIAN DEFENCE ACADEMY (NDA), KADUNA STATE

UNDER THE FEDERAL GOVERNMENT OF NIGERIA (FGN) ENERGIZING EDUCATION PROGRAMME (EEP) PHASE II

(DRAFT REPORT)

SUBMITTED TO

THE FEDERAL MINISTRY OF ENVIRONMENT

MARCH 2020

[1] The proposed project is being co-financed by the World Bank. If reference is made to the FMEnv procedure, the term "EIA" is used, while if reference is made to the project's broader perspective, the term "ESIA" is used. Both ESIA and EIA are synonymous.

DRAFT ESIA REPORT

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TABLE OF CONTENTS

Title Page i
Table of Contents iii
List of Tables v
List of Figures vii
List of Plates viii
List of Acronyms and Abbreviations ix
List of ESIA Preparers xi

CHAPTER ONE: INTRODUCTION

1.1 Background Information 1-2
1.2 Objectives of the ESIA Study 1-3
1.3 Scope of the ESIA Study 1-4
1.4 ESIA Study Approach / Methodology 1-4
1.5 Limitations of the ESIA Study 1-5
1.6 Legal and Administrative Framework 1-5
1.7 Institutional Arrangements for Environmental and Social Management 1-19
1.8 Report Structure 1-20

CHAPTER TWO: PROJECT JUSTIFICATION

2.1 Need for the Project 2-2
2.2 Value of the Project 2-3
2.3 Project Benefits 2-3
2.4 Envisaged Sustainability 2-4
2.5 Project Alternatives 2-5
2.6 Project Options 2-11

CHAPTER THREE: PROJECT DESCRIPTION

3.1 Introduction 3-2
3.2 Project Location 3-2
3.3 Project Components 3-11
3.4 Engineering Codes and Standards 3-15
3.5 Project Implementation Phase 3-16
3.6 Water Use and Supply 3-17
3.7 Health and Safety 3-18
3.8 Waste Management 3-19
3.9 Project Schedule 3-23

CHAPTER FOUR: DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction 4-2
4.2 Baseline Data Collection 4-4
4.3 Description of Biophysical Environment of the Study Area 4-7
4.4 Description of Socio-economic Environment of the Project Area 4-35

4.5 Stakeholder Engagement 4-58

CHAPTER FIVE: ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction 5-2
5.2 Impact Assessment Overview 5-2
5.3 Identification of Environmental and Socio-economic Aspects and Impacts 5-3
5.4 Determination of Impact Significance 5-9
5.5 Impacts Discussion 5-15
5.6 Risk and Hazard Assessment 5-31
5.7 Summary 5-32

CHAPTER SIX: MITIGATION MEASURES

6.1 Introduction 6-2
6.2 Mitigation Measures Approach 6-2
6.3 Mitigation Measures for the Identified Significant Negative Impacts 6-2
6.4 Mitigation Measures for the Identified Project Risks and Hazards 6-3
6.5 Enhancement Measures for Identified Positive Impacts 6-4

CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction 7-2
7.2 Objectives of the ESMP 7-2
7.3 Environmental and Social Management Measures 7-3
7.4 Roles, Responsibilities and Accountabilities 7-18
7.5 Additional Management Plans 7-23
7.6 Environmental Monitoring Programme 7-28
7.7 Training, Awareness and Capacity Building 7-30
7.8 Implementation Schedule and Reporting 7-30
7.9 ESMP Costing 7-31

CHAPTER EIGHT: REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

8.1 Introduction 8-2
8.2 Decommissioning Activities 8-2
8.3 Management of Decommissioning Activities 8-2
8.4 Abandonment Plan 8-5
8.5 Roles, Responsibilities and Accountabilities for Decommissioning Phase 8-5

CHAPTER NINE: STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

9.1 Stakeholder Engagement 9-2
9.2 Legal and Administrative Framework Guiding Stakeholder Engagement 9-2

9.3 Objectives of Stakeholder Engagement 9-3
9.4 Stakeholder Identification and Analysis 9-4
9.5 Management Function and Grievance Mechanism 9-13

CHAPTER TEN: CONCLUSION AND RECOMMENDATIONS
10.1 Conclusion 10-2
10.2 Recommendations 10-4

LIST OF TABLES

Table 1.1: Applicability of the World Bank Safeguard Policies to the proposed Project 1-12
Table 2.1: Comparison between CSP and PV Solar Technology 2-8
Table 3.1: Summary of Energy Demand Audit for NDA, July 2016 3-11
Table 3.2: Summary of Wastes Stream associated with the proposed Project and Handling Techniques 3-22
Table 3.3: Tentative Project Schedule 3-23
Table 4.1: Analytical methods employed for field sample analysis 4-7
Table 4.2: Monthly Mean Climatic Characteristics of the Project Area (1991-2017) 4-8
Table 4.3: Ambient Air Quality Standards 4-13
Table 4.4: Noise Exposure Limits for Nigeria 4-13
Table 4.5: Noise Level Guidelines adopted by the World Bank 4-13
Table 4.6: Geographical coordinates of Air quality sampling locations in the Project Area 4-13
Table 4.7: Results of ambient air quality and noise levels measured in the Project area 4-14
Table 4.8: Geographical coordinates of Soil Sampling Locations in the Project Area 4-16
Table 4.9: Physico-chemical and microbial properties of top soils (0 – 15cm) from the Project area 4-17
Table 4.10: Geographical coordinates of Groundwater sampling locations in the Project Area 4-20
Table 4.11: Physico-chemical and microbial characteristics of groundwater samples from the Project area 4-21
Table 4.12: Surface water sampling locations 4-23
Table 4.13: Physico-chemical and microbial characteristics of surface water samples from the Project area 4-23
Table 4.14: Plant inventory and Conservation Status 4-27
Table 4.15: List of Fauna Species Encountered in the Project Area 4-28
Table 4.16: Existing Land Use within the wider area (outside the Project site) 4-30
Table 4.17: Vehicle Classification Scheme used for the traffic survey 4-32
Table 4.18: Summary of the process and stages of consultation for the ESIA 4-59
Table 4.19: Initial Scoping Consultation Findings 4-62
Table 5.1: Example of a Link between Activities, Environmental Aspects and Impacts 5-4
Table 5.2: Summary of the proposed Project Activities 5-6
Table 5.3: Resource/Receptors and Impacts Indicators Considered 5-6
Table 5.4: Activity-Receptor Interaction for Impact Screening 5-8
Table 5.5: Impact Magnitude Criteria for Socio-economic Impacts 5-10
Table 5.6: Bio-physical and Socio-economic Receptor-Sensitivity/

	Fragility/ Value Criteria	5-11
Table 5.7:	Environmental Impact Significance Rankings	5-12
Table 5.8:	Leopold's Activity-Receptor Interaction Matrix (Impact Significance Matrix)	5-14
Table 5.9:	Summary of Potential Negative Impacts Associated with the Pre-Construction Phase of the proposed Project	5-20
Table 5.10:	Summary of Potential Negative Impacts Associated with the Construction Phase of the proposed Project	5-26
Table 5.11:	Summary of Potential Impact Associated with the Commissioning Phase of the proposed Project	5-27
Table 5.12:	Summary of Potential Negative Impacts Associated with Operational Phase of the proposed Project	5-30
Table 6.1:	Mitigation Measures for the Potential Negative Impacts of the proposed Project	6-6
Table 7.1a:	Environmental Management Measures for Pre-construction Phase of the proposed Project	7-4
Table 7.1b:	Social Management Measures for Pre-construction Phase of the proposed Project	7-6
Table 7.2a:	Environmental Management Measures for Construction Phase of the proposed Project	7-7
Table 7.2b:	Social Management Measures for Construction Phase of the proposed Project	7-10
Table 7.3a:	Environmental Management Measures for Commissioning Phase	7-14
Table 7.3b:	Social Management Measures for Commissioning Phase	7-15
Table 7.4a:	Environmental Management Measures for Operational Phase	7-15
Table 7.4b:	Social Management Measures for Operational Phase	7-17
Table 7.5:	Additional Management Plans and Timing for Development	7-28
Table 7.6:	Environmental Monitoring Programme for the proposed Project	7-29
Table 7.7:	Institutional Capacity Strengthening Plan	7-30
Table 7.8:	ESMP Costing	7-31
Table 8.1:	Environmental and Social Management Measures for Decommissioning Phase	8-7
Table 9.1:	Identified stakeholders associated with the Project	9-5
Table 9.2:	Stakeholder Engagement Process	9-7
Table 9.3:	Stakeholder Engagement Tools and Communication	9-8
Table 9.4:	Stakeholder Group Consultation Methods	9-8
Table 9.5:	Initial Stakeholder Consultation Findings	9-11

LIST OF FIGURES

Figure 1.1: Schematic presentation of the general methodology for the ESIA 1-5
Figure 2.1: Photovoltaic power potential of Nigeria 2-7
Figure 2.2: Typical appearance of mono-crystalline silicon PV panels 2-9
Figure 2.3: Typical Appearance of Polycrystalline Silicon PV panels 2-9
Figure 2.4: Typical appearance of Thin-Film CdTe panels 2-10
Figure 3.1: Administrative Map of Nigeria highlighting Kaduna State 3-4
Figure 3.2: Administrative Map of Kaduna State highlighting Igabi Local Government Area 3-5
Figure 3.3: The Location of NDA in Igabi Local Government Area 3-6
Figure 3.4: Map of the Project site within the NDA campus 3-7
Figure 3.5: Aerial imagery of the Project site and the surrounding infrastructure within NDA campus 3-8
Figure 4.1: Aerial imagery of the Project's Area of Influence for biophysical and socio-economic survey 4-3
Figure 4.2: Management program employed for field sampling 4-6
Figure 4.3: Average rainfall characteristics of the Project area (1991- 2017) 4-8
Figure 4.4: Monthly Mean Temperature Characteristics of the Project Area 4-9
Figure 4.5: Monthly Relative Humidity Characteristics of the Project Area (1991-2017) 4-10
Figure 4.6: Monthly Average Wind Speeds of the Project Area (1991- 2017) 4-11
Figure 4.7: Monthly Average of Sunshine Hours for the Project Area (1991-2017) 4-11
Figure 4.8: Geology of Kaduna State indicating the project area outlined in red 4-12
Figure 4.9: Air quality/ Noise sampling locations map 4-14
Figure 4.10: Soil Sampling Locations Map 4-16
Figure 4.11: Map of Groundwater Sampling Locations in the Project Area 4-20
Figure 4.12: Map of Surface water Sampling Locations at the study area 4-23
Figure 4.13: BOD water quality chart 4-25
Figure 4.15: Land use map of the Project site and area of influence 4-30
Figure 4.16: Land use composition within the Project area of influence 4-30
Figure 4.17: Aerial Imagery of the project site showing the screen lines 4-32
Figure 4.18: Average traffic flow result for the screen lines (SL1 & SL2) 4-34
Figure 4.19: Percentage composition of vehicles for the screen lines (SL1 & SL2) 4-34
Figure 4.20: Distribution of religion among the respondents 4-38
Figure 4.21: Chart showing the level of education among respondents in the study area 4-53
Figure 4.22: Showing distribution of respondent's general health status 4-57
Figure 5.1: Overview of the Impact Assessment Process 5-3
Figure 5.2: Impact Magnitude-Receptor Sensitivity Product Results 5-13

Figure 5.3: Risk Assessment Matrix 5-32
Figure 7.1: Roles and Responsibilities for the Pre Construction and Construction Phase 7-21
Figure 7.2: Roles and Responsibilities for the Operational Phase 7-23

LIST OF PLATES

Plate 3.1:	Cross-sectional view of the Project Site within NDA campus	3-10
Plate 3.2:	Aerial view of the Project site within NDA campus (shown with the red arrow)	3-10
Plate 3.3:	A typical low voltage switchgear cabinet	3-14
Plate 3.4:	Sample of stand-alone and pole-mounted streetlights in NDA campus	3-15
Plate 4.1:	Sample Photographs of Field Sampling Activities in the Project's Area of Influence: A- Noise/Air sampling, B- Soil sampling, C-Socio-economic survey, D- Groundwater sampling	4-5
Plate 4.2:	Cross sectional views of the Project site	4-26
Plate 4.3:	Some of the flora species observed in the Project area	4-28
Plate 4.4:	Some of the animals sighted in the Project area	4-29
Plate 4.5:	Traffic count by field observer in the Project area	4-33
Plate 4.6:	Questionnaire administration around the community	4-39
Plate 4.7:	FGDs with men and youths in Mando community	4-39
Plate 4.8:	Interview with health matron and a member of the community	4-39
Plate 4.9:	Focus group discussions held with women and men in the community	4-40
Plate 4.10:	(A) Palace of the Seriki of Mando village (B) KII with the Seriki	4-45
Plate 4.11:	Security organisation within the community	4-46
Plate 4.12:	Trading activities ongoing in Mando market	4-48
Plate 4.13:	Generator as alternative source of electricity found in the village	4-50
Plate 4.14:	Water facilities found within the community	4-51
Plate 4.15:	Different sources of water available in Mando community	4-51
Plate 4.16:	Internal roads within the Mando community	4-51
Plate 4.17:	Transportation forms in the study area	4-51
Plate 4.18:	Telecommunication mast and school observed in the community	4-52
Plate 4.19:	Recreation (board games) and leisure activities (sport betting) within the community	4-53
Plate 4.20:	Housing and business structures observed in the community	4-54
Plate 4.21:	Healthcare facilities found in the study area	4-56
Plate 4.22:	Sample pictures taken during Stakeholder Consultations	4-60
Plate 9.1:	Sample pictures taken during Stakeholder Consultations	9-11

LIST OF ACRONYMS AND ABBREVIATIONS

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

IHR	-	International Health Regulations
ILO	-	International Labour Organisation
IPAN	-	Institute of Public Analysts of Nigeria
ITCZ	-	Inter-Tropical Convergence Zone
IUCN	-	International Union for Conservation of Nature
KEPA	-	Kaduna State Environmental Protection Authority
KII	-	Key Informant Interview
LEMP	-	Labour and Employment Management Plan
LGA	-	Local Government Area
mono-Si	-	Mono-crystalline silicon
M.Sc.	-	Master of Science
MW	-	Megawatt
NAAQS	-	Nigerian Ambient Air Quality Standards
NBS	-	National Bureau of Statistics
NDA	-	Nigerian Defence Academy
NDC	-	Nationally Determined Contributions
NEPP	-	National Electric Power Policy
NERC	-	Nigerian Electricity Regulatory Commission
NESREA	-	National Environmental Standards and Regulations Enforcement Agency
Ni	-	Nickel
NiCd	-	Nickel cadmium
NiNAS	-	Nigeria National Accreditation Service
NiMet	-	Nigerian Meteorological Agency
NO_2	-	Nitrogen dioxide
NPC	-	National Population Commission
OP	-	Operational Policy
OPC	-	Organic Photovoltaic Cells
OSH	-	Occupational Safety and Health
Pb	-	Lead
PHCN	-	Power Holding Company of Nigeria
PM	-	Particulate Matter
PMT	-	Project Management Team
poly-Si	-	Polycrystalline silicon
PPE	-	Personal Protective Equipment
PV	-	Photovoltaic
QA/QC	-	Quality Assurance and Quality Control
REA	-	Rural Electrification Agency
RH	-	Relative Humidity
SEA	-	Sexual Exploitation and Abuse
SL	-	Screen Line
SMEs	-	Small Medium Enterprises
SO_2	-	Sulphur dioxide

SOP	-	Standard Operating Procedure
TDS	-	Total Dissolved Solids
TFSC	-	Thin-film solar cell
TMP	-	Traffic Management Plan
TOC	-	Total Organic Carbon
TSP	-	Total Suspended Particulate
V	-	Vanadium
VOC	-	Volatile Organic Compounds
VRFB	-	Vanadium Redox Flow Battery
WBG	-	World Bank Group
WHO	-	World Health Organisation
WMP	-	Waste Management Plan
Zn	-	Zinc

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

This report documents the Environmental and Social Impact Assessment (ESIA) study for the proposed 2.5 MW solar power plant and associated infrastructure in Nigerian Defence Academy (NDA), Kaduna State, under the Federal Government's Energizing Education Programme (EEP) Phase II.

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

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

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

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

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

- EIA Act CAP E12 LFN 2004
- National Policy on the Environment, 1989 (revised in 1999 and 2017)
- World Bank Safeguard Policies on Environmental Assessment
- National Environmental (Energy Sector) Regulations, 2014

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

2.0 PROJECT JUSTIFICATION

Need for the Project and Benefits

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

The potential Project benefits include, amongst others:

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

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

Envisaged Sustainability of the Project

Technical Sustainability: The Project development shall be handled by qualified and experienced EPC contractor (to be selected by REA through a competitive process) according to pre-established standards and procedures. The design and construction phase of the Project shall be overseen by qualified engineers from REA and the Department of Works and Physical Planning in NDA. Upon completion of the construction phase, an O&M contractor will be engaged to operate and maintain the Project, in conjunction with the team from NDA's Works and Physical Planning Department.

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

Economic Sustainability: The proposed Project is part of the FGN's EEP initiative, a component of NEP. NEP is being funded by the World Bank with Three Hundred and Fifty Million US Dollars ($350,000,000) loan, of which One Hundred and Five Million US Dollars ($105,000,000) is allocated for projects under the EEP. The proposed Project in NDA, as part of the EEP Phase II, will be financed from the NEP fund. Upon completion, the Project will significantly reduce the use of diesel generators in the University thereby saving costs on diesel fuel and generator maintenance, amongst others. Also, monthly expenditures to the local power distribution company for power consumption from the national grid would be saved. Part of such savings will be used for the maintenance of the Project facilities in the long run.

Social Sustainability: Stakeholder consultation has been carried out as part of the ESIA process in ensuring that all relevant stakeholders are presented with the opportunity to provide input into the Project at the early stage. This has also assisted in laying a good foundation for building relationship with the stakeholders. In addition, a Stakeholder Engagement Plan (SEP) has been developed as part of the ESIA study to ensure continuous engagement with relevant stakeholders throughout

the Project life cycle. In addition, a grievance redress mechanism (GRM) has been developed by REA for the Project.

Project Alternatives

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

3.0 PROJECT DESCRIPTION

An approximately 43.0 ha of land within the NDA campus has been allocated for the proposed Project; however approximately 20 % of the entire land would be used. The geographical coordinates of the Project site are Latitude 10.60766°N to 10.59908°N and Longitude 7.37041°E to 7.384725°E. A large portion (approximately 70 %) of the Project site is used for subsistence farming by relatives of some NDA staff. There are no existing physical structures within the site. There is no local community presence on the Project site (e.g. farming and wood/fruits gathering activities). Also, the site is not within any designated grazing reserves, breeding areas, or animal migratory routes. The nearest community to the Project site is Mando which is situated about 1 km away from the University

The proposed solar power plant will involve the use of PV technology for power generation. PV panels will be installed on the site using piling foundations and the power generated will be evacuated via an 11 kV underground armoured cable to the existing power house (also the switch yard) and distributed within the University. The exact number of the panels is yet to be finalized. However, based on the review of similar solar power projects, about 7,920 PV panels (for example, JKM340PP-72H-V) would be required to generate a power capacity of 3.0 MW.

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

The pre-construction phase activities for the Project will include site clearing, and mobilization of equipment and construction materials to site. The construction phase activities will include civil, mechanical and electrical works; installation of PV panels and associated components such as mounting structures, inverters, batteries, and switchgear. The exact number of PV panels, batteries and inverters to be

installed is yet to be finalized. Also, the construction of renewable energy training centre as well as installation of additional streetlights will be carried out during the construction phase.

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

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

It is estimated that about 4,000 people would be employed during the construction phase. Occupational health and safety (OHS) plans shall be developed and maintained by all contractors involved in the implementation of the proposed Project. The contractors shall provide OHS training which will include hazard awareness, safe work practices and emergency preparedness. Worker activities will be managed through appropriate planning and the application of Permit-to-Work system, Job Hazard/Safety Analysis, Personal Protective Equipment (PPE) requirements and other safety based protocols.

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

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

The proposed Solar Power Project is planned to be commissioned in the fourth quarter (Q4) of 2021.

4.0 DESCRIPTION OF THE ENVIRONMENT

The description of environmental conditions of the Project's area of influence is based on desktop studies and field investigations. Field sampling was conducted from August 5 to 6, 2019 by a team of environmental and social specialists.

A 1 km radius from the centre of the Project site was selected as the spatial boundary for biophysical sampling while a 2 km radius was selected as the spatial boundary for socio-economic survey. The rationale for the spatial boundary was based on the consideration of potential environmental and social aspects of the proposed Project as well as observations noted during the reconnaissance survey.

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

Climate and Meteorology: Kaduna State is characterized as a sub humid zone with derived guinea savannah vegetation and patches of rainforest. The climate of the study area is tropical and it is under the influence of the Inter-Tropical Convergence Zone (ITCZ) or Inter-Tropical Discontinuity Zone (ITDZ). Based on the review of long term (1991-2017) climatic data of the study area obtained from the Nigerian Meteorological Agency (NiMet), rainfall generally occurs from April to October with a peak period in August (284.74 mm). The monthly temperature is relatively high and stable all year with the highest value of 36.01^0C in the month of March.

Geology and Hydrogeology: The geology of Kaduna State is part of the basement complex geology of central Nigeria. It is composed of older high grade metamorphosed gnesis interspersed by belt of young metasediment of mainly quartzites and schist. The region is underlain by older granitic crystalline, metamorphic rocks of precambrain to low Paleozoic age.

Air Quality and Noise: A total of 8 locations were sampled (4 locations within the Project site, 2 within the 1 km AoI, and 2 at control/buffer points). The concentrations of air quality parameters recorded within the Project site and at the control/buffer areas were generally below the National Ambient Air Quality Standards and the World Health Organization (WHO) Air Quality Guidelines. The noise levels recorded within the Project site were also within acceptable limits (World Bank limit of 55 dB(A) for educational institution and FMEnv limit of 90 dB(A). In summary, the ambient air quality and noise within the Project site and the surrounding environment is considered to be satisfactory.

Soil Quality: The dominant soil type within the Project site is clay based on the grain size analysis. No heavy metal and hydrocarbon pollution was recorded in the soil samples collected from the Project site. Lead (Pb), Cadmium (Cd), Chromium (Cr)

and Nickel (Ni) were below the detection limits in the samples from the Project site and AoI. The concentrations of Zinc (Zn) recorded in the soil samples from the Project site, the 1km area of influence and the control/buffer points had a range of 0.033 mg/kg – 0.915 mg/kg, 0.013 mg/kg – 0.286 mg/kg, 0.014 mg/kg – 0.114 mg/kg respectively in the top soil while in the subsoil, a range of 0.034 mg/kg – 0.428 mg/kg, 0.011 mg/kg – 0.034 mg/kg, 0.016 mg/kg – 0.102 mg/kg respectively was recorded in the sub soil.

Groundwater Quality: Groundwater samples were collected from two (2) different boreholes in the study area (one close to the Project site and one from the nearby local community). The concentrations of parameters analyzed in the groundwater samples were generally within the FMEnv and WHO limits for substances and characteristics affecting the acceptability of groundwater for domestic use.

Terrestrial Flora: The natural ecosystem of the Project site was observed to have been substantially modified by human activities (mainly development activities within the university). The physiognomy of the entire study area is characterized by open vegetation of thorny shrubs, grasses and trees. Based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species classification, no endangered species were recorded within the Project site. The plants species noted include *Ageratum conyzoides, Panicum maximum, Ipomoea involucrate, Sida acuta, Tridax procumbens* and *Pennisetum spp*. Also, the site is not within any designated grazing reserves, breeding areas, or animal migratory routes.

Terrestrial Fauna: The fauna species observed at the Project site were generally few and restricted to small invertebrates such as earthworms, insects, grasshoppers, butterflies, spiders. Also, vertebrates such as Lizards (*Agama agama*), birds (Cattle egret, Black Kite, Green fruit Pigeon etc.) and a few grazing animals (cows and sheep) were sighted within the Project site. Based on the IUCN classification, no threatened or endangered fauna species were recorded in the study area.

Socio-economic and Health: the identified local community in the Project's AoI is Mando community located about 1 km away from the University. The socio-economic characteristics of the community based on information gathered through focus group discussions, key informants interviews, direct observations, and surveys are summarized as follows:

- Mando community is relatively heterogeneous in terms of ethnicity and language.
- The community has an estimated population of 4,000 residents.
- Islam is the most prevalent religion in the community.
- There are government hospital, private hospital and pharmaceutical outlets.

- The settlement pattern in the community is nucleated while houses are built with cement blocks and aluminium, corrugated iron roofing sheet
- Trading and agricultural activities are the common livelihood activities in the community
- Majority of the houses within the community are connected to the national grid for electricity supply. Although a few residents stated that they have privately owned generators as backup source of electricity.
- Public and private boreholes are found within the community as well as water vendors who supply water to individuals.
- Women in the community perform majorly domestic roles and are also allowed to take leadership positions. Women are also allowed to form associations and hold leadership positions in the community.
- Gender Based Violence (GBV) incidents were reported to be uncommon within the community and measures of resolving such cases are through the intervention of the village leaders or police.
- Based on interviews with community leadership and respondents in the community, there are no direct livelihood activities or ecosystem services that they obtain from the Project site.
- Members of the community were positively disposed to the proposed Project. They believe that the Project will improve the economic values of the communities, impact positively on entrepreneurship and create job opportunity for community members.

5.0 ASSOCIATED AND POTENTIAL RISKS AND IMPACTS

The potential environmental and social (E&S) risks and impacts associated with the proposed Project were identified and ranked across each phase of the Project development. In the pre-construction phase, the significant impacts identified include increase in vehicular movement and traffic including potential for road accident, soil degradation as a result of site clearing and loss of farmlands. For construction phase, the potential impacts identified include: soil degradation, decrease in ambient air quality, increased noise emission, GBV risks, community health and safety impacts due to influx of workers and construction activities, and occupational health and safety hazards. During the commissioning phase, the proposed Project is presumed to have minor noise impact and OHS hazards such as injuries. The operational phase will have significant risks such as electric shock and injuries to workers, GBV risks, and work related issues (poor working conditions and discrimination). The decommissioning phase will have significant impacts on the soil and road traffic of the Project area.

Some of the potential positive impacts associated with the proposed Project include: employment opportunity, promotion of clean energy source, reduction of GHG

emissions, and skill acquisition and transfer of knowledge through training and retraining.

6.0 MITIGATION MEASURES

Recommended mitigation measures required to complement those incorporated in the Project design for the identified negative impacts were proffered while enhancement measures for the positive impacts were similarly presented and documented in this report.

The summary of the recommended mitigation measures for the identified significant negative impacts is provided as follows:

Pre-construction Phase

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

- Only the portion of the site required for Project development shall be cleared for construction.
- The affected farmers on the site shall be allowed to harvest their crops before commencement of construction activities.
- NDA shall provide alternative farmlands within the University for the affected persons.
- The commitment for the provision of alternative land for the affected persons shall be documented in a letter signed by the NDA Commandant or his designate.
- The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited.
- Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas.
- Disturbed areas will be rehabilitated with native plants as soon as possible to prevent erosion.
- Site clearing equipment / machinery shall be operated and maintained under optimum fuel efficient conditions.
- Site clearing activities shall be carried out only during the daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).
- A traffic management plan (TMP) shall be developed and implemented by the EPC Contractor.
- Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided.

- Drivers' competency shall be assessed and where required, appropriate training shall be provided. This will include training on safe driving measures such as adherence to speed limits (of less than 10 km/h) in the Project area.
- Provision of adequate PPE especially gloves, safety boots, and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.
- Unregistered labourers and touts shall not be patronised for off-loading materials.
- The site shall be secured with perimeter fencing and/or security.

Construction Phase

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

- Excavation works shall not be executed under aggressive weather conditions.
- Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion.
- Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.
- Construction machinery shall be turned off when not in use.
- Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities.
- All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimize introduction of alien species.
- Employment of workers for construction activities shall be open and fair.
- The GBV Action Plan for EEP shall be implemented for the Project.
- All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA).
- GBV sensitive channels for reporting in GRM shall be implemented for the Project.
- The EPC Contractor shall be required to hire a Gender/GBV officer.
- Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured.
- All workers shall be required to undergo regular training and refreshers on GBV
- The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site.
- All gender-based violence incidents shall be reported and dealt with as per the law.

- Health and Safety Plan shall be developed and implemented. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence.
- Daily toolbox talks prior to commencement of work activities shall be carried out.
- Construction activities shall be limited to daytime as much as possible.
- Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.
- Proper safety signs and signage shall be placed at strategic locations within the site.
- PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored.
- Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers.
- The NEP Grievance Redress Mechanism (GRM) for receiving complaints arising from damage to infrastructure and private property during construction activities shall be developed.
- Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible.
- Public access shall be restricted to construction area via security fencing and appropriate signage.

<u>Commissioning Phase</u>

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

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

<u>Operation Phase</u>

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

- All lighting will be kept to a minimum within the requirements of safety and efficiency. Where such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage will be used.
- Appropriate PPE shall be provided for workers.

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

7.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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

REA-PMU is committed to the implementation of the ESMP and shall work with relevant agencies at local, state and national levels to ensure full compliance. REA

shall have principal responsibility for all measures outlined in the ESMP, but may delegate responsibility to its contractors, where appropriate and monitor the implementation. The relevant regulatory authorities at Federal, State and Local Government levels shall also be involved in the monitoring of the ESMP implementation.

An environmental monitoring programme, which outlines specific environmental/social components to be measured, methodology, parameters/requirement, frequency of monitoring, timelines, and estimated budget, has also been developed as part of the ESMP.

Table ES 1 provides the summary of cost estimate required for the implementation of recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed Project.

Table ES 1: Cost Estimate for ESMP Implementation

S/N	Fundamental ESMP Activities	Cost Estimates (US Dollars)
1.	Pre-construction phase E&S management activities	4,000
	Construction phase E&S management activities	13,500
	Commissioning phase E&S management activities	700
	Operational phase E&S management activities	9,000
2.	Preparation of additional management plans	17,500
3.	Institutional Capacity Strengthening Plan	3,000
4.	Monitoring and Evaluation Programme	19,000
Total		**66,700**

8.0 REMEDIATION PLAN AFTER DECOMMISSIONING/CLOSURE

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

In the event of decommissioning, REA, in conjunction with the leadership of NDA, shall ensure that the Project site is left in a safe and environmentally acceptable condition. A standard decommissioning, abandonment and closure programme shall be invoked. The tasks will include, amongst others:

- Evacuation of the dismantled PV panels and other related items (such as inverters, and control devices) to the manufacturers for recycling.
- Transportation of spent batteries to recycling facilities;
- Restoration of the Project site to baseline conditions (as much as practicable) in line with legislative and regulatory requirements.

- Assessing the residual impact, if any, the project has on the environment.
- Monitoring the abandoned project environment as necessary.

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

9.0 STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

Stakeholder engagement was conducted as part of the ESIA for the proposed project. This included a review of the legal and administrative framework, stakeholder identification and analysis, and initial consultation with stakeholders. Comments and issues raised by relevant stakeholders consulted during the ESIA study were provided in the report. The consultations were carried out from August 3 to 6, 2019 with the following:

- Kaduna State Ministry of Environment and Natural Resources
- Kaduna State Environmental Protection Authority
- Kaduna State Ministry of Women Affairs and Social Development
- Kaduna State Ministry of Youth and Sports
- Management of Nigerian Defense Academy
- NDA Physical Planning Office
- Igabi Local Government
- Seriki of Mando (Local community)
- Civil Society Organizations
    - Empowering Women for Excellence Initiative (EWEI)
- Farmers within the Project site

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

A grievance redress mechanism (GRM) has been developed by REA which applies to all components of the NEP; including the EEP Projects. The GRM has identified potentials for grievance associated with the proposed project and outlines the activities, timeframe, procedures and personnel that will be involved in its implementation.

10.0 CONCLUSION AND RECOMMENDATIONS

The ESIA of the proposed Project has been conducted in accordance with the relevant requirements of the FMEnv and other relevant regulatory agencies in Nigeria, as well as the applicable requirements of the World Bank Safeguard Policies,

specifically the Operational Policy 4.01 and Involuntary Resettlement Policy 4.12 triggered by the proposed Project.

Consistent with the regulatory standards, the assessment of the environmental status and the socio-economic aspects of the proposed Project's area of influence have been carefully carried out using accepted scientific methodology. Evaluation of associated and potential impacts of the proposed Project identified both positive and negative interactions with the receiving biophysical and socio-economic environment.

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

The ESIA study recommends the following:

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

CHAPTER ONE:

INTRODUCTION

CHAPTER ONE

INTRODUCTION

1.1 Background Information

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

One of the key components of the NEP is Energizing Education Programme (EEP). The objective of the EEP is to provide dedicated, clean and reliable power supply to 37 Federal Universities and 7 affiliated University Teaching Hospitals across the country. The scope of the EEP includes provision of off-grid, dedicated and independent power plant, rehabilitation of existing electricity distribution infrastructure, and provision of street lighting (for illumination and improved security) as well as a world class renewable energy training centre for each of the beneficiary Universities.

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

One of the beneficiary universities under the EEP Phase II is the Nigerian Defence Academy (NDA) in Kaduna State, Northwest region of Nigeria. The NDA was established on February 5, 1964 in response to the defence needs of independent Nigeria to train officers for the Armed Forces of Nigeria. The NDA is situated on approximately 1,217.61 hectares (ha) of land and the Academy population as at July 2016 stood at 5,800 persons (REA Energy Audit Report, 2019).

Based on the energy demand audit conducted by REA in conjunction with the National Universities Commission (NUC), a 2.5 megawatt (MW) power plant is proposed for NDA. This is in addition to other associated infrastructure under the EEP. The proposed power plant will be solar hybrid technology.

In compliance with the relevant requirements of the Federal Ministry of Environment (FMEnv.) and other relevant regulatory agencies in Nigeria, as well as the applicable requirements of the World Bank Safeguard Policies, an Environmental and Social Impact Assessment (ESIA[1]) of the proposed solar-hybrid power plant and associated infrastructure in NDA, Kaduna State (the "Project") has been conducted. The ESIA study is also in fulfilment of commitments documented in the Environmental and Social Management Framework (ESMF) for NEP.

The ESIA study covers the entire life cycle of the proposed Project (i.e. pre-construction, construction, commissioning, operation, decommissioning and closure).

1.2 Objectives of the ESIA Study

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

The specific objectives of the ESIA study are to:

- Establish and document the existing environmental and social conditions of the Project's Area of Influence[2] prior to construction, including any cultural resources and sensitive components of the environment.
- Assist Project design and planning by identifying those aspects of location, construction, operation and decommissioning which may cause adverse environmental and social impacts, including occupational and community health and safety issues.
- Develop appropriate and practicable mitigation measures and environmental and social management plan (ESMP)[3] including monitoring programme, responsible parties, timeframe and cost estimates required to address the

[1] The proposed project is being co-financed by the World Bank. If reference is made to the FMEnv procedure, the term "EIA" is used, while if reference is made to the project's broader perspective, the term "ESIA" is used. Both ESIA and EIA are synonymous.

[2] Based on the consideration of potential environmental and social aspects/footprints of the proposed Project, the Area of Influence (AoI) for the Project covers the Project site (approximately 43.0 hectares of land within the NDA campus) and its surrounding environment up to 2 km radius from the centre of the site (as discussed in details in chapter 4). This also includes the areas where the cumulative impacts of the Project may be experienced, as well as the transport route.

[3] The term "ESMP" is used in this ESIA report to ensure consistency with the World Bank requirements. The term is, however, synonymous with Environmental Management Plan (EMP) adopted by the FMEnv

identified adverse impacts and enhance the associated Project benefits (e.g. positive climate impact).
- Identify, where required, the need for development and implementation of a Resettlement Action Plan (RAP) / Livelihood Restoration Plan (LRP).
- Conduct stakeholder consultations to capture the concerns of the various stakeholders (e.g. relevant government institutions, potentially affected persons, etc.) about the Project including gender-based violence (GBV) risks.
- Prepare a detailed report presenting clear and concise information on the findings of the ESIA study.
- Obtain FMEnv approval for the proposed Project.

1.3 Scope of the ESIA Study

The scope of the ESIA study covers the following:

- Review of applicable local and international laws, regulations, standards and industry codes that apply to the proposed Project.
- Description of all actions/activities that will be carried out in the course of the Project development and implementation.
- Desktop review of relevant documents pertaining to the Project and the environment where the Project would be located. These documents include the NEP ESMF, amongst others.
- 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, NDA management representatives, etc. Detailed information on stakeholder consultations conducted as part of the ESIA study for the proposed Project is documented in Chapter 4 of this report.
- Laboratory analysis of field samples and data analysis.
- Impacts identification and evaluation, and development of appropriate and practicable mitigation measures and EMP.
- Perimeter survey of the Project site, including development of survey maps.
- Report preparation and disclosure.

1.4 ESIA Study Approach / Methodology

The ESIA of the proposed Project has been carried out in line with the FMEnv-approved ESIA process for mini-grid/off-grid projects being implemented under NEP. It also takes into consideration the requirements of relevant international standards and guidelines, such as the World Bank Environmental and Social (E&S) Safeguard Policies.The illustration of general methodology adopted for the ESIA

study is provided in Figure 1.1. Detailed information on each of the activities is provided in the subsequent chapters of this report.

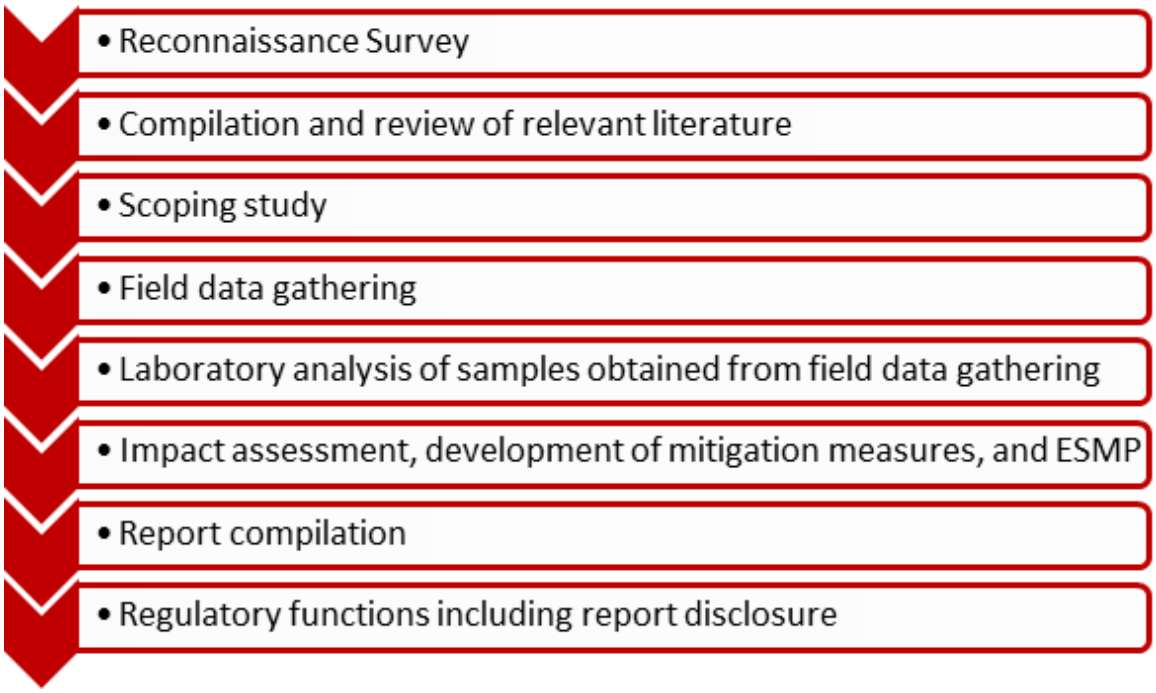


Figure 1.1: Schematic presentation of the general methodology for the ESIA

1.5 Limitations of the ESIA Study

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

1.6 Legal and Administrative Framework

The proposed Project is part of the FGN's EEP, a component of NEP. Several laws and regulations apply to the energy sector in Nigeria. In addition, a number of laws, policies and instruments have been established to support environmental management and the EIA process in Nigeria.

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

1.6.1 National Policy, Guidelines and Regulations

1.6.1.1 Federal Ministry of Environment (FMEnv.)

The FMEnv is the primary authority for the regulation and enforcement of environmental laws in Nigeria. The Act establishing the Ministry places on it the responsibilities of ensuring that all development and industry activity, operations and emissions are within the limits prescribed in the national guidelines and standards, and comply with relevant regulations for environmental pollution management in Nigeria as may be released by the Ministry.

In furtherance of her mandate, the FMEnv developed laws, guidelines and regulations on various sectors of the national economy. The specific policies, acts, guidelines enforced by FMEnv that apply to the proposed Project are summarized in the following paragraphs:

- *National Policy on the Environment, 1989 (revised in 1999 and 2017)*

The National Policy on the Environment, 1989 (revised 1999 and 2017) provides for a viable national mechanism for cooperation, coordination and regular consultation, as well as harmonious management of the policy formulation and implementation process which requires the establishment of effective institutions and linkages within and among the various tiers of government.

The objective of the policy is to achieve sustainable development in Nigeria and in particular to:

- Secure a quality environment adequate for good health and wellbeing;
- Conserve the environment and natural resources for the benefit of present and future generations;
- Raise public awareness and promoting understanding of the essential linkages between the environmental resources and developments and encouraging individual and community participations 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.

- *The National Guidelines and Standards for Environmental Pollution Control in Nigeria*

This was launched on March 12th, 1991 and represents the basic instrument for monitoring and controlling industrial and urban pollution.

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

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

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

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

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

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

- *National Environmental Impact Assessment Procedural and Sectoral Guidelines*

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

1.6.1.2 National Environmental Standards and Regulation Enforcement Agency

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

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

The purpose of this regulation is the adoption of sustainable and environment

friendly practices in environmental sanitation and waste management to minimize pollution.

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

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

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

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

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

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

Other NESREA regulations relevant to the proposed Project are:

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

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

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

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

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

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

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

1.6.1.3 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 No 28 of 1988, the National Electric Power Policy, 2001, the Electric Power Sector Reform Act, 2005, the Roadmap for Power Sector Reform, 2010, the National Energy Policy, 2013 and the National Energy Efficiency Action Plans, 2015.

1.6.1.4 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency inaugurated on October 31, 2005. The Commission is mandated to carry out the following, amongst others: i) monitor and regulate the activities of the electricity industry in Nigeria; ii) issue licenses to market participants; iii) ensure compliance with market rules and operating guidelines.

1.6.1.5 Endangered Species Act 1985

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

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

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

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

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

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

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

1.6.1.9 Labour Act CAP L1, LFN 2004

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

1.6.1.10 National Policy on Occupational Safety and Health

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

1.6.1.11 Land Use Act CAP L5 LFN 2004

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

1.6.1.12 Violence Against Persons (Prohibition) Act, 2015

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

1.6.2 State and Local Government Environmental Authorities

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

The proposed Project will be located within NDA campus in Igabi Local Government Area (LGA) of Kaduna State. The key State and local government administrative authorities with statutory functions related to the Project are briefly described below:

❖ *Kaduna State Ministry of the Environment and Natural Resources*

The Kaduna State Ministry of the Environment and Natural Resources is responsible for the policy awareness and intervention of key environmental issues in Kaduna State. The key environmental issues include desertification and deforestation, pollution and waste management, climate change and clean energy, flood and erosion, and environmental standards and regulations.

❖ *Kaduna State Environmental Protection Authority*

The Kaduna State Environmental Protection Authority (KEPA) was established by edict of 1994 and later revised in 1998 to ensure sustainability in Kaduna State. The authority is charged with the responsibility of addressing all environmental problems in the state including but not limited to organising programmes aimed at changing people's negative attitudes towards environmental management for sustainable development. The functions of KEPA include, amongst others, the following:

- Enact and enforce State regulations, procedures, guidelines, and environmental standards for effective prevention, remediation, control and monitoring of point and non – point sources of pollution and degradation;
- Implement and review environmental policy in the State; and in particular to demand and review environmental impact assessments/statements for new development projects.
- Monitor environmental quality, conduct programmes for continuing surveillance and regular periodic inspection of actual or potential contaminants of point and non-point sources of environmental pollution in accordance with the laid down regulations as the Authority may deem fit;
- Without prejudice to the provision of any existing law relating to refuse disposal, the Authority shall establish operational mechanisms for refuse collection, transportation and disposal in cooperation with the Local Governments of the State.

❖ *Igabi Local Government Area*

The Local Government has an Environmental Health Department which ensures compliance with environmental sanitation law, which includes maintaining good housekeeping and proper management of waste, amongst others.

1.6.3 International Guidelines, Conventions and Industry Codes

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

1.5.3.1 International Guidelines and Standards

❖ *The World Bank Safeguard Policies*

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

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

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
1.	Environmental Assessment (OP/BP 4.01)	The World Bank requires Environmental Assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making.	Yes	The proposed Project in NDA under the FGN's EEP Phase II has associated environmental and social aspects which may affect the environment. Thus, this ESIA study has been conducted to ensure that the potential environmental and social impacts/ risks of the proposed Project are identified and managed appropriately.	Chapter 3 – Project Description Chapter 4 – Description of the Environment Chapter 5 – Potential and Associated Impact Chapter 6 – Mitigation Measures Chapter 7 – Environmental and Social Management Plan
2.	Forests (OP/BP 4.36)	Operational Policy on Forests (OP 4.36) is proactive in both identifying and	No	There are no natural or planted forests within the	-

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
		protecting critical forest conservation areas and in supporting improved forest management in production forests outside these areas. The Forests Policy covers all projects that affect natural or planted forests, whether positively or negatively		Project site and its immediate surroundings environment that would be affected by the proposed Project.	
3.	Involuntary Resettlement (OP/BP 4.12)	The Involuntary Resettlement Policy (OP/BP 4.12) applies to projects involving either (i) the involuntary taking of land for project purposes that leads to physical relocation, loss of assets, or loss of income sources or livelihoods for the affected persons; or (ii) the involuntary restriction of access to legally designated protected areas that leads to adverse impacts on the livelihoods of the affected persons. To address these impacts, the policy requires the preparation of (i) either a Resettlement Plan or Resettlement Policy Framework in the case of involuntary land taking; and (ii) a Process Framework in the case of involuntary restriction of access to the natural resources within parks and protected areas.	Yes	The proposed solar-hybrid power plant and associated infrastructure will be sited within the land property owned by NDA. No additional land outside the NDA campus will be expropriated for the Project. The subsistence farm lands observed on the proposed Project site during site visit are cultivated by staff of NDA and their relatives (i.e. Project Affected Persons).	Chapter 3 – Project Description Chapter 4 – Description of the Environment Chapter 5 – Potential and Associated Impact Chapter 6 – Mitigation Measures Chapter 7 – Environmental and Social Management Plan
4.	Indigenous Peoples (OP/BP 4.10)	The Indigenous Peoples Policy (OP/BP 4.10) specifies how Indigenous Peoples need to be consulted and involved in the design of projects that may affect them (positively or negatively). Key requirements of OP 4.10 are social	No	The people in the Project's area of influence are not considered as Indigenous Peoples as defined by the World Bank.	-

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
		assessment; free, prior, and informed consultations leading to broad community support to the project; and development and disclosure of an Indigenous Peoples Plan or Planning Framework.			
5.	Safety of Dams (OP/BP 4.37)	This policy (OP 4.37) applies to projects that construct, rehabilitate, or substantially depend upon large or high-hazard dams, whether these dams are for hydropower, water supply, or other functions (including mine tailings containment). The Bank requires that such projects adopt and implement certain dam safety measures.	No	The proposed Project is not in any way linked to any known dam.	-
6.	Pest Management (OP 4.09)	The Pest Management Policy (OP 4.09) applies to projects that (i) involve (through World Bank or counterpart funds) the procurement of pesticides or pesticide application equipment; (ii) would lead to substantially increased pesticide use; or (iii) would maintain or expand pest management practices that are unsustainable or risky from an environmental or health standpoint. In Bank-financed projects, the borrower is required to address pest management issues in the context of the project's environmental assessment	No	The development and operation of the proposed Project will not involve substantial use of pesticides.	-
7.	Physical Cultural Resources (OP/BP 4.11)	This policy applies to projects that might affect sites and objects of archaeological, paleontological, historical, architectural, religious, aesthetic, or	No	Based on field observations, documents review and interviews, there are no cultural sites	-

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
		other cultural significance. It is required that the physical cultural resources component of the EA includes an investigation and inventory of physical cultural resources likely to be affected by the project; documentation of the significance of such physical cultural resources; and assessment of the nature and extent of potential impacts on these resources.		within and around the Project site.	
8.	Natural Habitats (OP/BP 4.04)	The Natural Habitats Policy (OP/BP 4.04) covers projects that affect natural forests or other non-forest natural ecosystems, with special focus on those projects that might lead to significant loss or degradation of natural habitats. The Bank supports, and expects such projects to apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development	No	The Project site is characterized by secondary vegetation, dominated by grasses (refer to Chapter 3 of this report for sample photographs of the Project site). Also, it is not likely that the proposed evacuation route would impact any natural habitat.	-
9.	Projects in Disputed Areas (OP/BP 7.60)	This policy prescribes special consultation and due diligence procedures for any projects proposed in geographic areas that are disputed between two or more countries.	No	The Project site does not fall in a disputed location.	-
10.	Projects on International Waterways (OP 7.50)	This policy (OP 7.50) covers projects that could appreciably affect international waterways, or the quantity or quality of water in more than one country.	No	There are no known international waterways within the Project's Area of Influence that could be affected by the proposed Project.	-

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

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

The World Bank EHS Guidelines relevant to the proposed Project are:

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

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

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

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

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

1.6.3.2 International Conventions

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

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

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

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

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

- *The Minamata Convention on Mercury*

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

- *The United Nations Convention on Biological Diversity*

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

- *The United Nations Framework Convention on Climate Change*

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

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

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

- *International Health Regulations (2005)*

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

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

The principles of this Declaration relevant to the proposed Project are summarized below:

Principle 2: The natural resources of the earth, including the air, water, land, flora and fauna especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate.

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

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

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

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

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

These guidelines call for coherent policies to protect workers from occupational hazards and risks while improving productivity. The guidelines present practical approaches and tools for assisting organizations, competent national institutions, employers, workers and other social partners in establishing, implementing and improving occupational safety and health management systems, with the aim of reducing work-related injuries, ill health, diseases, incidents and deaths. Nigeria ratified the guidelines in 2001.

1.6.3.3 Industry Codes and Standards

- *International Electrochemical Commission (IEC)*

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

1.7 Institutional Arrangements for Environmental and Social Management

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

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

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

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

In addition, the World Bank will provide overall supervision, facilitation and co-ordination of the Project, and monitor Project performance indicators.

Further information on E&S risk management process for the Project is provided in Chapter 7 of this report.

1.8 Report Structure

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

- **Preliminary Sections:** containing table of contents, lists of ESIA preparers, Executive Summary, amongst others.

- **Chapter One**: Introduction containing an overview of the proposed Project, the ESIA objectives and study approach and applicable legal and administrative framework.

- **Chapter Two**: Project Justification containing a rationale for the proposed Project as well as the analysis of Project alternatives and development options.

- **Chapter Three**: Project Description containing the technical elements of the Project. It concisely describes the proposed Project and its geographic and temporal context, including the Project's associated infrastructure.

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

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

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

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

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

- **Chapter Nine**: describes the stakeholder engagement activities carried out during the ESIA and an overview of the grievance redress mechanism for the Project.

- **Chapter Ten**: Conclusion and Recommendations

The report also includes references and appendices.

CHAPTER TWO:

PROJECT JUSTIFICATION

CHAPTER TWO

INTRODUCTION

This chapter presents the justification for the proposed 2.5 MW solar-hybrid power plant and associated infrastructure in Nigerian Defence Academy (NDA), Kaduna State, as part of the Federal Government of Nigeria (FGN) Energizing Education Programme (EEP) Phase II. It also includes the description of alternatives and development options considered for the proposed Project.

2.1 Need for the Project

The Federal Universities in Nigeria remain the top choice for a large percentage of students seeking admission into tertiary institutions in the country. . However, inadequate power supply from the grid is a major challenge facing many of these universities (for example, the energy demand audit conducted by REA and NUC at NDA in 2019 reveals that the University still has issues with constant power supply from the national grid). To cope with the situation, most of the universities rely on diesel-fuelled generators for power generation, with significant economic and environmental implications.

Part of the FGN's initiatives to address inadequate power supply in the country is the Nigeria Electrification Project (NEP). NEP is an innovative programme that seeks to provide electricity access to off-grid communities across the country through renewable power sources. It is being implemented by REA and co-financed by the World Bank.

One of the components of the NEP is EEP, with the objective of providing dedicated, clean and reliable power supply to Federal Universities and affiliated University Teaching Hospitals across the country. However, the current phase covers 7 universities and 2 affiliated teaching hospitals. Also, the EEP is part of measures in ensuring that Nigeria achieves its carbon emission targets (20 % - 30 % carbon emission reduction by the year 2030) as contained in its Nationally Determined Contributions (NDC), under the Paris Agreement.

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

2.2 Value of the Project

NEP is being co-financed by the World Bank through a $350 million loan. However, $105 million has been allocated for the implementation of EEP as a component of NEP. The finance required for the proposed Project in NDA will be obtained from the $105 million.

2.3 Project Benefits

The proposed Project is envisaged to have a range of associated benefits, since the importance of gaining access to reliable and steady power supply cannot be over-emphasized. Some of the benefits are a function of the objectives of the Project, while others are a function of the way in which the Project is designed to meet its objectives.

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

- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Reduction in fossil fuel consumption by the University thereby leading to reduction in carbon emissions and improvement in eco-balance. The University's average monthly diesel consumption is 24,000 litres (REA Energy Audit Report, 2016).
- Significant reduction in the cost of power generation by the University through diesel-fuelled generators. The University has 12 generators and spends ₦5,760,000 on diesel monthly to self-generate 1,592kW of power 2 hours daily (REA Energy Audit Report, 2016). Such savings would be used for other undertakings that will benefit the University.
- Increase in social interactions within the University. There will be enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.
- Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the Project.
- Improvement in livelihood enhancing activities within the University.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects.
- Increase in local and regional economy through award of contracts and purchase of supplies for Project development.

- Increase in financial and technical collaborations between the FGN, the University, REA, World Bank and other relevant Ministries, Departments and Agencies (MDAs).
- Contributing to the Nigeria's NDC to cut carbon emission by 20 % to 30 % by the year 2030, under the Paris Agreement.

2.4 Envisaged Sustainability

2.4.1 Technical Sustainability

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

Upon completion of the construction phase, the EPC contractor will operate and maintain the Project in conjunction with the team from NDA's Works and Physical Planning Unit. In addition, adequate capacity building shall be provided to the University personnel that will work with the O&M Contractor for the day-to-day operations of the Project in the long run.

2.4.2 Environmental Sustainability

The environmental sustainability measures for the Project include the use of renewable source of energy (solar) for electricity generation (with negligible greenhouse gas (GHG) emissions compared to fossil fuel-burning power plants). In addition, the establishment of REA-PMU (which includes experienced Environmental and Social Safeguards Specialists) to oversee the implementation of the Project will contribute to environmental sustainability of the Project. More so, this ESIA study undertaken at the early stage of the Project development phase (and the commitment to implement the recommended mitigation measures and the ESMP developed as part of the ESIA) is geared towards ensuring the environmental sustainability of the Project.

2.4.3 Economic Sustainability

The proposed Project is part of the FGN's EEP initiative, a component of NEP. NEP is being funded by the World Bank with Three Hundred and Fifty Million US Dollars ($350,000,000) loan, of which One Hundred and Five Million US Dollars ($105,000,000) is allocated for projects under the EEP. The proposed Project in

NDA, as part of the EEP Phase II, will be financed from the NEP fund. Upon completion, the Project will significantly reduce the use of diesel generators in the University thereby saving costs on diesel fuel and generator maintenance, amongst others. Also, the monthly payment to distribution company (Kaduna Electricity Distribution Company) for power consumption through the grid would stop (the University consumes an average of 308,100kWh monthly from the grid). Part of such savings will be used for the maintenance of the Project facilities in the long run.

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

2.4.4 Social Sustainability

Stakeholder consultation has been carried out as part of the ESIA process in ensuring that all relevant stakeholders are presented with the opportunity to provide input into the Project at the early stage. This has also assisted in laying a good foundation for building relationship with the stakeholders. In addition, initial stakeholder engagement activities carried out during the ESIA have been presented in the report. A Stakeholder Engagement Plan (SEP) shall be developed to ensure continuous engagement with relevant stakeholders throughout the Project life cycle. In addition, a grievance redress mechanism (GRM) has been developed by REA for the Project. The GRM provides the communication channel to receive any complaints from stakeholders on the proposed Project and ensures that they are timely and adequately addressed. Details on stakeholder consultations carried out till date on the proposed Project are provided in Chapter 9 of this report.

2.5 Project Alternatives

2.5.1 Site Alternatives

An approximately 43.0 hectares of land within the NDA campus has been allocated by the University authority for the proposed Project. The Project site has been selected based on a number of considerations including: i) proximity to the existing substation which is located about 25m away from the site; ii) accessibility - the Project site can easily be accessed through the existing road network within the campus; iii) security; iv) absence of any physical structure that could be affected by the proposed Project; v) absence of any rocky outcrops on the site that could pose

constraints to the solar panels to be installed; vi) absence of any ecologically sensitive areas and/or cultural resources within and around the Project site.

Other candidate sites considered within the University campus for the proposed Project were rejected due to some factors such as: i) presence of physical structure and agricultural crops which could trigger major displacement and relocation issues; ii) far distance from the existing substation; iii) poor accessibility; iv) technical considerations for installation of solar panels, for example, topography.

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

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

2.5.2.1 Overview

Solar power generation is currently one of the fastest growing areas in renewable energy. Beyond panel production, it does not emit any significant GHGs. Compared to alternative renewable generation technologies such as wind turbines or biofuel generators, Solar energy is produced by converting the sun's radiation – a process void of any smoke, gas, or other chemical by-product, which makes this technology to meet the clean development mechanism of the Kyoto Protocol. This is the main driving force behind all green energy technology, as nations attempt to meet climate change obligations in curbing emissions.

The use of solar energy for the proposed power plant in NDA will significantly avoid the generation of GHG emissions associated with fossil-fuelled power plants. Thus, the proposed Project will help contribute to Nigeria's NDC on climate change. In addition, the high solar irradiation in Kaduna State (as indicated in Figure 2.1) will be able to support the proposed power plant.

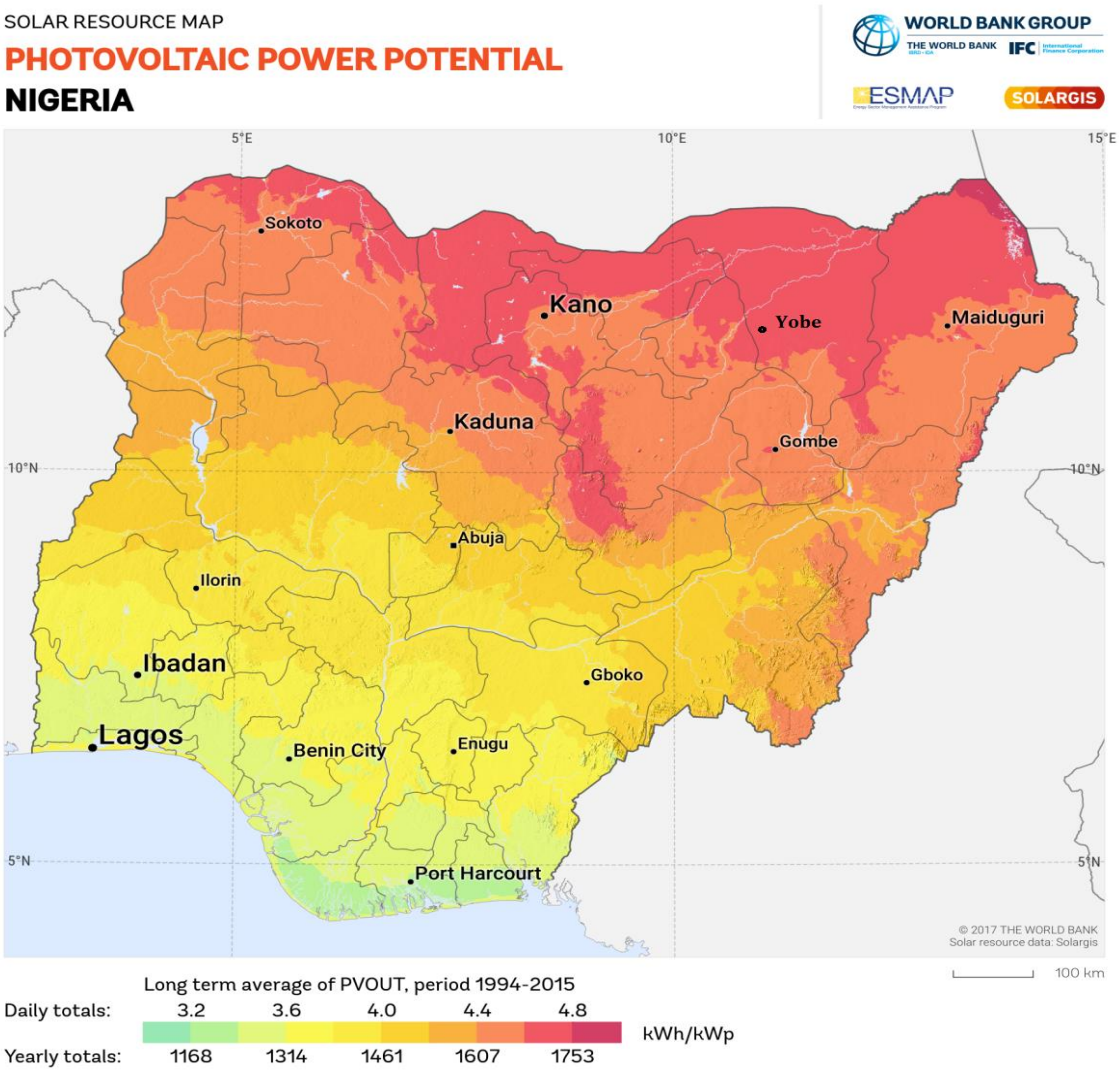


Figure 2.1: Photovoltaic power potential of Nigeria
Source: © 2017 The World Bank, Solar resource data: Solargis

2.5.2.2 Solar Power Technology Alternatives

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

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

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

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

Table 2.1: Comparison between CSP and PV Solar Technology

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

Culled from different online sources

2.5.2.3 PV Panel Alternatives

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

The types of solar cells that are commonly used in PV technology are: i) mono-crystalline silicon; ii) poly-crystalline silicon; and iii) thin film. The typical appearance of each of these PV panels is shown in Figures 2.2 to 2.4.

Based on the consideration of cost and efficiency, polycrystalline silicon PV panels are envisaged to be used for the proposed Project.

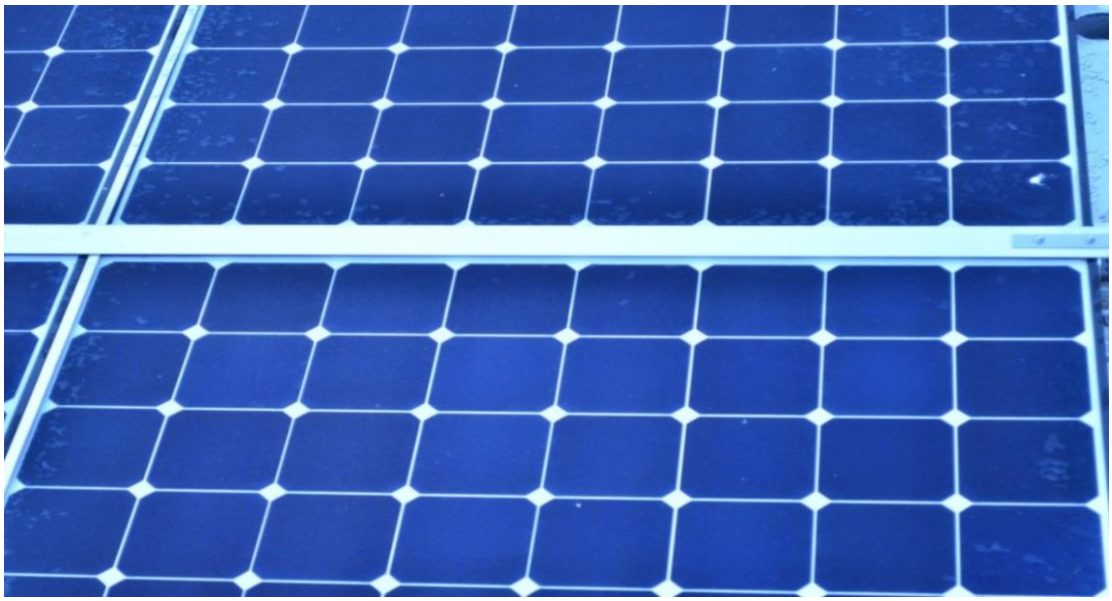


Figure 2.2: Typical appearance of mono-crystalline silicon PV panels

Figure 2.3: Typical Appearance of Polycrystalline Silicon PV panels

Figure 2.4: Typical appearance of Thin-Film CdTe panels

2.5.3 Battery Types Alternative

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

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

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

- ***Lead-Acid Batteries***

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

❖ ***Lithium-Ion Batteries***

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

❖ ***Flow Batteries***

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

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

❖ ***Nickel-cadmium Batteries***

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

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

2.6 Project Options

2.6.1 No Project Option

One of the reasons for the proposed Project in NDA is that the current demand for electricity in the University significantly exceeds generation/supply and, that the current power supply through the grid is unreliable and suffers interruptions. If the Project does not go ahead, access to reliable, safe and cheaper power supply may be

difficult to realize. In addition, the potential benefits associated with the Project would not be realized. Furthermore, the no project option would mean that the University will continue to significantly rely on diesel-fuelled generators for self-generation of power considering the current situation of electricity supply to the University through the grid. This has serious economic implications to the University and would not also be in line the FGN's efforts in achieving its carbon emission targets. Thus, the No Project option is not considered a viable option to adopt.

2.6.2 Delayed Option

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

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

2.6.3 Go Ahead Option

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

CHAPTER THREE:

PROJECT DESCRIPTION

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

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

3.2 Project Location

3.2.1 About NDA

NDA is a Federal Government-owned tertiary institution, with its campus situated on approximately 1,217.61 hectares of land in Igabi Local Government Area of Kaduna State, Northwestern geo-political region of Nigeria (Figures 3.1 to 3.4).

The Nigerian Defence Academy was established on 5 February 1964 in response to the defence needs of independent Nigeria to train officers for the Armed Forces of Nigeria. Before then, the institution was known as the Royal Military Forces Training College (RMFTC). After independence in 1960, it became known as the Nigerian Military Training College.

The institution trains the officer corps of the Nigerian Army, Navy and Nigerian Air force. In 1985, the academy started offering undergraduate courses to military officers and currently offers postgraduate studies for M.Sc. and Ph.D. for both military and civilian students. As at July 2016, the population of NDA stood at 5,800 persons, consisting of 4,200 undergraduate and postgraduate students, 1,200 civil staff (non-academic) and 400 military staff.

3.2.2 Description of the Project Site

An approximately 43.0 hectares (ha) of land within the NDA campus has been earmarked for the proposed Project; however approximately 20 % of the entire land would be used. The geographical coordinates of the Project site are Latitude 10.60766°N to 10.59908°N and Longitude 7.37041°E to 7.384725°E, and the site boundary is bordered to the south and west by farmlands and a small stream, to the north by residential quarters and to the east by NDA substation and power house, as indicated in Figure 3.5. A cross-sectional view of the Project site is shown in Plate 3.1 while its aerial view is presented in Plate 3.2.

The topography of the Project site is undulating and slopes towards a seasonal stream located approximately 90 m south of the site. There are no existing physical structures within the site.

A large portion (approximately 70 %) of the Project site is used for subsistence farming by relatives of some NDA staff living on campus (the exact number of persons involved could not be ascertained as at the time of site visit), while the uncultivated portion of the site is characterized by vegetation which includes shrubs, grasses, and trees. The crops planted include cassava and maize. It was gathered during interviews with some of the people farming on the site that they were permitted by the University management.

There is no local community presence on the Project site (e.g. farming and wood/fruits gathering activities by members of the nearby local community). Also, the site is not within any designated grazing reserves, breeding areas, or animal migratory routes. The nearest community to the Project site is Mando which is situated about 1 km away from the University. Detailed information on the local community is provided in Chapter 4 of this report.

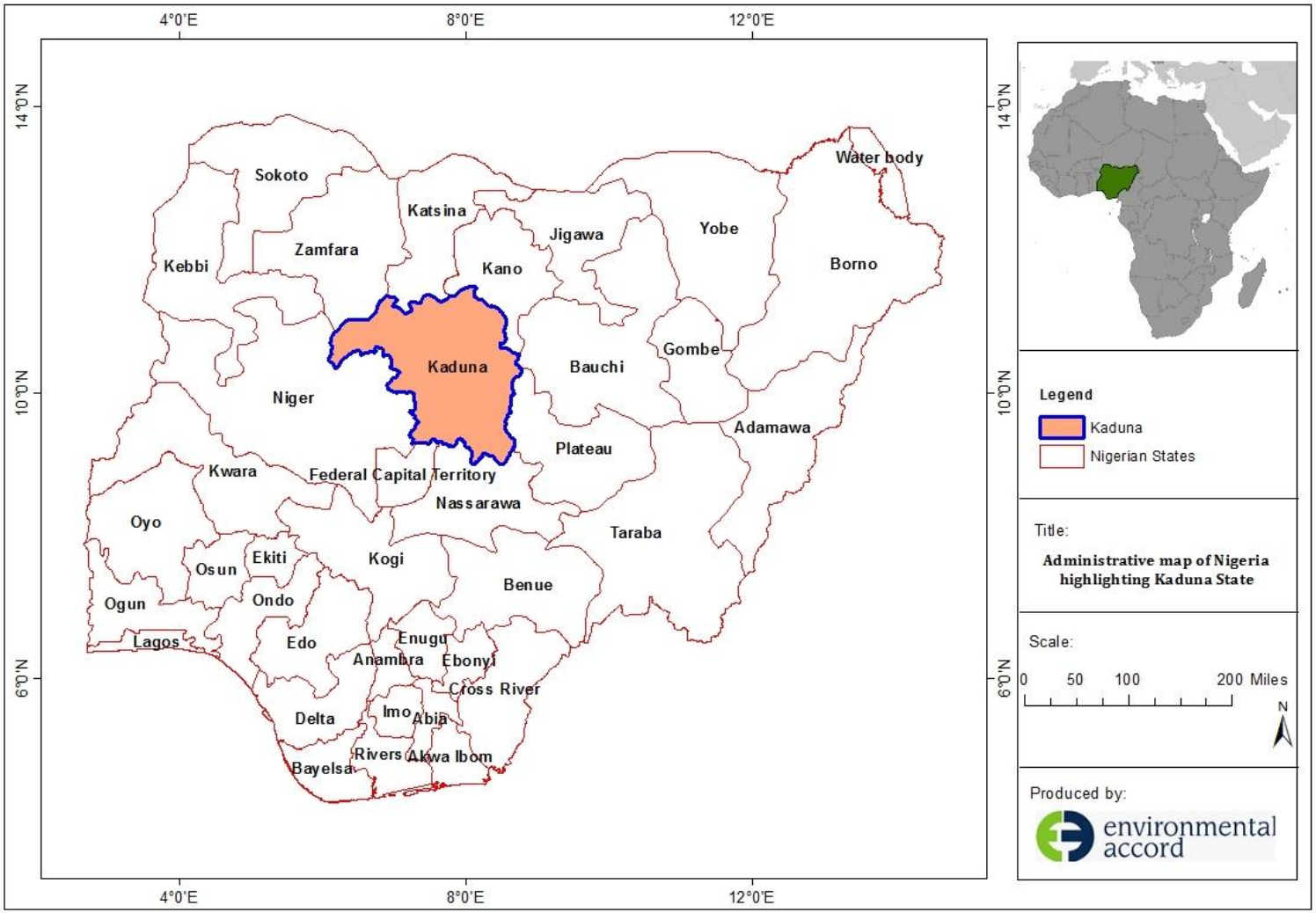


Figure 3.1: Administrative Map of Nigeria highlighting Kaduna State
(Source: EnvAccord GIS, 2019)

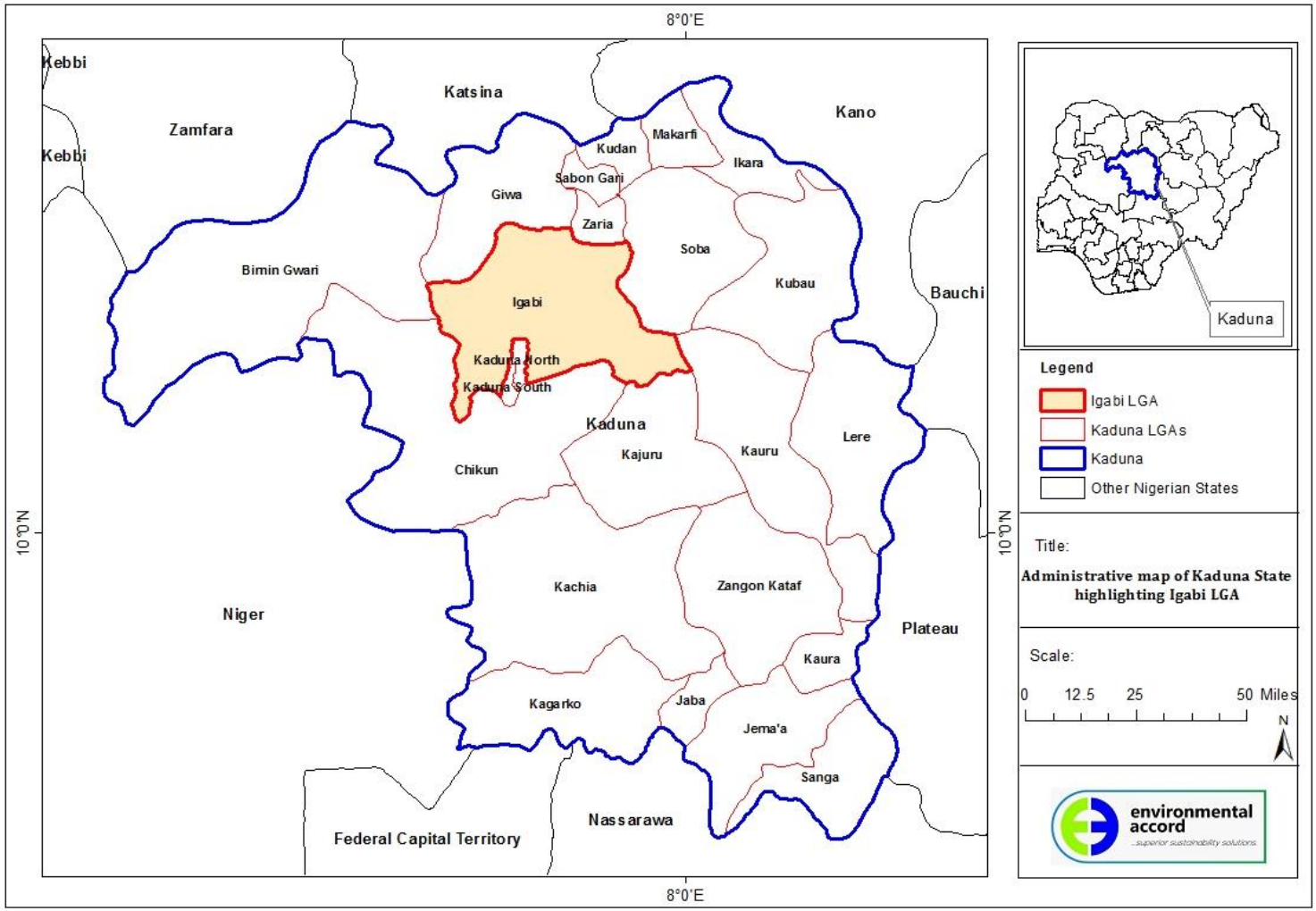


Figure 3.2: Administrative Map of Kaduna State highlighting Igabi Local Government Area
(Source: EnvAccord GIS, 2019)

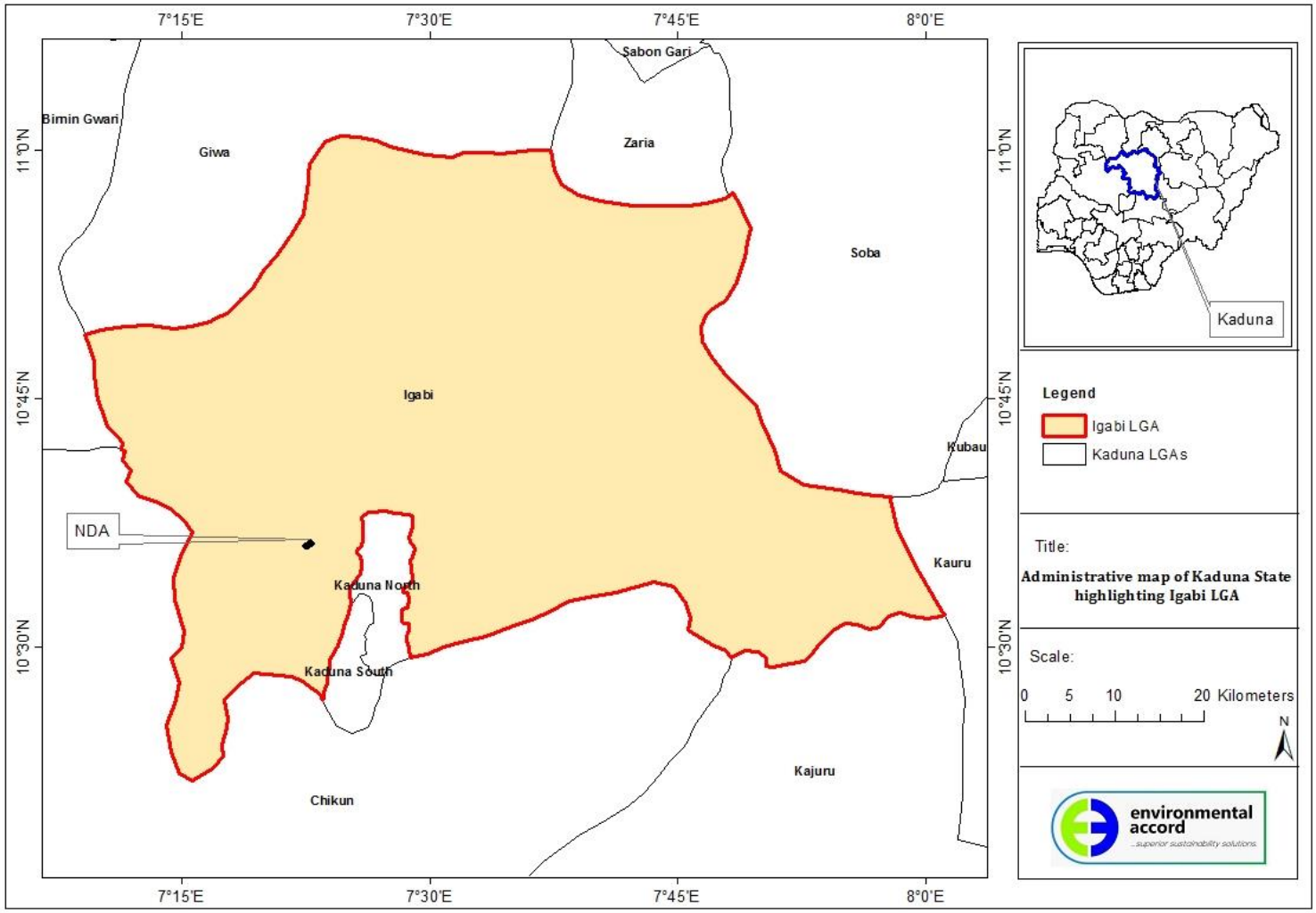


Figure 3.3: The Location of NDA in Igabi Local Government Area
(Source: EnvAccord GIS, 2019)

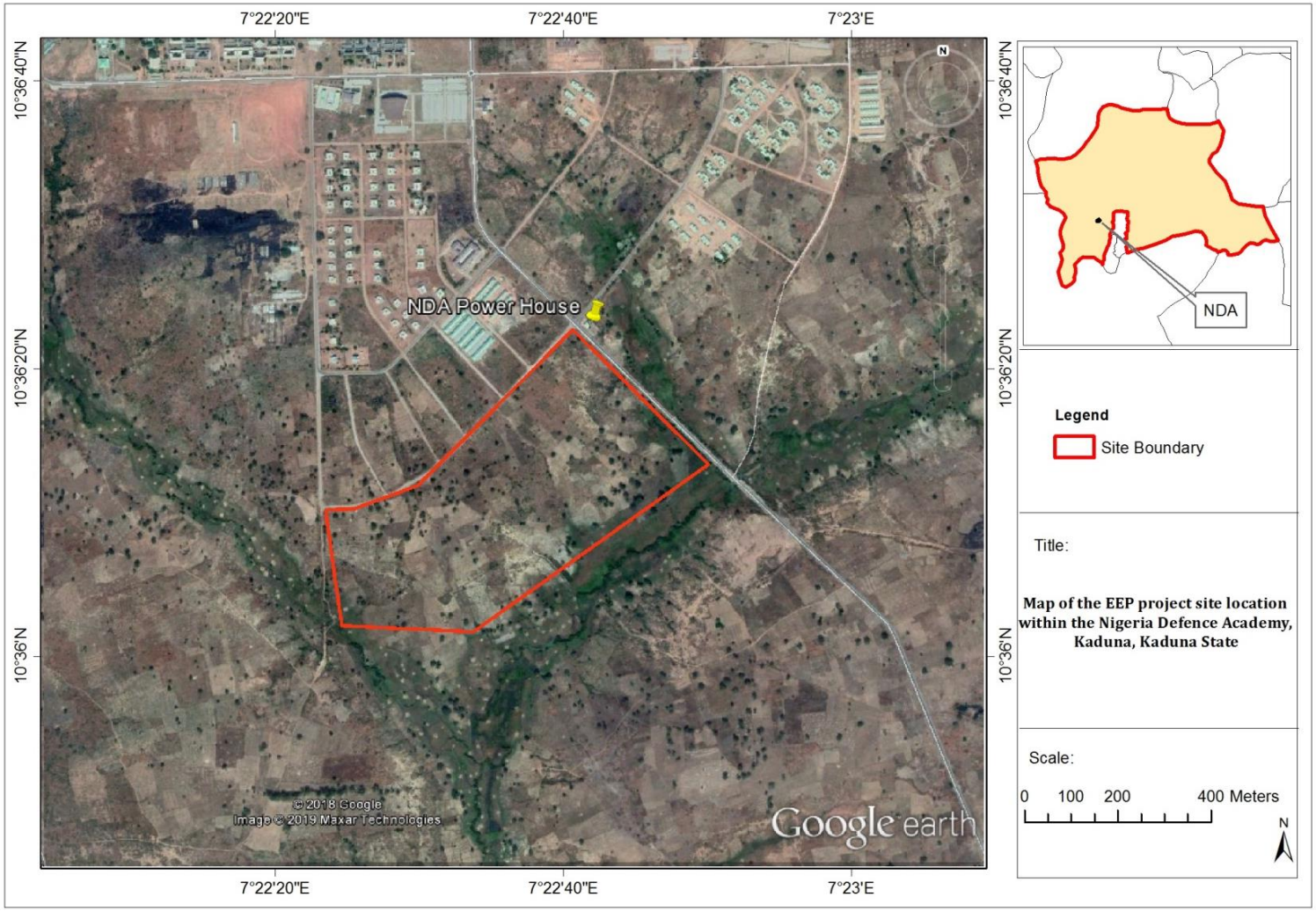


Figure 3.4: Map of the Project site within the NDA campus
(Source: Google Earth, 2019)

Figure 3.5: Aerial imagery of the Project site and the surrounding infrastructure within NDA campus
(Source: REA energy audit report, 2016)

Plate 3.1: Cross-sectional view of the Project Site within NDA campus
(Source: EnvAccord fieldwork, 2019)

Plate 3.2: Aerial view of the Project site within NDA campus (shown with the red arrow)
Source: EnvAccord Field Survey, 2019

3.3 Project Components

As previously stated, the scope of the EEP includes the provision of an independent power plant, rehabilitation of existing electricity distribution infrastructure, provision of street lighting as well as a renewable energy training center. Each of these components as they relate to NDA is discussed below.

3.3.1 Proposed Solar-Hybrid Power Plant

As part of the initial activities, an energy demand audit of NDA was carried out in July 2016, by REA in conjunction with the NUC. The summary of the audit findings is provided in Table 3.1.

Table 3.1: Summary of Energy Demand Audit for NDA, July 2016

S/N	Item	Value	Duration/ Remarks
1.	Daily Energy Consumption (Measured) (kWh)	10,270.00	1 day
2.	Daily Energy Inductive Consumption (Measured) (kVARH, kilovolts amperes reactive hours)	4,000.00	
3.	Daily Capacitive Energy Consumption (Measured) (kVARH)	0.00	
4.	Daily Peak Power Demand (Measured) (kW)	886.30	5:00am to 4:00pm
5.	Daily Off-Peak Power Demand (Measured) (kW)	481.00	
6.	Daily Energy Consumption (Historical Data) (kWh)	11,208	
7.	Total energy consumed per month from grid supply (kWh)	308,100.00	
8.	Total capacity of self- generation (kW)	1,273.60	
9.	Total Number of Diesel Generating (DG) Sets	12	
10.	Estimated hours of grid supply per day (h)	22	
11.	Yearly Energy Consumption (Historical Data) (kWh)	4,091,040.00	
12.	Displacement Power Factor (DPF) (%)	0.95	
13.	Power Factor Total (PFT) (%)	0.94	
14.	Total Harmonic Distortion (THD) (%)	3	
15.	Measured Power Demand (kW)	886.30	
16.	Estimated Annual Power Demand Growth (%)	45	
17.	Estimated Power Demand Forecast (kW)	1,500.00	
18.	Proposed Plant Size (kW)	3,000.00	

Source: REA Energy Demand Audit report for NDA, 2016

Based on the findings of the energy audit, a 2.5 MW solar-hybrid power plant is proposed for NDA. The proposed power plant will involve the use of solar PV technology for power generation.

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

PV technology is basically comprised of:

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

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

The most likely PV panels to be used for the proposed power plant in NDA are of poly-crystalline silicon as discussed in Chapter 2. However, the exact number of the panels is yet to be finalized. Based on the review of similar solar power projects, about 6,600 PV panels (for example, JKM340PP-72H-V) would be required to generate a power capacity of 2.5MW.

The PV panels to be installed will have following characteristics:

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

- PV structural components will be corrosion resistant.

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

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

Inverter: An inverter converts the variable DC output of a PV panel into a utility frequency alternating current (AC) that can be used by a local, off-grid electrical network or fed into a commercial electrical grid. Solar inverters are usually designed to have in-built safety features required by PV cells as well as special functions adapted for use with PV arrays, including string current monitoring and anti-islanding protection. The number and specification of inverters to be installed as part of the proposed solar-hybrid power plant is yet to be finalized. The inverters shall however be acquired from the internationally recognized manufacturers such as WSTech, Ingeteam, Gamesa, Jema, Power Electronics, GPTech, and Helios Systems.

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

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

Power distribution cabinet and synchronization panel: Power from the inverters will be synchronized before it is evacuated to injection station (power house in the University). During plant operation, more than one inverter will be used to convert DC from the PV panels to AC, hence the need for synchronization. Synchronization is the process of matching the speed and frequency of all the operating inverters before the generated power is evacuated. The power from the inverters will be inefficient unless they are running at the same frequency. Therefore, a synchronization panel will be used for matching the speed and frequency of all the inverters installed for the power plant.

Underground cable for power evacuation: The power generated from the proposed plant would be evacuated to the existing power house in the University through an

11kV underground armoured cable. The distance between the Project site and the existing power house is approximately 25m. Information on the size of the evacuation cable is not available yet.

Low and medium voltage switchgear cabinets: Power generation and distribution during plant operation involves the use of various types of circuit breakers and surge protectors, which will be enclosed in low and medium voltage switchgear cabinets. The switch gear cabinets to be installed at the plant site will contain a combination of electrical disconnect switches, fuses and circuit breakers. These components will be used to control, protect and isolate power generation and distribution activities during operation. A typical low voltage switchgear cabinet is shown in Plate 3.3.

Plate 3.3: A typical low voltage switchgear cabinet
Source: bowerselec.co.uk/low-voltage-switchgear, 2018

3.3.2 Rehabilitation of Existing Distribution Infrastructure

The energy audit conducted at NDA indicates that the major power equipment in the University such as transformers, distribution network are in good condition. In addition, there are high level interconnection substations in place with installed distribution capacity of 9.5 MVA. Where required, the existing distribution network

will be upgraded to accommodate the generated power from the proposed solar power plant.

3.3.3 Provision of Street Lighting

Information obtained from the report of energy demand audit conducted in NDA in July 2016 reveals that the University has largely solar type streetlights (conventional and standalone) covering major roads within the campus. Sample photographs of the streetlights are shown in Plate 3.4. As part of proposed Project, new and additional streetlights will be installed (where required) to ensure that different areas within the University campus are well illuminated.

Plate 3.4: Sample of stand-alone and pole-mounted streetlights in NDA campus

3.3.4 Renewable Energy Training Centre

Students from the University will be allowed to access the Project site for learning and training purposes. Therefore, a renewable energy training centre will be constructed within the 43.0 ha of land earmarked for the entire Project. The training centre will also include storage room, workshop and toilet facilities.

3.4 Engineering Codes and Standards

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

3.5 Project Implementation Phases

3.5.1 Pre-construction Phase Activities

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

3.5.2 Construction Phase Activities

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

It is envisaged that approximately 4,000 people would be required for construction activities. These are divided into low skilled workers (e.g. construction labour who will form majority of the workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers and expatriates). Most of the unskilled and semi-skilled workers would be drawn from the nearby local community (located outside the University campus) to enhance the job opportunities associated with the proposed Project. Moderate level of migrant workers may also be associated with the construction phase activities (potential impacts associated with the migrant workers as well as the proffered mitigation measures are covered in Chapters 5 and 6). No workers camp is planned to be established onsite during construction.

3.5.3 Commissioning Phase Activities

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

3.5.4 Operational Phase Activities

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

The EPC contractor shall develop standard operating procedures (SOPs) for the operation and maintenance of the solar panels, inverters, batteries, and other associated components of the Project. If need be, the SOPs shall be further reviewed

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

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

The average life span of the PV power plant is 25 years which can be extended through regular maintenance. Even after the 25 years, the PV panels can still generate up to 90% of the design capacity.

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

3.6 Water Use and Supply

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

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

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

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

3.7 Health and Safety

The EPC Contractor shall engage dedicated personnel competent on the basis of appropriate education, training, and experience to manage and oversee the Health, Safety and Environment (HSE) aspects of the Project. The HSE personnel shall ensure that the Project and subcontractors operate in accordance with the applicable regulatory HSE requirements and plans; and also monitor implementation of environmental and social protection measures.

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

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

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

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

3.8 Waste Management

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

3.8.1 Overview

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

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

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

- **Reduction at Source** – The elimination or minimization of waste generation through equipment modifications and installation of pollution abatement equipment.
- **Reuse** – Using an item for its original purpose, or similar purpose, in its original form. Wastes generated from one operation shall be put to use in

other operations where they are found useful without compromising standards and safety.

- **Recycling** – conversion of waste materials into reusable objects. This will involve using FMEnv/NESREA approved companies involved in recycling business using best available technology that meet international standards.
- **Residue Disposal** - disposal of wastes in a Government-approved dumpsite.

3.8.2 Associated Waste Streams

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

Pre-construction Phase

The waste streams associated with the pre-construction phase of the Project include cleared vegetation (during site preparation), food waste, and general rubbish. The cleared vegetation (mostly grasses) will be removed from the site and allow to biodegrade at a portion of the site while wood from felled trees will be made available to the local community. The general rubbish will be collected within the Project site and disposed of at a government-approved dumpsite through a third party waste contractor accredited by the Kaduna State Environmental Protection Agency (KEPA).

Construction Phase

The planned activities during the construction phase include civil, mechanical and electrical works and installation of PV panels and associated components which will be carried out by a number of construction workers. The waste streams associated with the construction activities include excavated soil, general refuse, garbage, inert construction materials, metal scraps, concrete waste, food waste, and used packaging materials. In line with the NEP ESMF, the EPC contractor shall put in place and comply with a site waste management plan. The plan shall be developed to address all waste streams associated with the construction activities and comply with relevant regulations. The contractor shall comply with the national requirements and building rules on storage of construction materials.

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

All electronic equipment shall be supplied by credible manufacturers to reduce the risk of generating wastes from faulty equipment. All damaged PV panels generated during the installation activities shall be collected in a dedicated container and

returned to the manufacturer outside the country for proper recycling since there is currently no recycling facility in Nigeria that handles PV panels.

Litter collection facilities shall be provided and all solid waste materials that are not identified for reuse or recycling will be placed in appropriate on-site storage containers (black-coloured waste receptacles for food waste, blue-coded bins for paper, and yellow-coded bins for general rubbish) and periodically disposed of (at least once a week throughout the construction period or on the need basis depending on the volume of the waste) at a government-approved dumpsite through a third party waste contractor approved by KEPA. It is estimated that approximately 0.30 m^3 of construction debris will be produced per week.

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

Operational Phase

Solid wastes generated during the operational phase of the Project will be incorporated into the existing NDA waste management approach (there is a dedicated site within the University environment where solid wastes are collected for disposal). Approximately 3.00 cm^3 of solid waste is estimated to be generated per week during the operational phase.

In line with NEP ESMF, the University shall be encouraged to prepare e-waste management plans that account for safe end-of-life disposal of equipment from the solar power plant. The Extended Producer Responsibility program (EPR) will be implemented for solar panels, inverters, batteries and other electrical components to be installed for the Project. Damaged or discarded PV panels and inverters will be collected and sent to the manufacturer for recycling in line with the EPR model. Spent, damaged or expired batteries will also be returned to the manufacturer for recycling. Alternatively, the spent batteries will be recycled by local and accredited battery recycling companies in Nigeria. These batteries shall be stored in red coloured waste receptacles before they are transported to the accredited battery recycling companies. The quantity of waste batteries generated typically depends on a number of factors such as type, capacity and number of batteries installed and depth of discharge.

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

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

Decommissioning

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

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

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

Waste Stream	Sources	Waste Generation Phase Construction (C), Operation (O), Decommissioning (D)	Handling Techniques
General rubbish, refuse, and putrescible wastes (food wastes)	Wood splinter, domestic waste, food packs, used bottles	C, O, D	On-site waste segregation; disposal of non-reusable waste through a third party waste contractor approved by Kaduna State Environmental Protection Agency (KEPA).
Cleared vegetation	During site clearing and preparation	C	Composting, collection for biomass fuel
Scrap metals	Used tubular and casings, used iron rods	C, O, D	Scrap metals will be collected for recycling
Excavated materials	Foundation works	C, D	Excavated materials generated during foundation works will be used for back-filling. Excess excavated spoil will be stockpiled and reused as part of materials for construction of plant buildings.
Damaged/expired PV panels	PV modules	C, O, D	Return to the manufacturer for recycling using the EPR model

Waste Stream	Sources	Waste Generation Phase Construction (C), Operation (O), Decommissioning (D)	Handling Techniques
Expired inverters	Electrical installation	O, D	Return to the manufacturer for recycling using EPR model
Damaged/expired Batteries	Power generation	O, D	Return to the manufacturer using the EPR model
Sanitary waste	Training centre	C, O, D	Periodic evacuation of content of the septic tank by KEPA accredited third party waste contractor.

3.9 Project Schedule

The proposed Project is planned to be operational by the fourth quarter (Q4) of 2021. The tentative Project schedule is provided in Table 3.3.

Table 3.3: Tentative Project Schedule

Project Schedule	Timeline											
	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site allocation												
Energy demand audit												
ESIA study and Approval												
Selection of EPC Contractor and contract signing												
Civil, electrical, and mechanical design												
Procurement (manufacturing and transportation)												
Preconstruction and construction Phase Activities												
Commissioning												
Commencement of operation												

CHAPTER FOUR:

DESCRIPTION OF THE ENVIRONMENT

CHAPTER FOUR

DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction

This chapter provides a description of the existing environmental and socio-economic conditions of the Project's area of influence, which covers the Project site and its surrounding environment up to 3 km, including the area where the cumulative impacts of the Project may be experienced.

Data and information for the environmental description of the Project area were based on field data gathering (primary data) as well as review of relevant literature (secondary data).

The field sampling was carried out from August 5 to 6, 2019 (wet season) by different specialists. Based on the consideration of the potential environmental and social footprints of the proposed Project, the observations noted during the preliminary visit to the Project site as well as the need to ensure that all the sensitive receptors that could be potentially affected by the proposed Project have been captured, a 1km radius from the centre of the Project site was selected as the spatial boundary for biophysical sampling while the socio-economic survey was extended to approximately 3 km radius from the centre of the Project site, as illustrated in Figure 4.1.

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

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

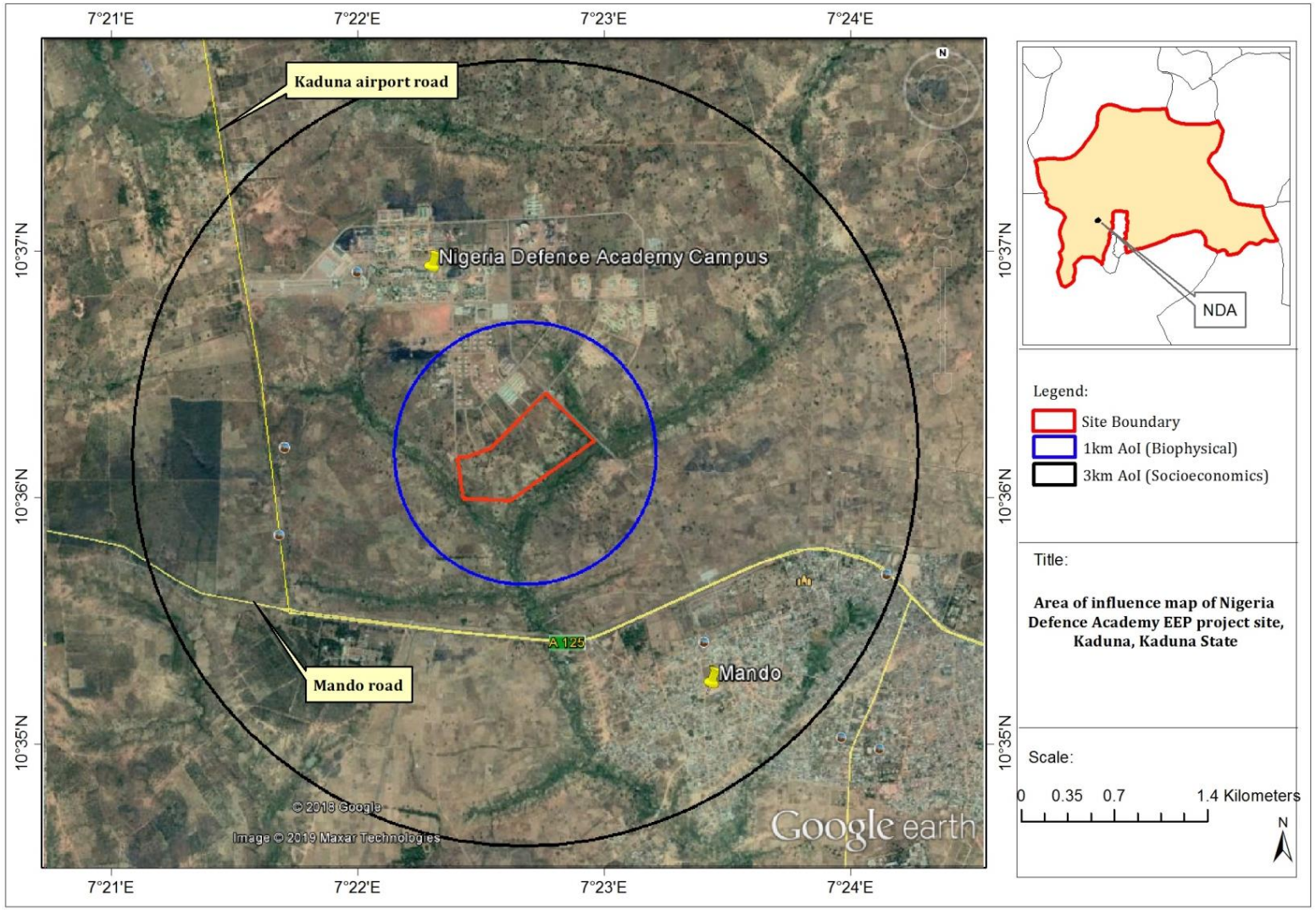


Figure 4.1: Aerial imagery of the Project's Area of Influence for biophysical and socio-economic survey
Source: EnvAccord Field Survey, 2019

4.2 Baseline Data Collection

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

The study approach includes the following:

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

4.2.1 Desktop Studies/Literature Review

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

4.2.2 Field Sampling and Laboratory Analysis

4.2.2.1 Field Sampling

In order to effectively characterise the environment of the Project area, field sampling was conducted from August 5 to 6, 2019. The objective of the field survey was to obtain the baseline data of the Project's area of influence and describe its environmental and social context. Sampling locations were identified using recent satellite imagery of the Project area. The basis of the sampling design was informed by a preliminary characterization of the Project area through desktop research and nearby sensitive receptors.

Sampling locations for biophysical components were randomly selected to cover as much as possible the land area for the proposed Project as well as the surrounding environment, while the socio-economic survey focused on the potentially affected community (Mando Community) identified within the Project's area of influence. All sampling locations were geo-referenced using Garmin Map-62 series Global Positioning System (GPS) handsets.

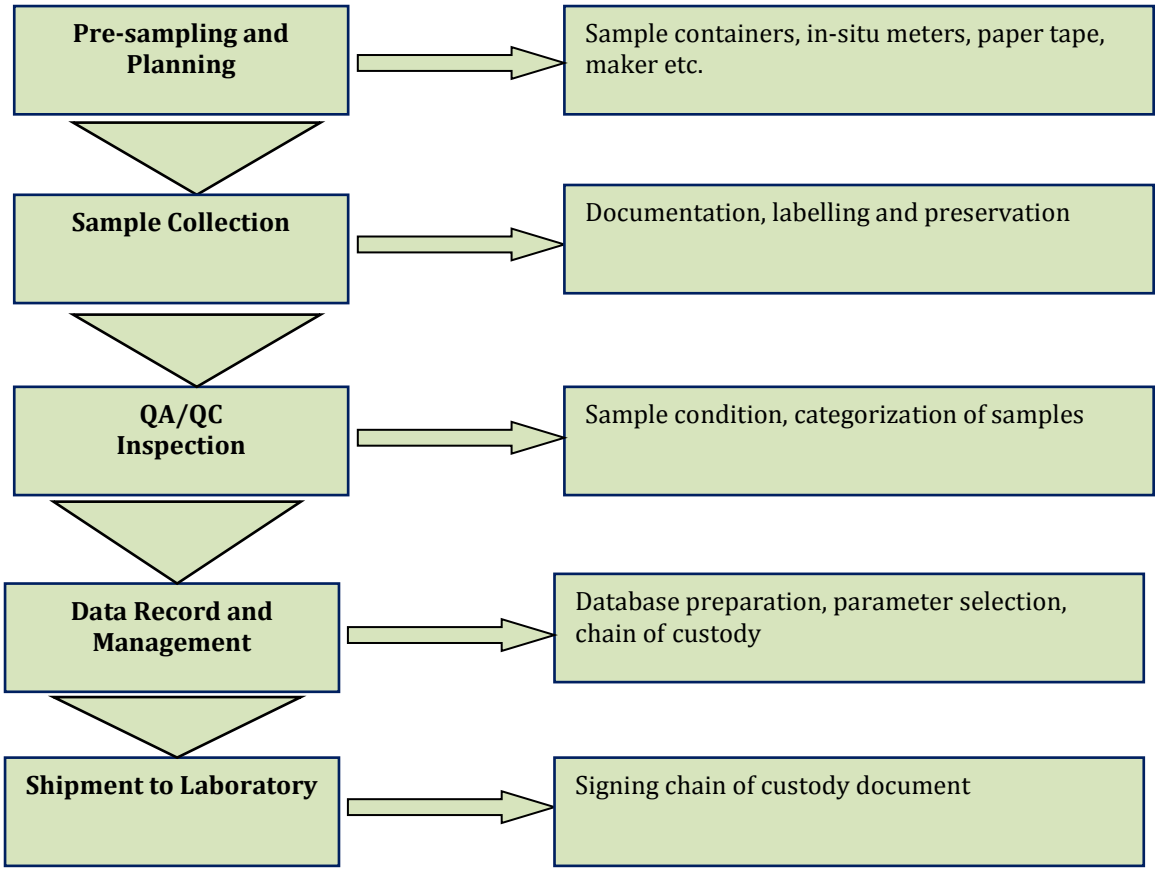
Plate 4.1 shows sample photographs of field sampling activities in the Project's AoI.

Plate 4.1: Sample Photographs of Field Sampling Activities in the Project's Area of Influence: A- Noise/Air sampling, B- Soil sampling, C- Socio-economic survey, D- Groundwater sampling **Source: EnvAccord Field Survey, 2019**

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

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

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



Source: EnvAccord Field Survey, 2019

Figure 4.2: Management program employed for field sampling

4.2.2.2 Laboratory Analysis of Field Samples

Field samples collected during the baseline survey were conveyed to the laboratory for analysis, along with the completed chain of custody forms. The samples were preserved with appropriate reagents (such as nitric acid and sulphuric acid), and the recommended temperature of 4^0C for the samples was maintained in-transit with the use of ice-chest and ice chips in different insulating containers.

The field samples were analysed for physico-chemical and microbial parameters at EnvAccord Laboratory located at 13 Alabi Street off Oguntona Crescent Gbagada Phase 1, Lagos. The Laboratory is accredited by FMEnv and other relevant regulatory agencies.

The laboratory analyses were undertaken in consistent with the approved standard methodologies such as those recommended by the American Society for Testing and Materials (ASTM) International, the American Public Health Association (APHA) and the FMEnv. The summary of analytical methods employed is presented in Table 4.1.

Table 4.1: Analytical methods employed for field sample analysis

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

Source: EnvAccord Field Survey, 2019

4.3 Description of Biophysical Environment of the Study Area

4.3.1 Climate and Meteorology

Kaduna State is characterized as a sub humid zone with derived guinea savannah vegetation, patches of rainforest and harsh tolerance plant species. The climate of the study area is tropical and it is under the influence of the Inter-Tropical Convergence Zone (ITCZ) or Inter-Tropical Discontinuity Zone (ITDZ).

Movement of these air masses results in two main seasons; a wet season from April to October, and a dry season from November to March. During the dry season, there are periods when the harmattan (a period characterized by dry dusty winds and relatively low temperatures) is experienced. This typically occurs during the months of December and January.

In this section of the report, the dominant climatic elements and factors within the regional Project area are discussed. These include rainfall, ambient temperature, relative humidity, sunshine, wind speed and wind direction. Information on the

climatic data of the Project area is sourced from NiMet, and it spans from 1991 to 2017.

Table 4.2 summarizes the monthly mean climatic characteristics of the Project area from 1991 to 2017.

Table 4.2: Monthly Mean Climatic Characteristics of the Project Area (1991-2017)

Month	Temperature (°C)		Rainfall (mm)	Relative Humidity (%)		Sunshine hours	Wind speed (m/s)
	Min.	Max.		9:00 hrs	15:00 hrs		
January	15.38	31.60	0.00	21.56	18.48	8.57	6.58
February	17.97	33.80	0.06	23.00	18.59	8.83	6.74
March	21.12	36.01	7.77	30.85	22.30	7.82	5.64
April	22.74	35.34	47.70	52.22	34.04	8.00	5.46
May	22.12	32.97	104.23	67.41	50.00	7.86	5.55
June	20.74	30.49	174.03	75.07	58.89	7.40	5.62
July	20.53	28.91	230.66	79.30	63.30	5.68	5.24
August	20.62	28.54	284.60	81.70	67.04	5.25	4.49
September	20.01	30.03	239.74	76.15	59.41	6.31	3.77
October	19.55	31.61	81.71	65.89	43.89	7.81	3.30
November	16.33	32.81	0.05	32.59	23.85	9.25	4.95
December	14.77	31.58	0.00	24.70	21.22	8.98	5.69

Source: NiMet, 2018

i) Rainfall

The rainfall pattern in the area is characterized by high precipitation in the months of April to October (wet season) while the no rainfall was recorded in December and January. Of the total amount (1170.55 mm), about 1162.67 mm is recorded during the wet season (April – October) while only 7.88 mm is recorded in the dry season (November to March) as shown in Figure 4.3).

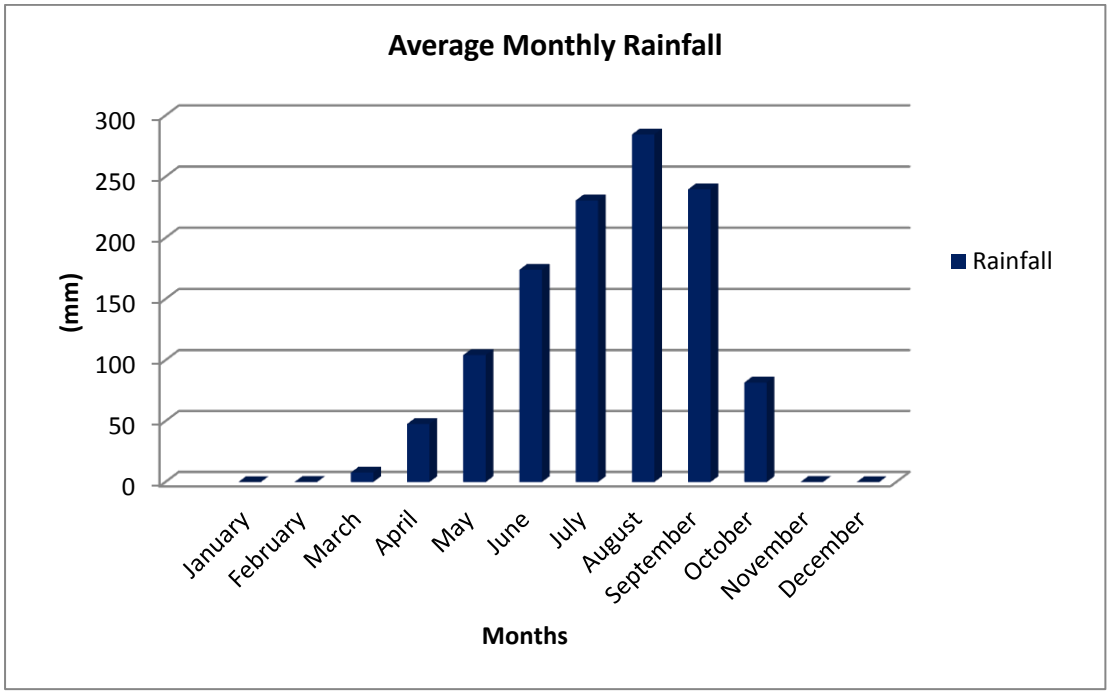


Figure 4.3: Average rainfall characteristics of the Project area (1991- 2017)
Source: NiMet, 2018

ii) Ambient Temperature

Temperature is relatively high all the year round in view of the location of the study area around the tropic. The highest temperature values are recorded in the dry season months and the lowest at the peak of wet season period (Figure 4.4).

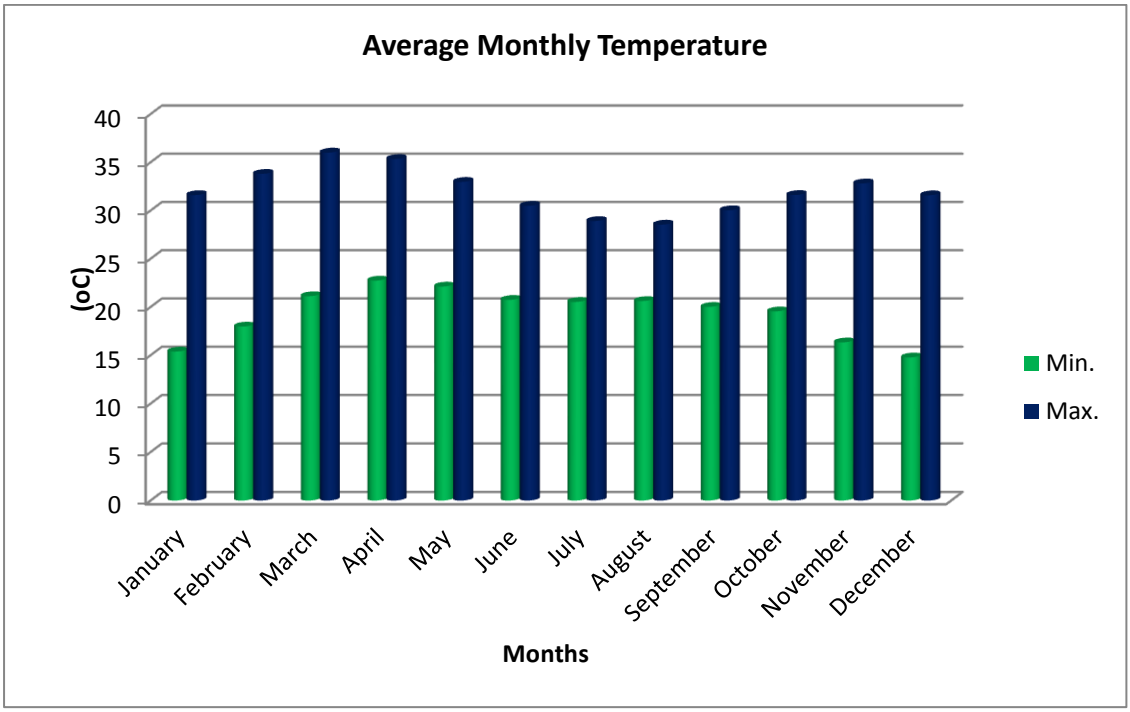


Figure 4.4: Monthly Mean Temperature Characteristics of the Project Area (1991-2017) Source: NiMet, 2018

iii) Relative Humidity

High relative humidity is experienced in the area as a result of the prevailing Tropical Maritime (Tm) air mass that blows over the environment almost all the year round. Data for Kaduna State indicate that humidity measured in the morning ranges between 23.00 % in February and 81.70 % in August while at night the value ranges from 18.48 % (in January) to 67.04 % (in August) as shown in Figure 4.5.

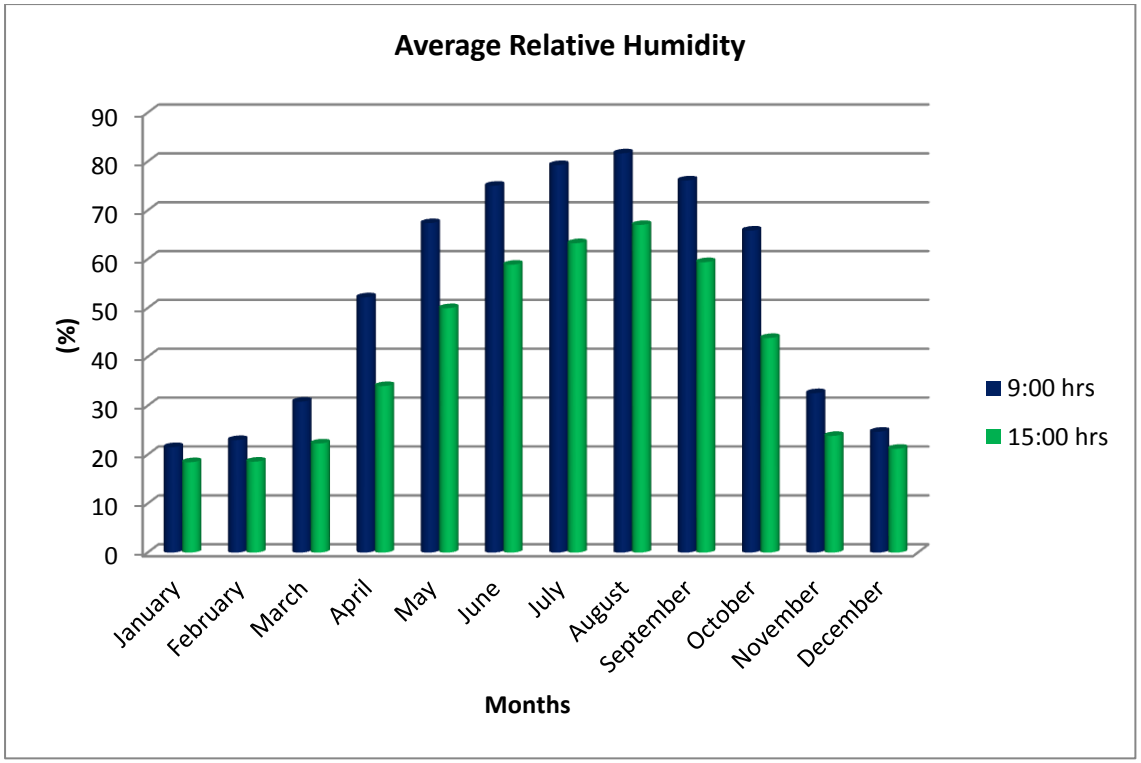


Figure 4.5: Monthly Relative Humidity Characteristics of the Project Area (1991-2017) Source: NiMet, 2018

iv) Wind Direction and Speed

Wind follows the distinctive pattern of the Tropical continental, (Tc) (Northeast) and Tropical maritime, Tm (Southwest) directions depending on the apparent location of the sun and the dominant of the two. The moisture laden and rain bearing Southwesterly from the Atlantic predominates during the wet season. It is calmer due to its higher moisture load. The Tc is of less intensity and prevails between December and March. The two major wind patterns are however modified marginally by warm Benguela Current and the North-East Harmattan winds.

The monthly average wind speed in the area ranges from 3.30 m/s to 6.74 m/s (Figure 4.6). Highest speed is recorded at the onset and offset of seasons when squalls, lightning and thunder accompany torrential rains.

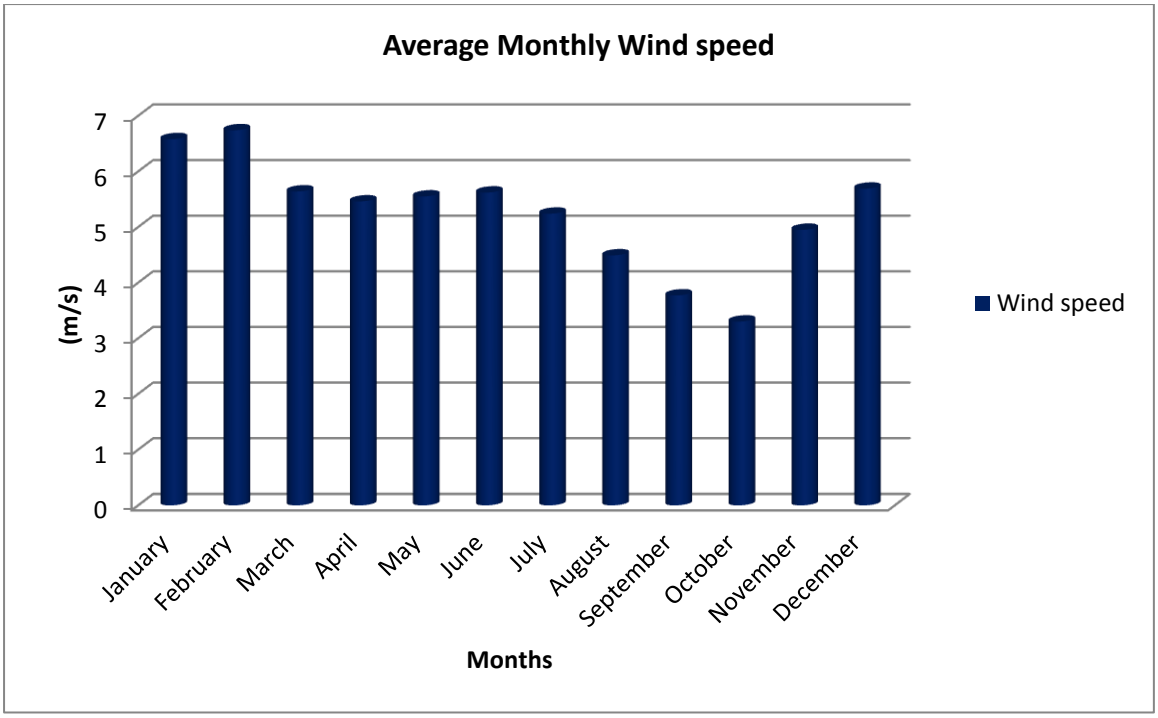


Figure 4.6: Monthly Average Wind Speeds of the Project Area (1991- 2017)
Source: NiMet, 2018

v) Sunshine Hours

A general assessment of the sunshine hours for the project area in Kaduna State revealed that the lowest sunshine hours (5.25 and 5.68) are at the peak of the rainy season (July and August) while the brightest months occur in November (Figure 4.7).

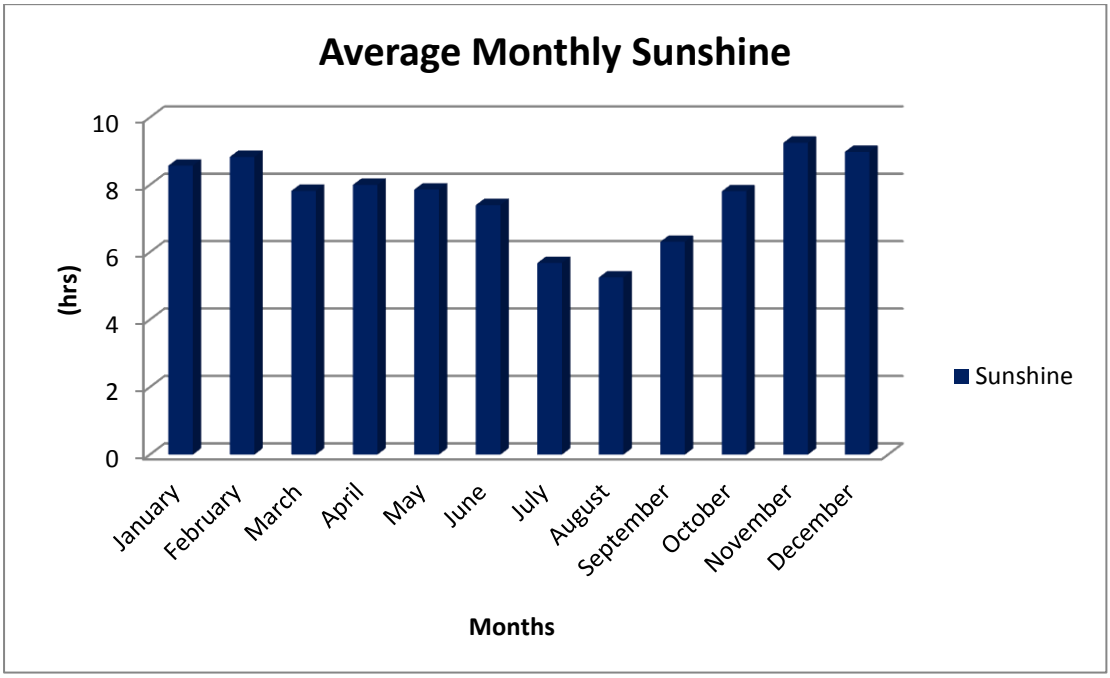


Figure 4.7: Monthly Average of Sunshine Hours for the Project Area (1991-2017)
Source: NiMet, 2018

4.3.2 Geology and Hydrogeology

The geology of Kaduna State is part of the basement complex geology of central Nigeria. It is composed of older high grade metamorphosed gnesis interspersed by belt of young metasediment of mainly quartzites and schist. The region is underlain by older granitic crystalline, metamorphic rocks of precambrain to low Paleozoic age (Oguntoyinbo *et al*., 1983). It also consists of gneisses which has suffered intense weathering and have remained stable for millions of years. The prolonged weathering under tropical bioclimatic condition has produced rolling plains dotted with residuals of different origin (Ariko *et al*., 2014).

Igabi local government area of Kaduna State is mainly composed of older granite and meta-sediment (Figure 4.8).

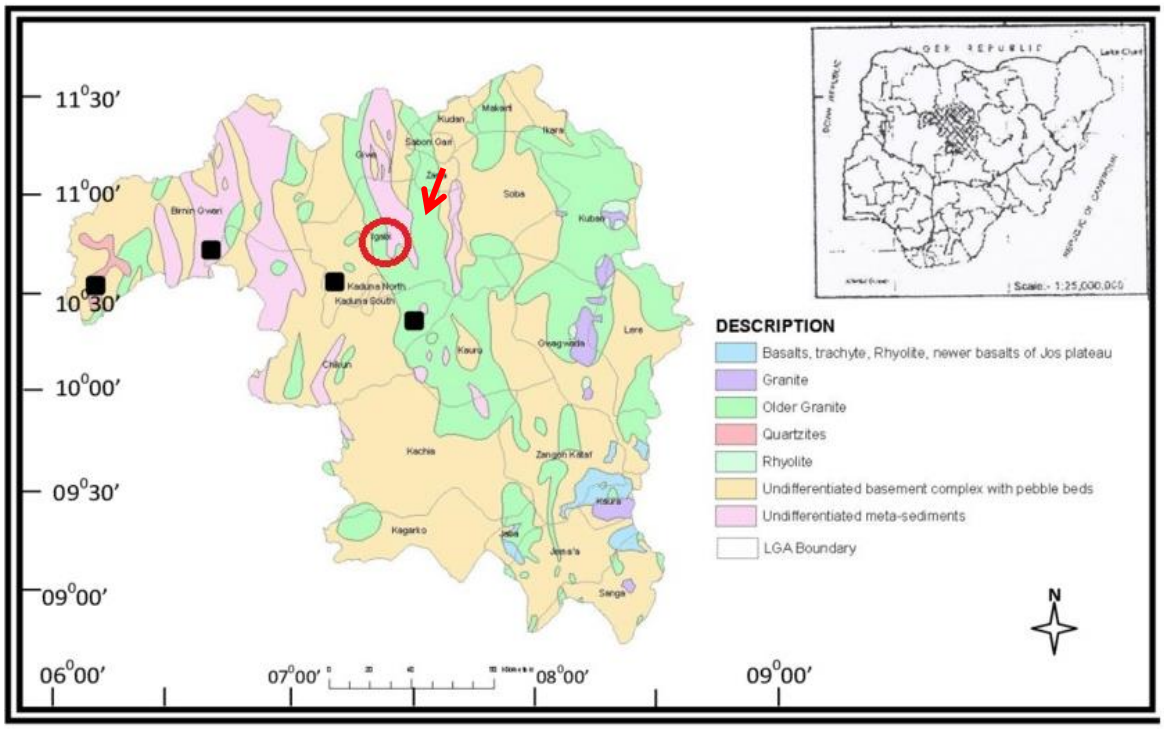


Figure 4.8: Geology of Kaduna State indicating the project area (outlined in red)

4.3.3 Ambient Air Quality and Noise

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

Ambient noise levels were measured using an Extech Integrated Sound Level Meter with a detection range of 30 dB(A) to 130 dB(A). Noise Level measurements were

taken at a height of approximately 2m above ground level and the response time was set to slow and read on the 'A' frequency weighting scale in unit decibels.

A total of eight (8) sampling locations (4 within the Project site, 2 within 1km radius, and 2 at control/buffer points) were established for ambient air quality and noise study. The air quality and noise sampling locations map is presented in Figure 4.9.

4.3.3.1 Air Quality Standards

The concentrations of air quality parameters recorded at the Project area were compared to the Nigerian Ambient Air Quality Standards (NAAQS), World Health Organization (WHO) Air Quality Guidelines, and World Bank noise level guidelines. The summary of these limits is provided in Tables 4.3 to 4.5.

Table 4.3: Ambient Air Quality Standards

Parameter	Averaging Period	Nigeria Standards FMEnv Limit (µg/m³)	WHO Ambient Air Quality Guideline values (µg/m³)
CO	1-hour	11, 400	-
NO_2	1-hour	75 - 113	200
SO_2	1-hour	260	500 (10-minutes)
TSP	1-hour	250	-

Source: FMEnv, 1991; and World Bank General EHS 2007

Table 4.4: Noise Exposure Limits for Nigeria

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

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

Table 4.5: Noise Level Guidelines adopted by the World Bank

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

Source: The World Bank General EHS Guidelines, 2007

4.3.3.2 Air Quality of the Project Area

The geographical coordinates of the air sampling locations established in the Project area are presented in Table 4.6.

Table 4.6: Geographical coordinates of Air quality sampling locations in the Project Area

Sampling Code	Latitude (N)	Longitude (E)
Within the Project site		
AQ1	10.60568	7.37962
AQ2	10.60301	7.38062
AQ3	10.60226	7.37822
AQ4	10.60196	7.37455

Sampling Code	Latitude (N)	Longitude (E)
Within the Project site		
Within 1km AoI (area of influence) radius		
AQ5	10.59581	7.38912
AQ6	10.61482	7.37669
Control/buffer points		
AQ7	10.60118	7.34970
AQ8	10.58908	7.40544

Source: EnvAccord Field Survey, 2019

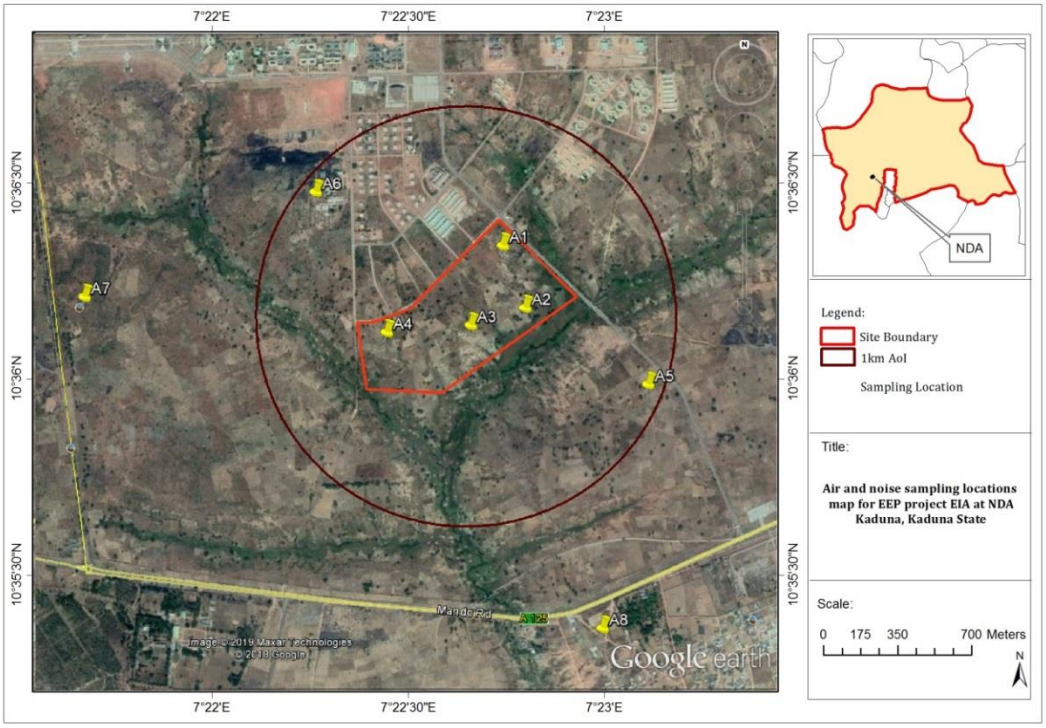


Figure 4.9: Air quality/ Noise sampling locations map
Source: EnvAccord Field Survey, 2019

The results of air quality and noise level measurements conducted in the Project area are presented in Table 4.7.

Table 4.7: Results of ambient air quality and noise levels measured in the Project area

Sampling Code	TSP	NO_2	SO_2	VOC	CO_2	CO	CH_4	H_2S	Noise dB(A)
	(mg/m^3)								
Within the Project site									
A1	0.022	0.000	0.001	1.0	1098	BDL	BDL	BDL	51.5
A2	0.015	0.010	0.010	1.0	1081	BDL	BDL	BDL	53.4
A3	0.018	0.008	0.004	2.0	1097	BDL	BDL	BDL	52.2
A4	0.013	0.002	0.000	3.0	1084	BDL	BDL	BDL	50.7
Within 1km AoI (area of influence) radius									
A5	0.031	0.000	0.012	2.0	1092	BDL	BDL	BDL	51.9
A6	0.038	0.021	0.001	1.0	1101	BDL	BDL	BDL	54.8
Control/Buffer points									
A7	0.025	0.018	0.007	3.0	1165	BDL	BDL	BDL	52.6
A8	0.044	0.040	0.009	15.0	1177	BDL	BDL	BDL	61.2

Source: EnvAccord Field Survey, 2019. BDL= Below Detection Limit (VOC = 0.1; CH_4, = 0.01; CO = 0.01; H_2S = 0.01)

Total Suspended Particulate (TSP): Within the Project site, the measured TSP values ranged from 0.013 mg/m^3 to 0.022 mg/m^3 while the TSP values recorded at locations established outside the Project site but within its 1km radius ranged from 0.031 mg/m^3 to 0.038 mg/m^3. At the control/buffer points, the measured TSP values ranged from 0.025 mg/m^3 to 0.038 mg/m^3. The TSP values recorded in all the sampling locations were below the FMEnv 1hr averaging time limit of 0.25 mg/m^3 for TSP in ambient air. This implies that the ambient air of the Project area in terms of TSP could be considered to be unpolluted. No elevated TSP concentrations beyond the regulatory limit were recorded in the Project area.

Nitrogen dioxide (NO_2): The results of air quality measurement conducted in the Project area show that the NO_2 values recorded within the Project site ranged from below the equipment detection limit to 0.008 mg/m^3 while at 1km area of influence of the Project site, the measured NO_2 values ranged from <0.001 mg/m^3 to 0.012 mg/m^3. For the control/buffer points, a range of 0.007 mg/m^3 to 0.009 mg/m^3 was obtained. The concentrations of NO_2 recorded in all the sampling locations during the field survey were below the FMEnv recommended threshold limit of 0.113 mg/m^3 and the WHO guideline value of 0.2 mg/m^3 respectively for 1hr averaging time of NO_2 in ambient air.

Sulphur dioxide (SO_2): At the time of field sampling, the concentrations of SO_2 recorded at four (4) different locations established within the Project site ranged from 0.001 mg/m^3 to 0.010 mg/m^3, while the measured SO_2 values within 1km radius of the Project site ranged from 0.001 mg/m^3 to 0.012 mg/m^3. The control points recorded a range of 0.007 mg/m^3 to 0.009 mg/m^3. The SO_2 values recorded in all the sampling locations were below the FMEnv recommended threshold limit (1-hour averaging time) of 0.026 mg/m^3 for SO_2 in ambient air. The measured SO_2 values were also lower than the WHO guideline value of 0.5 mg/m^3 for SO_2 in ambient air (10-minutes averaging period).

Ambient Noise Level: Within the Project site, the measured noise levels ranged from 50.5 dB(A) to 53.4 dB(A) while the 1km area of influence had a range of 51.9 dB(A) to 54.8 dB(A). At the control points, the noise levels ranged from 52.6 dB(A) to 61.2 dB(A). The measured noise levels at the Project site and its surrounding environment were within the World Bank noise limit of 55 dB(A) (1hour Leq day time) for educational institution. In addition, the noise levels (by extrapolation) were also below the FMEnv limit of 90 dB(A) for 8-hour occupational exposure.

4.3.4 Soil Quality

4.3.4.1 Soil Sampling

A total of eight (8) soil sampling stations (4 within the Project site, 2 within 1km radius, and 2 at control/buffer points) were established in the Project area. At each

of the sampling station, both top soil (0-15cm) and sub-soil (15-30cm) were collected.

Soil sampling was carried out using a stainless steel auger. The soil samples collected were homogenized in plastic bucket lined with aluminum foil sheet, and from the homogenized soil samples, sub samples were taken for physico-chemical analysis. All samples collected were preserved and transported to the laboratory for analysis. The geographical coordinates of the soil sampling locations are presented in Table 4.8 while the soil sampling locations map is depicted in Figure 4.10.

Table 4.8: Geographical coordinates of Soil Sampling Locations in the Project Area

Sampling Code	Latitude (N)	Longitude (E)
Within the Project site		
S01	10.60568	7.37962
S02	10.60301	7.38062
S03	10.60226	7.37822
S04	10.60196	7.37455
Within 1km AoI (area of influence) radius		
S05	10.59581	7.38912
S06	10.61482	7.37669
Control/buffer points		
S07	10.60118	7.34970
S08	10.58908	7.40544

Source: EnvAccord Field Survey, 2019

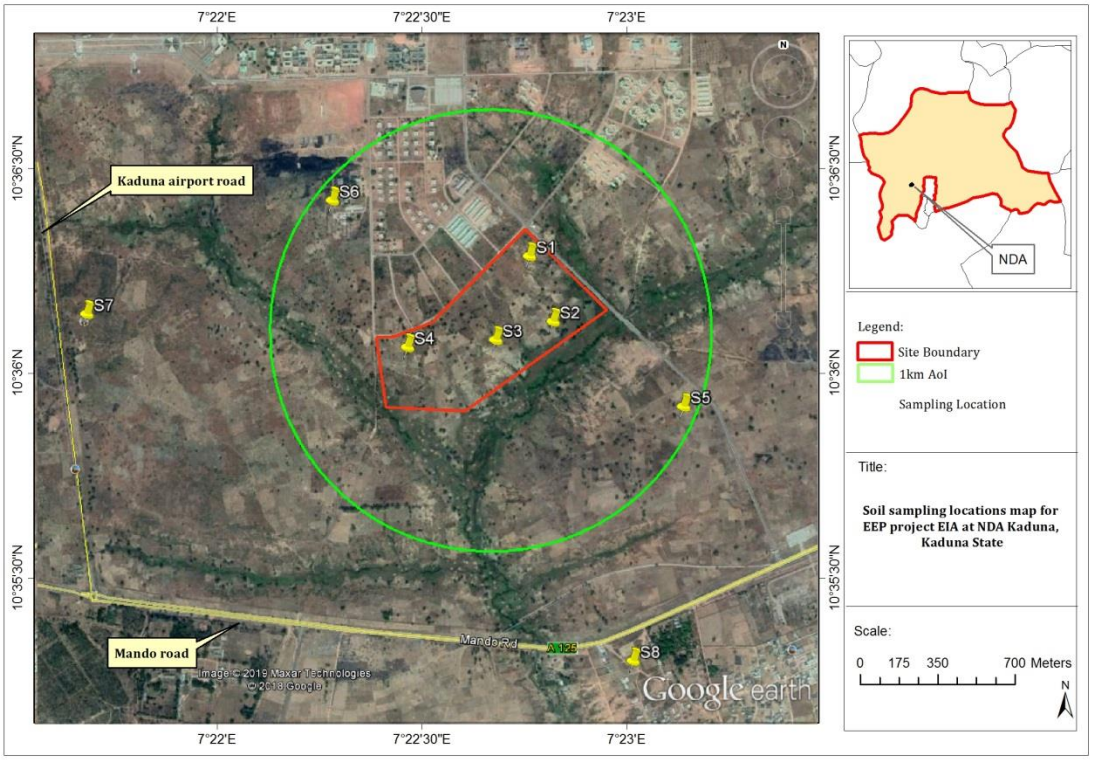


Figure 4.10: Soil Sampling Locations Map

Source: EnvAccord Field Survey, 2019

Table 4.9 presents the descriptive summary of the results of physicochemical and microbial parameters analysed in soil samples collected from the project site as well as the project Aol. The full results are provided in Appendix 4.1,

Table 4.9: Physico-chemical and microbial properties of top soils (0 – 15cm) from the Project area

Parameters	0-15			15-30			Limits Alloway (1991): Allen *et al* (1974)
	Min	Max	Mean	Min	Max	Mean	
pH	5.84	7.88	69.22	6.48	7.58	70.19	-
Conductivity µS/cm	109	210	1545	110	221	1534	-
Moisture Content %	0.85	2.62	19.17	1.26	2.5	19.46	-
TOC %	0.85	2.06	13.67	0.92	1.96	13.7	-
Carbonate mg/Kg	2.5	5.25	41.41	3.5	5.35	43.9	-
Chloride mg/Kg	10.995	16.243	138.935	11.744	16.492	142.681	-
Nitrate mg/Kg	0.013	0.178	1.136	0.018	0.166	1.032	-
Sulphate mg/Kg	13.662	27.032	198.653	12.449	25.531	201.184	-
Phosphate mg/Kg	0.27	0.99	6.67	0.31	0.99	6.77	-
Cu mg/Kg	0.011	0.212	0.667	0.009	0.163	0.534	5-500
Pb mg/Kg	0	0	0	BDL	BDL	BDL	2-20
Fe mg/Kg	31.71	84.57	593.62	39.52	83.14	625.55	NS
Zn mg/Kg	0.013	0.915	2.704	0.011	0.428	1.237	10-50
Ni mg/Kg	BDL	BDL	BDL	BDL	BDL	BDL	5-500
Cd mg/Kg	BDL	BDL	BDL	BDL	BDL	BDL	0.03-0.30
Cr mg/Kg	BDL	BDL	BDL	BDL	BDL	BDL	-
Hg mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	-
Na mg/Kg	41.13	97.34	717.95	54.58	84.32	705.89	-
K mg/Kg	2.94	15.95	72.88	2.15	13.25	64.79	-
Ca mg/Kg	6.48	38.68	233.54	7.83	43.38	290.85	-
Mg mg/Kg	1.48	4.05	26.84	1.46	3.14	25.18	-
Sand %	7.35	16.54	106.98	7.45	17.89	109.61	-
Silt %	7.62	13.17	97.57	7.55	13.18	101.4	-
Clay %	75.84	82.43	798.4	72.36	82.9	790.33	-
Oil and Grease	BDL	BDL	BDL	BDL	BDL	BDL	-
Total Heterotrophic Bacteria cfu/g	$1.5x10^7$	$5.2x10^7$	-	$1.3 x10^7$	$8.1 x10^7$	-	-
Total Heterotrophic Fungi cfu/g	$2.3x104^4$	$7.8x10^4$	-	$1.9x10^4$	$7.8x10^4$	-	-
Total Coliform cfu/g	0	0	-	0	0	-	
Hydrocarbon Utilizing Bacteria cfu/g	$7.5x10^2$	$8.5x10^3$	-	$3.8 x10^3$	$6.8x10^3$	-	-
Hydrocarbon Utilizing Fungi cfu/ml	$20 x10^2$	$89 x10^2$	-	$64.0x10^2$	$23.0x10^3$	-	-
% HUB	0.0109	0.0923	0.4823	0.0045	0.0914	0.411	

Source: EnvAccord Field Survey, 2019

BDL= Below Detection Limit. Equipment Detection Limit = Cu, 0.005; Pb, 0.04; Ni, 0.05; Cd, 0.01; Cr, 0.04; Hg, 0.001; oil and grease, 0.001

The discussion of the soil quality results is provided in the following paragraphs:

Soil Physical properties (Sand, Clay, and Silt): The soil texture is determined by the balance of clay, silt and sand particles. The soil environment of the Project site can be

classified as of clay texture going by their particle size distribution. The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 7.35 % – 16.54 %, silt ranged from 7.62 % – 13.17 % while the percentage of clay particles ranged from 75.84 % – 82.38 %. In the sub soil, sand particles ranged from 7.45% – 17.89 %, silt ranged from 7.55% – 13.18% while clay ranged from 72.36% – 82.90 %. Generally, sand, sandy loam and loam textured soils tend to be less eroded than silt, very fine sand, and clay textured soils.

Soil pH (soil reaction): Soil reaction, which is given in terms of pH values, measures the free H^+ and OH^- concentration of soil solutions. The importance of soil reaction lies in the fact that it provides a variety of useful information such as relative availability of plant nutrients, extent of H^+ formation by hydrolysis of aluminum and degree of dissociation of H^+ from cation exchange sites. The pH of soil samples from the Project site ranged from 5.84 to 7.88 (slightly acidic to neutral) for top soil and a range of 6.48 to 7.58 (slightly acidic to neutral) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on site. Similarly, within the 1km area of influence, the pH values ranged from 6.48 to 6.96 while at the control points, a range of 6.83 to 7.58 was recorded.

Soil Anions: The concentrations of anions measured in the soil were generally within the prescribed limits for tropical soil. Among the anions, sulphate had the highest concentrations in the soil samples with a range of 13.662 mg/kg to 27.032 mg/kg while phosphate had the least concentration with a range of from 0.270 mg/kg to 0.990 mg/kg. As indicated in Table 4.9 the nitrate concentration in the soil samples from the Project site is low indicating relative low nutrient. This could be expected since the Project site is dominated by grasses and it is not currently used for farming. This inference could also be supported by low percentage of total organic carbon recorded in soil samples from the Project site.

Soil Cations: The concentrations of Sodium (Na), Calcium (Na), Potassium (K) and Magnesium (Mg) recorded in soil samples from the Project area fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991). Within the Project site, Na recorded the highest concentration among the anion analyzed. In the top soil, the Na concentrations ranged from 41.13mg/kg to 97.34mg/kg while in the sub-soil, the measured Na values ranged from 54.58mg/kg to 84.32mg/kg. Similar trends were obtained in the soil samples collected within the 1km radius of the Project site as well as the control/buffer points.

Heavy Metals: Heavy metals occur naturally in the environment at low concentrations; however elevated levels of these metals in the environment may be experienced due to anthropogenic activities. The presence of heavy metals in soil at the level within the naturally occurring concentration is, therefore, not indicative of

contamination. The concentration of metals in uncontaminated soil is primarily related to the geology of the parent material from which the soil was formed (McLean and Bledsoe, 1992).

Based on the results of laboratory analysis conducted on soil samples from the Project site and its surrounding environment, no heavy pollution was recorded in the soil samples from the Project area. Lead (Pb), Cadmium (Cd), Chromium (Cr) Nickel (Ni) and Mercury (Hg) were below the detection limits of 0.005m/kg, 0.04mg/kg, 0.01mg/kg, 0.04mg/kg, 0.05mg/kg and 0.001 mg/kg respectively. The concentrations of Zinc (Zn) recorded in the soil samples from the Project site, the 1km area of influence and the control/buffer points had a range of 0.033mg/kg – 0.915mg/kg, 0.013 mg/kg – 0.286 mg/kg, 0.014 mg/kg – 0.114 mg/kg respectively in the top soil while in the subsoil, a range of 0.034 mg/kg – 0.428 mg/kg, 0.011 mg/kg – 0.034 mg/kg, 0.016 mg/kg – 0.102 mg/kg respectively was recorded in the sub soil. The measured Zn values in all the soil samples collected from the Project area were within the naturally occurring levels. Due to the geological nature of the Project area, Iron (Fe) recorded the highest concentrations amongst the heavy metals recorded in the soil samples as indicated in Table 4.9 above. This also reflected in the Fe concentration recorded in the groundwater samples from the area.

Soil Microbiology: Microorganisms are one of the major components of soil. Microbial community in soil make important contributions to biogeochemical cycling and the carbon, nitrogen, sulfur, iron and manganese cycle. The population counts of Total Heterotrophic Bacteria (THB) and Total Heterotrophic Fungi (THF) in the soil samples from the Project area ranged from 1.50×10^7 to 5.20×10^7 cfu/gm and 2.3×10^4 to 7.8×10^4 cfu/gm respectively. The percentage of hydrocarbon utilizing bacteria (HUB) recorded was less than 1 % of the total heterotrophic bacteria, indicating that the soil environment is not polluted with hydrocarbon compounds that could serve as substrates for the HUB to thrive well. Predominant species of microorganisms isolated includes *Corynebacterium* spp., *Nocardia* spp., *Aspergillus flavus*, *Bacillus* spp., *Penicillium* spp., and *Fusarium* spp.

4.3.5 Groundwater Quality

Groundwater quality refers to the state of water that is located beneath Earth's surface. Naturally, groundwater contains mineral ions. Microbial matter is also a natural constituent of groundwater (Harter 2003).

In order to assess the quality of existing groundwater in the Project area, water samples were collected from existing groundwater resources in the Project area and analyzed. The results of the physico-chemical and microbial characteristics of the groundwater samples were compared with the WHO standards (highest desirable level and maximum permissible limits for substances and characteristics affecting the acceptability of water for domestic use) as well as the FMEnv prescribed limits for

drinking water as highlighted in the National Guidelines and Standards for Water Quality in Nigeria, 1999.

4.3.5.1 Groundwater Sampling

Groundwater samples were collected from two (2) different boreholes in the Project area during the field sampling; one close to the Project site and one from the nearby local community. At each sampling location, groundwater samples were collected into a 2-litre polyethylene bottle for general physico-chemical analysis, while samples for oil & grease determination were collected in 1-litre glass bottle and preserved with concentrated sulphuric acid. Samples for heavy metals were fixed with concentrated nitric acid. Pre-sterilized 50ml McCartney bottles were used for samples meant for microbial analysis. In-situ measurements of pH, Electrical Conductivity, Total Dissolved Solids (TDS), Temperature, and Dissolved Oxygen (DO) were taken at each location using Extech Digital DO700 meter. Table 4.10 shows the coordinates of the groundwater sampling points while Figure 4.12 shows the sampling locations map.

Table 4.10: Geographical coordinates of Groundwater sampling locations in the Project Area

Sampling Code	Latitude (N)	Longitude (E)
NDA GW 01	10.60747	7.37757
NDA GW 02	10.61028	7.38256

Source: EnvAccord Field Survey, 2019

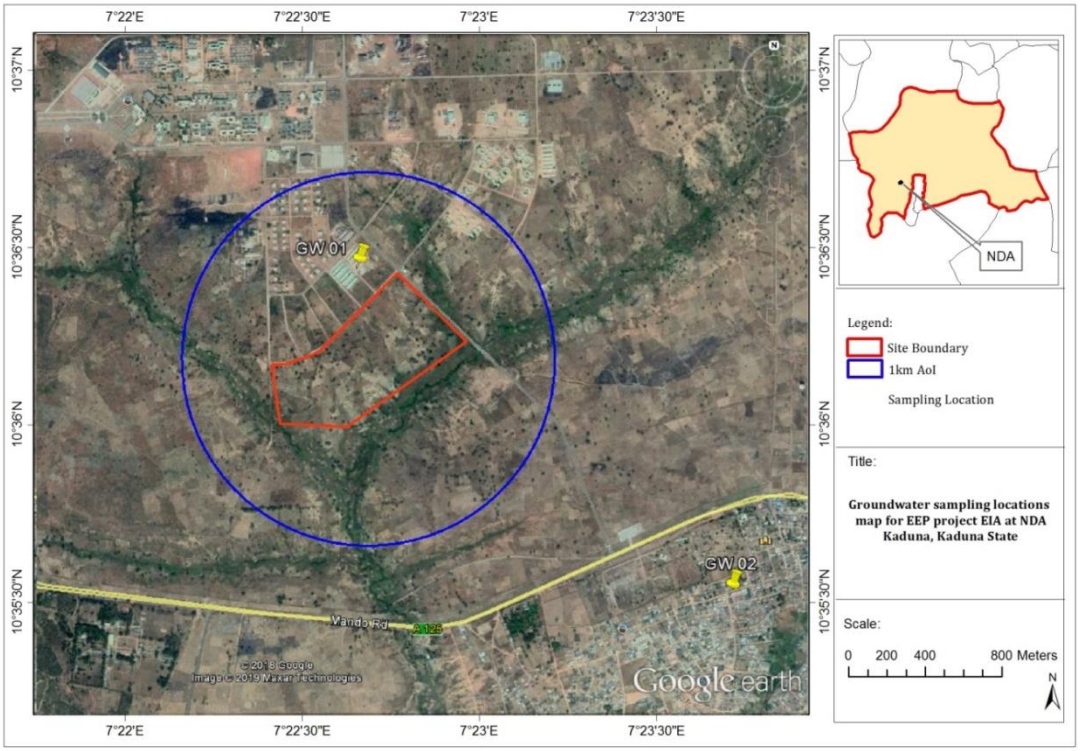


Figure 4.11: Map of Groundwater Sampling Locations in the Project Area

Source: EnvAccord Field Survey, 2019

4.3.5.2 Physico-chemical and Microbial Characteristics of Groundwater Samples

The results of physico-chemical and microbial analyses conducted on

groundwater samples from the Project area are presented in Table 4.11.

Table 4.11: Physico-chemical and microbial characteristics of groundwater samples from the Project area

Parameter / Unit	GW 01	GW 02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	5.70	5.53	7.0-8.5	6.5-9.2	6.5-8.5
Temperature ^{0}C	28.1	27.9	NS	NS	<40
Appearance	clear	clear	NS	NS	NS
Conductivity µS/cm	20.00	104.00	NS	1000	-
TDS mg/L	10.00	52.00	200	500	500
Salinity ppt	0.04	0.01	NS	NS	NS
Colour PtCo	2.00	2.00			
Total Hardness mg/l	65.20	92.00	100	500	200
TSS mg/L	0.00	0.00	NS	NS	NS
Turbidity NTU	0.37	0.35	NS	NS	1
Dissolved Oxygen mg/L	2.30	2.70	NS	NS	7.5
BOD mg/L	0.20	1.60	NS	NS	0
COD mg/L	48.60	43.82	NS	NS	NS
Carbonate mg/L	2.50	2.00	NS	NS	NS
Chloride mg/L	12.590	20.990	-	-	250
Nitrate mg/L	0.000	0.000	NS	NS	10
Sulphate mg/L	0.000	0.000	200	400	500
Phosphate	0.000	0.100	NS	NS	5
Cu mg/L	0.012	0.018	0.05	1.5	1.0
Pb mg/L	BDL	BDL	NS	NS	0.05
Fe mg/L	4.342	2.223	NS	NS	1.0
Zn mg/L	0.01	0.11	5.0	15.0	5.0
Ni mg/L	BDL	BDL	NS	NS	NS
Cd mg/L	BDL	BDL	NS	NS	0.05
Cr mg/L	BDL	BDL	NS	NS	<1.0
Na mg/L	3.05	2.97	NS	NS	NS
Hg mg/l	BDL	BDL	NS	NS	NS
K mg/l	2.00	1.69	NS	NS	NS
Ca mg/L	9.07	10.38	75	200	NS
Mg mg/L	4.00	5.93	30	150	NS
Oil/Grease mg/L	BDL	BDL	NS	NS	0.05
Total Heterotrophic Bacteria cfu/g	$6.0x10^2$	$2.9x10^2$	-	-	-
Total Heterotrophic Fungi cfu/g	$8.0x10^1$	$3.0x10^1$	-	-	-
Total coliform	Nil	Nil	-	-	-

Source: EnvAccord Field survey, 2019, NS = Not Specified

BDL= Below Detection Limit. Equipment Detection Limits are as follows: Cu, 0.005; Pb, 0.04; Ni, 0.05; Cd, 0.01; Cr, 0.04; Mn, 0.03; Hg, 0.001; oil and grease, 0.001.

The pH of the groundwater samples ranged from 5.53 to 5.70 (*i.e.* slightly alkaline) while the in-situ water temperature ranged between 28.1^{0}C and 27.9^{0}C. The measured pH and temperature values in the groundwater samples fall within the FMEnv recommended limits of 6.5 – 8.5 and 40 ^{0}C for pH and temperature respectively for potable water.

Electrical conductivity, a measure of the ability of the water to pass an electrical current, ranged from 20.00µS/cm to 104.00µS/cm. The conductivity values obtained in the groundwater samples were within the WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 10.00mg/l to 52.00mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (below 1ppm) indicating a fresh water environment.

Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel, Lead, Mercury, Cadmium and Chromium were not detected in the samples. Zinc ranged from less than the detection limit of 0.01 to 0.11 mg/l, Iron ranged from 4.342 to 2.223 mg/l, while Copper ranged from 0.012 to 0.018 mg/l in all the groundwater samples analysed.

Similarly, the concentrations of oil and grease measured in the groundwater samples were below the detection limit of 0.001mg/l, indicating that the groundwater samples are not polluted with hydrocarbons.

The population counts of Total Heterotrophic Bacteria (THB) and Total Heterotrophic Fungi (THF) recorded in the groundwater samples ranged from $2.9x10^2$ to $6.0x10^2$ cfu/gm and $3.0x10^1$ to $8.0x10^1$ cfu/gm respectively. The percentage of hydrocarbon utilizing bacteria (HUB) recorded was less than 1 % of the total heterotrophic bacteria, indicating that the groundwater is not polluted with hydrocarbon compounds that could serve as substrates for the HUB to thrive well. Microbes are naturally found in groundwater resources. Predominant species of microorganisms isolated in the groundwater samples from the Project area are *Aspergillus niger*., *Bacillus* spp., and *Mucor* spp.

4.3.6 Surface water Quality

Surface water samples were collected from three (3) different locations from the stream within the vicinity of the study area.

Surface water samples were collected with the use of pre-cleaned water sampler. At each sampling location, samples were collected into 2-litre polyethylene bottle for general physico-chemical analysis, while samples for Oil & Grease and Total Hydrocarbon Content (THC) determination were collected in 1 litre glass bottles and preserved with concentrated sulphuric acid. Samples for heavy metals were collected separately in plastic containers and fixed with concentrated nitric acid. Pre-sterilized 50 ml McCartney bottles were used for samples meant for microbial analysis.

The geographical coordinates of the surface water sampling locations are presented below in Table 4.12 while the sampling maps are shown in Figure 4.13.

Table 4.12: Surface water sampling locations

Sampling Code	Latitude	Longitude
SW 1	10.60334	7.38355
SW 2	10.59964	7.37911
SW 3	10.60010	7.37344

Source: EnvAccord Field Survey, 2019

The results of the physico-chemical and microbial analyses of the water samples are provided in Table 4.13. The results were compared with the FMEnv limits for aquatic life as well as the surface water quality criteria for fisheries and recreation quality as enshrined in the National Environmental (Surface and Groundwater Quality Control) Regulations, 2011.

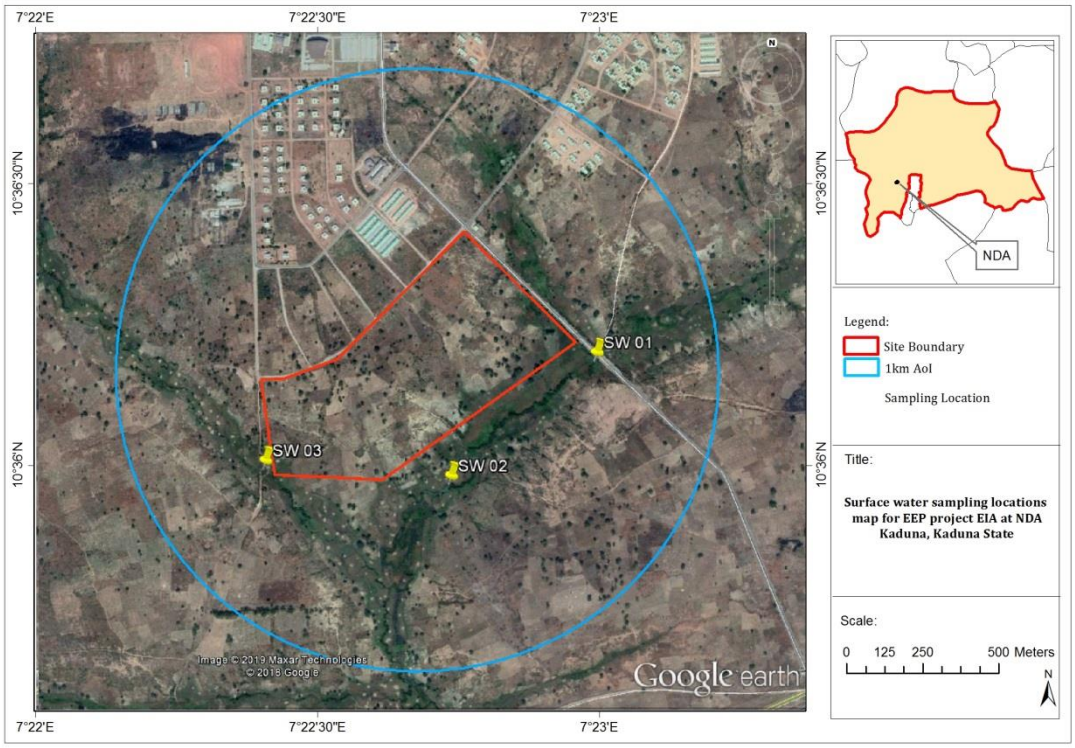


Figure 4.12: Map of Surface water Sampling Locations at the study area
Source: EnvAccord Field Survey, 2019

Table 4.13: Physico-chemical and microbial characteristics of surface water samples from the Project area

Sample ID	SW01	SW 02	SW 03	FMEnv. Limits (Aquatic life)	*NESREA Limit
pH	5.44	5.95	5.56	6.0 -9.0	6.5 – 8.5
Temperature ^{0}C	28.3	28.2	28.5	20 - 33	NS
Conductivity µS/cm	72.00	66.00	46.90	NS	NS
TDS mg/L	36.00	33.00	23.50	NS	NS
Appearance	Brownish	Cloudy	Brownish		
Total Hardness mg/L	88.00	80.00	73.20	NS	NS

Sample ID	SW01	SW 02	SW 03	FMEnv. Limits (Aquatic life)	*NESREA Limit
Salinity ppt	0.11	0.11	0.11	NS	NS
Colour PtCo	5.00	5.00	5.00		
TSS mg/L	1.17	1.03	1.08	NS	0.25
Turbidity NTU	0.40	0.99	0.44	NS	NS
DO mg/L	2.20	3.30	2.50	6.8	6.0
BOD mg/L	0.40	1.20	1.20	4.0	3.0
COD mg/L	34.86	30.72	37.38	NS	30.0
Carbonate mg/L	1.70	2.20	3.00		
Chloride mg/L	13.99	15.99	14.59	NS	300
Nitrate mg/L	0.120	0.100	0.150	NS	9.1
Sulphate mg/L	2.940	2.710	4.213	NS	NS
Phosphate mg/L	0.000	0.000	0.000	NS	3.5
Copper mg/L	0.011	0.021	0.115	2.4	0.001
Lead mg/L	<0.04	<0.04	<0.04	1.7	0.01
Iron mg/L	3.821	4.110	5.264	1.0	0.05
Hg mg/L	BDL	BDL		NS	NS
Zinc mg/L	0.03	0.01	0.13	0.03	0.01
Nickel mg/L	BDL	BDL	BDL	25 - 150	0.01
Cd mg/L	BDL	BDL	BDL	0.2 – 1.8	0.005
Cr mg/L	BDL	BDL	BDL	0.02 – 2.0	0.5
Na mg/L	3.71	5.15	8.23	NS	120.0
K mg/L	2.21	2.40	3.72	NS	50.0
Ca mg/L	7.06	6.00	6.83	NS	180.0
Mg mg/L	5.68	6.61	8.25	NS	40.0
Oil/Grease mg/L	BDL	BDL	BDL	NS	0.01
THB(cfu/ml)	$3.8x10^6$	$3.2x10^6$	$4.2x10^6$	-	-
THF(cfu/ml)	$2.0x10^2$	$3.0x10^2$	$2.30x10^2$	-	-
Total Coliform	$4.0x10^1$	0.00	$5.0x10^1$	-	-

Source: EnvAccord Field survey, 2019, NS = Not Specified

BDL= Below Detection Limit. Equipment Detection Limits are as follows: Cu, 0.005; Pb, 0.04; Ni, 0.05; Cd, 0.01; Cr, 0.04; Mn, 0.03; oil and grease, 0.001.

***NESREA Limit (for Surface water for Fisheries and recreation quality criteria standards)**

The pH of the surface water in the sampled environment ranged from 5.44 to 5.95, indicating that the water body is moderately acidic and below the NESREA and FMEnv limits of 6.5-8.5 and 6.0 – 9.0 respectively. The ambient water temperature ranged from 28.2^0C to 28.5^0C at the time of survey. The electrical conductivity of the surface water samples ranged from 46.90 µS/cm to 72.00 µS/cm while the Total Dissolved Solids which is roughly proportional to the conductivity, ranged from 23.50 mg/l to 36.00 mg/l.

Dissolved oxygen is the amount of gaseous oxygen dissolved in an aqueous solution. Oxygen is an essential element to all forms of life and natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. Oxygen gets into water via diffusion from the surrounding air, aeration and as a waste product of photosynthesis. The DO values for the surface water sampled ranged from 2.20 mg/l to 3.30 mg/l.

BOD values recorded in surface water samples ranged from 0.40 mg/l to 1.20 mg/l. The BOD concentrations recorded in the surface water samples were lower

than NESREA limit of 3.0 mg/l for aquatic life and can be classified as very good base on Figure 4.13.

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

Figure 4.13: BOD water quality chart
Source: www.pharmaguideline.com

With regard to cations, Magnesium ion recorded the higest concentration and it ranged from 5.68 to 8.25 mg/l while the least cation recorded is Potassium ion which ranged from 2.21 to 3.72 mg/l. Among the anions, phosphate ion was not detected while the chloride ion recorded the highest value with a range of 13.99 to 15.99 mg/l.

For heavy metals, the concentrations of the Copper ranged from 0.011 to 0.153 mg/l, which is below NESREA limit of 2.4 mg/l but above FMEnv limit of 0.0001 mg/l. Iron concentrations ranged from 3.821 to 5.264 mg/l, the recorded values are above NESREA and FMEnv limits of 1.0 and 0.05 respectively. Zinc ranged from 0.01 to 0.13 mg/l while concentrations of Lead, Nickel, Cadmium and Chromium were below detection limits of <0.04, <0.05, <0.01 and <0.04 respectively.

In microbiology, the THB count ranged from 3.2 x 10^6 cfu/ml to 4.2 x 10^6 cfu/ml while THF population varied between 2.0 x 10^2 cfu/ml and 3.0 x 12^3cfu/ml. The total coliform ranged from 0.00 to 5.0x10^1 cfu/ml.

4.3.6 Terrestrial Flora and Fauna

4.3.6.1 Terrestrial Flora

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

understanding the nature of the site, potential human health and ecological risk, and the feasibility of different mitigation approaches.

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

The results of the vegetation assessment are presented as follows:

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

- *Habitat characterization*

The vegetation of Kaduna comprises of low land forests which have become secondary rainforests or forest re-growth because of the increase in land use and exposure. The natural vegetation within the Project site was observed to have been modified habitat as a result of human interference; mainly crop farm plots as shown in plate 4.2 below. The dominant vegetation observed on the site can be classified as secondary vegetation dominated by grasses, shrubs, and a few trees.

Plate 4.2: Cross sectional views of the Project site
Source: EnvAccord Field Survey, 2019

- *Physiognomy, Floristic composition, and Biodiversity assessment*

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

In terms of biodiversity assessment, the IUCN (International Union of Conservation of Nature) Red List of Threatened Species was employed. The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed

to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable).

The IUCN Red List also includes information on plants, fungi and animals that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e., are Data Deficient); and on plants, fungi and animals that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e., are Near Threatened).

None of the plant species recorded in the Project area belongs to the endangered status. In addition, there are no known protected species on the Project site under the Nigerian legislation. The IUCN status of the plant species encountered in the Project area is highlighted in Table 4.14 while sample pictures of some flora species observed in the Project area are shown in Plate 4.3.

Table 4.14: Plant inventory and Conservation Status

Dominant Species Encountered	Family Name	Common Name (Local name)	Plant Forms	IUCN Status
Azadirachta indica	Meliaceae	Neem tree	Tree	NA
Ageratum conyzoides	Asteraceae	Goat Weed	Herb	NA
Arachis hypogaea	Fabaceae	Groundnut	Herb	NA
Zea Mays	Poaceae	Maize	Shrub	NA
Manihot esculenta	Euphorbiaceae	Cassava	Shrub	NA
Psidium guajava	Mayrtaceae	Guava	Shrub	NA
Colocasia esclulenta	Araceae	Cocoyam	Shrub	NA
Ipomoea batatas	Convolvulaceae	Potato	Climber	NA
Mangifera indica	Anacardaceae	Mango	Tree	NA
Nauclea latifolia	Rubiaceae	African Peach	Tree	NA
Dioscorea rotundata	Dioscoreaceae	White yam	Climber	NA
Panicum maximum	Poaceae	Guinea Grass	Grass	NA
Tridax procumbens	Compositae	Tridax	Herb	NA
Parkia spp	Fabaceae	African locust bean	Tree	NA
Pennisetum spp.	Poaceae	Elephant grass	Grass	NA
Paspalum spp	Poaceae	Crown grass	Grass	NA
Cajanus cajan	Fabaceae	Pigeon pea	Shrub	NA
Solanum lycopersicum	Solanaceae	Tomato	Shrub	NA
Cucumis sativus	Cucurbitaceae	Cucumber	Vine	NA
Ipomoea involucrata	Convolvulaceae	Morning glory	Vine	NA
Synedrella nodiflora	Asteraceae	Node weed	Shrub	NA
Sida acuta	Malvaceae	Broom weed	Shrub	NA
Luffa cylindrical	Cucurbitaceae	Sponge gourd	Vine	NA
Dactyloctenium aegyptium	Poaceae	Cow foot grass	Grass	NA
Oryza Sativa	Poaceae	Rice	Herb	NA

Source: EnvAccord Field Survey, 2019; NE= Not Evaluated

IUCN – International Union for Conservation of Nature

Plate 4.3: Some of the flora species observed in the Project area
Source: EnvAccord Field Survey, 2019

4.3.6.2 Fauna Species

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

The fauna species observed at the site were generally few and restricted to small invertebrates such as earthworms, insects, Grasshoppers, Butterflies, spiders. Also, vertebrates such as Lizards, birds and rodents were sighted within the Project site and AoI. Table 4.15 presents a list of some fauna species encountered in the Project area while sample pictures taken are shown in Plate 4.4.

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

Common (Local) Names	Species	Family	Group	IUCN status
Millipede	*Archispirostreptus gigas*	Spirostretidae	Arthropoda	Not evaluated
Black ant	*Lasius niger*	Formicidae	Insecta	Not evaluated
Black Kite	*Muluus migrans*	Accipitridae	Aves	Least concern
Bush fowl	*Francolinus bicalcaratus*	Phasianidae	Aves	Not evaluated
Earthworm	*Lumbricus terrestris*	Acanthodrilidae	Annelida	Not evaluated
Giant African mantis	*Sphodromantis viridis*	Mantidae	Insecta	Not evaluated
Green fruit Pigeon	*Treron australis*	Columbidae	Aves	Least concern

Common (Local) Names	Species	Family	Group	IUCN status
Lizard	*Varanus albigularis*	Varanidae	Reptilia	Not evaluated
Butterfly	*Chlosyne rosita*	Nymphalidae	Insecta	Not evaluated
Soldier ant	*Strongylognathus alboini*	Formicidae	Insecta	Not evaluated
Cattle egret	*Bubulcus ibis*	Ardeidae	Aves	Least Concern
Cattle (cows)	*Bos Taurus*	Bovidae	Mammalia	Least Concern
Housefly	*Musca domestica*	Muscidae	Insecta	Not evaluated
Western Honey bee	*Apis mellifera*	Apidae	Insecta	Data deficient
Red headed Malimbe	*Malimbus rubricollis*	Ploceidae	Aves	Least concern
Bush rat	*Rattus fuscipes*	Muridae	Mammalia	Least concern

Source: EnvAccord Field Survey, 2019; NE= Not Evaluated; LC = Least Concern
IUCN – International Union for Conservation of Nature

Source: EnvAccord Field Survey, 2019

Plate 4.4: Some of the animals sighted in the Project area

4.3.7 Land Use/Land Cover

This section discusses the existing land use / land cover type in the Project area. The land use map (Figure 4.15) was produced from a combination of ground truthing, aerial imagery (LandSat ETM+) and topographical maps covering the Project area. The study covers the land use within the Project site boundary and the wider area area (1km from the Project site).

The land use of the project site is noted to be farming while the wider study area can be categorized in three major classes. The classes are Built-up area, Wetland and farming (Figure 4.16). The estimated area covered by each of the land use types is presented in Table 4.16.

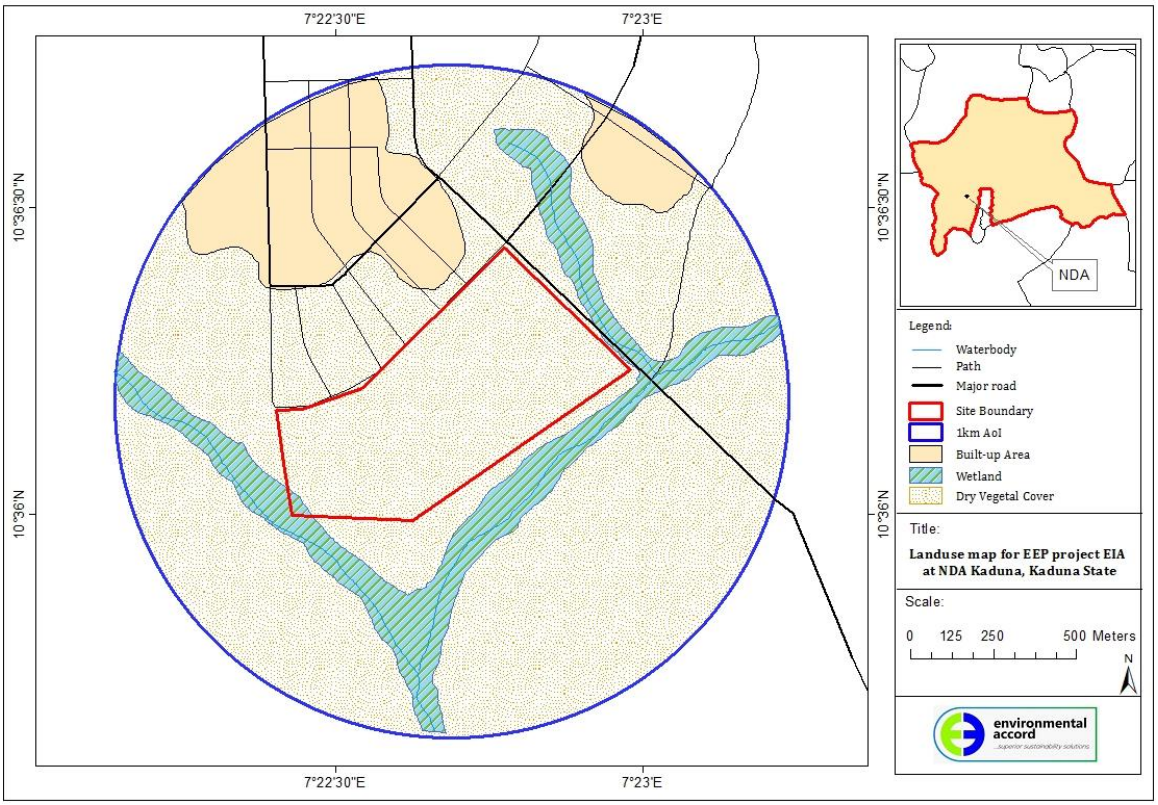


Figure 4.15: Land use map of the Project site and area of influence
Source: EnvAccord GIS. 2019

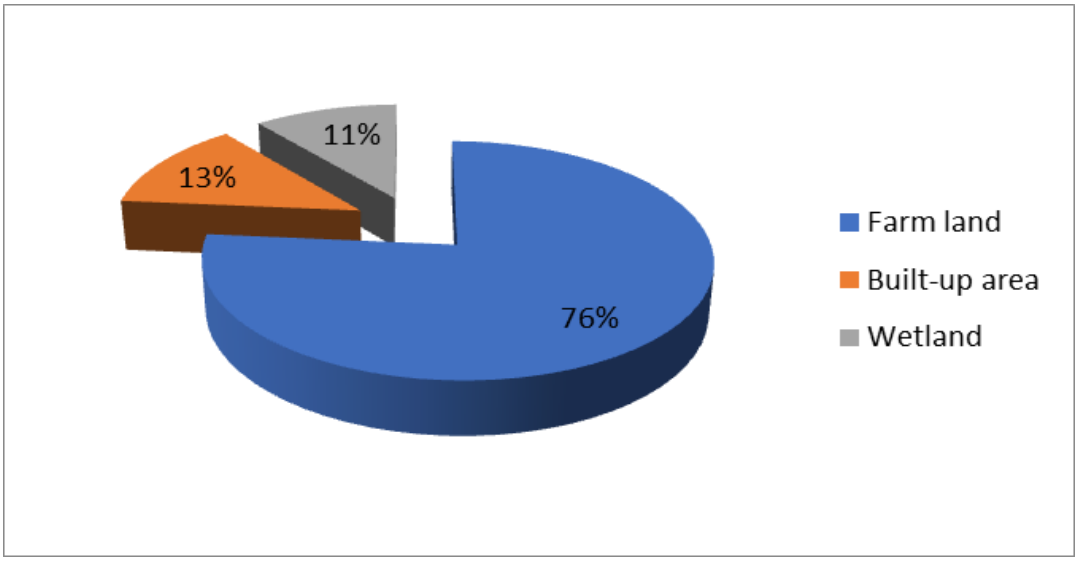


Figure 4.16: Land use composition within the Project area of influence
Source: EnvAccord Field Survey. 2019

Table 4.16: Existing Land Use within the wider area (outside the Project site)

S/N	Land use/ Land cover	Area (ha)	Percentage (%)
1	Farm land	243.6	76.45
2	Built-up area	40.54	12.72
3	Wetland	34.5	10.83
	Total	**318.64**	**100**

Source: EnvAccord Field Survey. 2019

- **Farmland**

The project site and the wider study area constituted several plots of farm land. This class covers about over 80%. Some of the crops planted are maize, millet, rice and vegetables. Among other crops are the root tubers such as cassava and yam.

- **Built-up area**

The major constituent of this class is part of the NDA administrative and residential structures. This covers over 12% of the entire wider study area. The closest residential structures are the living quarters about 200m north of the Project site.

- **Wetland**

Another important class within the wider study area is wetland. It harbours a stream of water and covers approximately 11% of the wider study area.

4.3.8 Traffic Survey

Traffic survey was conducted as part of the ESIA study to understand the traffic nature of the Project's area of influence, including the type of vehicles plying the area, in order to put in place appropriate mitigation measures during the Project development and operation.

4.3.8.1 Survey Methodology and Analysis

There are two (2) sampling techniques for conducting traffic surveys in order to account for the number, movements, and classifications of vehicles at a given location over a period of time. The techniques are manual and automatic counts.

A manual count method was adopted for this survey. The count period for the survey was selected using daily traffic peak periods (7:30 am to 9:00 am and 3:30 pm to 5:00 pm).

4.3.8.2 Selection of Screen Lines

The screen lines for the traffic survey were selected based on the direction of movements that may be impacted during the phases of the Project. As presented in Figure 4.17, two (2) screen lines which were principal routes leading to the Project site, were identified and surveyed.

- *Screen Line 1 (SL1):* to capture the traffic flow from Mando community to NDA second gate. This is the direct road to the project site.

- *Screen Line 2 (SL2):* to capture the traffic flow from NDA second gate to Mando Community.

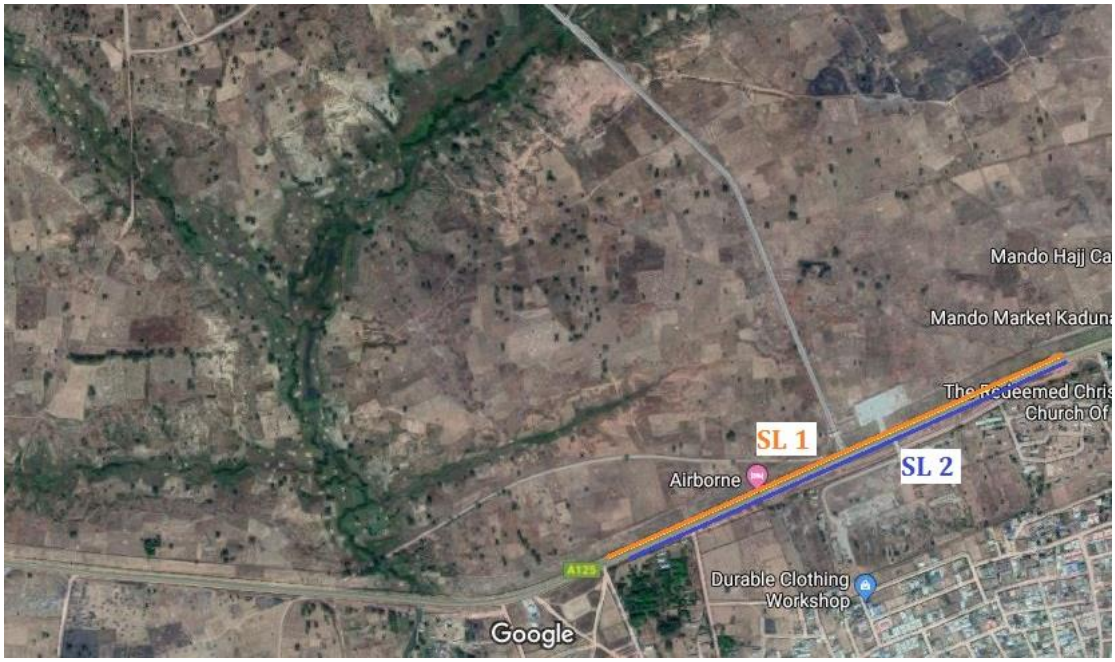


Figure 4.17: Aerial Imagery of the project site showing the screen lines
Source: EnvAccord Field Survey, 2019

The data collected by the traffic survey team were recorded on a traffic survey designed sheets using tally system as shown in Plate 4.5. A stopwatch was used to monitor the count intervals. The vehicle classification schemes used for this survey are presented in Table 4.17 below:

Table 4.17: Vehicle Classification Scheme used for the traffic survey

S/N	Vehicle Classification	Vehicle Types
1.	Trucks/Lorries,	Tankers
		Trucks
		Pick-ups
		Heavy duty vehicles
		Trailers
2.	Buses,	Private buses
		Commercial buses
		Coaster buses
		Mini buses
		Vans
3.	Cars and Sport Utility Vehicles (SUVs),	Cars
		Jeeps
		Space buses
4.	Cycles	Motorcycles
		Bicycles
5.	Tricycles	Three wheeled vehicles

Plate 4.5: Traffic count by field observer in the Project area
Source: EnvAccord Field Survey 2018

4.3.8.3 Results and Discussion

Based on field observation, the prominent means of transportation is motorcycles, followed by cars, while buses/trucks are also relatively abundant. The motorcycles are mainly used for commercial purposes to commute students, staff and visitors. Buses are owned by the University to shuttle students from the University gate to other areas within the campus at a subsidized rate. At SL1, the traffic count reaches its peak between 7:30am and 9:00am when the road experiences heavy traffic flow. At SL2, the traffic count reaches its peak between 4:00pm and 5:30pm. This was as a result of the movement of lecturers, students and non-academic staff back to their homes after working hours. The results from the average count at the screen lines are presented in Figure 4.18 while the percentage composition of vehicles is presented in Figure 4.19.

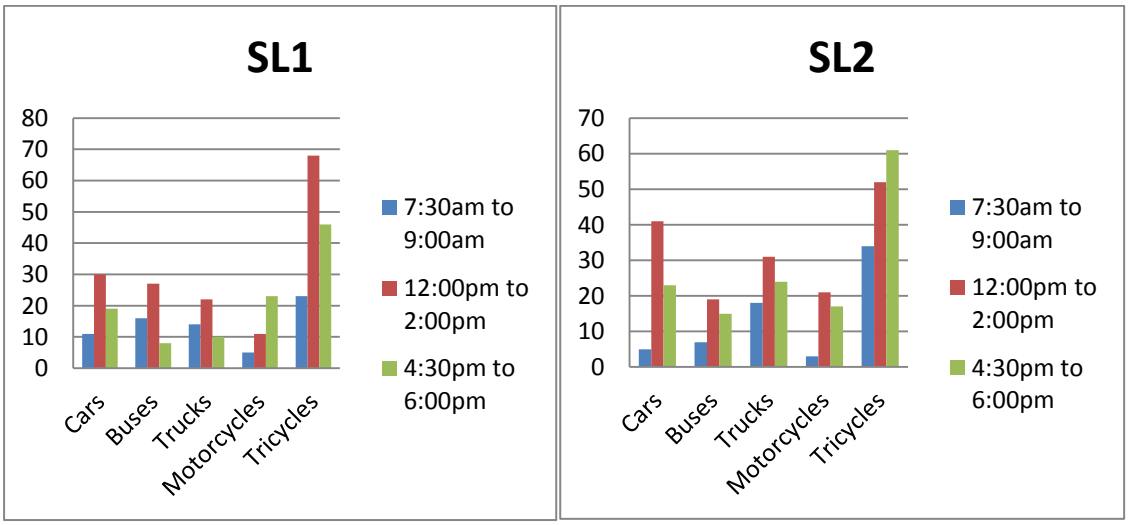


Figure 4.18: Average traffic flow result for the screen lines (SL1 & SL2)
Source: EnvAccord Field Survey, 2018

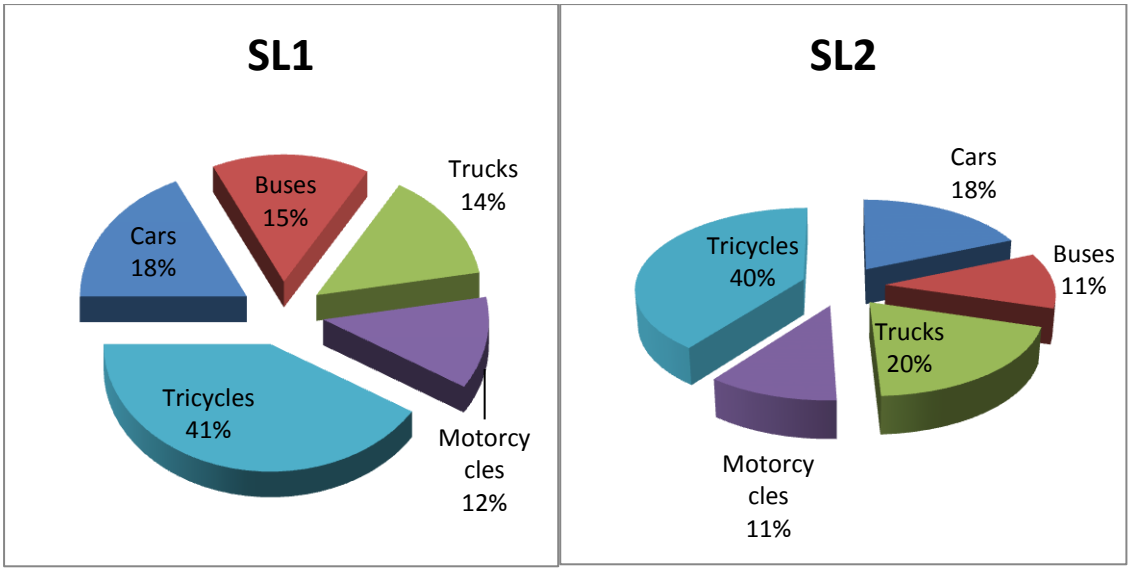


Figure 4.19: Percentage composition of vehicles for the screen lines (SL1 & SL2)
Source: EnvAccord Field Survey, 2018

The traffic nature of the studied area is generally busy and there were no traffic signs and signals installed along the route to the proposed project site. The most commonly used transport means are motorcycles due to the flexibility of their route.

Additional traffic which might result from the Project activities is therefore envisaged to have a negligible impact on the traffic situation in the Project area as further discussed in Chapter 5.

4.4 Description of Socio-economic Environment of the Project Area

4.4.1 Introduction

The proposed Project will be sited within the NDA campus in Igabi Local Government Area of Kaduna State. There is no local community within the Project site. However, the identified community within the 3km radius of the Project site considered for the ESIA study is Mando Community, Afuka District in Igabi LGA of Kaduna State. This section thus provides baseline information on the socio-economic and health survey conducted in the community.

4.4.2 Study Approach and Methodology

4.4.2.1 Study Area

The study was conducted in the village of Mando in the district of Afuka, Igabi Local Government Area of Kaduna State. This Village is directly opposite the Nigeria Defense Academy. Igabi Local Government Area of Kaduna State was created out of Zaria Local Government in 1989 with its headquarters at Turunku, located in the northern part of the state.

Igabi Local Government covers a land area of approximately 3,727km^2 and shares boundaries with Kaduna North, Kaduna South, Zaria, Kajuru, Kauru, and Birnin-Gwari Local Government Councils. The majority of the populations are predominantly Muslim.

4.4.2.2 Study Population

The target populations for the study are Federal Low-Cost community residents who are above the age of 18 years. This study also considered community heads (often referred to as ward head), healthcare practitioners, youths and women.

4.4.2.3 Study Design

The study employed a sequential mixed methods research design using quantitative and qualitative methods of data gathering, analysis, and reporting. Information obtained during the study was investigated to separate perception from reality and to check for information consistency, reliability, and validity. The study was carried out from August 5 to 6, 2019. The study employed questionnaire administration for quantitative data gathering; while Key Informant Interview (KII), Focus Group Discussions (FGD) and stakeholders' consultation were used for the qualitative data gathering.

4.4.2.4 Sample Size and Sampling Techniques

The study population is largely homogenous with respect to ethnicity and language. The community does not have a large population. The sample size was calculated using the Cochran Formula.

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

Where n is the sample size

p is the estimate of the proportion of interest (i.e. 0.29)

q is 1 – p (i.e. 0.71)

e is the desired level of precision (i.e. 0.07)

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

n = 180

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

For the qualitative data, Focus Group Discussions (FGDs) were conducted (2 male groups, 1 female group) making a total of 3 FGDs. Each FGD includes a minimum of 6 and maximum of 15 participants. Different categories of respondents including

youths, adults, males, females, people living with disabilities, educated and non-educated etc. were included in each FGD session. Key informant interviews were held with the local chief i.e. Village leaders and in-depth interview was held with healthcare practitioner who has been in the Village for more ten (10) years.

Data Collection, Analysis and Reporting

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

The Socio-Economic Baseline Report Structure

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

- Overview of key socio-economic indicators
- Demographic Profile;
- Administrative and socio-cultural institutions
- Livelihood Assets and Activities
- Infrastructure and Services
- Housing Structures
- The Living Environment
- Land Acquisition
- Health Profile
- Village Concerns and Perceptions
- Stakeholders' Consultation

Demographic Profile of the Study Area

- *Population Distribution*

The proposed project is situated in Igabi LGA of Kaduna State. Kaduna State is located in the North-west geo political zone of Nigeria. The capital city of the state is Kaduna. The main urban areas in Kaduna state are Kaduna city, Zaria and Kafanchan. Over 60 ethnic groups made up the State such as the Gbayi, Hausa, Fulani, Gwong, Atuku, Bajju, Atyab, Gure and Ninkyop among others. Kaduna State is one of the major economic hubs of the Northern region, a trade centre and transportation axis to nearby agricultural areas and states.

According to the National Population Commission, the 2006 census puts the population of the State at 6, 113, 503 people. Additionally, the Housing Census of the same year stated that Kaduna is made of 3, 090, 438 males and 3, 023, 065 females. Kaduna is today the fifth largest city in Nigeria behind Lagos, Kano, Ibadan and Abuja in descending order. The National Bureau of Statistics (NBS) put the annual population growth rate at 3.2%, therefore Kaduna state has a 2019

population projection estimate of 9,285,923. The age distribution within Kaduna State is skewed towards young people; 51% are within the age group of 15-64 years and 46.16% are within the age group of 0-14 years.

Igabi LGA occupies a land size of 3,727km^2 and population density of 156km^2 (NBS, 2016). Using the Nigeria population growth rate of 3.2% (NBS, 2018), the local government has approximately 654, 279 people; 50.5% of the population being male and 49.5% being female.

- *Culture, Ethnicity and Religion*

Nigeria is a multi-ethnic nation-state with diverse socio-cultural differences among its component ethnic groups all of which have resulted into cultural dissimilarities. These cultural dissimilarities have been manifested by the differences in culture which may include language, diet, dress and type of social system. Nigeria has over 250 ethnic groups; the most populous and politically influential are: Hausa and the Fulani 29%, Yoruba 21%, Igbo (Ibo) 18%, Ijaw 10%, Kanuri 4%, Ibibio 3.5%, Tiv 2.5% and others 12% (CIA World Factbook, 2018).

There are over 500 indigenous languages spoken in Nigeria but the most populous ones are Igbo (Ibo), Hausa and Yoruba. English is the official spoken language in Nigeria. The most predominant religion in Nigeria is Christianity and Islam although there are also few traditional worshippers and atheist. In 2016, Havard Religious Literacy Project suggested that half of the Nigeria population is Muslim while 40-45% are Christians and 5-10% practice the indigenous religious traditions. However, 2018 NDHS reported that 10.4% of Nigerians are Catholic while 35.6% are Other Christians; 53.5% are Muslims and 0.3% are traditionalist.

Kaduna is a diverse society with different people engaging in various forms of festivals ranging from the religion festival, cultural, social and entertainment. Other ceremonies like marriage, chieftaincy installation, are common in Kaduna. Religious festivals are quite common, Christmas celebration by the Christians in the Village and Muslims celebrating Id-el Fitri and Id-el Kabir.

There are several ethnic group in Kaduna; Fulani, Hausa, Tiv, Igbo, Yoruba, Sayawa, Gwarri, Igala, Bende among others. The major religions are Christianity and Islam. There has been no recent report of religious crisis in Mando Village in the last one (1) year.

In the study area, the survey data of the sampled respondents revealed that there are 109 Muslim respondents (54.50%) and 91 Christians respondents (45.50%). The survey enumerators observed and noticed during the interview with the Village stakeholders such village head, youth leader and healthcare practitioners that the village is heterogeneous. There are people from almost every region of the

country who reside in the village. Therefore, the village is a multiethnic environment in which different people are welcomed. The survey data shows that 42% of the sampled respondents Hausa, 27.79% of Gwarri tribe, 20.50% are Yoruba people and 1.50% of people of Fulani tribe. However, there are about 36% of the respondents who belong to other ethnic group such as Bende (5.56%), Fantsuam (5.56%), Igala (16.67%), Igere (5.56%), Tiv (5.56%).

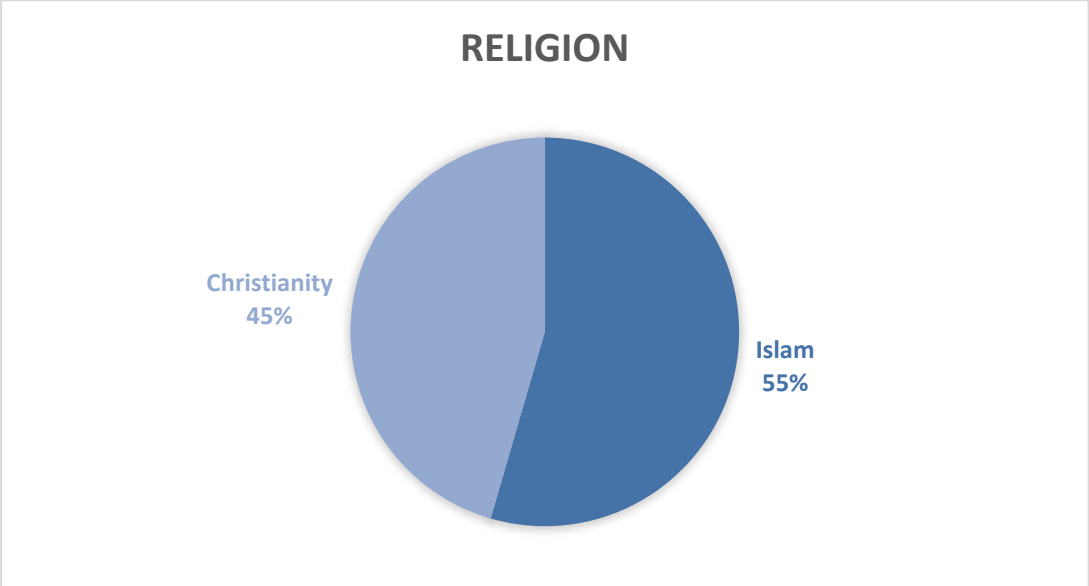


Figure 4.20: distribution of religion among the respondents.

- *Village Migration Status and Patterns*

There is historical migration into the study area. From the qualitative data gathered and responses from Village stakeholders, it was observed that some of the migrants in the Village came from neighbouring towns and cities within Kaduna State. As discussed with the village head during the key informant interview, communal clashes and religion extremism conflicts are parts of the reason people move from one area of Kaduna to another, especially into Mando village. The Village has been peaceful because of the influence of the National Defense Academy situated directly opposite the village. People of different ethnic group, culture and religion migrate into the village for security purposes.

Plate 4.6: Questionnaire administration around the community

Plate 4.7: FGDs with youths and men in Mando community

Plate 4.8: Interview with health matron and a member of the community

- *Crime, Security and Safety*

During the interview with the Village leader, it was expressly stated by the village head that Mando village is peaceful and without any fear of theft and conflict. This was however accorded to the influence of Nigeria Defense Academy close to the village and number of staff in the academy who live within the village. There is harmonious relationship between the village leaders and NDA because the academy has exercised there cooperate social responsibility for the people in the village by showing support whenever there is a security challenges in the village.

Gender Issues in Population, Education, Health and Livelihood Activities

Gender issues are central to the attainment of development goals and poverty reduction and they play prominent role in the Sustainable Development Goals, which have been commonly accepted as a framework for measuring development progress.

Plate 4.9: Focus group discussions held with women and men in the community

- *Role of Women*

Women are engaged in domestic home keeping duties such as care for children and husband. They also get involved in petty trading like; making of soaps, cream, tailoring, home petty trading such as sales of zobo drink and pure water. They are also involved in rearing of livestock like layers and broilers to support the family. Women are allowed to inherit property and can also own land in the community.

- *Major Challenges Faced By Women*

The major challenge to health is the inadequacy of the health infrastructures and imbalance doctor to patient ratio. The major financial challenge they reported was the limited funds to grow their business. Also, they had experienced cases of insecurity in the past such as kidnapping and robbery but it has reduced.

- *Women Representation In Leadership*

They have the women leader who is part of the leadership council of the community. The women are organized in such a way that they can reach out to the community leader to make complaints and requests. The Village has diverse association for women such as**;** Afonka Unity Assembly (Aya), Gbayi Association, Garukuwa Association and many more. Each ethnic group represented in the village as its association. Women are not limited in social participation.

- *Autonomy of Decision Making*

Decision making regarding the general public cannot be made without consulting the "Seriki", the village head. However, individual level decisions can be made independently. No major cultural taboo and limitation for women were reported within the community.

- *Major Grievances From The Women*

The major grievances from women in Mando Village are evident in their lamentation for empowerment for women to raise capital for their businesses, sustainable power supply and need for good roads. Also the women expressed their grievance for the low quality education. A large proportion of the population

fall within the low income group and incapacitated in enrolling their children in private schools, they expressed their grievance for the poor quality of education in government schools and emphasized the need for an upgrade so their children will have access to quality education like those in private schools. The government schools are not well equipped, no chairs, inadequate classrooms and imbalance student to teacher ratio.

- *Gender Based Violence*

According to Nigeria Demographic and Health Survey, the percentage of women who have experienced physical, sexual, or emotional violence committed by their current or most recent husband/partner in Kaduna State was 59.4% which is high compared to some other states in Nigeria (Nigeria DHS, 2018).

However, Mando village has varying ethnic groups which is a pointer to some level of civilization within the Village hence, cases of gender based violence are minimal and the established measures of resolving such cases is through the intervention of the Village leaders or Police. The GBV response center closest to the community is located at Mando primary health care center.

Also, the village elders referred to awareness programs recently conducted by a civil society organization in the community. They program served to sensitize both men and women on the causes, impact, and effect of gender based violence. The village leaders stated that any man found in the act of hurting women would be reported to the police. They also added that the time of the survey, no GBV incidents had been reported in the community.

Vulnerable or Marginalized Groups

Vulnerability is the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard (IFC, 2012). In the context of this report, vulnerable groups are groups who by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage or social status may be more adversely affected by a project than others. They may include people who are limited in their ability to take advantage of a project's development benefits.

Vulnerable groups within the Village were found to be elderly men and women. This classification is by virtue of their economic vulnerability based on dependency. The elderly women depend on their husbands, who often are not economically buoyant while the elderly men are often farmers with depleting strength, many of whom also depend on the remittances from their children to survive. However, none of the vulnerable groups identified during study have direct links or derive benefits from the proposed Project site

Host Community Profile

Mando Village is the host community for Nigeria Defense Academy.

Box 4.1: Overview of the Project AoI – Demographic Profile

- **The village of Mando is relatively heterogeneous in terms of ethnicity and language.**
- **Islam is the most prevalent religions in the village.**
- **The housing pattern in the Village is nucleated, with cement block and aluminums roofing sheets**
- **Land is owned by individual and can be leased, gifted and sold.**
- **Trading is the common livelihood activities in the Village**

Mando Village: Is a rural village in Afaku district of Igabi LGA with an estimated population of about 4,000 residents. The Village is nucleated and has several untarred roads connecting one area of the village to another. The common housing structures are bungalow and tenement houses. The village has its own existing central market where varieties of agricultural products are being sold, including the meats.

During the baseline survey, 62% of the respondents were males while 38% were females representing 129 males and 71 females among the respondents. It was however observed that there is a smooth relationship between the genders and no socio-cultural belief and attitude that may affect the interaction and relationship between them. It was observed that the dressing pattern among many women in the village is religiously influenced. Several women wore their hijab in different colours while many of the men are in their common regalia, trousers and "*jalabia*"

The survey analysis result shows that the average household size in the study Village is 7.5 persons, meaning that each sample household has about eight (8) people living in it. There are males, averaging 4.3 per household and females, averaging 3.7 per household. The Village has an economically active and youthful population 40% are with the age group of 18 – 30 years, 42.50% are within the age group of 31 – 45 years, 9.50% are within the age of 46 – 65 and 8% of the sampled respondents are 65 years old and above.

Further analysis of the baseline data shows the age distribution among the gender, while 55% of respondents within the age group of 18-30 years are male, 45% are female. The male respondents within the age group of 31-45 years are 67.06% while 32.94% are of female gender. The male respondents within the age group of 46-65 are 78.95% and female being 21.05%. There is a share of percentage among the gender for respondents above 65 years of age; 50% of male and female respondents within this age group. It is apparent from the data that more men appear during the baseline data gathering than women. In addition, the survey

enumerators observed that the appearance of men in the village is common, i.e. men can be seen in virtually every corner of the village while women activities and social engagement are often purposeful, they can be seen trading in the market, attending to their business on the street of the village.

The survey data shows that education is very important to the people of Mando village. Respondents with no education are 16% of the total sampled respondents, representing 32 people within the village. Those who have attained primary school level of education and could not further their education are just 4%. A large percentage (58%) of respondents have attained senior secondary school level of education and 16% have tertiary education, from polytechnic, colleges of education and universities. There are 5.50% of the respondents who have acquired some vocational training that served as their educational attainment.

Further analysis of the data to show the level of education among female respondents revealed that 44.83% of the women who were interviewed and responded to the questionnaire distributed have attained senior secondary school education, 24.24% have attained tertiary education be it colleges of education or universities. When compared with men who responded to the questionnaire distributed, it was evident that men are more educated than women in the village, 55.17% have attained senior secondary school education and 75.76% have attained tertiary education.

Economic engagement in the village is skewed towards self-employment, with 65% of respondents stating that they are gainfully employed within their own business. The self-employment was observed in the village to be artisanship, trading of goods in the market and in the front of their houses, offering of services like barbing and salons, bike hailing services, taxi driving, tailoring among other activities. 7.50% of the respondents recognised themselves as students, many of which are students who resides in the Village. 4% are farmers, although none of them have their farm land on the proposed project site. 8% are not employed, but they are economically active and seeking for gainful employment while 15.50% of the respondents are gainfully employed either in public service or private enterprise.

Administrative and Socio-Cultural Institutions

- *Government Institutions*

Nigeria is made up of 36 states and one Federal Capital Territory (FCT). Each of the states is subdivided into smaller administrative units called Local Government Areas (LGAs). There is a total of 774 LGAs in Nigeria. It has a mixed legal system of English Common law, Islamic law and traditional law.

Igabi LGA is divided into 12 political Wards namely – Igabi, Turunku, Panshanu, Kwarau, Birnin Yero, Zangon Aya, Kerawa, Sabon Birnin Daji, Afaka, RigaIgabi, Rigasa and Gwaraji ward respectively. There are also 14 traditional districts in the LGA each headed by a District Head who is under the Zazzau Emirate Council. These are: Rigasa, Rigachukun, Turunku, Igabi, Zangon Aya, Kwarau, Jaji, Gwada, Pansahnu, Afuka, Gwaraji, Kerawa, Sabon Birni, and Farakwai. These district are complemented by 322 villages and Village Heads within the Local Government.

With respect to the proposed project, relevant government ministries and Non-Governmental Organisation (NGO) in Kaduna have been consulted, which include:

- Kaduna State Environmental Protection Authority
- Kaduna State Ministry of Environment
- Empowering Women For Excellence Imitative

- *Traditional Leadership Patterns and Representations*

Traditional leadership remains a strong and respected structure in Kaduna State, just like many other States in Nigeria. The powers of traditional leaders are still much relevant in modern times, the respect and ceremony that surround these positions remain strong, and also these leaders retain significant influence over their people.

The district of Afuka is headed by the district head who is responsible to Zazzau Emirate Council. Mando is a village within the district of Afuka and headed by the Seriki, Alhaji Musa Sanni who inherited the position from his father. The Seriki spearheaded the council of chiefs within the village popularly called Magwa. Power and authority is hierarchically structured as the Magwa is directly responsible to the Seriki, while the Seriki is directly responsible to the district head. The position of Seriki is lifetime. Alhaji Musa Sanni is widely respected by the village elders and members because of his leadership qualities and elderliness. He is assisted by the Magwas who are also respected members of the village. They assisted in overseeing the day to day administration of the village.

Plate 4.10: (A) Palace of the Seriki of Mando village (B) KII with the Seriki

The village leader ensures that everybody is well-represented in the decision-making process, although women are not represented among the council of chiefs. However, women have the freedom to form association, make decisions among themselves and elect leaders within the association jurisdiction.

- *Village-based Organizations and Other Local Institutions*

Village groups are an important source of social capital in Nigeria, providing social, livelihood, financial and religious support. Most communities in the country typically have a variety of associations, including livelihood-based groups, saving groups, religious groups and other Village-based organizations that play an important role in the management of the Village. There is open membership opportunity in most of these groups, and there is the possibility of people belonging to more than one group. However, groups such as Elders Forums and Traditional Cultural Groups have restricted participation.

Plate 4.11: Security organization within the Community

Within the study area, the most common groups are Association of the Youths, Traders Association, Women Groups and the village security group, known as JTF.

- *Social Conflict*

The village leader stated with confidence during the interaction with the survey team that there is no recent record of conflict in the village. In cases of dispute that cannot be resolved within the household, the village chiefs, the Magwas interfere and handle the situation. When a conflict cannot be resolve with their jurisdiction, the move it to the council of chief meeting with the Seriki to resolve the issue. However, when the situation is more than what the district can handle, the district

head will be called to see to the situation. The power command in Mando village also helps in handling cases that are civil.

Livelihood Assets and Activities (Economics, Livelihoods, and Employment)

- **Key Livelihoods**

Nigeria is Africa's largest economy, but currently struggling due to the global fall in the price of oil, the country's main source of foreign exchange earnings and government financing. Therefore, growth expectations for the economy have continued to deteriorate as a result of falling oil price. The Gross Domestic Product (GDP) in Nigeria expanded 2.85 percent in the second quarter of 2019 over the previous quarter. GDP Growth Rate in Nigeria averaged 1.04 percent from 2010 until 2019, reaching an all-time high of 10.59 percent in the third quarter of 2010 and a record low of -13.97 percent in the first quarter of 2016 (Trading Economic, "Nigeria GDP Growth Rate", 2019).

Nigeria's Labour Force Participation Rate dropped to 55.2 % in Dec 2018, compared with 55.2 % in the previous year. Nigeria's Labour Force Participation Rate is updated yearly, available from Dec 1990 to Dec 2018, with an average rate of 55.1 %. The data reached the all-time high of 55.9 % in Dec 1990 and a record low of 54.7 % in Dec 2004 (World Bank, 2019).

Agriculture is the largest economic sector nationally, employing approximately 70% of the labour force as of 1999. Key products include cocoa, peanuts, cotton, palm oil, rubber, maize and rice. Industry accounts for 10% and other services 20% (CIA World Factbook, 2011).

There is no data to show the proportion of its inhabitants that are living below or above poverty line. However, there is a perceived high level of unemployment, incidence of diseases and food insecurity. This situation could be attributed to low level of agricultural production, due to subsistence farming and non-irrigation farming, as well as, lack of economic diversification.

Box 4.2: Overview of the Project AoI – Key assets and livelihood

- **The principal economic activity in the village is trading.**
- **There is a central market within the Village**
- **Traders mostly sell goods such as farm produce, cooked food and other items such foodstuffs**
- **Self-employment is the common livelihood activities in the Village.**
- **There are several service providers such as salons, tailors, taxi driving, among others.**

Livelihood Assets of the Host Community

Farming

Farming is one of primary occupation of some residents in the village. This farming is done mostly by men along with their family members. However, some women were found the on the proposed project farm land inside the NDA. Notably crops plants by the farmers are corn, beans, wheat, garden egg, maize, melon, water melon, among others. Animal rearing and husbandry is also a notably agricultural activity in the Village. Cows, goat, rams, sheep and fowls are common animal being reared. They either sell their farm produce or consume them with their family. There are village members who have their agricultural land with the village but the villagers do not have farms within the Project site.

However, the discussion held with the farmers on the proposed Project site revealed that the farmland does not permanently belong to them; they obtained permission to use the land from the management of the Nigeria Defense Academy.

The farmers use crude tools, and some were observed to use cattle for ploughing the land. During the survey, some of the farmers were interviewed. They stated that their activities were for subsistence purposes and they do not sell their crops in the market. They cultivate crops such as maize, groundnut, vegetables, rice, etc.

Trading

The exchange of goods and services is very popular in the village. This exchange occurs almost in every corner, from the front house kiosk to the main market and the street as people were observed hawking different products. This activity is not gender specific as both men and women were found selling and buying in the goods market and around the Village. The street hawking is common among the children, as there are individuals of young age carrying trays of different products on their heads and calling potential buyers. Trading activities begin very early in the morning and close late in the night. Some common products found in the markets are vegetables, meats, peppers and other food supplements, clothes; and services like tailoring, barbing, hairdressing salons. From the survey data, 42.50% of the respondents are traders and 36% are artisans, such as tailors, barbers and hairdressers.

Plate 4.12: Trading activities ongoing in Mando market

Formal Employment

Aside for the number of Nigeria Defense Academy staff who reside in the village, there are few people who are working actively in the formal sector. The village has government schools, private schools and police station. 11.50% of the respondents are corporate workers, 4% are civil/public service.

Income Levels and Poverty

The survey data reveals the income differences in the study area. Respondents were allowed to provide an estimate of their income per month in their respective livelihood activities. 30.99% of the respondents earn below N10, 000 per month, 66.20% of respondents earn between N10, 000 – N50, 000 and 2.82% earn more than N100, 000 per month.

The survey data further analysed to show the distribution of income among the gender. It was evident that men earn more than women in the Village. There are 70.21% of men in the Village who earn between N10, 000 – N50, 000 while only 29.79% of women earn such income. There are 63.64% of women who earn less than N10, 000 per month while 36.36% of men earn such income. 100% of who those who earn N100, 000 per month are men. However, it is should be noted as a factor that there are more male respondents than female in the sample survey.

Infrastructure and Services

Box 4.3: Overview of the Project AoI – Infrastructure and Services

- **Social infrastructure in the Village is on average. The internal road networks are neither paved nor tarred.**
- **There are government hospital, private hospital and pharmaceutical outlets.**
- **The Village has existing market accessible for members and non-members**
- **The village has primary and secondary school both for public and private.**

- *Access to Electricity*

The village was provided with transformers, cables, poles and sub-station equipment to enable them to connect to the national grid. However, the village has outgrown the installed capacity of power facilities provided for them such as transformers and sub-stations as discussed during the interview with the village members and their leaders. Their displeasure on the instability of the power supply was made known and that it has been a huge challenge as businesses in the village rely on alternative source of electricity through generators.

Sources of power and access to electricity vary within the village. The survey data revealed that 100% of respondents have access to the national electricity or are connected to the national grid. However, due to the epileptic nature of power supply, some of them use generator as an alternative source of power.

Plate 4.13: Generator as alternative source of electricity found in the village

- *Access to Water*

Both public and private boreholes, including wells were found in the village by the survey enumerators. There is high proportion of people who have access to water. The survey data revealed that 42% of the respondents depend on hand-dug well as their source of water supply; 21.50% depend on public water supply – government stationed some tab water and boreholes in some strategic places in the village while 30.50% of respondents depend on their privately owned boreholes. There are also members of the village who have access to more than one sources of water, especially who have hand-dug well water and can also access other available sources of water such as boreholes in neighbor's houses or buy from water vendors.

Plate 4.14: Water facilities found within the community

Plate 4.15: Different sources of water available in Mando community

- *Telecommunication, Transportation and Road Infrastructure*

The Village have access to all the available mobile telecommunication networks in Nigeria such as MTN, Airtel, Glo and 9mobile. This makes it quite easy to communicate socially and also carry out business transactions within any part of the village.

Plate 4.16: Internal roads within the Mando community

Plate 4.17: Transportation forms in the study area

Plate 4.18: Telecommunication masts and school observed in the community

The common forms of transportation in the study area are commercial buses, cars, motorcycles, tricycles and bicycles. The road networks linking into the village are tarred but the internal roads are neither paved nor tarred. The roads are less busy with a width of less than 10m.

- *Access to Education*

Given the standard Pupil-Teacher ratio of 1:45, Igabi Local Government Area has an estimated number of 286 public primary schools with total enrolment of about 219,188 Pupils and 1,827 Teachers (ASC, 2015/2016). The ratio of Pupils to Teacher is put at 1:120. This revealed that the ratio is above the standard threshold with 75 pupils for each Teacher in Local Government. Taking the ratio of total population of Pupils aged 6-11 (181,655) in the LGA and Teachers (1,827) shows a ratio of 1:99 pupils. This shows seventy (75) additional pupils over and above the standard threshold for the Teachers (Igabi Local Government Development Plan, 2018).

Literacy level in the village is above average with 58% of respondents have attained secondary school education, 16.50% attained tertiary education and 5.50% acquired vocational training as basic education acquisition, 4% attained

primary school education and 16% of the respondents have no education. A gender analysis of the survey data revealed that education uptake among the women in the Village is encouraging as all respondents who attained primary school education are female, 44.83% of those who attained secondary school education are also female, and 24.24% of those who have attained tertiary education are female. Male respondents (75.76%) have attained tertiary education while 55.17% have attained secondary school education. It is apparent that there is a gap in education acquisition between the two genders as men have acquired education at high level than female.

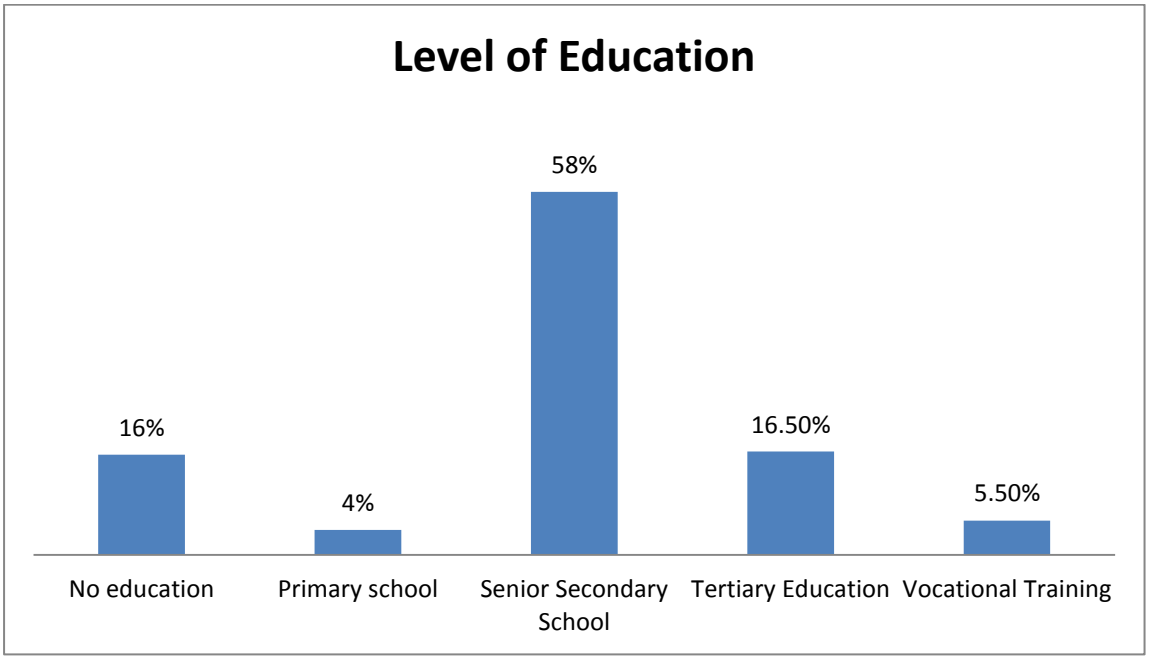


Figure 4.21: Chart showing the level of education among respondents in the study area

- *Recreation*

The field survey enumerators observed that the Village members also congregate at different points within the Village to play local games. The young and old adults make use of viewing centres to watch football match English Football Association (FA) League and other European football competition.

Plate 4.19: Recreation (board games) and leisure activities (sport betting) within the community

- *Housing / Settlement Patterns*

The houses in Mando community are arranged in nucleated settlement patterns. They have well laid streets containing tenement houses built with concrete blocks and cements; there are family bungalows and block of flats. The survey data revealed that 53% of houses occupied by the sampled respondents are tenement houses, 35.50% are blocks of flats and 11.50% are single family bungalow. All these houses are built with either cements blocks or mud. From the survey data, 76% of respondents' houses are built with cement while 24% respondents' houses are built with mud. Cement block houses are generally solid and durable.

The common roofing sheets are aluminum, asbestos, corrugated iron sheets and wood. The survey data shows that 10 % of respondents have houses that are roofed with aluminum; 13% have houses roofed with asbestos while 77% have houses with corrugated iron sheets. The plastering material of most houses is cement.

The use of toilet in an environment can give the impression of cleanliness among the people. In the study area of Mando village, respondents who are using water closets and pit latrine as their toilets are 48% and 50% respectively while 2% are using pail system and bush respectively.

Plate 4.20: Housing and business structures observed in the community

Land Acquisition

- Land Ownership, Tenure and Use

In the study area, lands are owned by individuals and families. It can be bought, sold and leased. Indigenes and non-indigenes alike in the communities can own a piece of land and erect structures or put to any use of their choice as long as they are able to fulfil the transaction obligations with the family owner or Village. Rights over lands within a family are handed down from one generation to another. Village land acquisition is preferred that the village elders starting from the Magwa to Seriki should be involve to determine the genuineness of land ownership. The discussion held with the villahe head, Alhaji Musa Sanni revealed that the approval of land purchase must pass through the Magwa, Seriki and the District head.

The proposed land meant for the project site is within the National Defence Academy campus. The land is an agrarian land currently used for agricultural purposes.

Project Affected Persons (PAPs)

Project affected persons are the people whose activities may be directly or indirectly affected by the proposed Project. Such people include farmers that may temporarily cultivate on the Project site or those who navigate the access road beside the Project site leading to their farmland. During the FGD sessions with men and women in the communities, it was discovered that no member of the community engage in farming activities on the proposed Project site as their means of livelihood.

However, the PAPs identified for the Project are the NDA staff and their families who engage in farming activities on the proposed project site. However, the farmers stated that the farming activities are not their major source of income and they do not sell their crops for income.

Health Profile

Box 4.4: Highlight of the Village Health Profile

- **Household survey data indicated that majority of the residents have good health**
- **Malaria, Typhoid, Headaches, Stomach pain are the identified health challenges in the village.**
- **Most of the residents in the Village make use of public and private healthcare facilities and pharmaceutical outlets**
- **Majority of the population have access to medical care.**

Mando village has both private and public health care facilities; a primary health care is situated close to the market area in the village while private healthcare facilities are within the village. There are several private hospitals and clinics around the village and many pharmaceutical outlets managed by respective personnel who live around the village.

From the discussion held with the health matron at a private clinic in the village, it was revealed that there are more than five (5) healthcare facilities in the village of Mando including public hospital, private hospital and pharmaceutical outlets. The matron of Amazing Grace Clinic and Maternity, Matron Saadatu Ibrahim mentioned that malaria and Anemia are serious issues within the issues, she furthered that there is a lack of vitamin in food consumptions among the villagers. The clinic also serves as maternity health for nursing mothers. The choice of health services being used by the members of the village is defined by individual economic ability.

Access to health care facilities and personnel in the village is quite encouraging based on the survey data. The percentage of respondents who can access to medical facilities such as pharmaceutical outlets, private clinic and public hospital at their convenience is 98.50% while a smaller percentage 1.50% representing three (3) respondents cannot access healthcare facilities. 27.41% of the sampled respondents make use of government owned healthcare facilities such as the primary healthcare in the village, 28.93% make use of the pharmaceutical outlets and 43.65% make use of private healthcare facilities in the last three (3) months. Respondents make use of health care facility in different ways and there are many contributing factors to this, such factors can be the cost of medical bills, availability and attitudes.

Plate 4.21: Healthcare facilities found in the study area

The income level of respondents was compared with healthcare facilities usage, the data revealed that 100% of those who made use of government owned health facilities are people whose income level are between N10, 000 – N50, 000. 70% are those whose income are between less than N10, 000 per mouth often make use of pharmacy anytime they feel sick. The people who make use of private hospital, 50.70% of them are earning above N100, 000 per month, 49.30% are earning between N10, 000 and – N50, 000.

The health status of respondents is quite encouraging with the data showing that 83.10% agreed that they have good health, 16.90% rated their health excellent, and they hardly get sick. The survey data further revealed that 63% of respondents never had any reason to consult or visit any healthcare facilities while 31% have one or two times in the last three (3) months, and 6% have visit health care centre three to four times in the last three (3) months.

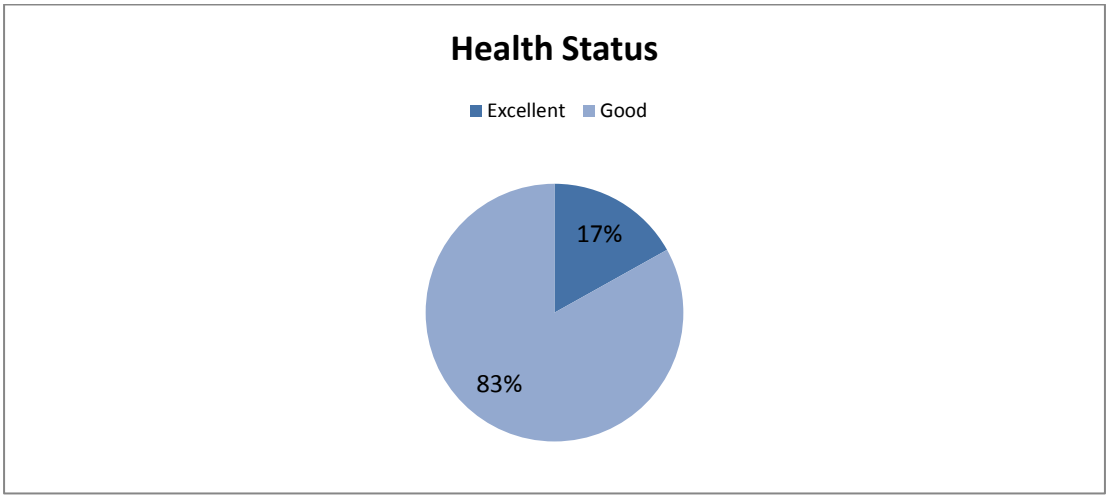


Figure 4.22: Showing distribution of respondent's general health status

Community Concerns and Perception

The survey data revealed that none of the respondents were aware of the proposed Project until the survey team explained the Project in detail to the community leader and members. During the discussion with the men, youths and

women, the Project components and associated impacts were carefully explained. The reaction was positive as the participants believe that there is an impending economic advantage for them in terms of temporary jobs on site during construction.

CHAPTER FIVE:

ASSOCIATED AND POTENTIAL IMPACTS

CHAPTER FIVE

ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

This chapter presents the potential environmental and social (E&S) impacts and risks associated with the proposed 2.5 MW solar-hybrid power plant and associated infrastructure in the Nigerian Defence Academy (NDA) Kaduna, Kaduna State, under the Federal Government's Energizing Education Programme (EEP), a component of the Nigeria Electrification Project (NEP). It also includes the methodology employed to assess the significance of the E&S impacts and risks.

5.2 Impact Assessment Overview

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

The primary objectives of the impact assessment process are to:

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

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

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

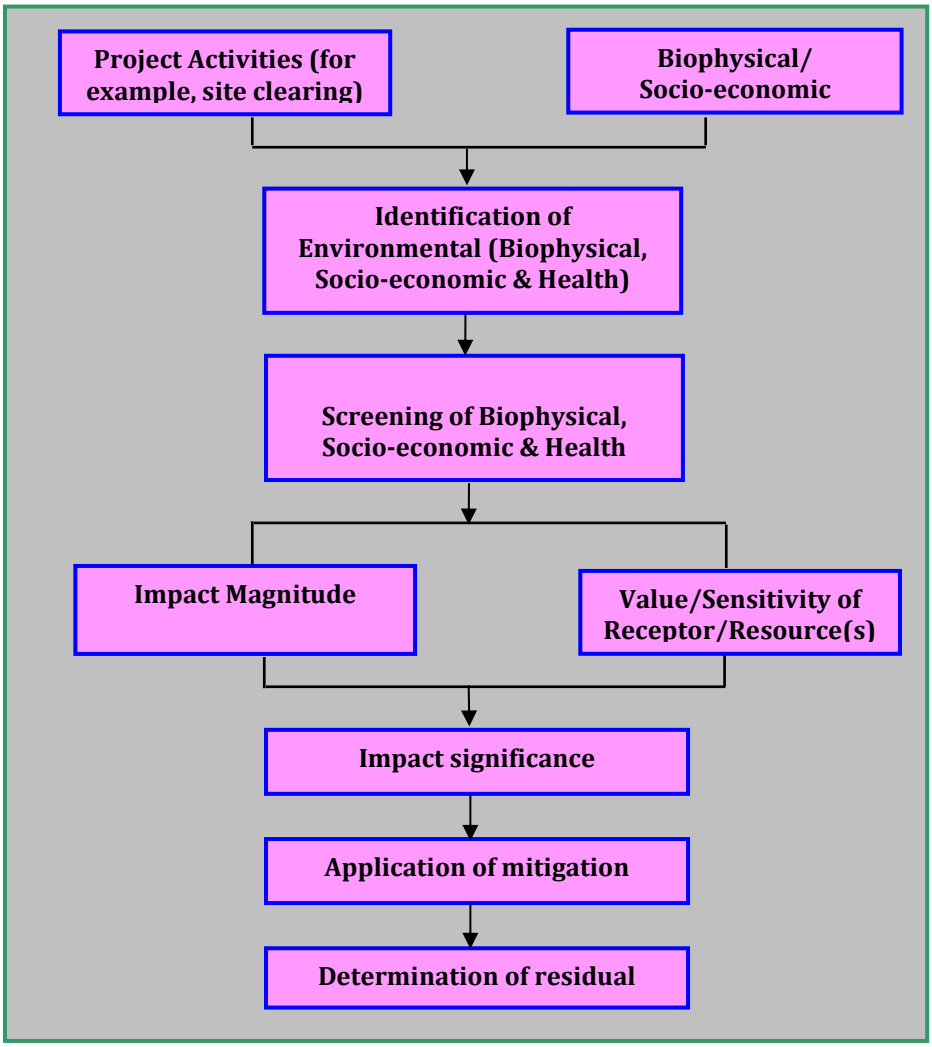


Figure 5.1: Overview of the Impact Assessment Process

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

5.3.1 Defining Environmental and Socio-economic Aspects and Impacts

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

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

- Interact with the existing natural environment including its physical and biological elements;

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

Activities assessed covered planned and non-planned events.

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

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

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

5.3.2 Potential Impact Characteristics

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.3.3 Screening and Scoping for Potential Impacts

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

- Knowledge of the Project activities as summarized in Table 5.2.
- Detailed information on the environmental and socio-economic setting of the Project's area of influence as documented in Chapter 4. The potential

environmental and social receptors/resources that could be affected by the proposed Project are summarized in Table 5.3.

- Consultation with relevant stakeholders including potentially affected community
- Review of other ESIA reports on similar projects/environments.
- Series of experts group discussions, meetings and experience on similar projects.

Table 5.2: Summary of the proposed Project Activities

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

Note: Activities related to decommissioning are discussed in Chapter 8

Table 5.3: Resource/Receptors and Impacts Indicators Considered

Environmental Receptor/Medium	Comment	Impact Indicators
Physical		
Air	Ambient air quality within the Project's area of influence.	Increase in concentration of gaseous and particulate pollutants.
Noise	Ambient noise level within the Project's area of influence.	Increase in ambient noise level; day and night-time disturbance; communication impairment, etc.
Soil	Soil environment the Project's area of influence.	Changes in physical, chemical and biological properties of the soil; loss of soil ecology and fertility; soil erosion, etc.
Groundwater/ aquifers	Underground water resources in the Project's area of influence.	Decrease in underground water/aquifer reservoir level; groundwater contamination.
Surface water	Surface water body in the Project's area of influence	Surface water contamination.
Landscape/ topography	The geomorphological land forms and terrain of the Project site and its surrounding environment.	Alteration in drainage pattern; changes in landscape.
Biological		
Terrestrial flora and habitats	Plant species (vegetation) in the Project's area of influence.	Loss of terrestrial flora; introduction of new species.
Terrestrial fauna	Terrestrial fauna in the Project's area of influence.	Loss of terrestrial fauna; involuntary migration.

Environmental Receptor/Medium	Comment	Impact Indicators
Socio-economic Environment		
Land use	Existing land use within the Project site and its surrounding environment.	Loss of existing land use.
Loss of livelihoods or access to economic resources.	Existing farm plots within the Project site	Loss of farming rights
Visual prominence	The aesthetic quality of the proposed Project on the surrounding visual catchment.	The compatibility of the Project with the character of the locality; visual nuisance through reflection of panels.
Demography	Demography of community in the Project's area of influence.	Changes in demography, gender ratio, age distribution, socio-economic structure, etc. of the local community
Utilities	The existing utilities (e.g. power supply, water, sewer services, etc.) in the Project's area of influence.	Changes in existing utilities; potential damage to public utilities.
Infrastructure	The existing infrastructure such as road, waste handling facilities, etc. within the Project's area of influence.	Potential damage to road infrastructure; road traffic and accidents; increased pressure on waste management facilities.
Employment/income	The employment situation in the Project's area of influence.	Opportunities for local employment; changes in income level.
Gender	Gender and disproportionate gender impacts	Potential for gender-based violence (GBV); marginalization of women; gender pay gaps; discrimination, etc.
Other (Health and Safety)		
Construction workers	Health and safety of construction workers.	Accident, injury, fatality, exposure to nuisance (dust, noise), fire, etc.
Workplace health and safety	Health and safety of employees involved in the operational phase of the Project operation.	Accident, injury, fire, explosion, etc.
General public	Health and safety of the general public	Accident, fire, explosion, etc.

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

Table 5.4: Activity-Receptor Interaction for Impact Screening

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

Note: Decommissioning is separately covered in Chapter 8

5.4 Determination of Impact Significance

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

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

5.4.1 Impact Magnitude

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

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

5.4.1.1 Determining Magnitude for Biophysical Impacts

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

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

A **Medium Magnitude Impact** affects a portion of an area, system, aspect (physical), population or species (biological) and at sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels (when compared with national or international limits and standards specific to the receptors) and may

bring about a change in species abundance, but does not threaten the integrity of that population or any population dependent on it.

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

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

5.4.1.2 Determining Magnitude for Socio-economic Impacts

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

Table 5.5: Impact Magnitude Criteria for Socio-economic Impacts

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

Category	Ranking	Definition
		limited extent, i.e. (days).
Negligible	1	▪ Possible nuisance to human health and well-being (e.g. occasional unpleasant odours) ▪ Inconvenience experienced in accessing community facilities and utilities (e.g. electricity supply disruption for short (hours) period of time). ▪ No impact on livelihood, community facilities and human health.
Positive	+	▪ Beneficial improvement to human health. ▪ Benefits to individual livelihoods (e.g. additional employment opportunities). ▪ Improvements to community facilities/utilities. ▪ Increased economy (e.g. local procurement, sourcing of supplies).

5.4.2 Determining Receptor Sensitivity

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

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

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

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

Category	Ranking	Definition
Physical (for example, air quality)		
High	3	All ambient conditions/concentrations exceed guideline limits and are indicative of the resource being impacted or polluted. There is no (or very little) assimilation capacity for increased concentrations/ change in conditions.
Medium	2	Some ambient conditions/concentrations exceed guideline limits while others fall within the limits. There is some small assimilation capacity for increased concentrations/ change in conditions. Resource use does affect other users
Low	1	All ambient conditions/concentrations are significantly lower than guideline limits and there is capacity for assimilation for additional concentrations/ change in conditions. Resource use does not significantly affect other users.
Biological (for example, terrestrial ecology)		
High	3	Specifically protected under Nigerian legislation and/or international conventions such as International Union for Conservation of Nature (IUCN); considered to be of critical importance to the local use; and totally dependent on for livelihood or means of survival.

Category	Ranking	Definition
Physical (for example, air quality)		
Medium	2	Not protected or listed but may be a species common globally but rare in Nigeria with little resilience to ecosystem changes, important to ecosystem functions, or one under threat or population decline; considered to be of moderate importance to the local use; and partially dependent on for livelihood or means of survival.
Low	1	Not protected or listed as common / abundant; or not critical to other ecosystem functions; considered to be of minor importance to the local use; and local communities do not depend on the resources for livelihood.
Socio-economic and Health		
High	3	Those affected will not be able to adapt to changes and continue to maintain pre-impact status.
Medium	2	Able to adapt with some difficulty and maintain pre-impact status but only with a degree of support.
Low	1	Those affected are able to adapt with relative ease and maintain pre-impact status.

5.4.3 Significance

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

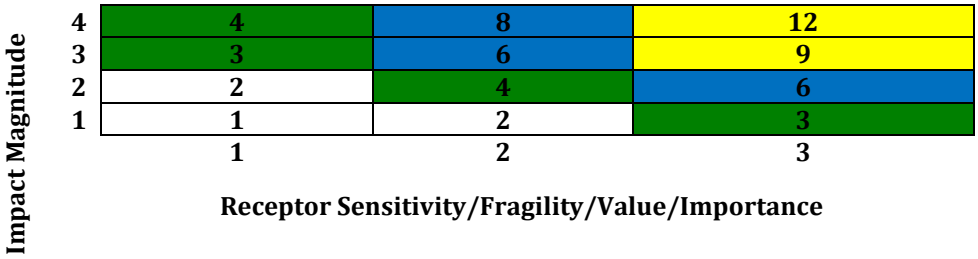


Figure 5.2: Impact Magnitude-Receptor Sensitivity Product Results

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

Table 5.7: Environmental Impact Significance Rankings

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

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

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

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

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

5.4.3.1 Determining the Significance of Potentials Impacts of the Project

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

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

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

Note: Decommissioning is separately covered in Chapter 8

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

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

Impact sensitivity raking: 1 = Low; 2 = Medium; 3 = High.

5.5 Impacts Discussion

5.5.1 Potential Positive Impacts

The proposed Project seeks to provide independent and reliable power supply to Nigeria Defence Academy (NDA) Kaduna through a renewable (solar) energy source and thus, enhance learning and institutional operations. It also forms part of the measures in ensuring that Nigeria achieves its carbon emission reduction targets (20% - 30% carbon emission reduction by the year 2030) as contained in Nigeria's Nationally Determined Contributions (NDC) on climate change. In line with the Federal Government's plans for Power Sector reform, the Project will assist to promote stronger relationship and collaboration between the Federal Government of Nigeria (FGN), Nigerian Universities, REA, and other relevant regulatory bodies.

Another component of the proposed Project is the construction of a world-class renewable energy workshop/training centre within the Project site. The facility will enhance learning in renewable energy in the University thus leading to certification. Also, the installation of streetlights as part of the proposed Project will boost safety and security within the University.

In addition, the Project will improve social economic activities within the University and help to enhance internally generated revenue. Furthermore, there are employment opportunities associated with the proposed Project for skilled, semi-skilled and unskilled workforce. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects. For example, during the construction phase, about 4,000 workers would be engaged. The larger portion (60%) of the workforce (especially semi-skilled and unskilled craftsmen) would be drawn from the Project area.

Other potential benefits of the proposed Project include increase in local and regional economy through award of contracts and purchase of supplies for Project development as well as waste management.

5.5.2 Potential Negative Impacts

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

- Potential impact of the proposed 2.5 MW solar-hybrid power plant and associated infrastructure
- Potential cumulative impacts

It is important to note that the significance of potential environmental and social impacts discussed in this section is without mitigation measures except those

already built into the Project design. Implementation of additional mitigation measures (presented in Chapter Six of this report) are expected to further reduce the impact rating as low as reasonably practicable.

5.5.2.1 Potential Impacts of the proposed Project

5.5.2.1.1 Pre-Construction Phase Activities

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

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

❖ ***Site Selection***

The proposed Project will be sited on approximately 43.0 ha of land within the existing land property owned by NDA. No additional land take, either from a private or public property, will be expropriated for the Project.

The Project site is characterized by vegetation which includes shrubs, grasses, and trees. However, a large portion (approximately 70 %) of the site is used for subsistence farming by relatives of some NDA staff living within the University campus (the exact number of persons involved could not be ascertained at the time of site visit).

The selection of the site for the proposed Project would affect the existing farming activities onsite. The impact magnitude is considered to be low given that about 20 % of the entire 43.0 hectares of land would only be used for Project development. Also, the sensitivity of the receptor is regarded as medium. The Project Affected Persons (PAPs) who are relatives of the NDA staff are few in number (only 4 farmers were identified as at the time of the field survey in August 2019). In addition, the Project site is used only for subsistence farming. The discussions with the University representative from the Physical Planning Unit also revealed that the affected persons will be allowed to harvest their crops before commencement of construction activities. In addition, alternative land within the University campus will be provided for the affected persons to continue their farming activities. The impact significance of site selection for the proposed Project on the existing land use is rated **moderate**.

❖ ***Site Clearing and Preparation***

The Project site will be cleared of vegetation prior to construction activities. The site clearing activities would likely 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 (43.0 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)-2018 classification scheme. Also, the local community has no direct or indirect ecosystem services that they 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.

With regard to the clearing of the Project site for construction purpose, the potential impact on terrestrial fauna species may include loss of individual or localized population of fauna species or disturbance to avifauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species (including avi-fauna) encountered or reported in the Project site belongs to the IUCN classification of threatened animal species which include those classified as critically endangered, endangered or vulnerable. The major fauna species observed on the site were mostly the birds nesting on some of the trees within the site. However, the site is not a designated bird nesting area. The sensitivity of the fauna species recorded on the Project site is thus regarded as low. The impact magnitude is considered to be medium given that the site clearing activities would not cover all of the approximately 43.0 ha of land allocated for the Project. The impact significance is thus considered **minor.**

Potential Impact on Soil

The proposed site clearing and preparation activities could potentially impact the soil environment of the Project site. The potential effects on soil include degradation due to site preparation e.g. compaction of soil as a result of the movement of earth moving equipment. Soil degradation is the removal, alteration, or damage to soil and associated soil forming processes, usually related to human activities. The stripping of vegetation or disturbance to the natural ground level over disturbance areas will

negatively affect soil formation, moisture levels, soil density, soil chemistry, and biological activity. Uncontrolled site clearance of vegetation could lead to direct surface soil exposure and hence erosion of soil which could be significant.

The impact magnitude is considered as medium as the extent of soil erosion could be high, especially if the site clearing activities are carried out in the wet season. However, based on the results of laboratory analysis conducted on soil samples from the Project area, the Project site is not considered to be significantly prone to land-based erosion. The soil texture analysis of soil samples collected at the Project site and its surrounding environment showed high percentage of clay followed by sand and then silt. For example, at the Project site, sand particles ranged from 7.35 % – 16.54 %, silt ranged from 7.62 % – 13.17 % while the percentage of clay particles ranged from 75.84 % – 82.38 % in the top soil, while in the sub soil, sand particles ranged from 7.45% – 17.89 %, silt ranged from 7.55% – 13.18% while clay ranged from 72.36% – 82.90 %. This revealed that the near-surface ground of the area was formed of compacted fine-grained sediments, such as clays and silts and a conglomerate with lateritic matrix. In addition, the no heavy metal pollution was recorded in the soil samples from the Project site and it surrounding environment. Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni) were below the detection limits of 0.04mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively while the concentrations of Zinc (Zn) recorded in the soil samples from the Project site, the 1km area of influence and the control/buffer points had a range of 0.033mg/kg – 0.915mg/kg, 0.013 mg/kg – 0.286 mg/kg, 0.014 mg/kg – 0.114 mg/kg respectively in the top soil and a range of 0.034 mg/kg – 0.428 mg/kg, 0.011 mg/kg – 0.034 mg/kg, 0.016 mg/kg – 0.102 mg/kg respectively was recorded in the sub soil. The measured Zn values in all the soil samples from the Project area were below the recommended limit of 50 mg/kg. 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 NO_x, CO, SO_x from combustion engines of the earth moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is considered to be low since the activities will be short-termed, intermittent, localized and reversible. The site clearing activities will take less than 1 week. The sensitivity of the air shed of the Project area is also regarded as low based on the results of air quality measurements conducted in the area during the field data gathering. No elevated concentrations of air pollutant criteria beyond the FMEnv, WHO, and the World Bank Ambient Air Emission Limits were recorded in the Project site and its surrounding environment. For example, within the Project site, the measured TSP values ranged from 0.013 mg/m^3 to 0.022 mg/m^3 while the TSP values recorded at

locations established outside the Project site but within its 1km radius ranged from 0.031 mg/m^3 to 0.038 mg/m^3. At the control/buffer points, the measured TSP values ranged from 0.025 mg/m^3 to 0.038 mg/m^3. The TSP values recorded in all the sampling locations were below the FMEnv 1hr averaging time limit of 0.25 mg/m^3 for TSP in ambient air. The impact significance of site clearing on the ambient air environment of the Project site is considered to be **minor**.

Potential Impact on Workers Safety

Site clearing and preparation are potentially hazardous activities. Accidents may occur especially when those involved are unskilled. Such accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. The site clearing activities will take less than 1 week and the number of workers required would be less than fifty (50). The impact significance is considered to be **minor**.

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

Potential Impact on Air Quality and Ambient Noise

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

It is anticipated that the potential impacts will be similar to those experienced during site clearing activities. The capacity for assimilation of vehicular emissions and dust associated with the mobilization activities in the Project's 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 community health and safety, the mobilization activities during the pre-construction phase of the Project could increase the traffic volume in the Project area (and potential for road accident) as a result of movement of vehicles in and out of the Project site. The social aspects of these activities could lead to accident, traffic congestion and annoyance from other road users in the area. The magnitude of the impact is considered low since the mobilization activities would be less than 1 week. The sensitivity of the receptors is adjudged as medium given that the existing vehicular movement in the University environment is high. The prominent means of transportation are cars, tricycles, and motorcycles while buses/trucks are rare. The impact significance is considered to be **minor**.

Potential Impact on Workers Safety

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

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

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

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

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

5.5.2.1.2 Construction Phase

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

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

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

Potential Impact on Air Quality

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

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

Potential Impact on Noise Levels

The planned activities during the construction phase of the Project have the potential to increase the ambient noise levels at the Project site and its surroundings. Based on in situ measurements conducted as part of field survey in August 2019, the day-time noise level recorded in the Project site ranged from 50.5 dB(A) to 53.4 dB(A); at the 1km, it ranged from 51.9 dB(A) to 54.8 dB(A) while at the control/buffer points, a range of 52.6 dB(A) to 61.2 dB(A) was obtained. The measured noise levels at the Project site and its surrounding environment were within the World Bank noise limit of 55 dB(A) (1hour Leq day time) for educational institution. In addition, the noise levels (by extrapolation) were also below the FMEnv limit of 90 dB(A) for 8-hour occupational exposure.

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. The noise levels from construction activities would be intermittent and localized and are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location offsite (e.g. Living Quarters about 200m away). The potential impact magnitude is regarded as low due to the envisaged low extent of its effect. The overall impact significance is considered **moderate.**

Potential Impact on Soil

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

Soil environment of the Project site could be impacted in terms of removal of topsoil and soil compaction, reduction in structural stability and percolative ability of soil, loss of soil dwelling organisms resulting from compaction during excavation and installation activities. These activities also have the potential to increase siltation as a result of accelerated erosion. The impact magnitude is considered to be medium considering that foundation works would only be required for the proposed training centre while the trenching for the underground power evacuation cable to be installed would be minimal. The sensitivity of the soil environment of the Project area is considered to be low based on the laboratory results. No evidence of heavy metal and/or hydrocarbon pollution was recorded in soil samples from the Project area. Thus, the impact significance is considered to be **minor**.

Potential Impact on Surface water

The quality of water from the stream within the vicinity of the study area could be impacted due to increased sediment load as a result of accelerated erosion from the Project site during construction. Also, any contaminated run-off from the construction site as well as improper handling of construction wastes could pose adverse impact on the quality of the water. The potential impact on the stream would be localized, indirect and reversible. The impact magnitude is considered to be medium. In terms of receptor sensitivity/importance, the results of laboratory analysis conducted on the water sample did not indicate heavy metals and hydrocarbon loads. This implies that although there may be some minor effect on the ecological balance. Thus, the impact significance is rated **minor**.

Potential Impact on Terrestrial Flora and Fauna

The construction activities may potentially cause disturbance to flora and fauna species as a result of increase in human activity, noise level, creation of areas of bare

soil, etc. which may alter the composition and diversity of plant species around the Project site and drive many fauna species away from the area. In addition, the potential for plant species invasion is likely to increase as a result of increase in areas of bare soil around the Project site.

Also the disturbance associated with noise and movement of construction equipment and personnel at the Project site may deter bird species from the area and disrupt the breeding of avifauna. It may also lead to increased risk to species such as snakes, rodents and mammals. The sensitivity of the receptor is adjudged to be low. The Project area is not known as a migratory route for avifauna species based on desktop reviews and field observation. The impact significance is regarded as **minor**.

Potential Impact on Hydrogeology and Groundwater Quality

The construction activities could lead to potential impacts on hydrogeology of the Project area. These include increased sediment load in the drainage channels as a result of erosion; increased storm water runoff from a decrease in infiltration; and increased runoff from hardstanding areas.

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

The potential impact on the existing underground aquifer (water reserve) of the Project area as a result of water abstraction for construction activities such as concrete mixing and washing of construction equipment is considered to be **negligible** since the use of water for construction activities would be minimal. There are several boreholes within the University campus as noted during the site visit. The recharge of the existing boreholes in the Project area is largely due to direct precipitation. During the rainy season, the water reserve of the aquifer in the study area increases; thus, hand dug wells and boreholes yields improve significantly.

Potential impact on Gender

Construction activities in Nigeria are typically dominated by males which presents a major challenge for equal opportunities for women. Generally, the Nigerian

construction sector has a particularly low participation rate for women, both in industry and academia. Key Informant Interviews (KII) and Focus Group Discussions (FGD) conducted within the local community revealed that although women are allowed to work and trade freely; they are underrepresented in leadership positions.

During construction activities, women may experience discrimination as most employment and training opportunities may be provided to men, while women will be left with menial jobs. This may result in marginalization due to lack of adequate training, thereby reinforcing gender stereotypes and gender pay gaps. Furthermore, there is the possibility of gender-based violence cases (GBV) against women employed to work at the Project site. However, FGD with the women in the local community revealed that GBV incidents are not frequent within the community. The NDA management expressed their commitment to providing a safe and conducive environment for all women within the institution. Nevertheless, the sensitivity of gender impacts is rated high due to cultural and religious doctrine that is deeply rooted in the belief and customs of an average Northerner therefore, the impact significance is regarded as **moderate**.

Potential Impact on Socio-economic and Health

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

With regard to the presence of construction workers on site, the manner in which the workers conduct themselves can affect the local community in terms of disruption of existing family structures due to influx of migrant workers. The potential behaviour of construction 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 (approximately 4,000) for the construction phase of the Project is relatively high, the potential risk to local family structures is regarded as high. Given that the majority of the construction workers, especially unskilled labour force would be drawn from the local community, the impact significance is considered to be **moderate**.

Potential Impact on Infrastructure (Road)

Regarding road infrastructure, the movement of construction vehicles in and out of the Project site during construction has the potential to increase road traffic and accidents. The impact magnitude is considered as low due to the minimal (about 2-3

daily) number of Project vehicles and trucks to be used during the construction phase. Also, traffic survey at the second gate through Mando road leading to the University indicated a medium volume of vehicles (mostly cars and buses) on the road during peak periods. The impact sensitivity is rated medium. Therefore, the impact significance is considered **minor**.

Potential Impact on Construction Workers Safety

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

- ***Waste Generation and Disposal***

Potential Impact on Soil

Construction activities are associated with waste generation. The potential wastes to be generated during the construction phase of the Project include scrap metals, electrical cables, spent oils, damaged batteries, wood/planks, paper waste, food remnants, leftover sand and gravel, etc. The waste streams if not properly handled, could contaminate the soil environment within the Project site and its surrounding environment. The impact sensitivity of the soil environment of the Project area is low judging by the results of laboratory analysis conducted on the soil samples. The impact significance is considered to be **minor**.

Potential Impact on Groundwater

Groundwater may be impacted as a result of infiltration of contaminants associated with liquid wastes especially from damaged batteries and spent oils. The impact magnitude is considered low; the nearest existing groundwater source to the Project site is over 300m away. The results of laboratory analysis conducted on groundwater samples from existing boreholes in the Project area did not reflect any heavy metal and hydrocarbon pollution. The potential for groundwater contamination as result of waste disposal is rated **minor**.

Potential Impact on Infrastructure (Waste Management Facility)

Construction waste can potentially have impact on the existing waste management facility of the Project area. Domestic wastes in NDA are collected by Kaduna State Environmental Protection Authority (KEPA) accredited waste collectors. However, construction wastes such as scrap electrical components, batteries, damaged/defective panels and electrical cables (e-waste) cannot be disposed of in such manner. These wastes shall be returned to the manufacturers based on a take-

back scheme or recycled as appropriate. The quantity of domestic wastes designated for the dumping site will thus be low. The impact of the waste on the waste management facility of the Project area is considered **negligible**.

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

Table 5.10 summarizes the potential negative impacts associated with the construction phase of the proposed Project.

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

Activity	Receptor	Associated Impact	Significance
Civil and Electrical Works/ Installation Activities	Air Quality	• Air quality impacts due to emission from construction equipment (SPM, NOx, CO, SO_x) • Increase in dust from cleared land and windblown stockpiles	Minor
	Ambient Nosie	• Increase in noise level due to construction activities	Moderate
	Soil	• Increased erosion potential as a result of construction activities such as excavation • Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Minor
	Terrestrial Flora and Fauna	• Loss of plant species as a result of introduction of alien plants which may prevent the natural recovery of the natural vegetation on the site and power evacuation route. • Loss of fauna as a result of increased human activity and associated noise.	Minor
	Hydrogeology and Groundwater	• Decrease in groundwater aquifer as a result of groundwater abstraction for construction activities e.g. concrete mixing, equipment washing, etc. • Groundwater contamination	Minor
	Surface water	• Surface water contamination	Minor
	Gender	• Discrimination of women during employment • GBV	Moderate
	Socio-economic and health	• Influx of migrant workers, increase in sexual transmitted diseases.	Moderate
	Infrastructure (road)	• Road damage, traffic and safety impacts.	Minor
	Construction workers safety	• Injury to construction workers during construction activities.	Moderate
Waste Generation and Disposal	Soil	• Decrease in soil quality	Minor
	Groundwater	• Groundwater contamination	Minor
	Infrastructure (waste management facility)	• Disposal of construction wastes to existing waste management facility in the Project area.	Negligible

5.5.2.1.3 Commissioning Phase

Once the construction phase of the proposed Project is completed, the power plant and associated infrastructure will be tested to ensure that they have been installed according to the pre-design and operational requirements. During the commissioning, there could be increase in noise level due to humming noise emission from the plant components (inverters and batteries), vehicular movement (transportation of commissioning officials), crowd noise, and other ceremonial activities. The ambient noise levels recorded in the area during baseline data gathering were generally below the FMEnv and World Bank recommended limits. Also, considering that the commissioning activities would be short-termed and localized, the impact significance is rated **minor**.

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

The commissioning phase will lead to an influx of guest and officials which will have an impact on the existing population and infrastructure (road) of the Project area. Due to the short duration of the commissioning activities, the impacts are considered to be **negligible**.

Table 5.11 summarizes the potential negative impacts associated with the commissioning phase of the proposed Project.

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

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

5.5.2.1.4 Operational Phase

❖ ***Power Generation and Distribution***

Potential Impact on Noise

The potential sources of noise during the power plant operations are inverters and batteries. Typically, the designed noise level from an inverter is approximately 30-35 dB(A) while that of a battery is 15-20 dB(A). The associated noise levels from the inverters an batteries are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location offsite (e.g. female

hostel located about 300 m away). The impact significance is considered to be **negligible**.

Potential Impact on Gender

Women have conventionally been under-represented in the energy sector; they are often marginalized from many power sector employment and training opportunities. There is a potential that this situation may come to play during the operations phase of the Project as women may experience discrimination during employment and training opportunities. Also poor working conditions and GBV issues such as sexual harassment, intimate partner violence, assault (physical and psychological), are likely to arise during operations.

Although the number of personnel working at the Project site would be minimal, the likelihood of gender-based impacts predicted during the construction phase may exists. Therefore, the impact significance is regarded as **moderate**

Potential Impact on Socio-economic and Health

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

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

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

Solar PV panels produce low levels of extremely low frequency (ELF) EMF, with measured field strengths of less than one mG. The measured EMF level decreases as the distance from the PV panel increases (Chang and Jennings, 1994).

Research has not been able to prove that the ELF-EMF radiations generated from PV arrays or transmission line have an adverse impact on human health, as most studies show a weak association between magnetic field and adverse health effects. The World Health Organization (WHO) has designated ELF-EMF as a possible

carcinogen (WHO, 2007). The use of the label "possible carcinogen" indicates that there is not enough evidence to designate ELF-EMF as a "probable carcinogen "or "human carcinogen," the two indicators of higher potential for being carcinogenic in humans. Thus, the potential impact of EMF radiation from the proposed Solar-hybrid Power Plant on community health and safety is considered to be **negligible**.

Potential Impact on Occupational Health, Safety and Welfare of Workers

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

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

Potential Impact on Soil

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

Potential Impact on Groundwater

Potential impacts may include decrease in amount of groundwater reservoir as a result of water abstraction for cleaning of the PV panels. Cleaning of the PV panels is envisaged to be carried out about three (3) times during the raining reason and this would be more than three times during the dry season.

Based on previous experience, each panel would require approximately 5 litres of water per cleaning cycle. With an estimated number of 6,600 panels for 2.5 MW generation, it is envisaged that the proposed Project would consume approximately 16,500 litres of water per cleaning cycle. The water required for the cleaning purpose would be obtained from the existing boreholes within the University campus. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have serious effect on the existing groundwater aquifer of the Project area as well as the local water use. Thus, the impact significance is considered **minor**.

Potential Impact on Occupational Health, and Safety of Workers

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

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

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

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

Activity	Receptor	Associated Impact	Significance
Power Generation and distribution	Noise	• Noise from batteries and inverters during power generation and evacuation	Negligible
	Gender	• Discrimination of women during employment • GBV (sexual harassment, assault and poor working condition)	Moderate
	Socio-economic (visual prominence)	• Landscape alterations resulting in unpleasant changes in the visual character of the area	Minor
	Socio-economic (health issues)	• Community health and safety impact due to electromagnetic field (EMF) radiation from the Solar-hybrid power plant	Negligible
	Health, safety and welfare of staff during Plant operation	• Electric shock, injuries to personnel associated with the Power Plant operations, • Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions	Moderate
Routine Maintenance, Waste Generation and Disposal	Soil	• Soil contamination from spent batteries and inverters	Minor
	Groundwater	• Groundwater abstraction from cleaning of PV panels	Minor
		• Groundwater and soil contamination	Negligible
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor

5.5.2.2 Potential Cumulative Impacts

Cumulative impacts are those impacts resulting from the combined effects of past, present or reasonably foreseeable actions owing to the project aspects and activities outside the project (GSI, 2003). The concept of cumulative effects is an important one. It holds that, while impacts may be small individually, the overall impact of all

environmental changes affecting the receptors taken together can be significant. When a resource is nearing its tolerance threshold, a small change can push it over.

The major existing activities around the Project area are farmlands and the university switchyard. Given the nature of the activities associated with the proposed Project and the existing activities around the project area, the potential cumulative impacts of the Project on road traffic, ambient noise levels and groundwater availability is considered **low**.

5.6 Risk and Hazard Assessment

5.6.1 Overview

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

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

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

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

Figure 5.3: Risk Assessment Matrix

5.6.2 Project Specific Risks and Hazards

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

5.6.2.1 Fire and Explosion

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

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

5.6.2.2 Electrocution

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

5.6.2.3 Occupational Hazards

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

5.7 Summary

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

CHAPTER SIX:

MITIGATION MEASURES

CHAPTER SIX

MITIGATION MEASURES

6.1 Introduction

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

6.2 Mitigation Measures Approach

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

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

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

6.3 Mitigation Measures for the Identified Significant Negative Impacts

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

implementation of the proffered mitigation measures highlighted in Table 6.1, are of negligible to minor significance.

6.4 Mitigation Measures for the Identified Project Risks and Hazards

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

Fire and Explosion

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

Electrocution

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

Occupational Hazards

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

6.5 Enhancement Measures for Identified Positive Impacts

6.5.1 Reduction in Carbon Emissions

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

- In cases where the power generated (2.5 MW) is insufficient to meet the power demands of the University in the next 10 to 20 years, power shall be distributed to high priority areas so as to reduce/eliminate the use of diesel-powered generators. In addition, the Project will be designed and constructed to allow for further expansion in power generation and distribution capacity to meet the University's demands.
- The University shall implement energy conservation measures such as encouraging switching off appliances, use of energy-saving bulbs, purchase of low-energy appliances such as printers, computers, refrigerators, etc.

6.5.2 Enhancement of Learning

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

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

6.5.3 Direct Employment and Training

The Project will give rise to direct employment opportunities across different skill levels, from unskilled to highly skilled labour. It is estimated that during construction phase, at least 4,000 job opportunities would be created. Training for local people from skilled technicians shall also be carried out.

The following measures shall be implemented to ensure that direct employment and training opportunities are maximized:

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

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

6.5.4 Procurement and Indirect Employment

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

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

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Pre-construction Phase					
Site selection	Existing farmland on site	• Livelihood /Economic displacement due to land selection	Minor	▪ Livelihood Restoration Plan (LRP) shall be developed and implemented (in consistent with the requirements of OP 4.12, Annex A - Involuntary Resettlement Instruments) for the affected persons ▪ Only the portion of the site required for Project development shall be cleared for construction. ▪ The affected farmers on the site shall be allowed to harvest their crops before commencement of construction activities. ▪ NDA shall provide alternative farmlands within the University for the affected persons. ▪ The commitment for the provision of alternative land for the affected persons shall be documented in a letter signed by the NDA Commandant or his designate.	Negligible
Site clearing and preparation	Terrestrial flora and fauna	• Vegetation loss • Direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project site	Minor	▪ 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. ▪ Hunting or deliberate killing of animals by workers shall be prohibited and monitored. Workers shall be sensitized on ecological protection.	Negligible
	Soil	• Removal of top soil and soil compaction associated with site clearing • Loss of top soil • Increased erosion potential	Moderate	▪ Removal of vegetation and soil cover shall be restricted to the areas required for the Project. Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas. ▪ Disturbed areas will be rehabilitated as soon as possible to prevent erosion. ▪ The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		• Reduction in structural stability and percolative ability of soil		the approved working corridor shall be prohibited. ▪ Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	
	Air quality and noise	• Air quality impacts due to emission from site clearing equipment • Increase in ambient noise levels	Minor	▪ Site clearing equipment / machinery shall be operated and maintained under optimum fuel efficient conditions. ▪ Noise suppression equipment shall be fitted on machinery. ▪ Site clearing equipment shall be turned off when not in use. ▪ Equipment/machinery with lower sound power levels shall be selected and used for site clearing.	Negligible
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor	▪ Site clearing shall be limited to the day time as much as possible. ▪ Unregistered labourers and touts shall not be engaged for off-loading materials ▪ Provision of adequate personal protective equipment (PPE) such as nose masks shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.	Negligible
Mobilization of personnel, materials and equipment to site	Air quality and noise	• Air quality impacts from vehicular emissions • Increase in ambient noise levels	Minor	▪ Construction vehicles with efficient engine performance and with minimal noise and air emissions shall be selected and used. This can be achieved through regular servicing and maintenance. ▪ All materials with potential to result in dust emissions shall be covered during transport. ▪ Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h so as to reduce dust generation.	Negligible
	Infrastructure (road)	• Increase in vehicular movement and traffic around the project site; • Potential for road accident.	Minor	▪ A traffic management plan (TMP) shall be developed by the EPC Contractor and implemented. ▪ Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided. ▪ The local community shall be sensitized about the Project activities and the need to comply with the traffic management plan put in place.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Project related vehicles shall be regularly serviced and maintained. ▪ Drivers' competency shall be assessed and where required, appropriate training shall be provided. This will include training on safe driving measures such as adherence to speed limits (of less than 10 km/h) in the Project area. ▪ A procedure for recording traffic incidents/accidents associated with the Project shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc.	
Construction Phase					
Civil and Electrical Works/ Installation Activities	Soil	• Increased erosion potential as a result of construction activities such as excavation • Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Minor	▪ Excavation works shall not be executed under aggressive weather conditions. ▪ Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion. ▪ 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 footprint.	Negligible
	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	• Increase in noise level due to construction	Moderate	▪ Construction activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). In the event that noisy activities are undertaken	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		activities; • Disturbance to neighbouring community and local ecology		outside of the specified working hours, all noise receptors in the Project area shall be informed of such activities in advance. ▪ Construction machinery shall be turned off when not in use. ▪ Machinery/equipment to be used for construction work shall meet industry best standard in relation to noise attenuation. ▪ Construction equipment shall be properly maintained and serviced. ▪ Major construction activities shall be limited to a particular area within the site. ▪ Construction-related vehicles shall be limited to access areas. ▪ Noise complaints related to the construction activities shall be assessed and appropriately addressed. ▪ Noise monitoring at locations with persistent noise complaints shall be maintained.	
	Infrastructure (road)	• Road damage, traffic and safety impacts.	Minor	▪ A TMP shall be developed by the EPC Contractor and implemented. ▪ Speed limits for all construction-related vehicles shall be established and enforced. ▪ Construction related vehicles shall be regularly serviced and maintained. ▪ Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active. ▪ Drivers' competency shall be assessed and where 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. ▪ The NEP Grievance Redress Mechanism (GRM) shall be implemented for receiving complaints arising from damage to infrastructure and private property during construction activities shall be developed. The EPC contractor shall	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				receive the complaints and repair damages as quickly as possible.	
	Groundwater and surface water	• Groundwater and surface water contamination	Minor	▪ Training shall be provided for workers on safe storage and handling practices and rapid spill response and clean-up techniques during induction. ▪ Spill control and response plans to respond to spills and leaks shall be implemented. ▪ Waste receptacles shall be provided within a secured area within the project site for collection of solid waste. ▪ General wastes that cannot be reused shall be periodically evacuated by the government accredited waste contractor	Negligible
	Terrestrial Flora and Fauna	• Loss of plant species as a result of introduction of alien plants which may prevent the natural recovery of the natural vegetation on the site. • Loss of fauna as a result of increased human activity and associated noise.	Minor	▪ Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities. ▪ All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimise introduction of alien species. ▪ If sand or other natural materials for building are required and brought onto site, the stored heaps will be monitored for the growth and germination of alien species and will be regularly cleared during construction. ▪ Regular monitoring will be undertaken to ensure that alien plants are not increasing as a result of the disturbance that has taken place. ▪ Hunting or deliberate killing of animals by construction workers shall be prohibited and monitored. ▪ In order to reduce collision of vehicles with fauna, a 10 km/hr speed limit by construction-related vehicles shall be enforced in the Project area.	Negligible
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate	Moderate	▪ Equal treatment of workers shall be ensured. ▪ The GBV Action Plan for EEP shall be implemented for the Project ▪ All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		partner violence, poor working)		▪ GBV sensitive channels for reporting in GRM shall be implemented for the Project ▪ The EPC Contractor shall be required to hire a Gender/GBV officer. ▪ Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured. ▪ All workers shall be required to undergo regular training and refreshers on GBV ▪ The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site. ▪ All gender-based violence incidents shall be reported and dealt with as per the law.	
	Construction workers safety	• Injury to construction workers during construction activities.	Moderate	▪ Health and Safety Plan shall be developed and implemented. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence. ▪ Construction workers shall be sensitized and monitored on the need to be safety conscious. ▪ Daily toolbox talks prior to commencement of work activities shall be carried out. ▪ Construction activities shall be limited to daytime as much as possible. ▪ Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules. ▪ Proper safety signs and signage shall be placed at strategic locations within the site. ▪ PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored. ▪ Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers.	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented. ▪ The site shall be secured with perimeter fencing and/or security. ▪ Sanitary amenities and potable water shall be provided	
	Socio-economic and health	• Influx of people, increase in sexual transmitted diseases.	Moderate	▪ Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible. ▪ No person under the age of 18 shall be engaged to work on the project. The EPC Contractor shall ensure that children and minors are not employed directly or indirectly on the project ▪ Any child dropout should be reported to the relevant government agency ▪ The local community shall be informed of the Project activities prior to commencement of work. ▪ An induction and sensitization programme, including a Code of Conduct, for all construction workers shall be 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. ▪ The CoC shall include provisions to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse by workers within the local community. ▪ Public access shall be restricted to construction area via security fencing and appropriate signage.	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ 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.	
Waste Disposal and Generation	Infrastructure (waste management facility)	• E-waste generation • Disposal of construction wastes to existing waste management facility in the Project area.	Minor	▪ A Waste Management Plan shall be developed and implemented ▪ 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. ▪ Construction vehicles and equipment shall be serviced regularly.	Negligible
	Soil	• Soil contamination from solid and liquid construction waste streams.	Minor	▪ Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. ▪ Portable spill containment and clean-up kits shall be available onsite. ▪ Construction workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Negligible
	Groundwater	• Groundwater contamination of liquid construction waste streams.	Minor	▪ Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site. ▪ Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. ▪ Portable spill containment and clean-up kits shall be available onsite. ▪ Waste management plan (WMP) shall be developed by the	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				EPC Contractor and implemented. ▪ Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. ▪ Construction waste, as much as practicable, shall be reused or recycled. ▪ Waste that cannot be reused or recycled shall be disposed of at an approved dumpsite.	
Commissioning Phase					
Plant Testing	Ambient noise	• Increase in ambient noise level	Minor	▪ The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ▪ Strict compliance to the Standard Operating Procedures shall be ensured. ▪ The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation.	Negligible
	Workers	• Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Moderate	▪ Plant testing shall be carried out by experienced personnel. ▪ Adequate PPE shall be worn. ▪ The Project components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ▪ The EPC contractor shall develop the Standard Operating Procedures (SOPs) for the operational phase of the project ▪ Strict compliance to the (SOPs) shall be ensured. ▪ Prior to the Plant commissioning, appropriate emergency equipment (such as first aid box, fire extinguishers) shall be provided onsite. ▪ Plant testing shall be restricted to the daytime. ▪ The site shall be secured with perimeter fencing and/or security ▪ Sanitary amenities and potable water shall be provided	Negligible
Operational Phase					
Power Generation and Evacuation	Socio-economic (visual prominence)	• Landscape alterations resulting in unpleasant changes in the visual	MInor	▪ All lighting will be kept to a minimum within the requirements of safety and efficiency. Where such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage will be used.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		character of the area		▪ Site fencing if required shall be implemented.	
	Health, safety and welfare of staff during Plant operation	• Electric shock, injuries to personnel associated with the Power Plant operations, • Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions	Moderate	▪ Appropriate PPE shall be provided for workers. ▪ Training shall be provided to employees on emergency preparedness and responses. ▪ Provision of medical insurance scheme for employees shall be ensured. ▪ Appropriate safety signage shall be placed at strategic locations within the site. ▪ Strict compliance to the SOPs/ code of conduct shall be ensured. ▪ A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.	Negligible
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working)	Minor	▪ Equal treatment of workers shall be ensured. ▪ Continuous implementation of the GBV Action Plan for EEP shall be sustained for the Project ▪ All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) ▪ GBV sensitive channels for reporting in GRM shall be implemented for the Project ▪ The O&M Contractor shall be required to hire a Gender/GBV officer. ▪ Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained. ▪ All workers shall be required to undergo regular training and refreshers on GBV ▪ The O&M Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site. ▪ All gender-based violence incidents shall be reported and dealt with as per the law.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Routine Maintenance, Waste Generation and Disposal	Soil	• Soil contamination from spent batteries and inverters	Minor	▪ General housekeeping to ensure the site is not overgrown with grasses shall be maintained ▪ Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. ▪ General waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. ▪ WMP shall be implemented. ▪ Burning of waste shall be prohibited. ▪ Damaged/expired Lithium ion batteries, solar panels, inverters and electric components shall be returned to the manufacturer based on the Extended Producer Warranty (EPR) model. Prior to returning them to the manufacturers, they will be stored on impermeable surfaces within the site.	Negligible
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor	▪ Appropriate PPE shall be provided for workers. ▪ Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. ▪ Strict compliance to the SOPs shall be ensured.	Negligible
	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. During rainy season, cleaning is estimated to occur not more than thrice; however during dry season the interval shall depend on the rate of dust accumulation. ▪ Periodic monitoring of groundwater resources in the Project's area of influence shall be implemented.	Negligible

CHAPTER SEVEN:

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction

The potential and associated impacts of the proposed 2.5 MW solar-hybrid power plant and associated infrastructure in the Nigerian Defence Academy (NDA) Kaduna, Kaduna State, as part of the Federal Government's Energizing Education Programme, have been analyzed and documented in Chapter 5 of this report. The results show that if the recommended mitigation measures (presented in Chapter 6) are implemented, the identified impacts of the Project are not severe and can be reduced to as low as reasonably practicable. It is thus important that those recommended mitigation measures be translated into practical management actions, which can be adequately resourced and integrated into the Project phases.

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

7.2 Objectives of the ESMP

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

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

The specific objectives of the ESMP are to:

- Promote environmental and social management and communicate the aims and goals of the ESMP;

- Ensure that all workers, subcontractors and others involved in the Project meet legal and regulatory requirements with regard to environmental management;
- Incorporate environmental and social management into Project design and operating procedures;
- Serve as an action plan for environmental and social management for the Project;
- Provide a framework for implementing Project environmental and social commitments (i.e. mitigation measures identified in the ESIA);
- Prepare and maintain records of Project environmental and social performance (i.e. monitoring, audits and non-compliance tracking).

7.3 Environmental and Social Management Measures

Tables 7.1 to 7.5 present the recommended environmental and social management measures required to mitigate the identified impacts of the Project development and operation. Environmental and social measures for the decommissioning are documented in Chapter 8.

Table 7.1a: 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							
Vegetation loss; direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species	Vegetation clearing shall be limited to the areas within the site needed for the Project. Use of herbicides for clearing shall be avoided. Site clearing and preparation shall be done mechanically.	Inspection	Daily	Adherence to measures	EPC Contractor	REA (PMU) NDA (Site Engineer)	-
	Bush burning shall be avoided.	Inspection	Daily	Adherence to measures			
	Any cleared areas which are not used will be re-vegetated using plants or seeds of locally occurring species.	Inspection	Monthly after the site clearing phase	Re-vegetated land			
	The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited.	Inspection	Monthly before the site clearing activities	Adherence to measures			
	Hunting or deliberate killing of animals by workers shall be prohibited and monitored. Workers shall be sensitized on ecological protection	Inspection	Daily before the site clearing activities	Adherence to measures			
Removal of top soil and soil compaction; loss of top soil; increased erosion potential; reduction in structural stability and percolative ability of soil	Removal of vegetation and soil cover shall be restricted to the areas required for the Project. Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas.	Inspection	Daily	Re-vegetated land			
	Use of silt traps or similar systems to reduce discharge of silt shall be	Inspection	Monthly before the site clearing	Re-vegetated land			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	ensured.		activities				
Air quality impacts due to emission from site clearing equipment; increase in ambient noise levels	Site clearing equipment / machinery shall be operated and maintained under optimum fuel efficient conditions.	Maintenance records; Fuel consumption records	Daily	Adherence to measures			
	Site clearing activities shall be carried out only during the daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr)	Inspection	Daily	Adherence to measures			
Mobilization of Materials and Equipment to Site							
Air quality impacts from vehicular emissions; Increase in ambient noise levels	Project vehicles with efficient engine performance and with minimal noise and air emissions shall be selected and used. This can be achieved through regular servicing and maintenance	Inspection; Maintenance records	Once before vehicle commences journey	Adherence to measures	EPC Contractor	REA (PMU) NDA (Site Engineer)	2000
	All materials with potential to result in dust emissions shall be covered during transport.	Inspection	Once before vehicle commences journey	Adherence to measures	EPC Contractor		
	Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h so as to reduce dust generation.	Inspection	Daily	Adherence to measures	EPC Contractor		
	Unnecessary engine idling shall be avoided.	Inspection	Daily	Adherence to measures	EPC Contractor		
	Site roads and access roads shall be sprinkled as needed to prevent dust entrainment.	Inspection	Daily	Adherence to measures	EPC Contractor		

Table 7.1b: 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	
Loss of existing farmlands on site due to land take for the Project	Livelihood Restoration Plan (LRP) shall be developed and implemented (in consistent with the requirements of OP 4.12, Annex A - Involuntary Resettlement Instruments) to restore livelihood of the affected persons.	OP 4.12, Annex A - Involuntary Resettlement	Prior to mobilization to site / site clearing and construction	Involuntary Resettlement (OP/BP 4.12)	NDA Management EPC Contractor	REA (PMU)	-
	Only the portion of the site required for Project development shall be cleared for construction.	Inspection	Prior to construction activities	Adherence to measure			
	The affected farmers on the site shall be allowed to harvest their crops before commencement of construction activities.	Inspection	Prior to mobilization to site / site clearing and construction	Adherence to measure			
	NDA shall provide alternative farmlands within the University for the affected persons.	Inspection	Prior to mobilization to site / site clearing and construction	Alternative farmlands for the affected persons			
	The commitment for the provision of alternative land for the affected persons shall be documented in a letter signed by the NDA Commandant or his designate	Letter of commitment	Prior to mobilization to site / site clearing and construction	Adherence to measure			
Injuries and accidents to workers during loading and off-loading construction materials.	Provision of adequate PPE especially gloves, safety shoes, and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.	Availability of PPE	Daily	PPE compliance	EPC Contractor	REA (PMU) NDA (Site Engineer)	500
	Unregistered labourers and touts shall not be engaged for off-loading materials.	Employment records of all staff on site	Once before commencement of mobilization	Labour Act	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Increase in vehicular movement and traffic including potential for road accident	A TMP shall be developed by the EPC contractor and implemented	TMP implementation records	Daily	Benchmarks stated in the TMP	EPC Contractor	REA (PMU) NDA (Site Engineer)	1000
	Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided.	Safety signs and barriers	Before and during mobilization	Adherence to measures	EPC Contractor		
	Speed limit around community areas shall be limited to a maximum of 20 km/hr	Evidence of consultation with local community	Before and during mobilization	Adherence to measures	EPC Contractor		
	Drivers' competency shall be assessed and where required, appropriate training shall be provided.	Drivers' competency assessments; training records	Once before commencement of mobilization	Passing of competency assessment or training completion certificates	EPC Contractor		
	A procedure for recording traffic incidents/accidents associated with the Project shall be developed and implemented.	Incident forms	Daily	Completed incident forms	EPC Contractor		
	Employee violations of speed limit and other traffic rules will result in disciplinary action ranging from warning to dismissal.	Incident forms, GRM	Daily	Completed incident forms	EPC Contractor		

Table 7.2a: 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							
Air quality impacts due to emission from construction equipment;	Regular maintenance and servicing of construction equipment /machinery shall be ensured.	Maintenance records	Monthly during construction phase	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer)	1000

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Increase in dust from cleared land and windblown stockpiles	Routine water sprinkling shall be carried out to minimize dust generation during construction.	Inspection	Daily during civil work activities	Adherence to measures	EPC Contractor	Kaduna State Ministry of Environment	
Increase in noise level	Construction activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer) Kaduna State Ministry of Environment	-
	Construction machinery shall be turned off when not in use.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	Construction equipment shall be properly maintained and serviced.	Maintenance records	Monthly during construction phase	Adherence to measures	EPC Contractor		
	Noise complaints related to the construction activities shall be assessed and appropriately addressed.	Complaint records	Weekly during construction phase	World Bank Good Practice Note on Addressing Grievances	EPC Contractor		
	Noise monitoring at locations with persistent noise complaints shall be maintained.	Noise monitoring records	Monthly during construction phase	FMEnv Noise limit World Bank Noise Limit	EPC Contractor		
Increased soil erosion potential; reduction in structural stability and percolative ability of soil	Excavation works shall not be executed under aggressive weather conditions.	Inspection	Daily during excavation activities	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer) Kaduna State Ministry of Environment	-
	Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion.	Inspection	Daily during civil work activities	Adherence to measures	EPC Contractor		
Loss of plant species as a result of introduction of alien plants; loss of fauna as a result of	Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities.	Training records	Once before start of construction phase	Certificates of Training	EPC Contractor	REA-PMU NDA (Site Engineer)	-

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
increased human activity and associated noise.	All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimise introduction of alien species. If sand or other natural materials for building are required and brought onto site, the stored heaps will be monitored for the growth and germination of alien species and will be regularly cleared during construction.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor	Kaduna State Ministry of Environment	
	Regular monitoring will be undertaken to ensure that alien plants are not increasing as a result of the disturbance that has taken place.	Monitoring records	Monthly during construction phase	Adherence to measures	EPC Contractor		
Waste Disposal and Generation							
E-waste generation	A Waste Management Plan shall be developed and implemented	Waste Management records	Weekly during construction phase	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment	2500
	Training shall be provided for workers on safe storage, use and handling of e-waste on site.	Training records	Once before commencement of construction	Certificates of completion of trainings	EPC Contractor		
	E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal	Waste consignment notes, waste receptacles on site	Weekly during construction phase	Adherence to measures	EPC Contractor		
Soil contamination from solid and liquid construction waste streams.	Hazardous substances and materials shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures World Bank General EHS Guidelines	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv	1500
	Construction workers shall be	Training records	Once before	Certificates of	EPC Contractor	Kaduna State	

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	provided with adequate training on use, storage and handling of hazardous substances.		commencement of construction	completion of trainings		Ministry of Environment	
Groundwater contamination of liquid construction waste streams.	Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site.	Training records	Once before commencement of construction	Certificates of completion of trainings	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment	
	Hazardous substances and materials shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures World Bank General EHS Guidelines	EPC Contractor		
	Waste management plan (WMP) shall be developed and implemented.	WMP implementation records	Daily during construction phase	Benchmarks stated in WMP World Bank General EHS Guidelines	EPC Contractor		

Table 7.2b: Social Management Measures for Construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Civil and Electrical Works/ Installation Activities							
Discrimination during employment and training opportunities	Employment of workers for construction activities shall be open and fair. However, no person under the age of 18 shall be engaged on the project sites.	Employment records	Once before start of construction	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of	2000

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
						Environment	
GBV (sexual harassment, intimate partner violence, poor working)	The EEP GBV Action Plan shall be implemented for the Project	Implementation by the EPC Contractor	Once before start of construction	Evidence to show implementation of EEP GBV action plan	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment Kaduna State Ministry of Women Affairs and Social Development GBV/SEA service providers	
	All workers shall be required to undergo regular training and refreshers on GBV	Organize regular onsite training and refreshers	Monthly during construction phase	Records of regular training and attendance	EPC Contractor		
	All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)	Develop CoC forms for workers	Once before start of construction	Signed CoC forms	EPC Contractor		
	GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish accessible GRM reporting channels	Monthly during construction	GRM records	EPC Contractor		
	The EPC Contractor shall be required to hire a Gender/GBV officer	Employ GRM Officer	Once before start of construction	Employment records and job description	EPC Contractor		
	Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured	Engagement of GBV service provider	Once before start of construction	Records of ongoing engagement and consultation with GBV service providers	EPC Contractor		
	The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site	Erection of separate convenience facilities and display of GBV signage	Once before start of construction	Inspection of facilities to ensure adequacy	EPC Contractor		
Influx of people, increase in sexual transmitted diseases.	Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible.	Employment records and prepare a labour management plan	Once before start of construction	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv	3000
	An induction and sensitization programme, including a Code of	Induction records and training on the code of	Once before start of construction	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Conduct, for all construction workers shall be carried out prior to construction activities. This will increase sensitivity to local norms and customs, provide awareness to construction workers of appropriate and acceptable behaviours, and will govern worker interactions / fraternization with the local community.	conduct				Kaduna State Ministry of Environment Kaduna State Ministry of women affairs and Social Development GBV/SEA service providers	
	Awareness education about GBV/SEA/HIV/AIDS and other sexually transmitted diseases shall be created among the workforce and extended to the local community	Training records	Once before start of construction	Adherence to measures	EPC Contractor		
	Public access shall be restricted to construction area via security fencing and appropriate signage	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	All workers on the project shall be required to sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse	Signed code of conduct records	Once before start of construction	Adherence to measures	EPC Contractor		
	The NEP GRM Procedure for receiving and addressing community concerns shall be developed and implemented.	Consultations and grievance records	Weekly during construction phase	World Bank Good Practice Note on Addressing Grievances	EPC Contractor		
Injury to construction workers during construction activities	Health and Safety Plan shall be developed and implemented.	Health and Safety plan implementation records	Daily during construction phase	Benchmarks stated in Health and Safety Plan	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State	4000
	Community members and construction workers shall be sensitized and monitored on the need to be safety conscious. Daily toolbox talks prior to	Daily toolbox records	Daily during construction phase for workers and monthly for	Benchmarks stated in Health and Safety Plan	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	commencement of work activities shall be carried out for all workers.		communities as part of engagement			Ministry of Environment,	
	Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.	Qualified and dedicated safety officer	Once before commencement of construction	Adherence to measures	EPC Contractor		
	PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored.	Availability of PPE	Daily during construction phase	PPE compliance	EPC Contractor		
	Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers.	Training records	before commencement of construction and weekly	Certificates of completion of trainings	EPC Contractor		
	A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented.	Completed grievance forms	Weekly during construction phase	Adherence to measures	EPC Contractor		
	Hazardous substances and materials shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures World Bank General EHS Guidelines	EPC Contractor		
Road damage, traffic and safety impacts	TMP shall be developed by the EPC Contractor and implemented.	TMP implementation records	Daily during construction phase	Benchmarks stated in the TMP	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv	1000
	Speed limits for all construction-related vehicles shall be established and enforced.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	Appropriate barriers and signage	Safety signs and	Once before	Adherence to	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	shall be provided to demarcate areas in which construction traffic is active.	barriers	commencement of construction	measures		Kaduna State Ministry of Environment	
	Drivers' competency shall be assessed and where required training shall be provided.	Drivers' competency assessments; training records	Once before commencement of construction	Passing of competency assessment or training completion certificates	EPC Contractor		
	A procedure for recording all construction related traffic incidents/accidents shall be developed and implemented.	Incident forms	Daily during construction phase	Completed incident forms	EPC Contractor		
	The EPC contractor shall promptly repair damage to public infrastructure and repair or compensate for damage to private property.	Incident forms, GRM	Daily during construction phase	Completed incident forms	EPC Contractor		

Table 7.3a: Environmental Management Measures for Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Plant testing							
Increase in ambient noise level due to Plant testing	Strict compliance to the Standard Operating Procedures (SOPs) shall be ensured.	SOPs	Once before commissioning	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment	500
	The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		
	The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		

Table 7.3b: Social Management Measures for Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Plant testing							
Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Plant testing shall be carried out by experienced personnel.	Qualified and dedicated Engineer	Once before commissioning	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment	200
	Adequate PPE shall be worn	Availability of PPE	Once before commissioning	Adherence to measures			
	Prior to the Plant commissioning, appropriate emergency equipment.	Availability of emergency response equipment	Once before commissioning	Adherence to measures			
Wrong electrical connection leading to explosion/fire	Plant testing shall be carried out by experienced personnel.	Qualified and dedicated Engineer	Once before commissioning	Adherence to measures	EPC Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment	-

Table 7.4a: Environmental Management Measures for Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Power Generation and Evacuation							
Landscape alterations resulting in unpleasant changes in the visual character of the area	All lighting will be kept to a minimum within the requirements of safety and efficiency. Where such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage	Inspection	Monthly during operations	Adherence to measures	O&M Contractor	REA-PMU NDA (Site Engineer) FMEnv	-

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	will be used.					Kaduna State Ministry of Environment	
Routine Maintenance, Waste Generation and Disposal							
E-waste generation and disposal	Training shall be provided for workers on safe storage, use and handling of e-waste on site.	Training records	At induction of new staff , and in annual refresher training	Certificates of completion of trainings	O&M Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment	2000
	E-wastes generated shall be stored in appropriate locations prior to recycling; consignment notes will be maintained	Waste consignment notes, waste receptacles on site	Continuous during operations	Adherence to measures	O&M Contractor		
	Waste receptacles shall be provided within a secured area for collection of solid waste.	Waste consignment notes, waste receptacles on site	continuous during operations	Adherence to measures	O&M Contractor		
Soil contamination from spent batteries and inverters	Waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. Spent batteries and inverters shall be sent to manufacturers in line with the Extended Producer Responsibility (EPR) policy.	Consignment notes for spent batteries to manufacturers for recycling	Yearly	World Bank General EHS Guidelines	O&M Contractor	REA-PMU NDA (Site Engineer) Kaduna State Ministry of Environment	1000
	WMP shall be implemented.	WMP implementation records	Quarterly during operation phase	Benchmarks stated in WMP World Bank General EHS Guidelines	O&M Contractor		
Groundwater abstraction from cleaning of PV panels	Water management / conservation plan shall be implemented	Implementation records of water	Quarterly during operations	Benchmarks in water conservation	EPC Contractor	REA-PMU NDA (Site	500

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
		management plan		plan World Bank General EHS Guidelines		Engineer) Kaduna State Ministry of Environment	

Table 7.4b: Social Management Measures for Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Power Generation and Evacuation							
GBV (sexual harassment, intimate partner violence, poor working)	The EEP GBV Action Plan shall be implemented during operations	Implementation by the O&M Contractor	Continuously during operations	Evidence to show implementation of EEP GBV action plan	O&M Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment	2000
	All workers shall be required to undergo regular training and refreshers on GBV	Organize regular onsite training and refreshers	Monthly during operation phase	Records of attendance			
	All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)	Develop CoC forms for workers	Once before start of operations	Signed CoC forms			
	GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish GRM reporting channels	Once before start of operations	GRM records			
	The EPC Contractor shall be required to hire a Gender/GBV officer	Hire GRM Officer	Once before start of operations	Employment records and job description			
	Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured	Engagement of GBV service provider	Once before start of operations	Records of ongoing engagement and			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
				consultation with GBV service providers			
	The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site	Erection of separate convenience facilities and display of GBV signage	Once before start of operations	Inspection of facilities to ensure adequacy			
Health, safety and welfare of staff during Plant operation	Provision of medical insurance scheme for employees shall be ensured.	Employment forms of employees	Quarterly during operations	Adherence to measures	O&M Contractor	REA-PMU NDA (Site Engineer) FMEnv Kaduna State Ministry of Environment	3000
	Appropriate safety signage shall be placed at strategic locations within the site.	Safety signs	Quarterly during operations	Adherence to measures			
	Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures			
	The NEP grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.	Completed grievance forms	Monthly during operations	Adherence to measures			
Routine Maintenance, Waste Generation and Disposal							
Electric shock, injuries to personnel during maintenance	Appropriate PPE shall be provided for workers.	Availability of PPE	Quarterly during operations	Adherence to measures	O&M Contractor	REA-PMU NDA (Site Engineer) Kaduna State Ministry of Environment	500
	Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures			

7.4 Roles, Responsibilities and Accountabilities

The main responsibility for overseeing the implementation of the ESMP lies with the REA PMU throughout the project life span. However, conformance with the specific environmental measures detailed in Chapter Six of this report will be ensured by the EPC contractor during the construction phase and Operations and Maintenance (O&M) Contractor at the operational phase of the Project.

7.4.1 Pre-construction Phase

The key personnel and institutions with major roles in the implementation of the ESMP during pre-construction phase are:

NDA Director of Physical Planning

- Select the land for the proposed Project
- Appoint a Site Engineer
- Arrange and ensure adequate training is carried out for the Site Engineer
- Review the ESMP from the consultant
- Ensure the University's commitment to the ESMP implementation

REA-PMU

- Provide technical support to the University in identifying sufficient and suitable land for power station construction and the training center
- Appoint an EPC contractor
- Supervise the activities of the EPC contractor
- Review the ESMP from the consultant
- Ensure REA's commitment to the ESMP implementation

NDA Site Engineer

- Attend adequate training on ESMP implementation
- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures
- Report to NDA Director of Physical Planning on ESMP compliance and non-compliance issues

EPC Contractor

- Familiarize with ESMP requirements
- Ensure that all personnel are made aware of the management measures/plans that are to be implemented
- Report to the REA-PMU and NDA Site Engineer on ESMP compliance and non-compliance issues
- Implement ESMP requirements relevant to work being undertaken

7.4.2 Construction Phase

The key personnel and institutions with major roles in the implementation of the ESMP during construction phase are:

NDA Director of Physical Planning

- Supervise the activities of the Site Engineer by reviewing reports on ESMP issues
- Suggest ESMP improvements to REA-PMU to address non-compliance and upcoming issues

REA-PMU

- Supervise the activities of the EPC contractor by reviewing reports on ESMP issues
- Discuss ESMP improvements with NDA Director of Physical Planning to address non-compliance and upcoming issues
- Monitors the implementation of the ESMP

NDA Site Engineer

- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures
- Report to NDA Director of Physical Planning on ESMP compliance and non-compliance issues

EPC Contractor

- Implement ESMP requirements relevant to work being undertaken
- Hire a Gender/GBV officer
- Report to the REA-PMU and NDA Site Engineer on ESMP compliance and non-compliance issues

FMEnv Representatives

- Monitor the implementation of ESMP requirements (impact mitigation monitoring) relevant to work being undertaken
- Discuss ESMP improvements with NDA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

Kaduna State Ministry of Women Affairs and Social Development and GBV service provider

- Monitor the implementation of Gender mitigation measures relevant to work being undertaken
- Discuss ESMP improvements with the Gender/GBV officer, NDA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

Kaduna State Ministry of Environment Representatives

- Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken
- Discuss ESMP improvements with NDA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

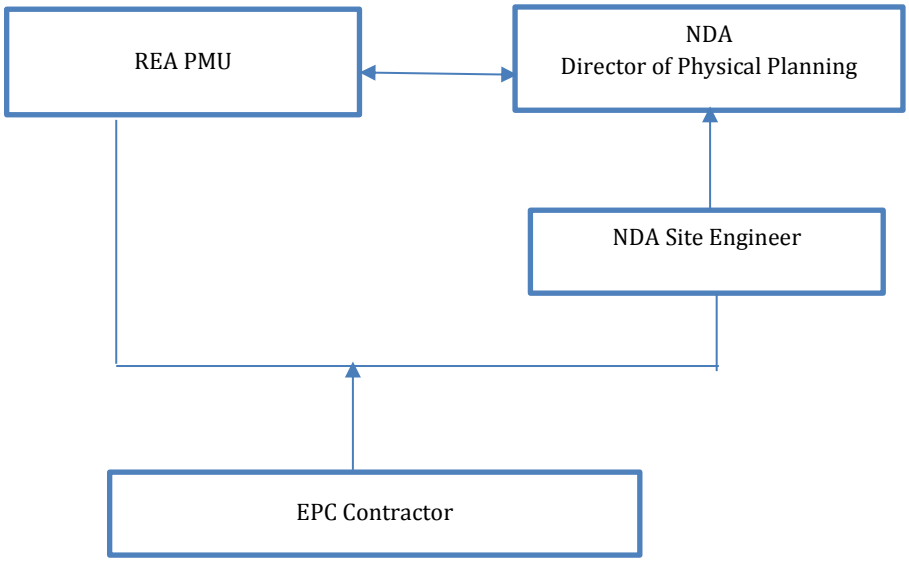


Figure 7.1: Roles and Responsibilities for the Pre Construction and Construction Phase

7.4.3 Operational Phase

NDA Director of Physical Planning

- Supervise the activities of the Site Engineer by reviewing reports on ESMP issues
- Suggest ESMP improvements to O&M Contractor and PMU to address non-compliance and upcoming issues

REA-PMU

- Appoint a O&M Contractor
- Supervise the activities of the O&M Contractor by reviewing reports on ESMP issues
- Discuss ESMP improvements with NDA Director of Physical Planning to address non-compliance and upcoming issues

NDA Site Engineer

- Supervise the activities of the O&M Contractor and ensure compliance ESMP with mitigation measures
- Report to NDA Director of Physical Planning on ESMP compliance and non-compliance issues

- O&M Contractor Implement ESMP requirements relevant to work being undertaken
- Hire a Gender/GBV officer
- Report to the REA-PMU and NDA Site Engineer on ESMP compliance and non-compliance issues

FMEnv Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with NDA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

NESREA Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with NDA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

Kaduna State Ministry of Women Affairs and Social Development and GBV service provider

- Monitor the implementation of Gender mitigation measures relevant to work being undertaken
- Discuss ESMP improvements with the Gender/GBv officer, NDA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

Kaduna State Ministry of Environment Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with NDA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

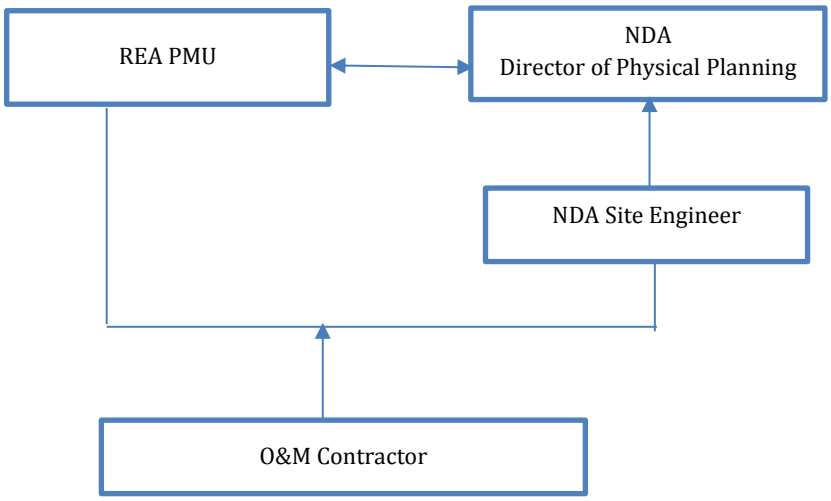


Figure 7.2: Roles and Responsibilities for the Operational Phase

7.5 Additional Management Plans

This section provides a framework for the contents of additional management plans to be developed and implemented, in support of this ESMP, for the proposed Project. As the Project progresses, the management plans will be expanded to include specific procedures to guide implementation by the relevant Project personnel including contractor and subcontractors.

The documents will be prepared strictly in line with the requirements set out in the relevant international standards and guidelines such as the World Bank General EHS Guidelines as well as other applicable national and local regulations and guidelines.

7.5.1 Stakeholder Engagement Plan

A Stakeholder Engagement Plan (SEP) shall be developed and implemented throughout the lifecycle of the proposed Project. The objectives of developing SEP for the proposed Project include the following:

- Ensuring stakeholder inclusion and involvement across the various phases of the project;
- Ensuring clarity and understanding through an open, inclusive and transparent process of culturally appropriate engagement and communication undertaken to ensure that stakeholders are well informed about the proposed Project;
- Building and maintaining productive relationship between REA and its various stakeholders through supporting open dialogue;
- Engaging vulnerable groups through an open and inclusive approach to consultation, thereby increasing the opportunity for stakeholders to provide comment and voice their concerns on the proposed Project;

- Managing expectations to ensure that the proposed Project does not create or allow unrealistic expectations to develop amongst stakeholders about proposed Project benefits. The engagement process will serve as a mechanism for understanding and managing stakeholder and community expectations, where the latter will be achieved by disseminating accurate information in an accessible way.
- Ensuring compliance with both local regulatory requirements and international best practice.
- Ensuring stakeholders are free of external manipulation or coercion.

REA is committed to implementing stakeholder management as part of its operations. As such REA will ensure that the responsibility for implementing the SEP is duly assigned and all components of the plan are well-defined within its organizational processes. REA shall also commit to providing the necessary support to implement the SEP.

In line with the Environmental and Social Management framework (ESMF) for NEP, an effective SEP should:

- ❖ Describe regulatory, lender, company, and/or other requirements for consultation and disclosure.
- ❖ Identify and prioritize key stakeholder groups, focusing on Affected Communities.
- ❖ Provide a strategy and timetable for sharing information and consulting with each of these groups.
- ❖ Describe resources and responsibilities for implementing stakeholder engagement activities.
- ❖ Describe how stakeholder engagement activities will be incorporated into a company's management system.

A sample SEP is outlined in the Environmental and Social Management framework (ESMF) for NEP (NEP ESMF, 2019).

7.5.1.1 Grievance Redress Mechanism

A Grievance Redress Mechanism (GRM) has been developed for NEP. The proposed solar-hybrid power plant and associated infrastructure in NDA is part of the NEP. The GRM provides a framework for addressing Project-related complaints, including logging, tracking, and grievances resolution. The GRM will be communicated to all stakeholders in the course of Project development and implementation and will make publicly available a record documenting the responses to all grievances received. The GRM shall be maintained throughout the project life cycle.

7.5.2 Emergency Preparedness and Response Plan (EPRP)

An Emergency Preparedness and Response Plan (EPRP) shall be developed and implemented for the proposed Power Plant. As part of the EPRP, the fire protection system for the Project will be designed to meet the requirements of the local fire codes under the National Fire Protection Association. In addition, the grounding and lightning protection systems for the Project shall be installed in a manner that will limit the effect of ground potential gradients to such voltage and current levels that will not endanger the safety of people or equipment under normal and fault conditions.

The EPRP shall include procedures for addressing all reasonably foreseeable and possible emergencies such as: fire, spill or release of hazardous wastes, medical and weather-related emergencies. It shall address the following aspects, amongst others:

- Identification of the emergency scenarios and the development of appropriate and specific emergency response procedures for each scenario;
- Training of emergency response teams on the appropriate procedures and the use of emergency response equipment;
- Identification of emergency contacts and support services and the development of effective communication systems / protocols;
- Emergency equipment and facilities must be provided (e.g., first aid stations, fire-fighting equipment, personal protective equipment);
- Development of decontamination / clean-up procedures and identify critical remedial measures to contain, limit and reduce pollution;
- Identification of potential risk relating the uncontrolled release of hazardous materials and the preparation of a spill prevention, control, and response plans including:
    - Training of operators on spill prevention.
    - Implementation of inspection programmes to confirm the integrity of secondary containment structures and equipment.
    - Development of standard operating procedures for filling containers or equipment and the transfer of hazardous materials.
    - Identification and availability of the appropriate personal protective equipment and equipment.

7.5.3 Traffic Management Plan (TMP)

The purpose of this plan is to adopt best transport safety practices across all the aspects of the Project (especially at the construction phase) with the goal of preventing traffic accidents and minimizing injuries suffered by Project personnel and the public. The measures to be included in the TMP should include the following, amongst others:

- Emphasizing safety aspects among drivers;
- Improving driving skills and requiring licensing of drivers;
- Adopting limits for trip duration and arranging driver rosters to avoid overtiredness;
- Avoiding dangerous routes and times of day to reduce the risk of accidents;

7.5.4 Waste Management Plan (WMP)

The primary purpose of the WMP is to ensure that wastes (hazardous/non-hazardous) are avoided or minimized, and any wastes that are generated are properly managed and disposed in an environmentally sound manner. The waste management hierarchy is expressed as follows:

- Prevention: avoid waste generation;
- Reduction at source - minimization of waste generation through installation of pollution abatement equipment;
- Reuse - Using an item for its original purpose, or similar purpose, in its original form;
- Recycling – conversion of waste materials into reusable objects;
- Disposal - disposal of wastes in an environmentally sound manner.

7.5.5 Occupational Health and Safety (OHS) Plan

The OHS plan must include the following elements, amongst others:

- Identification of potential hazards and development of responses to eliminate sources of risk or minimize workers' exposure to hazards;
- Provision of Personal Protective Equipment (PPE) to workers at no cost;
- Provision of training to all workers on all relevant aspects of occupational health and safety issues associated with their daily work, including emergency arrangements;
- Third parties (visitors and external service providers) must be briefed on the relevant aspects of health and safety and emergency response when accessing the site premises;

7.5.6 Local and Employment Management Plan (LEMP)

The LESMP should aim to promote Employment opportunities and training for local people in the Project's area of influence and include, amongst others:

- Targets for employing local labour;
- Targets for work experience opportunities;
- Notification of all Employment and training opportunities prior to them being advertised elsewhere;

- Measures to provide verifiable monitoring information regarding training and Employment. The training status for all workers must be recorded;

7.5.7 Erosion Control Management Plan

This Plan should aim to control soil erosion in the Project area. The timing of works and the installation of control measures has a major influence on the management of storm water. The Plan should include the following measures, amongst others:

- Clearing of only those areas necessary for construction works shall be ensured.
- Slopes of all cut and fill areas shall be rigorously controlled and will at no time be allowed to be greater than the slope established in the final design;
- Piles of soil or other materials shall be allowed for short periods of time and will be located only in flat areas and away from any storm water courses;
- Temporary protection of exposed soil surfaces with measures such as plastic film, bio-membranes or other means, will be implemented whenever necessary;

7.5.8 Water Conservation Plan

The Plan will address the appropriateness of water conservation, and efficient use of groundwater for construction activities and cleaning of PV panels during the operational phase of the Project.

7.5.9 EEP Gender-Based Violence (GBV) Action Plan

The GBV action plan shall be implemented throughout the project lifecycle. The components of the plan include:

- A GBV risk assessment; which has been conducted as part of the ESIA.
- Integration of GBV risk management in the ESMP.
- REA-PMU shall define GBV requirements in the contractor bid documents including the hiring of a Gender/GBV officer.
- REA-PMU shall evaluate GBV response protocol of the contractors before finalizing engagement contract.
- Contractors shall ensure that there are GBV-sensitive channels for reporting in GRM.
- Contractors shall inform Project affected communities about GBV risks.
- Contractors shall ensure code of conducts (CoC) forms are signed and understood by all workers. Workers shall be trained on CoC including regular training and refreshers

- Contractors shall ensure separate facilities for men and women and install GBV-free signage at the Project site.

Timely implementation of the EEP GBV action plan shall reduce GBV/SEA risks that may arise during Project development and operation.

7.5.10 Summary of Additional Management Plans

Table 7.5 summarizes the additional management plans required for the Project, including the cost estimate for developing each of the plans.

Table 7.5: Additional Management Plans and Timing for Development

S/N	Plan	Timing for Development	Cost Estimates (US Dollars)
1.	Emergency Preparedness and Response Plan	Pre-construction	2000
2.	Traffic Management Plan	Pre-construction	2000
3.	Waste Management Plan	Pre-construction	3000
4.	Occupational Health and Safety	Pre-construction	2000
5.	Local and Employment Management Plan	Pre-construction	1500
6.	Erosion and Sediment Control Plan	Pre-construction	2000
7.	Water Conservation Plan	Pre-construction	1000
8.	EEP Gender Action Plan	Pre-construction	2000
9.	Stakeholder Engagement Plan	Pre-construction	2000
Total			17,500

7.6 Environmental Monitoring Programme

Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Table 7.6 summarizes the environmental monitoring programme for the Project.

Table 7.6: Environmental Monitoring Programme for the proposed Project

Environmental Components/ Matrix	Sampling Locations	Sampling Method	Environmental/ Social Parameters to be monitored	Compliance Requirement	Frequency of Monitoring	Responsible Party	Project Development Phase	Estimated Cost (US Dollars)
Atmosphere (Air Quality & Noise)	• Project Site • Power evacuation route	• Air Quality Monitoring Equipment • Sound level meter	TSP, CO, NO_x, SO_x, Noise Level (dBA)	FMEnv/ WHO/ World Bank	Monthly monitoring; Monthly reporting	EPC Contractor	• Construction Phase	1000
Groundwater Quality	Borehole within the University	Thermometer, Water sampler, Turbidity meter, pH meter, AAS etc.	Temperature, pH, salinity, TDS, conductivity, DO, BOD, TOC, COD, NO_3, PO_4, Chloride, sulphate, Microbiology, Heavy metals, TSS and Turbidity	FMEnv/ WHO	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	• Construction Phase • Operations Phase	4000
Soil	Unpaved sections of the Plant	Composite soil samples collection for laboratory analysis.	pH, Moisture, TOC, THC, TPH, NO_3, PO_4, Chloride, sulphate, Microbiology, Heavy metals.	NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	• Construction Phase • Operations Phase	4000
Solid Waste	Operational areas	Monitor the handling and disposal of solid wastes generated onsite; waste tracking documentation.	Operational solid wastes including used packaging waste.	FMEnv/NESREA/ World Bank	Monthly monitoring; Quarterly reporting	EPC Contractor O&M Contractor	• Construction Phase • Operations Phase	2000
Health and Safety	Workers and Operational areas	Observe compliance to PPE and unsafe working conditions	Health and Safety Plan	FMEnv/NESREA/ World Bank	Daily monitoring; Quarterly reporting	EPC Contractor O&M Contractor	• Construction Phase • Operations Phase	2000
Training	Workers	Observe compliance with existing training plan	Training plan and records	FMEnv/NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	• Construction Phase • Operations Phase	2000
General Housekeeping	Construction sheds and operational areas	Observe cleanliness and aesthetics of Plant	Cleanliness and aesthetics of Plant	FMEnv/NESREA/ World Bank	Daily monitoring; Quarterly reporting	EPC Contractor O&M Contractor	• Construction Phase • Operations Phase	2000
Stakeholder Engagement	• Local community • Regulatory agencies	Observe evidence of stakeholder consultations	Stakeholder Engagement Plan	FMEnv/NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	• Construction Phase • Operations Phase	2000

7.7 Training, Awareness and Capacity Building

REA shall identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environmental or social conditions. The Project recognizes that it is important that employees at each relevant phase of the Project are aware of the potential impacts of their activities; and roles and responsibilities in achieving conformance with the management measures documented in this ESMP. This will be achieved through a formal training process.

In addition, training for local community on general environmental awareness and ESMP mitigation measures pertaining to community health, safety and security shall as be provided as indicated in Table 7.7.

Table 7.7: Institutional Capacity Strengthening Plan

Target Audience	Training Overview	Cost Estimates (US Dollars)
Site Engineer, REA, EPC contractor and their sub-contractors, O&M contractor	In-depth understanding of the mitigation measures proffered by the ESMP. Training on implementation of all emergency response procedures; training on Health, Environment, Safety, and Security Management Plan	2000
Local community	General environmental awareness and mitigation measures proffered by the ESMP pertaining to community health, safety and security.	1000
Total		**3000**

7.8 Implementation Schedule and Reporting

The implementation of the ESMP will take place from the planning stages to ensure quality equipment and support services is sourced, through construction, commissioning, operation to decommissioning phases. Once monitoring of the ESMP begins the officers responsible will report all issues identified to respective authorities in REA and corrective/ remedial actions taken without delay to ensure optimal performance of the Project while promoting environmental sustainability.

Also, REA shall keep the regulatory authorities (FMEnv, NESREA, Kaduna State Ministry of Environment) informed of the Project performance with respect to E&S related matters through reports that will be made available to the regulators when required. REA will provide appropriate documentation of HSE related activities, including internal inspection records, training records, and reports to the relevant authorities.

7.9 ESMP Costing

Table 7.8 provides the summary of cost estimate required to effective and efficiently implement the recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed Project.

Table 7.8: ESMP Costing

S/N	Fundamental ESMP Activities	Cost Estimates (US Dollars)
1.	Pre-construction phase E&S management activities	4,000
	Construction phase E&S management activities	13,500
	Commissioning phase E&S management activities	700
	Operational phase E&S management activities	9,000
2.	Preparation of additional management plans	17,500
3.	Institutional Capacity Strengthening Plan	3,000
4.	Monitoring and Evaluation Programme	19,000
Total		**66,700**

CHAPTER EIGHT:

REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

CHAPTER EIGHT

REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

8.1 Introduction

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

8.2 Decommissioning Activities

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

The decommissioning activities will typically include the following:

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

8.3 Management of Decommissioning Activities

In the event of decommissioning, REA, in conjunction with the leadership of NDA, shall ensure that the Project site is left in a safe and environmentally acceptable condition. A standard decommissioning, abandonment and closure programme shall be invoked. The tasks will include, amongst others:

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

- Monitoring the abandoned project environment as necessary.

Decommissioning activities will only begin after due consultation with the relevant stakeholders including the regulatory authorities. The decommissioning activities shall be carried out in line with the relevant provisions of the National Guidelines for Decommissioning of Facilities in Nigeria (2017) issued by the FMEnv.

Typically, the following actions shall be undertaken for decommissioning:

- An updated plan which takes into account the most cost-effective and best practicable methods, legal requirements and industry practices at that time for the facility decommissioning shall be developed and submitted to the FMEnv and other relevant regulatory authorities for approval. The plan shall include, but not limited to the following:
    - Description of the site and components to be decommissioned.
    - Description of the decommissioning scope, objectives, end state and strategy;
    - Activities to be performed during the decommissioning;
    - Schedule of decommissioning activities;
    - Estimate of the decommissioning cost;
    - Estimated inventory of waste streams to be generated during the decommissioning and handling techniques;
    - Decommissioning team (qualifications, roles and responsibilities)
- To ensure that due consideration is given to all options a detailed evaluation of facility decommissioning options shall be carried out. The options will include facility mothballing, partial facility decommissioning or complete site decommissioning. The evaluation will consider environmental issues in conjunction with technical, safety and cost implications to establish the best practicable environment friendly options for the Project decommissioning.
- A risk assessment shall be conducted to ensure that nothing, which could be constituted as a hazard for other users of the site or for the environment in general, will be left at the site. The Project site shall be left in a safe and environmentally acceptable condition.
- Hazard identification and analysis shall be conducted to determine special safety concerns to be addressed.
- An appropriate Health, Safety and Environment (HSE) plan shall be implemented to ensure that the decommissioning activities are carried out in an environmentally sound manner and in conformity with relevant laws and regulations guiding such operations
- Third party notifications shall be carried out before any demolition and shall be conducted in a phased sequence.

- Socio-economic considerations of facility decommissioning shall be carried out. These will include assessment of potential effects associated with termination of employment (at the end of operational phase) and the measures to minimize the effects by:
    - Ensuring that employees are fully informed about the decommissioning and how it will affect them before the project finally closes.
    - Building community capacity to manage opportunities and impacts arising from the decommissioning and post-decommissioning phase of the Project.
    - Providing training to build local skills tailored to project decommissioning and post-decommissioning activities (e.g. equipment dismantling, rehabilitation activities, monitoring, etc.).
    - Providing training to transfer project-learned skills to alternative and secondary industries tailored to respond to market economy.
- An effective waste management plan shall be developed for the decommissioning activities. The decommissioning options for redundant structures and equipment will include: the complete dismantling of structures and equipment and the return of all components to the equipment manufacturer for recycling. A detailed record of all suitable recycling materials shall be maintained.

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

8.3.1 Used Battery Management at Decommissioning Phase

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

Conversely, the University shall be encouraged to develop end-of-life management plans for the batteries and other electrical components. The plan shall include the development of procedures for safe handling, storage, and transport of the used batteries generated during Project operations. Also, procedures for identification and engagement of NESREA certified battery recycling companies based in Nigeria shall be developed and implemented for the Project.

8.4 Abandonment Plan

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

- Identification of the components of the Project that will be abandoned and/or removed;
- The proposed methods for abandonment or re-use of the Project equipment/material applicable;
- Processes put in place to mitigate potential environmental impacts associated with the abandonment process; and
- Appropriate site rehabilitation programs (including re-vegetation of the site with native plant species) to return the Project site to its original status (as much as possible).

The decommissioning, abandonment and/or closure programme shall generally be managed by a team of competent personnel from REA-Project Management Unit, the Department of Works and Physical Planning in NDA, the Federal Ministry of Environment and the Kaduna State Ministry of Environment. A close out report shall be prepared and archived for future reference.

8.5 Roles, Responsibilities and Accountabilities for Decommissioning Phase

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

<u>Contractor(s) Engaged for Decommissioning Activities</u>

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

<u>REA-PMU</u>

- Supervise the activities of the contractor(s) engaged for decommissioning purpose by ensuring that the recommended environmental and social measures and management actions are implemented.

- Discuss environmental and social management plan improvements with the Director of Works and Physical Planning Department in NDA to address non-compliance and upcoming issues.

NDA Site Engineer/Manager

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

Director of Works and Physical Planning Department in NDA

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

FMEnv/Kaduna State Ministry of Environment Representatives

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

Table 8.1: Environmental and Social Management Measures for Decommissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Removal of PV panels, batteries and inverters; demolition of buildings and associated facilities							
Soil contamination due to waste generation; soil compaction;	Excavation works shall not be executed under aggressive weather conditions.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	REA-PMU NDA (Site Manager and Director of Works and Physical Planning) FMEnv Kaduna State Ministry of Environment	5000
	Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion	Inspection	Daily	Adherence to measures			
	Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment (bund wall). Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily	Adherence to measures World Bank General EHS Guidelines			
	PV panels, batteries and inverters shall be collected and returned to the manufacturer for recycling.	Consignment notes for batteries to recycling plants	Daily	World Bank General EHS Guidelines			
	All impacted soil area shall be re-vegetated with native plant species	Inspection	Daily	Re-vegetated land			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	A decommissioning plan approved by the relevant regulatory authorities shall be developed and implemented.	Implementation records of decommissioning plan	Daily	Benchmarks in decommissioning plan			
Air quality impact; increase in dust level.	Dust suppression measures shall be implemented.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	REA-PMU NDA (Site Manager and Director of Works and Physical Planning) FMEnv Kaduna State Ministry of Environment	1000
	Decommissioning equipment shall be properly serviced and maintained.	Inspection; Maintenance records	Before commencement of decommissioning activities	Adherence to measures			
Discomforting noise from decommission-ing equipment and related activities	Noise suppression equipment (e.g. mufflers) shall be fitted on decommissioning equipment / machinery.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	REA-PMU NDA (Site Manager and Director of Works and Physical Planning) FMEnv Kaduna State	2000
	Decommissioning activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Inspection	Daily	Adherence to measures			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Equipment shall be turned off when not in use.	Inspection	Daily	Adherence to measures		Ministry of Environment	
	Equipment shall be properly maintained and serviced.	Inspection; Maintenance records	Once before commence ment	Adherence to measures			
	Noise complaints related to the construction activities shall be assessed and appropriately addressed.	Complaint records	Weekly	World Bank Good Practice Note on Addressing Grievances			
	Noise monitoring at locations with persistent noise complaints shall be maintained.	Noise monitoring records	Monthly	FMEnv Noise limit World Bank Noise Limit			
Groundwater and surface water contamination due to waste generation	Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site.	Training records	Once before commence ment	Certificates of completion of trainings	Contractor(s) engaged for facility decommissioning	REA-PMU NDA (Site Manager and Director of Works and Physical Planning) FMEnv Kaduna State Ministry of Environment	1500
	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	Inspection	Daily	Adherence to measures World Bank General EHS Guidelines			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	and clean-up kits shall be available onsite.						
	Waste Management Plan shall be implemented.	WMP implementation records	Daily	Benchmarks stated in WMP World Bank General EHS Guidelines			
Traffic due to transportation of dismantled equipment and materials from site including wastes	TMP shall be implemented.	TMP implementation records	Daily	Benchmarks stated in the TMP	Contractor(s) engaged for facility decommissioning	REA-PMU NDA (Site Manager and Director of Works and Physical Planning) FMEnv Kaduna State Ministry of Environment	2500
	Appropriate barriers and signage shall be provided to demarcate areas in which traffic is active.	Safety signs and barriers	Once before commencement	Adherence to measures			
	Drivers' competency shall be assessed and where required training shall be provided.	Drivers' competency assessments; training records	Once before commencement	Passing of competency assessment or training completion certificates			
	A procedure for recording all decommissioning related traffic incidents/accidents shall be developed and implemented. This will include date/time, location, reason for accident, corrective	Incident forms	Daily	Completed incident forms			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	measures, etc.						
Exposure to injuries, electrical shock, slip, trip and fall	All workers involved in the decommissioning activities shall be sensitized and monitored on the need to be safety conscious. Daily toolbox talks prior to commencement of work activities shall be carried out.	Daily toolbox records	Daily	Benchmarks stated in Health and Safety Plan	Contractor(s) engaged for facility decommissioning	REA-PMU NDA (Site Manager and Director of Works and Physical Planning) FMEnv Kaduna State Ministry of Environment	2500
	Appropriate PPE shall be provided for workers.	Availability of PPE	Daily	PPE compliance			
	Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.	Qualified and dedicated safety officer	Once before commencement	Adherence to measures			
	Health and safety plans shall be implemented.	Health and Safety plan implementation records	Daily during construction phase	Benchmarks stated in Health and Safety Plan			

CHAPTER NINE:

STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

CHAPTER NINE

STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

This chapter describes the Stakeholder engagement activities as well as the grievance mechanism to be implemented for the proposed 2.5 MW solar power plant and associated infrastructure in Nigerian Defence Academy (NDA), Kaduna State, as part of the Federal Government of Nigeria (FGN) Energizing Education Programme (EEP) Phase II.

9.1 Stakeholder Engagement

Stakeholder engagement is an ongoing process of sharing Project information, understanding stakeholder concerns, and building relationships based on collaboration. Stakeholder consultation is a key element of engagement and essential for effective Project delivery. Disclosure of information is equally as vital and must focus on informed consultation and participation with the local community and relevant stakeholders. If there are risks or adverse impacts from a Project, consultation must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views. In line with current guidance from the World Bank, consultation should ensure "*that appropriate project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible and appropriate manner and format*" In other words, effective consultation requires the prior disclosure of relevant and adequate Project information to enable stakeholders to understand the risks, impacts, and opportunities. The Project's consultation program was intended to ensure that stakeholder concerns are considered, addressed and incorporated in the development process, especially during the ESIA.

9.2 Legal and Administrative Framework Guiding Stakeholder Engagement

The stakeholder engagement was carried out to ensure compliance with both Nigerian legislative requirements, as well as international standards (as defined in the World Bank's Safeguard Policy – Operational Policy 4.01, Environmental Assessment). This section presents the relevant standards and legislation that relate directly to the public participation and stakeholder engagement requirements for the proposed Project.

9.2.1 Nigerian Legislative Requirements

9.2.1.1 EIA Act No. 86 of 1992 (as amended by the EIA Cap E12 LFN 2004)

The EIA Act is the primary Act governing the environmental and social assessment of developmental projects or activities in Nigeria. Section 2(2) of the Act requires

that where the extent, nature or location of a proposed project or activity is such that it is likely to significantly affect the environment, an EIA must be undertaken in accordance with the provisions of the Act.

Section 55 of the EIA Act provides for the maintenance of a Public Registry to facilitate public access to records relating to environmental assessments. Public hearings to which interested members of the public are invited are a key part of the approval process for EIA reports by the Federal Ministry of Environment (FMEnv). However, this project shall not be subject to a public hearing but rather an in-house review to be conducted by the FMEnv. This arrangement was adopted based on the abridged EIA process for the Nigeria Electrification Projects (NEP), which has been approved by the FMEnv.

9.2.2 International Requirements

9.2.2.1 World Bank requirements for Stakeholder Engagement and Information Disclosure

The project will endeavour to meet standards and requirements set out by the World Bank safeguard policies as defined below:

- *World Bank OP 4.01 - Environmental Assessment*

If there are risks or adverse impacts from the Project, engagement must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views. Engagement should ensure 'free, prior and informed engagement of the affected communities (1).' The World Bank Operational Policy (OP) 4.01 requires at least one round of engagement early in the Environmental and Social Impact Assessment (ESIA) process, and again one on the draft ESIA report before decision-making. In other words, effective engagement requires the prior disclosure of relevant and adequate project information to enable stakeholders to understand the risks, impacts, and opportunities.

9.3 Objectives of Stakeholder Engagement

The stakeholder engagement process was designed to conform to the Nigerian EIA Act and international standards. For this Project, the key objectives for stakeholder engagement are:

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

- take into account the views of stakeholders in the development of effective mitigation measures and management plans; and
- lay the foundation for future stakeholder engagement.

9.4 Stakeholder Identification and Analysis

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively (IFC, 2007). Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organizations and groups with special interests, the academic community, or other businesses.

Proper stakeholder identification forms the basis on which the stakeholder engagement was conducted for the Project as well as the development of the stakeholder engagement plan. It is necessary to determine who the stakeholders of a project are and understand their priorities and objectives. In addition it is also essential that stakeholders are classified based on their position, influence, capacity and interests in order to develop a functional Stakeholder Engagement Plan (SEP) that is tailored to meet the individual and group needs of the identified stakeholders.

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

A list of identified stakeholders for the Project is shown in Table 9.1. This consists of individuals, groups, and organizations that may be affected by or may influence project development positively or negatively. The list was developed using international guidance and considered the following groups: national and local governments; Local community leaders; community members including potentially vulnerable sub-groups such as women, youth and elderly; international, national and local environmental and social Non-Government Organizations (NGOs); Potential contractors and service suppliers; and local businesses/cooperatives and associations.

Table 9.1: Identified stakeholders associated with the Project

Stakeholder Group and Interest in the proposed project	Stakeholder Name	Stakeholder Level				Connection to the Proposed Project
		International	National	State	Local	
Development Financial Institution	World Bank	✓				Provide financial and technical support to Project development and operation
Regulatory Authorities	Federal Ministry of Environment (FMEnv)		✓			Has the responsibility for overseeing EIA process for the proposed Solar Projects and ensuring compliance to relevant environmental laws and regulations
	National Environmental Standards and Regulations Enforcement Agency (NESREA)		✓			Has the responsibility of enforcing the environmental laws, guidelines, standards and regulations in Nigeria, specifically during the operational phase of developmental projects.
	Federal Ministry of Power (Department of Renewable Energy)		✓	✓		The Department of the Renewable Energy and Rural Power Access of the Federal Ministry of Power, Works and Housing is charged with the responsibility to coordinate all issues relating to renewable energy and energy efficiency
	Nigerian Electricity Regulatory Commission (NERC)		✓	✓		Responsible for granting operating licences for the Solar Projects
	Kaduna State Ministry of Environment		✓	✓		The Ministry oversees the protection of environment in Kaduna State
	Kaduna State Environmental Protection Authority		✓	✓		Responsible for waste management in Kaduna State
	Kaduna State Ministry of Women Affairs and Social Development		✓	✓		Promotes the development of women with equal rights and corresponding responsibilities including gender inclusion
	Kaduna State Ministry of Sports and youth development		✓			Responsible for the inclusion of youths in Nigeria's development as well as the coordination of sports and recreational activities in the state

Stakeholder Group and Interest in the proposed project	Stakeholder Name	Stakeholder Level				Connection to the Proposed Project
		International	National	State	Local	
	Igabi Local Government Authority			✓		
Communities	Mando Community				✓	Households, communities and groups that may be directly or indirectly affected by the proposed Project and its activities.
University Representatives	Management of NDA				✓	Direct Project beneficiaries.
	Physical Planning Office				✓	
	NDA Student Union Body				✓	
Project Affected persons	Farmers within the project site				✓	Farmers are all families of NDA staff with farmlands on the project site.

9.4.1 Stakeholder Register

The project shall maintain a stakeholder engagement register for recording stakeholder information such as contact details, dates of engagement with comments and follow up requirements. A sample stakeholder engagement register is provided Appendix 9.1.

9.4.2 Stakeholder Engagement Process

REA shall adopt a proactive approach towards building and maintaining mutually beneficial relationships with all relevant stakeholders, throughout its operations. The engagement program shall be implemented to comply with national and international standards. The stakeholder engagement will be free of manipulation, interference, coercion, and intimidation. It shall be conducted on the basis of timely, relevant, understandable and accessible information.

Effective stakeholder engagement depends on mutual trust, respect and transparent communication between the Project and its stakeholders. It thereby improves REA's decision-making and performance by:

- **Managing costs:** Effective engagement can help project REA avoid costs, in terms of money and reputation;
- **Managing risk:** Engagement helps project REA and communities to identify, prevent, and mitigate environmental and social impacts that can threaten project viability;

- **Enhancing reputation:** By publicly recognising human rights and committing to environmental protection, REA and financial institutions (World Bank) involved in financing the project can boost their credibility and minimise risks;
- **Avoiding conflict:** Understanding current and potential issues such as land rights and proposed project activities;
- **Improving corporate policy:** Obtaining perceptions about a project, which can act as a catalyst for changes and improvements in REA corporate practices and policies;
- **Identifying, monitoring and reporting on impacts:** Understanding a project's impact on stakeholders, evaluating and reporting back on mechanisms to address these impacts; and
- **Managing stakeholder expectations:** Consultation also provides the opportunity for REA to become aware of and manage stakeholder attitudes and expectations.

Table 9.2 presents elements of the stakeholder engagement program to be implemented by REA.

Table 9.2: Stakeholder Engagement Process

Stakeholder Engagement Activity	Approach
Stakeholder Identification and Analysis	An initial stakeholder identification and analysis has been conducted as part of this ESIA. REA shall maintain a register of identified stakeholders and undertake periodic review on a need basis.
Information Disclosure	REA shall ensure that information is provided to relevant stakeholders on an on-going basis over the course of the Project lifecycle. REA shall maintain regular communication with its stakeholders throughout the project lifecycle.
Stakeholder Consultation	REA shall consult with its various stakeholders on mutual concerns to fulfil its compliance obligations in line with industry best practice. REA shall maintain records of its consultation with its various stakeholders.
Negotiation and Partnerships	REA shall adopt a stakeholder management process that fosters the mutual interest of all parties and adds value to its operation.
Grievance Management	REA shall provide appropriate channels for stakeholders to raise their concerns and grievances about its operations
Stakeholder Involvement	This entails procedures that allow the direct involvement of stakeholders in project related functions in order to foster transparency and credibility.
Reporting to Stakeholders	REA shall establish reporting procedure that allows information disclosure to stakeholders about the environmental social and economic performance of its operations.
Management Functions	REA shall build and maintain management capacity within the company to manage the process of stakeholder engagement, track commitments and report on progress.

9.4.3 Stakeholder Engagement Tool and Communication

REA recognizes the need to tailor its stakeholder engagement approach and information disclosure to suit the needs of each of its stakeholder. REA shall adopt a

variety of communication and engagement methods to ensure continuous engagement, dialogue and feedback is established during its engagement activities. Table 9.3 presents various tools and methods to be adopted by REA during its stakeholder engagement process.

Table 9.3: Stakeholder Engagement Tools and Communication

Medium	Most Appropriate Application
Stakeholder meetings	
One-on-one consultations	REA shall on a need basis hold consultation meetings with its individual stakeholders. These meetings will be held to: • Solicit views and opinions; • Discuss freely and confidently about stakeholder concerns and provide feedback etc.; • Build personal relations with stakeholders.
Focus group discussions	REA shall on a need basis hold focus group discussions (FGDs) to pull together a small group of people with the same interest into a single meeting to engage them on common issues. FGDs would have specific objective and be aligned with the expectations and interest of the stakeholders present.
Workshops	REA shall on a need basis hold workshops with its various stakeholders. Workshops are ad-hoc outcomes based meetings that seek to find solutions for specific issues facing the environment and social aspects. When conducting a workshop, REA shall use participatory exercises to facilitate group discussions, brainstorm issues, analyse information, and develop recommendations strategies.
Forum	REA shall on a need basis use forums to engage with various stakeholders. Participatory tools and methodologies such as workshops, town hall meetings, and FGDs will continue to be utilized, as they are more likely to increase stakeholder involvement in the process and elicit alternative responses, especially if there is controversy or complexity, or a need to build a consensus around possible solutions.
❖ Written / visual/electronic communication	
	REA shall use a variety of communication methods to disseminate information to its stakeholders. The approach adopted shall be based on the nature of the issue and the concerned stakeholder. External communications will include: ○ Project newsletters ○ Emails ○ Meetings ○ Executive Summary of the Environmental Impact Assessment ○ Mass Media, newspapers print etc. ○ Surveys

Table 9.4 presents a stakeholder analysis with respect to appropriate levels of consultation for each of the major stakeholder groups. REA shall determine the frequency of these interactions.

Table 9.4: Stakeholder Group Consultation Methods

STAKEHOLDER GROUP	CONSULTATION METHOD
Government and Regulators	• Email exchanges and letters • One-on-one consultations • Formal meetings • Print media • Compliance reporting

STAKEHOLDER GROUP	CONSULTATION METHOD
	• Performance report (Audits)
Project beneficiaries (NDA Management, Physical Planning, Students)	• Formal meetings • One-on-one consultations • Print media • Strategic collaboration • Information Centre
Employees	• Phone / email / text messaging/ WhatsApp • Print media • Workshops • Focus group meetings • Surveys • Management/departmental meetings • Performance appraisal • Trainings
NGO's	• Phone / email • One-on-one interviews • Town hall meetings • Focus group meetings • Information Centre

9.4.4 Principles for Effective Stakeholder Engagement

Stakeholder engagement is usually informed by a set of principles defining core values underpinning interactions with stakeholders. Common principles based on International Best Practice include the following:

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

9.4.5 Summary of Previous Stakeholder Engagement Activities

This section describes the initial Stakeholder engagement activities carried out during the ESIA. The initial consultations were carried out from August 3 to 6, 2019 with the following:

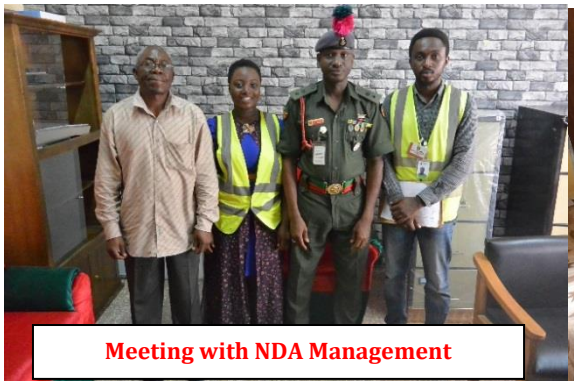
- Kaduna State Ministry of Environment and Natural Resources
- Kaduna State Environmental Protection Authority
- Kaduna State Ministry of Women Affairs and Social Development

- Kaduna State Ministry of Youth and Sports
- Management of Nigerian Defense Academy
- NDA Physical Planning Office
- Igabi Local Government
- Seriki of Mando (Local community)
- Civil Society Organizations
    - Empowering Women for Excellence Initiative (EWEI)
- Farmers within the Project site

The consultations served to provide stakeholders with information about the proposed Project and to gather information important to the ESIA. The objective was to identify any key concerns or high level issues that the stakeholders had at this early stage. Prior to the consultation, notification letters and Background Information Documents (BID) were sent to the stakeholders to provide high level information about the proposed Project. The notification letters and BID are provided in Appendix 9.2. Plate 9.1 shows some sample photographs of the stakeholder consultation exercise carried out during the ESIA.

Meeting with Kaduna State Ministry of Environment and Natural Resources

Meeting with Kaduna State Environmental Protection Authority



Meeting with NDA Management

Meeting with EWEI (NGO)

Plate 9.1: Sample pictures taken during Stakeholder Consultations

Records (attendance sheets) of consultation meetings are also provided in Appendix 9.2 while Table 9.5 below summarizes the findings of the stakeholder consultation meetings.

Table 9.5: Initial Stakeholder Consultation Findings

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
Kaduna State Ministry of Environment	ESIA Process and Stakeholder consultation	– The Project is a welcome development as it will produce power using renewable energy – The ESIA study should involve the local community and farmers on the Project site – The site selected for the Project should not be within any ecologically sensitive areas – All relevant stakeholders should be consulted – The baseline data gathering should be carried out with the correct procedures – Waste management plan should be developed to handle wastes generated from the Project –	– All relevant stakeholders to the project have been identified and will be consulted during the scoping phase – The site selected for the Project is a greenfield area characterized by farms. The Project will avoid any ecologically sensitive areas – The local community to the project has been identified and the people will be consulted accordingly – The baseline data gathering exercise for the Project will be carried out using the appropriate QA/QC procedures – A robust waste management plan will be developed and implemented for the Project
Kaduna State Environmental Protection Authority	ESIA process and stakeholder consultation	– All relevant regulation in the state should be applied to the Project	– A waste management plan that includes e-waste management will

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
		– All relevant stakeholders (including the local communities) should be consulted – The proponent should develop a site-specific waste management plan that includes E-waste	be developed and implemented for the Project
NDA Physical Planning Unit	Stakeholder consultation	– The Project is a good initiative for the University. – The land selected for the Project site has been approved by the management. – The affected farmers on the site will be notified and relocated to other available lands within the University	– All comments were duly noted –
Seriki of Mando Community	Stakeholder consultation	– The Project is a welcome development. – They would appreciate it if youths from the communities can be given employment – There are some people from the community that work as laborers on some of the farms inside NDA – The community has a good relationship with NDA Management	– A percentage of the workforce for the Project will be drawn from the host community –
Empowering Women For Excellence Initiative	ESIA process and stakeholder consultation	– The women that work on the Project site should be assigned the jobs that they can perform – The Project should provide a safe environment for the women and girls that would be employed during construction and operations – There should be mechanisms/procedure to address grievances raised by women working on the Project site	– Women will not be discriminated against during the employment process – Policy and procedures will be put in place to ensure a safe and fair working environment for the women employed for the Project.
Farmers on the Project site	Stakeholder consultation	– They are families of NDA staff	– The farmers will be notified by NDA before

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
		– They registered and obtained permission to use the Land from NDA Management – They have no legal claim to land and do not pay to use it – The farm is not their major source of livelihood and their harvest is for personal consumption	commencement of Project development and they will be given sufficient time to harvest their crops – NDA management will provide alternative land for them to continue their farming within the campus

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

9.5 Management Function and Grievance Mechanism

9.5.1 Management Commitment

REA is committed to implementing stakeholder management as part of its operations. As such REA will ensure that the responsibility for implementing the SEP is duly assigned and all components of the plan are well-defined within its organizational processes. REA shall also commit to providing the necessary support to implement the SEP. The management structure for the SEP shall include the following elements.

Systems: REA will pursue its Stakeholder engagement activities as scheduled in a systematic manner that creates predictability in the eyes of the stakeholder in order to support and foster a relationship that is based on trust.

Structure: REA will establish a Stakeholder focused-structure within its organizational processes to provide the needed decision-making authority to enable quicker turnaround time on Stakeholder engagement activities and grievance feedback.

Skills: REA will ensure that the required internal capacity for effective Stakeholder engagement is provided for the implementation of the stakeholder engagement plan.

9.5.2 Roles and Responsibilities

REA shall assign the responsibilities of conducting and organizing stakeholder consultation and involvement to competent individuals. The individuals shall be qualified professionals with relevant skills and experience. The REA Project Management Unit shall have the overall responsibility of overseeing the implementation of the SEP. The role of managing stakeholder engagement shall be given to the University's Community Liaison Officer (CLO). The CLO shall monitor the implementation of the Project's stakeholder engagement program and report findings to the REA Project Management Unit.

9.5.3 Grievance Redress Mechanism (GRM)

A grievance redress mechanism (GRM) has been developed by REA which is applicable to all components of the NEP; including the EEP Projects (Available in Appendix 9.3). The NEP GRM was developed to provide project affected persons (including interest groups) directly affected by its development activities with access to mechanisms for them to present their grievances and find solutions through avenues that are legitimate, reliable, transparent, cost-effective and easily accessible at the lowest level, without allowing them to escalate into unmanageable levels. This access will be all inclusive with consideration for people living with disabilities and vulnerable groups.

With respect to the EEP component of the NEP, the GRM has identified potentials for grievance associated with the proposed project. The GRM also outlines the following:

- Identification of core institutional blocks for the EEP;
- Provision of grievance uptake points, including a description of communication channels, actions, and timeframe;
- Composition of the Project Management Unit (PMU) Grievance redress committee, with details about their activities;
- Composition of the community based Grievance redress committee; and
- GRM structure to be implemented for the EEP Projects.

CHAPTER TEN:

CONCLUSION AND RECOMMENDATIONS

CHAPTER TEN

CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

The ESIA of the proposed 2.5 MW solar power plant and associated infrastructure in the NDA, under the EEP, has been conducted in accordance with the relevant requirements of the FMEnv guidelines and the applicable World Bank Safeguard Policies, specifically the Operational Policy 4.01 and Involuntary Resettlement Policy 4.12 triggered by the proposed Project.

The ESIA study consists of a number of key steps including: desktop review, scoping, consultations with relevant stakeholders including relevant government authorities and potentially affected community in the Project's area of influence, field data gathering, laboratory analysis of field samples, potential impact identification and evaluation, development of mitigation measures and environmental management plan, report writing and disclosure.

The essence of the ESIA process is aimed at ensuring informed decision-making and environmental accountability, and to assist in achieving environmentally sound operation and social acceptance throughout the life cycle of the proposed Project.

Consistent with the regulatory standards, the assessment of the environmental status and the socio-economic aspects of the proposed Project's area of influence have been carefully carried out using accepted scientific methodology. Evaluation of associated and potential impacts of the proposed Project identified both positive and negative interactions with the receiving biophysical and socio-economic environment.

The positive impacts associated with the Project include:

- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Reduction in fossil fuel consumption by the University thereby leading to reduction in carbon emissions and improvement in eco-balance.
- Significant reduction in the cost of power generation by the University through diesel-fuelled generators. Such savings would be used for other undertakings that will benefit the University.
- Increase in social interactions within the University. There will be enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.

- Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the Project.
- Improvement in livelihood enhancing activities within the University.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects.
- Increase in local and regional economy through award of contracts and purchase of supplies for Project development.
- Increase in financial and technical collaborations between the FGN, the University, REA, World Bank and other relevant Ministries, Departments and Agencies (MDAs).
- Contribution to the Nigeria's NDC to cut carbon emission by 20 % to 30 % by the year 2030, under the Paris Agreement.

The identified negative impacts of the proposed Project were mostly of minor to moderate significance, and they are largely site-specific and localized. The preferred site for the proposed Project within the University campus does not trigger any physical and economic displacement. In addition, there are no cultural resources within and around the Project site that would be affected during the Project development and operation. The identified potential negative impacts include:

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

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

effectiveness of the recommended mitigation measures and ensure long-term monitoring of the Project.

9.2 Recommendations

The ESIA study recommends the following:

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

REFERENCES

1. Alloway, B. J. (1990). *Heavy Metals in Soils*. Springer, Netherlands. 368 pp.
2. Azura (2012). Environmental Impact Assessment of the Proposed Azura-Edo Independent Power Project, 2012. 381 pp.
3. Adelana, S. M. A., Olasehinde, P. I., Bale, R. B., Vrbka, P., Edet, A. E., Goni, I. B. (2008). An Overview of geology and hydrogeology of Nigera. In Applied groundwater studies in Africa. IAH Selected papers on Hydrogeology. 13: 171-198.
4. Babalola, S. J., & Akor, M. (2013). An empirical analysis of labour force participation of married women in Adamawa State, Nigeria. Journal of Emerging Trend in Economics and Management Sciences, 4(1), 1-7.
5. Beeson, S. and Jones, C. R. J. (1988). The Combined EMT/VES Geophysical Method for Sitting Boreholes. *Groundwater***26** (1): 54-63.
6. Bhatia, S. C. (2014). Energy resources and their utilization. Advanced Renewable Energy Systems. Pages 1-31
7. Bloomfield, S., Poweri, C. R. and Cotterell, M. (2016). *Batteries and Solar Power: Guidance for domestic and small commercial consumers*. BRE, Garston. 12 pp.
8. Chang, G. J. and Jennings, C. (1994). Magnetic Field Survey at PG&E Photovoltaic Sites. PG&E R&D Report 007.5-94.6.
9. Dee, N., J. Baker, N. Drobny, K. Duke, and D. Fahringer. (1972). Environmental evaluation system for water resource planning (to Bureau of Reclamation, U.S. Department of Interior). Battelle Columbus Laboratory, Columbus, Ohio, January, 188 pages.
10. Doss, C., Deere, C.D. Abena, D. O. and Suchira J.Y. 2012 The Rural Gender Asset and Wealth Gaps. Evidence from Ghana, Ecuador, Uganda and Karnataka, India. Indian Institute of Management, Bangalore, India.
11. Energy Consumption Survey and Power Demand Forecast for the Nigeria Defense Academy, Kaduna State (2018). Prepared for Rural Electrification Agency, 2019
12. Environmental and Social Management Framework (ESMF) for Nigeria Electrification Project (NEP). Prepared for Rural Electrification Agency in March, 2018. (http://rea.gov.ng/NEP_ESMF_WB%20_April_8_2019_revised.pdf)
13. Espinosa, D. C. R. and Tenorio, J. A. S. (2006). Recycling of nickel–cadmium batteries-Thermogravimetric behavior of electrodes. *Journal of Power Sources* **160**(1): 744-751.
14. Federal Ministry of Environment (1999): National Guidelines and Standards for Water Quality in Nigeria.
15. Federal Ministry of Environment (FMEnv) (1999). *Green Book: Guidelines and Standards for Environmental Pollution Control in Nigeria*. FMEnv. 298 pp.

16. Gayawan, Ezra; Adebayo, Samson B. (2015) : Spatial analysis of women employment status in Nigeria, CBN Journal of Applied Statistics, ISSN 2476-8472, The Central Bank of Nigeria, Abuja, Vol. 6, Iss. 2, pp. 1-17
17. Geophysical Service Incorporated (GSI) (2003). *St Lawrence Survey. Environmental Assessment Report*. Prepared by Canning & Pitt Associates Inc. and assisted by Robert Hamelin & Associates. 198 pp.
18. Harter, T. (2003). Groundwater Quality and Groundwater Pollution. FWQP Reference Sheet 11:2.
19. International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines (2010): For Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300GHz). *Health Physics* **74** (4): 494-522.
20. International Energy Agency (IEA) (2014). *Technology Roadmap. Solar Thermal Electricity*. IEA. 52 pp.
21. International Finance Corporation (IFC) (2012). *International Finance Corporation Performance Standards*. World Bank Group. 196 pp.
22. International Finance Corporation (IFC) (2007). *Stakeholder Engagement*. A Good Practice Handbook for Companies Doing Business in Emerging Markets. World Bank Group. 201 pp.
23. IUCN (2016). IUCN Red List of Threatened Species. Retrieved from: www.iucnredlist.org.
24. Leopold, L. B., Clarke, F. E., Hanshaw, B. B. and Balsley, J. E. (1971). *A procedure for evaluating environmental impact. U.S*. Geological Survey Circular 645, Washington, D.C. 91 pp.
25. Liang, Y., Su, J., Xi, B., Yu, Y., Ji, D., Sun, Y., Cui, C. and Zhu, J. (2017). Life cycle assessment of lithium-ion batteries for greenhouse gas emissions. *Resources, Conservation and Recycling* **117:**285-293.
26. National Guidelines and Standards for Water Quality in Nigeria (1999).
27. National Population Commission (2010). 2006 Population and Housing Census Distribution by Sex, State, Local Government and Senatorial District. Priority Table, Volume III
28. Nigeria Bureau of Statistics, (2016). Annual Abstract of Statistics. Volume 1
29. Nigeria Bureau of Statistics, (2018). Demographic Statistics Bulletin.
30. Nigerian Bureau of Statistics (NBS) (2016). Data Sheet.
31. Nigerian Electricity Regulatory Commission (NERC) (2014). Solar Irradiation in Nigeria States.
32. Nigerian Meteorological Agency (NIMET) (2018). Data for Kaduna State, 2017.
33. Nigerian Population Commission (NPC) (2010). *NPC Priority Table Vol. IX – Size of Household*. NPC.
34. National Population Commission (NPC) [Nigeria] and ICF. 2019. *Nigeria Demographic and Health Survey 2018*. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF.

35. Odiegwu, P. (2009, October 27). 6.000MW: Can Yar'Adua Achieve December electricity deadline? Nigeria Tribune, p. 25.
36. Oyawoye, M. O. (1972). The basement complex of Nigeria. In Dessauvagie, F. and Whiteman, J. *Africa Geology*. University Press Ibadan, Nigeria. Pp: 18-27.
37. Paul Nwakpa. (2015). Research in Tertiary Institutions in Nigeria: Issues, Challenges And Prospects: Implication for Educational Managers. IOSR Journal Of Humanities And Social Science (IOSR-JHSS). Volume 20, Issue 6, Ver. I (Jun. 2015), PP 45-49
38. REA 2017 Presentation. *Upscaling minigrids for least cost and timely access to electricity.* Energizing Economies Programme Review. Rural Electrification Agency. December 4th – 8th, 2017.
39. REA, 2017. *Baseline Survey and Energy Audit Report*. Rural Electrification Agency. October 2017. Version 1.0
40. Rural Electrification Strategy and Implementation Plan (RESP), 2016
41. Sambo, A. S. (2008). *Matching Electricity Supply with Demand in Nigeria*. National Workshop on the Participation of State Governments in the Power Sector: Matching Supply with Demand. Abuja, Nigeria.
42. Shukla, A. K. and Hariprakash, B. (2009). Secondary batteries – nickel systems. Electrodes: Cadmium. *Chemistry, Molecular Sciences and Chemical Engineering*412-417.
43. Smyth E, Vanclay F. (2017). The social framework for projects: a conceptual but practical model to assist in assessing, planning and managing the social impacts of big projects. Impact Assessment& Project Appraisal. 35:65–80
44. Solar Resource Data: Solargis. © 2017 The World Bank
45. Sun, Z., Cao, H., Zhang, X., Lin, X., Zheng, W., Cao, G., Sun, Y. and Zhang, Y. (2017). Spent lead-acid battery recycling in China – A review and sustainable analyses on mass flow of lead. *Waste Management* **64:** 190-201.
46. The World Bank Group EHS Guidelines for Electric Power Transmission and Distribution (2007).
47. United Nations Development Program (UNDP) (2006). Human Development Report 2006. UNDP. 440 pp.
48. United Nations Environment Programme (UNEP) (2002). *EIA Training Resource Manual. Mitigation and Impact Management (2nd edition)*. UNEP. 56 pp.
49. United States Environmental Protection Agency (USEPA) (2000). *Meteorological monitoring guidance for regulatory modelling applications*. Office of Air Quality Planning and Standards, Research Triangle Park, USA. EPA 454/R-99-005.
50. Whitehead, A. H., Rabbow, T. J., Trampert, M. and Pokorny, P. (2017). Critical safety features of the vanadium redox flow battery. *Journal of Power Souces* **351** (31): 1-7.

51. World Bank Group (2007). *Environmental, Health, and Safety General Guidelines*. World Bank Group. 99 pp.
52. World Bank Safeguard Policies. Operational Manual (OP) 4.01 – Environmental Assessment. Revised in April 2013.
53. World Health Organization (2016). World Malaria Report. ISBN 978-92-4-151171-1
https://apps.who.int/iris/bitstream/handle/10665/252038/9789241511711-eng.pdf;jsessionid=2BF3F3AC29F8FA5D33C7FBF5AD04FFFC?sequence=1
54. World Health Organization (WHO) (2000). *World Health Organization, Potable Water Quality Guidelines.* WHO. 71 pp.
55. World Health Organization (WHO) (2007), *World Health Organization Research Agenda for Extremely Low Frequency Fields.* WHO. 8 pp.
56. Zhang, J., Chen, C., Zhang, X. and Liu, S. (2016). Study on the Environmental Risk Assessment of Lead-Acid Batteries. *Procedia Environmental Sciences* **31:**873-879.

APPENDICES

APPENDIX 4.1

Socio-Economic Data Gathering tools

Key Informant interview guide with Mando Community leader

Key Informant Interview Guide for Community Leader

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring highly quality data.

Consent form.

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Proposed Power Plant in this community. The study is important in order to have baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Respondent's Name: Alhaji Sanni Musa

Position in Community Sheriff of Mando community

Questions:

1. Can you provide a summary of the history of this community? — Fulani & Gwari & Hausa tribe.
2. How did you emerge as a leader and how long have you been in this position as a community leader?
3. Can individual own and sell land in the community?
4. What are the roles assigned to women within your community? Adash
5. How do you handle cases of ender based violence against women in your community?
6. Is there any land issues currently ongoing in the community?
7. Are there schools, hospitals, electricity, telecommunication, public and markets in the community?
8. What is the established mechanism for conflict resolution in the community?
9. What are the notable vices common about the youths of the community?

Focus Group discussion guide and attendance with men of Mando community

Focus Group Discussion Guide for Community Members
Group: Men within the host community

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring that we have a reliable gender disaggregated data suitable for analysing gender based issues in the community.

Consent form.

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Proposed Power Plant in this community. The study is important in order to have baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Socio-Demographic Characteristics of Respondents

Name of Community: Mando Community
Name of Moderator: Abiola Bolarinwa
Date of Interview: 16-05-2019

S/N	Name	Sex	Ethnic Origin	Religion	Educational level	Marital status
1	AREMU BADEJO JOEL	M	YORUBA	CHRISTIAN	B.TECH	SINGLE
2	Abdullahi Abubakar	M	Fulani	muslim	ND	Married
3	Suleiman Ahmed	M	Hausa	muslim	HND	married
4	Zakari Jamilu Muh'd	M	Hausa	Muslim	BSc.	Married
5	Usman Adamu	M	Hausa	Muslim	N.C.E.	Single
6	HUSSAINI MUSA	M	HAUSA	ISLAM	DIPLOMA	MARRIED
7	Mathew Adaralegbe	M	Yoruba	Christian	Secondary	Married
8	IBRAHIM MADAKI	M	HAUSA	ISLAM	PRI CERT.	MARRIED
9	Alhassan Musa	M	Hausa	Islam	ND	MARRIED
10	BAMIYI UCHARI	M.	KAGAGI	CHRISTIAN	PRIMARY	MARRIED
11.	ABUBAKAR JATAIYA	M	HAUSA	ISLAM	ARABIC	MARRIED
12.	HASHIMU ABDULLAHI	M.	HAUSA	ISLAM	ARABIC	MARRIED
13.	ABUBAKAR SHEHU	M.	HAUSA	ISLAM	ARABIC	MARRIED

Focus Group discussion guide and attendance with women of Mando community

Focus Group Discussion Guide for Community Members

(Women[redacted])

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring that we have a reliable gender disaggregated data suitable for analysing gender based issues in the community.

Consent form.

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Power Plant in this community. The study is important in order to have a baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Socio-Demographic Characteristics of Respondents

Name of Community:____________________
Name of Moderator:____________________
Date of Interview:____________________

S/N	Name	Sex	Ethnic Origin	Religion	Educational level	Marital status	Marital Age
1	HUSSAINA S GOJE	F	Fulani	muslim	NCE	Single	20yrs
2	Hauwa HASSAN	F	Hausa	muslim	N.D	married	25
3	Ladi Yakubu	F	Gbagyi	Christian	Pry.	✓	52
4	Regina Boniface	F	Lunguda	✓	✓	✓	55
5	Deborah Yohanna	F	Gbagyi	Christian	ND	Single	25yrs
6	Aisha Ibrahim	F	Hausa	muslim	Secondry	mr	25
7	Fatima Musa	F	Hausa	✓	Secondry	S	21
8	Ismail Khadija	F	Ebira	muslim	secondry	Single	17
9	Zuwaira Jibil	F	Hausa	muslim	Secondry	✓	26
10	Fatima Sanusa	F	Hausa	✓	Sd	SL	18
	Lamrat Sanusi	F	Hausa	✓	Sd	SL	18

Focus Group discussion guide and attendance with youth of Mando community

Focus Group Discussion Guide for Community Youths

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring that we have a reliable data.

Consent

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Proposed Power Plant in this community. The study is important in order to have baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Socio-Demographic Characteristics of Respondents

Name of Community: Mando/Afaka
Name of Moderator: Abiola Bolarinwa
Date of Interview:

S/N	Name	Sex	Ethnic Origin	Religion	Educational level	Marital status
	Kingsley	M	Igbo	Muslim		
	MUSA	M	Hausa	muslim		
	AMIR	M	Hausa	muslim		
	ALIYU	M	Fulani	"		
	ABDullahi	M	Hausa	"		
	Tasi'u	M	Hausa	"		
	Musa Yamma	M	Hausa	"		
	Musa	M	Hausa	"		
	Hassan	M	Hausa	"		
	ABDullahi Ma	M	Hausa	"		

KII with a Medical Health practitioner at Mando community

environmental accord

Key Informant Interview Guide for Community Health Care Practitioner

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring highly quality data.

Consent form.

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Proposed Power Plant in this community. The study is important in order to have baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Respondent's Name: SA'ADATU IBRAHIM

Position in Community EARTH CARE PRACTITIONAL

Questions:

1. How many health care facilities are available within the community?
2. What is the health status of this community? *Mortality and morbidity information.*
3. What is the ratio of health care workers per patient in this community?
4. What are the common diseases in the community and causes?
5. Are there facilities available for reporting and handling cases of gender based violence in this healthcare centre?
6. What are the local factors affecting community members' health?
7. Are there special health facilities for pregnant women and nursing mothers in the community?
8. Are there other unorthodox/traditional health care facilities available in the community?
9. What are your suggestions for harmonious relationship between EEP Power Plant Project and the community's healthcare personnel?

APPENDIX 9.1

A sample Stakeholder Engagement register

Sample Stakeholder Engagement Register

Stakeholder category (choose from the list)	Individual or group (choose from list)	Stakeholder name	Organization	Position in their organization /	Location	Contact address	Contact phone	Contact email	Stakeholder interest	Stakeholder priority	Engagement objectives	Method of engagement	Date of engagement	Issues raise	Follow-up action

APPENDIX 9.2

Stakeholder Engagement Documents

Stakeholder engagement letter to Kaduna State Ministry of Environment and Natural Resources

environmental accord
...superior sustainability solutions

July 25, 2019

OFFICE OF THE COMMISSIONER
RECEIVED
05 AUG 2019
Sign.....
Min. of Environment & Nat. Res., Kaduna

The Commissioner,
Ministry of Environment and Natural Resources,
State Secretariat Complex,
Independence Way,
Kaduna, Nigeria.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT, KADUNA: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the Nigerian Defence Academy (NDA) Solar Power Project, Afaka, Kaduna State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 6, 2019

Time: 9 a.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Attendance of meeting with Kaduna State Ministry of Environment and Natural Resources

ENVIRONMENTAL ACCORD NIGERIA LIMITED
36B, Oguntona Crescent, Gbagada (Phase 1), Lagos
0802-360-9591; 0813-636-3762
info@envaccord.com
http://www.envaccord.com

ATTENDANCE SHEET

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PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

DATE: 06 – AUG, 2019
VENUE: KADUNA STATE MIN. OF ENVIRONMENT AND NATURAL RESOURCES

S/N	Name	Designation	Organization	Phone Number	Email	Signature
01	Yusuf Muazu Usman	DE	MENR KD	08033968632	affumahmuy@gmail.com	[signature]
02	Francis Y Ganga	DDE	—	07082905210	Francisyganga@gmail.com	[signature]
03	Esther Yusuf	PEHS 1	MENR	08069313319	efasumalerke@gmail	[signature]
04	Sambe J. Musa	CEHO	MENR	08035991282	jmsambe4real@gmail.com	[signature]
05	Maureen Oyedoja	ADE	MENR	08033804878	sameldq1975@gmail.com	[signature]
06	Jibril Harums	PEHS 1	MENR	08099651155	ikhlascall@gmail.com	[signature]
07	Albright Olaitan	EnvAccord	Environmental Scientist	08075331833	aolaitan@envaccord.com	[signature]
08	Omotosho Rhoda	EnvAccord	Gender Specialist	08154728110	Temitdawatofunmi@gmail.com	[signature]
09	Abiola Bolarinwa	EnvAccord	Social Expert	08144155291	abolarinwa@envaccord.com	[signature]
10	Rose Stephen	SEHE	MENR	08172487773	—	[signature]

Stakeholder consultation letter to Kaduna State Environmental Protection Authority (KEPA)

environmental accord
...superior sustainability solutions

July 25, 2019

RECEIVED AT
KADUNA STATE ENVIRONMENTAL PROTECTION AUTHORITY (KEPA)
OFFICE OF THE GENERAL MANAGER
Sign ..... Date 5-8-2019

The General Manager,
Kaduna State Environmental Protection Authority,
L 10, Link Road, Ungwan Television,
Kaduna South,
Kaduna State.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT, KADUNA: STAKEHOLDER CONSULTATION MEETING

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An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 6, 2019

Time: 2 p.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Attendance of meeting with KEPA

ENVIRONMENTAL ACCORD NIGERIA LIMITED
36B, Oguntona Crescent, Gbagada (Phase 1), Lagos
0802-360-9591; 0813-636-3762
info@envaccord.com
http://www.envaccord.com

ATTENDANCE SHEET

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PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

DATE: 06-08-2019

VENUE: KADUNA ENVIRONMENTAL PROTECTION ~~AUTHORITY~~ AUTHORITY

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1.	Halima Abubakar	ADE	KEPA	08035059977	Halimahafis73@ [illegible]	[signature]
2.	Maryuma A. Yakubu	SSO	KEPA	08065653558	mazeeyak@gmail.com	[signature]
3.	Omotosho Aruda	Gender Specialist.	Env. Accord	[illegible]	Temilolu[illegible]1998 @gmail.com	[signature]
4.	Abiola Bolarinwa	Social Expert	Env Accord	08164155291	abolarinwa@ envaccord.com	[signature]
5	Albright Olaitan	Environmental Scientist	EnvAccord	08075331833	aolaitan@ envaccord.com	[signature]

Stakeholder Consultation letter to Kaduna State Ministry of Women Affairs

July 25, 2019

The Commissioner,
Ministry of Women Affairs,
State Secretariat Complex,
Independence Way,
Kaduna, Nigeria.

HON. COMMISSIONER
RECEIVED
05 AUG 2019
SIGN
MIN. OF WOMEN AFFAIRS & SOC. DEV. K.D.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT, KADUNA STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the Nigerian Defence Academy (NDA) Solar Power Project, Afaka, Kaduna State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 6, 2019

Time: 11 a.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Attendance for meeting with Kaduna State Ministry of Youth and Sports Development

July 25, 2019

The Commissioner,
Ministry of Youth and Sport Development,
State Secretariat Complex,
Independence Way,
Kaduna, Nigeria.

MINISTRY OF YOUTH AND CULTURE. KA
RECEIV
SIGN
DATE 05-08-2019

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT, KADUNA STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the Nigerian Defence Academy (NDA) Solar Power Project, Afaka, Kaduna State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 6, 2019

Time: 12 p.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Stakeholder consultation letter to Igabi Local Government

July 25, 2019

RECEIVED
5/08/2019
CHAIRMAN'S OFFICE
Igabi Local Government
SIGN

The Honourable Chairman,
Igabi Local Government,
Igabi local government secretariat,
Kaduna State,

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT, KADUNA: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the Nigerian Defence Academy (NDA) Solar Power Project, Afaka, Kaduna State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 5, 2019

Time: 2 p.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Stakeholder Consultation Letter to Empowering Women for Excellence Initiative (EWEI)

July 25, 2019

The Director,
Empowering Women For Excellence Initiative,
23A, Dan Buran Road,
Off Yahaya Road, Malali, G.R.A.,
Kaduna State.

Received by Grace Aftan
6/8/2019

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT, KADUNA: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the Nigerian Defence Academy (NDA) Solar Power Pr..ject, Afaka, Kaduna State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 6, 2019

Time: 1 p.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Attendance of meeting with EWEI

ENVIRONMENTAL ACCORD NIGERIA LIMITED
36B, Oguntona Crescent, Gbagada (Phase 1), Lagos
0802-360-9591; 0813-636-3762
info@envaccord.com
http://www.envaccord.com

ATTENDANCE SHEET

environmental accord ...superior sustainability solutions

PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

DATE: 06- AUG 2019
VENUE: EMPOWERING WOMEN FOR EXCELLENCE INITIATIVE, KADUNA

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1	Grace Attah	Programme Officer	EWEI	08137585932	graceattah@eweing.org	
2	Egbe Brown Uche	" "	"	08176146953	Uchebrown@eweing.org	
3.	Mendie N. Jeremiah	Gender Officer	EWEI	08062557288	mendiejeremiah@eweing.org	
4.	Atese Avadu	Programme Officer	"	08100127125	elizabethavadu@eweing.org	
5.	Onotosho Phede	Founder's Staff ~~Env accord~~	Env accord	08109438110	Temiloluwatofunmi1998@gmail.com	
6.	Abiola Bolarinwa	Social Expert	EnvAccord	08164155291	abolarinwa@envaccord.com	
7	Albright Olaitan	Environmental Scientist	EnvAccord	08075331833	aolaitan@envaccord.com	

Attendance of meeting with Nigerian Defence Academy Management

info@envaccord.com
http://www.envaccord.com

ATTENDANCE SHEET

STAKEHOLDERS

environmental accord

PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

DATE: 05-08-2019

VENUE: NIGERIAN DEFENCE ACADEMY, KADUNA

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1.	LT COL BY ABBAS		NDA	08035372622	byabbas@yahoo.com	
2	OTOLOWO ADEBAYO		NDA	08033176829	otolowoadebayo@gmail.com	
3	Albright Olaitan	Environmental Scientist	EnvAccord	08075331833	aolaitan@envaccord.com	
4	Onolosho Aluko	Gender based specialist	Env Accord	[illegible]	Temiloluwatofunmi1998@gmail.com	
5.	Abiola Bolarinwa	Social Expert	EnvAccord	08164155291	abolarinwa@envaccord.com	

Background Information Document Sent to Stakeholders

REA

RURAL ELECTRIFICATION AGENCY

BACKGROUND INFORMATION DOCUMENT (BID)

FOR

NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT IN KADUNA STATE

JULY, 2019

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT

A1.1 Introduction

Energizing Education Programme (EEP) is an initiative of the Federal Government of Nigeria (FGN), to provide sustainable and clean power supply to 37 Federal Universities and 7 University Teaching Hospitals across the country. The EEP project includes the provision of an independent power plant, upgrading existing distribution infrastructure, street lighting to improve security within the universities' campuses, as well as the development of a world class training centre on renewable energy for each university. Nigerian Defence Academy (NDA) in Kaduna State is one of the beneficiaries of the programme.

The project is being implemented by the Rural Electrification Agency (REA) and developed in Phases. The Phase 2 Projects involves the deployment of solar technology for generation of power supply to meet the current demands and future needs in some selected tertiary institutions and teaching hospitals across Nigeria.

REA proposes the installation of a 3.0MW Solar Power Plant within NDA for the generation and distribution of power to the institution. The aim of this document is to provide background information about the solar power project and to receive comments on any issues you may have, as one of the identified key stakeholders.

A1.2 Project Location

NDA is located within Igabi Local Government Area and occupies approximately 1,217.61 hectares along Kaduna Airport road, Afaka, Kaduna State. The land allocated for the Project within the university (GPS – Lat. 7.37333°N and Long. 10.60281°E) covers approximately 51.1 hectares is sited along the main road leading to NDA second gate (Figure 1). The proposed project site is a Greenfield area characterized by sparsely distributed trees, shrubs, grasses, and crops planted by families of the military personnel living within the institution (Plate 1). The site is bounded to the south by a small stream which also serves as a boundary of the land allocated for the project.

Figure 1: Satellite imagery of the proposed site within NDA.

Plate 1: Aerial picture of the proposed site within NDA

A1.3 Overview of the Project

The NDA Solar power project will involve the installation and operation of Solar panels and additional equipment to generate power for the university. Solar panels will be installed on the site using piling foundations and the power generated will be transmitted via underground cables to the existing power house (also the switch yard) located about 15m across the road leading to the site. No new transmission route is planned for the Project.

The power house will also serve as the holding area for the batteries and inverters to be installed for the Project. Power distribution within the institution will be via the existing power infrastructure (overhead cables). The project will serve all the buildings within the institution including all streetlights. Furthermore, a training and development centre for renewable energy will be constructed on the allocated land area for the proposed Project.

Upon completion of the project, NDA will be disconnected from the national grid and additional backup generators may be installed for the Project.

A1.4 Project Justification

Access to uninterrupted power supply in federal universities in Nigeria is a major challenge and barrier to effective research, student learning and institutional operations. Constant supply of electricity is of strategic importance in the conduct of research. In Nigeria, it has been extremely difficult to meet international research standards due to epileptic power supply in our tertiary institutions, which is a reflection of the generally poor supply of electricity in the country.

In view of this, the Federal Government of Nigeria through REA set up the Energizing Education Programme (EEP) for Federal Universities. Tertiary institutions that will benefit from this programme will be able to generate the power needed for all their operations. The EEP, is also a key programme to be implemented towards achieving a part of the Power Sector Recovery Programme (PSRP) objectives and provides a measure in ensuring that Nigeria achieves its carbon emission targets (to cut back on its carbon emission by 20 % on its own and 27 % with assistance from the climate change fund, in the next 15 years) as contained in its Nationally Determined Contributions (NDC), under the Paris Agreement.

The solar power project at NDA will ensure the provision of clean, affordable and uninterrupted power supply which would boost research, learning, and academic activities within the institution and also contribute to improving the safety and quality of the environment.

A1.5 Project Activities

The project activities can be divided into pre-construction and construction, operation and decommissioning phase.

Pre-Construction Phase Activities:

- Mobilization of personnel and materials to site;
- Site clearing and land preparation.

Construction/Installation Phase Activities:

- Erection of piling foundations;
- Solar PV panels and ancillary component installation;
- Upgrading of existing power distribution infrastructure;
- Installation of additional streetlights;
- Construction of training and development center.

Operation Phase Activities:

- Testing and commissioning;
- Power generation and distribution;
- Equipment maintenance;
- Utilities consumption.

Decommissioning Phase Activities:

- Dismantling of equipment and associated facilities;
- Scrapping and dismantling of equipment;
- Restoration of site to pre-existing conditions.

A1.6 Preliminary Impacts and Mitigation Measures

<u>Preliminary Potential Impacts</u>

Potential and associated impacts of the project preliminary identified at this stage include the following:

Air Quality

- Vehicular emissions during mobilization of personnel and equipment to the site. (impact would be localized).

Noise Emissions

- Noise emissions during the site clearing, panel installation, and fixture of other ancillary components (impact is site-specific).

Surface water and Groundwater Quality

- Potential contamination of surface water and groundwater during operations

as a result of washing the solar panels (the impact is site specific and negligible).

Flora and Fauna

- Site clearing may lead to loss of fauna due to destruction of habitats;
- Clearing of the land in preparation of erecting piling foundations may lead to loss natural vegetation and destruction of habitats.

Waste Generation

- Wastes from the installation activities may arise from a range of sources including the following: packaging materials; wastes from workers, equipment, and materials (impact would be localized);
- General and hazardous wastes (spent batteries, damaged/discarded solar panels) produced as a result of the operational processes (impact is site-specific).

Transport and Access

- Increased road traffic during installation of the project (impact is localized).

Occupational Health and Safety

- Potential impacts to workers during installation and operation phases include;
  - Safety and fire hazards;
  - Electric shock during electrical works.

Community Health and Safety

- Increase in risk factors associated with communicable diseases;

Peoples Way of Life and Business

- Loss of farmlands;
- Training and employment opportunities;
- Stimulation of educational activities thereby promoting research and development;
- Acquisition of new skill due to technology transfer.

Mitigation Measures

In the light of the preliminary potential impacts identified, appropriate mitigation measures has been incorporated in the Project design and additional mitigation measures will be recommended in the ESIA report which will be put in place throughout the life cycle of the Project to minimize its environmental footprint.

"We would like to meet with you to discuss any opinions and concerns you may have about any of these potential impacts".

NIGERIAN DEFENCE ACADEMY SOLAR POWER PROJECT: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

We would like you to take part in this ESIA process so you can raise any issues and comments you may have about the Solar Power Project. Your comments are a key part of the study to see whether the Project should proceed and it is important that REA understands your comments so that they can be answered and dealt with in the ESIA.

To receive regular information throughout the ESIA process, you must register as an Interested and Affected Party. To register please send this form to Rural Electrification Agency (through its consultant, EnvAccord) at the address given below. If you want to make any comments at this stage please use this form. Alternatively, please do not hesitate to send an email or write separately to the e-mail address provided below.

You can make additional comments for the study team to record on a separate page or on the reverse side of this form. Please post this comment sheet to the address below as soon as possible and preferably on or before August 30, 2019 so that we can take your comments into consideration in the ESIA. The comments could also be emailed to the address below.

Please fill in your details:	
Name:	Organization:
Telephone:	Position:
Cell phone:	Email:
Address:	

Please post or fax this form to the address below:

Environmental Accord Nigeria Limited
Attention: Albright Olaitan
Tel: +234 807-533-1833, +234-813-636-3762
Email: aolaitan@envaccord.com
Address: Environmental Accord Nigeria Limited
36B, Oguntona Crescent, Gbagada (Phase 1),
Lagos, Nigeria

Comments Form

It would be useful if you could answer the questions below but please feel free to provide any comments you would like to raise. Please continue on additional paper if required.

1. What are the primary comments that you have about this Project?

2. Do you have or know of any information that we should know for the ESIA (e.g. environmental information or community, social or economic information related to the Project location and/or the Project activities)?

Many thanks for your participation

APPENDIX 9.3

Grievance Redress Mechanism (GRM) for the Nigeria Electrification Project (NEP)